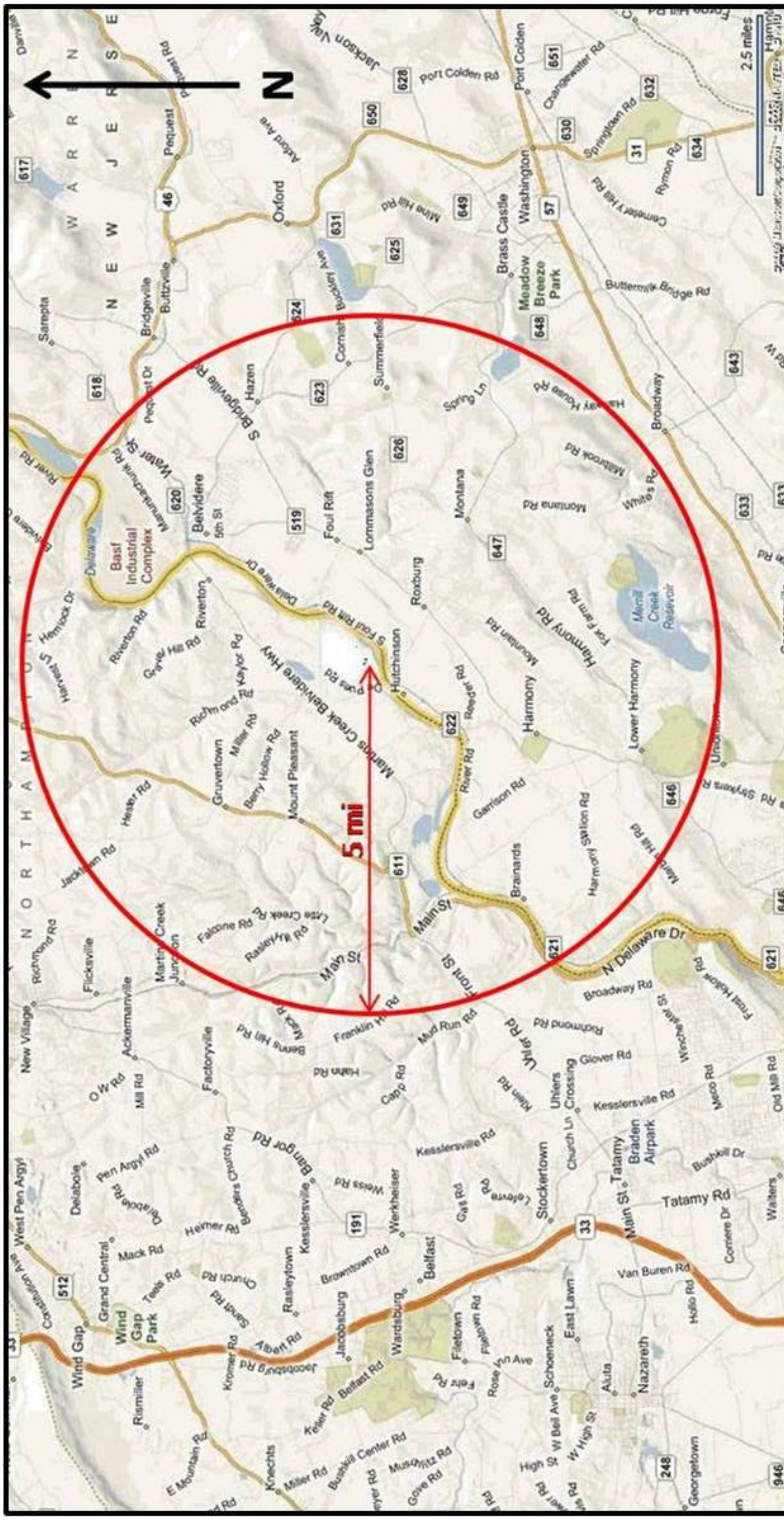
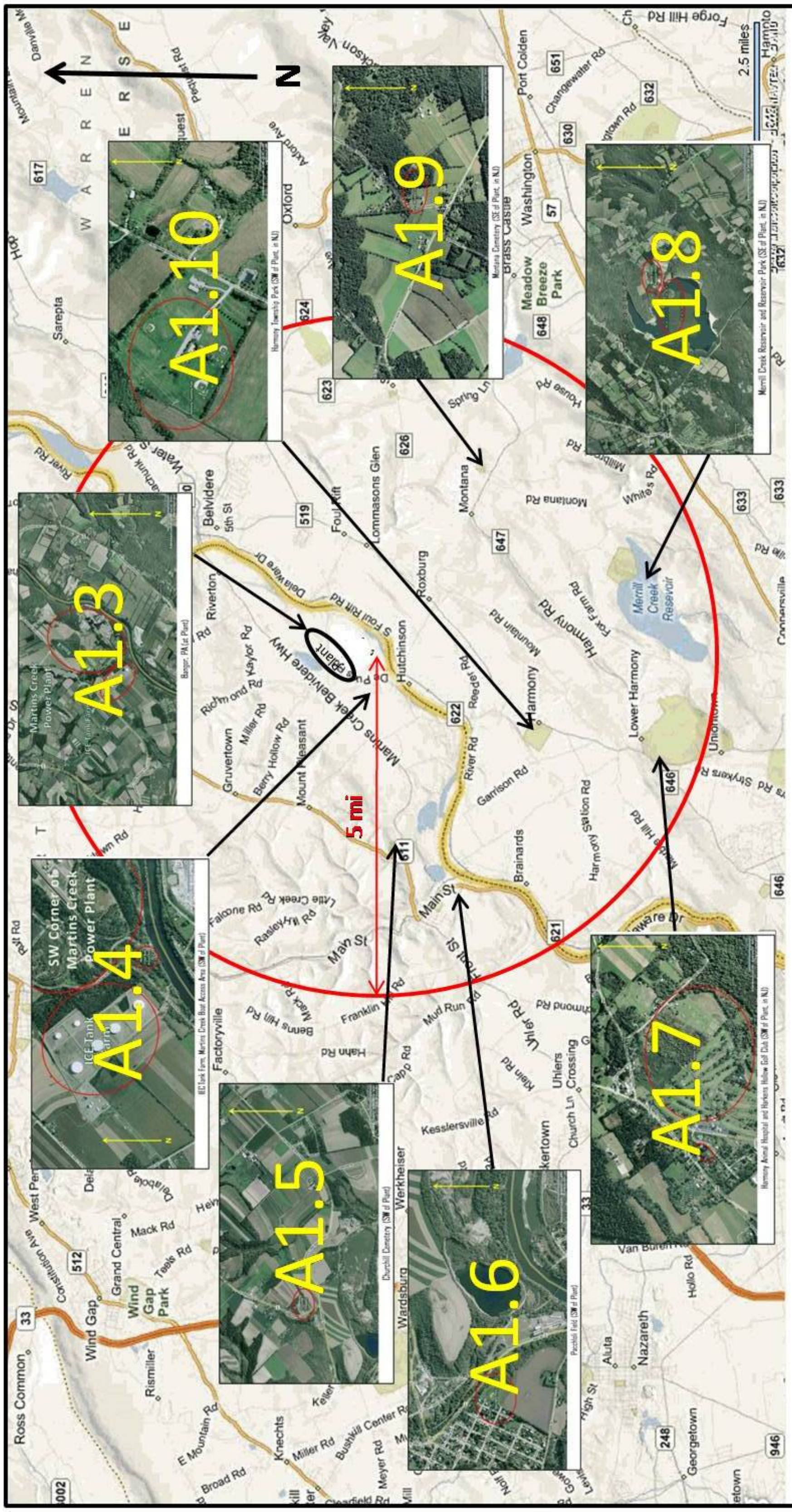
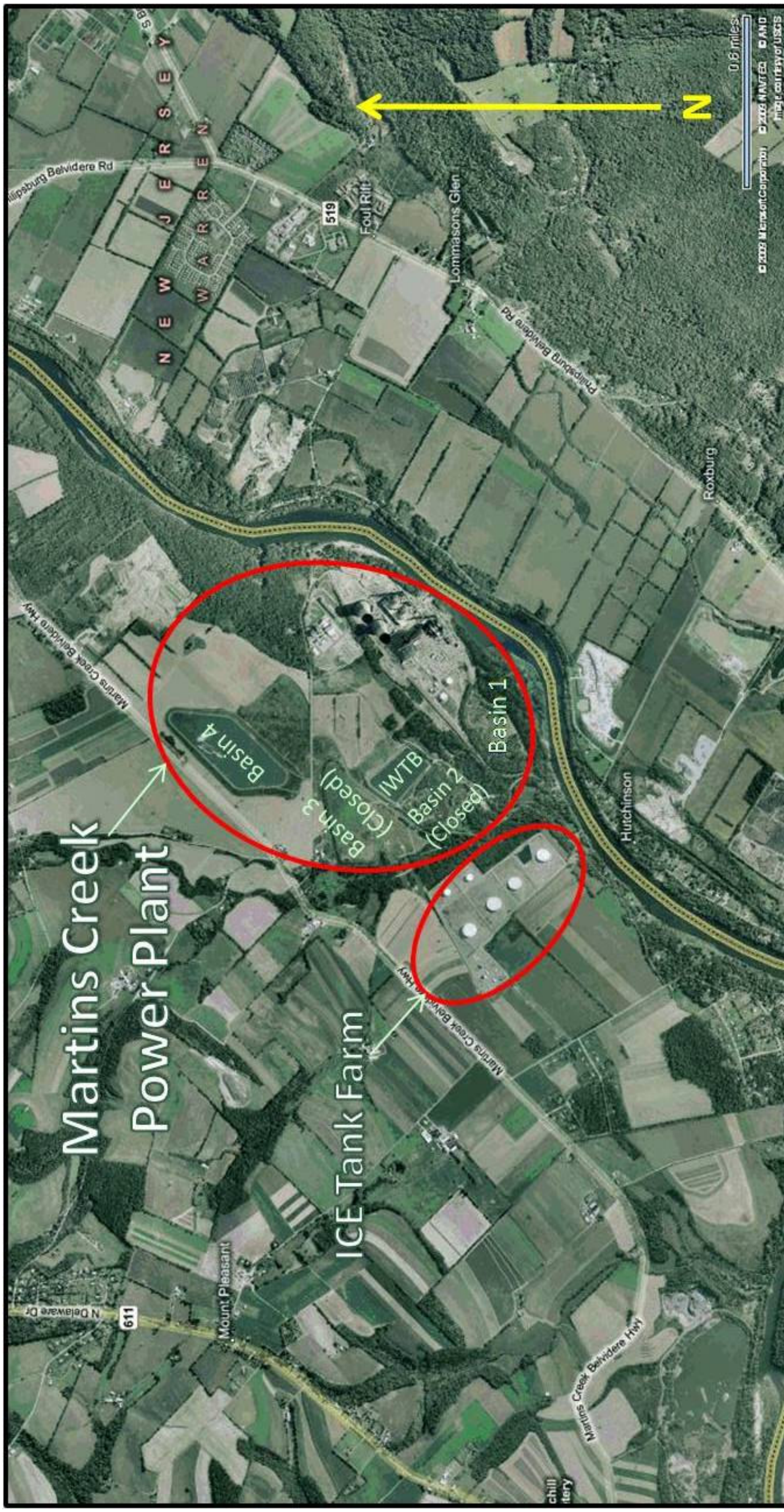


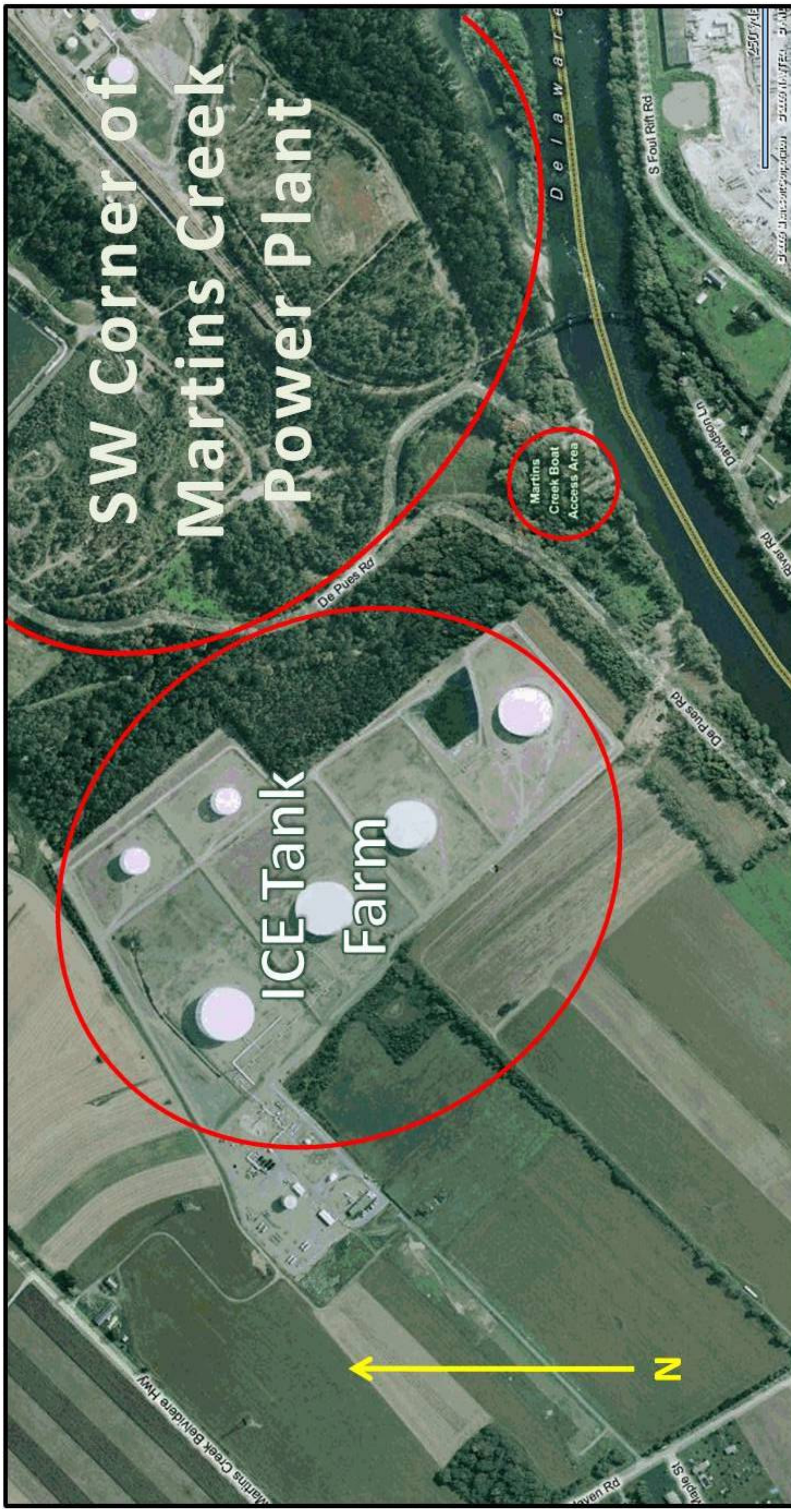
Martins Creek Power Plant 5 Mile Radius (Doc. A1.2 w/o identification of photo locations)



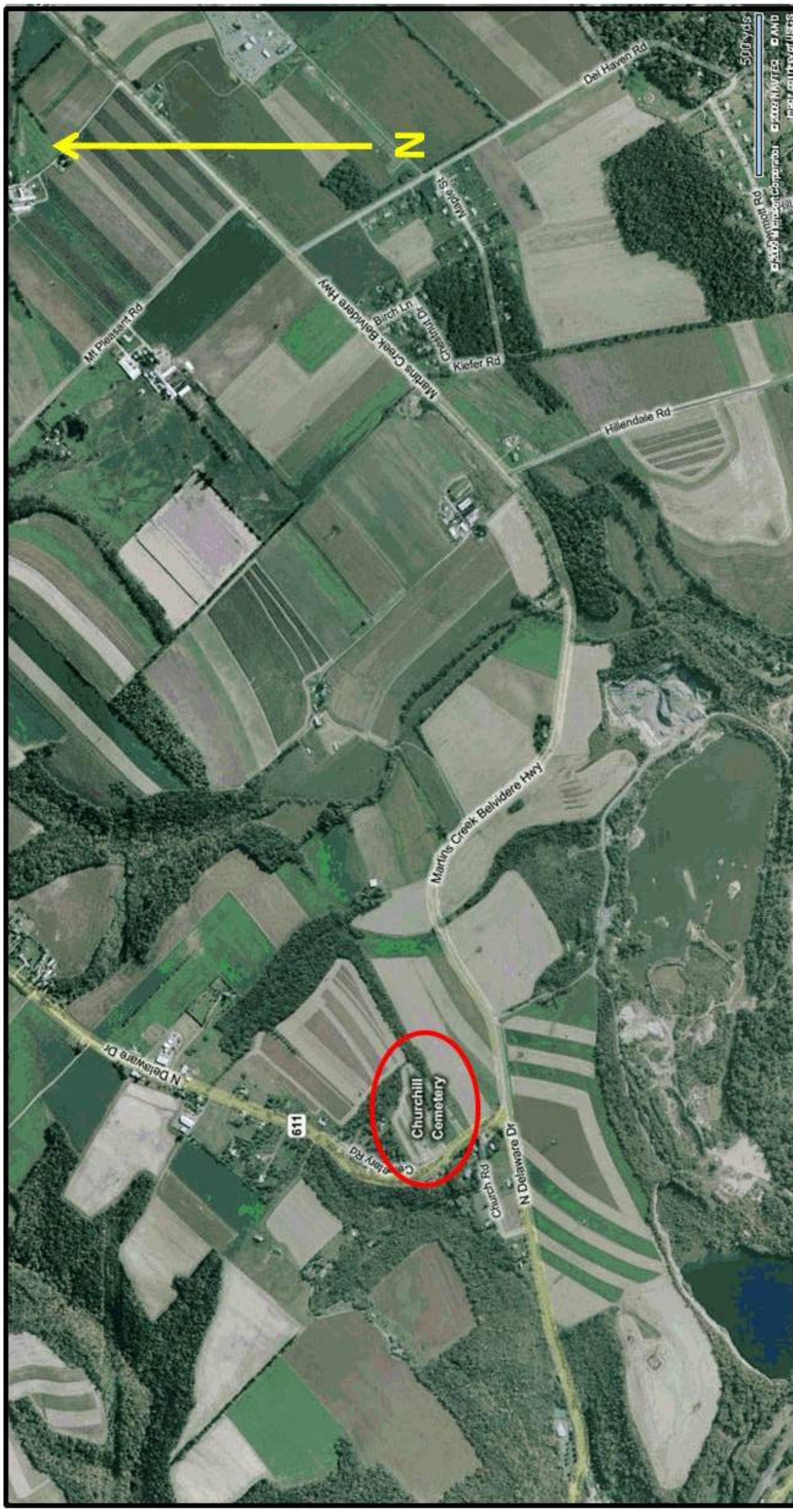
Martins Creek Power Plant Regional Map Showing the Management Unit(s) in Relationship to Critical Infrastructure (Photo Locations of Documents A1.3-A1.10)



Bangor, PA (at Plant)

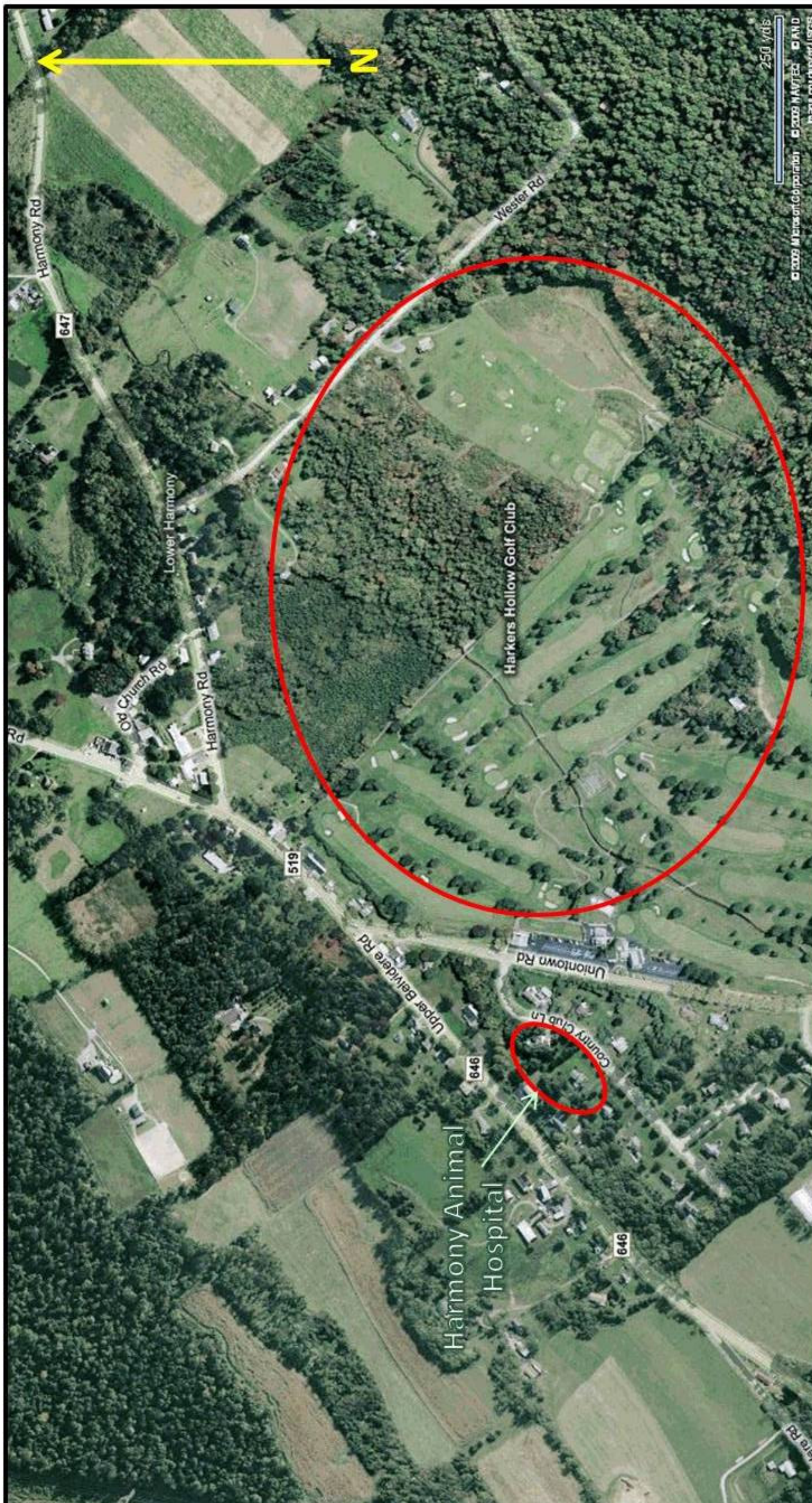


IEC Tank Farm, Martins Creek Boat Access Area (SW of Plant)

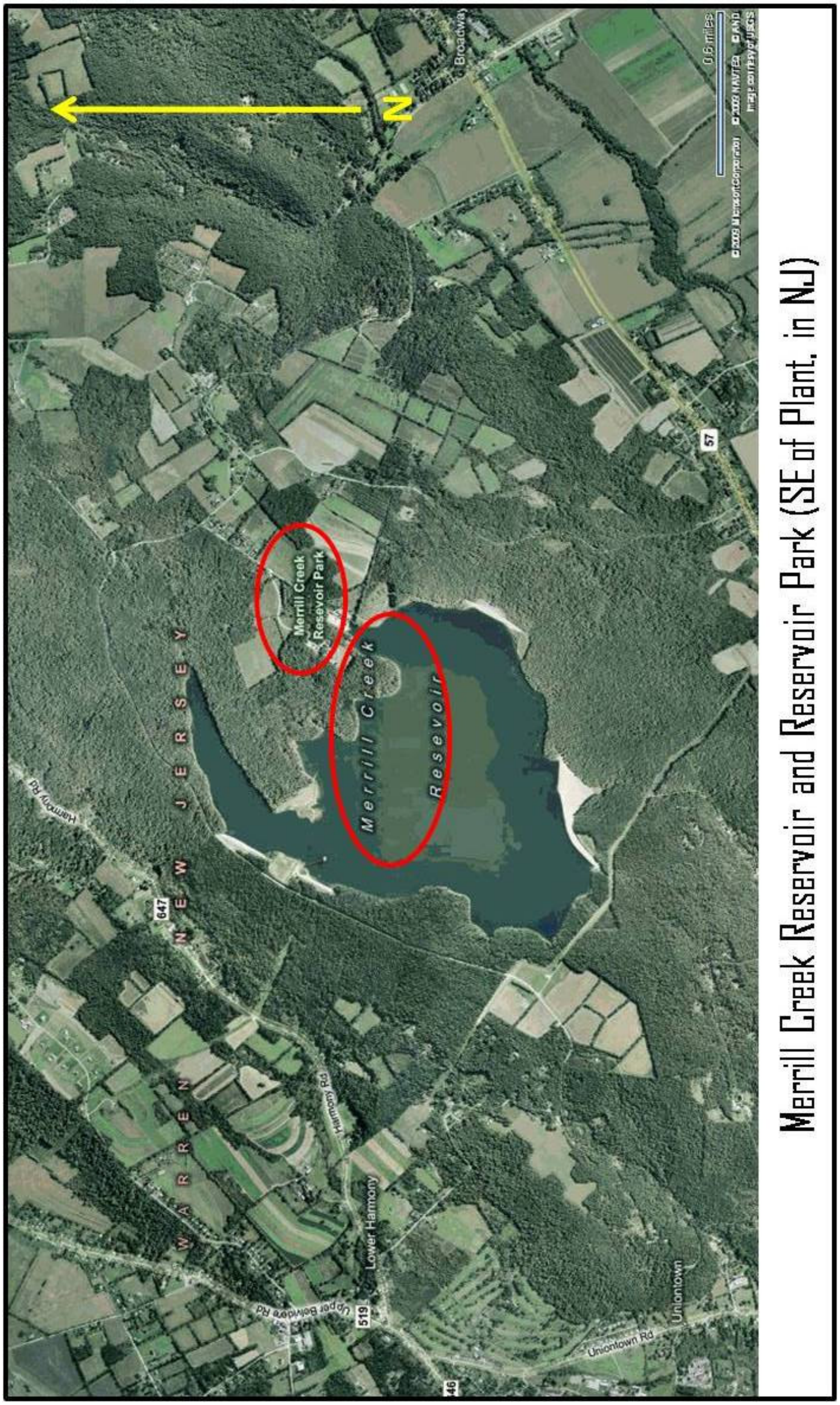


Churchill Cemetery (SW of Plant)

Pacchloli Field (**SW** of Plant)



Harmony Animal Hospital and Harkens Hollow Golf Club (SW of Plant, in NJ)



Merrill Creek Reservoir and Reservoir Park (SE of Plant, in NJ)

Montana Cemetery (SE of Plant, in NJ)

Harmony Township Park (SW of Plant, in NJ)

DEP comment # 6: PPL asserts that certain portions of the basin are susceptible to leaching dissolved selenium when ash remains saturated for a period of time. Please provide estimates of the amount of continuous precipitation that could result in the saturation of fly ash within the basin and the increase in water level within the aquifer beneath the basin such that it contacts the ash and affects groundwater.

PPL response:

In order to answer Comment #6, the movement of precipitation derived water through the ash basin was modeled. The objectives of the model were to simulate the effects of a wet year with an extreme storm event, with continuous precipitation lasting several days, and predict the following:

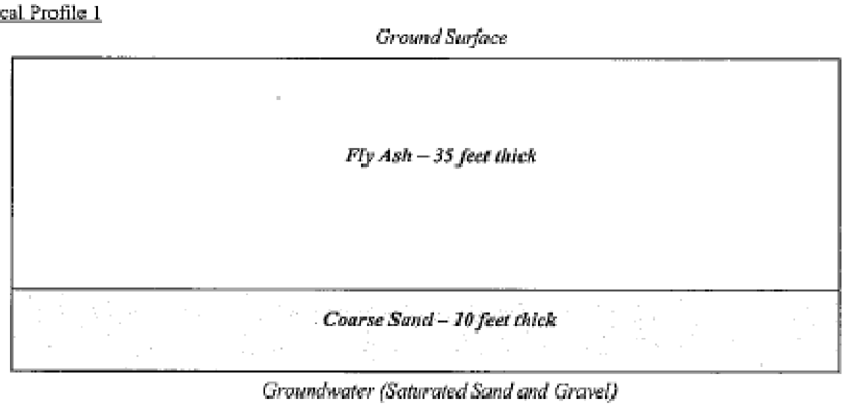
1. the resultant level of saturation of the ash units and the underlying vadose zone sand and gravel that overlie the water table;
2. the estimated rise in the water table due to the increase in precipitation; and
3. the possibility of the water table coming in contact with the bottom of the ash.

The United States Environmental Protection Agency (US EPA) model - Hydrologic Evaluation of Landfill Performance (HELP), Version 3.07 was used. HELP is a quasi two-dimensional hydrologic model of water movement across, into, through and out of landfills. The model accepts weather, soil and design data, and uses solution techniques that account for the effects of surface storage, snowmelt, runoff, infiltration, evapotranspiration, vegetative growth, soil moisture storage, lateral subsurface drainage, leachate recirculation, unsaturated vertical drainage, and leakage through soil, geomembrane or composite liners. The program was developed for EPA to conduct water balance analysis of landfills, cover systems and solid waste facilities.

For the Basin 1 saturation evaluation, the model was used to derive a water balance for a hypothetical scenario consisting of an extreme rain event. The model was used to facilitate the estimation of the amounts of runoff, evapotranspiration, and percolation / leakage rates that may result from a period of extreme precipitation.

The ash basin has complex stratigraphy; fly ash and bottom ash layers of varying thickness are underlain by naturally occurring sand and gravel unit. At most locations the top 10 feet or more of the sands and gravels are unsaturated. For the purposes of this evaluation, four vertical profiles were selected as representative of the different parts of the basin. Each of these profiles consisted of 45 feet thick sequences of unsaturated to partially saturated fly ash and bottom ash and sand and gravel layers that overlie the water table. The cross-sections for the modeled profiles are shown below.

<u>Vertical Profile 1</u>



5

Vertical Profile 2

Ground Surface

Bottom Ash – 35 feet thick

Coarse Sand – 10 feet thick

Groundwater (Saturated Sand and Gravel)

Vertical Profile 3

Ground Surface

Fly Ash – 10 feet thick

Bottom Ash – 15 feet thick

Fly Ash – 10 feet thick

Coarse Sand – 10 feet thick

Groundwater (Saturated Sand and Gravel)

Vertical Profile 4

Ground Surface

Bottom Ash – 10 feet thick

Fly Ash – 15 feet thick

Bottom Ash – 10 feet thick

Coarse Sand – 10 feet thick

Groundwater (Saturated Sand and Gravel)

6

Vertical Profile 3 may be the most representative as fly ash was initially deposited in the bottom of the basin.

The following assumptions and data inputs were used for constructing the model.

- The physical characteristics of the fly ash, bottom ash and the sand units, such as total porosity, field capacity, wilting point and saturated hydraulic conductivity (K) were based on the default values listed in the users guide to the HELP model. Fly ash and bottom ash values were for moderately-compacted, coal-burning, electric plant derived waste material. The porosity value for the bottom ash was adjusted to match field descriptions of the bottom ash in Basin 1

- In the model, fly ash is the most porous sediment (54% total porosity), followed by bottom ash (45% total porosity) and coarse sand (42% total porosity). Higher porosity values indicate higher capacity to assimilate infiltration prior to reaching saturation.

- In the model, fly ash is the least conductive material ($K = 5.0 \times 10^{-5}$ cm/sec). The bottom ash conducts water about 82 times faster than fly ash ($K = 4.1 \times 10^{-3}$ cm/sec); while the coarse sand ($K = 1.0 \times 10^{-2}$ cm/sec) transmits water rapidly at a rate that is about 200 times faster than fly ash and about 2.4 times faster than bottom ash.

- Weather records, including precipitation, solar radiation, and temperature were obtained from the nearest weather station at Philadelphia for which a comprehensive data base is available.

- Synthetic precipitation records were generated for a hypothetical wet year with an extreme storm event. Total annual precipitation was 77.20 inches, which approaches twice the normal precipitation rate of 41.42 inches/year. These are very extreme assumed precipitation conditions.

- Normal monthly precipitation values were used for the months January through November. For the first 24 days of December, a steady precipitation of 0.1 inches/day was used. During the last week of December, an extreme storm event was simulated, with 6 inches of rain/day over a seven day period. The storm is a hypothetical extreme event, resulting in 42 inches of precipitation over a one-week period, which is the equivalent to the normal annual total precipitation for the region.

- The timing of the storm was selected to coincide with low evapotranspiration in December arising from low temperatures, dormant vegetation, and low solar intensity. As a result, a small percentage of the precipitation is lost to the atmosphere via evapotranspiration, and more water is available for infiltration into ash.

- The vegetation type was selected to be a fair stand of grass. This vegetation type is representative of conditions at the PPL ash basin. In initial model simulations, the vegetation type was varied between bare soil and excellent stand of grass. The results indicate that the model has limited sensitivity to vegetation type.

- The surface area of the basin that is available for runoff was assumed to be zero, resulting in ponding of water over the basin. This allows the precipitation water to either infiltrate into the ash or be lost to the atmosphere via evapotranspiration, but not to runoff.

HELP Results

The HELP model was run for each of the four ash profiles in order to simulate the hypothetical wet year with an extreme 7-day, 42-inch rain storm. Detailed listings of the model inputs and the output are included in Attachment C. The model predictions of the resultant saturation of the ash and sand layers are tabulated below.

Profile	Profile Description	Layer Material	Layer Thickness (feet)	Post-Storm Water Storage (inch)	Post-Storm Water Storage (feet)	Total Porosity (vol/vol)	Post-Storm Water Storage (vol/vol)	Layer Saturation %
1	Fly Ash underlain by Sand	Fly Ash	35	165.72	13.81	0.54	0.39	73%
		Coarse Sand	10	13.12	1.09	0.42	0.11	26%
2	Bottom Ash underlain by Sand	Bottom Ash	35	104.60	8.72	0.45	0.25	55%
		Coarse Sand	10	14.77	1.23	0.42	0.12	30%
3	Bottom Ash interbedded in Fly Ash; underlain by Sand	Fly Ash	10	64.68	5.39	0.54	0.54	100%
		Bottom Ash	15	36.84	3.07	0.45	0.20	45%
		Fly Ash	10	37.80	3.15	0.54	0.32	58%
		Coarse Sand	10	14.78	1.23	0.42	0.12	30%
4	Fly Ash interbedded in Bottom Ash; underlain by Sand	Bottom Ash	10	34.36	2.86	0.45	0.29	64%
		Fly Ash	15	81.44	6.79	0.54	0.45	84%
		Bottom Ash	10	16.91	1.41	0.45	0.14	31%
		Coarse Sand	10	14.82	1.24	0.42	0.12	30%

The results of the model indicate that even for the extreme storm event during an unusually wet year, the combined fly ash and bottom ash profile is not fully saturated. For profile 3, the upper fly ash (10 feet thick) gets saturated after the extreme storm. But the underlying bottom ash layer (15 feet thick) is only partially saturated at 45%, and so are the lower fly ash layer (10 ft thick) at 58% saturation and the sand layer (10 ft) at 30% saturation. So there is 35 feet of unsaturated material acting as a buffer between the upper fly ash layer and the water table.

The 10 feet thick sand layer that separates the bottom of the ash from the water table is not predicted to be saturated for any of the profiles.

The model simulations were also used to predict the amounts of vertical leakage or percolation from the bottom layer of ash to the underlying sand and gravel. In theory, this leakage could create a local area of enhanced groundwater recharge at the basin, causing a mounding of the water table if the recharge rate from the basin exceeded the local groundwater recharge rate for the surrounding land. The leakage estimates for each layer model, for the extreme year of precipitation are tabulated below.

Profile	Profile Description	Leakage into Groundwater		Equivalent Rise of Water Table * (feet)
		(inches)	(feet)	
1	Fly Ash underlain by Sand	3.02	0.25	0.60
2	Bottom Ash underlain by Sand	23.00	1.92	4.56
3	Bottom Ash interbedded in Fly Ash; underlain by Sand	7.77	0.65	1.54
4	Fly Ash interbedded in Bottom Ash; underlain by Sand	14.81	1.23	2.94

Notes:

* Calculated on the basis of sand layer porosity of 42%. Each foot of leakage corresponds to 2.38 feet rise of the water table (1 foot / 0.42 = 2.38 ft)

The highest rise in the water table is for profile 2, which has a predicted recharge rate of 23 inches for the year. The predicted rise in the water table is 4.56 feet; indicating that the water table is still about 5.44 feet below the bottom of the ash for the hypothetical case. Therefore, even after the 7 day, 42 inch extreme storm event at the end of an extremely wet year (77.20 inches total annual precipitation), the water table is not expected to come in contact with the bottom of the ash.

This estimate of rise is extremely conservative (overestimates water table rise) in that it simulates a static system. It assumes there is no discharge downgradient of the area of interest. In reality the rise will be controlled by all elements of the area hydrologic cycle, such as regional recharge, upgradient and downgradient boundary conditions, regional evapotranspiration, stage of the Delaware River, and river bank storage, as well as leakage from the basin.

Comparison of HELP Results to Basin 1 Water Level Data

The highest water level elevations measured to date in the Basin 1 monitoring point system were measured on January 18, 2006 in response to a period of heavy precipitation. This rise from relatively static conditions is illustrated on Table 1 and Figure 2. The change in water levels is greatest at MW 1-7, likely in response to regional precipitation and the stage of the Delaware River. This is illustrated in the precipitation and river discharge record for the USGS gauging station at Belvidere, NJ, over the period of interest (see Figure 3). River stage data was not available for the gauging station.

It is interesting to note that all water levels vary to a different degree but that on January 18, 2007, the apex of all measurements, the values converge on a narrow range of elevations between 212.81 (PZ 1-17) and 213.58 (PZ 1-10, an upgradient monitoring point) feet above mean sea level. The lowest measured elevation of the bottom of the ash is 213.50 as measured during the drilling of PZ 1-18 (see Table 1).

Thus, considering all water level data taken on January 18, 2006, when the highest water levels of record were taken for Basin 1 monitoring wells, one water level elevation measurement, taken at a basin upgradient monitoring point (PZ 1-10) rose to a level slightly higher than the lowest ash elevation measured in Basin 1. The water level for PZ 1-17 is the most representative of water levels occurring in the basin and this level was 0.7 foot below the ash level at PZ 1-18.

Conclusions

A hypothetical extreme precipitation scenario was simulated in order to provide estimates of continuous precipitation that could result in the saturation of fly ash within the basin and increase in water level within the aquifer beneath the basin such that it contacts the ash and affects groundwater. The simulation was done for a hypothetical, extremely wet year (77.20 inches total annual precipitation, almost twice of normal precipitation), that had a 7-day, 42-inch extreme storm event at the end of the year. This is an unrealistic combination of events, but was simulated as an example of a worst possible case scenario. The model results show that even after the extreme precipitation, there is not sufficient water available to completely saturate the ash profiles or raise the water table to come in contact with the bottom of the ash.

HELP Reference

Schroeder, P. R., Aziz, N. M., Lloyd, C. M. and Zappi, P. A. (1994). "The Hydrologic Evaluation of Landfill Performance (HELP) Model: User's Guide for Version 3," EPA/600/R-94/168a, September 1994, U.S. Environmental Protection Agency Office of Research and Development, Washington, DC

ASH SATURATION EVALUATION
HELP MODEL REPORT
PPL MARTINS CREEK GENERATING STATION - ASH BASIN 1
LOWER MT. BETHEL TOWNSHIP
NORTHAMPTON COUNTY, PENNSYLVANIA

Prepared by Shaw Environmental, Inc., for PPL Services Corporation

Introduction

In the correspondence from PADEP dated February 3, 2009, PADEP requested that PPL update the previously provided HELP modeling that was used to estimate of the effects of precipitation on the saturation of ash within the basin and rise in the water table within the aquifer beneath the basin. Shaw Environmental, Inc. (Shaw) was contracted to perform the modeling on behalf of PPL. PADEP requested that the modeling scenarios be tied to specific basin grading and vegetation choices, and that the model be correlated to the Ash Basin No. 1 in terms of historic, current, and final proposed conditions in order to demonstrate that there would be no negative consequences from infiltration of rain water into the basin. The historic basin conditions are not considered significantly different than the current basin conditions therefore, for purposes of this modeling exercise, current and proposed future post-closure conditions were simulated.

The United States Environmental Protection Agency (US EPA) model - Hydrologic Evaluation of Landfill Performance (HELP), Version 3.07 was used. HELP is a quasi two-dimensional hydrologic model of water movement across, into, through and out of landfills. The model accepts weather, soil and design data, and uses solution techniques that account for the effects of surface storage, snowmelt, runoff, infiltration, evapotranspiration, vegetative growth, soil moisture storage, lateral subsurface drainage, leachate recirculation, unsaturated vertical drainage, and leakage through soil, geomembrane or composite liners. The program was developed to conduct water balance analysis of landfills, cover systems and solid waste facilities.

Approach

The objectives of the model were to simulate the effects of precipitation derived water infiltrating through the ash layers in the basin, and predict the following:

1. the resultant level of saturation of the ash units and the underlying vadose zone in the gravelly sand that underlies the basin,
2. the estimated rise in the water table due to infiltration of precipitation, and
3. the possibility of the raised water table coming in contact with the bottom of the ash.

In order to address the PADEP requests, to the extent possible, movement of precipitation derived water through the Ash Basin No. 1 was modeled using site specific lithologic profiles, precipitation rates, basin cover elevations, vegetation cover types, and associated parameter values.

Model layer material types for each of five areas (see **Figure 1**) were derived from five test boring logs for boreholes (TB 1-5, TB 1- 7, TB 1-15, TB 1-16, TB 1-17) (see **Attachment**) and from cross-sections previously provided to PADEP. Each area was modeled for the current and proposed future condition, for a total of ten modeled scenarios. The surface layer material types indicated for each of the five modeled areas were checked against soil descriptions from recent hand auger borings conducted by CEC to ascertain a selected surface layer material type that was most representative for each area. CEC was able to provide area specific laboratory measures for the field capacity and wilting point parameters, as well. CEC also worked with Shaw to achieve the most representative area specific input for the selection of vegetative cover type and associated values for evaporative depth zones and maximum leaf area index. Surface slopes were set at zero to best reflect the condition of no external drainage. Minor recontouring of surface materials will occur in modeled Areas 2 and 5. This only affected the representative surface layer thickness (increased the modeled surface layer thickness) in Area 2 for the post closure condition. Representative meteorological data was selected by using latitude adjusted values from the default Philadelphia regional data base.

Table 1 presents the current and proposed future post closure layer elevations and vegetation covers in each of the five sections of the ash basin. Depending upon the basin section, two or more of the following layers are present.

- Dredge Material (predominantly Fly Ash)
- Fly Ash
- Interbedded Fly and Bottom Ash
- Bottom Ash
- Sand and Gravel (poorly graded gravelly sand)

The HELP model was used to estimate the evapotranspiration, and percolation / leakage rates that may result from precipitation within each basin section.

The following assumptions and data inputs were used for constructing the model.

- The hydraulic characteristics of the dredge material, fly ash, bottom ash, interbedded fly and bottom ash, and the gravelly sand units, such as total porosity, field capacity, wilting point and saturated hydraulic conductivity (K) were initially based on the default values listed in the users guide to the HELP model. Fly ash and bottom ash values were for moderately-compacted, coal-burning, electric plant derived waste material. As stated above, site specific measurements of field capacity and wilting point were used where available (**Table 2**).

- Bottom ash is the most porous material in the model (58% total porosity), followed by fly ash (54% total porosity) and gravelly sand (42% total porosity). An average porosity value of 56% was assigned to the interbedded fly and bottom ash layer. Higher porosity values indicate higher capacity to assimilate infiltration prior to reaching saturation.

- Fly ash is the least conductive material ($K = 5.0 \times 10^{-5}$ cm/sec). The bottom ash conducts water about 82 times faster than fly ash ($K = 4.1 \times 10^{-3}$ cm/sec); while the gravelly sand ($K = 1.0 \times 10^{-2}$ cm/sec) transmits water rapidly at a rate that is about 200 times faster than fly ash and about 2.4 times faster than bottom ash.

- The HELP model weather data generator was used to estimate site specific precipitation, solar radiation, temperature and other weather parameters for the ash basin (Latitude 40.792 and longitude -75.115) by extrapolating from the records for the nearest weather station at Philadelphia for which a comprehensive data base was available.

- Total annual precipitation was 41.42 inches/year.

- Based on the current and proposed future post closure vegetation cover types listed in **Table 1**, evaporative zone depths and maximum leaf area indices were designated for each of the basin sections. These indices are shown in **Table 3** and are based on the following classification scheme:

  Evaporative Depth Zones (inches)
  - Bare Soil: 8
  - Good Grass: 21
  - Excellent Grass: 38
  - Good Trees: 38
  - Excellent Trees: 38

  Maximum Leaf Area Index
  - Bare Soil: 0
  - Good Grass: 3.0
  - Excellent Grass: 4.5
  - Good Trees: 4.0
  - Excellent Trees: 4.5

- The surface area of the basin that is available for runoff was assumed to be zero, resulting in ponding of water over the basin. This allows the precipitation water to either infiltrate into the ash or be lost to the atmosphere via evapotranspiration.

RESULTS

The HELP model was run for each of the five ash basin section profiles for the present and proposed future post closure conditions (total of ten runs) in order to simulate the effect of infiltration from precipitation on the rise of the water table and the saturation of the ash layers. As described above, to the extent possible, site specific parameter values were used as input to the HELP model. The model predictions of the resultant saturation of the ash and gravelly sand layers are shown in **Table 3**. Results indicate that for both the current and the proposed future post closure conditions, the combined fly ash and bottom ash profiles in each of the five representative sections of the ash basin are never fully saturated. The gravelly sand layer that separates the bottom of the ash from the water table is not predicted to be saturated for any of the profiles.

The model simulations were also used to predict the amounts of vertical leakage / percolation from the bottom layer of the profiles. The percolation would result in raising the water table, and if sufficient water percolates, there is a potential for the water table to rise and come in contact with the bottom of the ash. The leakage estimates are provided in **Table 4**. The estimated rise in the water table is expected to range from 1.5 to 2.7 feet. However, the unsaturated portion of the gravelly sand layer that underlies the ash layers ranges in thickness from about 11 to 15 feet. Therefore, the model predicts that the water table will not come in contact with the bottom of the ash.

References:

Schroeder, P. R., Aziz, N. M., Lloyd, C. M. and Zappi, P. A. (1994). "The Hydrologic Evaluation of Landfill Performance (HELP) Model: User's Guide for Version 3," EPA/600/R-94/168a, September 1994, U.S. Environmental Protection Agency Office of Research and Development, Washington, DC.


Shaw Environmental, Inc.
Figure 1
PPL Martins Creek SES
Ash Basin 1
HELP Model Areas
TB 1-16
5
TB 1-15
North End Basin 1
2
4
PZ 1-17
TB 1-14
3
PZ 1-5
TB 1-7
South End Basin 1
1
1
Modeled Area
Area Boundary
PZ 1-5
Test Boring Location

Table 1 - Inputs for HELP Modelling Scenarios

Ash Basin Section Representative Boring	1 TB 1-7		2 TB 1-17		3 TB 1-5		4 TB 1-15		5 TB 1-16	
Vegetative Covers	%		%		%		%		%	
Vegetation Current	80	Excellent Trees	85	Good Trees	50	Excellent Grasses/Forbs	85	Good Trees	75	Barren
	20	Excellent Grasses / Forbs	10	Excellent Grasses / Forbs	35	Good Trees	10	Fair Grasses/Forbs	20	Good Trees
			5	Barren	15	Barren	5	Barren	5	Fair Grasses/Forbs
Predominant Current Vegetation		Excellent Trees		Good Trees		Good Grasses		Good Trees		Bare Soil
Vegetation Proposed Future	80	Excellent Trees	90	Excellent Grasses / Forbs	70	Excellent Grasses / Forbs	70	Excellent Grasses / Forbs	95	Excellent Grasses / Forbs
	20	Excellent Grasses / Forbs	10	Excellent Trees	30	Excellent Trees	30	Excellent Trees	5	Excellent Trees
Predominant Proposed Vegetation		NC		Excellent Grasses		Excellent Grasses		Excellent Grasses		Excellent Grasses
Layer Elevations (in ft. msl)										
Current Conditions										
Top of Dredge Material Current		NP		NP		255		NP		NP
Top of Fly Ash Current		241.4		NP		247		254		250
Top of Interbedded Fly Ash & Bottom Ash		NP		248		NP		NP		NP
Top of Fly Ash Layer		NP		242		NP		NP		NP
Top of Compacted Bottom Ash		NP		NP		NP		251		246
Top of Fly Ash		NP		NP		NP		NP		241
Top of Gravelly Sand		220		223		222		225		223
Water Table - Est. Average of 2007 and 2008		208.9		209.6		207.8		210.1		210.3
Proposed Post-Closure Conditions										
New Elevations on Top Layer		NC		258		NC		NC		NC

Notes: NP = Not Present
NC = No Change

Table 2 – Hydraulic Properties Assigned to Basin Layers

Layer Description	HELP Default Property Values Assigned to Layers (all sections)				Site Specific Replacement Field Capacity and Wilting Point Values									
					Basin Section 1		Basin Section 2		Basin Section 3		Basin Section 4		Basin Section 5	
	Total Porosity (vol/vol)	Field Capacity (vol/vol)	Wilting Point (vol/vol)	Saturated Hydraulic Conductivity (cm/sec)	Field Capacity (vol/vol)	Wilting Point (vol/vol)	Field Capacity (vol/vol)	Wilting Point (vol/vol)	Field Capacity (vol/vol)	Wilting Point (vol/vol)	Field Capacity (vol/vol)	Wilting Point (vol/vol)	Field Capacity (vol/vol)	Wilting Point (vol/vol)
Dredged Material –Coal Fly Ash*	0.541	0.187	0.047	$5.0x10^{-5}$	NP	NP	NP	NP	0.253	0.072	NP	NP	NP	NP
Coal Fly Ash*	0.541	0.187	0.047	$5.0x10^{-5}$	NC	NC	0.305	0.058	0.253	0.072	0.488	0.048	0.300	0.024
Avg. of Coal Fly Ash and Bottom Ash*	0.560	0.132	0.036	$2.1X10^{-3}$	NP	NP	NC	NC	NP	NP	NP	NP	NP	NP
Coal Fly Ash*	0.541	0.187	0.047	$5.0x10^{-5}$	NP	NP	NC	NC	NP	NP	NP	NP	NP	NP
Coal Bottom Ash*	0.578	0.076	0.025	$4.1x10^{-3}$	NP	NP	NP	NP	NP	NP	NC	NC	0.206	0.032
Coal Fly Ash*	0.541	0.187	0.047	$5.0x10^{-5}$	NP	NP	NP	NP	NP	NP	NP	NP	NC	NC
Poorly graded gravelly sand	0.417	0.045	0.018	$1.0x10^{-2}$	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC

Notes:

* Moderately compacted coal burning electric plant material
NP = Not Present
NC = No Change

Table 4: PPL Ash Basin Water Table Mounding Evaluation

Basin Section	Scenario	Vegetation	Leakage Into Groundwater (Inches)	Leakage Into Groundwater (feet)	Equivalent Rise of Water Table (feet)	Separation between Ash and Water Table (feet)	Will water table rise into the ash?
1	Current	Excellent Trees	9.05	0.75	1.80	11.10	No
	Future	Excellent Trees	9.05	0.75	1.80		No
2	Current	Good Trees	9.90	0.82	1.96	13.40	No
	Future	Excellent Grasses	7.58	0.63	1.50		No
3	Current	Good Grasses	8.81	0.73	1.75	14.20	No
	Future	Excellent Grasses	7.40	0.62	1.47		No
4	Current	Good Trees	9.41	0.78	1.87	14.90	No
	Future	Excellent Grasses	8.89	0.74	1.76		No
5	Current	Bare Soil	13.52	1.13	2.68	12.70	No
	Future	Excellent Grasses	9.15	0.76	1.81		No

Notes:

Equivalent rise of water table calculated on the basis of gravelly sand layer porosity of 42%. Each foot of leakage corresponds to 2.38 feet rise of the water

± error in leakage prediction represents the variation from the mean leakage value by the equivalent of 1 standard deviation

Attachment - Soil Boring Logs

Drilling Log

Shaw® Shaw Environmental & Infrastructure, Inc.

Monitoring Well **TB 1-5**

Page: 1 of 2

Project	Basin # Geotechnical Assessment	Owner	PPL				
Location	Martins Creek	Proj. No.	112779.20				
Surface Elev.		Total Hole Depth	53.0 ft.	North		East	
Top of Casing	NA	Water Level Initial	Dry	Static	NA	Diameter	8.5 in.
Screen: Dia	2 in.	Length	7 ft.	Type/Size	PVC/0.010 in.		
Casing: Dia	2 in.	Length	17.5 ft.	Type	PVC SCH 40		
Fill Material	Sand	Rig/Core					
Drill Co.	Eichelbergers, Inc.	Method	HSA/SPT				
Driller	Will Deininger	Log By	M. Shaheen	Date	10/4/05	Permit #	NA
Checked By	R. Wardrop	License No.	PG000157G				

COMMENTS

Depth (ft.)	Sample ID % Recovery	Blow Count Recovery	USCS Class.	Description (Color, Texture, Structure) Geologic Descriptions are Based on the USCS.
0–6	100%	7-13-19	GM	Dark Gray SILT (FLY ASH), little FMC rounded GRAVEL, trace SAND, dry, moist.
6–18	100%	4-5-6	ML	Dark Gray SILT (FLY ASH) moist, medium dense, a small interval of CLAYEY SILT.
	50%	1-1-1		
	100%	1-1-1		Brownish Gray SILT (FLY ASH), very loose, saturated.
	100%	1-1-1		
18–21	100%	11-33-17	GW	Moderate Brown FMC SAND, and FMC rounded GRAVEL, dense, moist.
21–25	100%	4-6-10	ML	Dark Gray SILT (FLY ASH), medium dense, moist to wet.
	50%	7-7		

Columns not filled in: Well Completion, PID (ppm), Graphic Log.

Continued Next Page

Drilling Log

Shaw® Shaw Environmental & Infrastructure, Inc.

Monitoring Well **TB 1-5**

Page: 2 of 2

Project: *Basin 1 Geotechnical Assessment* Owner: *PPL*

Location: *Martins Creek* Proj. No. *117779.20*

Sample ID % Recovery	Blow Count Recovery	USCS Class.	Description (Color, Texture, Structure) Geologic Descriptions are Based on the USCS.
			Continued
	7		
100%	2, 4, 5		
100%	3, 3, 4		
100%	1, 2, 5	ML	
80%	1, 1, 5		Brownish Black SILT (FLY ASH), loose, moist to wet, some FM SAND.
100%	1, 2, 6		
100%	2, 15, 50		
30%	8, 7, 8		Moderate Brown to Green Medium SAND and Course GRAVEL, very dense, moist.
[illegible]	15, 13, 22, 50	GW	Moderate Brown FMC SAND and FC GRAVEL, some SILT, dry to moist.
30%	33, 50		
			Bottom of Boring at 52.6 Feet.

Depth (ft.): 26, 28, 30, 32, 34, 36, 38, 40, 42, 44, 46, 48, 50, 52, 54, 56, 58

SHAW ENVIRONMENTAL/INFRASTRUCTURE Rev: 3/17/03 MARTINS CREEK.GPJ IT CORP.GDT 12/2/09

Drilling Log

Shaw® Shaw Environmental & Infrastructure, Inc.

Soil Boring **TB 1-7**
Page: 1 of 1

Project: *Basin 1 Geotechnical Assessment* Owner: *PPL*
Location: *Martins Creek* Proj. No. *117779.20*
Surface Elev. ____ Total Hole Depth *10.0 ft.* North ____ East ____
Top of Casing *NA* Water Level Initial *NA* Static *NA* Diameter ____
Screen: Dia *NA* Length *NA* Type/Size *NA*
Casing: Dia *NA* Length *NA* Type *NA*
Fill Material *Sand* Rig/Core ____
Drill Co. *Eichelbergers, Inc.* Method *Hand Auger*
Driller *Will Deininger* Log By *M. Shaheen* Date *10/18/05* Permit # *NA*
Checked By *R. Wardrop* License No. *PG0001576*

COMMENTS

Depth (ft.)	PID (ppm)	Sample ID % Recovery	Blow Count Recovery	Graphic Log	USCS Class	Description (Color, Texture, Structure) Geologic Descriptions are Based on the USCS.
0		100%			ML	Brownish Gray Fine SAND (FLY ASH), loose, moist. Some roots and rootlets.
						Medium to Dark Gray SILT (FLY ASH), very moist.
2		50%			SP	Medium to Dark Gray FM SAND, moist.
						Brownish Gray to Dark Gray Fine SAND (FLY ASH).
4		35%				Dark Gray SILT (FLY ASH), moist, trace rootlets.
6		25%			ML	
						Dark Gray SILT to Medium Light Gray SAND (FLY ASH).
8		20%				Dark Gray SILT (FLYASH), loose, moist to very moist, trace rootlets.
10						Bottom of Boring at 10 Feet.
12						
14						

Drilling Log

Shaw® Shaw Environmental & Infrastructure, Inc.

Soil Boring **TB 1-15**

Page: 1 of 1

Project	*Basin 1 Geotechnical Assessment*	Owner	*PPL*		
Location	*Martins Creek*	Proj. No.	*117779.30*		
Surface Elev.		Total Hole Depth	*10.0 ft.*	North	East
Top of Casing	*NA*	Water Level Initial	*NA*	Static *NA*	Diameter
Screen: Dia	*NA*	Length	*NA*	Type/Size	*NA*
Casing: Dia	*NA*	Length	*NA*	Type	*NA*
Fill Material	*Sand*	Rig/Core			
Drill Co.	*Eichelbergers, Inc.*	Method	*Hand Auger*		
Driller	*Wil Deininger*	Log By	*M. Shaheen*	Date *10/18/05*	Permit # *NA*
Checked By	*R. Wardrop*	License No.	*PG000157G*		

COMMENTS

Depth (ft.)	PID (ppm)	Sample ID % Recovery	Blow Count Recovery	Graphic Log	USCS Class	Description (Color, Texture, Structure) Geologic Descriptions are Based on the USCS.
0		100%			ML	Dark Gray SILT (FLY ASH), little to some FM SAND, wet.
2		100%				Dark Gray to Brownish Gray FMC SAND, little Fine GRAVEL, Coal Fragmets and Cinders (BOTTOM ASH), moist.
4		100%				Brownish Gray FM SAND (BOTTOM ASH), moist, loose.
6		100%			SP SM	
						Brownish Gray FM SAND (BOTTOM ASH), trace to little SILT, loose, wet.
8		100%				
10						Bottom of Boring at 10 Feet.
12						
14						

Shaw® Shaw Environmental & Infrastructure, Inc.

Drilling Log

Soil Boring **TB 1-16**

Page: 1 of 1

Project	Basin 1 Geotechnical Assessment	Owner	PPL		
Location	Martins Creek	Proj. No.	117779.20		
Surface Elev.		Total Hole Depth	10.0 ft.	North	
East					
Top of Casing	NA	Water Level Initial	NA	Static	NA
Diameter					
Screen: Dia	NA	Length	NA	Type/Size	NA
Casing: Dia	NA	Length	NA	Type	NA
Fill Material	Sand	Rig/Core			
Drill Co.	Eichelbergers, Inc.	Method	Hand Auger		
Driller	Wil Deininger	Log By	M. Sheehan	Date	10/18/05
Permit #	NA				
Checked By	R. Wardrop	License No.	PG000157G		

COMMENTS

Depth (ft.)	PID (ppm)	Sample ID % Recovery	Blow Count Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Geologic Descriptions are Based on the USCS.
0		100%				
						Brownish Gray Fine to Very Fine SAND (FLY ASH), moist, very loose, trace leaves, rootlets.
2		100%				
						Dark Gray to Medium Light Gray SILT (FLY ASH), moist, loose, trace roots.
4		100%				
					ML	
6		100%				Dark Gray SILTY Very Fine SAND (FLY ASH), moist, loose.
8		100%				Brownish Gray to Medium Light Gray to Dark Gray SILT and some Fine SAND (FLY ASH), moist to wet.
10						Bottom of Boring at 10 Feet.
12						
14						

Drilling Log

Shaw Shaw Environmental & Infrastructure, Inc.

Monitoring Well **TB 1-17**

Page: 1 of 3

Project: Geotechnical Assessment		Owner: PPL	
Location: Martins Creek Steam Electric Station, PA		Proj. No.: 117779	
Surface Elev.:	Total Hole Depth: 62.0 ft.	North:	East:
Top of Casing: NA	Water Level Initial: 52.7 ft.	Static: NA	Diameter: 8.5 in.
Screen: Dia: 2 in.	Length: 10 ft.	Type/Size: PVC/0.020 in.	
Casing: Dia: 2 in.	Length: 48.5 ft.	Type: PVC SCH 40	
Fill Material: Sand		Rig/Core:	
Drill Co.: Eichelbergers, Inc.	Method:		
Driller: Wil Deininger	Log By: M. Shaheen	Date: 10/26/05	Permit #: NA
Checked By:		License No.:	

COMMENTS:

Depth (ft.)	Sample ID % Recovery	Blow Count Recovery	USCS Class.	Description (Color, Texture, Structure) Geologic Descriptions are Based on the USCS.
0–2.5	100%, 90%	1, 0, 0, 0, 4	ML	Medium Dark Gray SILT (FLY ASH), very loose, little Organic Material, wood chips, moist.
2.5–8.5	55%, 55%, 65%, 65%	5, 3, 4, 7, 2, 3, 5, 2, 3, 4, 1, 2	SM	Grayish Brown Wood Mulch and SILTY Fine SAND, dry to moist.
8.5–17.8	55%, 45%, 45%, 50%, 20%, 5%	12, 5, 6, 5, 3, 7, 10, 5, 3, 4, 2, 4, 7, 6, 5, 7, 4, 3	GM	Pale Brown SILT and FMC GRAVEL, medium dense, dry to moist.
17.8–19.3	100%	4, 7, 9	ML	Medium Gray SILT (FLY ASH), medium dense, wet to moist.
19.3–19.6		24	SM	Moderate Brown SILTY FM SAND, dense, moist to very moist.
19.6–20		5	ML	

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SHAW ENVIRONMENTAL INFRASTRUCTURE Rev. 3/17/03 MARTINS CREEK.GPJ IT CORP.GDT 11/28/05

Shaw® Shaw Environmental & Infrastructure, Inc.

Drilling Log

Monitoring Well **TB 1-17**

Page: 2 of 3

Project: *Geotechnical Assessment* Owner: *PPL*

Location: *Martins Creek Steam Electric Station, PA* Proj. No. *117779*

Depth (ft.) | Well Completion | PID (ppm) | Sample ID % Recovery | Blow Count Recovery | Graphic Log | USCS Class. | Description (Color, Texture, Structure) Geologic Descriptions are Based on the USCS.

Depth (ft.): 20, 22, 24, 26, 28, 30, 32, 34, 36, 38, 40, 42, 44, 46

% Recovery (top to bottom): 100%, 70%, 90%, 100%, 100%, 100%, 90%, 100%, 90%, 100%, 100%, 100%, 90%, 100%, 100%, 80%

Blow Count (top to bottom): 18, 20, 5, 5, 6, 2, 3, 6, 3, 4, 4, 2, 3, 5, 2, 3, 4, 1, 1, 3, 1, 2, 6, 1, 2, 6, 2, 2, 4, 3, 2, 5, 2, 2, 4, 1, 3, 6, 1, 3, 4, 2, 2, 12, 5, 7, 16

USCS Class.	Description
	Continued
SP	Brownish Gray SILT, trace Fine GRAVEL, very moist.
SP	Medium Dark Gray SILT (FLY ASH) to Brownish Gray Fine SAND, little course SAND, moist.
SW	Moderate Brown to Brownish Balck FM SAND (Bottom ASH), moist, loose.
ML	Dark Gray SILT to Very Fine SAND, loose, moist.
ML	Brownish Gray SILT (FLY ASH), loose, moist.
SW	Brownish Gray to Medium Dark Gray To Brownish Black SILT to Very Fine SAND to FM SAND, little Fine GRAVEL, moist, very loose.
ML	Brownish Gray to Dark Gray SILT, some very fine SAND, very loose, moist.
ML	Dark Gray SILT (FLY ASH).
ML	Wet to moist, very loose.
SM	Moderate Brown SILTY Fine SAND, medium dense, moist.

Continued Next Page

SHAW ENVIRONMENTAL & INFRASTRUCTURE ... MARTINS CREEK.GPJ IT CORP.GDT

Drilling Log

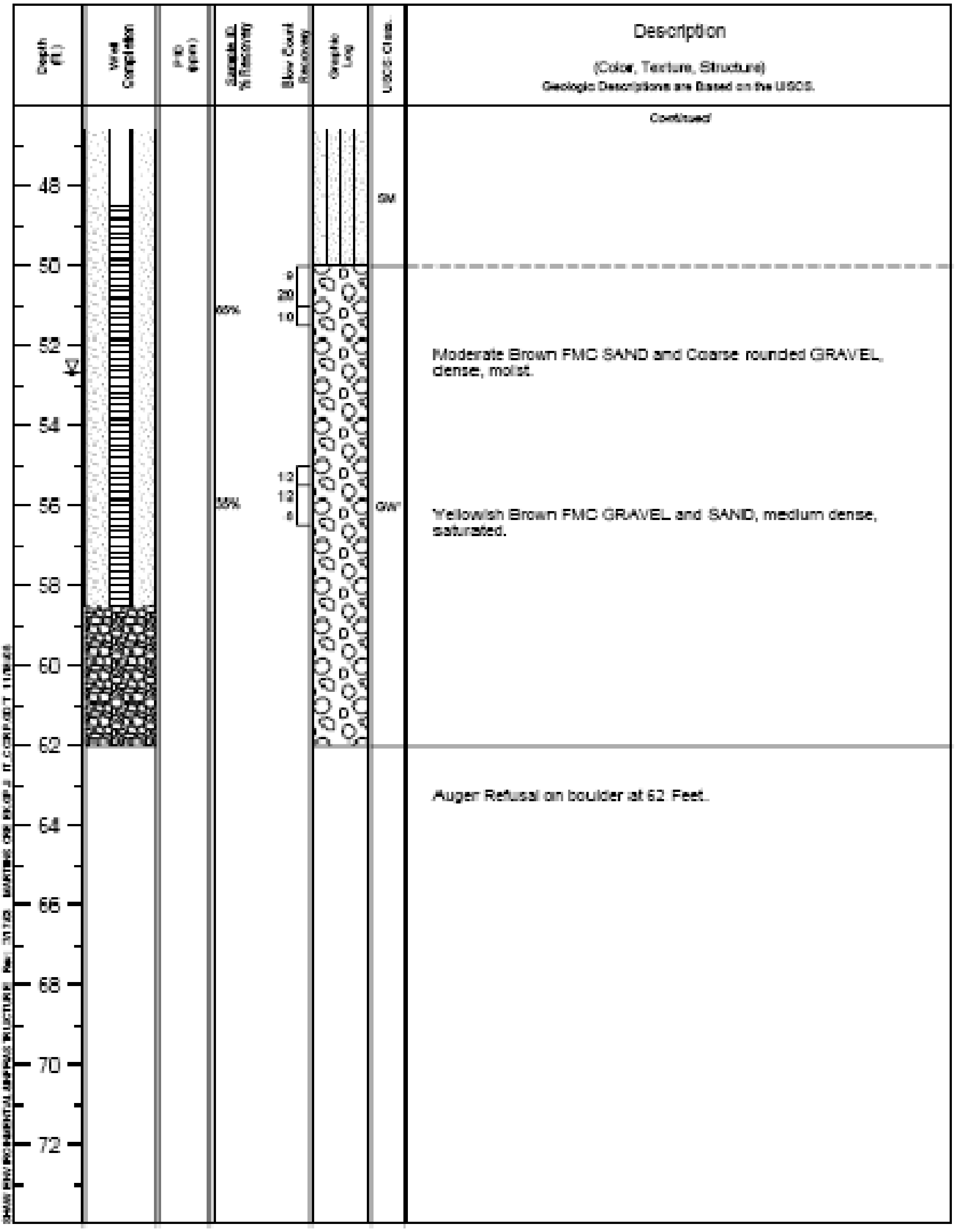
Shaw® Shaw Environmental & Infrastructure, Inc.

Monitoring Well **TB 1-17**

Page: 3 of 3

Project: *Geotechnical Assessment* Owner: *PPL*

Location: *Martins Creek Steam Electric Station, PA.* Proj. No. *117779*



MARTINS CREEK SES
ASH BASIN NO. 1 NORTH CLOSURE
MAJOR PERMIT MODIFICATION
WORK PLAN

(Referenced in Residual Waste Form 18R – Closure)

PPL is submitting a residual waste major permit modification for a natural closure of Martins Creek Ash Basin No. 1. The south end area (SEA) was closed naturally as a demonstration project that ran from 1999 to 2005. PPL is proposing to close the north end area (NEA) in a similar manner. The results of the SEA closure were so positive that PPL wishes to extend the same type of closure to the NEA. This permit modification requests that the SEA closure be accepted as closure and that the NEA closure be appended to it.

BACKGROUND

Ash Basin No. 1 received sluiced bottom ash until September of 2005. The plant had changed operations after a waste water minimization study and reduced the amount of water sluiced to Ash Basin 1 by nearly 60% and discovered that the bottom of the basin is permeable enough that the impounded sluice water never made it to the SEA where the basin's permitted discharge outlet is located. In fact, the flow-thru pipes leading from the NEA to the SEA were closed in 1999 to assure the SEA would not receive water from the NEA under normal circumstances in order to support the closure study of the SEA mentioned above.

Areas of the basin not seeing impounded sluice water (all of the SEA and most of the NEA) developed an extensive natural ecosystem and soil formation. The SEA closure plan, and similarly the one for the NEA, was to augment the development of the natural system through additional plantings, fertilizers, and soil additives.

During early September, 2005, following the fly ash spill from Ash Basin No. 4, the NEA underwent usage it hadn't seen in many years. Fly ash and bottom ash were both sluiced into the basin and sediments from the Delaware River were also pumped into the basin. This produced an unprecedented inundation of water flow into the basin for a two week period and this emergency usage caused some ground water quality changes in the basin's monitoring wells and stressed the trees and ecology that had established in the NEA over the years. In particular, ground water quality in monitoring well MW 1-6 indicated impacts for selenium. PPL investigated this impact and issued reports regarding the findings. PPL's investigation concluded that the basin is returning to pre-spill conditions. The basin has a long history of being in compliance with respect to ground water quality limits based on the permit required monitoring that has taken place. In addition, the impact on the eco-system within the NEA was not devastated by the impounded water. Although a few trees died, the majority of the basin's ecological foundation is still intact. Therefore, PPL suggests that the NEA can be successfully closed naturally with minimal disturbance and enhancements.

It should be noted here that a piezometer (PZ 1-17) placed after the spill in a plateau at the southeast corner of the NEA showed high levels of selenium. This plateau has existed for many years built out of intake debris, ash, and other wastes trucked to the basin from the Plant. The plateau was expanded in the Fall of 2005 as trucked fly ash and soil generated by the spill was dumped there. The selenium discovery has been studied and well documented in reports and correspondence submitted to the Department (NE Region). With respect to the basin closure, it is important to note that the selenium levels in the piezometer are going down and that the point of compliance monitoring wells were never out of compliance with respect to the permitted ground water limits established for them.

WORK PLAN

The best closure approach for the NEA of Basin No. 1 appears to be an extension of the minimal impact, natural closure approach demonstrated in the SEA of the basin.

The goals of the natural closure approach will be to:

- minimize use of heavy equipment
- apply practically no additional weight burden to the surface of the basin
- import only minimal outside resources into the basin
- maintain existing drainage patterns, physical structure and chemical equilibrium in the ash bed
- provide rapid effective vegetative cover by improving soil conditions, enhancing existing vegetation and planting ecologically appropriate selected species as needed
- documenting the progress of the natural closure with annual assessment reports with the intent that within thee to five years, the NEA can be demonstrated to be a self-sufficient, thriving eco-system.

As mentioned above, there are some differences between the NEA and the SEA caused by the history and operation of the NEA that will be addressed in the work plan. Drawing D-326672, included with this application, shows the various work areas discussed in the following item list.

1. REGRADING AND SCARIFYING SURFACE OF DIKE CREST

The crest (top) of the ash basin dikes have been used for access around the basin. As a result, it is flat and has been compacted thereby making it nearly impermeable. The work plan calls for regrading the dike crest such that it slopes inward towards the basin while backfilling any erosion scars that exist. Excess regraded soils will be pushed down the slope adjacent to the work area to flatten the inside dike slopes. Work will be done trying to minimize impact on the vegetation in the work areas. The intent of the regrading is to promote sheet flow runoff and reduce the chance of runoff erosion on the dike slopes.

After regrading, the dike crest will be scarified using a disc or a similar apparatus to break up the compaction. This will allow for infiltration and effective plant root growth. The dike crest will then be planted with natural grasses to provide surface stability and to further limit erosion. Vehicular access along the dike crest will be restricted after the dikes are regraded and scarified.

2. REGRADING AND SCARIFYING THE PLATEAU IN THE SOUTHEAST CORNER OF THE NEA.

The surface of the plateau in the southeast corner of the NEA has been rendered nearly impermeable by the loading from construction equipment and the gradation of the material placed there. As a result, nearly all rainfall that hits the plateau runs off and is impounded around the plateau until it seeps into the basin. The report about PZ 1-17 recommends that runoff be directed away from area around PZ 1-17. To this end, it is planned to flatten the outer slopes of the plateau and backfill low areas along its south and west sides. DEP requested that PZ 1-17 remain in service and be sampled during the quarterly ground water sampling events through the end of 2008. PPL plans to abandon the piezometer during closure regrading. If PZ 1-17 must remain, the height of its casing will have to be lowered to accommodate the regrading of the slope. The regrading work around the piezometer may cause material around the casing to collapse and cause a temporary change in water quality parameters. However, this is still inside the basin itself and will not affect the point of compliance well outside the basin.

In addition, the surface of the plateau must be scarified to allow some infiltration into its surface layers to promote vegetative growth. The surface will them be planted with grasses and trees as appropriate.

3. REGRADING NORTH END

The north end of the NEA has been where bottom ash and some fly ash have been discharged over the years. As a result, the coarsest materials are there and the gradation of materials grows finer further away from the inlet area. In 2007, bottom ash was removed from this area for use as an underlayment for the Plant's new Industrial Waste Treatment Basin liner. Some layers of fly ash were encountered and stockpiled nearby. In addition, some piles of bottom ash remain. As part of the closure plan, this area will be regraded to provide flatter slopes. The fly ash will be blended with the coarser bottom ash. The ash surface will be augmented with additives and vegetated with local grasses and trees. Runoff from surrounding areas will be allowed to flow into this area for infiltration.

4. FLY ASH DELTA TREATMENTS

Areas where fly ash remains on the basin surface from the sluicing in September, 2005, will need minor regrading, fertilizer and soil additives.

5. DEAD TREE REMOVAL

Trees killed by the high sluice waters in 2005 will be chopped down and chipped. The chips along with old hay bales and other useful organic materials on site will be used for erosion protection and soil augmentation.

SOIL TREATMENT AND PLANTINGS

Soil properties need improvement over most of the NEA. Preliminary soil testing of the ash-soils in the NEA showed plant nutrient levels will need to be supplemented with pasteurized poultry manure. Besides the organic materials discussed above, a seed mixture of fast-growing short-term nurse crop and slower growing perennial grass and forb species, including species with shade tolerance to improve the growth in the vicinity of the tress. Mulch will be used to improve vegetation establishment and long-term performance.

Experience in the SEA indicates that locally well adapted pioneer plant species are most effective and ecologically desirable. These plants are already found in the basin and have been gradually establishing their own eco-system. The intent of this closure program is to augment and speed up that process, resulting in a self-sustaining eco-culture.

To the extent possible, all work will be done with light pressure equipment so as not to disturb the ash deposits in the basin.

SCHEDULE

Earthwork can begin any time as long as the ground isn't frozen. Earthwork should take about three months. Following the regrading in each area, seeding and soil augmentation will take place. This work can be done on completed earthwork areas while other earthwork areas are still being done. The first round of seeding and fertilization should be completed by the end of 2009. Seeding and soil augmentation will continue as necessary until the NEA can be certified as being self-sufficient (perhaps 3-4 years). This determination will be based on the development of an organic mat, a thriving vegetation ecosystem, and no need to provide any more additives.

JUSTIFICATION FOR NATURAL CLOSURE (Residual Waste FORM Q)

Section 289.242 (c) The Department may waive the cap and drainage layer requirements…based on a demonstration that it is not necessary to limit infiltration into the waste.

The best demonstration that it is not necessary to limit infiltration into the waste is that the basin has never been out of compliance even when it was filled with water. That situation will never happen again, so any impact on the waste will be less than in the past.

The SEA was closed naturally beginning in 1999. Its ecological system is now self-sustaining supporting flora and fauna. Water quality remains good and there is no erosion occurring.

That SEA project demonstrates an alternative, minimum impact closure approach, or "natural closure approach", that focuses on achieving final closure and stabilization of the basin and its contents by directly vegetating the ash in the basin with locally indigenous and naturalized species. The NEA closure plan will take the same approach, which provides several benefits over conventional cap and close approaches. Specifically, the need to import soil and other natural resources from outside the basin is minimized or eliminated. Instead of exotic reclamation species often used in conventional closure approaches, locally adapted species insure rapid transition to natural successional processes and rapid increases in biodiversity. Carbon dioxide is removed biologically from the atmosphere more rapidly than using other methods. Natural ecosystem development and soil formation processes are enabled and assure the basin will develop increasingly effective ecological function and become continuously more secure over time. It should be noted that with a regulatory cap system, trees and brush are not allowed to grow on the surface because of their root impact on the cap liner system.

Trees have been growing in the basin for forty years in some cases and the ecology system, particularly in the SEA has developed without obvious detrimental impact from the constituents of the waste. Much of the vegetation has been rooted in fly ash and mixed ash its entire life. In addition, a diverse wildlife population populates the area. In fact, it has been documented in reports on the SEA that the waste mixture of fly ash and bottom ash has better potential for water retention within the growing medium and vegetative growth than the surrounding area's natural soils.

Process of Alternate Closure

Application for Solid Waste Permit Major Modification - Permit PA 301256
<u>At PPL Martins Creek SES - Ash Basin #1</u>

In accordance with Residual Waste Section 287.151 of the Pennsylvania Code, PPL Martins Creek, LLC is notifying you that PPL Martins Creek, LLC is making application to the Pennsylvania Department of Environmental to modify the current Solid Waste Permit - 301256 for the Martins Creek Steam Electric Station (SES) located in Lower Mount Bethel Township, Northampton County, Pennsylvania. The application will be filed on or before January 31, 2008.

Ash Basin #1 is a Class II Residual Waste Disposal Impoundment for the disposal of plant generated waste such as; Bottom Ash, Fly Ash, wastewater treatment sludge and various plant sump sludge. The ash basin has been out of service since 2005. PPL conducts groundwater monitoring through the use of various wells surrounding the facility. At this time PPL is completing a groundwater abatement project to address impacts identified in 2005 and 2006.

The permit modification is required because the basin is being closed before it reaches capacity. As a result, the originally submitted closure plan must be modified to include the current site grades and conditions.

The south end of the basin has been closed since 1999 with a natural closure consisting of existing vegetation and grading. The north end of the basin will be closed under a similar plan as part of this permit modification.

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3140-FM-WE0001 Rev. 2/2008

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL PROTECTION
BUREAU OF WATERWAYS ENGINEERING
DIVISION OF DAM SAFETY

DEP Data Records

DAM SAFETY INSPECTION NOTICE

DEP Office: Dam Safety Central Office
Phone: 717 787 8568
Dam Permit: D 48-145
Address: 400 Market Street, Harrisburg, PA 17105
Dam or Project Name: Martins Creek Basin No. 4
County: Northampton
Owner or Permittee: PPL Martins Creek, LLC
Municipality: Lower Mt. Bethel Twp
Complete Mailing Address: Attn: Elise Heller, P.E., 6605 Foul Rift Road, Bangor, PA 18013
Take GPS readings at the center of the crest of the dam
Latitude: 40 ° 47 ' 34 " N
Longitude: 75 ° 06 ' 47 " W

Type of Inspection:
- ☐ ADMIN - Administrative / File Review
- ☐ CEI - Compliance Evaluation
- ☐ COMPL - Complaint Inspection
- ☐ CONST - Construction Progress
- ☐ DAM12 - Category 1 or 2 dam
- ☐ DAM3 - Category 3 dam
- ☒ FUI - Follow-up Inspection
- ☐ INCDT - Incident response
- ☐ OTHER

Location / Appurtenance	Insp.	OK	Concern	Comment / Explain Concern	Violation? Check if yes	Cite 25 Pa. Code
Crest	☒	☐	☐	Basin is mostly covered with	☐	
Upstream Face	☒	☐	☐		☐	
Downstream Face	☒	☐	☐	vegetation, trees, & brush & grass	☐	
Outlet Structure	☒	☐	☐		☐	
Outlet Conduit	☐	☐	☐	Outlet pipe to interior is open and	☐	
Primary Spillway	☐	☐	☐		☐	
Emergency Spillway	☐	☐	☐	is routing basin.	☐	
Spillway Channels	☐	☐	☐		☐	
Downstream Toe Area	☒	☐	☐		☐	
Encroachments	☐	☐	☐		☐	
Site Restoration	☐	☐	☐		☐	
E & S Plan on Site	☐	☐	☐		☐	
E & S Controls	☐	☐	☐		☐	
	☐	☐	☐		☐	
	☐	☐	☐		☐	
	☐	☐	☐		☐	

Inspection Results Code:
- ☐ DVN (De Minimus Violation)
- ☒ NOVIO (No significant violations noted)
- ☐ OUTST (Outstanding violations, no action req'd)
- ☐ RECUR (Recurring violations)
- ☐ REPAR (Repairs or upgrade required)
- ☐ VIOCT (Viols noted and immediately corrected)
- ☐ VIOLS (Violation(s) noted)
- ☐ VOV (New and outstanding violations noted)
- ☐ VRV (New and recurring violations noted)

Violations Noted? ☐ Yes ☒ No   Field Notice of Violation? ☐ Yes ☒ No   Compliance Order? ☐ Yes ☒ No

Remarks: This report is a summary of the undersigned DEP representative's visual inspection only on this date, not an in-depth investigation of the dam's present condition or compliance history. The inspector's full report is available by contacting the DEP office noted above.

The Permit Application for closure of the basin has been submitted & is currently under review by the Division.

DEP Inspector was accompanied by	DEP Rep.
☒ Owner ☒ Engineer for Owner or Permittee	Signature: [signature] Date: 9/3/09
☐ Permittee ☒ Other: KPB Eng.	Print Name: Kristen ... Phone: 717 ... Time: 12:30 - 14:30

☒ White – Owner, Permittee, or Representative   ☒ Yellow – Division of Dam Safety, Central Office   ☒ Pink – DEP Regional File NERO

2540-PM-WM0365 1/95

PENNSYLVANIA DER

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL RESOURCES
BUREAU OF WASTE MANAGEMENT

Coordination #

FORM 6R
GEOLOGIC INFORMATION

This form must be fully and accurately completed. All required information must be typed or legibly printed in the spaces provided herein. Improperly completed forms may be rejected by the Department, may be considered to be violations of the Department's Rules and Regulations, and may result in assessment of fines and penalties.

DER USE ONLY

Application or Facility ID# ______
(Assigned by DER)

Stamp Date Application Received

WASTE MANAGEMENT
COUNTY: ______
SEP 1 0 1997
FACILITY: ______
CODE: ______

SECTION A. APPLICANT IDENTIFIER

Applicant Name: Pennsylvania Power & Light Company

SECTION B. PROJECT LOCATION

Facility Name: Martins Creek SES Ash Basin No. 1

County: Northampton

Municipality: Lower Mount Bethel Township

Instructions: All plans, cross-sections, and maps submitted to complement the descriptions required from the applicant in this portion of the application shall be on a scale of one inch equals no more than 200 feet on the base map so that all maps and cross-sections may be readily compared. The application shall contain a comprehensive narrative-type description of the geology in the proposed permit area and adjacent areas. Information (excepting maps and cross-sections) must be submitted on attached 8 1/2 x 11 inch sheets.

SECTION C. STRATIGRAPHY/LITHOLOGY See Attached Narrative

The narrative description should include information with regard to glacial, colluvial, alluvial, and lacustrine deposition including the range in thickness. Rock unit groups and formations should also be identified and development of any saprolite should be noted. The narrative description must be correlated with and be complementary to the base map, one copy of which must include geologic details.

1. Correlation of all strata (a minimum of two cross-sections or fence diagrams) including lithology, stratigraphy, existing ground surface, and all aquifers to be encountered or affected is required. Horizontal scale should be the same as the base map.

2. Geologic logs of all boreholes and core borings should use the format on page 3 of this form. Log description should include the actual surveyed surface elevation, bottom elevation, elevation of static ground water level, the date measured, and method of water level measurement. The lithologic description and thickness of each strata encountered must be detailed. The comments column should address moisture conditions, fractures, etc. No boreholes were drilled prior to construction.

   A minimum of three boreholes is required, at least one of which shall be a core boring.
   Boring logs are attached for 5 monitoring wells.

3. For any boring or coring not cased and capped or not to be used for ground water monitoring, plans for grouting or otherwise sealing the borehole must be submitted for Department approval. N/A

SECTION D. STRUCTURE See Attached Narrative

Applicants must submit a 1 inch equals 200 feet geologic map with an adequate number of measurements to fully characterize the structural features of the proposed permit area. The locations of all bedding planes, jointing, cleavage, and fault measurements must be shown on the map. All data should be based upon field measurements. The narrative must discuss the following:

1. Geologic structure within the proposed permit area in relation to regional geological structure.

2. Folding, fractures, joints, faults, bedding planes, and their control on the movement of ground water (spacing, width, filling, openness, etc.).

3. Local structure in detail (using cross-sections to enhance the description):

______

- 1 -

SECTION D. (Continued)

4. Folding as it applies to the site; using cross-sections (above) which should include a profile of the fold axis or axes (if any): ______________________

Strike of the fold axis or axes: ______________________

Plunge of axis or axes: ______________________

Location of the proposed site in relation to the local structure: ______________________

Borehole Number: ______________________

Surface Elevation (Ft/MSL): ______________(ft)

Borehole Diameter: __ inches, From __ To __

__ inches, From __ To __

Total Depth: ______________(ft)

Depth to Static Ground Water Level (SWL): ________(ft)

Date SWL Measured: ____________(mm/dd/yy)

Drilling Method: ______________________

Date Drilled: ____________(mm/dd/yy)

Drilled By: ______________________

Drillers License Number: ______________________

Logged By: ______________________

County: ______________________

Township or Municipality: ______________________

Depth (Ft)	Lithologic Description	Plot	Ground Water* Observations	Samples No.	Samples Rec**/Att	Comments	Well/Piezometer Construction	Depth (Ft)

* ▽ Encountered Ground Water ▼ Composite Static Water Level ** Recovered/Attempted

Use additional sheets with this format as necessary

Recycled Paper

- 3 -

MARTINS CREEK SES
ASH BASIN NO. 1
FORM 6R
GEOLOGIC INFORMATION

NARRATIVE

Section C. Stratigraphy/Lithology and Section D. Structure
Ref: "Environmental Assessment of Groundwater and Surface Water Quality, Ash Basin No. 1, Martins Creek SES" By Nittany Geoscience, Inc., Rev. January 1994.

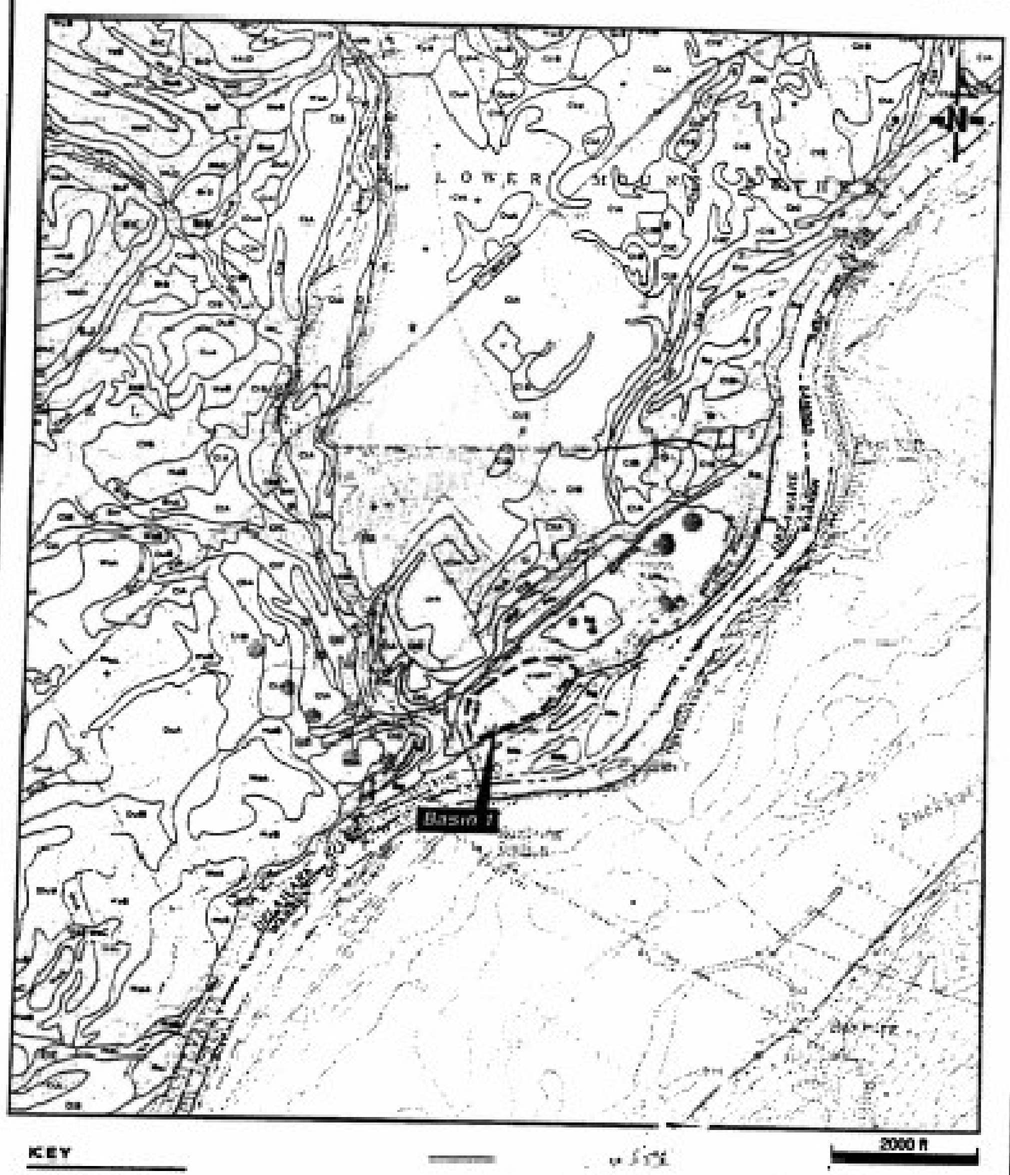
1. SOILS

The Soil Survey of Northampton County, Pennsylvania, identifies soils in the vicinity of Ash Basin No. 1 as those of the Conotton-Red Hook-Urban land association. This soil association typically occurs in nearly level to moderately steep elongate bands along streams and the Lehigh and Delaware Rivers in Northampton County. These deep, well-drained to somewhat poorly drained soils develop from underlying sand and gravel on terminal moraines, kames, eskers, out-wash terraces, and flood plains.

The Basin is surrounded by soils of the Barbour, Conotton, Middlebury, Urban land, and Washington series (Figure 2-2). The Barbour series is described as nearly level, deep, well-drained fine sandy loam to fine sand soils typically occurring on flood plains, alluvial fans, and low terraces along perennial streams. These moderately rapid permeable soils develop in mixed alluvial material. The average silt and clay content in the subsoils of the Barbour range from 9 percent to 63 percent, with average clay content in the range of 3 percent to 13 percent. Barbour soils located along small streams are occasionally flooded, and a seasonal high water table is usually encountered at depths greater than 36 inches below the surface.

The Conotton series is described as nearly level to very steep, deep, well-drained fine gravelly silt loam, gravelly loam, and very gravelly loam soils typically occurring on gravelly out-wash terraces, in valley fill and kames, and on terminal moraines. These rapidly permeable soils develop in stratified glacial drift containing many kinds of parent material. The average silt and clay content in the subsoils of the Conotton range from 17 percent to 25 percent, with average clay content in the range of 3 percent to 13 percent. A seasonal high water table is usually encountered in the Conotton soils at depths greater than 36 inches below the surface.

The Middlebury series is described as nearly level, deep, moderately well to somewhat poorly drained silt loam, sandy loam, and loam soils typically occurring on flood plains along perennial streams. These moderately permeable soils develop in mixed alluvial material. The average silt and clay content in the subsoils of the Middlebury range from 15 percent to 60 percent, with average clay content in the range of 3 percent to 14 percent. Middlebury soils in some locations are subject to flooding, and a seasonal high water table is usually encountered at depths from 12 to 30 inches below the surface.



KEY

- **Ub** Urban land
- **Bg** Barbour soils
- **Ct** Conotton soils
- **Mb** Middlebury soils
- **Wh** Washington soils

FIGURE 2-2
Soils of the PP&L Martins Creek SES,
Sheets 21, 22, and 29 of the Soil Survey of Northumberland County, PA.

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02/057-15
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The soil survey defines much of the area surrounding Ash Basin No. 1 as Urban land (Figure 2-2). Urban land is defined as that which has coverage of 85 percent or greater by buildings, streets, parking lots, and other structures. Structures obscure the land, and previous or current activities have disturbed the soil, making soil identification impractical. The urban soils in the vicinity of Ash Basin No. 1 have been described as soils developed in mixed alluvial material occurring on a smooth to slightly concave flood plain.

The Washington series is described as nearly level to very steep, deep, well-drained silt loam, silty clay loam, clay loam, loam, and very rocky silt loam soils typically occurring on smooth to mildly-karst uplands. These moderately permeable soils develop in glacial till and frost-churned material weathered primarily from limestone. The Washington soils often include mapping of rock outcrops and ledges. The average silt and clay content in the subsoils of Washington range from 62 percent to 78 percent, with average clay content in the range of 20 percent to 33 percent. Seasonal high water table is usually encountered at depths greater than 36 inches below the surface.

2. GEOLOGIC SETTING

2.1 Regional Geology

The Martins Creek SES and Ash Basin No. 1 are located within the Great Valley Section of the Valley and Ridge Physiographic Province (Figure 2-3). The Great Valley is characterized by folded and faulted Paleozoic sedimentary rocks, predominantly shale and sandstone in the northern half, and limestone and dolomite in the southern half. These rocks range in age from Cambrian to Ordovician (570 million to 438 million years). The Great Valley is characterized by a broad, moderately dissected, undulating surface with low to moderate relief. Karstic terrain is prominent in the southern half of the region, as evidenced by the presence of sinkholes. The topography has been formed by the processes of fluvial erosion, some periglacial mass wasting, glacial erosion and deposition in the north and east, and the dissolution of carbonate rocks.

Glacial activity of Wisconsinan and Illinoian age (28,000-75,000 and 350,000-550,000 years, respectively) has partially remolded the topography through erosion, and the deposition of unconsolidated deposits in the extreme northeast portion of the Great Valley. Glacial advances from the north, and subsequent retreats, have deposited till on the uplands and out-wash deposits along valley floors.

Site Geology

The Martins Creek SES is located along a southwest-northeast trending, overturned anticline. Bedrock underlying Basin No. 1 is identified as the Lower Ordovician Beekmantown Group, in particular, the Rickenbach and Epler Formations. Bedding across the site is variable and depends upon the position with respect to the limbs of folds within the area. In the vicinity of Ash Basin No. 1, dip is generally steep and towards the southeast. Glacial and alluvial deposits overlie bedrock across the site. These deposits range in texture from

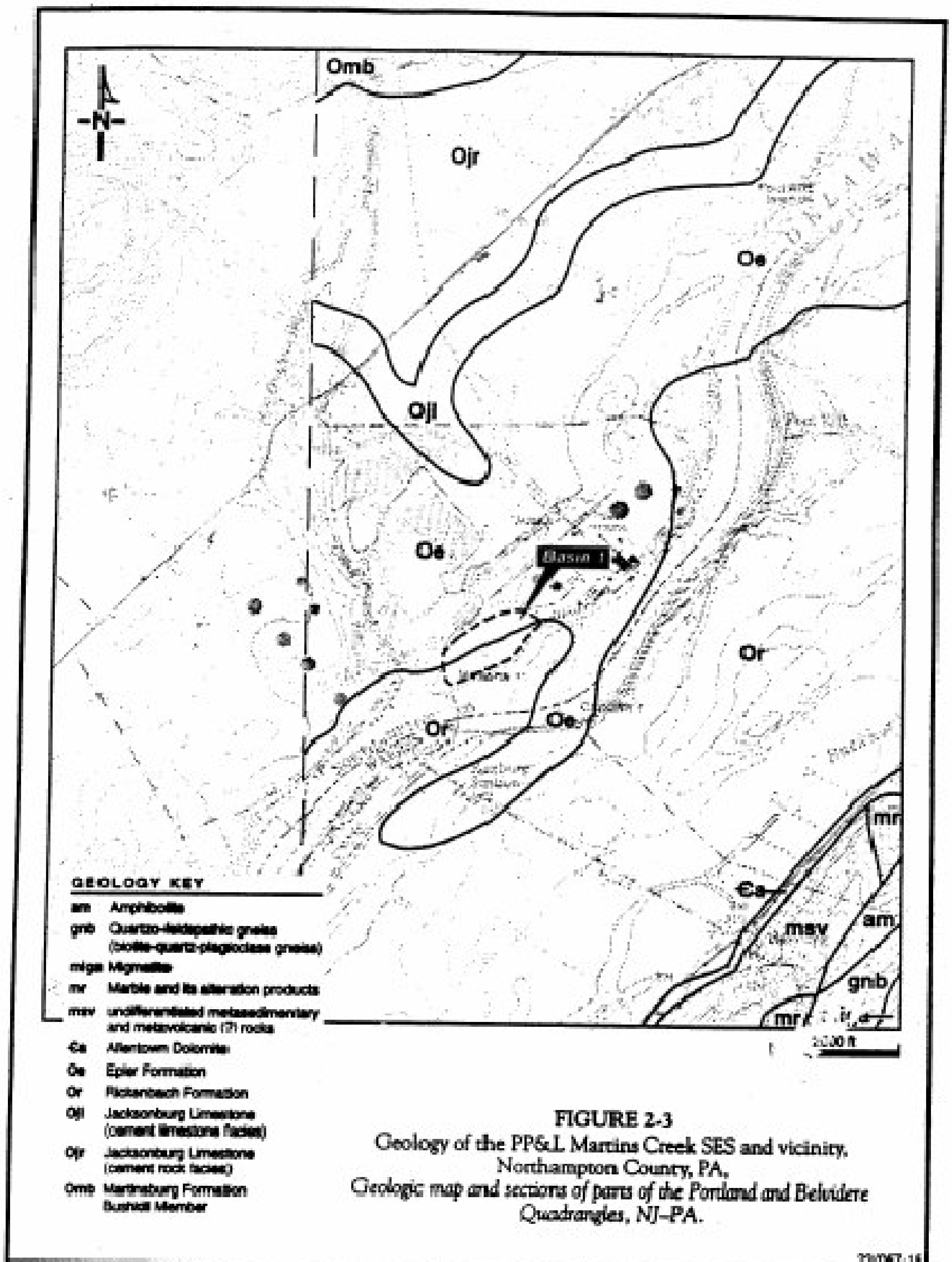

FIGURE 2-3
Geology of the PP&L Martins Creek SES and vicinity,
Northampton County, PA,
Geologic map and sections of parts of the Portland and Belvidere Quadrangles, NJ–PA.

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clay to gravel. Recent alluvial deposits overlay the glacial deposits or rest directly on bedrock. The alluvium ranges in texture from clay and silt to sand, gravel, and boulders. The local geologic setting of Basin No. 1 is illustrated in Figure 2-4.

The Rickenbach Formation occurs beneath the southeastern two-thirds of Ash Basin No. 1 (Figure 2-4). The Rickenbach is described as fine- to coarse-grained, light-medium to medium-dark-gray gray dololutite, dolarenite, and dolorudite. Sedimentary breccia and bedded and nodular chert are common in this Formation. The Rickenbach has a total thickness of approximately 500 to 650 feet in this area (Drake, Epstein, and Aaron, 1969). The Rickenbach lies conformably above the Stonehenge Formation, with the contact described as transitional from the limestone of the Stonehenge to the dolomite of the Rickenbach (Hobson, 1963). The Rickenbach can be subdivided into a lower and upper member. The lower member is described as a medium-gray to medium-dark-gray, finely to coarsely megacrystalline dolomite with characteristic massive and generally non-laminated beds. The upper member is composed of light-gray to medium-gray, microcrystalline to finely megacrystalline dolomite with interbedded fine-grained chert, and a zone of quartzose beds. Bedding in the upper member is generally uniformly thin and laminated (Hobson, 1963). Fractures in the Rickenbach Formation consist primarily of moderate to well developed, regularly spaced, moderately abundant, steeply and gently dipping, blocky joints (Geyer and Wilshusen, 1982). Most of the joints are open, but some are filled with calcite. Well-developed cleavage has been identified in the area of Martins Creek, and has a dip of approximately 45° to the southeast (Weston Geophysical, 1987). Joints, fractures, bedding, cleavage, and solutionally-enlarged channels provide the Rickenbach Formation with a secondary porosity of low to moderate magnitude, and high permeability (Geyer and Wilshusen, 1982).

The Epler Formation occurs beneath the northwestern one-third of Ash Basin No. 1 (Figure 2-4). The Epler is described as an interbedded, very fine grained to cryptogranular, light- to medium-gray limestone and fine- to medium-grained, light- to dark-medium-gray dolomite. Nodular and bedded chert, and beds and lenses of orthoquartzite are observed within this Formation. The Epler has a total thickness of approximately 650 to 800 feet in this area (Drake, Epstein, and Aaron, 1969). The Epler Formation lies conformably above the Rickenbach Formation, with the contact described as gradational from the predominantly limestone of the Epler to the dolomite of the Rickenbach (Hobson, 1963). Limestone in the lower part of the Epler is cryptogranular with large amounts of dolomite mottling, especially at the limestone-dolomite contacts. In the upper portions of the Formation, the limestone is characterized by large amounts of calcarenite intermixed with limestone pebbles and invertebrate remains. The dolomite is mostly microcrystalline to finely megacrystalline, and is common throughout the formation, occurring primarily as mottling and beds. The bedded dolomite is especially common in the lower one-half of the formation and near the contacts with adjacent formations (Hobson, 1963). Bedding is generally moderately well to well developed, and thin to flaggy. Fractures in the Epler Formation consist primarily of well to poorly developed, moderately spaced,

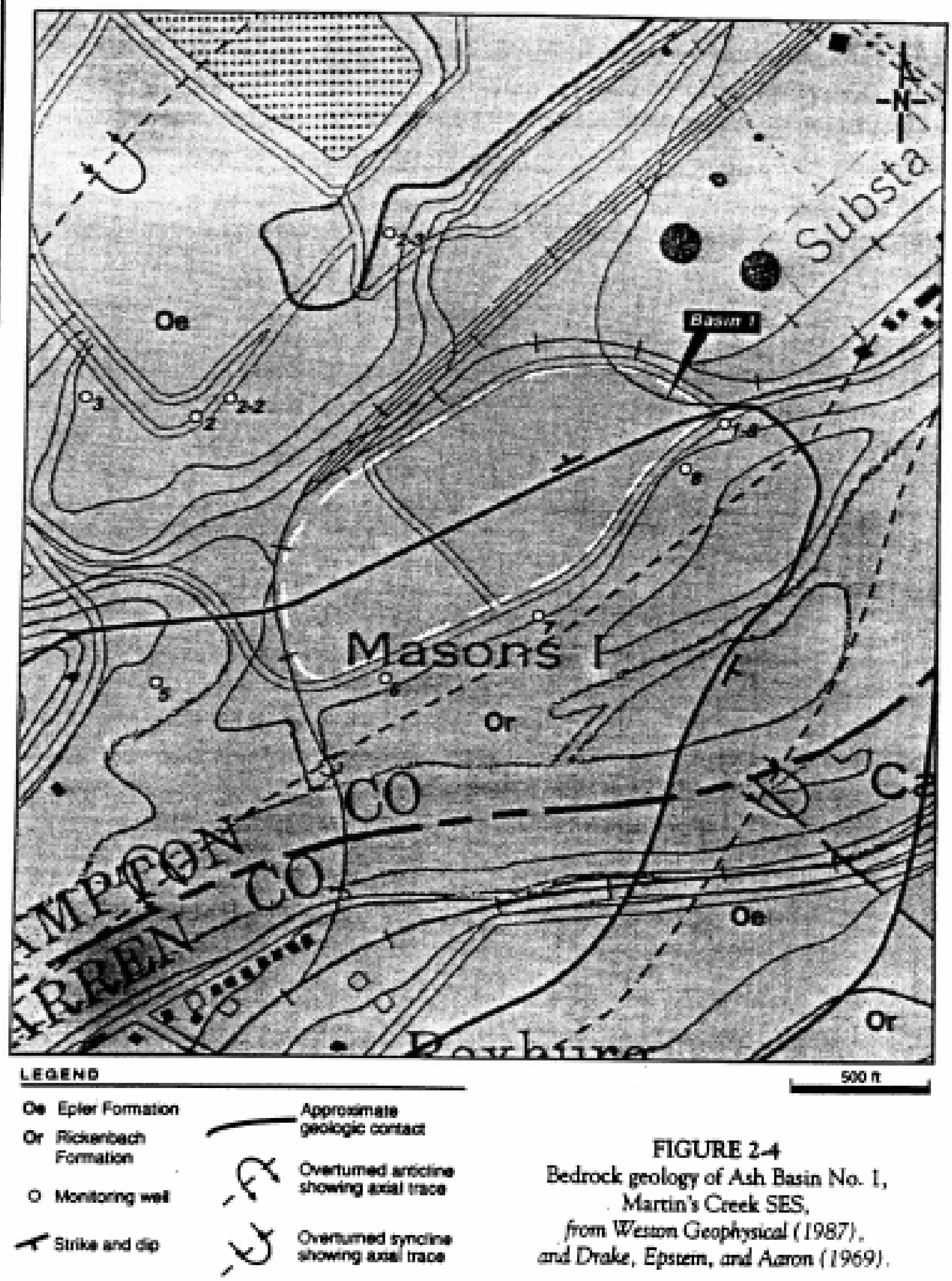

FIGURE 2-4
Bedrock geology of Ash Basin No. 1,
Martin's Creek SES,
from Weston Geophysical (1987),
and Drake, Epstein, and Aaron (1969).

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moderately abundant, open and steeply-dipping to vertical joints (Geyer and Wilshusen, 1982). Well-developed cleavage has been identified in the area of Martins Creek, and measured to have a dip of approximately 45° (Weston Geophysical, 1987). Joints, fractures, bedding, cleavage, and solutionally-enlarged channels provide the Epler Formation with a secondary porosity of low to moderate magnitude, and low permeability (Geyer and Wilshusen, 1982).

Glacial deposits, consisting of sand, gravel, till, and ground moraine are encountered across the Martins Creek site. Mapped locations of the deposits are limited to the northern portion of the SES and Basin No. 1, with a finger of these deposits protruding into the central portions of the Basin. These materials were deposited during the Wisconsinan and Illinoian glaciations (28,000-75,000 and 350,000-550,000 years, respectively). The Muncy Till occurs as patches of thin, gray, clayey to silty till covering up to 10 percent of the ground surface (Socolow, 1981). Stratified drift deposits are encountered along the terraces of the Delaware River, with the till deposits occupying the valley floors. The stratified drift along the river and its terraces, however, has been subject to reworking and redeposition by fluvial processes, possibly removing or shadowing those attributes identifying the material as glacial deposits. The material present beneath the Basin consists of varying thicknesses: glacial till, glacio-fluvial and fluvial sands, gravels, lag boulders, sands, and silts, the extent and thickness of which have been modified by erosion and redeposition (Weston Geophysical, 1987).

Overlying the glacial and fluvio-glacial deposits are more recent alluvial deposits. These deposits consist of clay, silt, sand and gravel overlying lag gravels and boulders, and coarse sand and gravels. These deposits are the result of channel erosion and filling, and overbank deposition (Weston Geophysical, 1987). Previous geologic investigations of the SES and Basin No. 1 have identified potential paleo river channels across the terrace occupied by Basin No. 1 (Weston Geophysical, 1987).

Monitoring well boring logs, showing some stratigraphic information on the area around the Basin, are present in Appendix A of the Nittany Geoscience Report.

ADS1.ol(G:misc)

APPENDIX B

MARTINS CREEK SES BASIN NO. 1

MONITORING WELL LOGS

Basin No. 1 Well

"New" Well 8 (1-8)   Elev. 242.53' (T.O.C.) 241.11' (ground)

Drilling Log

Date: 11/3/86

Interval (ft)	Strata Characteristics	Comments
0 - 3	Dark brown soil, gravel, & cobbles	moist
3 - 18	Light brown sand & well-rounded gravel & cobbles	dry
18 - 25	Light brown sand & well-rounded gravel	dry, hole would not stay open
25 - 37	Light brown sand, well-rounded gravel, & cobbles	dry, hole would not stay open
37 - 41	No cuttings returned	some water @ 37 ft.
41 - 44	Brown sand, well-rounded gravel & cobbles (river fill)	tools wet
44 - 50	Brown sand, well-rounded gravel & cobbles (river fill)	water @ 44 ft.

Hole filled into 22 ft. Installed 40 ft. of 8 in. casing to 39 ft. Drilled out to 40 ft. w/ 8 in. bit. Lost circulation below casing. While pulling bit from hole, casing weld @ 19 ft. separated. Pulled first 20 ft. joint of 8 in. casing from the hole.

Date: 11/4/86

Retreived bottom 20 ft. joint of 8 in. casing. Hole open to 31 ft. Installed 8 in. casing to 44 ft. Cleaned hole to 45 ft w/ 8 in. bit.

Completion Details

Date: 11/4/86

Filled in 1 ft. of well bore with sand (1/2 bag)
Installed 10 ft. of 4 in. PVC 0.02 slot size sreen from 44 to 34 ft
Screen is wrapped with 45 micron fabric filter
Installed 35 ft. of 4 in. PVC solid from 34 ft. to surface
Pulled 25 ft. of 8 in. casing, hole filled into 28 ft.
Sand packed w/ Morie #1 gravel from 28 to 24 ft. (1 1/2 bags)
Bentonite Seal from 24 to 21 ft. (2 buckets)
Standing Water Level - 34 ft.
Back filled well w/ cuttings to 12 ft.

Date: 11/5/86

Grouted w/ cement from 12 ft. to surface (6 bags)
Installed 5 ft. of 6 in. steel protective casing
Completed surface pad w/ cement (1 bag)
Installed 6 ft. of 1 1/4 in. PVC as a marker post
Installed locking cap
Stick up - 16.5 in. to top of steel casing

Well Development

Date: 11/6/86

Air developed - 60 minutes
Water rate - 1 gpm

Notes:
Cycled air: on for 2 minutes, off for 5 minutes. Water cleaned up slowly. Well is poor producer.

Craig S. Shamory

Craig S. Shamory

MW #1-2 (#6)

Dept. EMD

Date ______ 19____

Designed by PCL

Approved by

START 7/19/83

FINISH 7/20/83

PENNSYLVANIA POWER & LIGHT COMPANY
CALCULATION SHEET

PROJECT MARTINS CREEK GROUNDWATER STUDY

ER No. 773116

Sht. No. 1 of 2

SFC. EL 214

MW6

DEPTH (FT)	BLOWS ON SPOON,					REMARKS
0-2					10	DARK BROWN SILTY LOAM DRY W/ TRACE OF SAND FRIABLE
2-5						ADVANCED HOLE W/ AUGERS HIT COBBLES AT 4.0 FT (AUGERS BEGAN TO BOUNCE)
5-7	9	8	6	5	28	DARK SILTY LOAM W/ SAND SOME ORANGE MOTTLING. ANGULAR AND ROUNDED PEBBLES (≤1.5" D)
9.75	← DEPTH TO WATER ON COMPLETION →					
7-10						ADVANCED WITH AUGERS SOME COBBLES (3" D) COMING UP ON AUG FLIGHTS.
10-12	26	24	18	21	89	SAND, GRAVEL AND SILTY CLAY DARK BROWN WE
12-15						ADVANCED AUGERS EASILY (NO BOUNCE ON COBBLES)
15-17	15	10	8	10	43	COARSE SAND AND GRAVEL VERY W HYDROSTATIC PRESSURE GRADES PARTICLE SIZES IN SPOON
17-20						ADVANCED AUGERS EASILY THROUGH SAND & GRAV
20-22	9	11	5	8	33	COARSE SAND AND PEBBLES
22-25						ADVANCED AUGERS THROUGH SAND & GRA SOME COBBLES & BOULDERS
25-27	21	24	25	26	96	GRAVEL AND COARSE SAND. SOME FINES
27-31.5						SAND AND GRAVEL SOME COBBLES
31.5						TOP OF BEDROCK STARTED TO CORE
31.5-33.5						RECOVERED 0.5 FT OF HIGHLY WEATHERED HA GRAY LIMESTONE
33.5-35.5						REC'D 0.9' OF BROWN/GRAY LIMESTONE MANY FRA MOST W/ TRACES OF ORANGE-BROWN RUSTING
35.5-38.5						RECD 2.3 FT OF GRAY LIMESTONE W/ CALCITE SEAMS. LESS

* 140 lb HAMMER 3

GWMW #1 - 4 #6

Dept. ____	PENNSYLVANIA POWER & LIGHT COMPANY CALCULATION SHEET	ER No. 773116.40
Date ____ 19__		
Designed by PCL	PROJECT MARTINS CREEK	Sht. No. 2 of 2
Approved by ____		

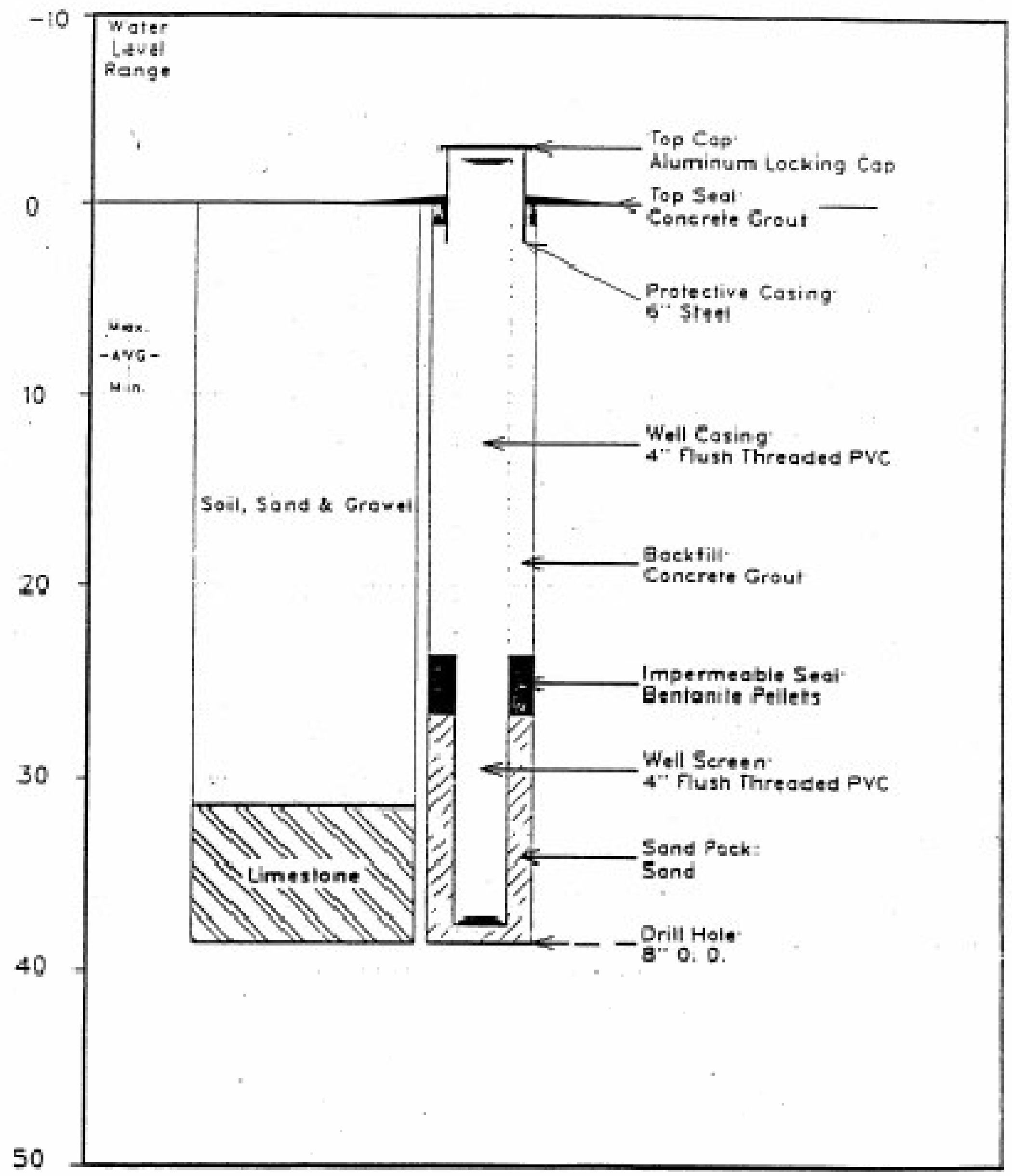
38.5 END OF BORING

REAMED OUT CASING TO 37.0' WITH ROLLER BIT

37.5 BOTTOM OF WELL

INSTALLED 10 FT 4" DIAMETER SLOTTED SECTION WRAPPED IN FILTER CLOTH
30 FT 4" PVC STAND PIPE THREADED FLUSH JOINT
5 FT 6" DIAMETER PROTECTIVE STEEL CASING AND CAP (LOCKED)
CEMENT SURFACE SEAL
PVC BOTTOM PLUG
NATURAL SAND PACK DEVELOPED.
36" CASING STICKUP.

PP&L
MARTINS CREEK S.E.S.
MONITORING WELL CONSTRUCTION DETAIL
GWMW 6



Installation Date: 7/20/83

GNMW - 1-3 (#

Dept. EM D
Date ______ 19____
Designed by PCL
Approved by ______
START 7/20/83
FINISH 7/22/83

PENNSYLVANIA POWER & LIGHT COMPANY
CALCULATION SHEET

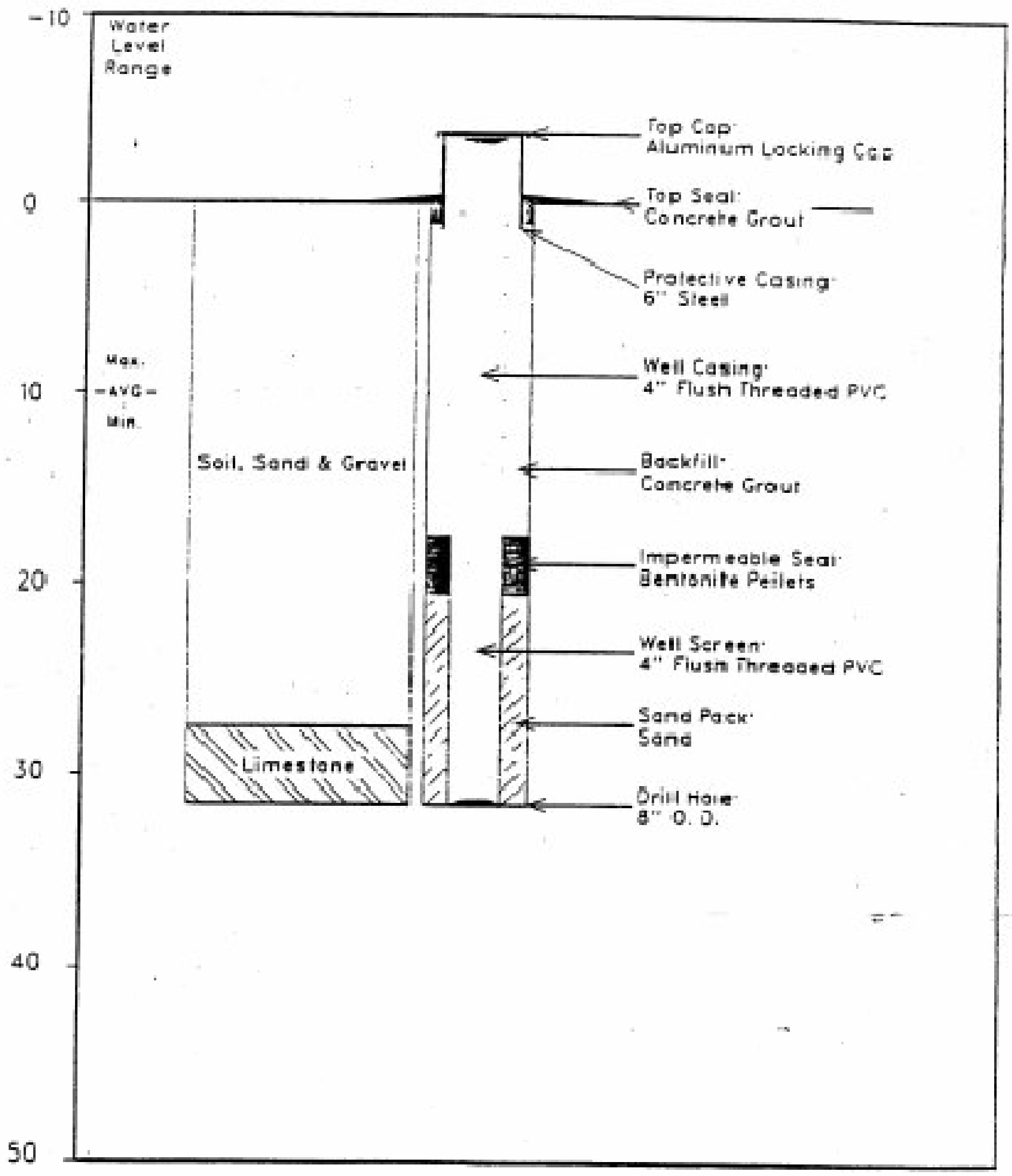
PROJECT MARTINS CREEK
GROUNDWATER STUDY

ER No. 773116.0
Sht. No. 1 of 1
SPC EL. 216 ±
GW 7

DEPTH (FT)	NO SPLIT SPOON SAMPLES TAKEN!	REMARKS
0 - 4		DARK BROWN SILTY LOAM W/ TRACE OF SAND RICH IN ORGANIC MATTER
4 - 27.5		SILTY SAND, GRAVEL, COBBLES AND BOULDERS (SIMILAR TO OTHER LOGS)
		FIRST SIGN OF MOISTURE @ 10 FT
10.0	* - GROUNDWATER LEVEL ON COMPLETION - *	
27.5		TOP OF BEDROCK WEATHERED & BADLY BROKEN LIMESTONE HLGO. SOME VOIDS ENCOUNTERED (CORE BARREL DROPPING)
33.0		END OF BORING
31.5	BOTTOM OF HOLE, WELL INSTALLED	REAMED OUT CORE WITH TRICONE ROLLER BIT

10 FT 4" DIAMETER PVC SCREEN WRAPPED IN FILTER CLOTH
25 FT 4" PVC STAND PIPE (THREADED FLUSH JOINT)
5 FT 6" STEEL PROTECTIVE CASING WITH LOCKING CAP
CEMENT SURFACE SEAL INSTALLED
PVC BOTTOM PLUG & NATURAL SAND PACK
36 INCH STICKUP

PP&L
MARTINS CREEK S.E.S.
MONITORING WELL CONSTRUCTION DETAIL
GWMW 7



Installation Date: 7/22/85

GNMW # 1-4

Dept. ______ PENNSYLVANIA POWER & LIGHT COMPANY ER No. 773116

Date ______ 19 ______ CALCULATION SHEET

Designed by PCL PROJECT MARTINS CREEK Sht. No. 1 of 1

Approved by ______ GROUNDWATER STUDY

START 7/25/83

FINISH 7/27/83

DEPTH (FT)	NO SPLIT SPOON SAMPLES TAKEN.	REMARKS
0 - 3		LIGHT BROWN SILTY SAND
3 - 10		COARSE SAND AND GRAVEL, FEW FINES
6.0	* WATER LEVEL ON COMPLETION	
10 - 13		COARSE SAND AND GRAVEL WITH COBBLES AND BOULDERS
13 - 16		BOULDERS AND COBBLES
16 - 20		BOULDERS AND COBBLES WITH LIGHT BROWN SILTY SAND LAYER
20 - 25.5		MORE BOULDERS AND COBBLES COARSE SAND AND GRAVEL.
25.5		TOP OF BEDROCK; STARTED TO CORE
25.5 - 26.5		LOST WASH WATER
26.5 - 31.0		HIGHLY WEATHERED HARD GREY LIMESTONE, MANY FRACTURES AND VOIDS. SOME SILT IN SEAMS.
31.0	BOTTOM OF HOLE	
27.5	BOTTOM OF WELL	

INSTALLED 10 FT 4 INCH DIAMETER PVC SLOTTED SECTION WRAPPED IN FILTER FABRIC

23 FT 4 INCH PVC STANDPIPE (THREADED FLUSH JOI...

5 FT 6 INCH DIAMETER PROTECTIVE STEEL CASING WITH LOCKED CAP

CEMENT SURFACE SEAL

BENTONITE BOTTOM PLUG AND DEVELOPED NATURAL SAND PACK.

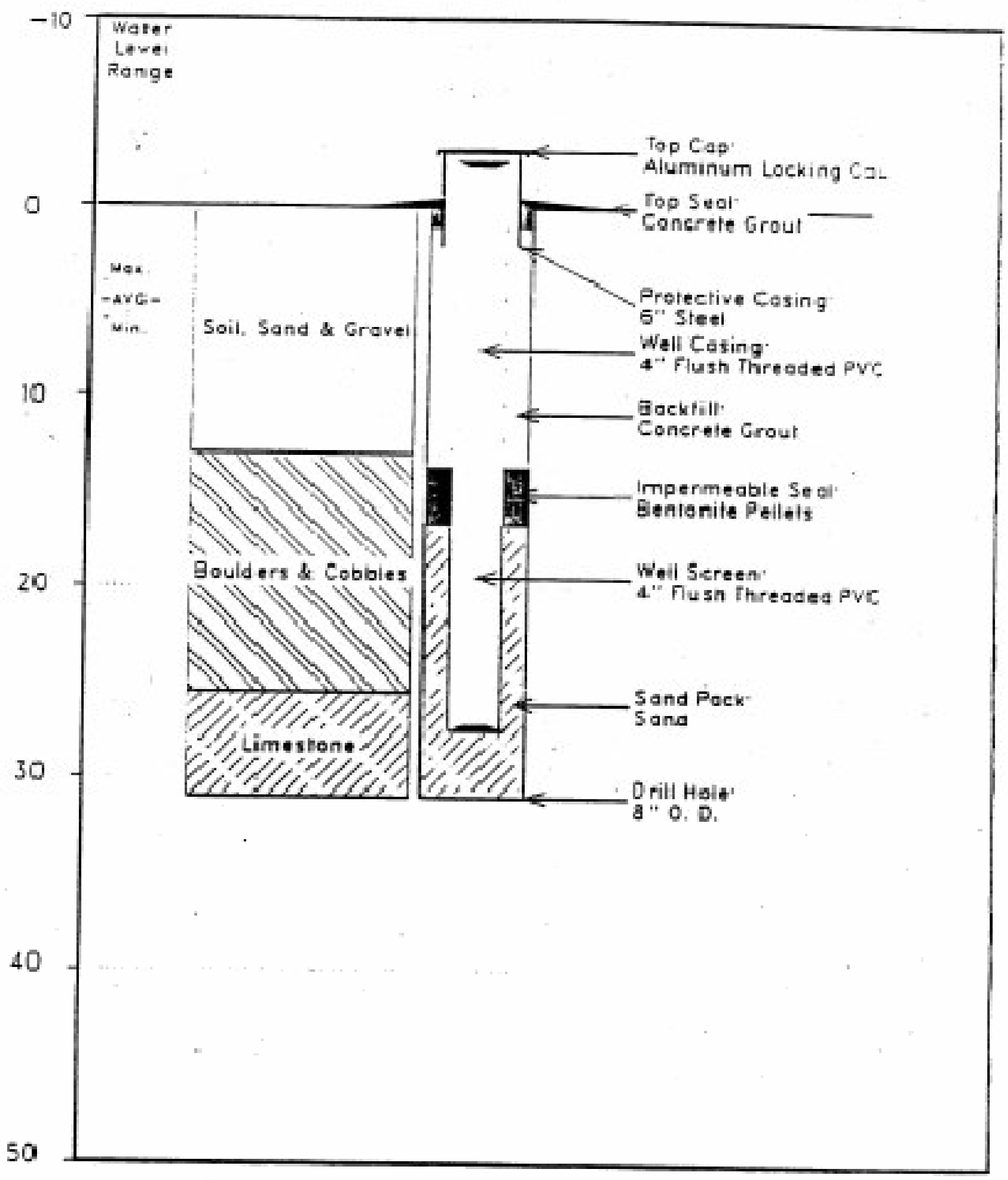
30 INCHES CASING STICK UP

PP&L

MARTINS CREEK S.E.S.

MONITORING WELL CONSTRUCTION DETAIL

GWMW 8



Installation Date: 7/17/93

Figure 1

AIR-ROTARY DRILLING LOG

Client: PP&L Martins Creek S.E.S.

Project No: 91580 Phase Task

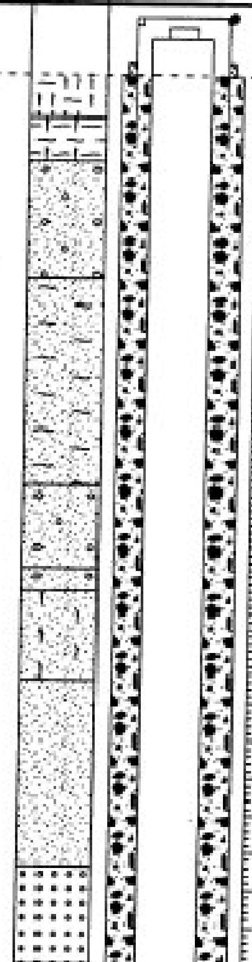
Boring No. MW 2-1AV Piezometer No.

Location

Surface Elev. FT.

Page 1 of 2

Dep. Feet	Blow Count	Sampler	Re-covery/ RQD.	Overburden/Lithologic Description	FID (ppm)	Graphic Log	Well Construction Graphics	Depth Feet	Well Construction Details
									T.O.C. Elev.
0	Ground Surface		FEET					0	
				Silty Clay: reddish-brown, trace gravel, slightly moist.					
				Clayey Silt: brown, trace gravel, slightly moist.				5	
10				Silty Sand: brown, 10% moderately well rounded gravel, trace clay, slightly moist. 40% gravel at 11'				10	
15				Silty Sand: brown, fine-grained, 10% moderately well rounded gravel, trace clay, trace wood fragments, slightly moist.				15	
20								20	Bentonite Grout
25								25	
30				Sandy Gravel: medium grey, coarse, well rounded, trace clay, slightly moist.				30	
35				Gravelly Sand: brown, fine-grained, 40% well rounded gravel, slightly moist.				35	
40				Clayey Sand: reddish-brown, fine-grained, slightly moist.				40	6" protective steel casing to 63 ft
45				Sand: brown, fine-grained, 10% moderately well rounded gravel, trace clay, slightly moist.				45	
50				40% well rounded gravel at 49'				50	
55				Gravel: grey, well rounded, trace fine-grained sand, slightly moist to moist.				55	
60								60	



Continued Next Page

Driller Miller Pump Service	Blown/Bailed Yield > 10 gpm	Bentonite Seal 76.5-80.0'
Logged By B. Breedon (RFWA)	Well Casing 4" Dia. 0.0' to 83.0'	Filter Pack Qty. 4 cu.ft
Drilling Started 12/4/91	Casing Type Schedule 40 PVC	Filter Pack Type Morie #0 sand
Drilling Completed 12/4/91	Well Screen 4" Dia. 83.0' to 123.0'	Static Water Level MSL
Construction Completed 12/4/91	Screen Type Schedule 40 PVC	Date
Development Completed 12/10/91	Slot Size 0.020"	Notes:
Water Bearing Zones 90' and 115'	Drilling Mud N/A	
	Grout Type 5% Bentonite Grout	

Form #wi-sc-1 (02/90)

AIR-ROTARY DRILLING LOG

Client: PP&L Martins Creek S.E.S.

Project No: 91580 Phase Task

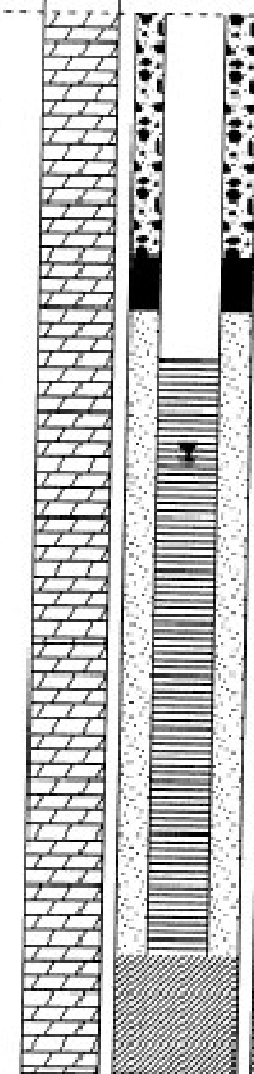
Boring No. MW 2-1AV Piezometer No.

Location

Surface Elev. FT.

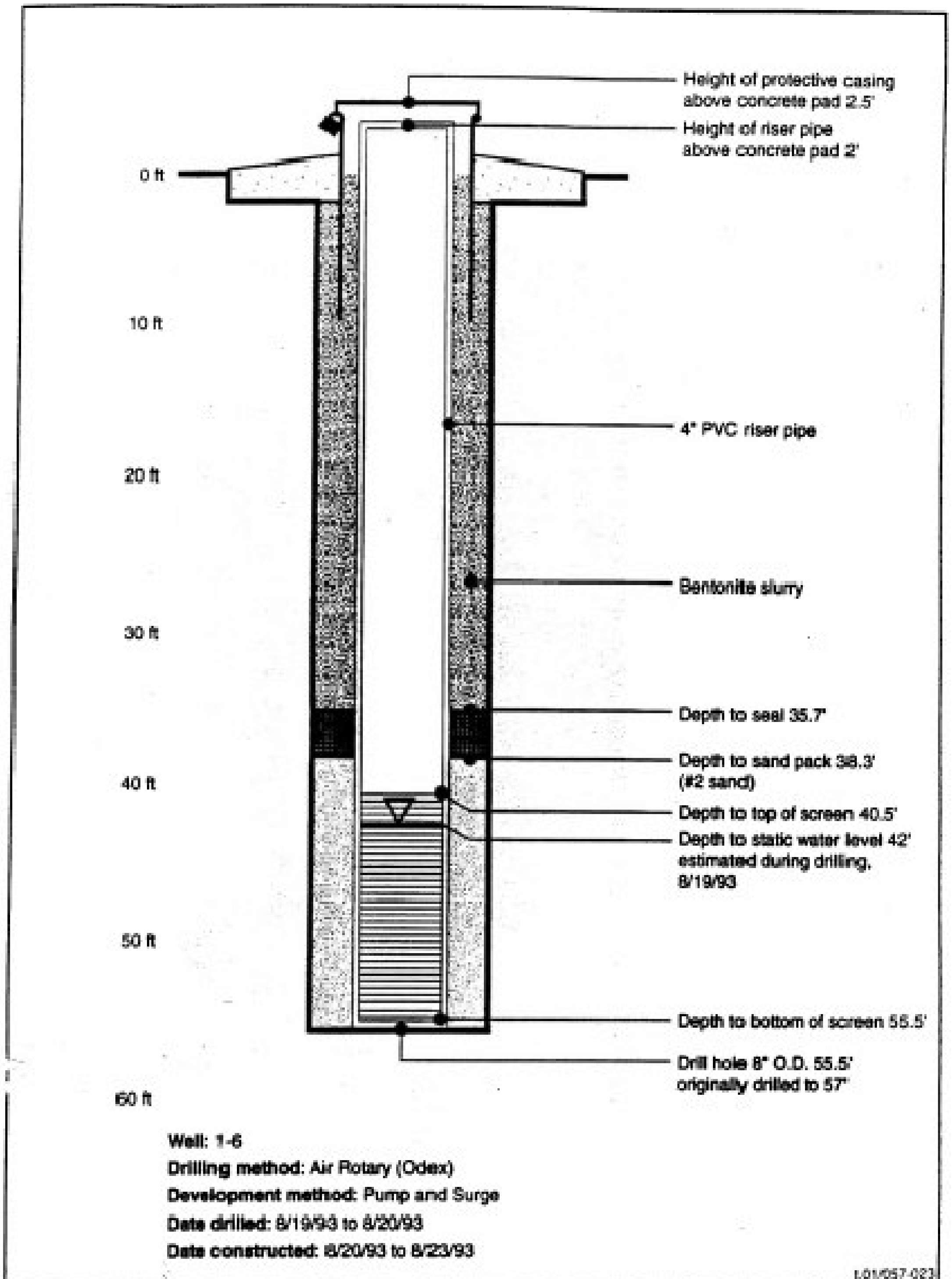
Page 2 of 2

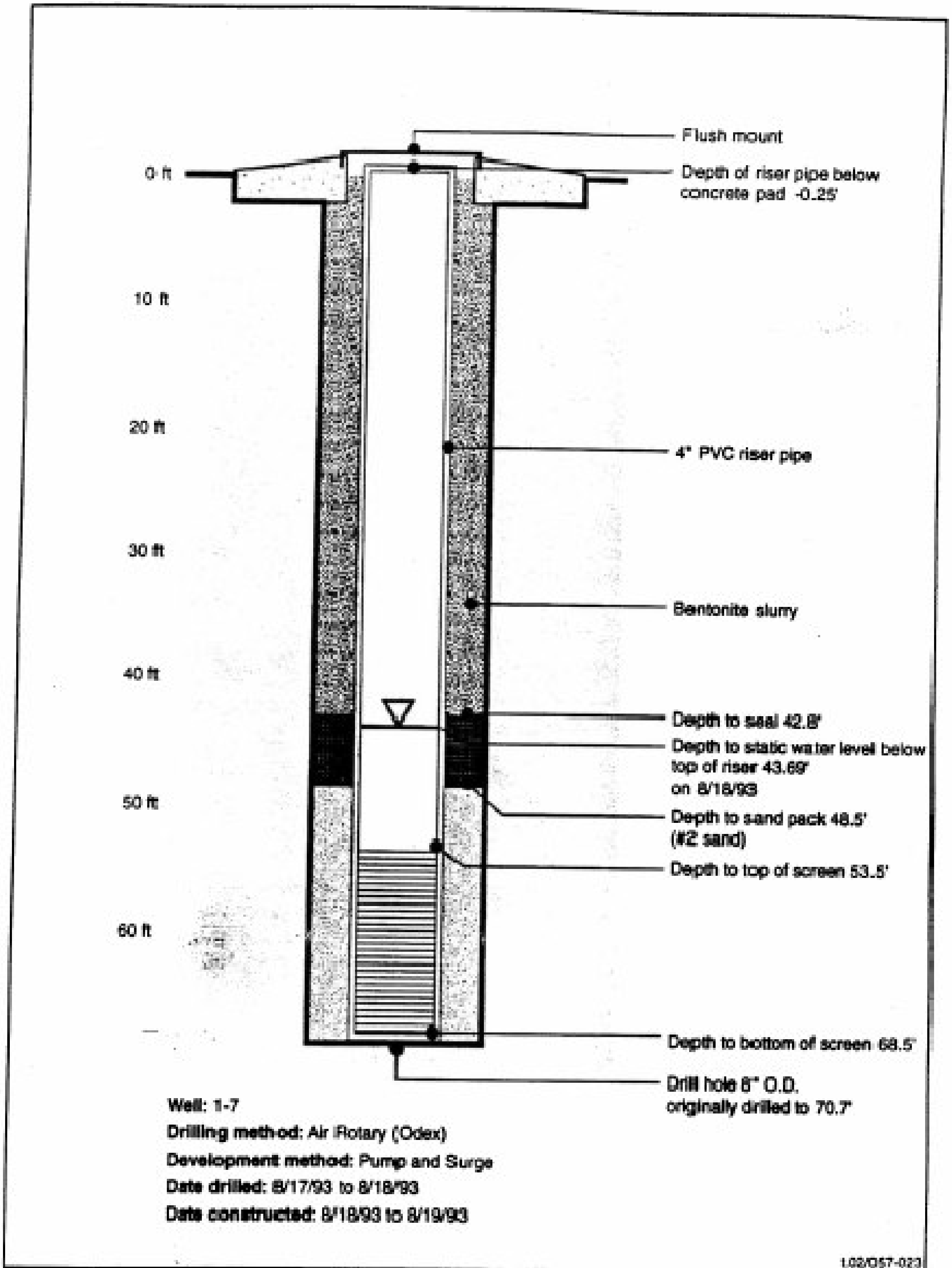
Depth Feet	Blow Count	Sampler	Re-covery/ RQD.	Overburden/Lithologic Description	PID (ppm)	Graphic Log	Well Construction Graphics	Depth Feet	Well Construction Details
				Continued from previous page					
60				Dolomite: dark grey, finely crystalline, argillaceous, abundant fractures filled with calcite.				60	
65				Fracture at 67'				65	
70				Dolomite: dark grey, finely crystalline, argillaceous.				70	
75				Fracture at 75'				75	
80				Dolomite: medium grey, finely crystalline, argillaceous, abundant fractures filled with calcite, trace chert.				80	Bentonite Seal
85								85	
90				Water bearing fracture zone at 90'				90	
95				Dolomite: dark grey, medium crystalline, trace fractures filled with calcite, trace chert.				95	
100								100	Morie #0 sand pack
105				Dolomite: dark grey, finely crystalline, argillaceous, abundant fractures filled with calcite, trace chert.				105	
110								110	
115				Water bearing fracture zone at 115'				115	
120								120	
125								125	Cavings
130								130	Total depth 131.0
135								135	
140								140	



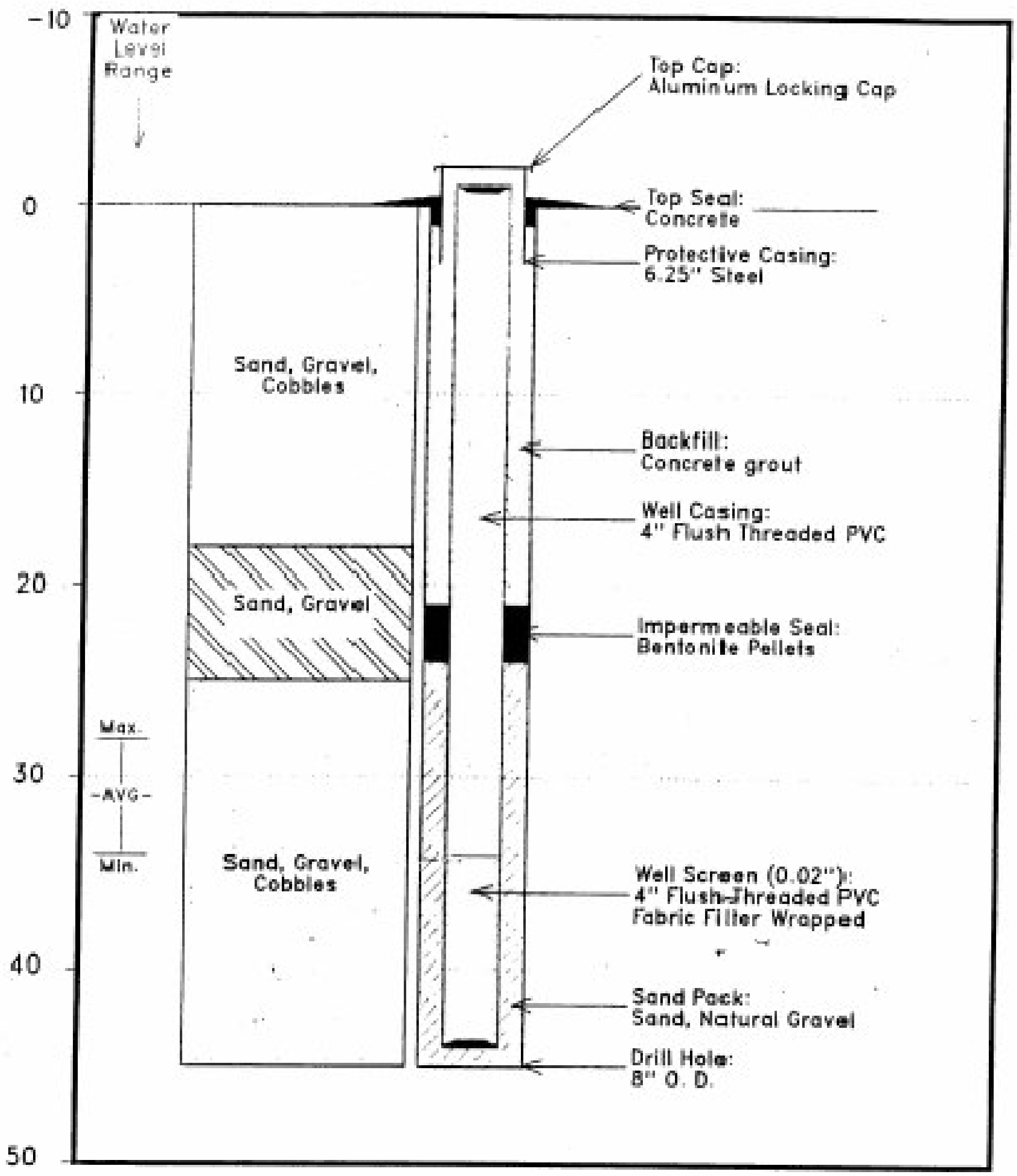
Form RWA-66-1 (02/90)

r.e. wright associates, inc.


Height of protective casing above concrete pad 2.5'
Height of riser pipe above concrete pad 2'
0 ft
10 ft
20 ft
30 ft
40 ft
50 ft
60 ft
4" PVC riser pipe
Bentonite slurry
Depth to seal 35.7'
Depth to sand pack 38.3' (#2 sand)
Depth to top of screen 40.5'
Depth to static water level 42' estimated during drilling, 8/19/93
Depth to bottom of screen 55.5'
Drill hole 8" O.D. 55.5' originally drilled to 57'
Well: 1-6
Drilling method: Air Rotary (Odex)
Development method: Pump and Surge
Date drilled: 8/19/93 to 8/20/93
Date constructed: 8/20/93 to 8/23/93
L01/057-023


Flush mount
0 ft
Depth of riser pipe below concrete pad -0.25'
10 ft
20 ft
4" PVC riser pipe
30 ft
Bentonite slurry
40 ft
Depth to seal 42.8'
Depth to static water level below top of riser 43.69' on 8/18/93
50 ft
Depth to sand pack 48.5' (#2 sand)
Depth to top of screen 53.5'
60 ft
Depth to bottom of screen 68.5'
Drill hole 8" O.D. originally drilled to 70.7'
Well: 1-7
Drilling method: Air Rotary (Odex)
Development method: Pump and Surge
Date drilled: 8/17/93 to 8/18/93
Date constructed: 8/18/93 to 8/19/93
L02/057-023

PP&L
MARTINS CREEK S.E.S.
MONITORING WELL CONSTRUCTION DETAIL
GWMW 1-8



Installation Date: 11/05/86

A History of Ash Basin 1
PPL Martins Creek SES

by

Bryce F. Payne Jr., PhD
Soil Ecosystems Services, Inc.
2007

Construction and Ash Particle Size Distribution

Basin 1 was constructed in several phases over the period from 1955 to 1985. The earth underlying Basin 1 is gravelly sand with cobbles. Anecdotal reports and the absence of notations or documents to the contrary indicate that there were no encounters with bedrock during construction of the basin. There have never been any subsidences in the basin that would suggest large open channels or developing sinkholes. Currently there are two exterior dikes that define the outer boundaries of the basin, and one median dike that divides the basin into the North and South Ends (see Fig. H-1). There are, however, in fact, three median dikes. Two are currently buried within the ash in what is now the North End.

The original area of the basin was bounded on the north end by the oldest median dike. It covered the southern ≈ 2/3 of the current basin and received comingled bottom (≈20%) and fly (≈80%) ash until 1964 (see Fig. H-2). The final top of the oldest dike was at an elevation of 245'. The lowest area on the original floor of the basin was apparently around 213' elevation.

In 1964 the second median dike was constructed on top of the ash then in the basin, about 200' to the southwest of and parallel to the original median dike (see Fig H-3). The exterior dikes were extended to enclose the current North End. The elevation of the top of these dikes was 250'. Records indicate that this construction occurred in 1964, enclosing roughly the northern half of the current basin. From 1964 onward Basin 1 received only bottom ash. There may have been some exceptional fly ash or other materials placed in Basin 1 during emergencies, but no such exceptional materials were indicated in the available records.

Apparently in 1969 both the first and second median dikes were intentionally breached, presumably to make use of ash storage volume remaining available south of the second median dike. Aerial photos and more recent soil investigations indicate a large channel was formed by water and bottom ash flowing through the breach (see Fig. H-3).

In 1973 the first lift of the median dike apparent today was constructed on top of the ash then in the basin. The exterior dikes north of the new median dike were also raised, setting the boundaries of the current North End. The elevation of the new North End dikes was 258'. The first of the current North-South overflow pipes were built into the new median dike. Those pipes were installed in line with and directly over the channel formed by the earlier breach of the first and second median dikes. In 1975 the North End dikes were raised to their final elevation of 263'.

Bottom ash accumulated in the North End through the 1970's and 80's. Aerial photographs indicate that the main water flows were channeling away from the river side of the basin to the overflow pipes in the median dike. In the late 1980's much of the bottom ash was excavated for use in construction of Basin 4. During that excavation fines were reportedly washed from the bottom ash prior to removal to Basin 4. Other photos (not included in this report) indicate the washed out fines accumulated along the margins of the first median dike. Photos also show that a channel was constructed inside and along the railroad side dike. This constructed channel enhanced the channeling of flows away from the river side of the basin that had developed spontaneously during ash accumulation in the North End. Also in the 1980's the southern corner of the North End began receiving trucked in ash, sediment and debris from cleaning of river water intakes, etc. (see Fig. H-4).

During each of these construction and operational phases the ash entering the basin self segregated as the particles settled out of the incoming slurry. The coarsest particles would remain in the immediate vicinity of the ash slurry inlet. Somewhat finer particles would settle out in channels where flow velocities were still relatively high. The fine bottom and fly ash particles would settle out in the open water areas that accumulated farther from the pipe outlet and outside channels. The finer the particles the farther from the inlet they settled out. Consequently, except in the main channel areas, the basin floor is covered by relatively old, relatively fine ash. The coarse particle and channel areas associated with the outlet of the slurry pipe in the far North End were effective from 1973 on, and especially important from the late 1980's until the fly ash was pumped in Aug-Sep 2005.

Internal Structure

The internal structure of the basin has horizontal and vertical aspects and is the combined result of constructed features and particle size distributions. There are two main constructed features: the oldest median dike and the main flow channel. There are three particle size distribution features: inlet and channel areas where coarse particles predominate, beds or pockets of fine particles, and coarse-fine interfaces between these concentrations of coarse and fine particles.

The first (oldest) median dike is the oldest constructed feature governing movement of water within the basin. That dike is a complete barrier to lateral subsurface flow from the upper ≈1/3 of the basin to any area southward (downstream), with a single exception. There is a water passage through that first dike in the breach intentionally opened in 1969 through both the first and second median dikes. The resulting flush of bottom ash and water through the breach resulted in formation of a channel from north of the original median dike through and into the current South End. Since that time there has been a resultant, large vein of mostly bottom ash through the otherwise fine ash in the South End.

The second constructed feature is the main flow channel. Following excavation of accumulated bottom ash in the late 1980's, water flows were intentionally directed along the railroad side (away from river side of the basin) by construction of a channel. That constructed channel followed roughly the flow pattern of channels that had developed spontaneously during previous operations. Over time the channel filled with relatively coarse bottom ash. The channel was directed to the pipes installed to provide overflow connection from the North to the South Ends of the basin. The channel was constructed into and atop the coarse ash materials that accumulated in the area of the 1969 breach of the first and second dikes. Consequently since construction of that channel there has been a contiguous vein of relatively coarse ash that provides a pathway for subsurface water flow from the far North End to the depression that still exists near the outlet structure in the far South End of Basin 1.

Apparent veining of coarser ash materials is common. There is also horizontal stratification of coarser ash both within and outside the veins. Inclusions of very fine or fly ash within these veins is limited (NOTE: There may be one important exception just upstream of the overflow pipes.)

The fine bottom and fly ash carried farther in standing water and settled out more slowly. Consequently, in contrast to the veining of coarser ash materials, the fine ash in the basin tends to occur in horizontally extensive strata or beds. It appears likely, for example, that most of the area on the floor of the basin from the first (oldest) median dike to the outlet end (the lower ≈2/3 of the basin) is covered with a bed of ≈80% fly, ≈20% bottom ash. Within the bed most of the bottom ash is nearer the center of the first dike and the ash becomes finer with distance from that point. With a couple exceptions, most of the ash above that original bed is bottom ash with a fairly wide range of particle sizes.

Fig. H-1. 6 November 2006 aerial image of Ash Basin 1 PPL Martins Creek SES

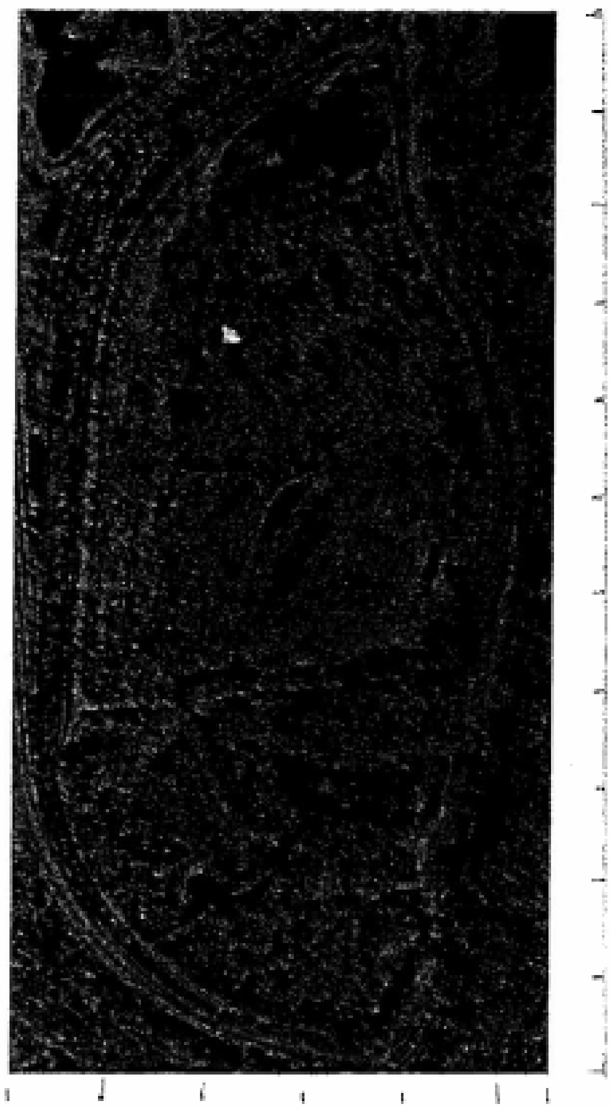
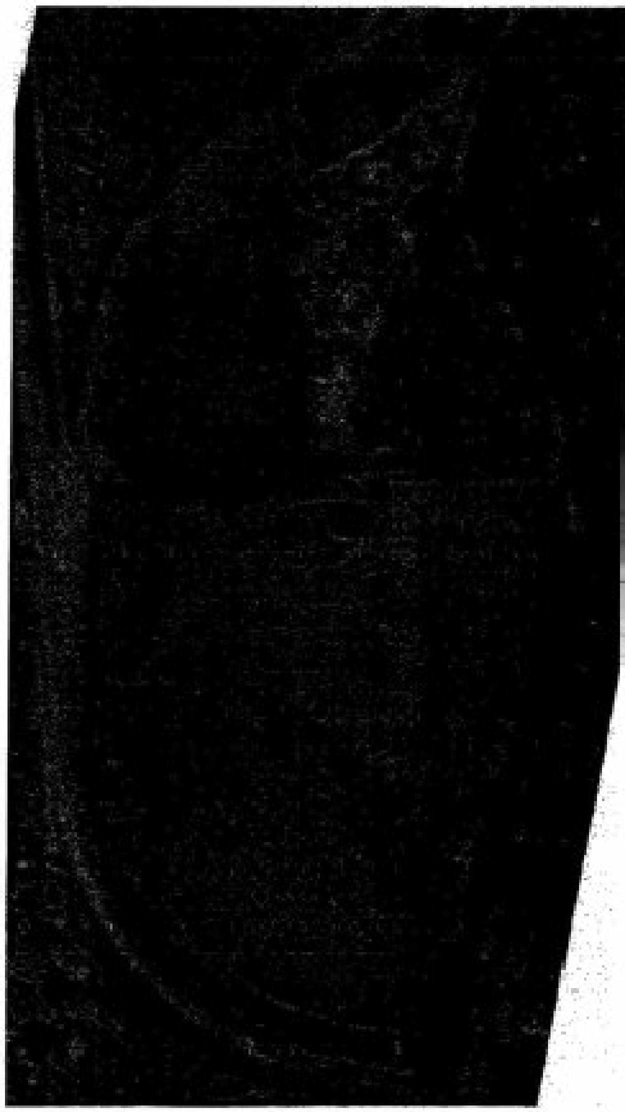
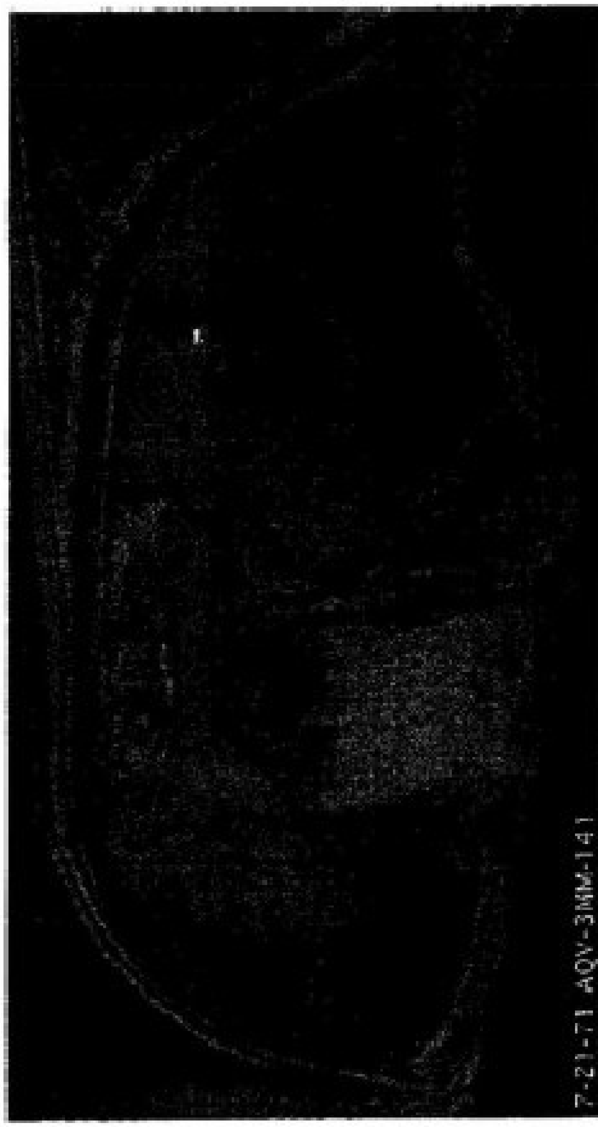


Fig. H-2. 16 October 1958 aerial image of Ash Basin 1 PPL Martins Creek SES



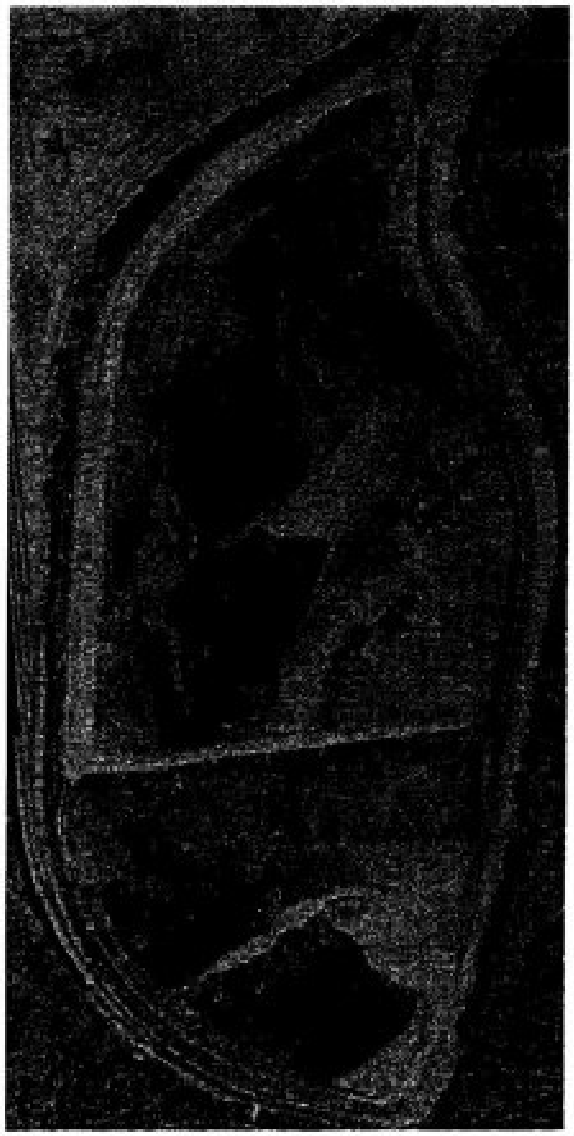
MW 1-7

Fig. H-3. 21 July 1971 aerial image of Ash Basin 1 PPL Martins Creek SES



MW 1-7

Fig. H-4. 29 April 1985 aerial image of Ash Basin 1 PPL Martins Creek SES



2540-PM-WM0366 1/95

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL RESOURCES
BUREAU OF WASTE MANAGEMENT

Coordination #

FORM 7R
HYDROGEOLOGIC INFORMATION

This form must be fully and accurately completed. All required information must be typed or legibly printed in the spaces provided herein. Improperly completed forms may be rejected by the Department, may be considered to be violations of the Department's Rules and Regulations, and may result in assessment of fines and penalties.	DER USE ONLY Application or Facility ID# ______ (Assigned by DER) Stamp Date Application Received COUNTY: SEP 10 1997 FACILITY: FILE CODE:

SECTION A. APPLICANT IDENTIFIER Martins Creek Ash Basin No. 1

Applicant Name: Pennsylvania Power & Light Co.

County: Northampton

Municipality: Lower Mount Bethel Township

Instructions: A narrative description of the general characteristics of the hydrogeology at the proposed site and contiguous properties (down to and including the lowest aquifer that may be affected by the facility) must be submitted, as well as the characteristics listed below. Information, except maps, may be provided on attached 8 1/2 x 11 inch sheets as needed.

SECTION B. HYDROLOGIC CHARACTERIZATION See Attached Narrative

General References: Sections 288.121, 288.122, 288.125, 289.121, 289.122, 289.125, 291.105 and 291.106

Hydrologic characterization of each aquifer will be based upon multiple well aquifer tests when possible; the following determinations must be made and calculations included:

a. Hydraulic conductivities.
b. Storage coefficients for confined aquifers and specific yield for unconfined.
c. Transmissivities.
d. Hydraulic gradients.
e. Ground water velocities.
f. Number of wells, borings, or test pits used.
g. Maximum depth to regional water table or piezometric surface within the site with date of measurement.
h. Minimum depth to regional water table or piezometric surface within the site with date of measurement.
i. Twelve month characterization of regional water table fluctuations, within the uppermost aquifer (four consecutive quarters).
j. Description of perched or special water table conditions including seasonal high water table.
k. Minimum depth to any perched water. N/A
l. Effects of any deep mines in the area. N/A
m. Directions of ground water movement (shown on Phase I base maps) including description of how determined.
n. Uses of aquifers.
o. Ground water divides (shown on Phase 1 base maps)
p. Three-dimensional ground water flow with discharge/recharge characteristics.

SECTION C. PROPOSED GROUND WATER QUALITY MONITORING POINTS

Proposed Ground Water Quality Monitoring Points (wells, piezometers, etc.) must be described in the follow[illegible] fo[illegible]nat and are subject to Department approval. Proposed monitoring points are to be permanently numbered in consecutive order. [illegible] or "D" should be added to the monitoring point number to identify upgradient/downgradient. For existing monitoring points, inf[illegible]tion is to be based upon data obtained at completion; for new monitoring points, construction information is to be based upon [illegible]cations. Monitoring wells will be designed, constructed, and maintained in accordance with Sections 288.251, 291.521 and 289.26[illegible] [illegible]ting to general requirement(s)), Sections 288.252, 292.522 and 289.262 (relating to number, location and depth), and Sections 28[illegible], 291.523 and 28[illegible]3 (relating to standards for casing of wells) and consistent with the requirements of Form R18 (relating to Phase II Water Quality Monitoring System information). Any proposed surface water monitoring point must have adequate flow to allow sampling even in the driest quarter of the year.

2540-PM-WM0044 1/98

SECTION C. (Continued)

ALL MONITORING POINTS MUST HAVE AN ASSOCIATED LATITUDE AND LONGITUDE DETERMINED ACCURATELY TO THE NEAREST ONE TENTH OF A SECOND (DD° MM' SS.S")

Wells and Piezometers

Monitoring Point Number	Drilling Method	Depth (Ft)	Borehole Diameter (in.)	Casing		Location		Measuring Point Elevation (Ft/MSL)
				Diameter (in.)	Screened Interval (ft)	Latitude	Longitude	
2-1N	Rotary	131	8	4	40	40°48'00"	75°07'06"	299.67
1-6	Rotary	55.5	8	4	15	40°47'26"	75°06'52"	244.87
1-7	Rotary	68.5	8	4	15	40°47'27"	75°06'49"	247.84
1-8	Rotary	45	8	4	10	40°47'38"	75°06'40"	242.50

Springs, Streams, Other Surface Water

Monitoring Point Number (Spring or Surface Water)	Elevation (Ft/MSL)	Flow Rate (GPM)	Date of Measurement	Location	
				Latitude	Longitude

SP - Spring
ST - Stream
S.W. - Surface Water

SECTION D. GROUND WATER QUALITY DESCRIPTION   SEE ATTACHED NARRATIVE

Items 3 and 4 (below) pertain only to Residual Waste Landfills and Disposal Impoundments and Land Application Sites; not to Composting Facilities, Transfer Stations, Storage Facilities, Incinerators or other Processing Facilities.

An application for a residual waste landfill or disposal impoundment must contain a description of the chemical characteristics of [illegible] aquifer in the proposed permit area and adjacent area, based upon at least two quarters of monitoring data, one of which shall be in the season of highest local groundwater levels of monitoring data. This requires at least two (2) sets of analyses on approximately a 90 [illegible] interval in the format of Form 8R. Proposed Mandatory Abatement Trigger Levels must be indicated in the designated column of Form [illegible]

An application for a residual waste land application site may, at the Department's discretion, require a desc[illegible] of the chemical characteristics of each aquifer in the proposed permit area and adjacent area based upon at least two (2) sets of analyses for consecutive quarters (except land disposal) in the format of Form 9R. For land disposal, three consecutive sets of analyses on monthly intervals are required. Proposed Mandatory Abatement Trigger Levels must be indicated in Form 9R.

Recycled Paper

SECTION E. SURFACE WATER INFORMATION See Attached Narrative

The application must contain a description of surface waters in the proposed permit area and adjacent areas including the questions posed below. The surface water information shall be based on a sufficient number of observations, calculations, weir, or flow meter readings and sample analyses to allow an accurate characterization of the physical, chemical, and biological characteristics of the surface waters.

Does the application include a description and map of the watershed in which the proposed permit area is located and other watersheds which may be affected by the proposed facility (including streams, springs, or wetlands that are representative of the surface and ground water system of the general area)?

Are surface elevations and rates of flow of streams, springs, seeps, and mine discharges in the proposed permit area and adjacent area included?

Is a description of the quality of surface waters which will receive flows from the surface or ground water of the proposed permit area included?

The following is not required for land application sites.

Has a description of the in-stream macroinvertebrate community in surface waters above and below the proposed permit area (within appropriate limits) been attached? Survey methods should follow the Department's Standardized Benthic Macroinvertebrate Field Collection Methods. The survey report should include the name and address of the biologist performing the survey.

See Attached Narrative

MARTINS CREEK SES
ASH BASIN NO. 1
FORM 7R
HYDROGEOLOGIC INFORMATION

NARRATIVE

Ref: "Environmental Assessment of Ground Water and Surface Water Quality - Basin No. 1, Martins Creek SES" by Nittany Geoscience, Inc., March 1994 - Included with Application.

Monitoring wells installed around Ash Basin No. 1 were not hydraulically tested and therefore most of the information requested in Section 1 is unavailable. The following section on hydrogeology provides regional and local information that is available. Drawing D-242663, Sheet 4, shows the ground water contours across the site and the basin's ground water monitoring wells. Ground water monitoring information has been submitted quarterly to the department for years.

1.0 HYDROGEOLOGY

1.1 Regional Hydrogeology

Ground water in the Valley and Ridge Physiographic Province is generally a subdued replica of the surface topography, with ground water flowing from recharge zones at higher elevations (greater potential) to discharge zones at lower elevations (less potential). Ground water may either eventually discharge to the surface as seeps, springs, and/or streams, or continue flowing as a component of deeper flow in a larger ground water system.

The flow of ground water in the folded bedrock of the Great Valley Section of the Valley and Ridge Province is controlled primarily by joints, faults, and bedding plane partings. Enlargement of both primary and secondary openings may occur through dissolution or chemical weathering of the rock material, which is the case in the carbonate rocks that underlie Basin No. 1 and the surrounding area.

Vertical to sub-vertical planes of fracture concentration are present in the Paleozoic rocks underlying the site. These zones often represent discrete pathways for enhanced ground water movement. Because they are nearly vertical, their expression on the land surface is a linear feature, regardless of the local topographic relief. Fracture traces, visible on air photographs, are natural linear-drainage, soil-tonal, and topographic alignments which are probably the surface manifestation of underlying zones of bedrock fracture (Lattman & Parizek, 1964). Interconnection of these fractures with bedding plane apertures provides reservoirs for ground water storage and pathways for ground water migration. Figure 2-5 illustrates fracture traces which were mapped in the SES and surrounding area. The relationship of the regional fracture traces to Ash Basin No. 1 is illustrated in Figure 2-6, which shows nine linear features that intersect the basin.

1

FIGURE 2-5
Regional fracture traces on 1991 base-photo of the Martins Creek SES.

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NITTANY GEOSCIENCE INC.

2-13

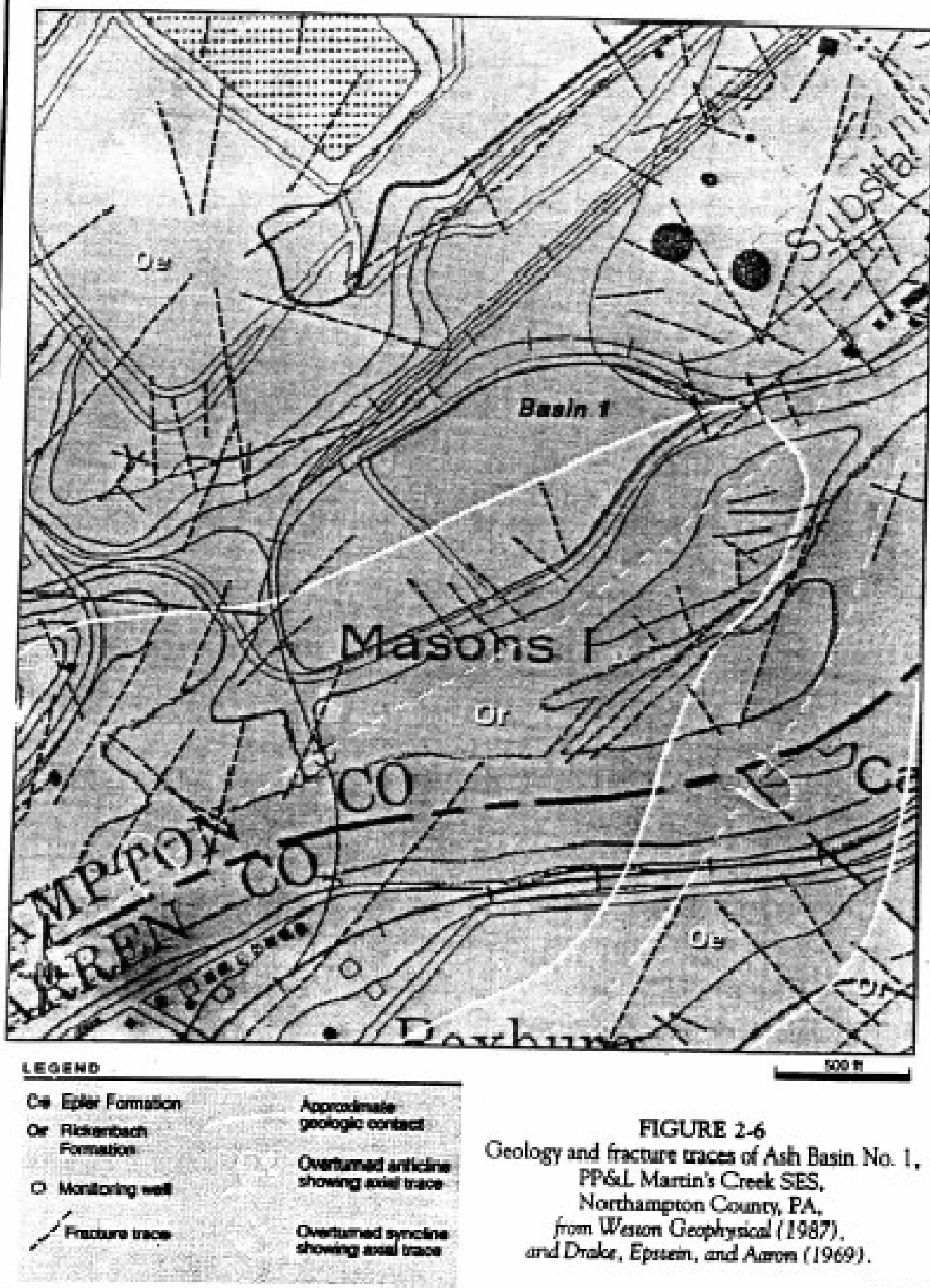


FIGURE 2-6
Geology and fracture traces of Ash Basin No. 1,
PP&L Martin's Creek SES,
Northampton County, PA,
from Weston Geophysical (1987),
and Drake, Epstein, and Aaron (1969).

21/057-15

NITTANY GEOSCIENCE INC.

2-14

Ground water levels fluctuate in response to the relative amounts of recharge to, and discharge from, the ground water flow system. Water levels generally peak in the early spring months following the spring thaw, late February to March, and preceding the onset of vigorous plant growth in April and May. Water levels steadily decline through the summer to October, the time of the first killing frost, as increased evapotranspiration inhibits recharge to the ground water system. Recharge may then occur until the ground freezes, therefore inhibiting the infiltration of precipitation.

Several geologic units have been identified underlying Ash Basin No. 1. These units form two major aquifers controlling ground water flow and movement in the vicinity of Ash Basin No. 1. The shallower of the two, referred to as the sand and gravel aquifer, includes sand and gravel deposits and weathered bedrock. Underlying the sand and gravel aquifer is the bedrock aquifer, consisting of relatively competent fractured bedrock of various lithologies. Along the basin's northeast margin, deposits of cobbles and boulders have been identified. These deposits occur between two sand and gravel deposits, with weathered bedrock below.

1.2 Local Hydrogeology

Sand and Gravel Aquifer

The sand and gravel aquifer is the uppermost aquifer and is composed primarily of sand and gravel deposits. This aquifer lies directly above bedrock across most of the site, except along the northeast end of Basin No. 1. In this area, the geologic log for MW 8 identifies a deposit of boulders and cobbles overlying bedrock, with the sand and gravel overlying the boulders and cobbles. The geologic log for MW 1-8 identifies deposits of sand, gravel, and cobbles, with an interbed or lens of sand and gravel. Bedrock was not encountered during the 50 feet of drilling for this well. The coarser deposits observed in these two wells may possibly represent a buried paleostream channel. Table 2-1 is a summary of the various hydrostratigraphic units identified at the Martins Creek SES Ash Basin No. 1 site. Included in the table are ranges of typical hydraulic conductivities and porosities for a sand and gravel aquifer. Site-specific hydraulic parameters are not available.

The sediments making up the sand and gravel aquifer beneath the basin and surrounding area are generally mixed fine to coarse sand, fine to coarse rounded gravel, and rounded cobbles and boulders. These deposits range in thickness from 27 and 32 feet near MW 6 and MW 7, to greater than 50 feet at MW 1-8.

Occurring directly beneath the mixed coarse sediment deposits is weathered bedrock, containing rock fragments, open fractures, and sediments derived from weathered parent material. The parent bedrock underlying the northwestern one-third of the basin consists of limestone with some interbedded dolomite. The southeastern two-thirds of the basin is underlain by predominantly dolomite.

The depth of weathering for each of these lithologies is unknown due to the limited depths of the wells drilled for the Ash Basin No. 1 area.

The depth to water in the sand and gravel aquifer ranges from approximately 3 to 35 feet below the surface along the eastern side of the impoundment. Figure 2-7 is a ground water elevation map of the Ash Basin No. 1 area, constructed from water level data of November 11-17, 1992. The monitoring well system contains one upgradient well (MW 2-1N) and three downgradient wells.

TABLE 2-1

Hydraulic Characteristics of the
Hydrostratigraphic Units
Martins Creek SES, Ash Basin No. 1

Unit	Hydraulic Conductivity (ft/day)*	Porosity (%)*
Sand and Gravel	10^{-1} to 10^{3}	25 - 40
Limestone/Dolomite	10^{-4} to 10^{-4}	5 - 50

* *Values obtained from Freeze and Cherry, 1979*

(MW 1-6, 1-7, and 1-8)*. The upgradient well is completed in bedrock and is located northwest of Basin No. 2. The three downgradient wells are distributed along the basin's eastern perimeter between the basin and the Delaware River. All monitoring wells are screened below the zone of seasonal and yearly ground water fluctuation. This indicates that well position and screen length were adequately chosen to monitor the aquifer.

Monitoring well MW 1-8 is the only well constructed entirely within the sand and gravel aquifer. Wells MW 6, 7, and 8 are constructed primarily within the sand and gravel aquifer, with a small portion of the wells constructed within the bedrock. MWs 1-6 and 1-7 were installed to replace MWs 6 and 7 and basically penetrate the same materials and were completed to the same subsurface layer. Small seasonal and yearly fluctuations in ground water elevations across the site indicate the sand and gravel aquifer to be a relatively static system (Figure 2-8).

Perturbations of the water-level contours indicate that Basin No. 1 is affecting ground water beneath the site. A component of radial flow in the flow field is observed along the southeast end of the basin, as the contours are apparently bowing towards the river. A steep gradient is observed between the river and

* New Wells 1-6 and 1-7 installed since 1992.

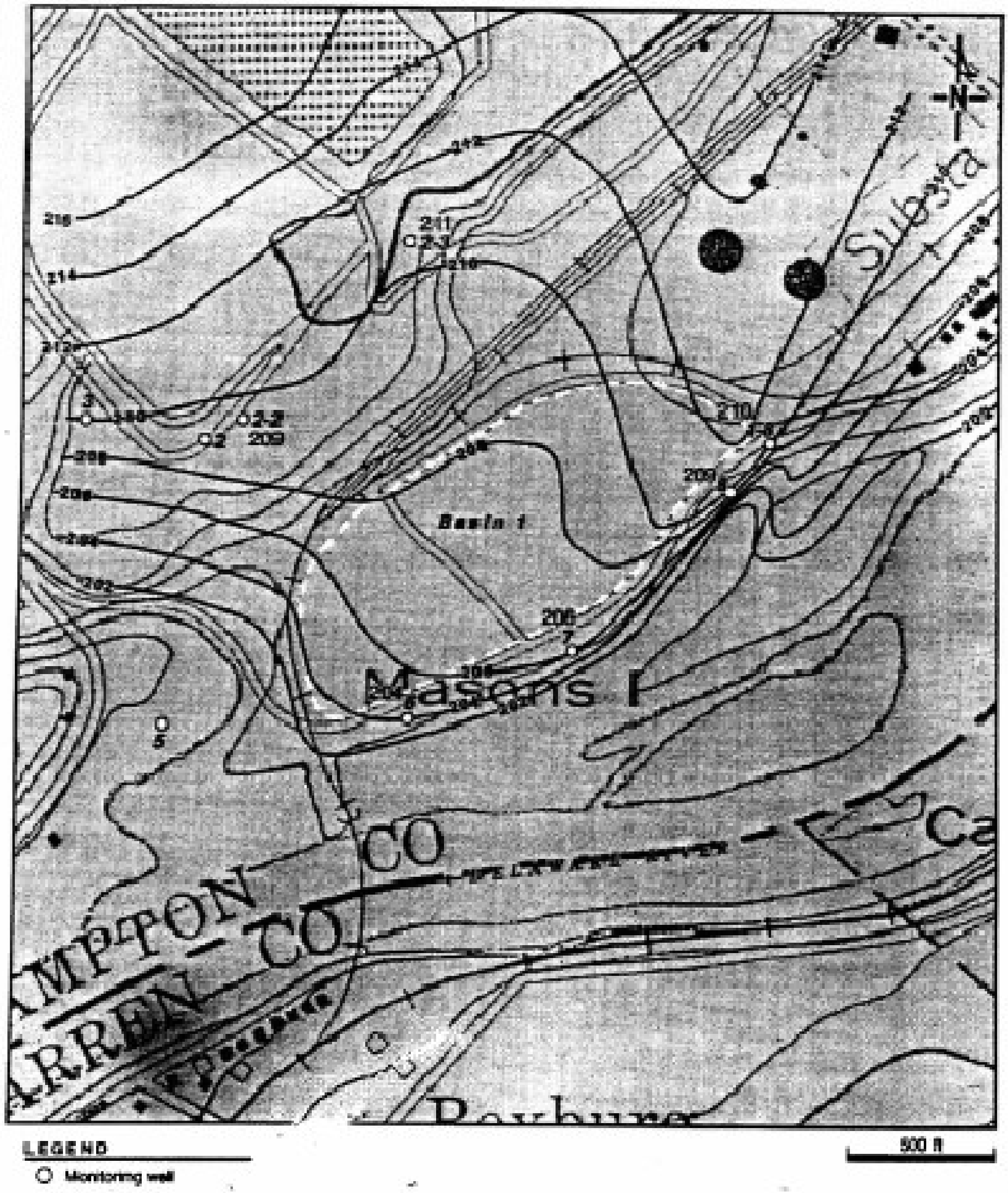


FIGURE 2-7
Groundwater elevation map, at Basin No. 1,
November 11-17, 1992,
PP&L Martin's Creek SES, Northampton County, PA.

08/057-15

NITTANY GEOSCIENCE INC.

2-17

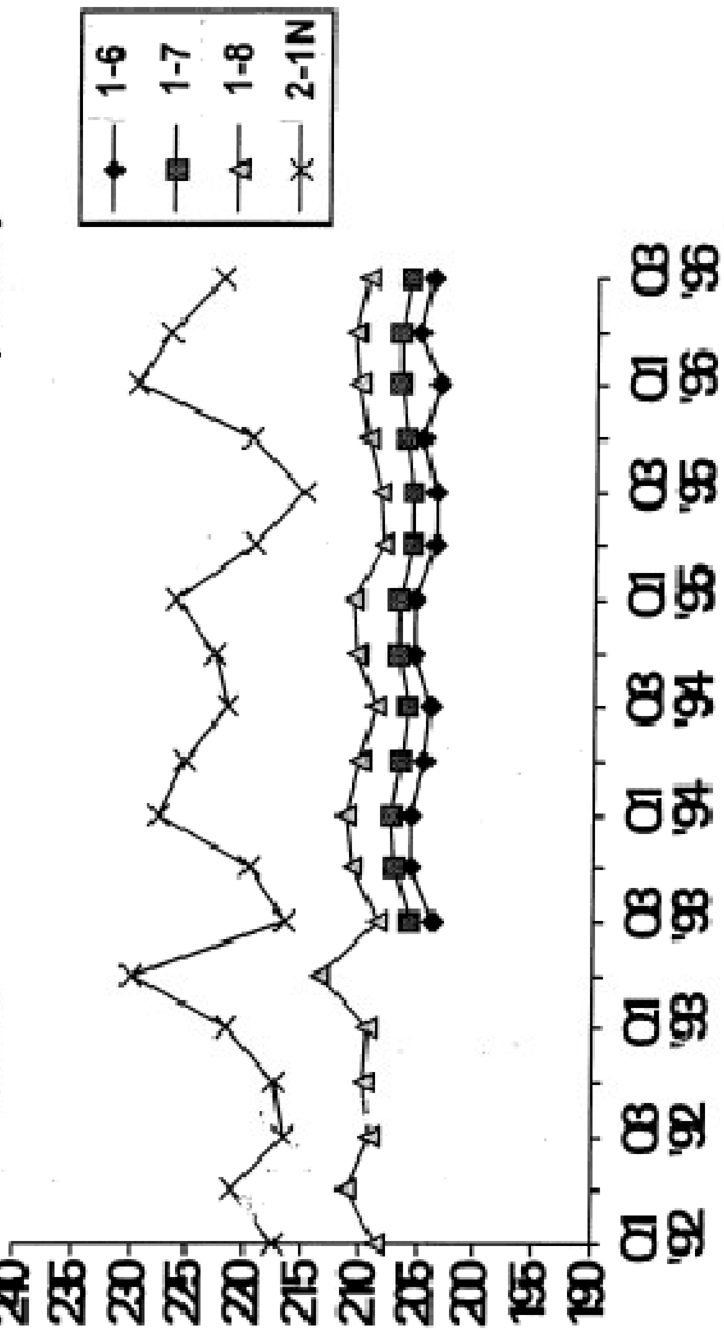


Figure 2-8
Martins Creek Basin No. 1 Water Elevation (Ft-MSL)

monitoring wells MW 8 and MW 1-8. The sluice-pipe inlet for Basin No. 1 is located in the upper portion of the basin near these wells, and the water levels observed in these wells may indicate the presence of a ground water mound created near the input from the sluice pipe. Based on the ground water elevation contour map, it appears that ground water in the sand and gravel aquifer discharges to the river. Some of the ground water is discharged along the basin's southeast margin, with other of the ground water flow directed southwest, subparallel to the river along the terrace. Ground water flowing in this direction might possibly be intercepted by domestic wells prior to reaching the river.

Bedrock Aquifer

Underlying the sand and gravel aquifer is the bedrock aquifer. This aquifer is composed of generally steeply dipping, southwest-northeast striking, competent limestone and dolomite. Bedrock beneath the northwestern one-third of the basin consists of limestone and interbedded dolomite (Epler Formation). The remaining southeastern two-thirds of the basin is underlain by dolomite (Rickenbach Formation). Table 2-1 is a summary of the various hydrostratigraphic units identified at the Martins Creek SES Ash Basin No. 1 site. Included in the table are ranges of typical hydraulic conductivities and porosities for the bedrock aquifer. Site-specific hydraulic parameters are lacking, because only one of the Basin No. 1 monitoring wells is constructed solely within the bedrock aquifer, and hydraulic testing of this well has not been performed.

Monitoring well MW 2-1N is the only well completed entirely in bedrock. Seasonal and yearly fluctuations in ground water elevations since indicate a maximum fluctuation of approximately 15 ft. (Figure 2-8). Water elevations in this bedrock monitoring well ranges from approximately 215 to 230 Ft-MSL.

The gradient of ground water flow in the bedrock aquifer is unknown due to the lack of deep monitoring wells. Upward gradient is expected in the vicinity of Ash Basin No. 1, as the river represents the major discharge point for ground water in the region. Upward flow from the bedrock aquifer would exploit steeply-inclined bedding plane partings, and near vertical zones of fracture concentration. Ground water from the bedrock aquifer probably discharges upward into the overlying sand and gravel aquifer, which then discharges to the river.

1.3 Regional and Background Ground Water Quality

In order to accurately determine the eff[illegible] of the basin on ground water, it is first necessary to characterize the upgra[illegible] (background) water quality. Well 2-1N, which serves as the upgradient well for regulatory purposes, was most appropriate as a source of background data. This well yields waters which typical of waters of the region and is not impacted by the operation of any ash disposal faciity. However, nearby farming practices sometimes causes high nitrate levels.

These data were compared to regional water quality data for the aquifers which underlie the basin as shown on Table 2-2. The carbonate aquifers yield hard to very hard, slightly alkaline water with appreciable calcium, bicarbonate, sulfate, iron, manganese nitrate, sodium, and moderate dissolved solids. The sand and gravel aquifer yields soft, slightly alkaline water with appreciable iron, sodium, and sulfate, with low dissolved solids.

2.0 SURFACE WATER QUALITY

PP&L, in cooperation with DER, has conducted annual environmental monitoring studies of the Delaware River to determine the effect of the entire Martins Creek SES on river quality. None of these surface water studies specifically target the area around Basin No. 1. The scope of these studies was to assess the overall impact of the Martins Creek SES on water quality and biota of the Delaware River in the vicinity of the SES. Some sampling points in the broader studies were located near the basin and can be used to categorize water quality in the vicinity of the basin (Appendix E of the Nittany Report).

Surface water quality results collected concurrently with biological sampling indicated that chemical impacts on water quality due to Martins Creek SES operations were not significant.

A biological survey of the Delaware River in the vicinity of the Martins Creek SES was conducted in August 1989 (most recent data available) during low flow conditions. Results of the survey concluded that discharges from the Martins Creek SES were not adversely affecting the fish community or benthic fauna of the Delaware River in the vicinity of Martins Creek SES.

A copy of the study report "Environmental Monitoring and Surveillance Program - Delaware River in the Vicinity of Martins Creek Steam Electric Station - 1989 Studies" is included with this application. This report documents the results of biological studies along the river near the plant.

In addition, the latest surface water sampling data for the river is appended to this narrative.

ADS6.el(G:misc)

Attachment

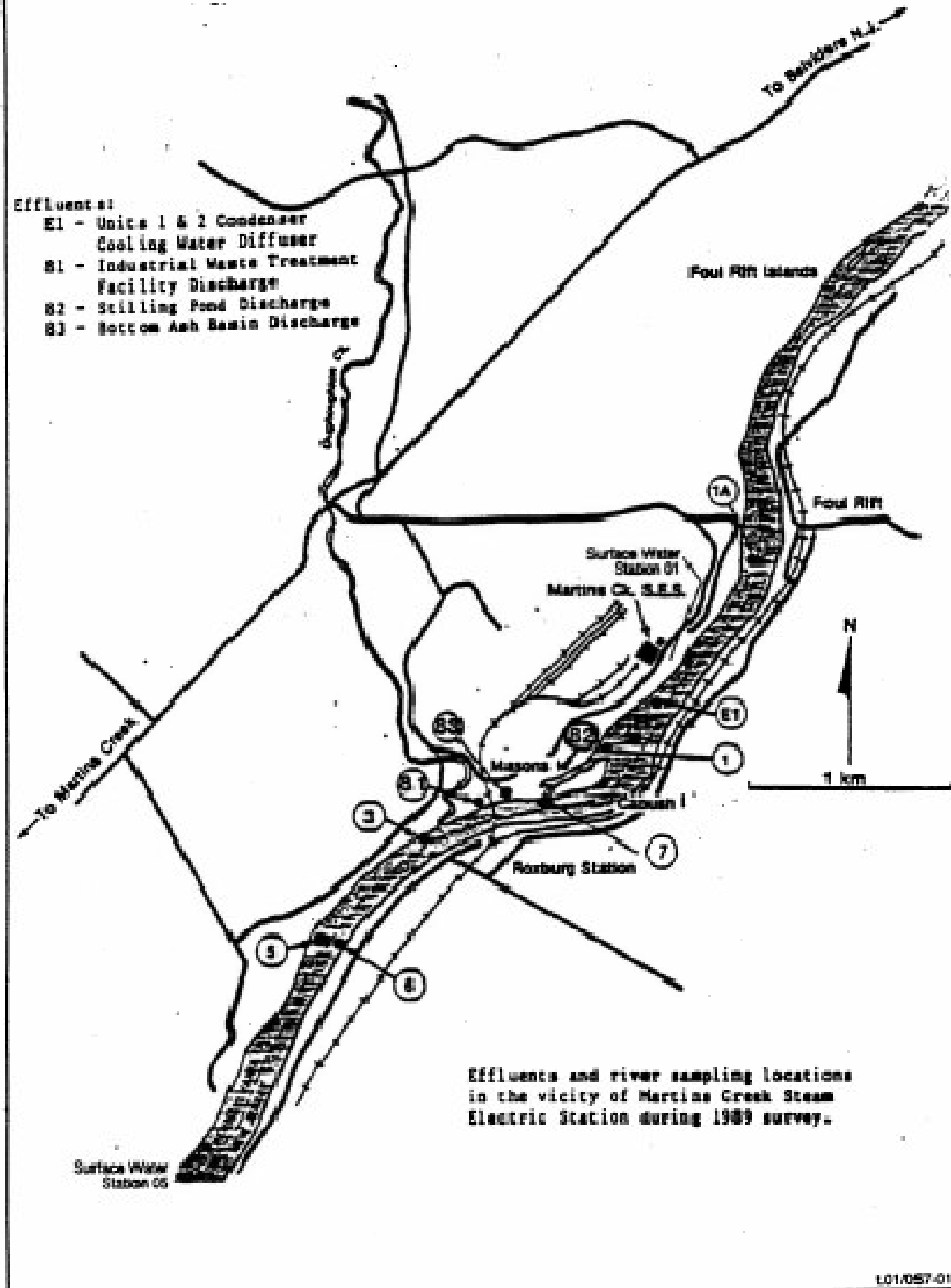
TABLE 2-2
Average Background Groundwater Quality Data
Carbonate and Glacial Aquifers of
Southeastern Pennsylvania

Aquifer Type	pH	Hardness	Bicarbonate	Calcium (Ca)	TDS†	Specific Conductance (µmhos/cm)	Chloride (Cl)	Iron (Fe)	Manganese (Mn)	Nitrate as N	Silica (SiO_2)	Sodium (Na)	Sulfate (SO_4)
Carbonate*	7.8	185	168	–	227	355	7.8	0.04	<0.01	14.0	–	4.2	25.0
Carbonate**	–	239	222	61	304	–	20	0.18	20	21	15	12***	33
Sand and Gravel*	7.2	40.0	23.0	–	78.0	317	4.0	4.4	<0.01	0.8	–	4.4	10.0

* Median values (in mg/L) from R. E.Wright & Associates, 1982
** Average values for limestone, dolomite, and marble, from Hall, 1934
*** Sodium and potassium
† Total Dissolved Solids
All units in mg/L unless otherwise noted

d.01/057-015

RIVER WATER QUALITY DATA



NITTANY GEOSCIENCE INC.

Martins Creek SES Surface Water Site 1
Analytical Results from Station 01
[illegible]

Station	Date	Aluminum-Tot	Ammonia, as N	Arsenic-Tot	Beryllium-Dis	Beryllium-Tot	Calcium-Dis	Cadmium-Tot	Chloride-Tot	Chromium-Tot
01	[illegible]	9.2	0.28	0.003		-0.004	13.7	0.00003	7.9	-0.01
01	[illegible]	0.8	0.15	0.005	-0.001		47.4	-0.0002	17.6	
01	[illegible]	0.75	0.02	0.127			24.3	-0.0002	14.6	-0.004

Station	Date	Chromium (VI)	Copper-Tot	Iron-Tot	Lead-Tot	Magnesium-Dis	Manganese-Tot	Nickel-Tot	Nitrate, as N	Nitrite-Tot
01	[illegible]		0.013	3.17	-0.004	2.7	0.18	0.006	0.60	
01	[illegible]	-0.01	-0.01	0.28	0.0005	6.8	-0.02	-0.020	0.08	0.41
01	[illegible]		-0.03	0.29	-0.004	4.5	0.02	-0.05	0.29	1.29

Station	Date	Nitrite, as N	Phosphorus-Tot	Potassium-Dis	Selenium-Tot	Sodium-Dis	Sulfate-Tot	Thallium-Dis	Thallium-Tot
01	[illegible]		0.30		-0.005		88.2		-0.2
01	[illegible]		0.03		0.0055		60	-0.3	0
01	[illegible]	0.012	0.21	2.4	0.008	25.2	53.1		-0.1

Station	Date	Zinc-Tot	Acid, as CaCO3	Air Temperature °C	Alkalinity, methyl orange, CaCO3	Alkalinity, phenolphthalein, CaCO3	Alkalinity-Tot	Dissolved Oxygen, Field	Collection Time in hours
01	[illegible]	0.028	3.4	28	1			7.2	1030
01	[illegible]	-0.01	0		35	2		7.4	920
01	[illegible]	0.01		26.6	45	4	45	7.6	1105

Station	Date	Color, pt-c	Field pH	Hardness as CaCO3	Hardness, as Calcium	Lab pH	Solids, Dissolved estimated	Solids, Dissolved 105 °C
01	[illegible]		8.1	45.4		12		
01	[illegible]		7.8	138.7	118.5	17.8		250
01	[illegible]	5	7.66	79.3	60.6	8	151.1	217

Station	Date	Solids, Dissolved 180 °C	Solids-Tot	Specific Conductance Field, umhos/cm	Specific Conductance Lab, umhos/cm	Suspended Solids	Turbidity, as NTU	Water Temperature °C
01	[illegible]	84.2	91.8	188	321	3.3	8	28.5
01	[illegible]		219	382	711	18	6.5	28.3
01	[illegible]		226	260	280	11.4	8.2	29.4

Note: Blank = not analyzed
ND = not detected, detection limit unknown
Negative values indicate non-detects (values correspond to detection limits)

Martins Creek SES Surface Water Site 8
Analytical Results from Stations 3, 5, 6, 7, 1A, 02
Unless otherwise noted, values in mg/l

Station	Date	Aluminum-Tot	Ammonia, as N	Arsenic-Tot	Beryllium-Dis	Beryllium-Tot	Cadmium-Tot	Calcium-Dis	Chloride-Tot	Chromium-Tot	Chromium (VI)	Copper-Tot
03 03 03 03	6/13/2006 7/21/06 7/26/07 6/21/08	-0.2 -0.2 -0.2 0.26	-0.05 -0.05 0.46 [illegible]	-0.001 -0.02 0.041 0.001	-0.001	-0.001 -0.001	-0.0002 -0.0002 -0.0002 -0.0002	38.2 14.8 18.8	88.6 11.6 9.7 18.1	-0.01 -0.004	-0.01 -0.01	-0.01 -0.01 -0.01 -0.05
05 05 05 05	6/13/2006 7/21/06 7/26/07 6/21/08	-0.2 -0.2 -0.2 0.18	0.06 0.06 0.06 3.2	0.006 0.003 0.013 0.003	-0.001	-0.001 -0.001	-0.0002 -0.0002 -0.0002 -0.0002	11.6 13.2 15.2	8.8 8.8 8.7 20.7	-0.01 -0.004	-0.01 -0.01	-0.01 -0.01 -0.01 -0.05
06 06 06 06	6/13/2006 7/21/06 7/26/07 6/21/08	-0.2 -0.2 -0.2 -0.18	0.32 0.06 0.1 0.44	-0.001 -0.001 -0.001 -0.001	-0.001	-0.001 -0.001	-0.0002 -0.0002 -0.0002	11.3 11.2 14.8	9.11 7.98 8.7 11.6	-0.01 0.0045	-0.01 -0.01	-0.01 -0.01 -0.01 -0.05
07 07 07 07	6/13/2006 7/21/06 7/26/07 6/21/08	-0.2 -0.2 -0.2 0.16	0.09 0.06 0.09 0.21	-0.001 -0.001 -0.001 -0.001	-0.001	-0.001 0.004	-0.0002 -0.0002 0.0002 -0.0002	10.8 11.4 14.7	8.1 8.8 8.1 15.8	-0.01 0.004	-0.01 -0.01	-0.01 0.004 -0.01 -0.05
1A 1A 1A 1A	6/13/2006 7/21/06 7/26/07 6/21/08	-0.2 -0.2 -0.2 0.23	0.03 0.05 0.08 0.22	-0.001 -0.001 -0.001 -0.001	-0.001	0.001 -0.001	-0.0002 -0.0002 -0.00048 -0.0002	11.4 11.8 14.7	9.1 7.8 8.7 17.8	-0.01 -0.004	-0.01 -0.01	-0.01 -0.01 -0.01 -0.05
02 02 02 02	6/13/2006 7/21/06 7/26/07 6/21/08	-0.2 -0.2 -0.2 -0.22	0.48 0.20 0.18 0.24	0.007 0.001 0.002 -0.001	-0.001	-0.008 0.001	-0.0002 -0.0002 0.00034 -0.0002	17.8 27.8 14.8	31.8 15.2 19.4 18.8	-0.01 -0.004	-0.01 -0.01	-0.01 0.012 -0.01 0.05

Note: Blank = not analyzed
ND = not detected, detection limit unknown
Negative values indicate non detects (values correspond to detection limits)

Martins Creek SES Surface Water Site 3 (cont.)
Analytical Results from Stations 3, 5, 6, 7, 1A, 82
Unless otherwise noted, units in mg/L

Station	Date	Iron Tot	Lead Tot	Magnesium Dis	Manganese Tot	Nickel Tot	Nitrate, as N	Nitrate Tot	Nitrite, as N	Phosphorus Tot	Potassium Dis	Selenium Tot	Sodium Dis
03	6/12/2006	0.12	-0.0046		0.03	-0.025	1.09			0.061		-0.0046	
03	7/21/2006	0.1	-0.0046	6.6	0.04	0.009	1.3			0.17		0.0145	
03	7/26/2007	0.07	-0.0046	3.4	0.03	-0.025	0.23	1				-0.0046	
03	8/21/2008	0.16	-0.0046	5	0.03	-0.05	0.56	2.62	0.0004	0.06	1.4	0.002	11.9
05	6/12/2006	0.11	-0.0046		0.03	-0.025	0.82			0.064		-0.0046	
05	7/21/2006	0.16	-0.0046	2.9	0.05	0.046	0.38			0.06		-0.0046	
05	7/26/2007	0.07	-0.0046	2.9	0.03	-0.025	0.16	0.7				-0.0046	
05	8/21/2008	0.13	-0.0046	4.1	0.03	-0.05	0.36	1.72	0.0006	0.06	1.1	-0.001	8.1
06	6/12/2006	0.1	-0.0046		0.03	-0.025	0.82			0.08		-0.0046	
06	7/21/2006	0.17	-0.0046	5	0.06	0.009	0.39			0.05		-0.0046	
06	7/26/2007	0.07	-0.0046	2.8	0.03	-0.025	0.13	0.58				-0.0046	
06	8/21/2008	0.1	-0.0046	4.1	0.03	-0.05	0.37	1.62	0.0004	0.06	1	-0.001	7.9
07	6/12/2006	0.12	-0.0046		0.03	-0.025	0.58			0.066		-0.0046	
07	7/21/2006	0.16	-0.0046	2.7	0.05	0.008	0.35			0.06		-0.0046	
07	7/26/2007	0.07	-0.0046	2.6	0.03	-0.025	0.11	0.6				-0.0046	
07	8/21/2008	0.29	-0.0046	3.6	0.03	-0.05	0.28	1.28	0.0004	0.06	1	-0.001	7.8
1A	6/12/2006	0.42	-0.0046		0.04	-0.025	0.88			0.082		-0.0046	
1A	7/21/2006	0.13	-0.0046	3.6	0.05	0.036	0.35			0.06		-0.0046	
1A	7/26/2007	0.08	-0.0046	3.7	0.03	-0.025	0.09	0.48				-0.0046	
1A	8/21/2008	0.11	-0.0046	3.8	0.03	-0.05	0.31	1.85	0.0008	0.06	1	-0.001	7.7
82	6/12/2006	0.88	-0.0046		0.43	-0.025	2.04			0.138		-0.0046	
82	7/21/2006	0.26	-0.0046	3.9	0.05	0.003	1.88			0.1		-0.0046	
82	7/26/2007	0.18	0.0042	8.2	0.03	-0.025	0.8	2.33		0.07		-0.0046	
82	8/21/2008	0.22	-0.0046	3.8	0.03	-0.05	0.34	1.6	0.0004	0.07	1	-0.005	7.9

Note: Blank = not analyzed
ND = not detected, detection limit unknown
Negative values indicate non detects (values correspond to detection limits)

Martins Creek SES Surface Water Site 3 (cont)
Analytical Results from Stations 3, 5, 6, 7, 1A, 02
Unless otherwise noted, units in mg/l

Station	Date	Sulfate-Tot	Thallium-Dis	Thallium-Tot	Zinc-Tot	Acid, as CaCO3	Air Temperature °C	Alkalinity-Tot	Alkalinity, methyl orange CaCO3	Alkalinity, phenolphthalein, CaCO3	Collection Time in hours
03	6/12/06	47.5		-0.3	-0.01		15		36		950
03	7/21/06	68		-0.3	0.004	1.1	28		67		1005
03	7/26/07	14	-0.3		-0.01	2.3			32	0	1015
03	8/21/08	22.9		-0.1	0.01		24.8	40	46	0	1110
05	6/12/06	28.8		-0.3	-0.01		18.3		33		830
05	7/21/06	12		-0.3	0.02	1.1	28		33		840
05	7/26/07	12	-0.3		-0.01	1.1			28	0	840
05	8/21/08	16.6		-0.1	0.01		24.8	38	38	0	1025
06	6/12/06	27		-0.3	-0.01		15		33		830
06	7/21/06	13		-0.3	0.017	1.1	27		33		850
06	7/26/07	10	-0.3		-0.01	2.3			29	0	848
06	8/21/08	10.3		-0.1	-0.01		24.8	38	38	0	1045
07	6/12/06	2		-0.3	-0.01		18		36		1045
07	7/21/06	-10		-0.3	0.048	1.1	28		24		1015
07	7/26/07	8.4	-0.3		-0.01	2.3			27	0	1020
07	8/21/08	10.8		-0.1	-0.01		29.8	38	27	1	1200
1A	6/12/06	25.5		-0.3	-0.01		23		30		1235
1A	7/21/06	12		-0.3	0.014	1.1	29		28		1145
1A	7/26/07	9	-0.3		-0.01	1.1			28	0	1120
1A	8/21/08	9.7		-0.1	-0.01		29.8	38	37	0	1400
02	6/12/06	68		-0.3	-0.01		28.5		61		1118
02	7/21/06	38.8		-0.3	0.002	1.1	29		57		1110
02	7/26/07	25	-0.3		-0.01	1.1			59	0	1218
02	8/21/08	10.1		-0.1	0.01		27.4	38	56	0	1230

Note: Blank = not analyzed
ND = not detected, detection limit unknown
Negative values indicate non-detects (values correspond to detection limits)

Martins Creek SES Surface Water Site 3 (cont)
Analytical Results from Stations 3, 5, 6, 7, 1A, 82
Unless otherwise noted, units in mg/l

Station	Date	Color, pt-co	[illegible]	Dissolved Oxygen, Field	Hardness as CaCO3	Hardness, as Calcium	Lab pH	Solids, Dissolved estimated	Solids, Dissolved at 500 °C	Solids, Dissolved at 180 °C	Solids Tot
03	5/13/98		7.6	9.8	66		7.4			99.2	101
03	7/21/98		7.65	7.8	102.3		7.6			101.2	100
03	7/28/97		8.1	7	66	37	7.6		100		100
03	8/21/98	10	7.25	8.1	76.1	46.5	7.6	132	132		132
05	5/13/98		7.6	8.5	69.2		7.6			75.8	77.8
05	7/21/98		7.4	7.4	60.4		7.45			68.2	73.1
05	7/28/97		8.1	7	42.4	30.6	7.6		84		104
05	8/21/98	-5	6.81	7.6	58.8	38	7.7	100.8	100		100
06	5/13/98		7.35	9.2	60.2		7.4			79.4	77.8
06	7/21/98		7.25	7.3	40.8		7.3			68.8	68.8
06	7/28/97		8.7	7.1	40.2	28.3	7.3		76		68
06	8/21/98	10	6.63	7.6	53.6	37	7.15	68.8	68		68
07	5/13/98		7.6	9.7	48.8		7.6			72	73.4
07	7/21/98		7.8	8.2	38.1		7.8			82.2	85.6
07	7/28/97		8.5	7.2	40.4	28.6	7.8		66		64
07	8/21/98	-5	7.38	8.2	52.6	38.8	7.3	67.6	78		78
1A	5/13/98		7.6	11.2	54.1		7.6			77.6	76.8
1A	7/21/98		7.25	7.6	40.4		7.7			65.2	65.6
1A	7/28/97		8.8	7.6	38.1	28	7.7		72		64
1A	8/21/98	15	6.96	8.6	52.9	38.9	7.6	67.6	130		130
82	5/13/98		8.8	10	104		8.3			107.6	176
82	7/21/98		7.6	7.4	68.1		7.9			98.2	107.8
82	7/28/97		7.15	7.6	91.2	60.6	8.1		176		150
82	8/21/98	15	6.63	7.6	92.7	37	8.1	97.6	100		100

Note: Blank = not analyzed
ND = not detected, detection limit unknown
Negative values indicate non-detects (values correspond to detection limits)

Martins Creek SES Surface Water Site 3 (cont)
Analytical Results from Stations 3, 5, 6, 7, 11A, 82
Unless otherwise noted, units in mg/L

Station	Date	Specific Conductance Field, umhos/cm	Specific Conductance Lab, umhos/cm	Suspended Solids	Turbidity, NTU	Water Temperature °C
03	[illegible]	130	350	1.8	[illegible]	19
03	[illegible]	280	[illegible]	4.8	4	[illegible]
03	[illegible]		[illegible]	8	[illegible]	28
03	[illegible]	180	170	3.6	[illegible]	[illegible]
05	[illegible]	110	[illegible]	1.5	1	[illegible]
05	[illegible]	110	[illegible]	[illegible]	[illegible]	25
05	[illegible]		[illegible]	10	1	29
05	[illegible]	140	[illegible]	2	[illegible]	24.5
06	[illegible]	110	[illegible]	[illegible]	[illegible]	18
06	[illegible]	120	[illegible]	3.7	[illegible]	26
06	[illegible]		[illegible]	10	[illegible]	[illegible]
06	[illegible]	141	150	1.5	[illegible]	26
07	[illegible]	110	271	1.4	[illegible]	[illegible]
07	[illegible]	113	[illegible]	[illegible]	[illegible]	26
07	[illegible]		245	6	[illegible]	[illegible]
07	[illegible]	150	190	[illegible]	[illegible]	27
11A	[illegible]	100	[illegible]	[illegible]	[illegible]	17
11A	[illegible]	115	[illegible]	2.4	[illegible]	[illegible]
11A	[illegible]	100	[illegible]	12	[illegible]	27
11A	[illegible]	142	145	[illegible]	1.7	[illegible]
82	[illegible]	230	[illegible]	10.8	5	[illegible]
82	[illegible]	120	[illegible]	[illegible]	[illegible]	27
82	[illegible]	257	[illegible]	14	2	28
82	[illegible]	140	155	[illegible]	[illegible]	[illegible]

Note: Blank = not analyzed

ND = not detected, detection limit unknown

Negative values indicate non-detects (values correspond to detection limits)

Martins Creek SES Surface Water Site 39
Analytical Results from Stations 3, 5, 1A
Unless otherwise noted units in mg/L

Station	Date	Aluminum-Tot	Ammonia, as N	Antimony-Tot	Arsenic-Tot	Barium-Tot	Beryllium-Tot	Boron-Tot	Calcium-Tot	Cadmium-Tot	Chloride-Tot	Chloride, as NaCl
03	3/13/92	0.84	0.14	-0.7	0.006	0.037	-0.0004	-0.04	10.98	0.0172	11.5	19
03	6/18/92	-0.06	0.13	-0.7	0.0216	0.031	-0.0004	0.064	18.28	-0.0016	8.6	14
03	9/18/92	0.2107	0.08	-0.7	0.0702	0.048	-0.0004	0.289	29.8	-0.0016	12.1	20
03	12/11/92	0.503	0.11	-0.7	0.0074	0.036	-0.0004		30.6	-0.0016	9.7	16
05	3/13/92	0.3	0.17	-0.7	0.001	0.038	-0.0004	-0.04	11.42	0.0067	11.5	19
05	6/18/92	-0.06	0.12	-0.7	-0.001	0.022	-0.0004	-0.04	17.72	-0.0016	10.3	17
05	9/18/92	0.06	0.13	-0.7	0.001	0.023	-0.0004	-0.04	17.7	-0.0016	11.5	19
05	12/11/92	0.058	0.22	-0.7	0.0016	0.048	-0.0004		25.3	-0.0016	17.5	29
1A	3/13/92	0.08	0.17	-0.7	0.001	0.033	-0.0004	-0.04	9.87	0.0158	10.3	17
1A	6/18/92	-0.06	0.13	-0.7	-0.001	0.031	-0.0004	-0.04	20.21	-0.0016	19.4	32
1A	9/18/92	-0.06	0.18	-0.7	-0.001	0.024	-0.0004	-0.04	12.3	-0.0016	10.2	17
1A	12/11/92	0.16	0.12	-0.7	-0.001	0.023	-0.0004		11.7	-0.0016	9.7	16

Note: Blank = not analyzed
ND = not detected, detection limit unknown
Negative values indicate non-detects (values correspond to detection limits)

Martins Creek SES Surface Water Site 39 (cont.)
Analytical Results from Stations 3, 5, 1A
Unless otherwise noted, units in mg/l.

Station	Date	Chromium-Tot	Copper-Tot	Iron-Tot	Lead-Tot	Lithium-Tot	Magnesium-Tot	Manganese-Tot	Molybdenum-Tot	Nickel-Tot	Nitrate, as N	Nitrate, as NO3
03	3/12/92	-0.011	-0.02	0.66	-0.007	-0.04	3.51	0.14	-0.14	-0.05	0.42	1.88
03	6/18/92	-0.004	-0.02	0.079	-0.01	-0.04	4.77	-0.02	-0.14	-0.05	0.65	2.86
03	9/18/92	0.0085	-0.02	0.17	-0.01	0.047	4.6	-0.02	-0.14	-0.05	1.08	4.80
03	12/11/92	-0.004	-0.02	0.16	-0.01		4.5	0.03		-0.05	0.69	3.04
05	3/12/92	-0.011	-0.02	0.30	-0.007	-0.04	3.53	0.07	-0.14	-0.05	0.88	3.87
05	6/18/92	-0.004	-0.02	0.063	-0.01	-0.04	4.98	-0.02	-0.14	-0.05	1.03	4.57
05	9/18/92	0.0095	-0.02	0.18	-0.01	0.04	5	-0.02	-0.14	-0.05	0.72	3.17
05	12/11/92	-0.004	-0.02	2.68	-0.01		3.9	0.211		-0.05	1.79	7.9
1A	3/12/92	-0.011	-0.02	5.48	-0.007	-0.04	1.78	0.11	-0.14	-0.05	0.35	1.57
1A	6/18/92	-0.004	-0.02	0.063	-0.01	-0.04	0.38	0.052	-0.14	-0.05	0.38	1.73
1A	9/18/92	0.0208	-0.02	0.18	-0.01	-0.04	3.3	0.027	-0.14	-0.05	0.28	1.23
1A	12/11/92	-0.004	-0.02	0.19	-0.01		3.3	0.051		-0.05	0.5	2.22

Note: Blank = not analyzed
ND = non detected, detection limit unknown
Negative values indicate non-detects (values correspond to detection limits)

Martins Creek SES Surface Water Sites 39 (cont)
Analytical Results from Stations 3, 5, 1A
Unless otherwise noted, units in mg/l

Station	Date	Potassium-Tot	Selenium-Tot	Silver-Total	Sodium-Tot	Strontium-Tot	Sulfate, as SO4	Thallium-Tot	Vanadium-Tot	Zinc-Tot	Alkalinity, methyl orange, CaCO3
03	3/13/92	1.5	0.002	-0.02	6.9	0.058	15	-0.011	-0.04	0.02	19
03	6/18/92	-2.78	0.0052	-0.02	8.79	0.118	383.3	-0.012	-0.06	-0.004	37
03	9/18/92	-2.78	0.0145	-0.02	32	0.261	622.6	-0.012	0.114	-0.004	41
03	12/11/92	-2.8	0.0115	-0.02	14.2		468.2	-0.012	0.102	-0.004	51
05	3/12/92	1	-0.001	-0.02	6.8	0.051	14.8	-0.011	-0.04	0.04	21
05	6/18/92	-2.78	-0.0005	-0.02	8.74	0.08	383.3	-0.012	-0.04	-0.004	34
05	9/18/92	-2.78	-0.0005	-0.02	8.8	0.566	148.22	-0.012	-0.04	-0.004	42
05	12/11/92	3	-0.0005	-0.02	10.2		29.7	-0.012	-0.04	-0.004	46
1A	3/12/92	0.8	-0.001	-0.02	6.8	0.008	11	-0.011	-0.06	0.02	14
1A	6/18/92	-2.78	-0.0005	-0.02	11.202	0.002	119.8	-0.012	-0.04	-0.004	25
1A	9/18/92	-2.78	-0.0005	-0.02	7.38	0.002	99.7	-0.012	-0.04	0.008	30
1A	12/11/92	-2.8	-0.0005	-0.02	6.8		103.1	-0.012	-0.04	0.04	33

Note: Blank = not analyzed
ND = not detected, detection limit unknown
Negative values indicate non-detects (values correspond to detection limits)

Martins Creek SES Surface Water Site 39 (cont.)
Analytical Results from Stations 3, 5, 1A
Unless otherwise noted, units in mg/l

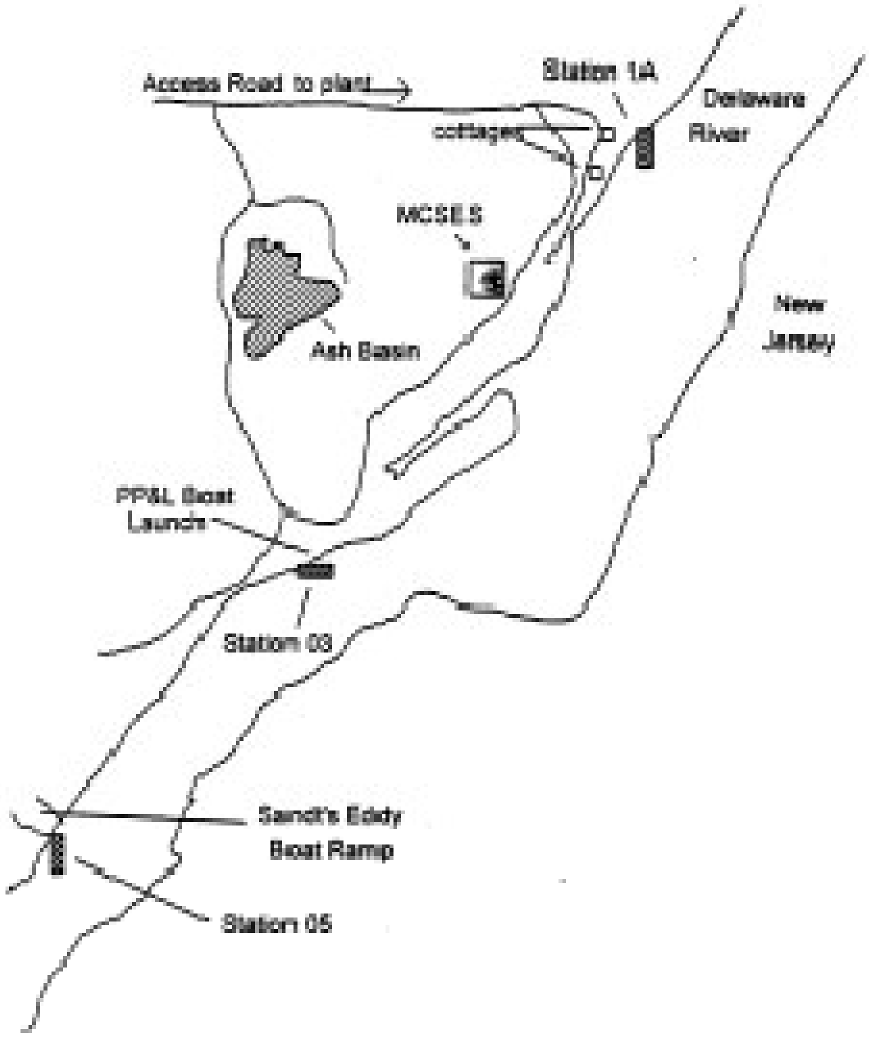
Station	Date	Alkalinity, phenolphthalein, CaCO3	Collection Time in hours	Field pH	Dissolved Oxygen, Field	Hardness as CaCO3	Lab pH	Solids, Dissolved estimated	Specific Conductance Field umhos/cm	Specific Conductance Lab umhos/cm
03	3/13/92	0	915	7.1	11.8	38.6	7.4	78.7	60	121
03	6/18/92	0	850	7.4	8.6	65.5	7.9	132.9	205	169
03	9/18/92	5		7.4	4.2		8.8		403	306
03	12/11/92	0	905	6.7	12.6	86.2	7.9	173.6	311	267
05	3/13/92	0	840	6.6	12	38.8	7.5	81.3	75	125
05	6/18/92	0	820	7.2	8.6	64.7	7.7	132.2	104	160
05	9/18/92	0		7.3	6.4		7.8		189	169
05	12/11/92	0	905	7.1	13.7	87.5	8	140.2	242	228
1A	3/13/92	0	835	7.1	11	39	7.2	66.3	70	102
1A	6/18/92	0	810	7.4	8.6	72.6	7.5	151.5	233	223
1A	9/18/92	0		7.4	6.3		7.6		141	131
1A	12/11/92	0	825	7.1	13.6	42.6	7.7	83.8	117	129

Note: Blank = not analyzed
ND = not detected, detection limit unknown
Negative values indicate non-detects (values correspond to detection limits)

Martins Creek SES Surface Water Site 39 (cont.)
Analytical Results from Stations 3, 5, 1A
Unless otherwise noted, units in mg/l

Station	Date	Suspended Solids	Water Temperature °C
03	3/12/02	27.7	5
03	6/18/02	7	21.8
03	9/18/02	8.8	18
03	12/11/02	8.8	5.5
05	3/12/02	16.7	5
05	6/18/02	2.2	19.9
05	9/18/02	0.8	21.4
05	12/11/02	650.0	5.4
1A	3/12/02	22.5	5
1A	6/18/02	3.6	22.3
1A	9/18/02	1.3	22.4
1A	12/11/02	3.3	2.1

Note: Blank = not analyzed
ND = not detected, detection limit unknown
Negative values indicate non-detects
[illegible]



Map 8
Martins Creek SES
Delaware River Stations

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Summary of Delaware River Water Quality near PP&L's Martins Creek Steam Electric Station. Data from 1992-95 Surface Water Monitoring Program.

Parameter	STATION 1A Above MSES Number	STATION 1A Above MSES Average	STATION 1A Above MSES Range	Location STATION 03 At MSES Number	Location STATION 03 At MSES Average	Location STATION 03 At MSES Range	STATION 05 Below MSES Number	STATION 05 Below MSES Average	STATION 05 Below MSES Range
Non Metals -									
M.O. Alkalinity, mg/l	16	24	10-41	19	51	9-102	15	50	10-200
Pheno. Alkalinity, mg/l	17	0	0-0	18	0	0-5	16	0	0-0
Field pH, s.u.	17	7.2	6.2-8.5	21	7.9	6.3-9.5	20	7.4	6.1-8.8
Lab pH @ 25 C	17	7.6	6.8-8.3	18	8.1	6.4-9.2	18	7.7	6.5-8.4
Ammonia as N, mg/l	17	0.09	0-0.24	18	0.1	0-0.18	16	0.1	0-0.25
Chloride, mg/l	17	10.1	6.43-15.2	18	12.8	6.41-26.4	16	11.4	5.61-17.8
Flouride, mg/l	12	0.00	0-0	12	<0.06	0-0.34	11	0.00	0-0
Tot. Hardness, mg/l	16	38.2	22.7-55.8	17	90	21.2-189.1	16	67.8	35.1-152.1
Nitrate as N, mg/l	17	0.27	<0.1-0.5	18	0.85	<0.1-1.45	16	0.91	0.43-1.79
Nitrate as NO3, mg/l	17	1.21	<0.4-2.20	18	3.77	<0.3-6.43	16	4.03	1.90-7.9
Diss. Oxygen, mg/l	10	9.2	6.3-13.8	12	8.8	4.2-12.6	10	8.9	5.8-13.7
Tot. Diss. Solids, mg/l	15	77	41-121	14	171	42-304	12	106	40-158
Susp. Solids @ 103 C, mg/l	17	6.9	0-53	18	8.8	0.7-56	16	14.7	0-109.2
Field Cond., umhos/cm	17	122.7	24.8-206	18	308.3	83-610	16	185	22.8-283
Lab Cond., umhos/cm	16	130.1	83-185	18	274.5	65-611	16	199.9	75-241
Sulfate, mg/l	17	11.4	8.5-19.8	18	60.8	9-184	16	22.8	9.8-55.9
Water Temperature, C	17	13.6	1.2-28	18	15.2	3.6-28.3	16	13.9	2.9-25.5
Metals -									
Tot. Aluminum, ug/l	17	246	<200-2380	18	357	<200-3150	18	406.8	<200-3959
Tot. Antimony, ug/l	17	<700	<700-<700	18	<700	<700-4900	16	<700	<700-<700
Tot. Arsenic, ug/l	13	<1	<1-1.4	14	42.4	<1-138	12	<1	<1-1.5
Tot. Barium, ug/l	17	36	22-53	18	37	26-50	10	36	20-48
Tot. Beryllium, ug/l	17	<0.4	<0.4-<0.4	18	<0.4	<0.4-1	16	<0.4	<0.4-<0.4
Tot. Boron, ug/l	3	<40	<40-<40	3	182.5	<40-266	3	<40	<40-<40
Tot. Cadmium, ug/l	17	<1.6	<1.6-10.6	18	<1.6	<1.6-17.2	16	<1.6	<1.6-8.7
Tot. Calcium, mg/l	17	11.9	8.8-15.1	18	26.6	6-54.2	16	17.2	7.1-35.3

Summary of Delaware River Water Quality near PP&L's Martins Creek Steam Electric Stations. Data from 1992-98 Surface Water Monitoring Program.

Parameter	Above MSES			At MSES			Below MSES		
	Number	Average	Range	Number	Average	Range	Number	Average	Range
Tot. Chromium, ug/l	16	<4	<4-20.6	18	4.2	<4-28.5	18	<4	<4-29.5
Tot. Copper, ug/l	17	<20	<20-<20	18	<20	<20-<20	18	<20	<20-<20
Tot. Iron, ug/l	17	235	<50-1910	18	288	<50-1920	18	404	<50-2760
Tot. Lead, ug/l	17	<10	<10-<10	18	<10	<10-<10	18	<10	<10-<10
Tot. Lithium, ug/l	3	<40	<40-<40	3	<40	<40-47	3	<40	<40-40
Tot. Magnesium, mg/l	17	2.7	1.8-3.9	18	8.2	1.8-8.3	18	4.3	1.8-6.1
Tot. Manganese, ug/l	17	55	<20-388	18	41	<20-287	18	54	<20-212
Tot. Molybdenum, ug/l	3	<140	<140-<140	3	<140	<140-<140	3	<140	<140-<140
Tot. Nickel, ug/l	17	<90	<90-<90	18	<90	<90-216	18	<90	<90-<90
Tot. Potassium, mg/l	17	<1.4	<1.4-<1.4	18	<1.4	<1.4-2.3	18	<1.4	<1.4-2.0
Tot. Selenium, ug/l	17	<1	<1-<1	18	6	<1-16.5	18	<1	<1-<1
Tot. Silver, ug/l	17	<20	<20-<20	18	<20	<20-<20	18	<20	<20-<20
Tot. Sodium, ug/l	17	6.1	2.9-8.3	18	15.8	2.9-42.9	18	7.1	3.1-10.2
Tot. Strontium, ug/l	3	53.3	39-62	3	189	59-281	3	82	51-99
Tot. Thallium, ug/l	17	<5	<5-<5	18	<5	<5-<5	18	<5	<5-<5
Tot. Vanadium, ug/l	17	<30	<30-<30	18	45	<30-341	18	<30	<30-<30
Tot. Zinc, ug/l	17	<40	<40-<40	18	<40	<40-101	18	<40	<40-<40

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COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL RESOURCES
BUREAU OF WASTE MANAGEMENT

Determination #

FORM 24R
RESIDUAL WASTE DISPOSAL IMPOUNDMENTS

This form must be fully and accurately completed. All required information must be typed or legibly printed in the spaces provided herein. Improperly completed forms may be rejected by the Department, may be considered to be violations of the Department's Rules and Regulations, and may result in assessments of fines and penalties.

Application or Permit No. (Assigned by DER)

Stamp Date Application Received: SEP 10 1991

General References: Section 289.[illegible]; 289.[illegible]; 289.[illegible]; 289.[illegible]

SECTION A. APPLICANT IDENTIFIER Pennsylvania Power & Light Company

Facility Name: Martins Creek SES Ash Basin No. 2

County: Northampton

Municipality: Lower Mount Bethel

☐ New ☒ Existing

Permit No. 0012831 (WP048)

SECTION B. IMPOUNDMENT PLAN (See Attached Narrative)

Attach a description of the impoundment plan, including specifications, designs, and cross sections. Describe the design of the impoundment, including the proposed volumetric capacity of each impoundment and schedule for construction and operation.

SECTION C. DESIGN REQUIREMENTS (See Attached Narrative 1-7)

1. Attach a slope stability analysis of the dike system that is proposed to contain the impoundment.

2. Attach calculations indicating the freeboard is capable of preventing overtopping, including overtopping caused by the 24-hour precipitation event to be expected once in 25 years.
Freeboard: ________________ inches.

3. Will/does the dike have sufficient structural integrity to prevent failure? What are the minimum safety factors of the dike for dynamic and static loads?

Safety factor for:
a. static load: ________________
b. dynamic load: ________________

4. Describe how the impoundment is (will be) equipped so that the flow of residual waste into the impoundment can be shut off immediately.

5. Describe how the dikes and berms are (will be) kept free of burrowing mammals and plants with root systems capable of displacing earthen materials upon which the structural integrity of the dikes or berms is dependent.

6. Demonstrate that the impoundment is/will be surrounded by structures sufficient to prevent surface run off from a 25-year, 24-hour precipitation event from entering the impoundment.

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SECTION C. DESIGN REQUIREMENTS (continued)

7. Describe how odors and the dispersal of residual waste or waste constituents by wind and water erosion shall be prevented.

8. Inside slopes (not applicable to impoundments with concrete walls):

a. What are the inside slopes (%)? 4.0%

b. Are the inside slopes designed and constructed with sufficient protective cover to prevent wind and water erosion, and to preserve the structural integrity of the dike? Describe how the inside slopes are designed and constructed.

The dikes are vegetated with crown vetch to limit runoff erosion. The basin typically is dry so there is little or no potential for wave action erosion.

9. Outside slopes and terraces:

a. What are the outside slopes (%)? 50%

b. Describe how the outside slopes and terraces of the impoundment are designed, constructed, and operated?

The outside slopes were built with a two horizontal to one vertical slope and are covered with crown vetch.

c. How are the outside slopes and terraces of the dike protected from wind and water erosion to preserve the structural integrity of the dike?

The crown vetch adequately protects the outside slopes.

SECTION D. WASTE SOLIDIFICATION PLAN

1. Attach a plan, including necessary drawings, designs, specifications, timetables, waste analyses, and narrative descriptions to solidify the waste. The plan shall include laboratory and field test results showing that the waste can be solidified as proposed.

SEE ATTACHED NARRATIVE

2. Indicate the maximum bearing capacity of the waste in the impoundment after the solidification process. 1.5 tons/ft²

The ash is already solid. The water within the ash will rapidly drain away through the discharge structure or by seepage at closure. It is possible to drive on the waste as soon as it is dewatered.

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MARTINS CREEK SES
ASH BASIN NO. 1
FORM 24R
RESIDUAL WASTE DISPOSAL IMPOUNDMENTS

B. Impoundment Plan

Martins Creek Ash Basin No. 1 was constructed in the early 1950's and is located just south of the generating plant along the Delaware River. Local soils were used to build the basin dikes and the basin is unlined. The basin sits on river sands and gravels which are quite permeable. The basin has only discharged in the past when the plant pumped ash sluice water to it continuously. This costly and unnecessary practice was discontinued several years ago, and the basin has discharged very rarely since. Any water pumped to the basin seeps out the bottom. Fortunately, bottom ash is inert and there are no significant ground water impacts. The outside basin dikes are typically 2 horizontal to 1 vertical and are covered with vegetation. The inside slopes are 2.5 horizontal to 1 vertical typically.

The basin has been raised and expanded over the years and some internal diking has been added to provide additional storage and water level controls. The south end of the basin is heavily vegetated with trees and grass. Bottom ash is discharged into the north end where it is stockpiled and hauled away for marketing by a contractor.

The basin's discharge structure is an inverted circular weir atop a standpipe, equipped with a skimmer box. Any basin discharge is directed under the plant rear-gate access road via a discharge pipe to the Delaware River.

There are no project earthwork specifications and project drawings are very limited. The following drawings are included with this permit application:

F119992 (E129816) Discharge Canal and Ash Disposal Area

C. Design Requirements

1. Slope Stability

Ash Basin No. 1 has been in service for over 40 years and has remained stable. The basin dikes are never at their most critical steady state condition based on maximum water height and resultant phreatic surface since the basin hardly ever has water in it. It is expected that the basin will not reach that condition considering the limited sluicing period (2 hours per day), seepage out the bottom, and the intent to market all bottom ash.

The files do not contain stability analyses for the basin nor corresponding soil strength parameters. There is some local soil information from other projects that allows an educated guess at what the strength parameters might be. Using this information, a stability analyses shows that the basin dikes have a factor of safety of about 1.6 without earthquake loading under maximum loading conditions which will

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7. Odors, Dust, Erosion Control

Bottom ash does not generate odors.

Bottom ash is removed from the basin for marketing so any dusting potential is minimized. Any ash that remains is covered with vegetation and moss, further reducing the dusting potential.

Any dusting created during basin closure will be controlled by a water truck. Once the basin is capped, dusting will be controlled by mulch and vegetation.

Erosion of the waste is not a concern in the basin.

D. Waste Solidification Plan

There is no need to solidify bottom ash. It is free draining and can be stockpiled using a loader even if the ash is submerged. The ash in the basin will be pushed into its closure configuration using dozers. Compaction will be done by the dozers, although a roller may be used to ensure a smooth surface for cap installation. Additional closure details are provided with Form 18R.

[illegible]

3

MONITORING WELL NETWORK AND
HYDROGEOLOGIC EVALUATION FOR BASIN NO. 1
PP&L MARTINS CREEK STEAM ELECTRIC STATION
LOWER MT. BETHEL TOWNSHIP, NORTHAMPTON
COUNTY, PA
ID #301256

JUNE 1998

MONITORING WELL NETWORK AND
HYDROGEOLOGIC EVALUATION FOR BASIN NO. 1
PP&L MARTINS CREEK STEAM ELECTRIC STATION
LOWER MT. BETHEL TOWNSHIP, NORTHAMPTON COUNTY, PA

Prepared for:

Pennsylvania Power and Light
Allentown, Pennsylvania

Prepared by:

Nittany Geoscience, Inc.
State College, Pennsylvania

Project No. C57-030/8.01/C57-030

June 1998

COMMONWEALTH OF PENNSYLVANIA
REGISTERED PROFESSIONAL
RICHARD T. WARDROP
GEOLOGIST
PG-000157-G

Richard T. Wardrop, PG-000157-G 6/10/98
Date

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1.0 INTRODUCTION

1.1 Purpose and Objectives

The purpose of this report is to respond to the Department of Environmental Protection's (DEP's) Pre-Denial Letter for the permitting of the Martins Creek SES Basin No. 1, dated January 20, 1998. Field activities have been conducted that address the concern that Mr. Robert C. Wallace, DEP, voiced in those letters, specifically that a liner waiver at Basin No. 1 cannot be addressed due to hydrogeological uncertainty. The tasks completed were developed to collect the necessary information to verify a detailed conceptual model of the hydrogeology of Basin No. 1 which is the basis for the appropriate monitoring network.

Specifically, the objectives of this report are:

1. Use the conceptual model and hydrologic criteria to evaluate the current Basin No. 1 monitoring well network;
2. Describe the field work that is being conducted in support of the permit renewal and describe which permit requirements the field work will satisfy; and,
3. Provide all field information currently available.

All field work described in this report was completed between May 18, 1998, and June 5, 1998, but certain portions of the data analysis are not yet available and will be submitted in an addendum to this report, to be submitted on or before July 24, 1998. These items will be described in more detail in their appropriate sections.

Appendix A contains several items of correspondence that were submitted to the DEP during the project including:

1. Work Plan Outline for Permit-Related Activities at Basins 1 and 4 to support Major Permit Modification Application, submitted to the DEP on May 6, 1998.
2. Summary and timeline of field activities to be completed at the PP&L Martins Creek SES, submitted on May 14, 1998.
3. Summary of field activities completed at the PP&L Martins Creek SES during the week of May 18, 1998 submitted on May 26, 1998.
4. Summary of field activities completed at the PP&L Martins Creek SES during the weeks of May 26, 1998, and June 1, 1998, submitted on June 10, 1998.

1.2 Organization of Report

Section 1 of this report provides an introduction to the project. Section 2 provides the site setting in order to provide a framework for the subsequent conceptual model. Section 3 describes the specific field activities that were conducted and the permit requirements that they will satisfy.

1.3 Project Background

Pennsylvania Power and Light Company's (PP&L's) Martins Creek Steam Electric Station (SES) is located along the western bank of the Delaware River, in Lower Mt. Bethel Township, Northampton County, Pennsylvania (Figure 1). The Martins Creek SES has been in operation since 1954 and has two coal-fired boilers (1 & 2) and two natural gas fired boilers (3 & 4). Boilers 1 and 2 burn bituminous coal, and collect fly ash through the use of electrostatic precipitators. Boilers 3 and 4 burn natural gas and produce no fly ash. Bottom ash generated at the Martins Creek SES is disposed of in the station's Basin No. 1, located directly southwest of the power plant along the west bank of the Delaware River. In the past, this basin received fly ash as well. Fly ash generated at the plant is presently disposed of in Basin No. 4, a lined Basin located north and up gradient of Basin No. 1.

1.3.1 Historic Sampling and Investigations

A number of geophysical and environmental investigations have been conducted at the SES. These are summarized in Appendix B, and referenced where appropriate in Section 2.

Quarterly groundwater sampling is conducted at the Basin No. 1 monitoring wells for the constituents shown on Table 1. Ash-related constituents including alkalinity, dissolved calcium, specific conductance, and sulfate (hereafter referred to as indicator parameters), as well as a number of other inorganic constituents, have been consistently detected in the wells. Graphs showing the historic trends of these constituents at each basin are included in Appendix C.

2.0 SITE DESCRIPTION

2.1 Site Setting

The purpose of this section is to describe the physical setting of the Martins Creek site which will provide a framework upon which the hydrogeologic conceptual model is developed.

2.1.1 Climate

The humid continental climate of Martins Creek and the surrounding region is characterized by warm summers and mild, moderately cold winters. Temperatures range from an average of 25.9°F (-3.9°C) in January, to 71.8°F (22.1°C) in July, for an average annual temperature of 49.5°F (9.7°C), as measured at the Stroudsburg climatological monitoring station, 1951 to 1980 (NOAA, 1991).

Precipitation varies monthly, with more than one-half of the total precipitation occurring in the months of April through September (USDA, 1974). Heavy rains can occur throughout the year, with severe thunderstorms generally occurring in the spring and summer months. These episodes of intense precipitation may occasionally cause flash flooding, especially in low-lying areas. Average annual precipitation for the Martins Creek area is 48 inches, as measured at the Stroudsburg climatological monitoring station, 1951 to 1980 (NOAA, 1991).

2.1.2 Soils

The Soil Survey of Northampton County, Pennsylvania, identifies soils in the vicinity of Ash Basin No. 1 as those of the Conotton-Red Hook-Urban land association. This soil association typically occurs in nearly level to moderately steep elongate bands along streams and the Lehigh and Delaware Rivers in Northampton County. These deep, well-drained to somewhat poorly drained soils develop from underlying sand and gravel on terminal moraines, kames, eskers, out-wash terraces, and flood plains.

The Basin is surrounded by soils of the Barbour, Conotton, Middlebury, Urban land, and Washington series (Figure 2). The Barbour series is described as nearly level, deep, well-drained fine sandy loam to fine sand soils typically occurring on flood plains, alluvial fans, and low terraces along perennial streams. These moderately rapid-permeable soils develop in mixed alluvial material. The average silt and clay content in the subsoils of the Barbour range from 9 to 63 percent, with average clay content in the range of 3 to 13 percent. Barbour soils located along small streams are occasionally flooded, and a seasonal high water table is usually encountered at depths greater than 36 inches below the surface.

The Conotton series is described as nearly level to very steep, deep, well-drained fine gravelly silt loam, gravelly loam, very gravelly loam and gravelly loam soils typically occurring on gravelly outwash terraces, in valley fill and kames, and on terminal moraines. These rapidly permeable soils develop in stratified glacial drift containing many kinds of parent material. The average silt and clay content in the subsoils of the Conotton range from 17 to 25 percent, with average clay content in the range of 3 to 13 percent. A seasonal high water table is usually encountered in the Conotton soils at depths greater than 36 inches below the surface.

The Middlebury series is described as nearly level, deep, moderately well to somewhat poorly drained silt loam, sandy loam, and loam soils typically occurring on flood plains along perennial streams. These moderately permeable soils develop in mixed alluvial material. The average silt and clay content in the subsoils of the Middlebury range from 15 to 60 percent, with average clay content in the range of 3 to 14 percent. Middlebury soils in some locations are subject to flooding, and a seasonal high water table is usually encountered at depths from 12 to 30 inches below the surface.

The soil survey defines much of the area surrounding Ash Basin No. 1 as Urban land (Figure 2). Urban land is defined as that which has coverage of eighty-five percent (85 percent) or greater by buildings, streets, parking lots, and other structures. Structures obscure the land, and previous or current activities have disturbed the soil, making soil identification impractical. The urban soils in the vicinity of Ash Basin No. 1 have been described as soils developed in mixed alluvial material occurring on a smooth to slightly concave flood plain.

The Washington series is described as nearly level to very steep, deep, well-drained silt loam, silty clay loam, clay loam, loam, and very rocky silt loam soils typically occurring on smooth to mildly-karst uplands. These moderately permeable soils develop in glacial till and frost-churned material weathered primarily from limestone. The Washington soils often include mapping of rock outcrops and ledges. The average silt and clay content in the subsoils of the Washington range from 62 to 78 percent, with average clay content in the range of 20 to 33 percent. Seasonal high water table is usually encountered at depths greater than 30 inches below the surface.

2.1.3 Geologic Setting

2.1.3.1 Regional Geology

The Martins Creek SES and Ash Basins No. 1 are located within the Great Valley Section of the Valley and Ridge Physiographic Province. The Great Valley is characterized by folded and faulted Paleozoic sedimentary rocks, predominantly shale and sandstone in the northern half, and limestone and dolomite in the southern half. These rocks range in age from Cambrian to Ordovician (570 million to 438 million years). The Great Valley has a broad, moderately dissected, undulating surface with low to moderate relief. Karstic terrain is prominent in the southern half of the region, as evidenced by the presence of sinkholes. The topography has been formed by the processes of fluvial erosion, some periglacial mass wasting, glacial erosion and deposition in the north and east, and the dissolution of carbonate rocks.

Glacial activity of Wisconsinan and Illinoian age (28,000 to 75,000 and 350,000 to 550,000 years, respectively) has partially remolded the topography through erosion, and the deposition of unconsolidated deposits in the extreme northeast portion of the Great Valley. Glacial advances from the north, and subsequent retreats, have deposited till on the uplands and outwash deposits along valley floors.

2.1.3.2 Site Geology

The Martins Creek SES is located along a northeast trending, overturned anticline. Bedrock underlying Basin No. 1 is identified as the Lower Ordovician Beekmantown Group, in particular, the Rickenbach and Epler Formations (Figure 3). Bedding across the site is variable, and depends upon the position with respect to the limbs of folds within the area. In the vicinity of Ash Basin No. 1 dip is generally steep and towards the southeast. Glacial and alluvial deposits overlie bedrock across the site. These deposits range in texture from clay to gravel. Recent alluvial deposits overly the glacial deposits, or rest directly on bedrock. The alluvium ranges in texture from clay and silt to sand, gravel, and boulders.

The Rickenbach Formation occurs beneath the southeastern two-thirds of Ash Basin No. 1 (Figure 3). The Rickenbach is described as a fine- to coarse-grained, light-medium- to medium-dark-gray dolostone. Sedimentary breccia, and bedded and nodular chert are common in this Formation. The Rickenbach has a total thickness of approximately 500 to 550 feet in this area (Drake, Epstein, and Aaron, 1969). The Rickenbach lies conformably above the Stonehenge Formation, with the contact described as transitional from the limestone of the Stonehenge to the dolomite of the Rickenbach (Hobson, 1963). The Rickenbach can be subdivided into an lower and upper member. The lower member is described as a medium-gray to medium-dark-gray, finely to coarsely megacrystalline dolomite with characteristic massive, and generally non-laminated beds. The upper member is composed of light-gray to medium-gray, microcrystalline to finely megacrystalline dolomite with interbedded fine-grained chert, and a zone of quartzose beds. Bedding in the upper member is generally uniformly thin and laminated (Hobson, 1963). Fractures in the Rickenbach Formation consist primarily of moderate to well developed, regularly spaced, moderately abundant, steeply and gently dipping, blocky joints (Geyer and Wilshusen, 1982). Most of the joints are open, but some are filled with calcite. Well-developed cleavage has been identified in the area of Martins Creek, and has a dip of approximately 45° to the southeast (Weston Geophysical, December 1987). Joints, fractures, bedding, cleavage, and solutionally-enlarged channels provide the Rickenbach Formation with a secondary porosity of low to moderate magnitude, and high permeability (Geyer and Wilshusen, 1982).

The Epler Formation occurs beneath the northwestern one-third of Ash Basin No. (Figure 3). The Epler is described as an interbedded, very fine grained to cryptogranular, light- to medium-gray limestone and fine- to medium-grained, light- to dark-medium-gray dolomite. Nodular and bedded chert, and beds and lenses of orthoquartzite are observed within this Formation. The Epler has a total thickness of approximately 650 to 800 feet in this area (Drake, Epstein, and Aaron, 1969). The Epler Formation lies conformably above the Rickenbach Formation, with the contact described as gradational from the predominantly limestone of the Epler to the dolomite of the Rickenbach (Hobson, 1963). Limestone in the lower part of the Epler is cryptogranular with large amounts of dolomite mottling, especially at the limestone-dolomite contacts. In the upper portions of the Formation, the limestone is characterized by large amounts of calcarenite intermixed with limestone pebbles and invertebrate remains. The dolomite is mostly microcrystalline to finely megacrystalline, and is common throughout the formation, occurring primarily as mottling and beds. The bedded dolomite is especially common in the lower one-half of the formation and near the contacts with adjacent formations (Hobson, 1963). Bedding is generally moderately-well to well developed, and thin to flaggy. Fractures in the Epler Formation consist primarily of well to poorly developed, moderately spaced, moderately abundant, open and steeply-dipping to vertical joints (Geyer and Wilshusen, 1982). Well-developed cleavage has been identified in the area of Martins Creek, and measured to have a dip of approximately 45° (Weston Geophysical, 1987). Joints, fractures, bedding, cleavage, and solutionally-enlarged channels provide the Epler Formation with a secondary porosity of low to moderate magnitude, and low permeability (Geyer and Wilshusen, 1982).

Glacial deposits, consisting of sand, gravel, till, and ground moraine are encountered on the Martins Creek site. Mapped locations of the deposits are limited to the northern portion of the SES and Basin No. 1, with a finger of these deposits protruding into the central portion of the Basin. These materials were deposited during the Wisconsinan and Illinoian glaciations (28,000 – 75,000 and 350,000 – 550,000 years, respectively). The Muncy Till occurs as patches of thin, gray, clayey to silty till covering up to 10 percent of the ground surface (Socolow, 1981). Stratified drift deposits are encountered along the terraces of the Delaware River, with the till deposits occupying the valley floors. The stratified drift along the river and its terraces, however, has been subjected to reworking and redeposit or by fluvial processes, possibly removing or shadowing those attributes identifying the material as glacial deposits. The material present beneath the Basin consists of varying thicknesses of glacial till, glacio-fluvial and fluvial sands, gravels, lag boulders, sands, and silts, the extent and thickness of which have been modified by erosion and redeposition (Weston Geophysical, 1987).

Overlying the glacial and fluvio-glacial deposits are more recent alluvial deposits. These deposits consist of clay, silt, sand and gravel overlying lag gravels and boulders, and coarse sand and gravels. These deposits are the result of channel erosion and filling, and overbank deposition (Weston Geophysical, 1987). Previous geologic investigations of the SES and Basin No. 1 have identified potential paleo-river channels across the terrace occupied by Basin No. 1 (Weston Geophysical, 1987).

Boring logs, showing detailed stratigraphic information on the area around the Basin, are presented in Appendix D. This information is further discussed in Section 2.2, Conceptual Model of Groundwater Flow.

2.1.4 Hydrogeologic Setting

2.1.4.1 Regional Hydrogeology

Groundwater in the Valley and Ridge Physiographic Province is generally a subdued replica of the surface topography, with groundwater flowing from recharge zones at higher elevations (greater potential) to discharge zones at lower elevations (less potential). Groundwater may either eventually discharge to the surface as seeps, springs, and/or streams, or continue flowing as a component of deeper flow in a larger groundwater system.

The flow of groundwater in the folded bedrock of the Great Valley Section of the Valley and Ridge Province is controlled primarily by joints, faults, and bedding plane partings. Enlargement of both primary and secondary openings may occur through dissolution or chemical weathering of the rock material, which is the case in the carbonate rocks that underlie the Basins and the surrounding area.

Vertical to sub-vertical planes of fracture concentration are present in the Paleozoic rocks underlying the site. These zones often represent discrete pathways for enhanced groundwater movement. Because they are nearly vertical, their expression on the land surface is a linear feature, regardless of the local topographic relief. Fracture traces, visible on air photographs, are natural linear-drainage, soil-tonal, and topographic alignments which are probably the surface manifestation of underlying zones of bedrock fracture (Lattman & Parizek, 1964). Interconnection of these fractures with bedding plane apertures provides reservoirs for groundwater storage and pathways for groundwater migration. Figure 4 illustrates fracture traces which were mapped in the SES and surrounding area. Nine linear features intersect Basin No. 1.

Groundwater levels fluctuate in response to the relative amounts of recharge to, and discharge from, the groundwater flow system. Water-levels generally peak in the early spring months following the spring thaw, late February to March, and preceding the onset of vigorous plant growth in April and May. Water-levels steadily decline through the summer to October, the time of the first killing frost, as increased evapotranspiration inhibits recharge to the groundwater system. Recharge may then occur until the ground freezes, inhibiting the infiltration of precipitation.

2.1.4.2 Local Hydrogeology

Several geologic units have been identified underlying Ash Basin No. 1. These units form two major aquifers controlling groundwater flow and movement in the vicinity of Ash Basin No. 1. The shallower of the two, referred to as the sand and gravel aquifer, includes sand and gravel deposits and weathered bedrock. Underlying the sand and gravel aquifer is the bedrock aquifer, consisting of relatively competent fractured bedrock of various lithologies. Along the Basin's northeast margin, deposits of cobbles and boulders have been identified. These deposits occur between two sand and gravel deposits, with weathered bedrock below.

Sand and Gravel Aquifer

The sand and gravel aquifer is the uppermost aquifer under Basin No. 1 and is composed primarily of sand and gravel deposits. This aquifer lies directly above bedrock across the lower portion of the site, except along the northeast end of Basin No. 1. The geologic log for abandoned monitoring well MW 8 identifies a deposit of boulders and cobbles overlying bedrock, with the sand and gravel overlying the boulders and cobbles. The geologic logs for MW 1-8, MW 1-8D (recently installed sand and gravel aquifer pumping well), and MW 1-9B (recently installed bedrock aquifer pumping well) identify deposits of sand, gravel, and cobbles, with interbeds or lenses of sand and gravel (see Appendix D). Bedrock was encountered at depths ranging from 50 to 65 feet below ground surface in these wells.

The sediments making up the sand and gravel aquifer beneath the Basin and surrounding area are generally mixed fine to coarse sand, fine to coarse rounded gravel, and rounded cobbles and boulders. These deposits range in thickness from 17 and 32 feet near former MW 1-6 and MW 1-7, to 50 to 65 feet at MW 1-8.

Occurring directly beneath the mixed coarse sediment deposits is weathered bedrock, containing rock fragments, open fractures, and sediments derived from weathered parent material. The parent bedrock underlying the northwestern one-third of the Basin consists of limestone with some interbedded dolomite. The southeastern two-thirds of the Basin is underlain by predominantly dolomite. The depth of weathering for each of varies considerably, up to 11 feet at MW 1-9 (recently installed bedrock aquifer monitoring well), but absent at MW 1-8B.

The depth to water in the sand and gravel aquifer ranges from approximately 3 to 35 feet below the surface along the eastern side of the impoundment. Figure 5 is a groundwater elevation map of the Ash Basin No. 1 area, constructed from water-level data of December 2-4, 1997. At that time, the overburden monitoring well system contained one upgradient well (MW 1-5) and three down-gradient overburden wells (MW 1-6, 1-7 and 1-8). MW 2-2 is completed in bedrock and is located northwest of Basin No. 1. The three down-gradient wells are distributed along the Basin's eastern perimeter between the Basin and the Delaware River. All monitoring wells are screened below the zone of seasonal and yearly groundwater fluctuation. This indicates that well position and screen length were adequately chosen to monitor the aquifer.

Monitoring well MW 1-8 is the only well constructed entirely within the sand and gravel aquifer. Wells MW 1-6 and 1-7 are screened primarily within the sand and gravel aquifer, with a small portions of the screened intervals constructed within weathered bedrock. Small seasonal and yearly fluctuations in groundwater elevations across the site indicate the sand and gravel aquifer to be a relatively static system (see Figure 6).

Site specific measures of hydraulic parameters of the sand and gravel aquifer will be reported in an addendum to this report and on Form 7E.

Bedrock Aquifer

Underlying the sand and gravel aquifer in the vicinity of Basin No. 1 is the bedrock aquifer. This aquifer is composed of generally steeply dipping, northeast striking, competent limestone and dolomite. Bedrock beneath the northwestern one-third of the Basin consists of limestone and interbedded dolomite (Epler Formation). The remaining southeastern two-thirds of the Basin is underlain by dolomite (Rickenbach Formation).

Wells MW 2-1N and MW 1-9 are the only monitoring wells completed entirely in bedrock. Seasonal and yearly fluctuations in groundwater elevations since 1992 indicate a maximum fluctuation of 16 feet in MW 2-1N (Figure 6). Depth to water in MW 2-1N ranges from approximately 85 to 69 feet. Depth to water in MW 1-9 was approximately 29 feet when it was drilled in May 1996.

Site specific measures of the hydraulic parameters of the bedrock aquifer will be reported in an addendum to this report and on Form 7R.

2.2 Conceptual Model of Groundwater Flow

The purpose of this section is to develop a conceptual model of groundwater flow near Basin No. 1. This is accomplished by reviewing Basin construction and history, background geology, hydrogeology, and climate. A thorough review of ash leachate quality was provided in the *Environmental Assessment of Groundwater and Surface Water Quality Basin No. 1* (Nittany Geoscience, Inc., March 1994) and is summarized in this section to evaluate the characteristics of those constituents expected in the ash leachate.

2.2.1 Basin No. 1 Construction and Operations

Ash Basin No. 1 was constructed in 1954 by excavating soils into the alluvium material, above the saturated materials. The berms for this unlined earthen impoundment were constructed using the excavated on-site materials. Following its construction, Basin No. 1 received fly ash and bottom ash sluiced with water. The disposal of fly ash in Basin No. 1 was minimized after the construction of Basin No. 2 in 1970, and it now receives fly ash only as a contingency for other site basins. Fly ash is now stored in Basin No. 4. In 1976, the capacity of Basin No. 1 was increased by raising the berm 5 feet. The disposal of bottom ash in Basin No. 1 continues to the present, though the majority of the bottom ash generated at Martins Creek is processed and sold for anti-skid material.

Basin No. 1 occupies roughly 24 acres and is approximately 1600 feet long by 650 feet wide. It is bordered to the northwest by railroad tracks and a small cliff, rising to Ash Basins No. 3 and 4, and the industrial waste treatment facility (Figure 1). The SES and associated buildings define the northeast extent of Ash Basin No. 1. The southeastern boundary of Basin No. 1 is defined by the Delaware River, which runs approximately 150 feet southeast of the Basin. Southeasterly-flowing Oughoughton Creek forms the Basin's southeast boundary. On its way to its discharge point on the Delaware River, Oughoughton Creek flows within approximately 100 feet of the Basin's southwest corner. At this point, the creek takes a southwest meander, and continues flowing to the river. Southwest of Oughoughton Creek are residential properties, the closest of which is approximately 800 feet southwest of Ash Basin No. 1. A set of residential wells in the vicinity of Basin No. 1 are monitored annually by PP&L.

The Basin has historically been divided into sections. A series of northwest-trending dikes are observed on the as-built schematics of Ash Basin No. 1. The dikes consist of a core of excavated ash with a mantle of earthen material. Discharge pipes allow the flow of water from one side of the dikes to the other. The most recent dike divides the Basin into a northern and southern section, with the northern section occupying approximately two-thirds of the entire basin area.

Sluiced bottom ash enters the northern portion of the Basin from a single pipe located along the Basin's northeast boundary. Discharge from the pipe is approximately 286,000 gallons per day of sluice water, and 38.4 tons of bottom ash. The sluice water ponds somewhat at the discharge point and flows approximately 100 feet before it spreads out and is completely infiltrated. The level of ash in the northern portion of the Basin was originally higher, but much of the ash has been excavated and removed for use in the construction of Basin No. 4. The remaining materials are a mixture of bottom and fly ash deposited in the Basin from 1954 to 1970, and bottom ash deposited from 1970 to present. Prior to sluicing into the Basin, the bottom ash is crushed to a nominal size of 1.25 inches or less. The sluice water is not neutralized prior to discharge into the Basin.

The southern one-third of the Basin is filled with ash. The surface of the ash is relatively flat, with some ponded stormwater along the southwest corner of the Basin. Surface discharge of Basin No. 1 waters is controlled by a weir constructed along the southeastern end of the Basin. Discharge from the Basin through the outlet structure is only observed during periods of high precipitation and/or snow melt. Discharge from the Basin's outlet structure to the Delaware River is regulated under NPDES permit No. PA0012823.

A water balance that accounts for Basin intakes and discharges was computed in the *Environmental Assessment of Groundwater and Surface Water Quality Basin No. 1* (Nittany Geoscience, Inc., March 1994). To summarize, the northern subdivision of the Basin receives an average daily inflow of 258,000 gallons per day from the bottom ash jet pumps. Precipitation onto the ash-filled Basin accounts for another water input to the Basin. Precipitation minus evaporation amounts to approximately 11,400 gallons per day (Nittany Geoscience, Inc., March 1994).

An assigned elevation of the Delaware River (200 feet msl) was obtained from large-scale topographic site maps. A surveyed elevation of the Delaware River has been measured and will be provided in an addendum to this report. The water balance indicates the existence of an input surplus of 299,400 gallons per day that recharges the underlying sand and gravel aquifer. Sources for this surplus includes Basin No. 1 influent and precipitation. The Delaware River receives the discharge from the sand and gravel aquifer, thereby becoming a receptor that could potentially be affected by Basin leakage (Nittany Geoscience, Inc., March 1994).

2.2.2 Basin No. 1 Interaction with Aquifers

2.2.2.1 Groundwater Flow Gradients

The gradient of groundwater flow in the area of Basin No. 1 is generally north to south. Perturbations of the water-level contours shown on Figure 5, indicate that Basin No. 1 is affecting groundwater near the Basin. A steep gradient is present between the river and monitoring well MW 1-8. The sluice-pipe inlet for Basin No. 1 is located in the upper portion of the Basin near this well, and the water levels observed in MW 1-8 indicates the presence of a local groundwater mound created near the input from the sluice pipe. Based on Figure 5, it appears that groundwater in the sand and gravel aquifer is discharging to the River.

The gradient of groundwater flow in the bedrock aquifer, as observed between upgradient well 2-3 and the new well MW 1-9, is also toward the river. The water levels in adjacent wells MW 1-8 and MW 1-9 are very similar. The actual gradient will be ascertained when a surveyed elevation for MW 1-9 is available. Based on recent field work it appears as though the water levels in the bedrock and the sand and gravel aquifers are approximately 10 feet above the level of the Delaware River. A very small gradient exists between the units indicating that the component of vertical flow is very small and the primary component of flow in both units lateral, toward the River, in both units.

The aquifers are not isolated from one another and connection primarily occurs where fractures or steeply inclined bedding planes in the bedrock aquifer meet the sand and gravel aquifer. The interconnection of the aquifers will be better understood when the analysis of the pumping test data is completed and will be described in the addendum to this report.

2.2.2.2 Leachate Chemistry

It is important to know the chemical character of Basin-derived leachate in order to assess the environmental impacts of Basin leakage on downgradient waters. An estimate of Basin leachate chemistry was reported in the Environmental Assessment of Groundwater and Surface Water Quality, Basin No. 1 (Nittany Geoscience, Inc., March 1994). The estimate was derived by applying the FOWL model (Hostetler, Erikson, and Kemner, 1990) to total elemental analysis of fly ash and bottom ash. Although bottom ash is the only material presently disposed of at the Basin, both were used because of past practices. Martins Creek ashes were sampled in 1992. The FOWL analysis was performed using an estimated pH of 5.0, which is that of rainwater.

The FOWL results suggested the major ions most likely to occur at high concentrations in the leachate are calcium (395 mg/L) and sulfate (956 mg/L). FOWL results indicated that the constituents likely to occur in leachate at concentrations greater than their groundwater parameters are aluminum, boron, chromium, molybdenum, nickel, strontium, and sulfate. Boron, calcium, and sulfate should behave as good indicators of this leachate in groundwater (Nittany Geoscience, Inc., March 1994).

3.0 MONITORING WELL NETWORK

The monitoring well network for Basin No. 1 is shown on Figure 5. Until just recently the network had been comprised of four wells; three downgradient wells (MW 1-6, MW 1-7, MW 1-8 and one upgradient well (MW 2-1N). MW 2-1N was selected, at the request of the DEP, as the upgradient monitoring well because it is hydrogeologically upgradient of Basin No. 1 and is unaffected by Basin No. 2. Due the local distribution of geologic materials MW 2-1N is screened in bedrock, whereas the downgradient wells are screened in the sand and gravel aquifer. The objective of wells the downgradient wells is to monitor water levels and quality of groundwater in the sand and gravel aquifer that may be affected by the historic mass of ash or infiltration of sluice waters. In response to the DEP comment letter dated January 20, 1998, a new downgradient, bedrock aquifer monitoring well (MW 1-9) has been constructed in the vicinity of MW 1-8 to obtain water level and water quality data from the deeper aquifer. In terms of location and construction, the ability of the monitoring well network to meet its objectives can be evaluated using four basic criteria:

1. Are the wells in the downgradient direction of groundwater flow from the assumed source?
2. Are the well generally evenly distributed about the downgradient perimeter of the assumed source?
3. Are the wells hydraulically connected to the rest of the aquifer mass in the area of the well?
4. Has the assumed source area affected the natural chemical quality of samples collected from the monitoring wells?

3.1 Position in Flow Field

The first criteria of an effective monitoring well network is that the wells are located downgradient of the assumed source. Figure 5 shows a groundwater elevation contour map for the Basin No. 1 area during the December 1997 monitoring event. The hydrologic gradient, as shown by the contour lines and flow lines, is generally south toward the Delaware River and the monitoring wells are located just outside the perimeter of the basin in the downgradient direction of groundwater flow. Therefore the criteria a of downgradient position is met

3.2 Spacial Distribution

The second criteria is that the downgradient wells are generally evenly distributed, reducing the potential of not detecting a release local to one area of the assumed source. As shown on Figure 5, the Basin No. 1 monitoring well network meets this criteria with three evenly spaced well locations along the downgradient side of the Basin No.1. The location selected for MW 1-9 is adjacent to MW 1-8 because the groundwater mound from the sluice water inlet occurs at this location. Consequently, MW 1-9 is in the most likely location to detect an effect on groundwater quality in the bedrock aquifer. The mound is created by ash laden sluice water, creating the greatest downward flow gradient from the sand and gravel aquifer to the bedrock aquifer present in the vicinity of the Basin.

3.3 Hydraulic Connection to the Aquifer

The third criteria is that the wells are drilled and constructed such that the screened interval has good hydraulic connection to the rest of the aquifer mass in the area of the well. Proof of this connection is either a relatively high estimated yield during well construction or a relatively rapid three-volume purge, with little drawdown, during sampling. All of the monitoring wells in the Basin No. 1 network have relatively high yields as estimated during drilling. Screened intervals are relatively long in the sand and gravel aquifer. At MW 1-6 and MW 1-7, the screened intervals were extended through the unconsolidated materials into the weathered zone of the bedrock. This was done to ensure sufficient saturated interval in the screens of the monitoring wells during dry weather. Because water that infiltrates from the basin is expected to percolate downward to the water table and then flows laterally toward the river, the locations of the screens of MW 1-6 and MW 1-1 at the overburden-weathered bedrock interface are appropriate to intersect water that has been impacted by the basin. In addition, the lower part of the MW 1-7 well screen is in a bedrock fractured zone or zone of weakness, assumed to have higher interconnected porosity than the surrounding portions of weathered bedrock. MW 1-9, MW 1-8B, and MW 1-9B is also located in an area with a high density of bedrock fracturing. The MW 1-9B pumping test was conducted at 80 gallons per minute, demonstrating good connection to local portions of the bedrock aquifer.

3.4 Groundwater Quality

Many years of chemical data are available, which can be used to evaluate whether the wells are effectively intercepting the water infiltrating from the Basin. The ash chemistry described in Section 2.2.2.2 can be used to derive tracers to verify the chemical quality of basin-affected groundwater. The concentrations of these tracer compounds have been historically elevated in the downgradient monitoring wells, indicating that the material sluiced into Basin No. 1 is infiltrating into the sand and gravel aquifer and is being detected in samples obtained from the monitoring wells. Graphs showing the historic concentrations of indicator parameters (alkalinity, sulfate, specific conductance and calcium) are included in Appendix C. Generally, the concentrations detected in samples from at MW 1-8 are more variable than at the other wells. The concentrations at MW 1-6 and MW 1-7 are more stable.

3.5 Justification of the Location of New Wells

In response to comments in the DEP's January 20, 1998, letter, three new wells were sited and drilled at Basin 1: bedrock monitoring well MW 1-9, a pumping well MW 1-9B, and an overburden pumping well, MW 1-8B.

The objectives of the new wells at the Martins Creek SES are:

1. To determine the vertical gradient between the two aquifer units.
2. To measure water quality of the bedrock aquifer unit downgradient of Basin No. 1.
3. To perform aquifer testing on both aquifer units.
4. To obtain water quality samples at the end of each pumping test.

The first and third objectives do not restrain the location of the wells, but do require that the wells be located close together to measure a vertical gradient and to ensure that water level responses indicating interconnection between the aquifers will not be missed during the pumping tests.

Objective 2 is the most important objective to the selection of an appropriate location for the wells. There are two scenarios under which one would be interested in water quality downgradient of the basin:

1. To look for an impact to groundwater from on-going activities, or
2. To look for an impact to groundwater from historic activities.

Because the objective of this investigation is a permit renewal, not a closure the first scenario is assumed to be most applicable, although the ideal solution would accomplish both.

Under current use conditions, ash is sluiced into the basin at the northeastern end. A small pond of water is present at the northeastern end of the basin. The rest of the basin is dry. Because water levels measured in MW 1-8 indicate that groundwater is between 25 and 30 feet below the ground surface, the water sluiced into the basin infiltrates, creating a groundwater mound directly under that portion of the basin. Figure 5 depicts the groundwater surface during the December 1997 groundwater sampling event. A ridge in the groundwater surface is shown at the northeastern end of the basin as a result of the ash sluicing. The approximate area of ponded water in the basin is delineated on Figure 5. Arrows indicate the direction of groundwater flow, interpreted from the groundwater contours. The principal direction of the flow lines is to the south-southeast, in the vicinity of MW 1-8. Flow lines that are not directed to the south-southeast travel a much longer distance before leaving the basin, likely mixing with, and being diluted by, water flowing from north of the basin. Because of its proximity to the basin inflow and the groundwater configuration resulting from that inflow, well MW 1-8 is located such that it should intercept overburden groundwater affected by current basin use.

Appendix C includes graphs of the historic concentrations of indicator parameters (alkalinity, sulfate, specific conductance and calcium) in the Basin No. 1 monitoring wells. As stated in section 3.4, the concentrations at MW 1-8 are more variable than at the other wells. The concentrations at MW 1-6 and MW 1-7 are more stable. The concentrations of indicator parameters (with the exception of sulfate) are typically higher at MW 1-8. Occasionally the concentration of indicator parameters are higher at MW 1-6 and MW 1-7 than at MW 1-8, but only because the concentration at MW 1-8 has decreased significantly. A likely explanation for this variability is that the indicator parameter concentrations at MW 1-8 are rapidly affected by changes in the basin inflow, whereas the indicator parameter concentrations in the water at MW 1-6 and MW 1-7 are controlled by the mass of historic ash present in the basin and are relatively unaffected by changes in inflow. When ash is not being sluiced into the basin, groundwater continues to flow through the historic ash at the same rate, and the indicator parameter concentrations at MW 1-6 and MW 1-7 vary little. The upgradient groundwater that MW 1-8 intercepts has flowed through a relatively narrow portion of the basin, so when ash sluicing is not occurring, the concentrations at MW 1-8 decrease. The primary distinction is that MW 1-8 is representative of the effects of on-going activities in the basin and that MW 1-6 and MW 1-7 are representative of the effects of historic activities.

The on-going source of indicator parameters to the overburden aquifer is the small portion of the basin which receives sluiced ash. The source of indicator parameters to the bedrock aquifer is the affected portion of the overburden aquifer, if a downward gradient is present between the overburden and bedrock aquifers. If an upward gradient exists between the overburden and bedrock aquifers, there is no pathway to the bedrock aquifer.

The groundwater mound created by the basin inflow will increase the downward gradient between the overburden and bedrock aquifers in the northeastern portion of the basin. In addition, because flow lines indicate that the water affected by indicator parameters flows to the south-southeast, a portion of the affected water which infiltrates to the bedrock aquifer will move toward MW 1-8. Several zones of fracture concentration as indicated by fracture traces are present in the vicinity of MW 1-8; such zones increase the local permeability of a bedrock aquifer. Other fractured zones identified by geophysical investigations, near MW 1-7, are not located such that they would intercept groundwater affected by on-going activities, but may intersect groundwater affected by the historic ash in the basin.

An additional advantage to performing aquifer testing in the vicinity of MW 1-8 was that this well is screened entirely in the overburden and can be used as an observation well for testing the overburden unit. If MW 1-8 was used as the overburden observation well, a total of three new wells, as opposed to four, meet the objectives of the investigation.

In conclusion, the new bedrock monitoring well, MW 1-5, was located within 50 feet of the existing well MW 1-8 for several reasons:

1. The source of indicator parameters, representative of on-going activities, to the overburden aquifer is the northeastern portion of the basin. Flow lines extrapolated from a groundwater contour map are oriented toward MW 1-8.
2. The source of indicator parameters, representative of on-going activities, to the bedrock aquifer is the affected portion of the overburden aquifer. A

pathway for indicator parameters to impact the bedrock aquifer is only present if a downward gradient exists between the overburden and bedrock aquifers. Because of the groundwater mound created by the inflow to the basin, a downward gradient is likely to be most significant in the northeastern portion of the basin, in the vicinity of MW 1-8.

3. Fracture zones have been indicated by aerial photography review in the vicinity of MW 1-8; such zones increase the local permeability of a bedrock aquifer.

4. Well MW 1-8 is screened entirely in the overburden, making it a suitable observation point for the overburden aquifer test. Using MW 1-8 as the overburden observation point is a cost-effective alternative, reducing the number of new wells from four to three.

4.0 RECENT FIELD ACTIVITIES

Nittany Geoscience proposed field work necessary to complete Forms 6R and 7R in support of the pending permit modifications for Basin No. 1, at a meeting with PaDEP on May 8, 1998. The work included installation of a sand and gravel aquifer pumping well (MW 1-8B), installations of a bedrock aquifer pumping well (MW 1-9B), and monitoring well (MW 1-9), and pumping tests for each aquifer. The work is being completed as of the submittal of this report and updated information and analysis will be submitted to PaDEP in an addendum, by July 24, 1998.

4.1 Well Construction

Three wells were drilled and constructed in the vicinity of MW 1-8. A six-inch diameter bedrock pumping well (MW 1-9B), to a depth of 123 feet, a two-inch diameter bedrock well (MW 1-9), to a depth of 115 feet, and a six-inch diameter overburden pumping well (MW 1-8B), to a depth of 50 feet. The locations of these wells are shown on Figure 5.

Geologic logs and well construction diagrams for the three new wells are included in Appendix D. These logs will be formatted to conform with page 5 of Form 6R.

The data collected during the drilling of the wells will be used, in conjunction with historic data, to complete Form 6R, Geologic Information. Using the well logs, two cross sections will be completed, as required by Section C.1 of Form 6R.

In addition, the survey data for the new wells will be included in Section C of Form 7R.

4.2 Aquifer Testing of Selected Wells

The new six-inch bedrock well (MW 1-9B) was tested on June 3, 1998, to develop aquifer parameters for the bedrock aquifer, using MW 1-5, MW 1-8, and MW 1-8B as observation wells. An 8-hour pumping test was conducted on MW 1-9B. The pumping rate of 80 gpm was selected based on the blown yield of the well measured during drilling. Prior to the pumping test, pressure transducers with dataloggers were placed in MW 1-9B, MW 1-9, MW 1-8B, and MW 1-8. Frequent hand measurements were collected in these wells as a back up for the dataloggers. Periodic hand measurements were collected from MW 1-6, MW 1-7, MW 2-2, MW 2-3, and MW 2-4, and stage at Basin No. 1. Hourly Delaware River elevation data were measured at the plant for the day prior to until the day following both tests. At the end of the pumping test, a sample was collected from the pumping well for analysis of parameters specified by the residual waste regulations.

The new overburden well (MW 1-3B) was tested on June 4, 1998, to develop aquifer parameters for the overburden aquifer, using wells MW 1-8, MW 1-9, and MW 1-6B as observation wells. The other Basin No. 1 monitoring wells were monitored periodically during the pumping test. At the end of the pumping test, a sample was collected from the pumping well for analysis of parameters specified by the residual waste regulations.

The results of the two pumping tests will be analyzed to determine the hydraulic connection between the aquifer units, as well as providing aquifer parameters to be included in Forms 7R Section B.

The pumping test data will be analyzed and the results and conclusions will be provided in an addendum to this report which will accompany completed Forms 5R and 7R, submitted on or before July 24, 1998.

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4.01/057-030

FIGURES

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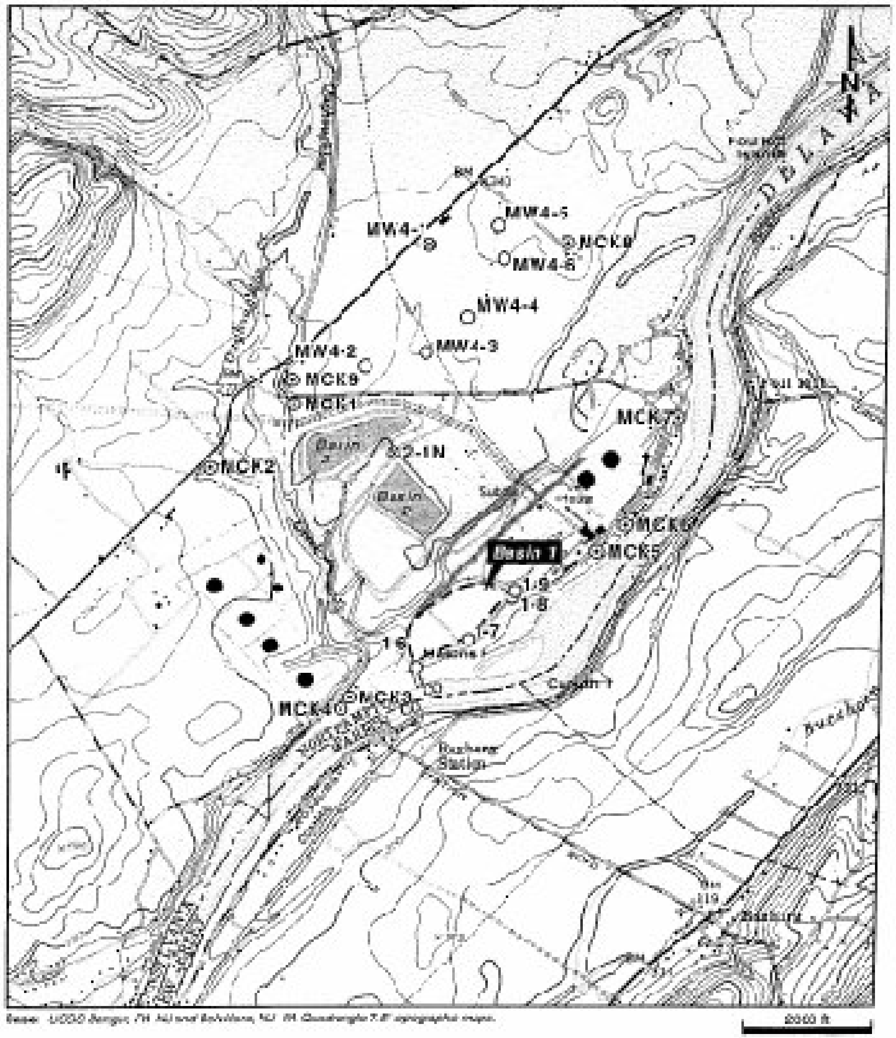

LEGEND

- Residential well
- Upgradient well
- Downgradient well

FIGURE 1
Location of the PP&L Martins Creek SES with monitoring well network.

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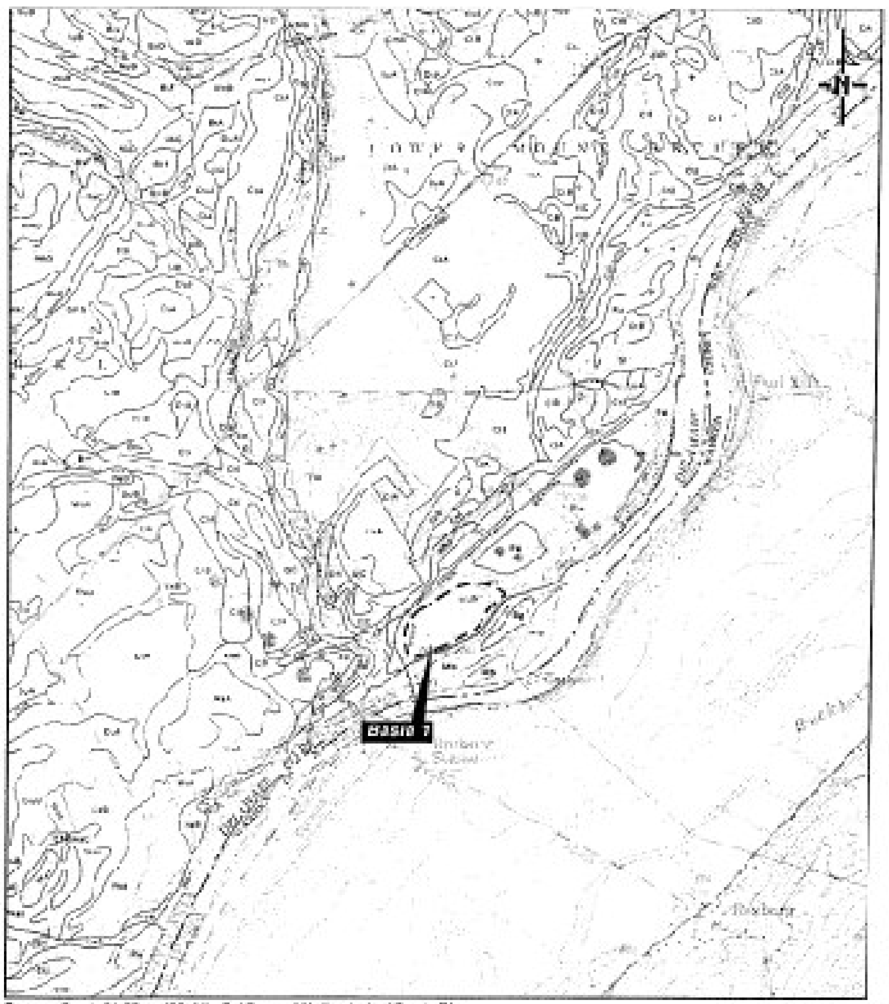
NITTANY GEOSCIENCE INC.



Source: Sheets 21, 22 and 29 of the Soil Survey of Northumberland County, PA.

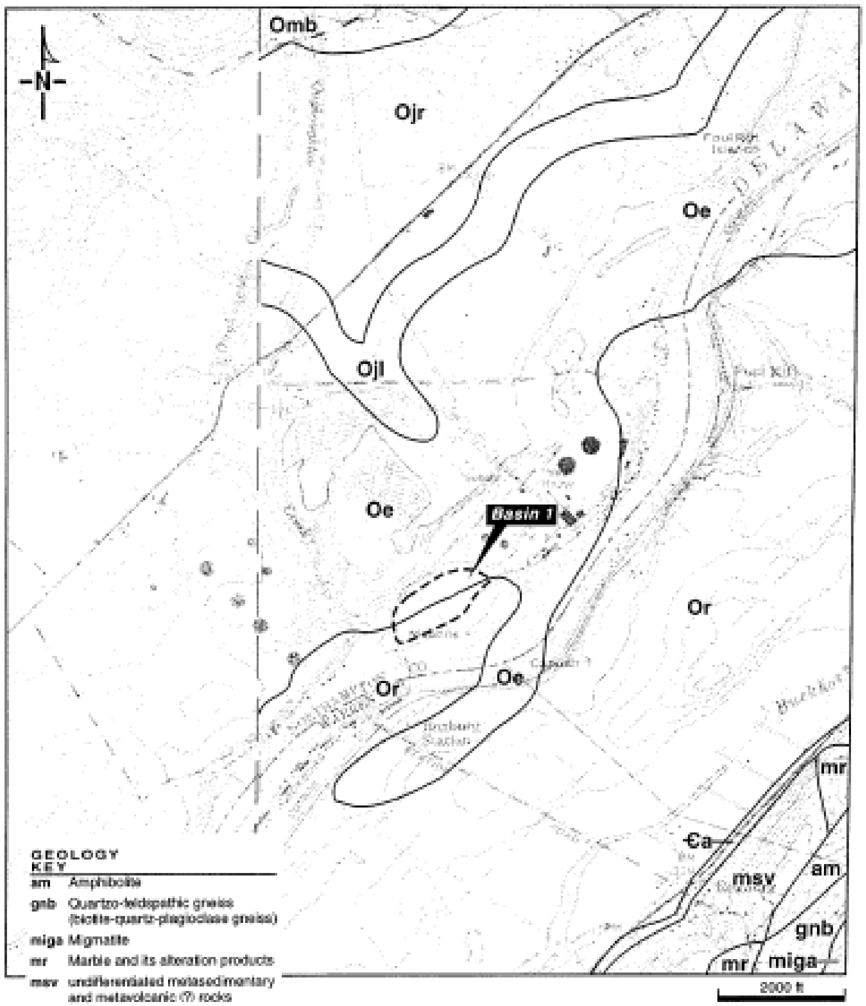
KEY

- Us Urban land
- Bg Barbour soils
- Ct Conotton soils
- Mb Middlebury soils
- Wh Washington soils

FIGURE 2
Soils of the PP&L Martins Creek SES.

09/027-030

NITTANY GEOSCIENCE inc.



GEOLOGY KEY

am	Amphibolite
gnb	Quartzo-feldspathic gneiss (biotite-quartz-plagioclase gneiss)
miga	Migmatite
mr	Marble and its alteration products
msv	undifferentiated metasedimentary and metavolcanic (?) rocks
Єa	Allentown Dolomite
Oe	Epler Formation
Or	Rickenbach Formation
Ojl	Jacksonburg Limestone (cement limestone facies)
Ojr	Jacksonburg Limestone (cement rock facies)
Omb	Martinsburg Formation Bushkill Member

FIGURE 3
Geology of the PP&L Martins Creek SES and vicinity, Northampton County, PA.

Source: *Geologic map and sections of parts of the Portland and Belvidere Quadrangles, NJ–PA (DRAKE, ET. AL. 1969).* 07/057-030

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FIGURE 4
Regional fracture traces on 1991 base-photo of the Martins Creek SES.

NITTANY GEOSCIENCE inc

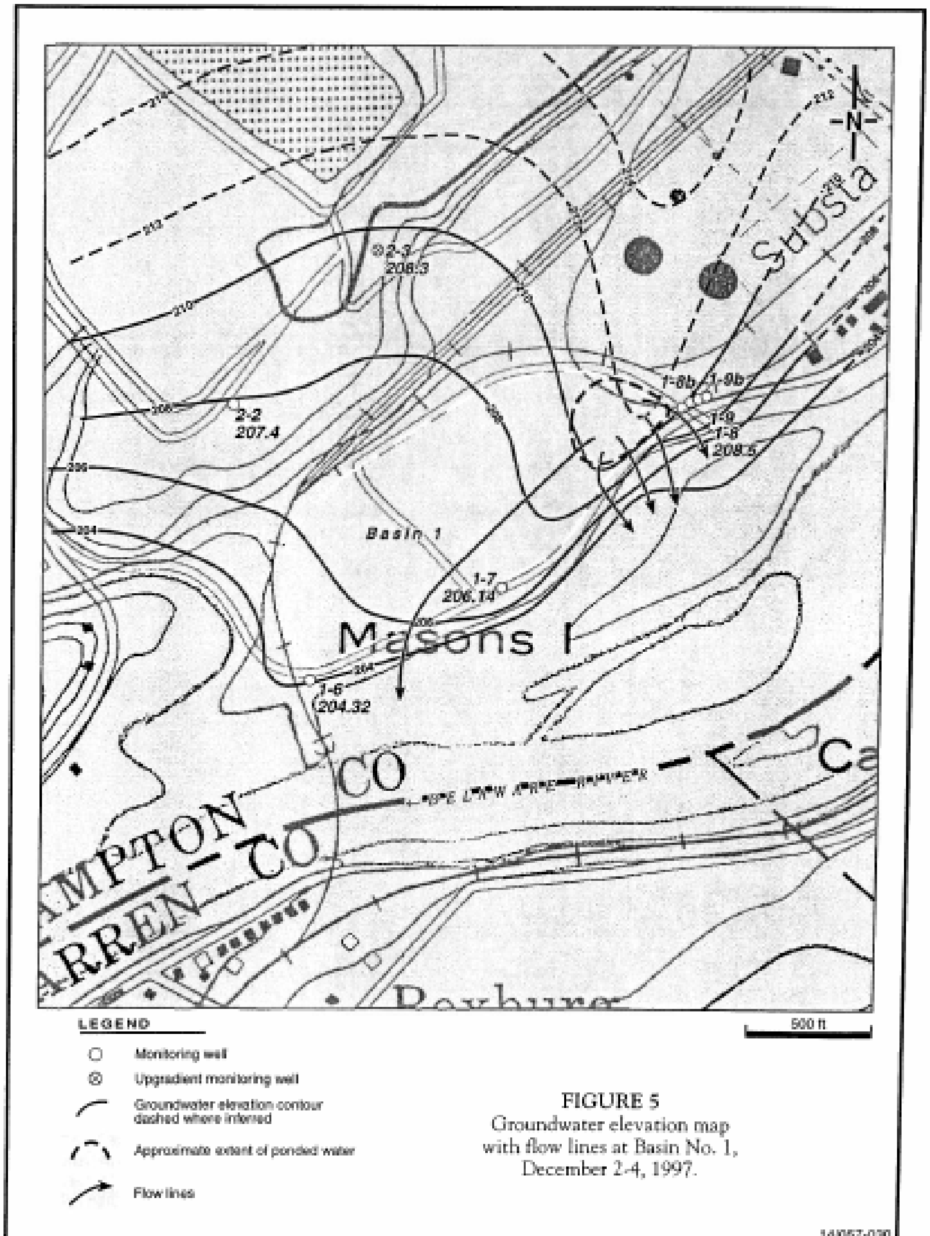

FIGURE 5
Groundwater elevation map with flow lines at Basin No. 1, December 2-4, 1997.

NITTANY GEOSCIENCE INC.

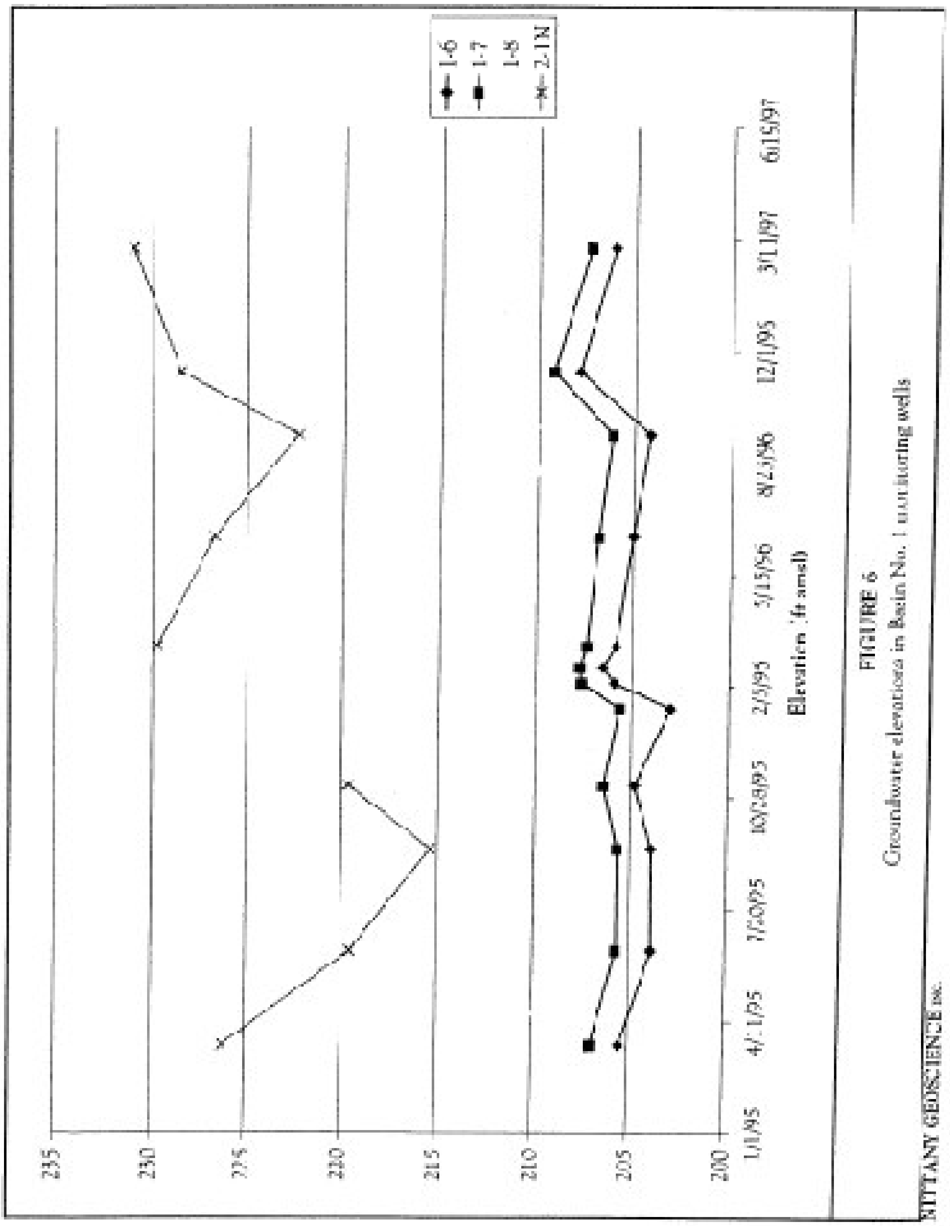

FIGURE 6
Groundwater elevations in Basin No. 1 monitoring wells

TABLES

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TABLE 1
Groundwater Sampling Parameter Lists for Monitoring Wells

Basin 1 Annual Groundwater Sampling Parameter List	Basin 1 Quarterly Groundwater Sampling Parameter List
1,1-Dichloroethane	Alkalinity-phosphate
1,1-Dichloroethene	Alkalinity-total
1,2-Dichloroethane	Boron-dissolved
1-Trichloroethane	Boron-total
cis-1,2-Dichloroethene	Calcium-dissolved
Perchloroethene	Calcium-total
trans-1,2-Dichloroethene	Chlorine-total
Trichloroethene	Chemical Oxygen Demand
Vinyl Chloride	Dissolved Oxygen, field
Silver-dissolved	Fluoride
Silver-total	Iron-dissolved
Alkalinity-phosphate	Iron-total
Alkalinity-total	HCO3
Arsenic-dissolved	Potassium-dissolved
Arsenic-total	Potassium-total
Boron-dissolved	Lithium-dissolved
Boron-total	Lithium-total
Barium-dissolved	Magnesium-dissolved
Barium-total	Magnesium-total
Calcium-dissolved	Manganese-dissolved
Calcium-total	Manganese-total
Cadmium-dissolved	Sodium-dissolved
Cadmium-total	Sodium-total
Chlorine-total	Ammonia, as Nitrogen
Chemical Oxygen Demand	Nitrate, IC
Chromium-dissolved	Nitrate, as Nitrogen
Chromium-total	Total Organic Carbon
Copper-dissolved	pH, field
Copper-total	pH, lab
Dissolved Oxygen	Redox
Fluorine-total	Sulfate
Iron-dissolved	Dissolved Solids
Iron-total	Specific Conductance, field
HCO3	Specific Conductance, lab
Mercury-dissolved	Turbidity
Mercury-total	Water Temperature
Potassium-dissolved	Depth to Water
Potassium-total	
Lithium-dissolved	
Lithium-total	
Magnesium-dissolved	
Magnesium-total	
Manganese-dissolved	
Manganese-total	
Sodium-dissolved	
Sodium-total	
Ammonia, as Nitrogen	
Nitrate, IC	
Nitrate, as Nitrogen	
Total Organic Carbon	
Lead-dissolved	
Lead-total	
pH-field	
pH-lab	
Selenium-dissolved	
Selenium-total	
Sulfate	
Dissolved Solids	
Specific Conductance, field	
Specific Conductance, lab	
Turbidity, lab	
Water Temperature	
Zinc-dissolved	
Zinc-total	
Depth to water	

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APPENDIX A

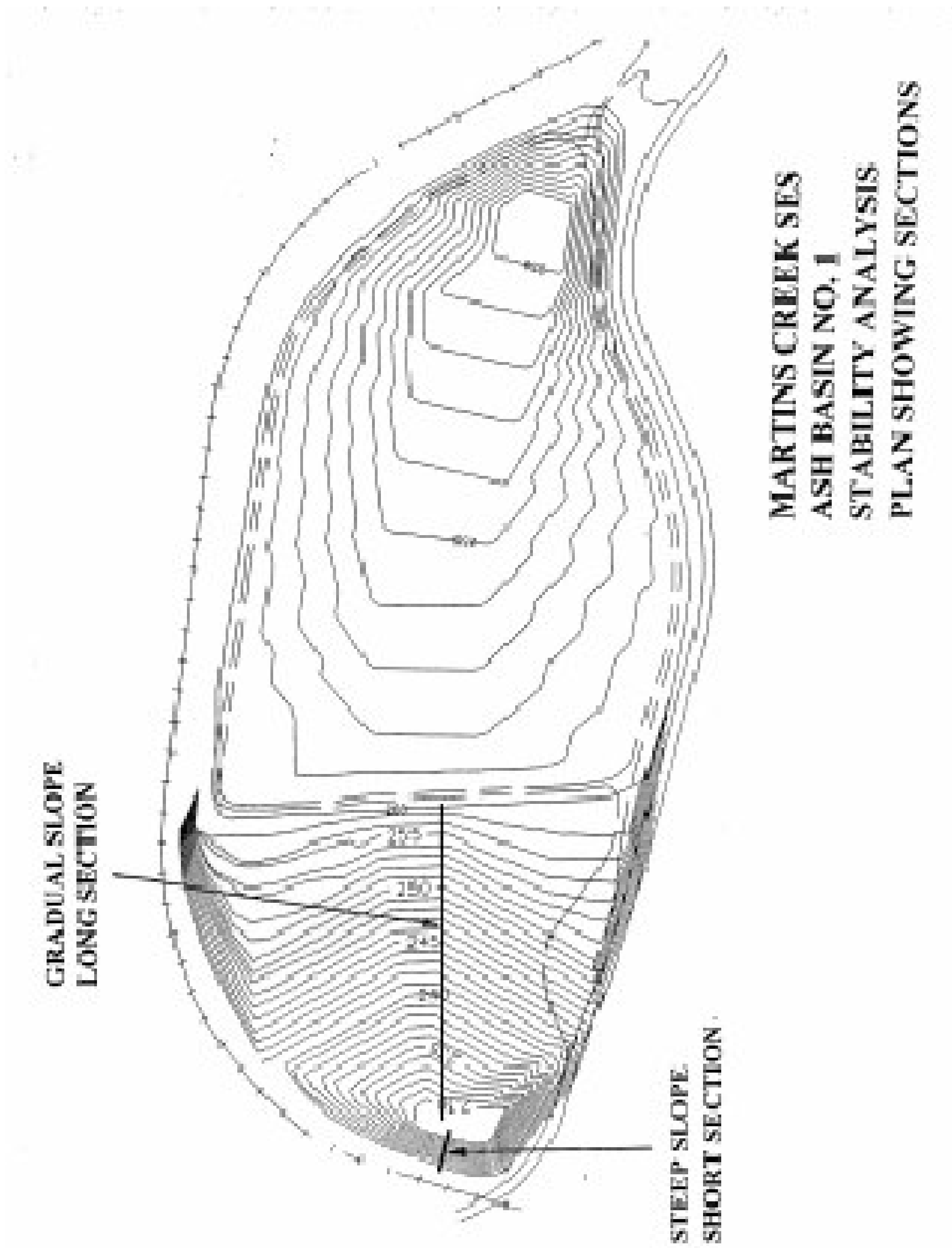
Documents Submitted to the DEP During Project

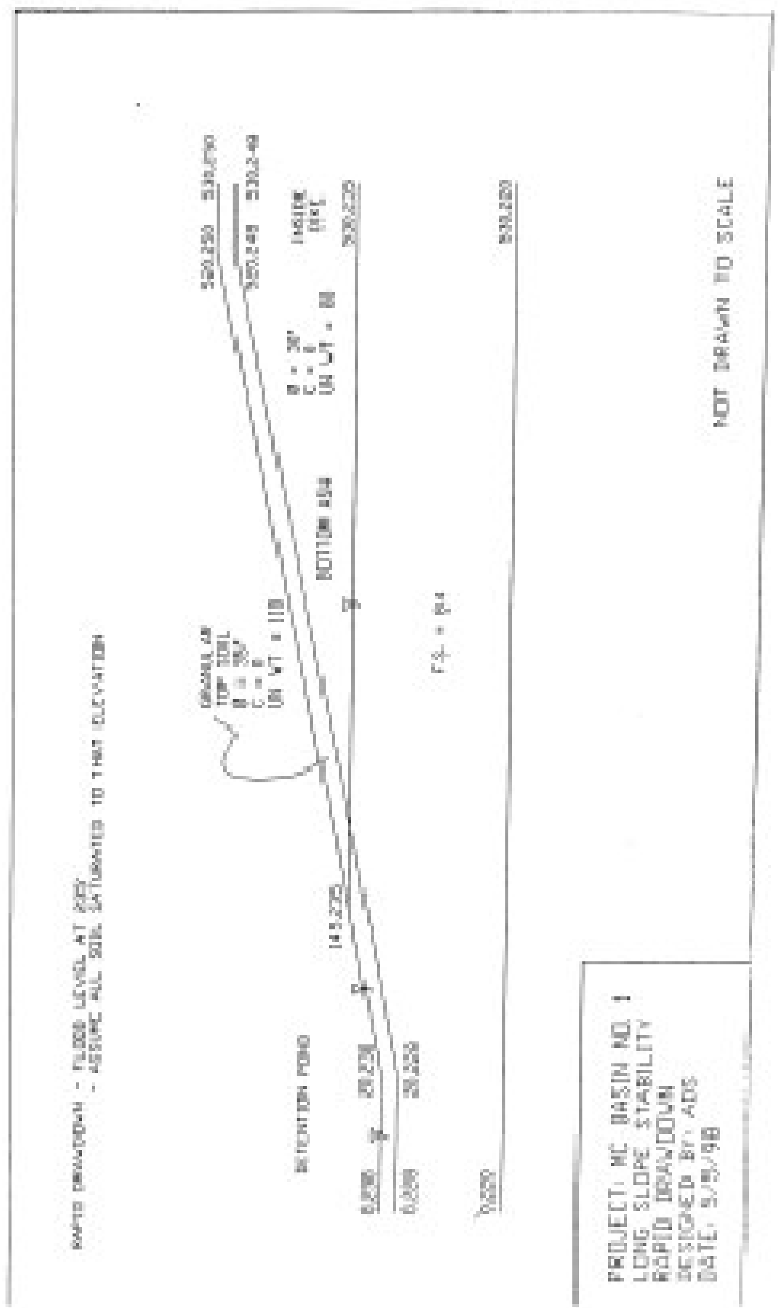
MARTINS CREEK ASH BASIN NO 1
INTERNAL STABILITY ANALYSIS

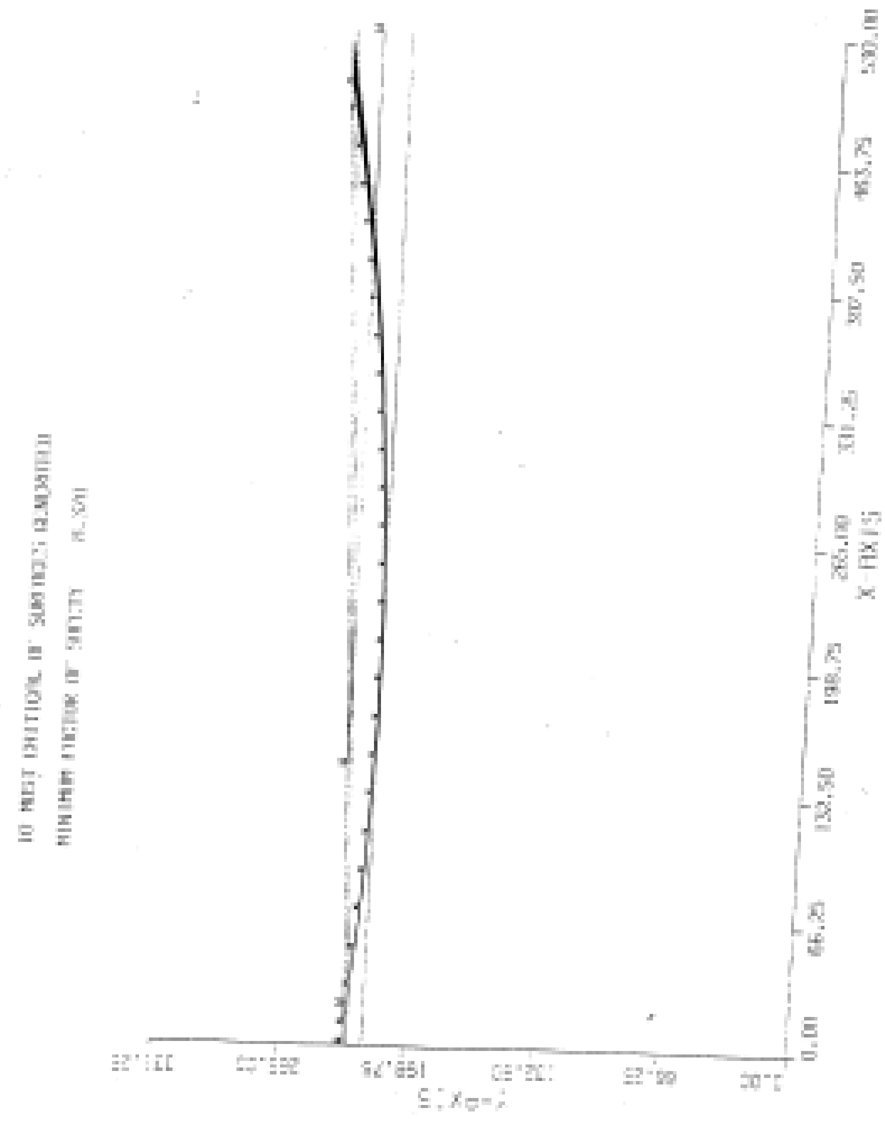
PP&L was requested to evaluate the impact of flooding on the internal slopes of the ash basin after it is closed. The 100 year flood would not flood the closed basin as it's elevation (235) is at least six feet below the top of the closed basin dikes at their lowest elevation. Nevertheless, PP&L assumed that the depression within the basin was filled to El 235 and then drained away quickly (rapid drawdown). The analysis assumes that entire soils layer below that elevation is totally saturated and that the phreatic surface parallels the soil surface up to that elevation. This models the soil after the water has drained away but the pore water in the soil hasn't had a chance to drain away yet. The added weight of the water impacts the soil stability.

Two cases were investigated. A steep short section shown on the attached plan and a long, flatter section. Both sections are the steepest ones anticipated for the closure. The steep section is made of only soil since it is the existing dike slope. The long, flatter section, assumed two feet of soil cover over bottom ash. The steep section had a factor of safety of 1.5, while the flatter one had one of 8.4. 1.2 is typically acceptable for rapid drawdown situations. Therefore, the stability of the closure should it get flooded somehow should not be a problem.

Attached is a site plan showing the location of the sections, schematics of the stability sections, the computer input and output sheets along with a stability plot, and a brief description of the PC version of the STABL Computer Program used for the analysis. The mainframe version was used for the analysis but it's manual is over 100 pages and the supporting documentation is two volumes. This can be provided if necessary.


GRADUAL SLOPE
LONG SECTION
STEEP SLOPE
SHORT SECTION
MARTINS CREEK SES
ASH BASIN NO. 1
STABILITY ANALYSIS
PLAN SHOWING SECTIONS


RAPID DRAWDOWN - FLOOD LEVEL AT 235'
- ASSUME ALL SOIL SATURATED TO THAT ELEVATION
DETENTION POND
BOTTOM ASH
INSIDE DIKE
F.S. = 1.4
PROJECT: MC BASIN NO. 1
LONG SLOPE STABILITY
RAPID DRAWDOWN
DESIGNED BY: ADS
DATE: 5/5/98
NOT DRAWN TO SCALE


X-AXIS
0.00
66.25
132.50
198.75
265.00
331.25
397.50
463.75
530.00

```
INPUT LISTING                                  PAGE 1.

PROFIL
MARTINS CREEK BASIN 1 - [illegible]
[illegible]
```

RAPID DRAWDOWN

F.S. 8.4

--SLOPE STABILITY ANALYSIS--
SIMPLIFIED JANBU METHOD OF SLICES
IRREGULAR FAILURE SURFACES

PROBLEM DESCRIPTION MARTINS CREEK BASIN 1 - LONG SLOPE
[illegible]

BOUNDARY COORDINATES

5 TOP BOUNDARIES
7 TOTAL BOUNDARIES

BOUNDARY NO.	X-LEFT (FT)	Y-LEFT (FT)	X-RIGHT (FT)	Y-RIGHT (FT)	SOIL TYPE BELOW BND
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

II. ISOTROPIC SOIL PARAMETERS

2 TYPE(S) OF SOIL

SOIL TYPE NO.	TOTAL UNIT WT. (PCF)	SATURATED UNIT WT. (PCF)	COHESION INTERCEPT (PSF)	FRICTION ANGLE (DEG)	PORE PRESSURE PARAMETER	PRESSURE CONSTANT (PSF)	PIEZOMETRIC SURFACE NO.
1	110.0	120.0	0.0	30.0	0.0	0.0	1
2	90.0	90.0	0.0	30.0	0.0	0.0	1

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

UNIT WEIGHT OF WATER = 62.40

PIEZOMETRIC SURFACE NO. 1 SPECIFIED BY 4 COORDINATE POINTS

POINT NO.	X-WATER (FT)	Y-WATER (FT)
1	0.0	2[illegible].00
2	[illegible]	[illegible]
3	1[illegible]	[illegible]
4	[illegible]	[illegible]

...ITICAL FAILURE SURFACE SEARCHING METHOD, USING A RANDOM
T...NIQUE FOR GENERATING CIRCULAR SURFACES, HAS BEEN SPECIFIED.

[illegible] TRIAL SURFACES HAVE BEEN GENERATED.

[illegible] SURFACES INITIATE FROM EACH OF [illegible] POINTS EQUALLY SPACED
ALONG THE GROUND SURFACE BETWEEN X = [illegible] FT.
AND X = [illegible] FT.

EACH SURFACE TERMINATES BETWEEN X = [illegible] FT.
AND X = [illegible] FT.

UNLESS FURTHER LIMITATIONS WERE IMPOSED, THE MINIMUM ELEVATION
AT WHICH A SURFACE EXTENDS IS Y = [illegible] FT.

[illegible] FT. LINE SEGMENTS DEFINE EACH TRIAL FAILURE SURFACE.

FO[illegible]OWING ARE DISPLAYED THE TEN MOST CRITICAL OF THE TRIAL FAILURE SURFACES EXAMINED. THEY ARE ORDERED - MOST CRITICAL FIRST.

SAFETY FACTORS ARE CALCULATED BY THE MODIFIED BISHOP METHOD.

FAILURE SURFACE SPECIFIED BY 2[illegible] COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
[illegible]	[illegible]	[illegible]

*** [illegible] ***

FAILURE SURFACE SPECIFIED BY 2[illegible] COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
[illegible]	[illegible]	[illegible]

FAILURE SURFACE SPECIFIED BY 26 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
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[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
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[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]

*** [illegible] ***

FAILURE SURFACE SPECIFIED BY 27 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
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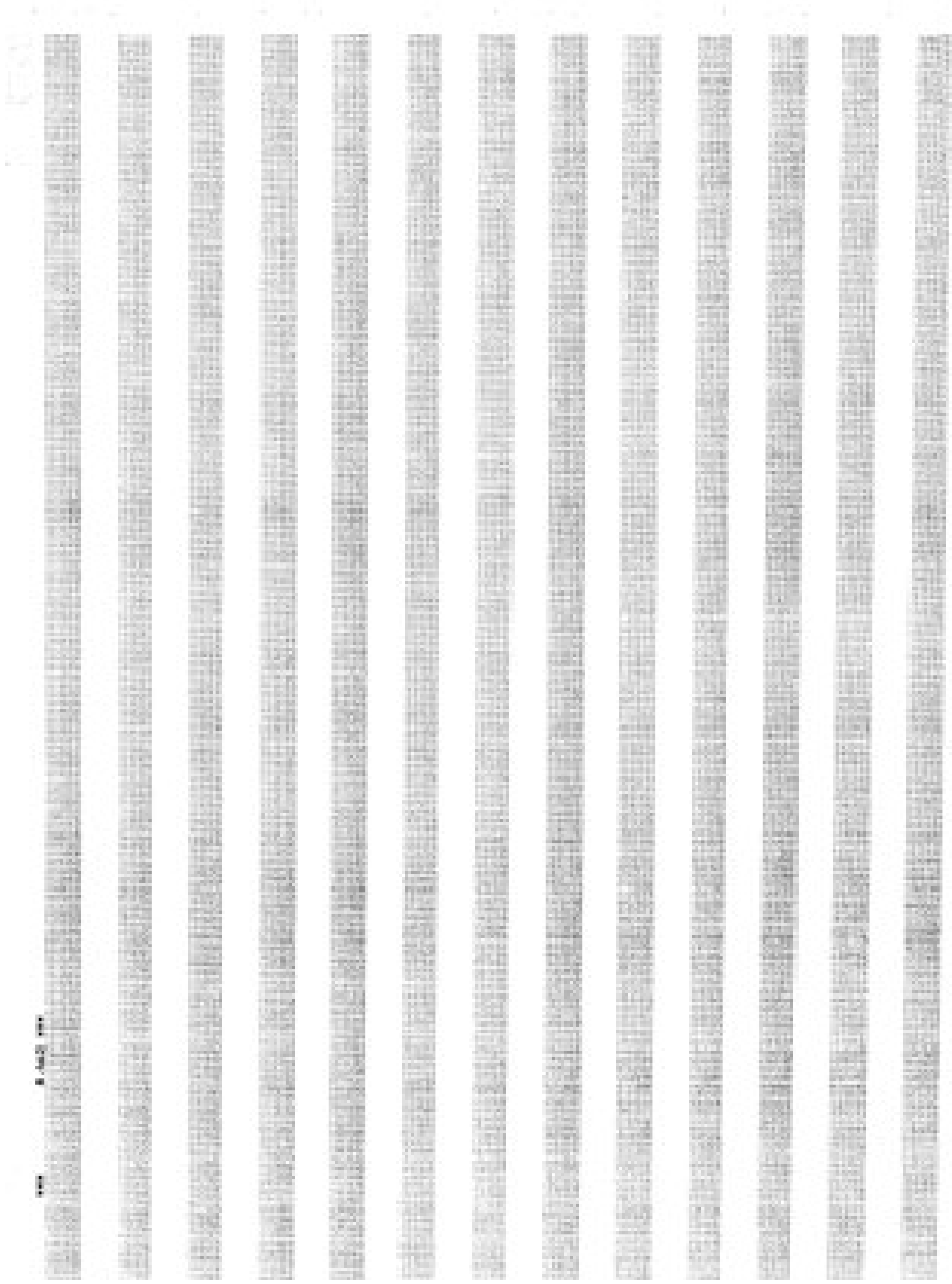

FAILURE SURFACE SPECIFIED BY 27 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
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2	[illegible]	[illegible]
3	[illegible]	[illegible]
4	[illegible]	[illegible]
5	[illegible]	[illegible]
6	[illegible]	[illegible]
7	[illegible]	[illegible]
8	[illegible]	[illegible]
9	[illegible]	[illegible]
10	[illegible]	[illegible]
11	[illegible]	[illegible]
12	[illegible]	[illegible]
13	[illegible]	[illegible]
14	[illegible]	[illegible]
15	[illegible]	[illegible]
16	[illegible]	[illegible]
17	[illegible]	[illegible]
18	[illegible]	[illegible]
19	[illegible]	[illegible]
20	[illegible]	[illegible]
21	[illegible]	[illegible]
22	[illegible]	[illegible]
23	[illegible]	[illegible]
24	[illegible]	[illegible]
25	[illegible]	[illegible]
26	[illegible]	[illegible]
27	[illegible]	[illegible]

*** [illegible] ***

FAILURE SURFACE SPECIFIED BY 27 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	[illegible]	[illegible]
2	[illegible]	[illegible]
3	[illegible]	[illegible]
4	[illegible]	[illegible]
5	[illegible]	[illegible]
6	[illegible]	[illegible]
7	[illegible]	[illegible]
8	[illegible]	[illegible]
9	[illegible]	[illegible]
10	[illegible]	[illegible]
11	[illegible]	[illegible]
12	[illegible]	[illegible]
13	[illegible]	[illegible]
14	[illegible]	[illegible]
15	[illegible]	[illegible]
16	[illegible]	[illegible]
17	[illegible]	[illegible]
18	[illegible]	[illegible]
19	[illegible]	[illegible]
20	[illegible]	[illegible]
21	[illegible]	[illegible]
22	[illegible]	[illegible]
23	[illegible]	[illegible]
24	[illegible]	[illegible]
25	[illegible]	[illegible]
26	[illegible]	[illegible]
27	[illegible]	[illegible]

FAILURE SURFACE SPECIFIED BY 27 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	[illegible]	[illegible]
2	[illegible]	[illegible]
3	[illegible]	[illegible]
4	[illegible]	[illegible]
5	[illegible]	[illegible]
6	[illegible]	[illegible]
7	[illegible]	[illegible]
8	[illegible]	[illegible]
9	[illegible]	[illegible]
10	[illegible]	[illegible]
11	[illegible]	[illegible]
12	[illegible]	[illegible]
13	[illegible]	[illegible]
14	[illegible]	[illegible]
15	[illegible]	[illegible]
16	[illegible]	[illegible]
17	[illegible]	[illegible]
18	[illegible]	[illegible]
19	[illegible]	[illegible]
20	[illegible]	[illegible]
21	[illegible]	[illegible]
22	[illegible]	[illegible]
23	[illegible]	[illegible]
24	[illegible]	[illegible]
25	[illegible]	[illegible]
26	[illegible]	[illegible]
27	[illegible]	[illegible]

*** [illegible] ***

FAILURE SURFACE SPECIFIED BY 27 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	[illegible]	[illegible]
2	[illegible]	[illegible]
3	[illegible]	[illegible]
4	[illegible]	[illegible]
5	[illegible]	[illegible]
6	[illegible]	[illegible]
7	[illegible]	[illegible]
8	[illegible]	[illegible]
9	[illegible]	[illegible]
10	[illegible]	[illegible]
11	[illegible]	[illegible]
12	[illegible]	[illegible]
13	[illegible]	[illegible]
14	[illegible]	[illegible]
15	[illegible]	[illegible]
16	[illegible]	[illegible]
17	[illegible]	[illegible]
18	[illegible]	[illegible]
19	[illegible]	[illegible]
20	[illegible]	[illegible]
21	[illegible]	[illegible]
22	[illegible]	[illegible]
23	[illegible]	[illegible]
24	[illegible]	[illegible]
25	[illegible]	[illegible]
26	[illegible]	[illegible]
27	[illegible]	[illegible]

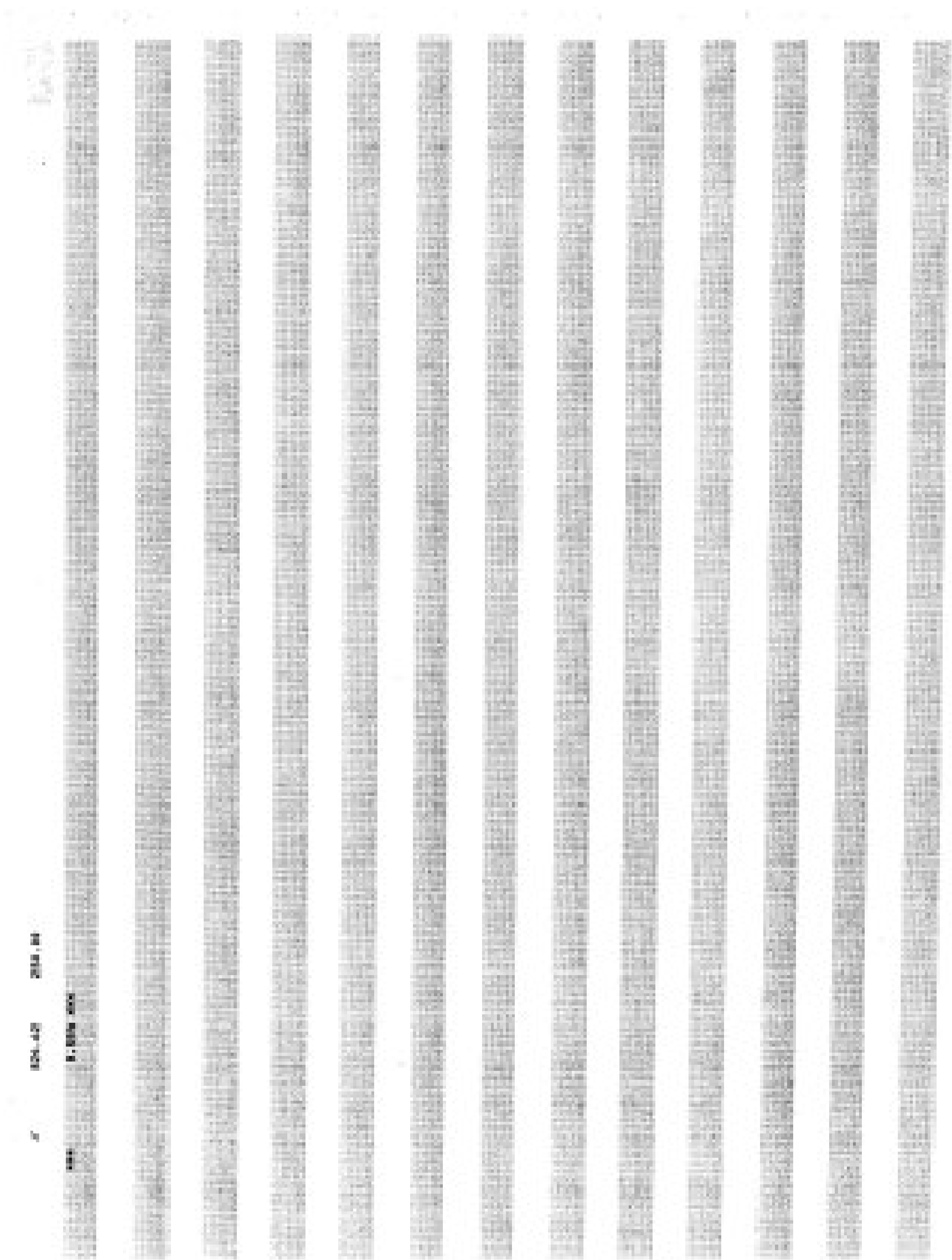
FA...RE SURFACE SPECIFIED BY 27 COORDINATE POINTS

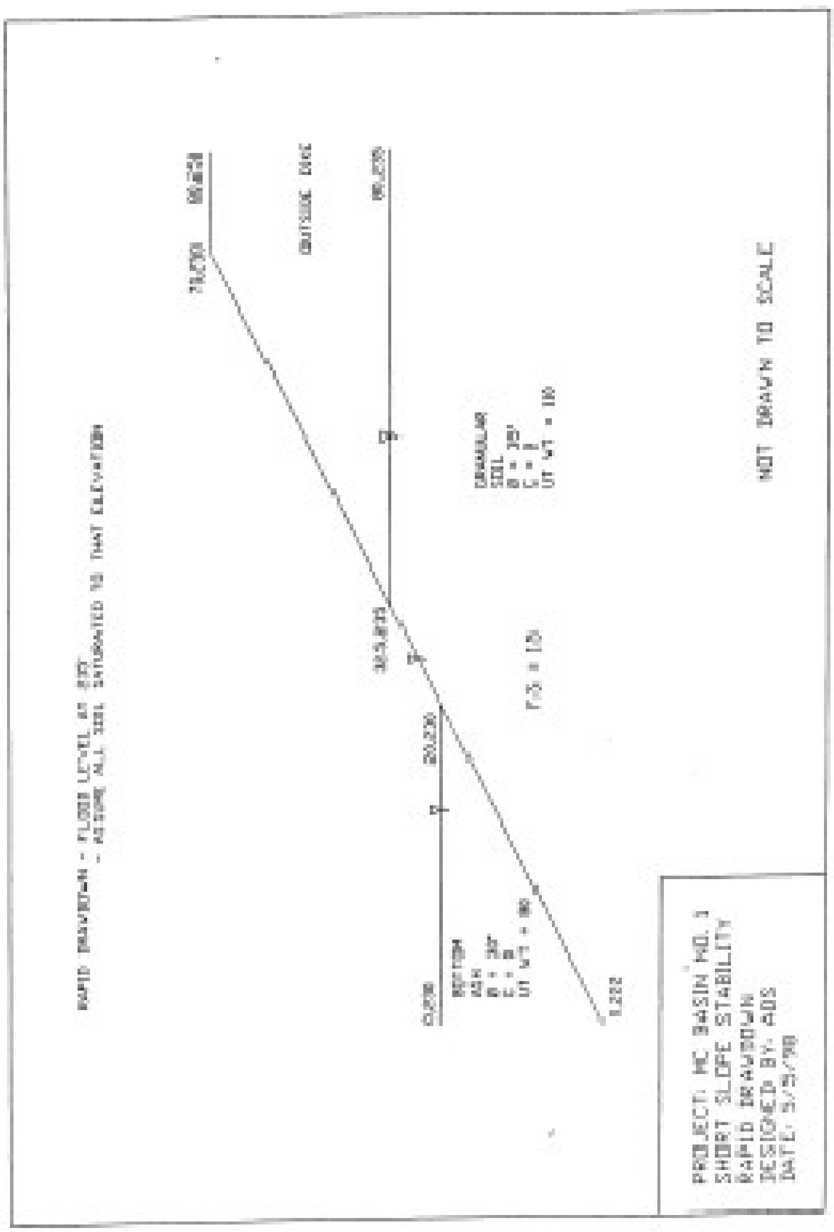
POINT NO.	X-SURF (FT)	Y-SURF (FT)
[illegible]	[illegible]	[illegible]

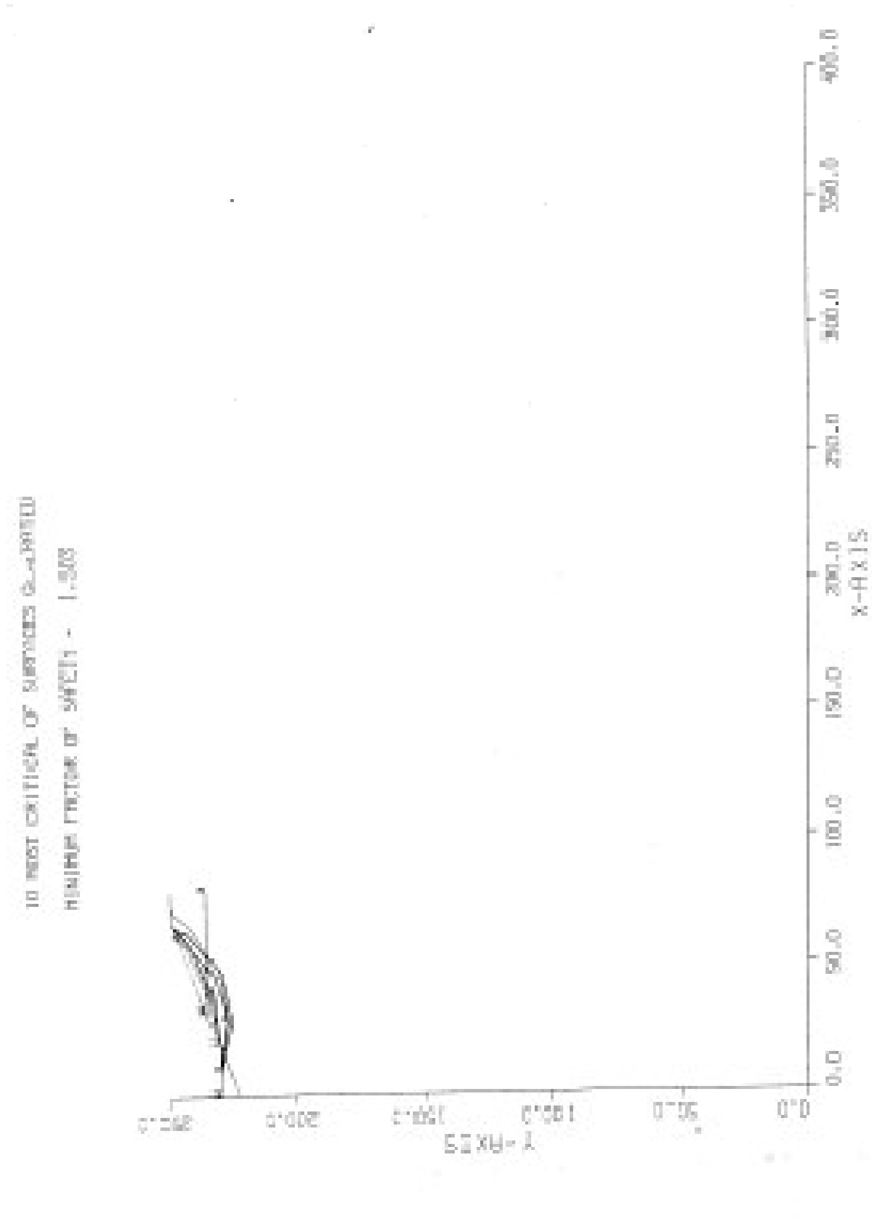
*** [illegible] ***

FAILURE SURFACE SPECIFIED BY 27 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
[illegible]	[illegible]	[illegible]




OUTSIDE DIKE
NOT DRAWN TO SCALE
PROJECT: MC BASIN NO. 1
SHORT SLOPE STABILITY
RAPID DRAWDOWN
DESIGNED BY: ADS



X-AXIS
Y-AXIS

INPUT LISTING PAGE 1

```
PROFIL
MARTINS CREEK BASIN 1 - SHORT SLOPE
[illegible]
[illegible]
[illegible]
[illegible]
[illegible]
SOIL
[illegible]
[illegible]
[illegible]
WATER
[illegible]
[illegible]
[illegible]
[illegible]
[illegible]
[illegible]
CIRCLE
[illegible]
[illegible]
[illegible]
```

Rapid Drawdown

F.S. 1.5

--SLOPE STABILITY ANALYSIS--
SIMPLIFIED JANBU METHOD OF SLICES
IRREGULAR FAILURE SURFACES

PROBLEM DESCRIPTION   MARTINS CREEK BASIN 1 - SHORT SLOPE
[illegible]

BOUNDARY COORDINATES

[illegible] TOP BOUNDARIES
[illegible] TOTAL BOUNDARIES

BOUNDARY NO.	X-LEFT (FT)	Y-LEFT (FT)	X-RIGHT (FT)	Y-RIGHT (FT)	SOIL TYPE BELOW BND
1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
3	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

1. [illegible] SOIL PARAMETERS

2 TYPE(S) OF SOIL

SOIL TYPE NO.	TOTAL UNIT WT. (PCF)	SATURATED UNIT WT. (PCF)	COHESION INTERCEPT (PSF)	FRICTION ANGLE (DEG)	PORE PRESSURE PARAMETER	PRESSURE CONSTANT (PSF)	PIEZOMETRIC SURFACE NO.
1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1
2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1

PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

UNIT WEIGHT OF WATER = 62.40

PIEZOMETRIC SURFACE NO. 1 SPECIFIED BY 4 COORDINATE POINTS

POINT NO.	X-WATER (FT)	Y-WATER (FT)
1	0.0	[illegible]
2	[illegible]	[illegible]
3	[illegible]	[illegible]
4	[illegible]	[illegible]

A TRIAL FAILURE SURFACE GENERATOR/SEARCHING METHOD, USING A RANDOM TECHNIQUE FOR GENERATING CIRCULAR SURFACES, HAS BEEN SPECIFIED.

200 TRIAL SURFACES HAVE BEEN GENERATED.

20 SURFACES INITIATE FROM EACH OF 10 POINTS EQUALLY SPACED ALONG THE GROUND SURFACE BETWEEN X = 15.00 FT.
AND X = 30.00 FT.

EACH SURFACE TERMINATES BETWEEN X = 45.00 FT.
AND X = 75.00 FT.

UNLESS FURTHER LIMITATIONS WERE IMPOSED, THE MINIMUM ELEVATION AT WHICH A SURFACE EXTENDS IS Y = -200.00 FT.

10.00 FT. LINE SEGMENTS DEFINE EACH TRIAL FAILURE SURFACE.

F... ...INGS ARE DISPLAYED THE TEN MOST CRITICAL OF THE TRIAL FA...RE SURFACES EXAMINED. THEY ARE ORDERED - MOST CRITICAL FIRST.

SAFETY FACTORS ARE CALCULATED BY THE MODIFIED BISHOP METHOD.

FAILURE SURFACE SPECIFIED BY 4 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	[illegible]	[illegible]
2	[illegible]	[illegible]
3	[illegible]	[illegible]
4	[illegible]	[illegible]

*** 1.[illegible] ***

FAILURE SURFACE SPECIFIED BY 5 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	[illegible]	[illegible]
2	[illegible]	[illegible]
3	[illegible]	[illegible]
4	[illegible]	[illegible]
5	[illegible]	[illegible]

*** 1.[illegible] ***

FAILURE SURFACE SPECIFIED BY 4 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	[illegible]	[illegible]
2	[illegible]	[illegible]
3	[illegible]	[illegible]
4	[illegible]	[illegible]
5	[illegible]	[illegible]

*** 3.[illegible] ***

FAILURE SURFACE SPECIFIED BY 4 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	[illegible]	[illegible]
2	[illegible]	[illegible]
3	[illegible]	[illegible]
4	[illegible]	[illegible]

*** [illegible] ***

FAILURE SURFACE SPECIFIED BY 4 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	[illegible]	[illegible]
2	[illegible]	[illegible]
3	[illegible]	[illegible]
4	[illegible]	[illegible]

*** 1.401 ***

FAILURE SURFACE SPECIFIED BY 4 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	[illegible]	[illegible]
2	[illegible]	[illegible]
3	[illegible]	[illegible]
4	[illegible]	[illegible]

*** 1.[illegible] ***

FAILURE SURFACE SPECIFIED BY 4 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	[illegible]	[illegible]
2	[illegible]	[illegible]
3	[illegible]	[illegible]
4	[illegible]	[illegible]

*** 1.[illegible] ***

FAILURE SURFACE SPECIFIED BY 6 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	[illegible]	[illegible]
2	[illegible]	[illegible]
3	[illegible]	[illegible]
4	[illegible]	[illegible]
5	[illegible]	[illegible]
6	[illegible]	[illegible]

*** 1.[illegible] ***

FAILURE SURFACE SPECIFIED BY [illegible] COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]

*** [illegible] ***

FAILURE SURFACE SPECIFIED BY 5 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]

*** [illegible] ***

```
**********************
*                    *
*      STABL4        *
*                    *
**********************
```

Computer Analysis of General
Slope Stability Problems

Originally authored by Ronald A. Siegel
Graduate Research Assistant

Joint Highway Research Project
Engineering Experiment station
Purdue University

Adapted for the IBM/PC 1984, by
Civil Engineering Shareware
P.O. Box 472
Lee's Summit, MO 64063

MARTINS CREEK SES
ASH BASIN 1
STABILITY ANALYSIS
SAMPLE DOCUMENTATION

The actual users manual is over 100 pages long. The stability analysis was done on PP&L's mainframe computer. This document is one included with a PC version of the software and provides some insight into the set up of the input.

The Modified Bishop Method was used for this analysis.

```
****************************** NOTICE ******************************
* A limited license is granted to all users of this program, to make      *
* copies of this program diskette, and give them to other users, on the   *
* following conditions:                                                   *
*     1. The notices contained in the program header display are not      *
*        to be altered, bypassed, or removed.                             *
*     2. No fee is to be charged, or any other consideration received,    *
*        for copying or distributing the program.                         *
*****************************************************************************
```

STABL4 USER MANUAL SUPPLEMENTAL INFORMATION
IBM/PC Version

Using STABL4 on the IBM/PC is easy and straight forward. The program is furnished on a standard IBM/PC diskette, as compiled executable code, using PC/DOS (tm) 2.10. The diskettes are formatted in nine eight sector format, which is compatible with earlier DOS versions as well.

In order to run this program, you will need an IBM/PC or compatible, with:

1. PC/DOS version 1.1 or later.
2. 256KB of installed RAM.
3. One double-sided 5-1/4 inch disk drive.
4. An optional 8087 Numeric Data Coprocessor.
5. A text processor capable of producing standard ASCII data files.
6. A standard IBM 80 column printer.
7. An IBM monochrome or color graphics display.

You should also be familiar with operation of the IBM/PC. If you are not, it is advisable to study the DOS manual for information on creating disk files.

and using file specifications. If you do not have an 8087 NDP installed in your PC, this program will still operate, however, the run times may be lengthy and in some cases excessive. Do not become impatient and press any keys while waiting for the program to complete it's run, as this will usually cause the program to abort. As with all software, it is advisable to make a back-up copy of the program diskette before attempting to run the program.

After you have backed up your program diskette, you are ready to run the program using the sample data files supplied with the program. To start operations, place the program diskette in your logged drive, and type STABL4 followed by the return key. You may also execute the program by typing B:STABL4, etc., depending on which drive the STABL4.EXE file is on. STABL4 is a large file, approximately 213KB, and will take a few seconds to load. After the program is loaded, you will see the ShareWare header screen, and the program title display. Press the return key to proceed. The program will prompt you for two user supplied filenames. The first prompt is for the input file. The input file must be a valid STABL4 input file as described in the program manual, and is specified in standard DOS format, using the drive designation and file name.(ie. B:SAMPLE1.DTA). The program will next prompt you for the output file. Any valid DOS file name may be used, such as B:TEST.OUT. This will write the output file to a disk file for later output to the printer or display screen. Alternately, you may type LPT1 for direct output to your printer.

You can use the utility program "PRINTOUT.EXE", on your program diskette to print the program output. Type "printout", and enter the output filespec at the prompt. Printout has the advantage of recognizing the embedded FORTRAN printer control codes, such as form feeds, and line feeds.

When both input and output files have been specified, the program will pause to allow you to change diskettes if you are using a single drive system. As soon as you press the return key, you will see a message which indicates the program operation has started and the elapsed time clock is started. Do not touch the keyboard until program operation is completed. When the program is done, it will display a message such as "Stop-program terminated". When outputting files to disk, make sure that you have enough free space on the diskette to write the output file. With the 8087 NDP, the program may take from two to fifteen minutes to operate. With out the 8087, you should expect runtimes of about twenty minutes up to two hours, depending on the complexity of the problem.

Input files may be generated using any text editor which will produce standard ASCII text files. Some word processor programs insert nonstandard characters, which are used for manuscript formatting. Most word processors will have a non-document mode which will produce acceptable input files. I often use a Shareware product called PC-Write to type input files. This program can be obtained by sending $10 to: PC-Write, 219 First N #224, Seattle, WA 98109. It is a first rate word processor, (I'm using it to type this) and is well worth the money. If you have an error in your input file, program operation will be terminated, and you will usually see a STABL4 error message which will point out the probable source line in which the error was detected. STABL4 has excellent error trapping and is a joy to use in this respect. Occasionally, you may see a compiler generated error message which will be a cryptic note, or and error number. If you have the Microsoft Fortran compiler manual, you will be able to look the error message up, otherwise, you will have to make a copy of the screen using shift-PrintScreen and send it to Civil Engineering ShareWare. I will try to help you figure out the problem. When ever you request help in running a program, include and exact copy of the input file you are attempting to run on a diskette, along with a complete description of the problem. I will try to return your diskette, along with the correction. This is a limited offer for registered users only. Your best bet is to look for an error in the input file, and to study the program manual carefully.

Use the example files included with the program to help you with preparing your input files. You can list these files to your printer by typing: COPY X:XXXXXXXX.XXX PRN. STABL4 is set up, such that the failure surface must move from the right to the left. In other words, the cross section is input with top of the slope on the right and the toe on the left. This is just opposite from what you may be used to, but is only a minor inconvenience. I usually prepare a scale drawing of the slope, including all soil types, piezometric surfaces, and other information. Using this sketch, I prepare the program input directly from the drawing. With Stabl, you must input all the surface boundaries first. Your origin will be at the lower left hand corner of your section, and you should make sure that all boundary coordinates are in the first quadrant. Stabl generates a character plot of the section it analyzes, together with a summary of the 10 most critical failure surfaces found. To get the best plot, you may need to adjust your coordinate system to fit. I like to use actual elevations, but when you input a Y-coordinate of say elevation 950, the character plot becomes too compressed to be useful. The best bet is to start at 0,0 and use actual dimensions rather than elevations.

The typical format for data input is summarized below the most frequently used commands. Free form data input is used, a single blank space should be inserted to separate each data item on a card. If a gap of more than one space separates two adjacent data items, all subsequent data items will be ignored, and most likely a input error will occur. Each card, actually a line in the input file, containing numerical data should be typed with the first data item on the card starting in the first column. An integer is a whole number used for counting, while a real number is a rational number used for measurement of magnitude. Real numbers contain a decimal point, whereas integers do not. For the title card associated with the PROFIL command, any combination of letters, numbers, blanks, or special characters may be used, up to a maximum of eighty spaces. A new line of data (card) should be started whenever a data card of command card is encountered.

****

PARTIAL LIST OF INPUT COMMANDS FOR STABL4

****

COMMAND CARD PROFIL Command code for section profile input.

DATA CARD Title

DATA CARD Integer Total number of boundaries
Integer Total number of surface boundaries

DATA CARD Real X-coordinate of left end of boundary (ft)

Real Y coordinate of left end of boundary (ft)
Real X coordinate of right end of boundary (ft)
Real Y coordinate of right end of boundary (ft)
Integer Soil type index number for material immediately beneath boundary

NOTE: Repeat preceding card for each boundary. All surface boundaries are input first. Subsequent boundaries must be input from left to right, and from top down.

****

COMMAND CARD- SOIL Command code for soil type input.

DATA CARD Integer Number of soil types

DATA CARD Real Moist unit weight (pcf)
Real Saturated unit weight (pcf)
Real Isotropic strength intercept (psf)
Real Isotropic strength angle (deg)
Real Pore pressure parameter
Real Pore pressure constant (psf)
Integer Piezometric surface index number

NOTE: Repeat preceding data for each soil type.

****

COMMAND CARD WATER Command code for Piezometric surface input.

DATA CARD Integer Number of piezometric surfaces defined.
Real Unit weight of water. (62.4 pcf)

DATA CARD Integer Number of points defining the water surface

DATA CARD Real X coordinate of point on water surface (ft)
Real Y coordinate of point on water surface (ft)

NOTE: Repeat preceding data card for each point on the piezometric surface, specifying points from left to right. If one or more piezometric surfaces are specified, each soil type defined under SOIL must be assigned a piezometric surface index number of one of the piezometric surfaces defined under WATER. Soils may be located totally above their respective piezometric surface.

****

COMMAND CARD EQUAKE Command code for pseudostatic earthquake load.

DATA CARD Real Earthquake coefficient for horizontal acceleration. (Positive to the left)
Real Earthquake coefficient for vertical acceleration. (Positive upward)
Real Cavitation pressure (psf)

****

COMMAND CARD LIMITS Command code for trial surface generation limits.

DATA CARD Integer Total number of generation boundaries.
Integer Number of generation boundaries which deflect upward.

DATA CARD Real X coordinate of left end of generation boundary. (ft)
Real Y coordinate of left end of generation boundary. (ft)
Real X coordinate of right end of generation boundary. (ft)
Real Y coordinate of right end of generation boundary. (ft)

NOTE: Repeat proceeding data for each generation boundary.

****

COMMAND CARD CIRCLE Command code for circular surface search method. (Use CIRCL2 for modified Bishop factor of safety method).

DATA CARD Integer Number of initiation points.
Integer Number of surfaces to be generated from each initiation point.
Real X coordinate of leftmost initiation pt. (ft)
Real X coordinate of rightmost initiation pt. (ft)
Real X coordinate of left termination limit (ft)
Real X coordinate of right termination limit (ft)
Real Minimum elev. of surface development. (ft)
Real Length of segments defining surfaces. (ft)
Real Counterclockwise direction limit. (deg.)
Real Clockwise direction limit. (deg)

****

COMMAND CARD RANDOM Command code for irregular surface searching.

NOTE: Same format as CIRCLE above.

****

COMMAND CARD BLOCK Command code for block surface search method.

DATA CARD Integer Total number of surfaces to be generated.
Integer Number of boxes used to generate base of central block.
Real Length of segments defining surfaces. (ft)

DATA CARD   Real   X coordinate of left end of centerline
defining the box. (ft)
Real   Y coordinate of left end of centerline
defining the box. (ft)
Real   X coordinate of right end of centerline
defining the box. (ft)
Real   Y coordinate of right end of centerline
defining the box. (ft)
Real   Length of vertical side of the box. (ft)

NOTE: Repeat the preceding data card for each box.

****

COMMAND CARD   BLOCK2   Command code for Rankine method for active
and passive wedges.

NOTE: Use same format as the BLOCK command above.

****

COMMAND CARD   TIES   Command Code

DATA CARD   Integer   Number of tieback loads

DATA CARD   Integer   Boundary number where tieback
load is applied.

Real   X coordinate of the point of
application of tieback load
(ft) or (m).

Real   Load per tieback
(lbs) or (kg).

Real   Horizontal spacing between
tiebacks (ft) or (m).

****

This is only a summary of the most used Stabl commands, see the Stabl User Manual for a complete listing, and the detailed description of program methods of operation. The user manual also contains an explanation of the Stabl generated error messages. These occupy about 10 pages and are too voluminous to include here.

In comparing results of the IBM/PC version of STABL4 with examples contained in the User Manual, you will probably note small differences in the calculated factors of safety. This is due to the differences in the way the mainframe computer used to calculate the example data, and the IBM/PC determine the random numbers used in the search routines. One of the characteristics of the Janbu method of slices, is that the resulting factor of safety computed by the Janbu method is generally more conservative (lower) than that calculated by other methods. In some cases where the failure circles are relatively deep, and the initial portion of the failure surface is very steep, the Janbu method produces excessively conservative (low) factors of safety. For these cases, it is better to use the Modified Bishop method (CIRCL2) to calculate the factor of safety since the result will generally be more reasonable. This was one of the more significant modifications to the original program, and is well documented in the program literature.

STABL4 is a sophisticated program, capable of handling most slope stability analysis problems you are likely to encounter in practice. These include end of construction, steady state seepage, earthquake, rapid drawdown, and anisotropic soil strength. Failure surfaces can be generated as circles, random surfaces, and block failure surfaces. If you are using this program and find it useful, and have not already done so, you can register your copy by sending $35 to: Civil Engineering Shareware, P.O. Box 472, Lee's Summit, MO 64063. Registration will entitle you to information on ordering program documentation and program usage, as well a catalog of other Civil Engineering ShareWare programs available.

****

**** DISCLAIMER NOTICE ****

Civil Engineering Shareware has taken reasonable care to insure that the IBM/PC version of STABL4 performs as documented in the program user manuals. Since we did not originally author the program, and have no control over how it is used, we cannot be responsible for the correct application of the program to actual slope stability calculations. Users of this program are expected to be competent, trained engineers, and are expected to exercise sound professional judgement in using this or any computer program, and in the evaluation of the results for accuracy and reasonableness.

****

February 1, 1986 Civil Engineering ShareWare

Pennsylvania Department of Environmental Protection

Rachel Carson State Office Building
P.O. Box 8554
Harrisburg, PA 17105-8554
February 26, 2009

Bureau of Waterways Engineering 717-772-5957

Steven Holler, P.E., P.L.S.
PPL Martins Creek, LLC
6605 Foul Rift Road
Bangor, PA 18013

Re: Jurisdictional Determination
Martins Creek Ash Basin No. 1 Dam
Lower Mount Bethel Township, Northampton County
DEP File No. D48-165

Dear Mr. Holler:

On January 15, 2009, representatives from the Department performed an inspection of the Martins Creek Ash Basin No.1 Dam, located within the Oughoughton Creek Watershed in Lower Mt. Bethel Township, Northampton County. This inspection was performed to assure that coal ash basin dams within the Commonwealth are being operated and maintained in a safe manner and as a result of the recent coal ash basin failures in Tennessee and Alabama. The purpose of this letter is to advise PPL of the Department's findings and the regulations governing the safe operation and maintenance of this dam.

The following impounding structures (dams) not located on a watercourse are regulated by this agency pursuant to Section 4 of the Dam Safety and Encroachments Act, Act No. 325, and Section 105.3 of the Department's Rules and Regulations, Chapter 105, Dam Safety and Waterway Management:

- Dams used for the storage of fluids or semifluids other than water, the escape of which may result in air, water or land pollution or in danger to persons or property.

Based on the information during the Department's January 15, 2009 site inspection and the provisions of Section 4 of the Dam Safety and Encroachments Act, we have determined that the proposed dam is regulated by this Act.

The Department has classified this dam as a Size Category "C" and a Hazard Potential Category "3" dam. Refer to Section 105.91 of the Department's regulations. This classification is based on the following:

- A dam having a height equal to or less than 40 feet or having a storage capacity of 1,000 acre-feet or less, is classified as a Size Category "C" dam.

- The Hazard Potential Category is determined relative to the area of inundation that would be expected if the dam were to suddenly fail. Downstream data (location of dwellings, roadways, utilities, etc.) was field reviewed during the inspection and it was found that no habitable structures or sole public access roads are expected to be impacted should this dam fail. Therefore, a Hazard Potential Category of "3" is appropriate.

As a "C-3" dam, the Martins Creek Ash Basin No. 1 does not require a Dam Permit for its continued operation and maintenance, per a waiver within the Chapter 105 Regulations at §105.12(b)(2); however, should PPL choose to modify or abandon this dam, a Dam Permit will be required from our office.

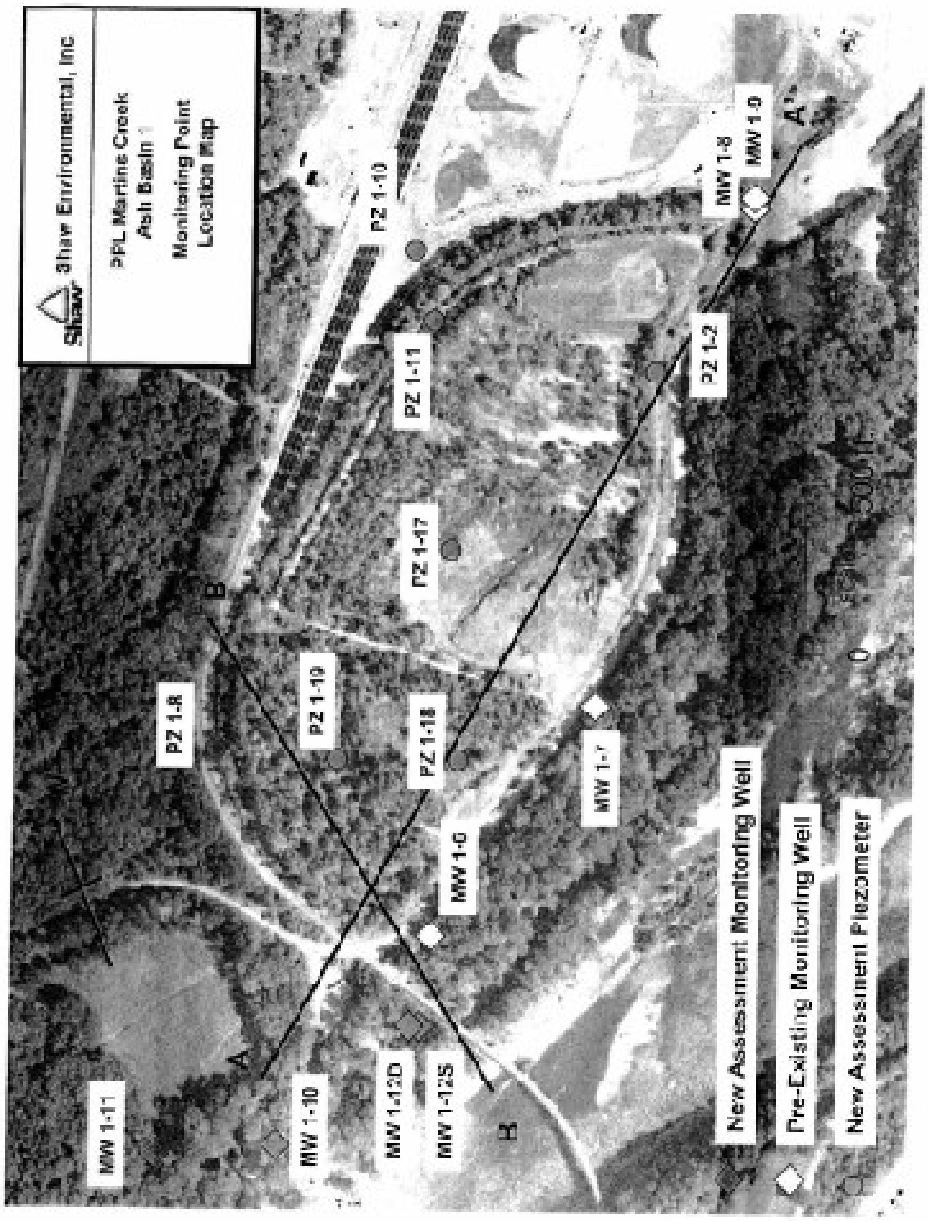
The proper operation and maintenance of this dam is PPL's responsibility. To assist in this endeavor, we have enclosed the Department's complimentary manual, "*Inspection, Maintenance, and Operation of Dams in Pennsylvania*." Please review this manual and pay particular attention to Section 2 – Dam Inspections, and Section 3 – Dam Maintenance. The Department will conduct periodic dam inspections and will notify PPL of our findings.

If you have any questions concerning the above determination or our requirements in this matter, please contact me at the above number.

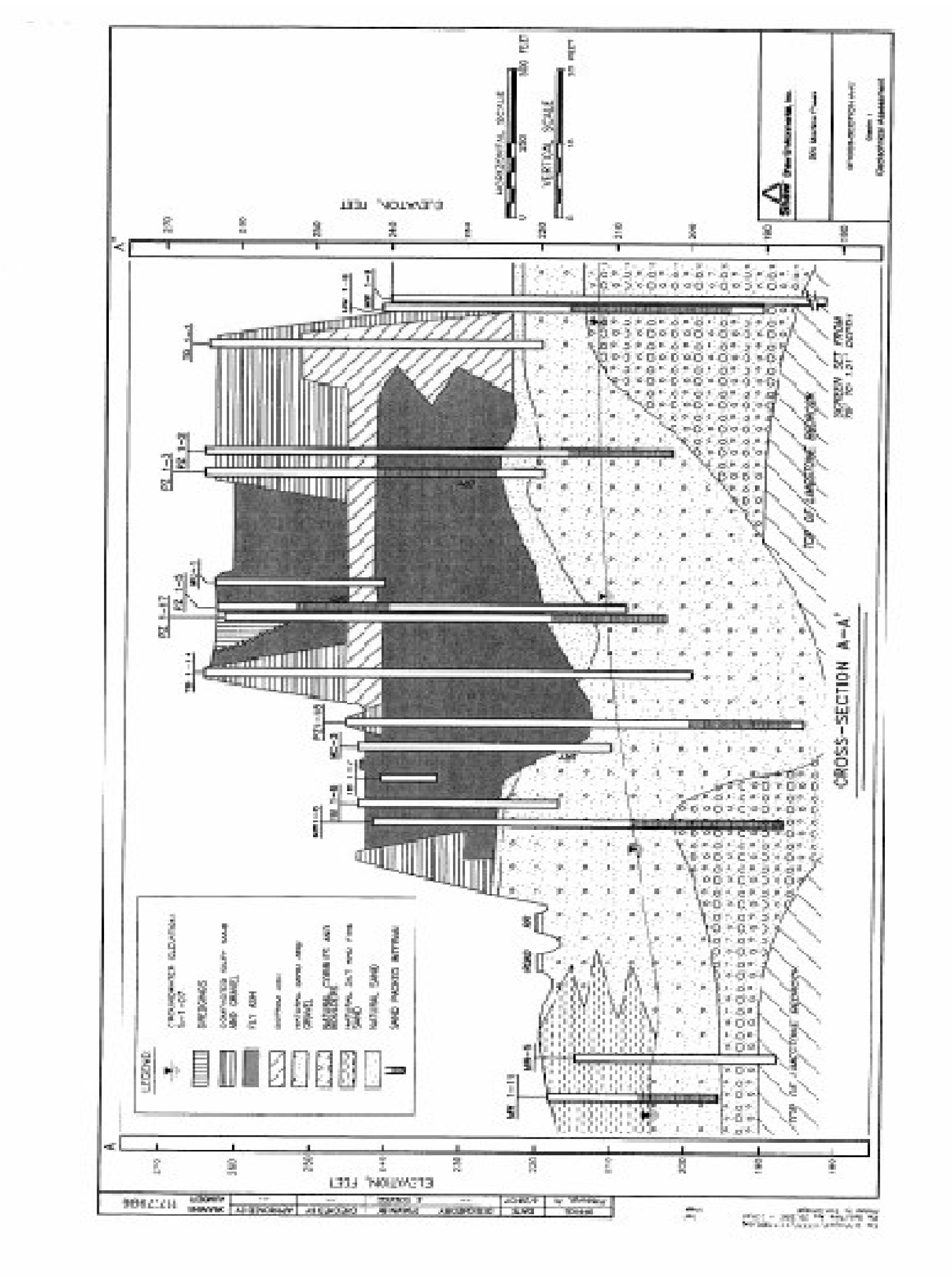
Sincerely,

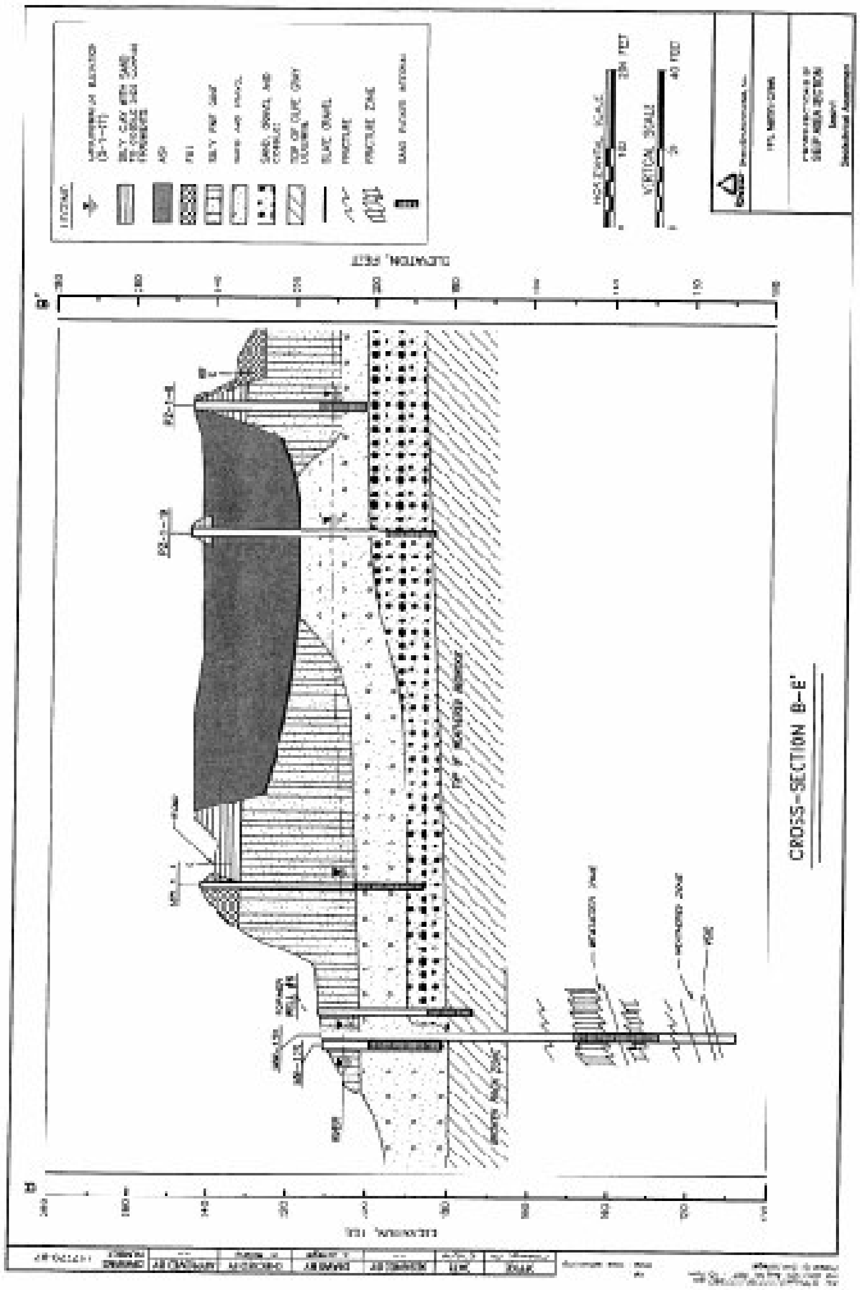
Richard A. Reisinger, P.E.
Chief
Delaware Watershed Section
Division of Dam Safety

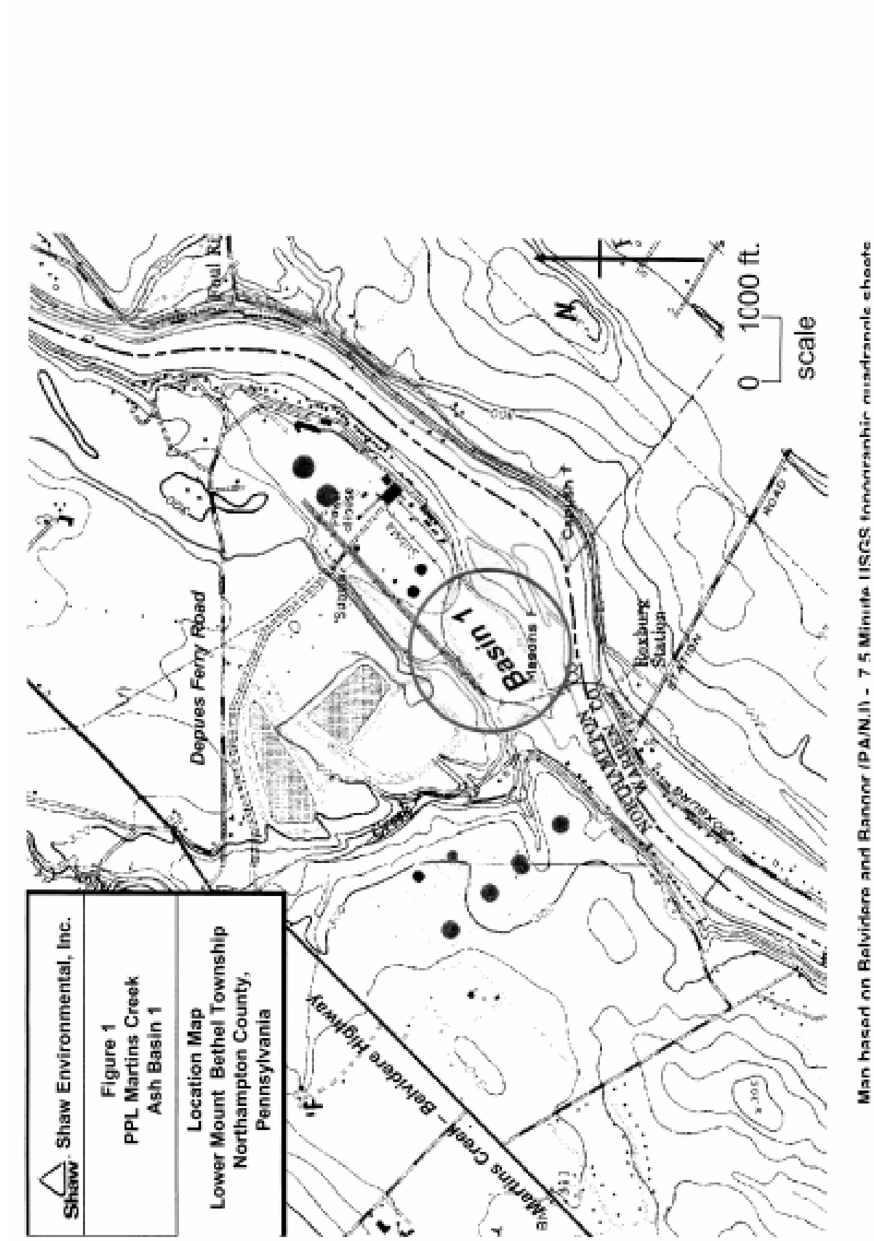
Enclosure: Manual "*Inspection, Maintenance, and Operation of Dams in Pennsylvania*"

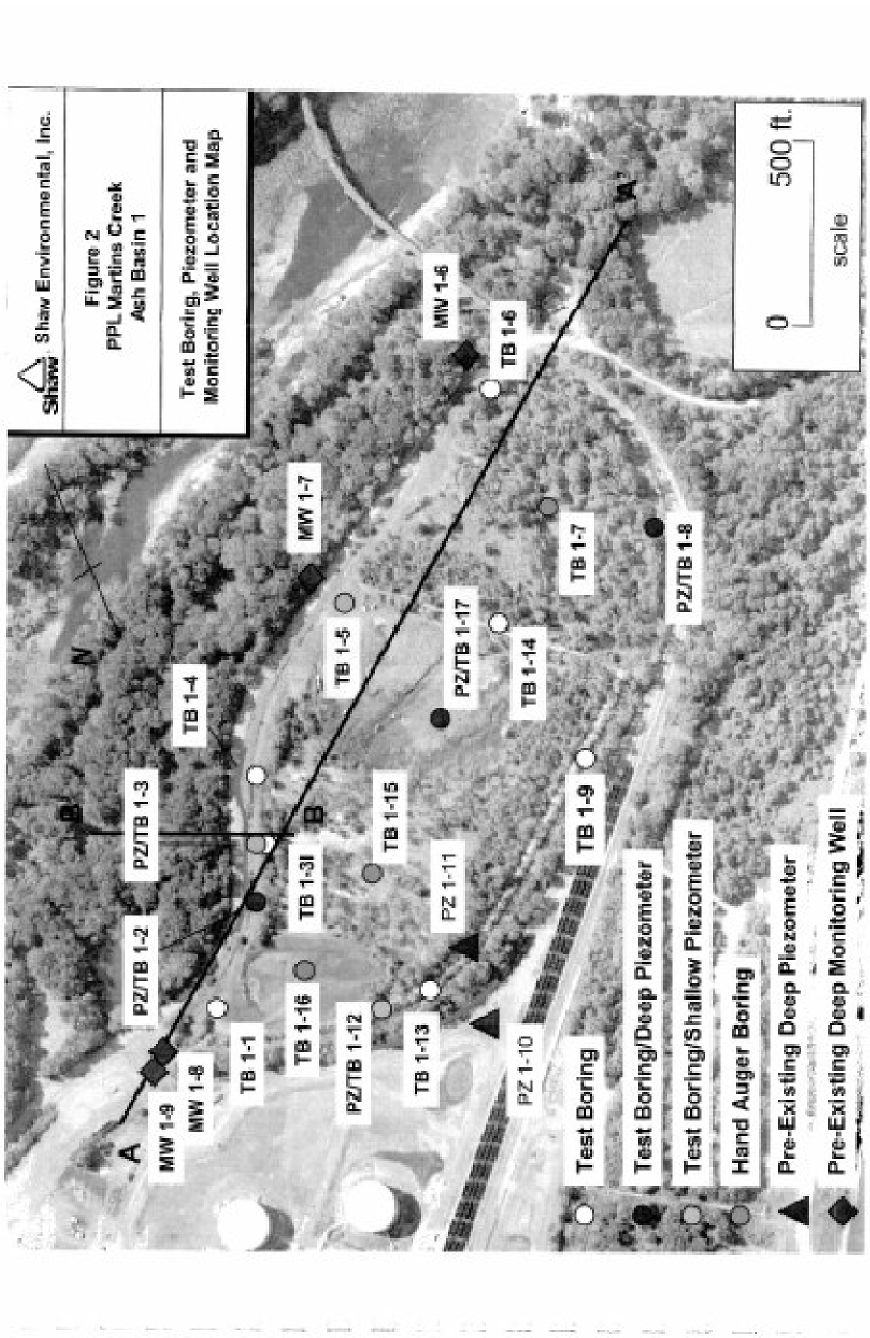


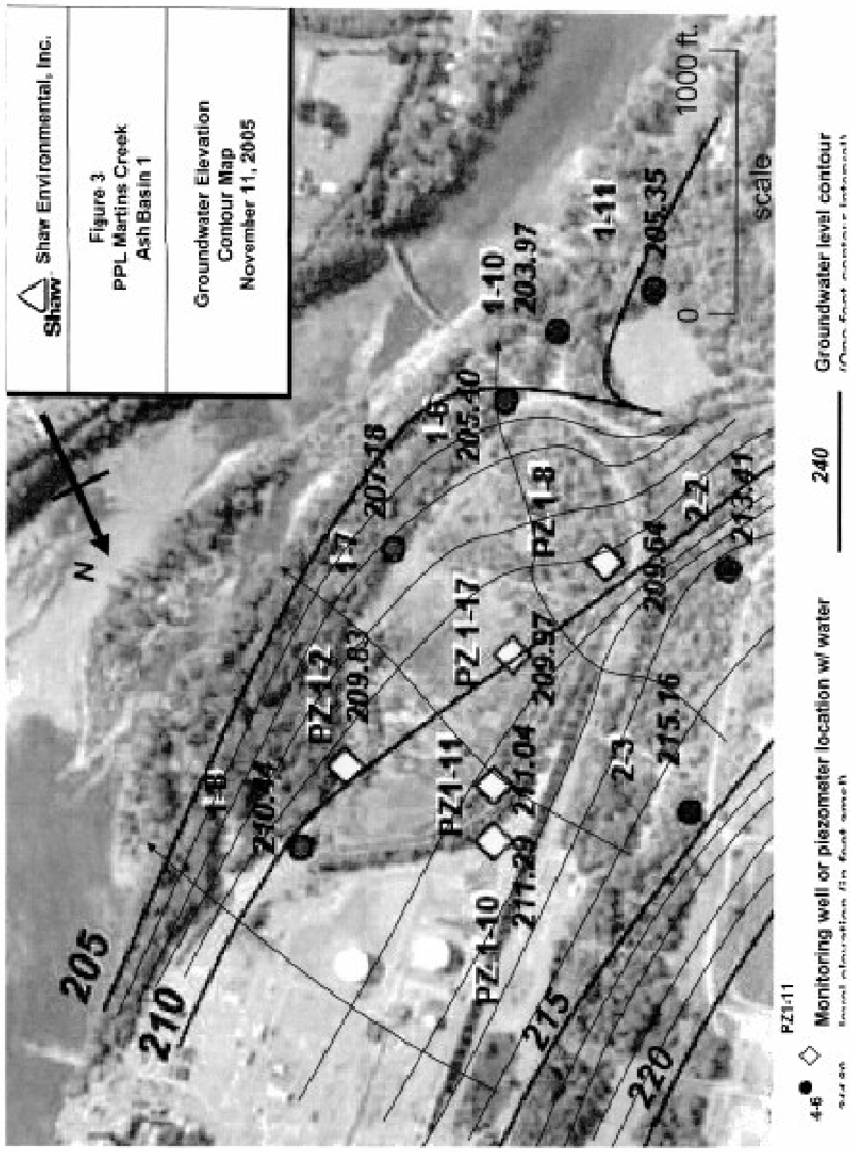
Shaw Environmental, Inc
PPL Martins Creek
Ash Basin 1
Monitoring Point
Location Map
PZ 1-10
PZ 1-11
PZ 1-17
PZ 1-2
MW 1-8
MW 1-9
A'
PZ 1-8
PZ 1-19
PZ 1-18
MW 1-6
B
MW 1-11
A
MW 1-10
MW 1-12D
MW 1-12S
B'
New Assessment Monitoring Well
Pre-Existing Monitoring Well
New Assessment Piezometer

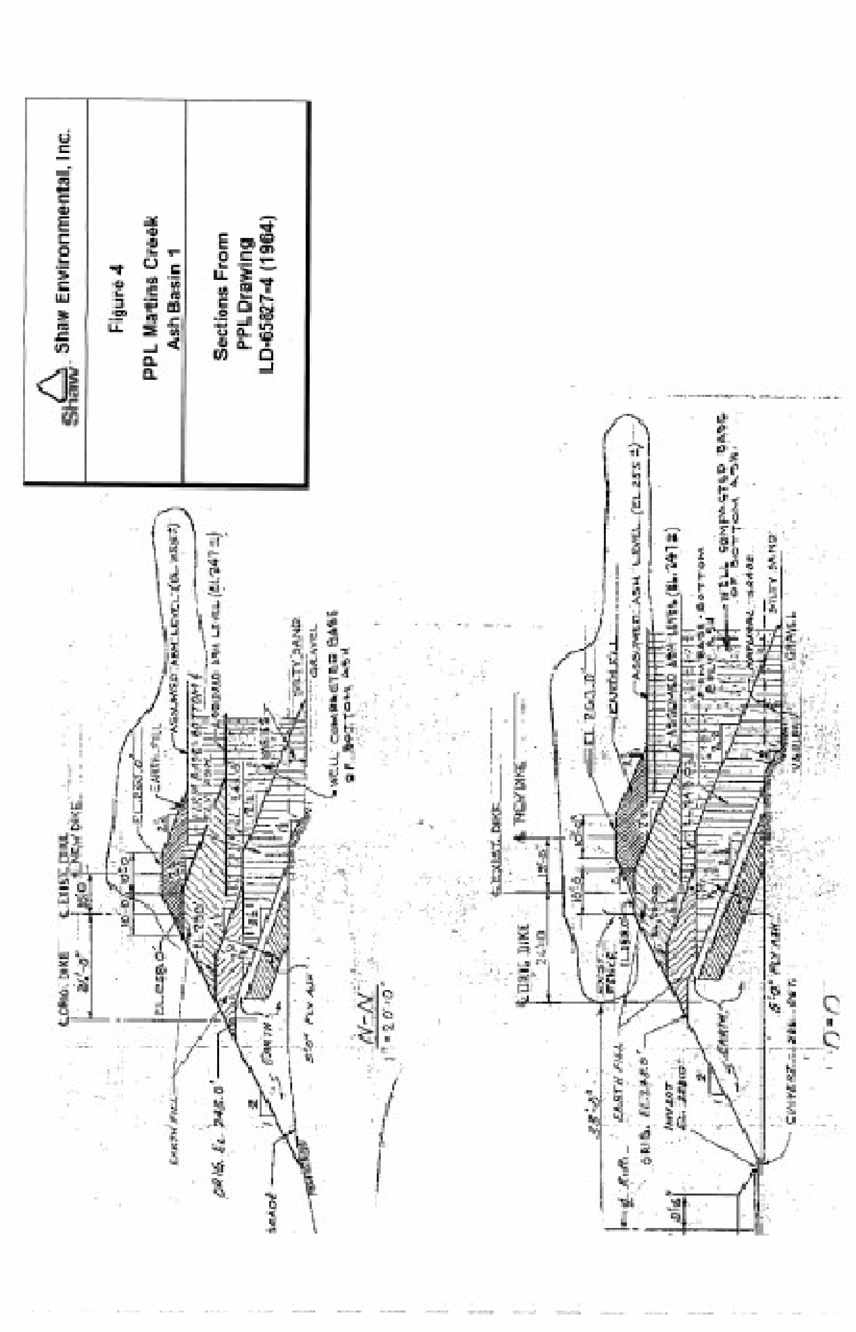

CROSS-SECTION A-A'
ELEVATION, FEET
LEGEND
HORIZONTAL SCALE
VERTICAL SCALE
TOP OF SANDSTONE BEDROCK

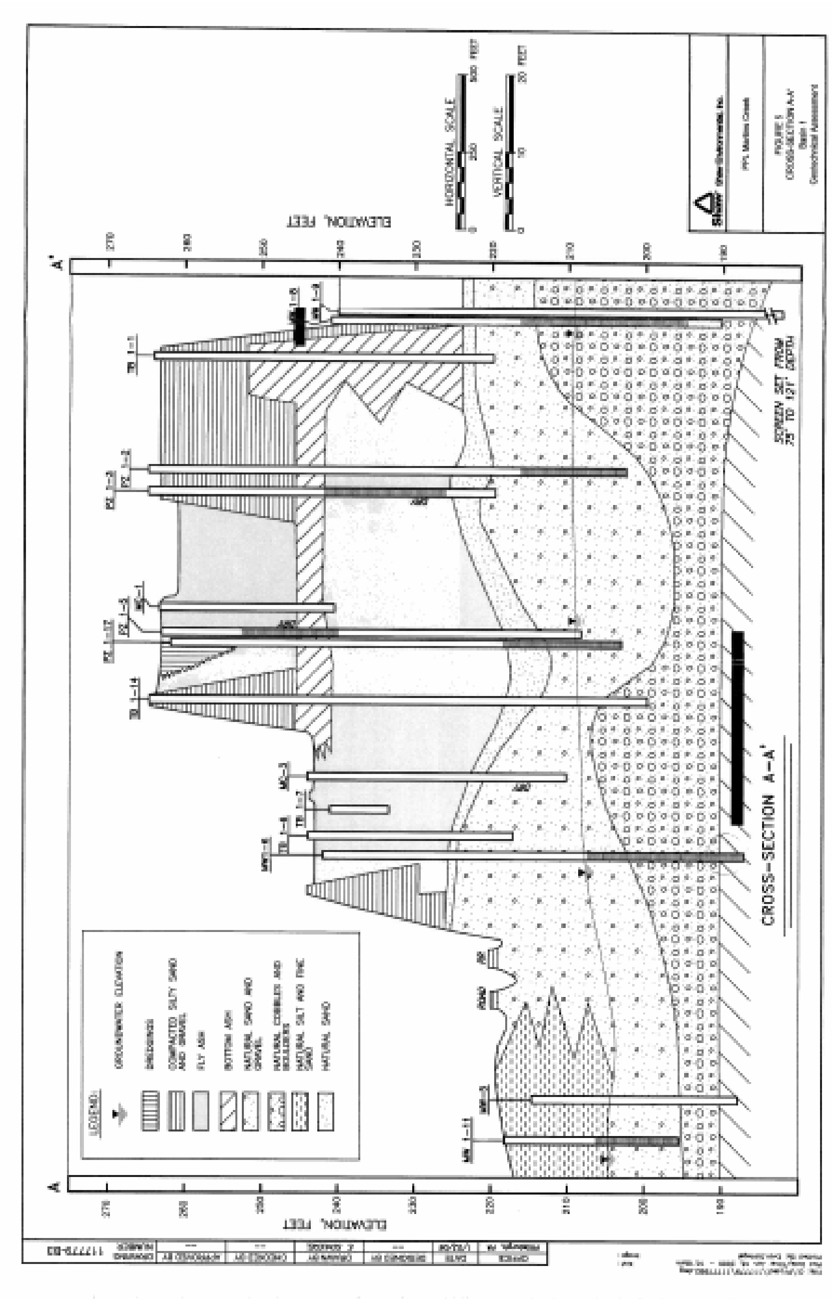

CROSS-SECTION B-B'

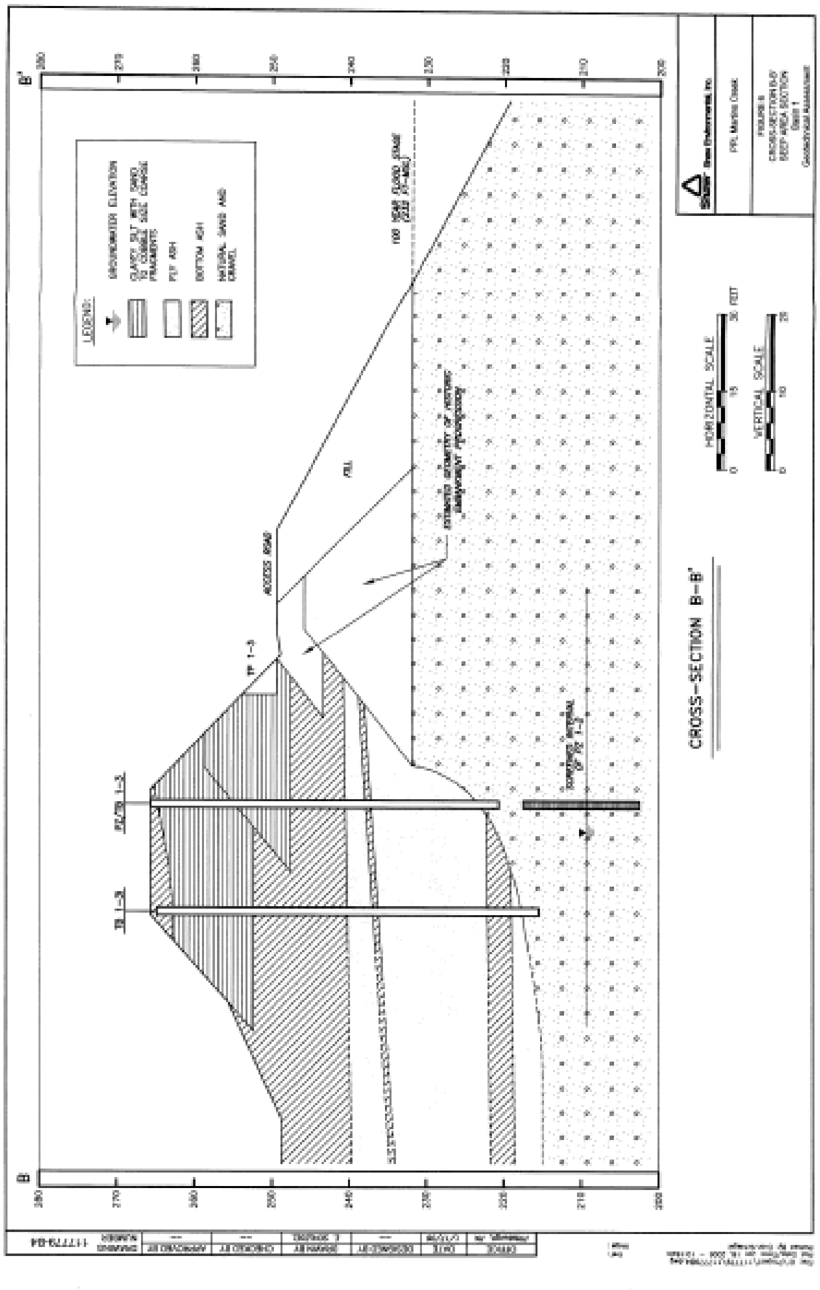

Shaw Environmental, Inc.
Figure 1
PPL Martins Creek
Ash Basin 1
Location Map
Lower Mount Bethel Township
Northampton County,
Pennsylvania
Depues Ferry Road
Basin 1
Roxburg Station
Martins Creek - Belvidere Highway
0 1000 ft.
scale
Map based on Belvidere and Bangor (PA/NJ) - 7.5 Minute USGS topographic quadrangle sheets


Shaw Environmental, Inc.
Figure 2
PPL Martins Creek
Ash Basin 1
Test Boring, Piezometer and Monitoring Well Location Map
N
0
500 ft.
scale
A
A'
B
B'
MW 1-9
MW 1-8
MW 1-7
MW 1-6
TB 1-1
PZ/TB 1-2
PZ/TB 1-3
TB 1-3I
TB 1-4
TB 1-5
TB 1-6
TB 1-7
PZ/TB 1-8
TB 1-9
PZ 1-10
PZ 1-11
PZ/TB 1-12
TB 1-13
TB 1-14
TB 1-15
TB 1-16
PZ/TB 1-17
Test Boring
Test Boring/Deep Piezometer
Test Boring/Shallow Piezometer
Hand Auger Boring
Pre-Existing Deep Piezometer
Pre-Existing Deep Monitoring Well

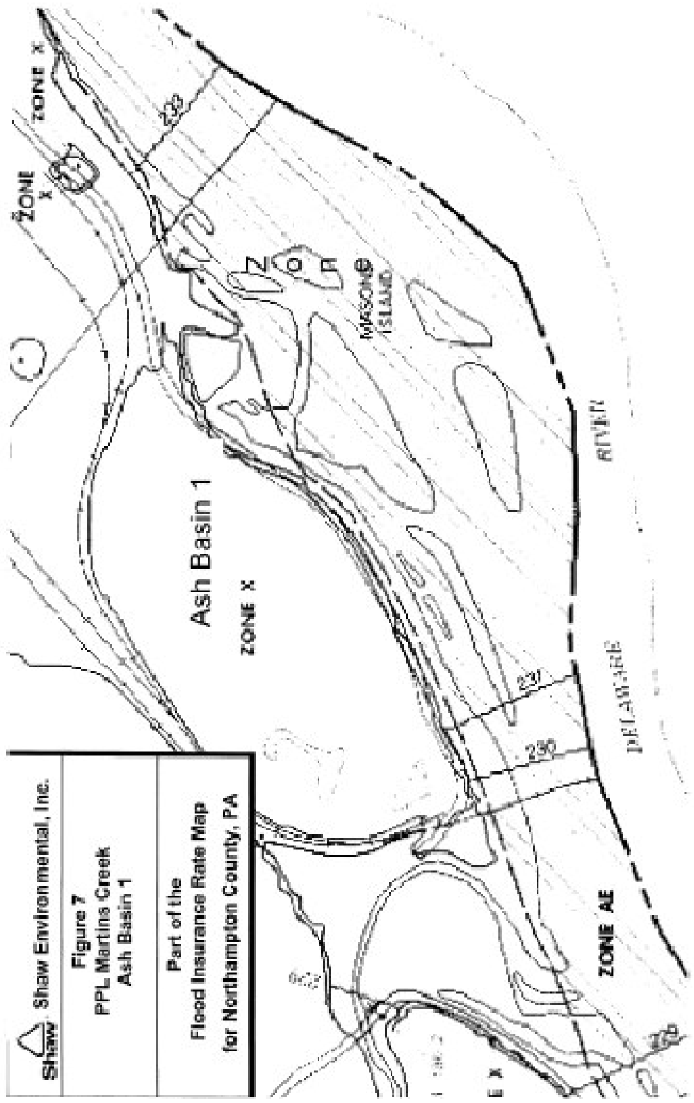

Shaw Environmental, Inc.
Figure 3
PPL Martins Creek
Ash Basin 1
Groundwater Elevation
Contour Map
November 11, 2005
N
205
210
215
220
1-8
210.44
PZ-1-2
209.83
1-7
207.18
1-6
205.40
1-10
203.97
1-11
205.35
PZ-1-47
209.97
PZ-1-8
209.64
2-2
213.41
PZ-1-11
211.04
PZ-1-10
211.29
2-3
215.16
0
1000 ft.
scale
Monitoring well or piezometer location w/ water
240
Groundwater level contour


Shaw Environmental, Inc.
Figure 4
PPL Martins Creek
Ash Basin 1
Sections From
PPL Drawing
LD-65827-4 (1964)


CROSS-SECTION A-A'
ELEVATION, FEET
HORIZONTAL SCALE
VERTICAL SCALE
LEGEND:
GROUNDWATER ELEVATION
DREDGINGS
FLY ASH
BOTTOM ASH
NATURAL SAND
SCREEN SET FROM 75' TO 121' DEPTH
ROAD



LEGEND:
GROUNDWATER ELEVATION
FLY ASH
BOTTOM ASH
ACCESS ROAD
FILL
CROSS-SECTION B-B'
HORIZONTAL SCALE
VERTICAL SCALE



Zone AE - Special flood hazard areas inundated by 100-year flood, base flood elevations determined.

Zone X - Areas of 500-year flood; areas of 100-year flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 100-year flood

Source: Panel 186 of 355, Map 42095C0186 D, FEMA, April 6, 2001

4.7 **ASH DISPOSAL BASIN SINKHOLE DAMAGE CONTINGENCY PLAN**

Regulatory Requirements

Should a sinkhole occur under the dikes or bottom of an active portion of an ash disposal basin, this contingency plan shall be instituted in accordance with § 289.274 of the Pennsylvania Residual Waste Regulations, as follows:

Failure.

(a) If an impoundment fails, the operator shall immediately comply with the following:

(1) Stop adding waste to the impoundment.

(2) Contain discharges that have occurred or are occurring.

(3) Notify the Department of the failure of the impoundment and the measures taken to remedy the failure.

(b) An impoundment that has been removed from service due to failure may not be restored to service unless the impoundment has been repaired, the repair has been certified to the Department in writing by a registered professional engineer and the Department has approved in writing the restoration of the impoundment to service.

Stop Adding Waste

It is unlikely that a sinkhole would develop in Ash Basin No. 1 due to its location over an alluvial aquifer. However, should one occur in the active, northern portion of the basin, bottom ash sluice will be pumped from the ash bottom into mobile dewatering tanks. Sluice water will be directed to the Units 1 and 2 main station sump and pumped to the IWTB wastewater storage basin. Dewatered bottom ash will be temporarily stockpiled in accordance with the coal ash storage requirements of the residual waste regulations. Other miscellaneous wastes permitted to be disposed in Basin No. 1 via dump truck or vacuum truck will be disposed in Basin No. 4, if permitted, or shipped to an off-site permitted waste disposal facility.

In the event that a sinkhole develops in Basin No. 4, fly ash sluice will be temporarily diverted to Ash Basin No. 1 for disposal. Other miscellaneous wastes permitted to be disposed in Basin No. 4 via dump truck or vacuum truck will be disposed in Basin No. 1, if permitted, or shipped to an off-site permitted waste disposal facility.

Contain Discharges

If there is a release of basin contents into the ground or onto the ground surface, containment dikes or other barricades will be built using on-site materials as much as possible to prevent the flows from spilling or spreading further. Additional soils, if needed, will be obtained from nearby fields on PP&L property. If PP&L equipment is not readily available to perform this work, the following contractors will be contacted:

- J. E. Beers, Inc. at 759-7727, or
- Eastern Industries, Inc. at 258-2345.

Solid wastes shall be recovered and hauled to a permitted facility on-site or to a permitted off-site waste disposal facility.

Stoplogs or riser sections should be removed gradually, as appropriate, from the basin's discharge structure to lower the impounded water level assuming the liquid portion has not escaped through a breach.

Any escaped liquid that can be recovered will be pumped into vacuum trucks, pumped to other permitted basins, or pumped directly into the damaged basin's discharge structure pending the results of water quality testing.

Sinkholes will be repaired in accordance with recommendations provided by PP&L's Engineering & Technical Services Engineer.

Notifications

In the event of a ash basin sinkhole failure, notifications will be made in accordance with the Emergency Response Action Plan (Section 1.1).

Certification and Reuse

The basin will not be placed back into service until completed repairs have been certified to the DEP in a letter written by a registered professional engineer and the DEP has responded in writing approving the repair work and authorizing the basin's reuse.

Van Ness & Associates
CONSULTING GEOLOGIST
1517 Shenford Road
Bethlehem, PA 18018

May 1, 1998

Mr. Donald Cntko
Consultant - Compliance Services
PP&L, Inc.
2 North 9th Street (GENN-5)
Allentown, PA 18101

MARTINS CREEK SES ASH BASIN NO. 1
SINKHOLE EVALUATION REPORT

Dear Mr. Cntko:

At your request, I have prepared a report analyzing the probability of sinkholes forming in the area of Basin No. 1 at the Martins Creek Steam Electric Station, Northampton County, Pennsylvania. This report reviews the mechanisms of sinkhole formation, and the geologic conditions present in the Basin No. 1 area.

Sincerely,

Charles G. Van Ness
Professional Geologist
License No. PG-000153

Abstract

The purpose of this report is to evaluate the potential for sinkhole development at PP&L, Inc.'s Martins Creek Steam Electric Station Basin No. 1. The approach used to make this evaluation was the following:

1) Review of studies performed in the area, including various PP&L, Inc. site reports, Pennsylvania Geologic & Topographic Survey sinkhole reports, and other relevant published reports.

2) Review of site information to determine plant and basin construction histories and details;

3) Review of the mechanisms that contribute to the formation of sinkholes to determine if the Basin No. 1 area is one that is conducive to sinkhole development;

4) Preparation of various maps, sections, etc., that compile the above information relevant for this report.

Based on a review of Pennsylvania Geologic & Topographic Survey sinkhole reports, sinkholes are not present in the immediate vicinity of Basin No. 1. A factor believed to be responsible for the lack of sinkholes in the immediate basin area is the fact that Basin No. 1 was developed on saturated alluvium adjacent to the Delaware River. To test the hypothesis that the geologic setting of Basin No. 1 is the reason for the absence of sinkholes, a further review of the sinkhole report was made. No evidence of sinkholes was found in similar alluvial areas along the Delaware River over a 12-mile stretch between Easton and Foul Rift, which is just upstream of the plant. The relatively thick blanket of saturated alluvium above the carbonate formations is believed to intercept and buffer surface infiltration before it reaches the carbonate substrate, thereby preventing sinkhole development. Based upon the absence of sinkholes in the vicinity of Basin No. 1 during its 50-year operating life, the absence of sinkholes in nearby settings similar to those at Basin No. 1, and the absence of conditions requisite to the development of sinkholes, the potential for sinkhole development in the area of Basin No. 1 is considered negligible.

Introduction

PP&L, Inc. is in the process of repermitting Basin No. 1 at its Martins Creek Steam Electric Station located in Lower Mount Bethel Township (see Figure 1). One area of concern for the Pennsylvania Department of Environmental Protection (DEP) in the permitting process involves the potential for future sinkhole development at the basin since the surrounding area is one of known Karst features. Basin No. 1 is an unlined earthen impoundment. As part of the permit application, PP&L, Inc. requested waivers of the liner and cap requirements based upon ground water quality monitoring which indicates only slight degradation, with constituents below DEP Ground Water Parameters. However, if there is a real potential for sinkhole development at Basin No. 1, the requested waivers could not be granted. PP&L, Inc. hired Van Ness and Associates to assess the potential for sinkhole development at Basin No. 1, which is located approximately one-quarter mile southwest of the coal-fired units and has been in service for nearly 50 years.

Currently, Basin No. 1 is used to dewater bottom ash and for disposal of bottom ash and miscellaneous other plant residual waste streams. This ash, which is very coarse and chemically inert, is beneficially used for anti-skid material. Basin No. 1 also serves as an emergency fly ash disposal impoundment.

This evaluation of the potential for sinkhole development was based upon:

- A review of studies performed in the area, including various PP&L site reports, prepared by consultants and in house professional staff, reports by the Pennsylvania Geologic and Topographic Survey, and other published reports relevant to the area.
- A review of site information to determine plant and basin construction history and plans.
- A review of geologic processes and mechanisms that lead to the formation of sinkholes to determine if conditions in the Basin No. 1 area are conducive to Karst development.
- Preparation of various maps, sections, etc., which summarize the above information.

The answers to three important questions will determine if the Basin No. 1 area is sinkhole prone.

- Is the geologic setting, construction and operation of Basin No. 1 conducive to sinkhole development based upon a knowledge of how sinkholes form?
- Are sinkholes present in the Basin No. 1 area or were there sinkholes present before plant construction that are now filled or covered?
- What is the incidence of sinkhole development in geologic settings similar to those of Basin No. 1 along the Delaware River?

1

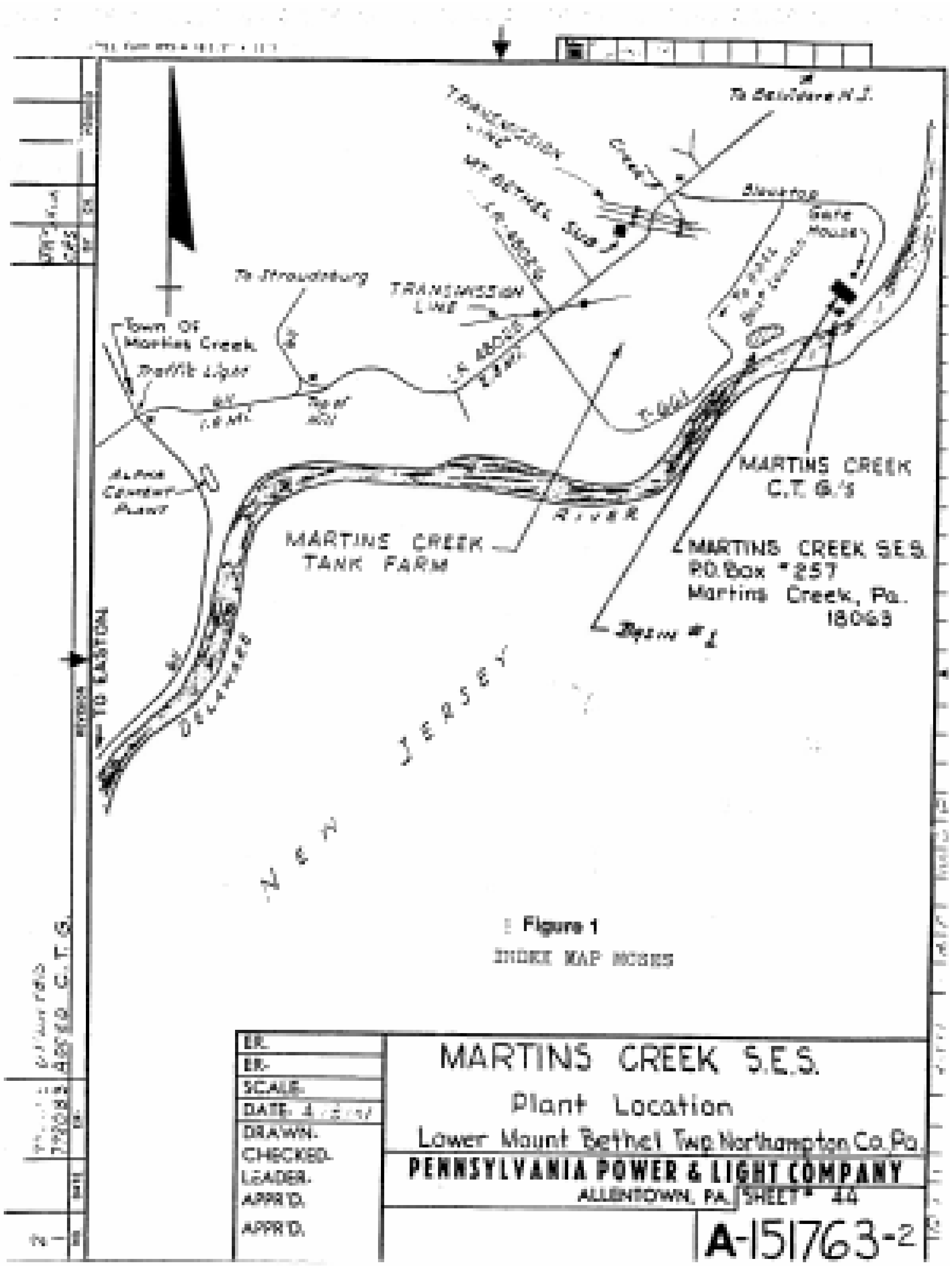


Figure 1

INDEX MAP MCSES

Background - Mechanisms of Sinkhole Development

Thornbury (1954) lists four conditions essential for Karst development. They are:

1. A soluble rock (limestone, dolomite, etc.) present near ground surface.

2. The rock should be dense, highly jointed or fractured and well bedded.

3. Entrenched major drainage below uplands to permit ground water to migrate downward.

4. A moderate amount of rainfall.

First, there must be present at or near the surface a soluble rock such as limestone or dolomite; however, dolomite is not as readily soluble as limestone. The rock-soil interface in the area where sinkholes develop often is highly irregular, with undissolved pinnacles of carbonate rock near the surface surrounded by residual soils.

Secondly, the soluble rock should be dense, highly jointed and/or fractured, and thinly bedded. Each of these planar features can be open, providing a pathway for the ground water and an exposed surface upon which the dissolution process can act.

A third condition essential to sinkhole development is that there exist entrenched valleys below uplands underlain by soluble, fractured carbonate. A large annual fluctuation in the water table can create the same conditions. It is essential that ground water is able to descend through a carbonate rock, carry on its solutioning activity, and emerge into surface streams. Solution cavities develop in carbonate rocks lying above the water table through the action of surface infiltration and/or diverted surface waters.

Finally, sinkhole development requires at least a moderate amount of rainfall. Sinkholes and caverns have formed in what are now semi-arid areas (Carlsbad), but it is probable that, during the Pleistocene, rainfall was considerably greater than it is now.

In areas where the above conditions are satisfied, solution of the carbonates occurs as surface water infiltration, charged with carbon dioxide (CO_2) from atmospheric diffusion and sometimes humic and acetic acids absorbed from soils lying above bedrock, comes in contact with calcium and magnesium carbonates (Thornbury 1954). The acid-bearing waters dissolve a portion of the bedrock material and then are rather quickly neutralized by the carbonates. The solution cavity is enlarged as ground water with fresh acids circulates through the carbonates.

Some enlargement of solution cavities is attributable to mechanical erosion (corrosion). Circulating water with entrained sand and gravel can enlarge cavities by scour.

Geology

PP&L's Martins Creek Steam Electric Station is located (see index map Figure 1) along the western bank of the Delaware River, in Lower Mt. Bethel Township, Northampton County, Pennsylvania. The site is underlain by intensely folded carbonates of Ordovician Age overlain by both glacial and unsorted fluvial deposits. Carbonates of Ordovician Age are subdivided into the Beekmantown Group and Jacksonburg Formation (Figure 2). The Beekmantown Group includes the Ontelaunee Formation, which is not recognized in this area.

In the Martins Creek area, the basal Beekmantown unit is the Rickenbach Formation, which is a cherty dolomite with some limestone interbeds. The contact with the overlying Epler Formation is conformable and subject to interpretation, as the Epler Formation is described as a limestone with interbedded dolomite. The Epler becomes more limey towards the upper contact with the Jacksonburg Formation.

The Jacksonburg Formation is comprised of two units in the Martins Creek area. The lower unit is described as the Jacksonburg limestone. The contact between the Beekmantown and Jacksonburg Formations has been described as unconformable (Miller, 1939). The contact, if present on the Martins Creek property, is buried under the Muncy Till. The upper unit of the Jacksonburg is the argillaceous limestone known as the "cement rock." In this area, the cement rock exhibits slaty cleavage.

Logging of the drill holes of various monitoring wells and borings at Martins Creek (summarized in Table 1) has been left mostly to the drillers, whose logs have proven able to distinguish rock from sand and gravel. The cement rock is distinctive enough that even a driller's log would recognize it. There is no report of any slaty or shaly dark limestone indicating the presence of Jacksonburg cement rock on the logs. As such, few if any correlations as to Beekmantown or Jacksonburg limestone can be made from Martins Creek logging. For the purposes of this report, bedrock is termed Ordovician carbonates.

The structure of the rocks in this area is extremely complex. The rocks in this area are contained in the upper limb of the Musconetcong Nappe (Drake, 1969). The general dip of the complex fold structure is to the northwest, but the intense folding has produced many minor folds and axial plane cleavage. Folding has generally fractured the carbonate rocks rectilinearly. The cleavage, bedding planes, and rectilinear fractures, together with surface jointing, produce a significant fracture porosity in the carbonate rocks.

Glacial deposits cover most of the carbonates on the Martins Creek property. The glacial deposits consist of poorly sorted sand, gravel, and till known as the Muncy Till of Wisconsin Age. Glacial deposits range from 5 to 60 feet in thickness. The Muncy Till, which is deposited mostly on the upper terraces (see Figure 3), contains enough clay to reduce permeability.

Stratified glacial drift deposits are found along the lower terraces and river banks. These deposits have been reworked and redeposited by river/stream action. These deposits contain glacial-fluvial sands, gravels, lag boulders, and silts, modified by erosion and redeposition. These units possess moderate porosity and permeability.

Overlying the glacial and fluvial glacial deposits are relatively recent alluvial deposits. These deposits consist of lag gravels, coarse sand, and gravels, with lenses of clay, silt, and fine sands. The fine sediment lenses produce a somewhat slower hydrologic response. Logging techniques often overlook thin silt and clay lenses. Plant construction has altered surface features around Basin No. 1 and to the northeast.

Two distinct geologic terraces have developed which generally match the land forms present. Erosional terraces have been developed by a combination of processes. The upper terrace,

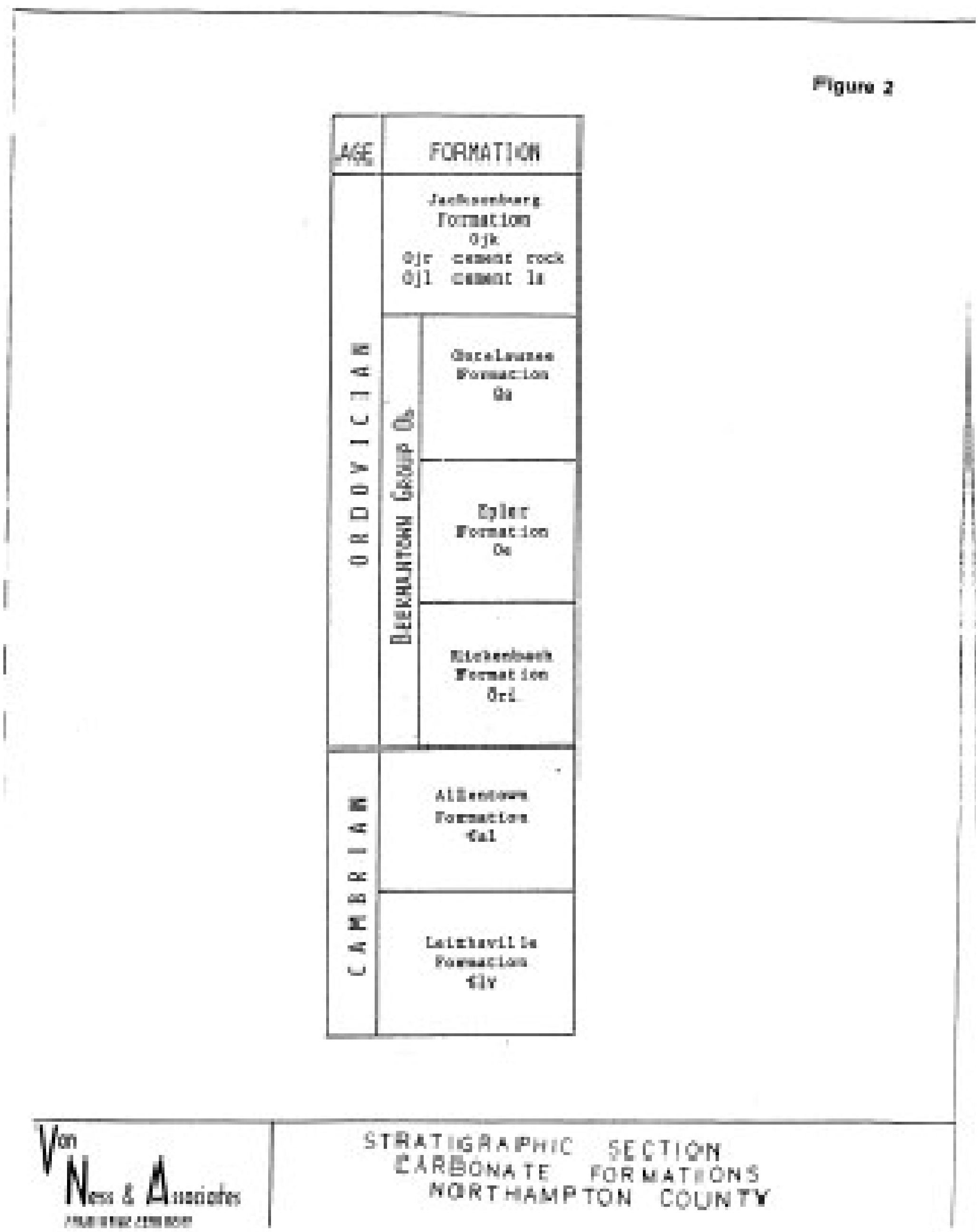


Figure 2
AGE
FORMATION
Jacksonburg Formation Ojk
Ojr cement rock
Ojl cement ls
ORDOVICIAN
BEEKMANTOWN GROUP Ob
Ontelaunee Formation Oo
Epler Formation Oe
Rickenbach Formation Ori
CAMBRIAN
Allentown Formation Єal
Leithsville Formation Єlv
Van Ness & Associates
STRATIGRAPHIC SECTION
CARBONATE FORMATIONS
NORTHAMPTON COUNTY

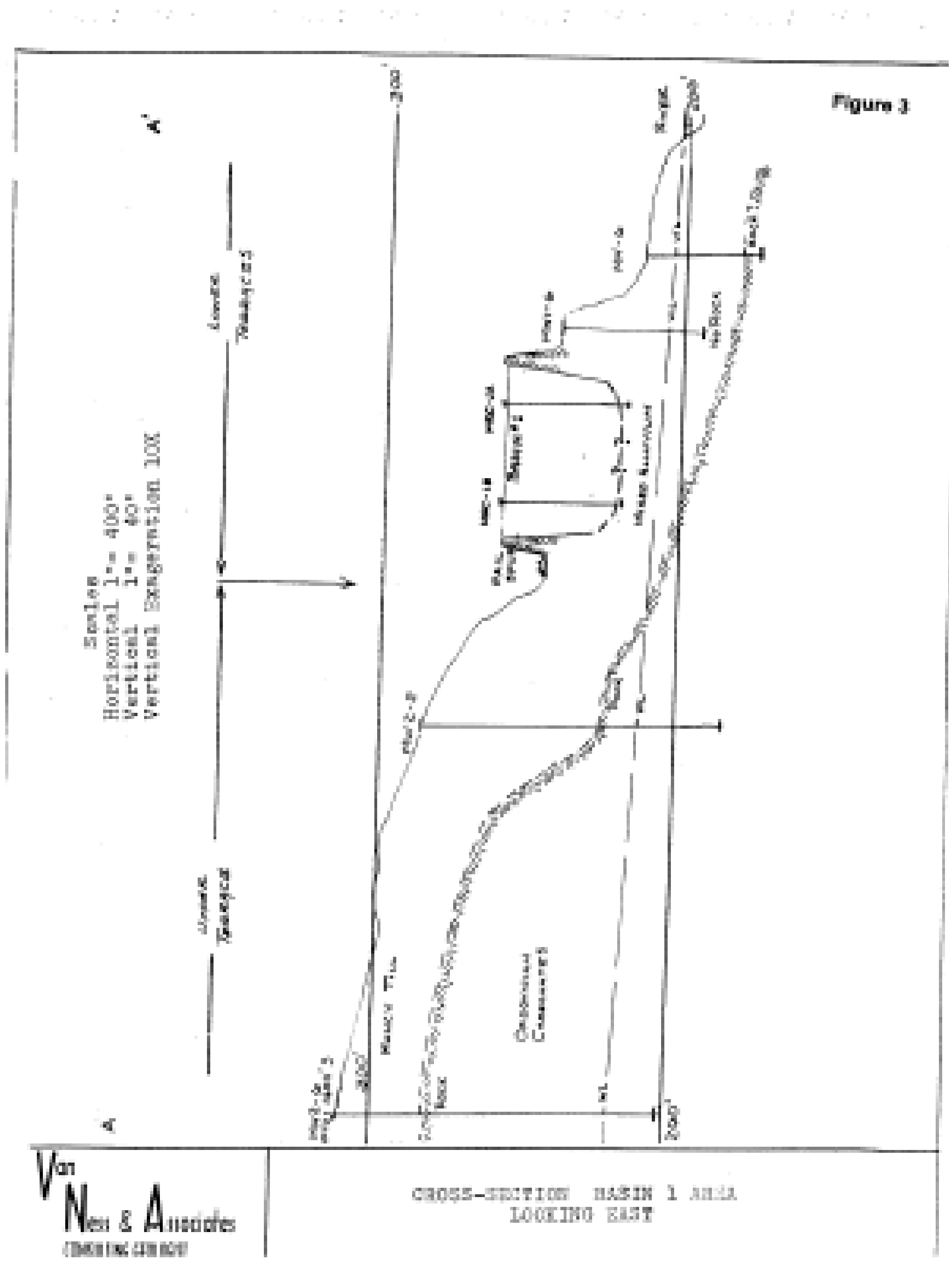


Figure 3
Scales
Horizontal 1"= 400'
Vertical 1"= 40'
Vertical Exaggeration 10X
A
A'
Van Ness & Associates
CROSS-SECTION BASIN 1 AREA
LOOKING EAST

where Basin Nos 2, 3, and 4 are located, is underlain by Ordovician carbonates, and has been modified by glacial action. In addition to the till deposited, Wisconsin terminal moraines have been identified north of the plant (Miller 1939).

In contrast to the upper terrace, the lower terrace, where Basin No. 1 lies, is developed upon sands, gravels, and other unconsolidated sediments deposited by the Delaware River. These sediments are estimated to be 40-60 feet thick and were deposited upon Ordovician carbonates.

Ground Water

Figure 4 illustrates the ground water elevations in the Basin No. 1 area, based upon water elevation data gathered from local monitoring wells. Ground water elevations were taken in March, 1997 and represent maximum elevations for the year. The water table is highest in the northeastern part of the Martins Creek SES property along the Belvidere Road (LR 48025), where it attains an elevation of 270 feet above sea level. The water table declines southward towards the river. As the water table approaches the river, flow becomes southwestward parallel to the river.

Ground water flow in the upper terrace is significantly different from that of the lower terrace, due to the underlying geology. Ground water flow in the Ordovician carbonates of the upper terrace is primarily through secondary porosity produced by a combination of open fractures, joints, and bedding planes. Observations made at the Friedensville Mine in nearby Lehigh County, which is developed in the highly fractured Rickenbach Formation, suggest that a fractured carbonate has a highly irregular, discontinuous, but unrestricted flow along rectilinear surfaces and solution cavities. Sealing one fracture or zone would only increase flow from other fractures. Dye tests, using fluorescene, generally were unsuccessful. As a result, prediction of ground water flow within a fractured carbonate with Karst development is very difficult. The geological setting of the Ordovician carbonates below the upper terrace at Martin's Creek SES is similar to that at Friedensville: both are carbonates of the same formation (Beekmantown) and both are heavily fractured. Ground water beneath the upper terrace depends upon precipitation and diverted surface waters for recharge. Variations in water level in a given monitoring well can range up to 40 feet between wet and dry seasons.

All of the mechanisms needed to form sinkholes are present under the upper terrace.

- Carbonates are present at the rock-soil interface.
- Carbonates present are highly jointed and fractured.
- The Delaware River is some 120' to 140' below the upper terrace.
- Rainfall averages 45" per year (Miller).

Ground water pH from samples taken from the carbonates underlying the upper terrace is, as expected, alkaline. The pH of these samples averages 7.5. This indicates surface waters (presumed to be slightly acidic) infiltrating the upper terrace are rapidly neutralized.

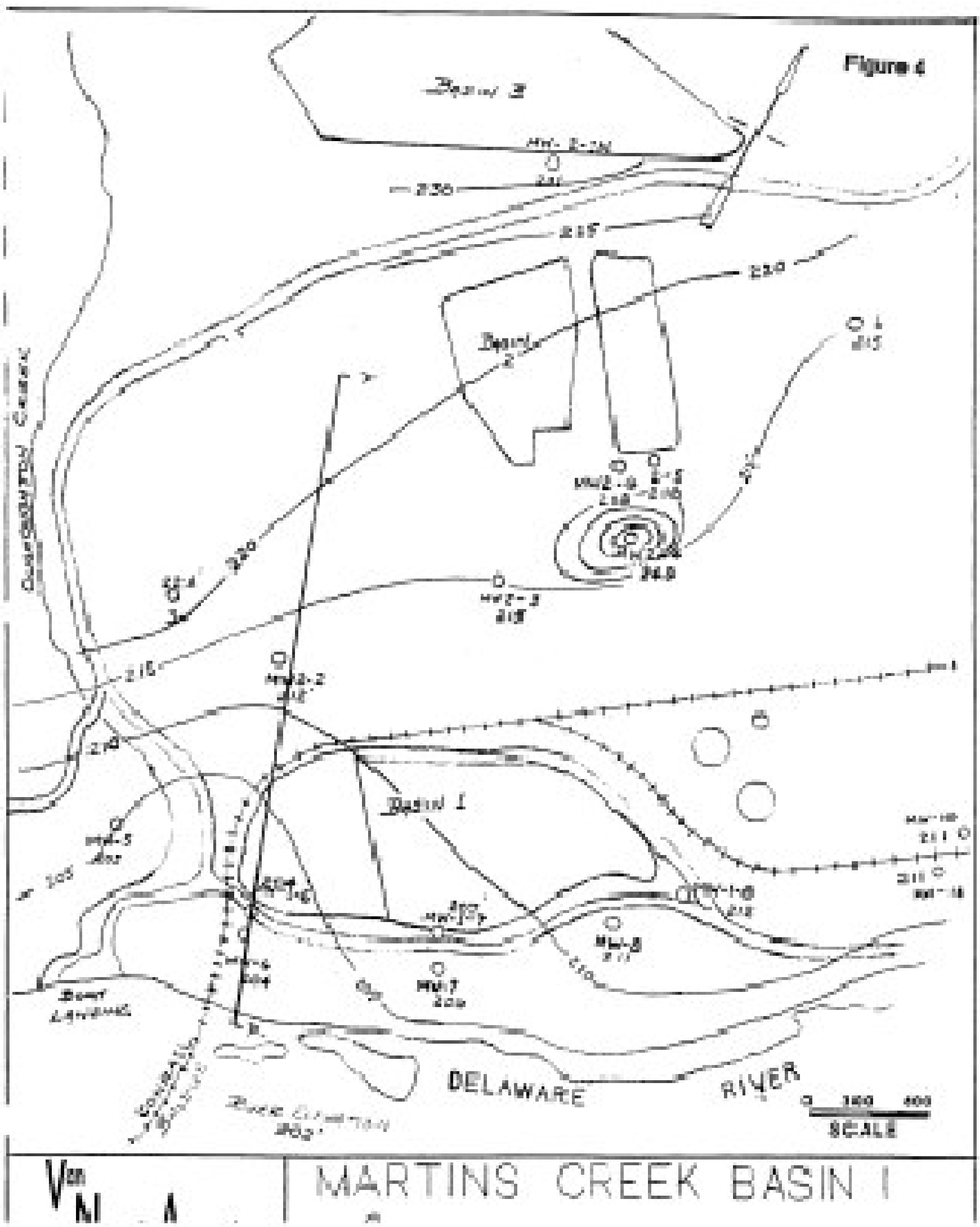


Figure 4
Basin 3
Basin 2
Basin 1
DELAWARE
RIVER
SCALE
MARTINS CREEK BASIN I

Hydrologic conditions under the lower terrace are quite different from those described above for the upper terrace. The lower terrace is developed on thick (40-60 feet) fluvial-glacial sediments overlying Ordovician carbonate. These sediments are predominately sands, gravels, and silts reworked by the Delaware River. Isotropic flow as a result of primary porosity is expected in the sands and gravels underlying the lower terrace. The water table elevations vary only about 4 to 6 feet over the year (see Table 2, Appendix), with seasonal lows in the summer months. The annual change in the water table elevation is less than the thickness of the alluvial sediments, so that the top of the water table never reaches the depth of the underlying carbonate rocks (see Figure 3).

Basin No. 1 Area

Basin No. 1 was constructed by excavating into the glaciofluvial-alluvial sediments of the lower terrace, mostly gravels and sand. Wells were installed in the basin by Atlantic Environmental Services as part of a closure study in 1993. These wells indicate that Basin No. 1 is 43 feet deep from the top of the dike to the bottom of the basin, with sand and gravel below the ash fill. (See Atlantic Environmental Services maps and logs in Appendix.) Bedrock elevations (Figure 5), based on nearby drill holes, place the rock-soil interface approximately 25 to 30 feet below the bottom of Basin No. 1. Most of the sands and gravel thickness present below Basin No. 1 is saturated (see Figure 3). Annual variation in the depth of the water table in the Basin No. 1 area is 4 to 5 feet (Table 2, Appendix).

Basin No. 1 currently receives bottom ash that is sluiced from the two coal-fired units. Each operating day Basin No. 1 receives an estimated 288,000 gallons of water along with the bottom ash. Bottom ash is periodically removed and beneficially used by a contractor as anti-skid material. All water entering the basin, minus evaporation, infiltrates through the bottom of the basin into the underlying sand and gravel. No water is currently discharged through the basin outfall. This practice has been followed for nearly 50 years, although initially the basin also received fly ash sluice water at a rate significantly greater than the current rate of flow. If the area were sinkhole prone, concentrating a flow of even 288,000 gallons of water on a daily basis for nearly 50 years could be expected to produce sinkhole activity; but it has not. This same type of operation of the former unlined Basin No. 2, which was constructed after Basin No. 1 and is located on the upper terrace, is reported to have produced a major sinkhole in the early 1970's, only a few years after it began receiving ash.

It is unlikely that sinkholes would develop on the lower terrace. Most of the following geologic conditions conducive to sinkhole development and present under the upper terrace are not present in the lower terrace and the Basin No. 1 area:

- Carbonate rocks are present 15 to 20 feet below the water table.
- The water table gradient is slight to flat; therefore, there is no chance for vertical solution development or scour.
- Seasonal variations of water table elevation beneath the lower terrace is limited to a few feet.

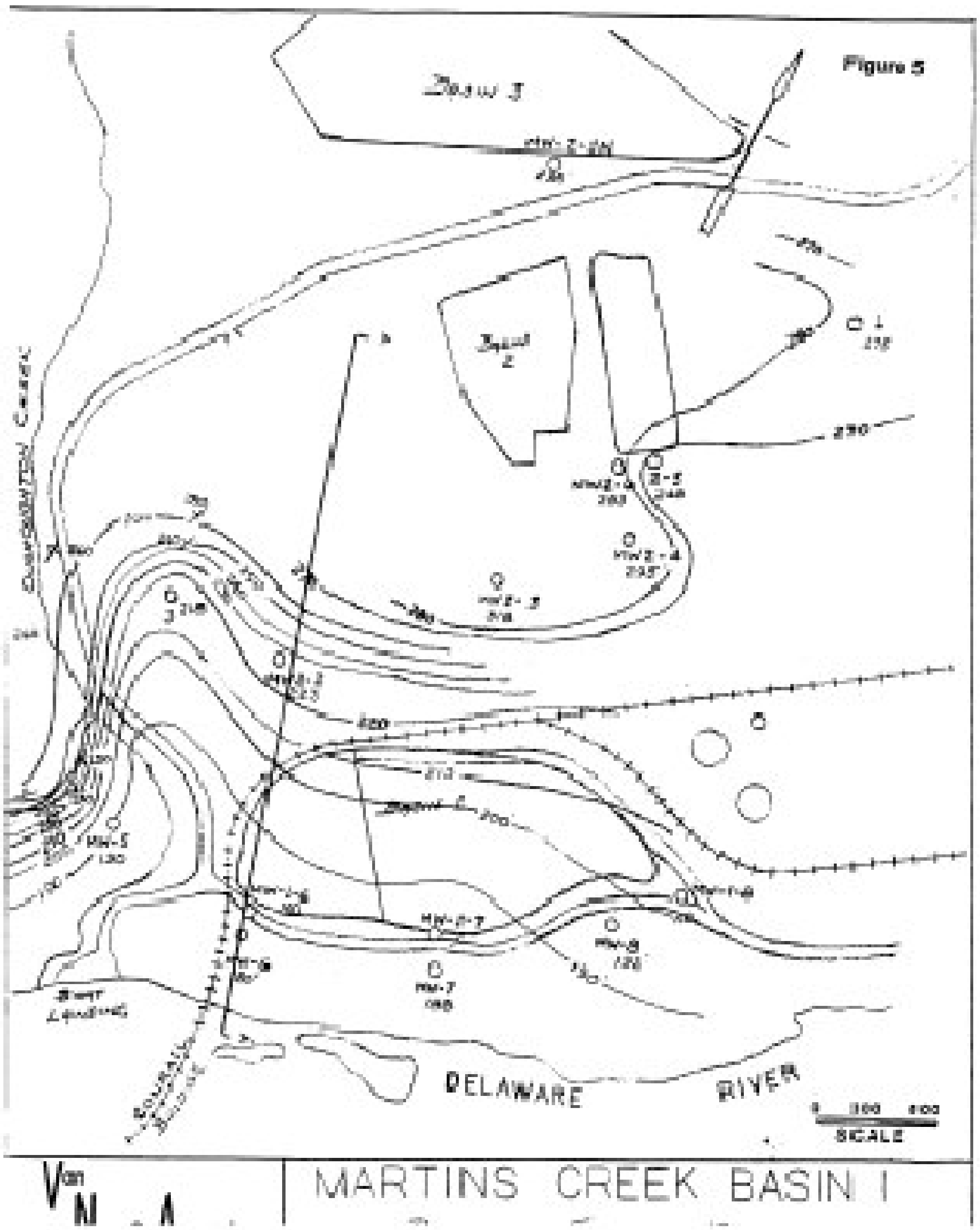


Figure 5
DELAWARE
RIVER
SCALE
MARTINS CREEK BASIN I

- An extensive saturated zone of highly buffered water exists above the bedrock to neutralize any acidic precipitation infiltrating the lower terrace.

Regional Sinkhole Studies

To verify the theory that sinkhole development is not likely at Basin No. 1 due to its geologic setting, an investigation of published government reports was undertaken to determine the incidence of sinkhole development in geologic settings similar to those present at Basin No. 1 and to determine if there was evidence of sinkholes in the area of Basin No. 1 before it was constructed.

A study of the sinkholes in Northampton County was recently published as an open-file report by the Bureau of Topographic and Geologic Survey (OFR 87-02). Kochanov states, "Most of the data for this report was derived from aerial photographic interpretation and field observations. Initially, one set of aerial photographs was reviewed and surface features (sinkholes, depressions, patterned ground, abandoned surface mines, outcrops and other anomalous features) were outlined on the aerial photographs and then later transferred to 7.5-minute geologic base maps. These surface features were then field checked and bedrock exposures examined. Once the field study had been completed, additional sets of aerial photographs were reviewed to complete the survey. The aerial photographs used were USDA, mounted, black and white stereo pairs, 1:20,000 scale, for 1947, 1958, 1964 and 1971."

Figures 6 through 11 were taken from OFR-87-02. An outline was drawn at an elevation 40 feet above river level to simulate conditions present near Basin No. 1. This outlined area is highlighted in yellow on Figures 6 through 11. The area examined extended from Foul Rift east of the plant to the confluence of the Lehigh River in Easton, a distance of approximately 12 miles. In this distance 90% of the bedrock substrate, beneath the alluvial cover, is carbonate. No sinkholes were reported in the outlined area in the entire 12 miles examined, 90% of which duplicate geologic conditions at Basin No. 1. Also, no sinkholes were identified in the area of Basin No. 1 from the aerial photographs that were taken before the basin was constructed.

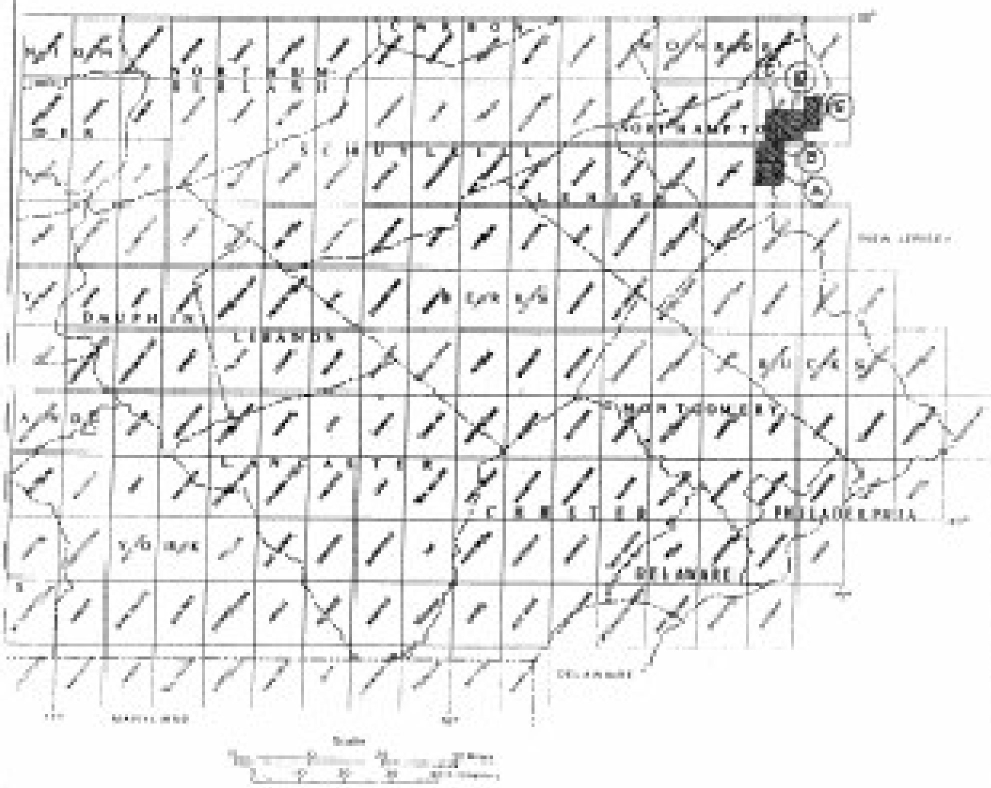
More than 100 sinkholes are noted in Kochanov's report over the upper terrace on the Martins Creek plant property (see Figure 12). The fact that no sinkholes are noted in this extensive report in conditions similar to the lower terrace, while at the same time they are abundant on the upper terrace immediately adjacent to the lower terrace, indicates that the theory discussed above is accurate. Sinkhole-conducive conditions clearly do not exist in the lower terrace and at Basin No. 1.

Summary

The answers to the three questions posed in the introduction indicate that the likelihood of sinkhole development at Basin No. 1 is negligible.

The first question was, " Are the geologic setting, construction and operation of Basin No. 1 conducive to sinkhole development based upon a knowledge of how sinkholes develop? An evaluation of the geologic setting at the Martins Creek plant property indicates that sinkhole-conducive conditions do exist at the upper terrace where Basin Nos 2, 3, and 4 are located but not at the lower terrace where Basin No. 1 is located. On the upper terrace, carbonates are

Figure 6



Van Ness & Associates

INDEX MAP SINKHOLE STUDY AREA

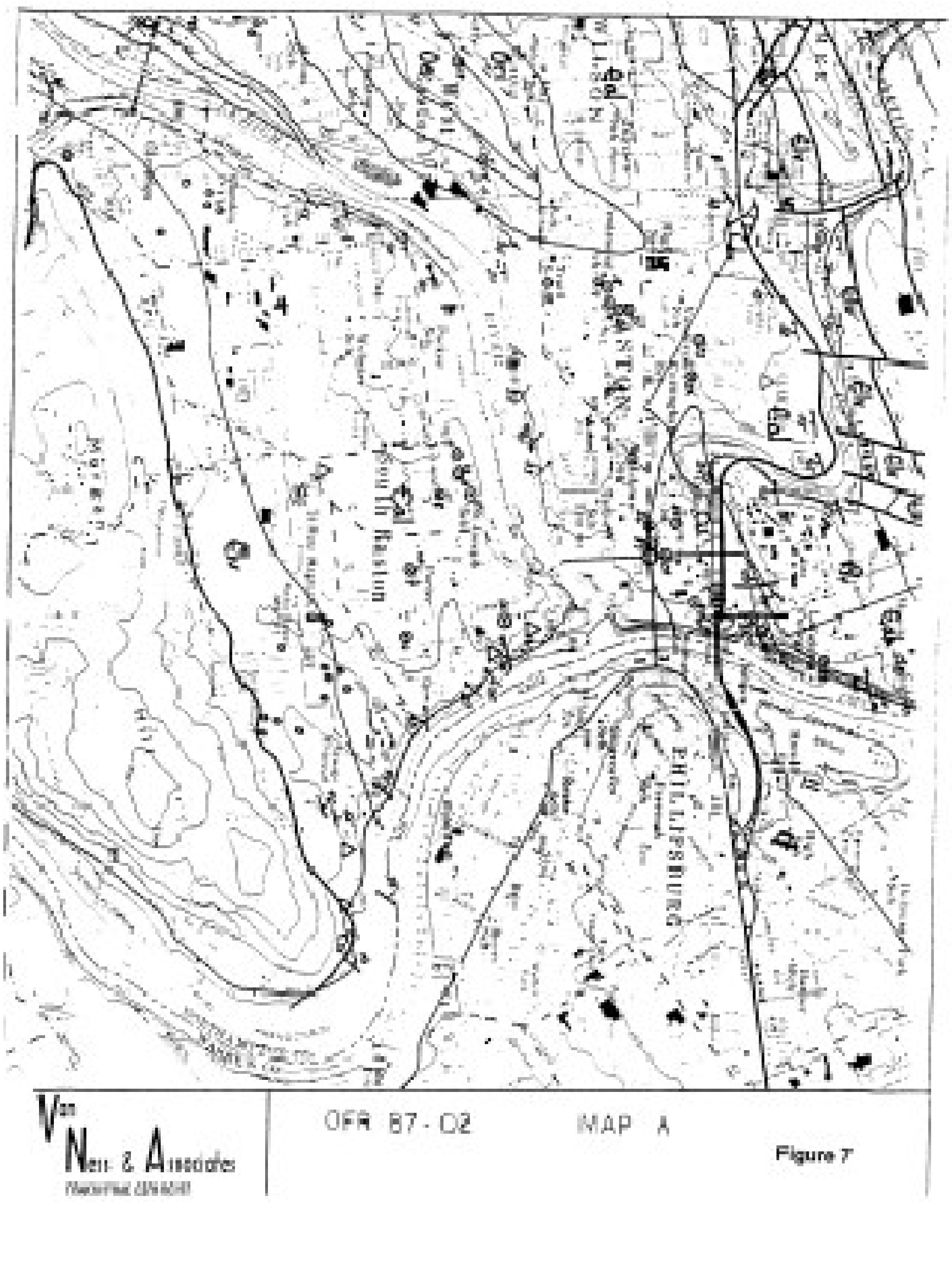

EASTON
South Easton
PHILLIPSBURG
Van Nelt & Associates
OFR 87-02
MAP A

Figure 7

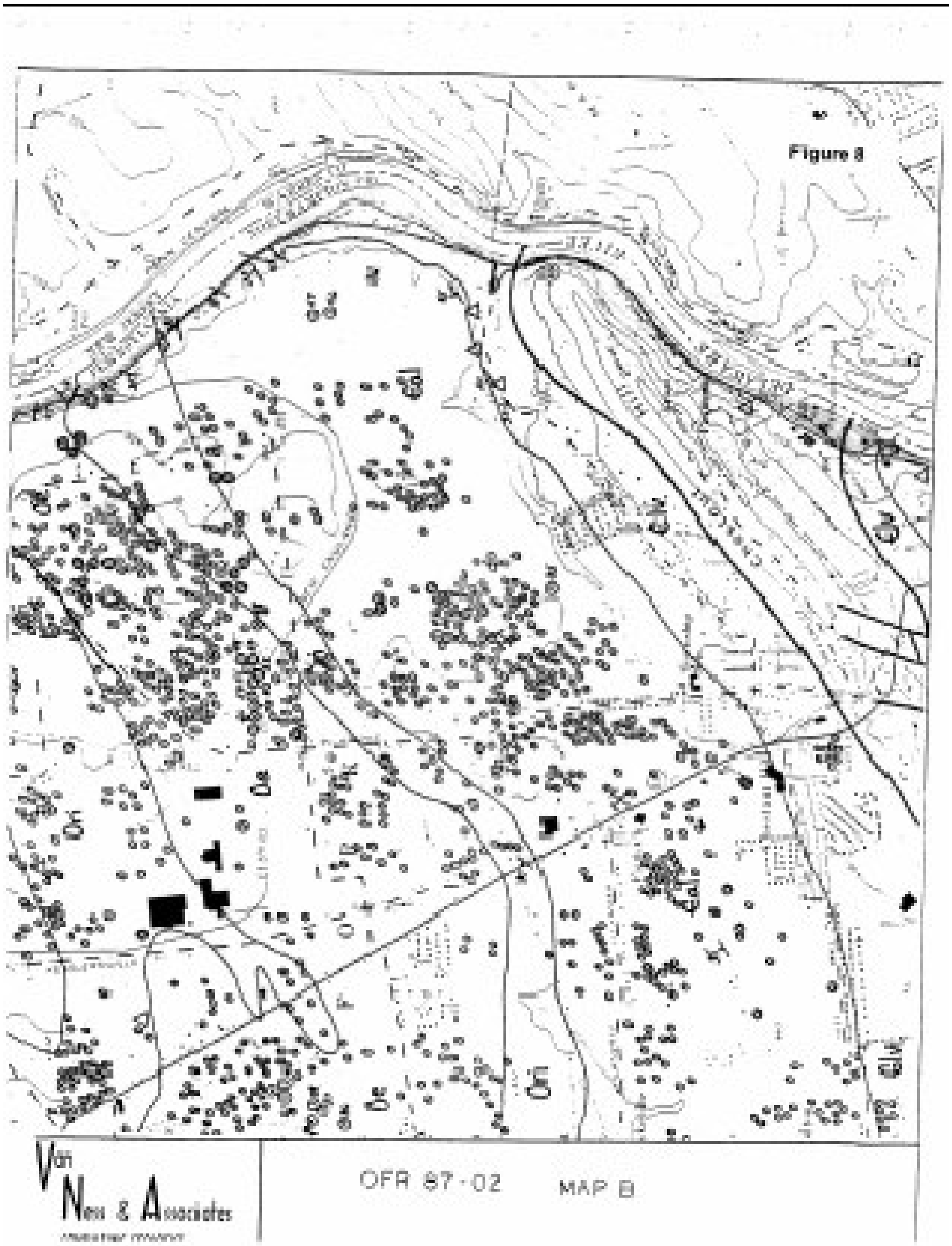


Figure 8
Van Ness & Associates
OFR 87-02
MAP B


Figure 9
Van Ness & Associates
OFR 87-02 MAP C

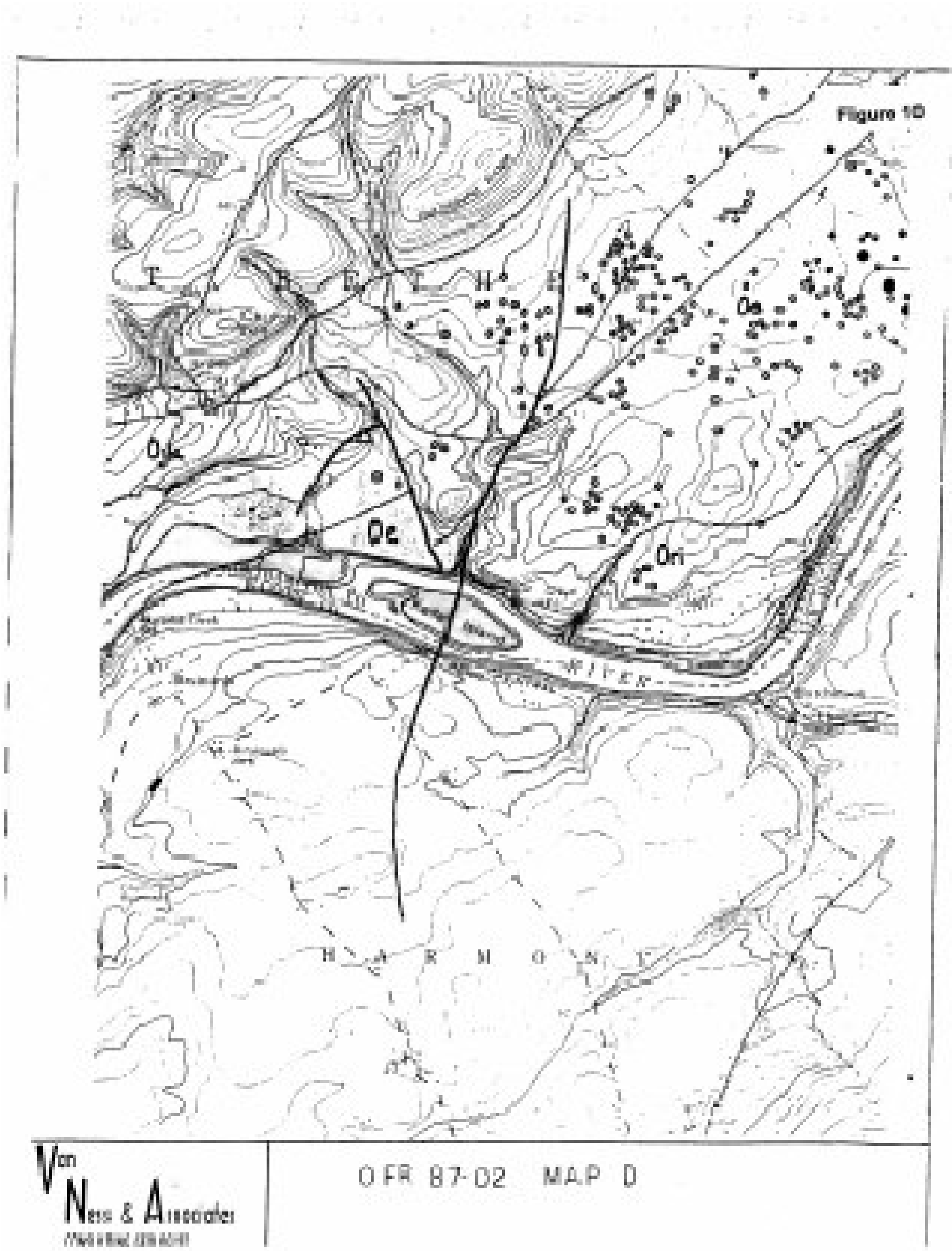


Figure 10
Oe
Oe
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OFR 87-02 MAP D
Von
Ness & Associates

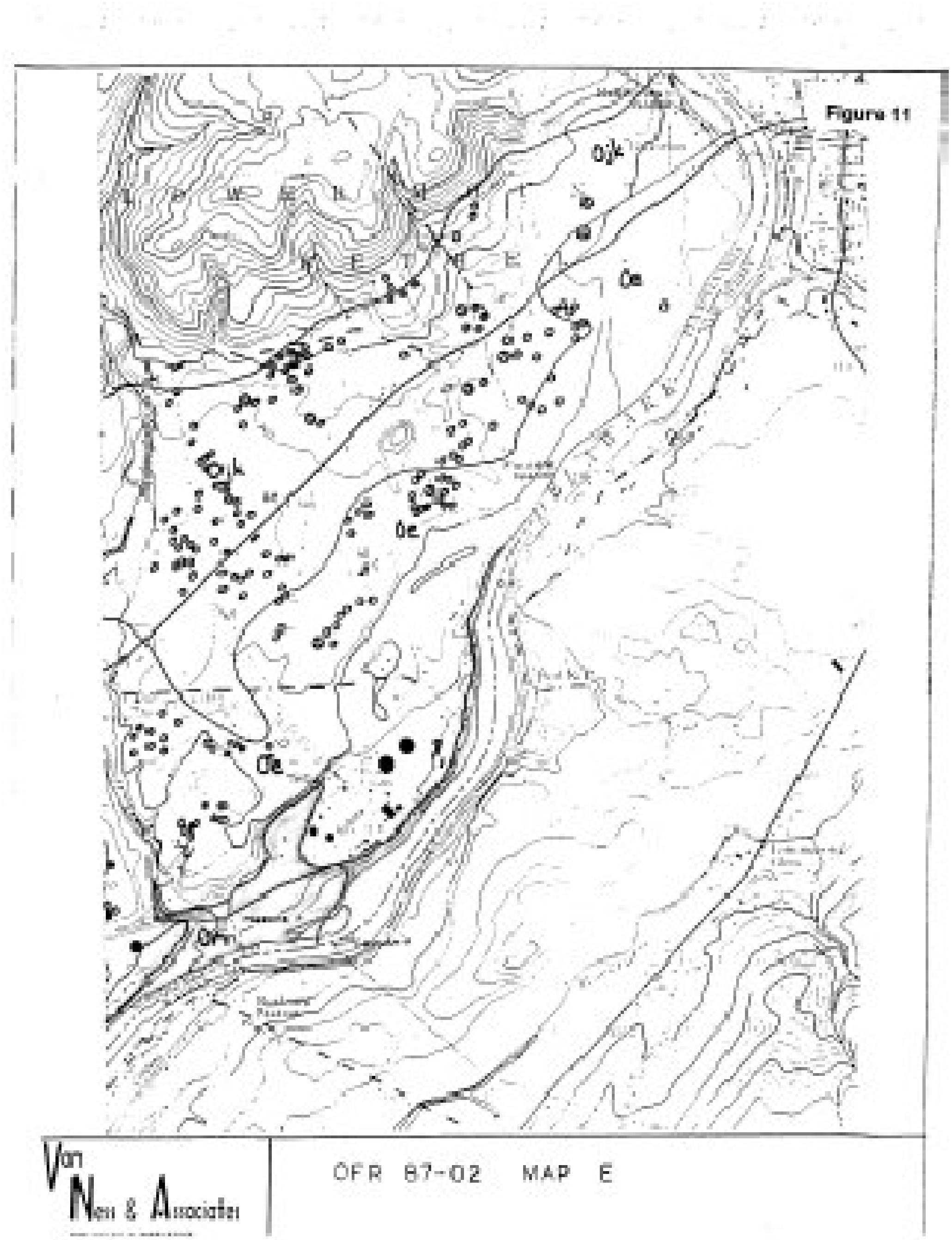
Figure 11
OFR 87-02 MAP E
Van Ness & Associates

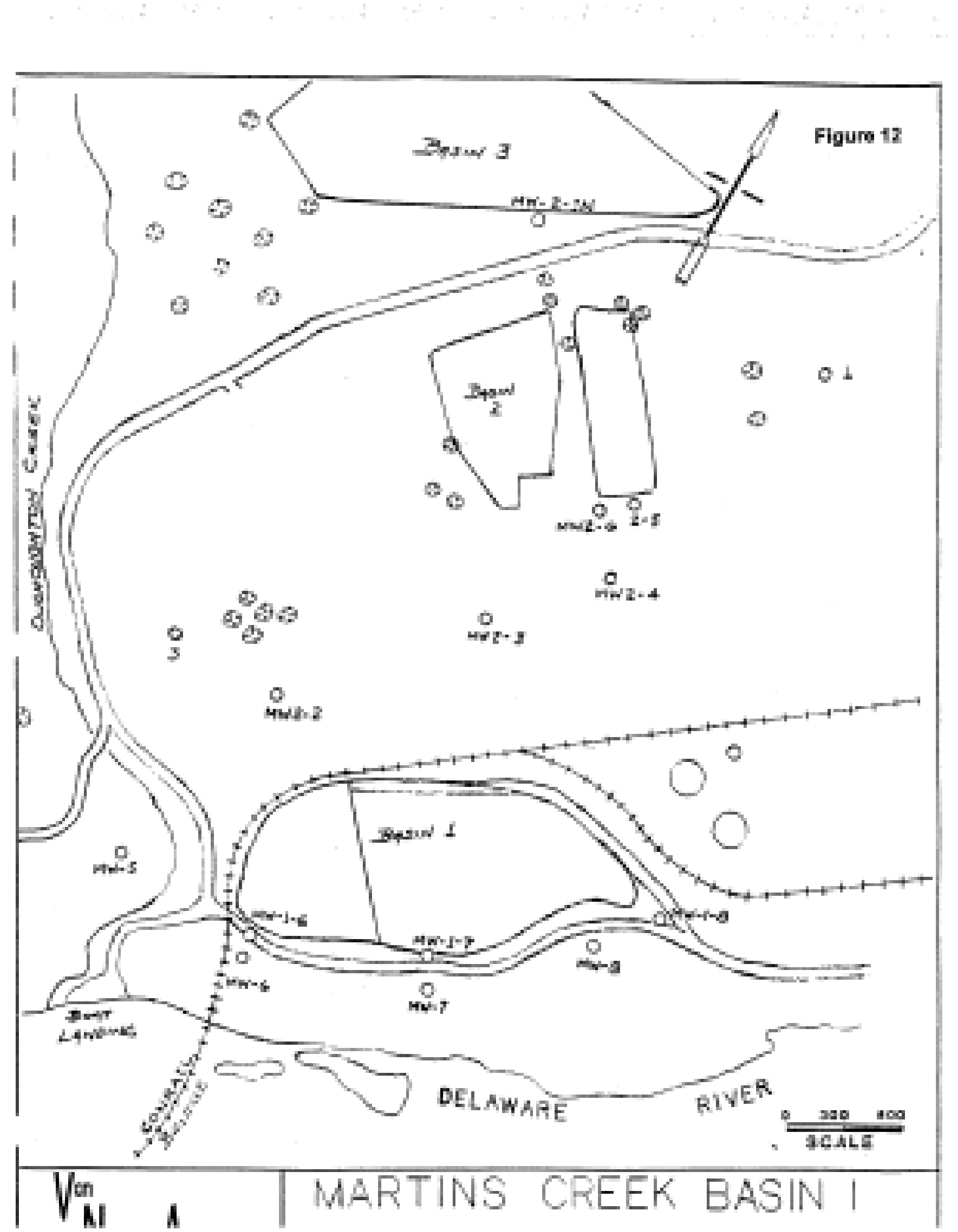
Figure 12
BASIN 3
BASIN 2
BASIN 1
MW-2
MW-5
MW-6
MW-7
MW-8
DELAWARE
RIVER
SCALE
MARTINS CREEK BASIN I

located beneath the soils but above the water table. These carbonates are highly jointed and fractured and water levels in monitoring wells on the upper terrace show a 40-foot-variation throughout the year. These conditions allow presumably acidic surface waters to infiltrate and dissolve the carbonate rocks as it migrates down to the water table. On the lower terrace, however, the carbonate rocks are covered by 40-60 feet of sands and gravels. The water table is 15-20 feet above the carbonates in this sand and gravel and serves to mix and neutralize surface water infiltration and inhibit sinkhole development (see Figure 13).

The second question was, "Are sinkholes present in the Basin No. 1 area or were there sinkholes present before plant construction that are now filled or covered?" Field observations in the Basin No. 1 area showed no sinkholes currently present. Kochanov's study (1987) also indicates none. Figure 12 shows the location of known sinkholes mapped by Kochanov. The closest sinkholes are northwest of MW2-2, on the upper terrace, about 1,000 feet from Basin No. 1. The Kochanov report also includes an evaluation of aerial photographs dating from 1947, which is prior to the construction of the Martins Creek Plant. No sinkholes were identified from these pre-construction photos.

The third important question was, "What is the incidence of sinkhole development in similar geologic settings along the Delaware River?" A review of the Kochanov report in areas of similar geologic setting to those of Basin No. 1, which included a 12-mile stretch along the Delaware River, indicated no sinkholes present in this geologic setting.

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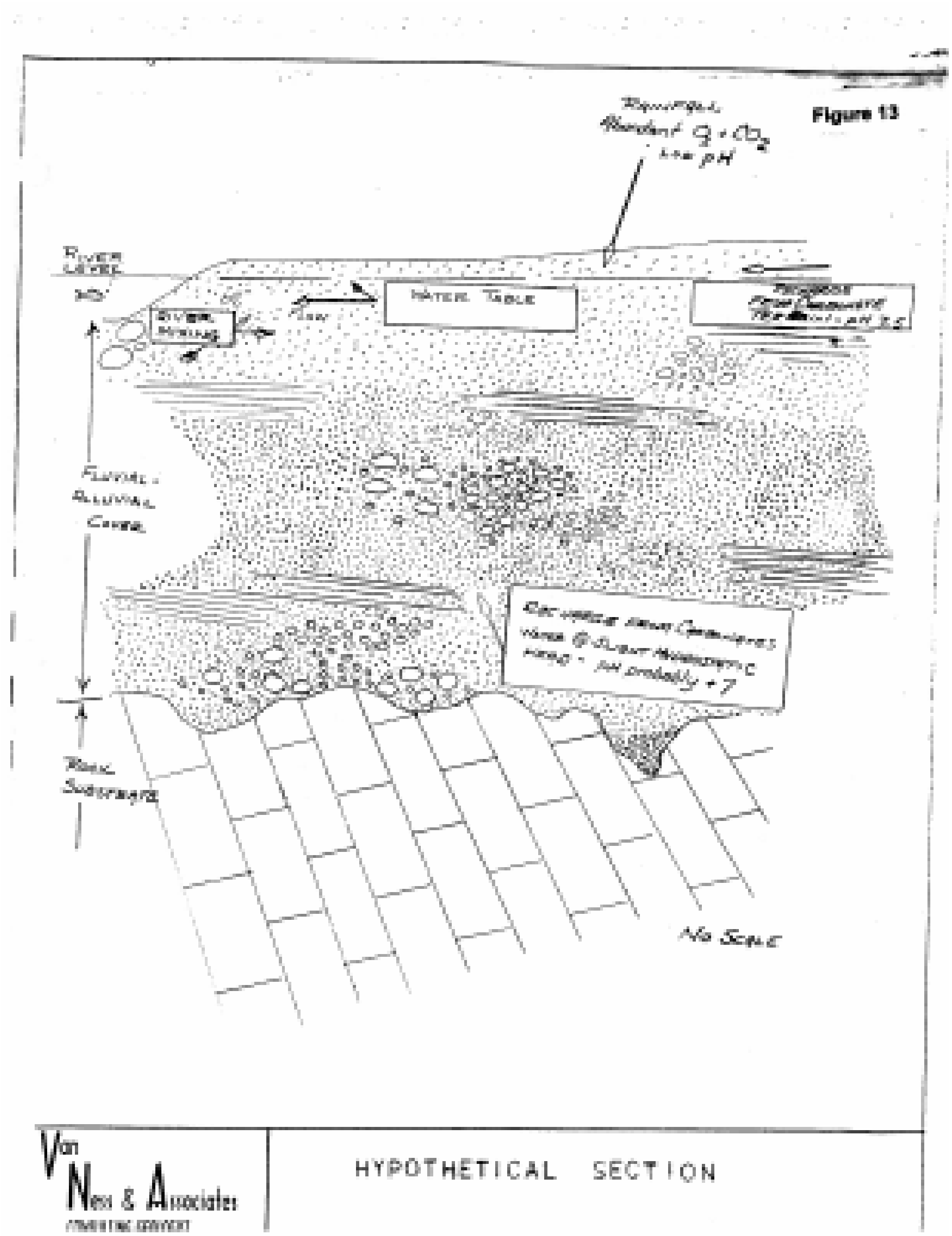
Figure 13
WATER TABLE
FLUVIAL - ALLUVIAL COVER
No SCALE
HYPOTHETICAL SECTION
Van Ness & Associates

APPENDIX

List of Figures

References

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VITAE

Charles G. Van Ness

Lafayette College 1958 - A. B. Geology
Lehigh University 1960 - M. S. Geology

Professional Organizations

Fellow - Society of Economic Geologists
Member of Geological Society of America
Served on Pennsylvania Electric Energy Research Council - Fuels Working Group
Pennsylvania Academy of Science Editorial Board

License - Commonwealth of Pennsylvania
Professional Geologist #PG-000153

Pertinent Experience

Early professional experience was with the exploration group of New Jersey Zinc Company. The New Jersey Zinc Company mined zinc in numerous locations throughout the United States. Nearly all the zinc mined by New Jersey Zinc was contained in carbonate host rocks.

Of particular interest to the subject is the experience gained at the Friedensville Mine, located beneath Saucon Valley, south of Bethlehem, Pennsylvania.

The Friedensville Mine produced 2,000 tons of zinc ore from the Rickenbach Formation (Lower Ordovician). The mine, which is one of the wettest mines in North America, pumped an average of 30,000 gallons per minute from the highly fractured and karstified Rickenbach carbonates, similar to those present at Martins Creek.

Mr. Van Ness participated in the publication of two scientific articles on the Friedensville Mine. They are:

"Field Guide to the Friedensville Mine" by R. W. Metsger, A. H. Willman and C. G. Van Ness - for the Geological Society of America, Northeast Section Meeting, March 1973.

"Field Guide to the Friedensville Mine of the New Jersey Zinc Company", by R. W. Metsger, A. H. Willman and C. G. Van Ness for 5th Symposium of the International Association on the Genesis of Ore Deposits, August 1978.

TABLE 1 - GROUND WATER AND BEDROCK ELEVATIONS IN BASIN NO. 1 AREA

Hole	Collar Elevation	TD	Year Drilled	Bedrock Depth	Bedrock Elevation	Water Depth	Water Elevation*	Overburden	Rock	Condition
MW-5	219'c	28'	1983	23.5'	190'	9'	205'	Sand & Gravel	Hard Dark Limestone	Sealed
MW-6	219'c	38.5'	1983	[illegible]	180'	10'	204'	Sand & Gravel	Weathered Limestone	
MW-7	215'c	31.5	1983	27.5'	188'	10'	206'	Sand & Gravel	Broken Carbonate	
MW-8	215'	31	1983	25'	192'	6	211'	Boulders, Sand & Gravel	Weathered Carbonate	
MW-1-6	242'	46'	?	NO	-	36'	206'	Boulders, Sand & Gravel	None	
MW-1-7	324'	71'	1989		-	41'	207'	Boulders, Sand & Gravel	None	Plugged
MW-1-8	243'	46'	1986	NO	-	31'	212'	Boulders, Sand & Gravel	None	
MW-2-2	285'	101'	1985	60'	223'	63'	312'	Clay		
MW-2-3	321'	160'	1985	0'	318'	106'	215'	None	Carbonate	
MW-2-4	316'	100'	1985'	20'	295'	67'	249'			
MW-2-5	315'	140'	?	45'	268'	99'	218'	0-20' Clay 20-45 Regolith	Carbonate	
MW-2-6	318'	110'	?	30'	283'		231'	Silty Clay	Carbonate	
MW-2-1N	298'	131'	1991	60'	238'		224'	Silt-Sand Sand & Gravel @ Bottom 44-60'	Interbedded Limestone & Dolomite	
MW-2-3N	248'	59'	1972	30'	218'					
MW-2-1N	308'	105'	1973	33'	275'	93'	215'	Soil & Gravel	Limestone	Closed
MW-2-2N	279'			No Observations						
MW-14	236	34	1990	No Observations		25'	211	Sand & Gravel	None	
MW-19	235	35	1990	No Observations		24'	211	Sand & Gravel	None	

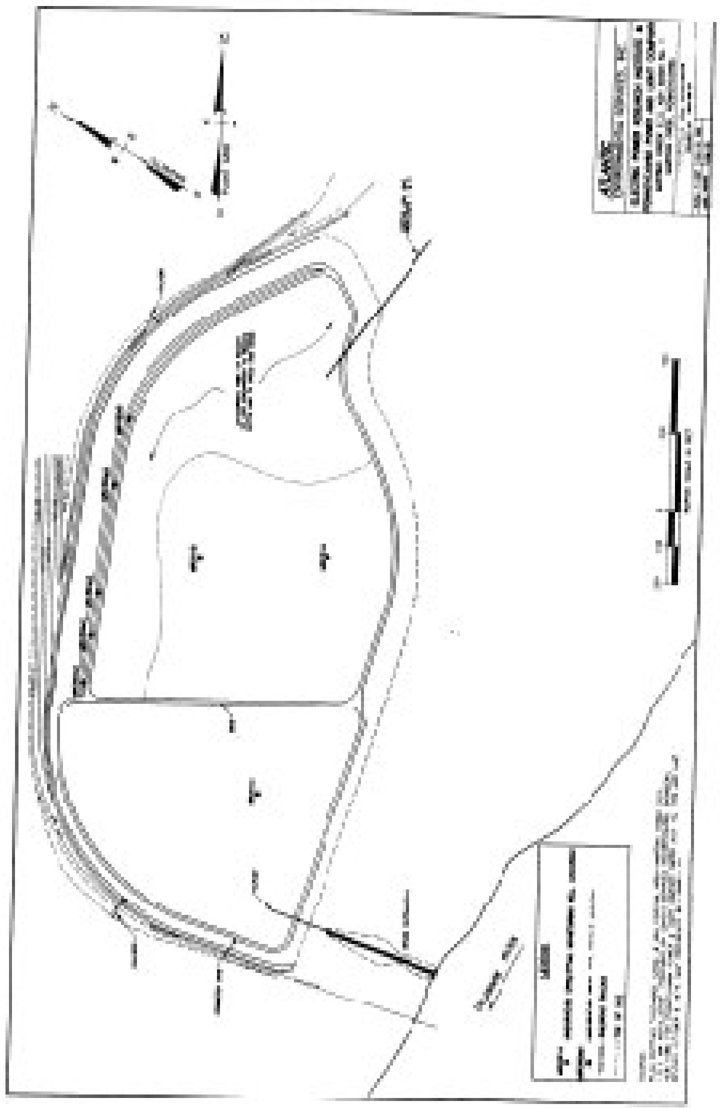
*Most Observations - March 1997

TABLE 2

Summary of Groundwater Surface Elevations in Site Wells
Pennsylvania Power and Light Company - Martins Creek S.E.S.
REWEI Project 92585

Date	Groundwater Level in Feet Above Mean Sea Level (AMSL)									
	MW-8	MW-9	MW-11	MW-14	MW-16	MW-17	MW-18	MW-19	MW-20	
	TD - 55.50 Datum - 215.29	TD - 34.78 Datum - 233.78	TD - 39.93 Datum - 236.10	TD - 19.00 Datum - 236.25	TD - 19.00 Datum - 233.47	TD - 19.00 Datum - 235.33	TD - 23.00 Datum - 234.99	TD - 23.00 Datum - 235.00	TD - 24.2 Datum - 233.44	
09/21/94	–	–	–	–	–	–	–	–	–	
10/05/94	–	–	–	–	–	–	–	–	–	
10/12/94	210.38	209.64	209.51	209.69	210.36	210.51	209.56	210.08	–	
10/19/94	–	–	–	–	–	–	–	–	–	
11/08/94	209.96	210.40	208.13	209.11	210.06	210.23	209.15	209.04	–	
11/23/94	–	–	–	–	–	–	–	–	–	
12/09/94	212.09	211.40	211.18	210.96	212.41	212.03	211.15	210.90	–	
12/14/94	–	–	–	210.80	211.81	–	211.14	210.90	–	
12/21/94	–	–	–	–	–	–	–	–	–	
12/28/94	211.04	210.07	210.24	[illegible]	211.06	211.27	210.20	210.80	–	
01/16/95	210.93	210.48	210.29	210.13	211.00	211.22	210.87	210.64	–	
02/12/95	210.36	209.75	209.60	–	210.34	–	210.28	210.20	–	
02/22/95	–	–	–	–	–	–	–	–	–	
03/10/95	211.15	211.53	211.30	211.03	212.11	212.12	211.79	211.48	–	
03/22/95	211.88	–	–	–	–	–	–	–	–	
05/24/95	210.39	–	–	–	–	–	–	–	–	
06/05/95	209.74	209.11	209.00	208.95	209.19	209.95	209.54	209.45	–	
06/21/95	209.49	–	–	–	–	–	–	–	–	
07/10/95	210.28	–	–	–	–	–	–	–	–	
07/25/95	209.85	–	209.15	–	209.81	210.06	209.60	209.63	–	
08/23/95	[illegible]	–	–	–	–	–	–	–	–	
09/20/95	208.88	–	–	–	–	–	–	–	–	
09/28/95	209.20	208.78	208.55	208.17	209.30	208.94	208.45	208.30	–	
10/18/95	210.19	–	–	–	–	–	–	–	–	

TD - Total Depth
Datum - Surveyed Elevation of Top of Well Casing [illegible]
– = No Measurement Acquired



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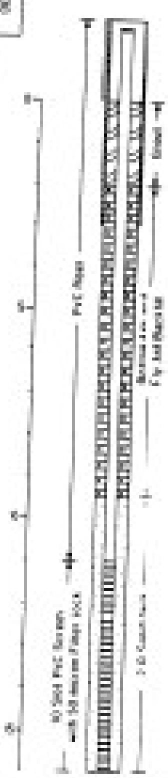
DATE: [illegible]
DRILLING CONTRACTOR: NORTHSTAR DRILLING COMPANY
DRILLING METHOD: HOLLOW STEM AUGER
SAMPLING METHOD: SPLIT SPOON (UNLESS NOTED)

INSPECTOR: TERRY TAYLOR
WELL ELEVATION (FT):
DEPTH TO WATER (FT):
DATUM:
LOCATION: MARTINS CREEK BASIN NO. 1

SPLIT SPOON SAMPLE DEPTH (ft)	BLOWS PER 6"	% RECOVERY	SOIL DESCRIPTION (color, density, SOIL name, moisture, other notes, ORIGIN)
0-2	1,2 1,1	50	Dark gray to brown FLY ASH, crumbly, dry, trace cobble size fragments and coal and bark, orange stained
2-4	1,1 1,1	[illegible]	Brown to gray FLY ASH with some very fine bottom ash, trace coal and [illegible], dry, trace rock fragments
4-6	2,2 2,2	25	Dark gray FLY ASH with fine bottom ash, trace slag, coal and greenish brown [illegible] cobbles, dry
6-8	7,7 8,6	80	[illegible] gray FLY ASH, trace [illegible] bottom ash, some [illegible] at 6.1 feet, dry Coarse to pebbly BOTTOM ASH, trace fly ash, dry
8-10	6,5 5,5	80	Coarse BOTTOM ASH, trace pebbles Gray to dark gray FLY ASH with coarse [illegible], moist from 8.3 to 8.4 Gray very fine BOTTOM ASH and FLY ASH
10-12	1,1 2,1	80	Very fine BOTTOM ASH, dry Gray to dark gray FLY ASH, dry and fairly compact, wet from 10.[illegible] to 11.[illegible] feet Fine [illegible] BOTTOM ASH, dry Gray FLY ASH, moist
12-14	1,2 2,3	85	Layered FLY ASH and [illegible], trace of coal at 12.5 feet Gray FLY ASH with fine BOTTOM ASH, dry, moist from 13.8 to 13.[illegible] feet
14-16	1,5 10	70	Layered fine BOTTOM ASH and FLY ASH, dry, moist from 14.5 to 15.5 Gray FLY ASH, wet

MOISTURE CONTENT: DRY / MOIST / WET — SAMPLE ANALYSIS — LITHOLOGY — DEPTH (FT)

WELL CONSTRUCTION



ATLANTIC

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Page 2 of 3

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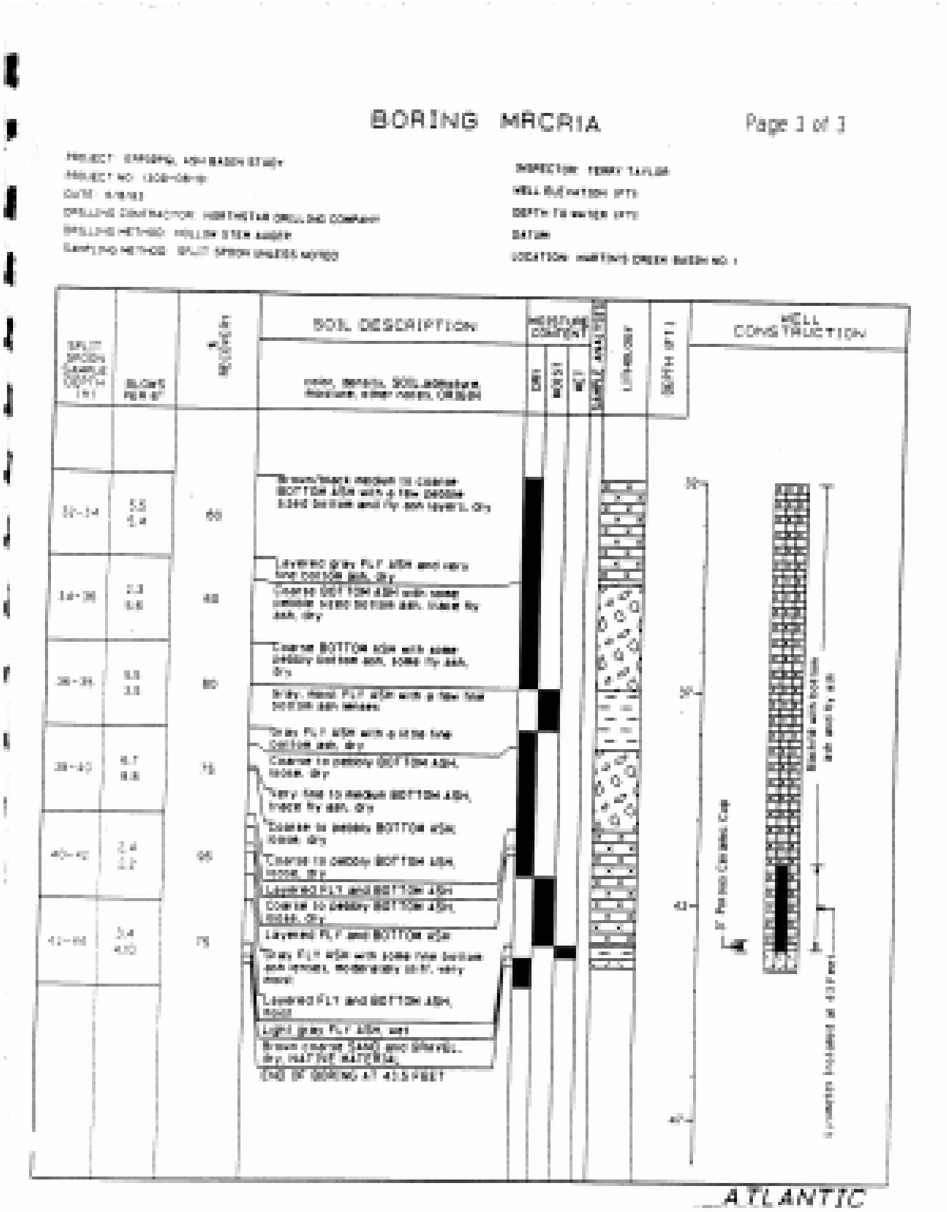
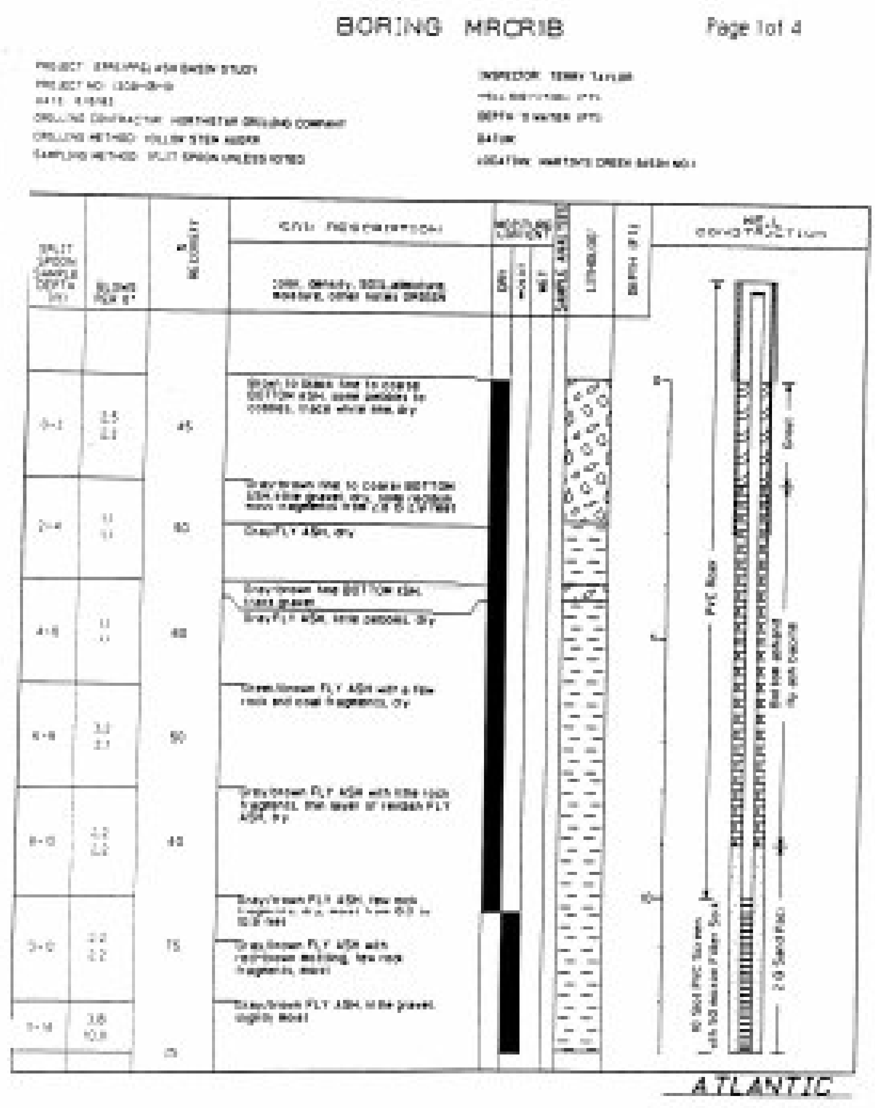
PROJECT NO: [illegible]
DATE: [illegible]
DRILLING CONTRACTOR: [illegible] DRILLING COMPANY
DRILLING METHOD: HOLLOW STEM AUGER
[illegible]

INSPECTOR: TERRY NAYLOR
WELL ELEVATION (FT):
DEPTH TO WATER (FT):
DATUM:
LOCATION: MARTINS CREEK BASIN NO. 1

SPLIT SPOON SAMPLE DEPTH (ft)	BLOWS PER 6"	% RECOVERY	SOIL DESCRIPTION (color, density, SOIL/ash type, moisture, other notes, ORIGIN)
16-18	0.8 0.1	80	Gray soft FLY ASH, wet Gray FLY ASH, wet
18-20	[illegible]	50	[illegible] BOTTOM ASH [illegible], few organics (roots)
20-22	1.2 2.3	50	Pink/brown fine BOTTOM ASH, trace organics (roots), dry Gray fine BOTTOM ASH with a few fly ash lenses, dry Gray FLY ASH with a few fine [illegible]
22-24	3.3 7.7	80	Pink/black fine BOTTOM ASH, trace organics Gray FLY ASH with some bottom ash, fairly compacted, dry
24-26	5.6 4.4	50	Fine BOTTOM ASH, some FLY ASH lenses, slightly moist [illegible] FLY ASH and medium to coarse BOTTOM ASH, dry Medium to coarse BOTTOM ASH, few pebbly bottom ash, trace fly ash lenses, loose, dry
26-28	4.4 3.1	40	Medium to coarse BOTTOM ASH, dry Gray FLY ASH and very fine BOTTOM ASH Medium BOTTOM ASH and FLY ASH, few pebbles, dry
28-30	4.3 4.4	15	Coarse BOTTOM ASH with a few pebbles, trace fly ash lenses, fairly loose, dry
30-32	3.3 4.4	60	[illegible] BOTTOM ASH, dry

ATLANTIC


BORING MRCR1A
Page 3 of 3
SOIL DESCRIPTION
MOISTURE CONTENT
WELL CONSTRUCTION
Layered gray FLY ASH and very fine bottom ash, dry
Coarse BOTTOM ASH with some pebbly bottom ash, some fly ash, dry
Coarse to pebbly BOTTOM ASH, loose, dry
Layered FLY and BOTTOM ASH
Light gray FLY ASH, wet
Brown coarse SAND and GRAVEL, dry, NATIVE MATERIAL
END OF BORING AT 43.5 FEET
ATLANTIC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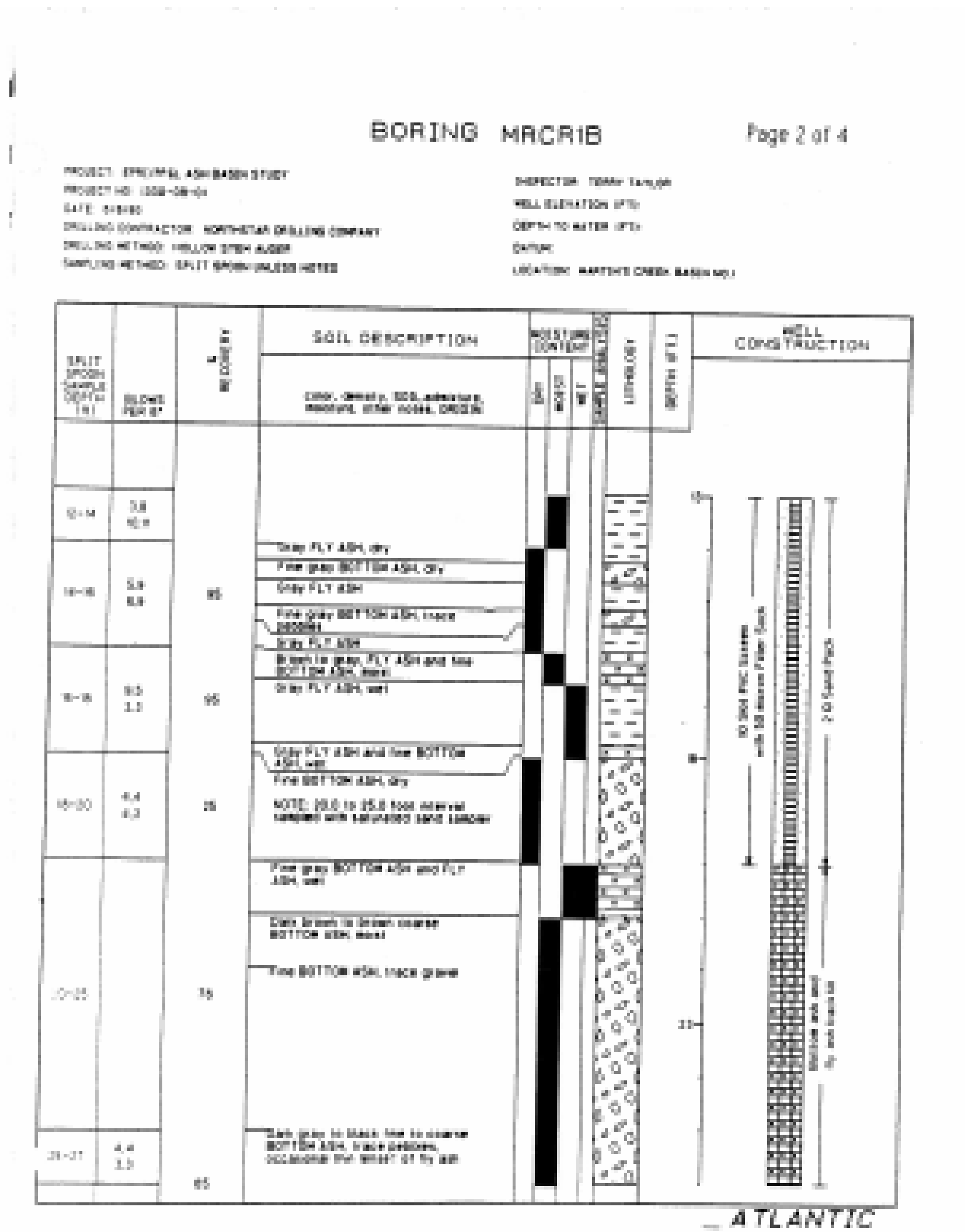

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PROJECT NO: [illegible]
DATE: [illegible]
DRILLING CONTRACTOR: NORTHSTAR DRILLING COMPANY
DRILLING METHOD: HOLLOW STEM AUGER
SAMPLING METHOD: SPLIT SPOON UNLESS NOTED

INSPECTOR: [illegible]
WELL ELEVATION (FT):
DEPTH TO WATER (FT):
DATUM:
LOCATION: MARTIN'S CREEK BASIN NO. 1

SPLIT SPOON SAMPLE DEPTH (FT)	BLOWS PER 6"	% RECOVERY	SOIL DESCRIPTION (color, density, SOIL, admixture, moisture, other notes, ORIGIN)
12-14	3,8 / 10,11		
14-16	5,9 / 8,8	95	Gray FLY ASH, dry; Fine gray BOTTOM ASH, dry; Gray FLY ASH; Fine gray BOTTOM ASH, trace pebbles; Gray FLY ASH
16-18	9,5 / 3,3	95	Brown to gray FLY ASH and fine BOTTOM ASH, moist; Gray FLY ASH, wet
18-20	4,4 / 4,3	25	Gray FLY ASH and fine BOTTOM ASH, wet; Fine BOTTOM ASH, dry; NOTE: 20.0 to 25.0 foot interval sampled with saturated sand sampler
20-25		75	Fine gray BOTTOM ASH and FLY ASH, wet; Dark brown to brown coarse BOTTOM ASH, moist; Fine BOTTOM ASH, trace gravel
25-27	4,4 / 3,3	65	Dark gray to black fine to coarse BOTTOM ASH, trace pebbles, occasional thin seam of fly ash

ATLANTIC

BORING MRCR1B

Page 3 of 4

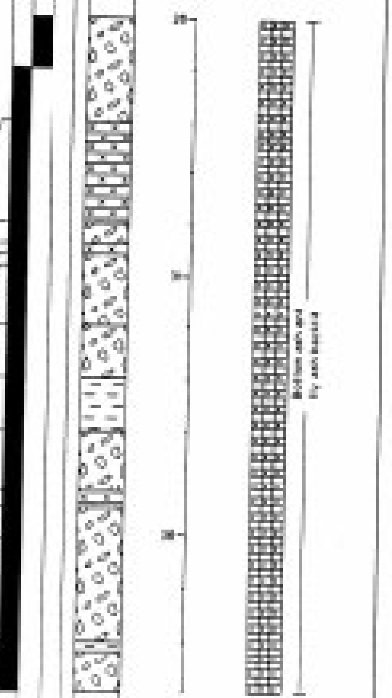
PROJECT: EPRI/PPL ASH BASIN STUDY
PROJECT NO: 1009-08-01
DATE: 6/8/90
DRILLING CONTRACTOR: NORTHSTAR DRILLING COMPANY
DRILLING METHOD: HOLLOW STEM AUGER
SAMPLING METHOD: SPLIT SPOON / HOLLOW AUGER

INSPECTOR: TERRY TAYLOR
WELL ELEVATION (ft)
DEPTH TO WATER (ft)
DATUM:
LOCATION: MARTINS CREEK BASIN NO. 1

SPLIT SPOON SAMPLE DEPTH (ft)	BLOWS PER 6"	% RECOVERY	SOIL DESCRIPTION (color, density, SOIL/admixture, moisture, other notes, ORIGIN)
25-27	1-8 1-3		
27-29	3-3 4-5	70	Dark gray medium to coarse BOTTOM ASH, dry Fine gray BOTTOM ASH, dry Medium to coarse BOTTOM ASH, little gravel Interlayered FLY ASH and BOTTOM ASH, dry
29-30	54	36	NOTE: Used oversized split sampler on 29-30' interval
30-35		80	Dark gray medium to coarse BOTTOM ASH, trace gravel Gray FLY ASH and fine BOTTOM ASH Dark gray medium to coarse BOTTOM ASH, trace gravel Gray FLY ASH Dark gray FLY ASH Dark brown to black fine to medium BOTTOM ASH Dark gray FLY ASH Dark brown to black fine to medium BOTTOM ASH
35-37	2-3 6-4	70	Fine BOTTOM ASH, some gravel Interlayered FLY ASH and fine BOTTOM ASH and medium to coarse BOTTOM ASH Gray coarse BOTTOM ASH some gravel Fine BOTTOM ASH Gray coarse BOTTOM ASH, some gravel
37-39	4-5 4-4	85	Brown to dark gray coarse BOTTOM ASH, some gravel Gray FLY ASH Medium to coarse BOTTOM ASH

MOISTURE CONTENT: DRY / MOIST / WET — SAMPLE / LITHOLOGY / DEPTH (ft)

WELL CONSTRUCTION



ATLANTIC

BORING MRCR1B

Page 4 of 4

PROJECT: [illegible] ASH BASIN STUDY
PROJECT NO: [illegible]
DATE: [illegible]
DRILLING CONTRACTOR: NORTHSTAR DRILLING COMPANY
DRILLING METHOD: HOLLOW STEM AUGER
SAMPLING METHOD: SPLIT SPOON UNLESS NOTED

INSPECTOR: [illegible]
WELL ELEVATION (FT):
DEPTH TO WATER (FT):
DATUM:
LOCATION: MARTIN'S CREEK BASIN NO. 1

SPLIT SPOON SAMPLE DEPTH (FT)	BLOWS PER 6"	% RECOVERY	SOIL DESCRIPTION (COLOR, DENSITY, SOIL, ADMIXTURE, MOISTURE, OTHER NOTES, ORIGIN)	MOISTURE CONTENT	LITHOLOGY	DEPTH (FT)	WELL CONSTRUCTION
38-40	5,6	80	Dark gray FLY ASH and fine BOTTOM ASH Dark gray coarse BOTTOM ASH Gray FLY ASH Dark gray to black coarse BOTTOM ASH, some gravel			38	
40-43.5		68	Dark [illegible] saturated sand [illegible] 42.0 feet. Grove [illegible] to 43.5 feet Dark gray fine to coarse BOTTOM ASH, little gravel, dry				
			Red-brown fine to medium sand, NATIVE MATERIAL				
			END OF BORING AT 43.5 FEET			40	
						45	

ATLANTIC

Final Report
South End Experimental Process
Ash Basin 1
PPL Martins Creek Steam Electric Station

This report prepared by

Bryce F. Payne Jr., PhD
Soil Scientist
Soil Ecosystems Services, Inc.

for

PPL Martins Creek Steam Electric Station
Lower Mount Bethel Township
Northampton County
Pennsylvania

in fulfillment of the

Reporting Requirements for the
South End Area Experimental Process
Ash Basin 1

as stipulated in

Part III, Section III, Subsection 5
Solid Waste Permit #301256

issued by the

Northeast Regional Office
Pennsylvania Department of Environmental Protection

FINAL ASH/SOILS REPORT
PPL CORPORATION
MARTINS CREEK STEAM ELECTRIC STATION
SOUTH END ASH BASIN NO. 1

EXECUTIVE SUMMARY

A six year study has been completed by the author to determine if the coal combustion ash in the South End Area (SEA) of Ash Basin 1 at PPL Corporation's Martins Creek Steam Electric Station (SES) in eastern Pennsylvania can serve as a cover soil for the basin. Specifically, the study was commissioned by PPL and the Pennsylvania Department of Environmental Protection (DEP) to determine whether coal ash can serve as a parent material in which natural soil formation will occur and whether the ash soils can support a self-sustaining plant/soil ecosystem that will secure ash deposits in the basin. Prior to the study, a significant stand of natural pioneer trees and underbrush had established over much of the area. During the study, the ash was periodically amended with combinations of nutrients, fertilizers, mulch, and minimal applications of grass seeds. Soils and vegetation were periodically sampled and tested. Annual progress reports were prepared.

The conclusions of the study and this final report are that all the data clearly indicate that soil formation is advancing rapidly in the SEA ash; that the SEA ecosystem is functional and can be expected to remain so; and that the ash soil will secure the ash in the SEA into the foreseeable future with the same or better effectiveness than imported local cover soils and reclamation vegetation.

FINAL ASH/SOILS REPORT
PPL CORPORATION
MARTINS CREEK STEAM ELECTRIC STATION
SOUTH END ASH BASIN NO. 1

Table of Contents

Appendix C.

Developmental history of the SEA based on analysis of older aerial photos and recollections of plant personnel.

(Note: The text in this Appendix was copied directly from the original 1999 Report on the initial evaluation of the Status of the Ecosystem in the South End Area of MC SES Ash Basin 1. In that 1999 Report the "South End Area" of Ash Basin 1 was referred to as the "Lower End Area". Any data references [Tables, Figures, photos, etc.] in this Appendix are to data presented in the 1999 Report. That data is not included in this Appendix or the Final Report except portions coincidentally as needed for specific purposes.)

During the first years of operation of Ash Basin 1 (1965-58) the only actively used portion of Ash Basin 1 was effectively today's SEA. Presumably ash settled throughout the current SEA. It can be presumed that the coarser bottom ash would have settled out of the slurry water much closer to the point of release in the north/west end and, consequently, that the ash deposited in the south/east areas was mostly fly ash.

By the 1960's the working area of Basin 1 had been shifted to the NE by construction of 2 median dikes in what is now the North End Area. Apparently for some time ash was settled primarily in this second active area to the north of the current SEA. It appears the SEA was used only to catch overflow and associated fly ash from this new active area. In the late 1960's the active area was again extended to the NE, and the two northern median dikes were intentionally breached. Presumably this was to redistribute the sediment load over the entire basin. The breaching of the dikes and the resultant flows apparently cut channels into the ash deposits in what is now the SEA. The fly ash deposits were apparently churned and mixed with bottom ash carried in from the North End of Basin 1. This channeling and mixing of fly and bottom ashes occurred for the most part in the areas that now run along the West dike of the South End Area.

By the early 1970's the main fly ash stream from the MC SES was diverted to a new basin. The current NW-SE dike separating the North and South End Areas was constructed in 1975 defining and dramatically reducing ash input to the South End Area. By this time the oldest undisturbed fly ash deposits were in the functionally intact SE delta (*V-S* Plain). For another few years this area apparently continued to receive fly ash trucked from the plant. In 1985 the SE delta was used for machine access to open the channels between the NW-SE dike and the 2d Berm. Effectively all ash disposal activity in the South End Area ended with the construction of the channels in 1985. The retarded biological development on the *V-S* Plain compared to the areas N and W of the channels is presumed to be due to recurring traffic and use of the surface of the SE delta. The consequent compaction and mechanical stabilization of the underlying fly ash deposit is apparent as a distinct compaction layer under the *V-S* Plain.

There were areas of unvegetated, exposed ash soil surfaces in Spring 1999 that were concluded to be due either to excessive wetness and recurring inundation and sediment deposition, or excessive dryness and heat on exposed surfaces of higher elevation and coarser ash texture (lower soil water holding capacity). The Outlet Basin floor had been affected by recurring wetness, including periods of inundation and prolonged periods of saturation. The floor of the northern channel and the far SE corner of the South End Area were affected by recurring inundation and sediment deposition. Though well drained, the stressed plants in the channels were not able to grow fast enough to overcome recurrent burial under deposited then moved and re-deposited sediments. The Barrens in the northern South End Area and barren areas on the Central Rise were affected by excessive drainage and dryness (higher elevation deposits of coarser texture due to more entrained bottom ash) and excessive heat due to exposure.

PP&L, Inc.
Two North Ninth Street
Allentown, PA 18101-1179
610.774.5151

ppl

WASTE MANAGEMENT
COUNTY: Northampton
SEP 20 1999
FACILITY:
FILE CODE:
ID #: 301256

September 17, 1999

Mr. Robert C. Wallace
Chief, Engineering & Facilities Section
Waste Management Program
Pennsylvania Department of Environmental Protection
2 Public Square
Wilkes-Barre, Pennsylvania 18711-0790

MARTINS CREEK SES
ASH BASIN NO. 1
PERMIT CONDITION
PART III, ITEM III 6b7
DIKE STABILITY ANALYSIS
ID #301256

Dear Mr. Wallace:

The permit for Martins Creek SES Ash Basin No. 1 states on page 53 of 55, Item 7

> Within sixty (60) days of permit issuance, the permittee will provide stability calculations for the Ash Basin No. 1 external dikes subjected to the external loading of the 100 year flooding event.

The flood record on the Delaware River is Hurricane Diane in 1955. That flood is typically considered a 100 year flood or more. During that flood, the plant was not flooded. The plant grade is elevation 235. Note on the enclosed Drawing D-242663, Sh. 2 that the toe of the basin is elevation 235 or higher. Therefore, the 100 year flood should not impact the basin dikes.

To accommodate this condition and alleviate any concerns about dike stability, we analyzed the dike for rapid drawdown assuming a flood at least 15 feet higher than any recorded flood (EL. 250).

Since we don't have soil strength data on the Ash Basin No. 1 dikes, we used data from the Ash Basin No. 4 dikes. The following table documents the result of the analysis.

Mr. Robert C. Wallace
September 17, 1999
Page 2

Ash Basin No. 1 Dike
Maximum Sections Along Railroad Tracks
Rapid Drawdown Stability Analysis Results

ϕ Angle*	Cohesion*	Safety Factor
34-1/2°	1,000 psf	3.7
36°	650 psf	2.9
40°	200 psf	2.0
30°	150 psf	1.4
27°	800 psf	2.8
AVE 33.5	560 psf	2.6

*Based on laboratory testing of Ash Basin No. 4 dike soils.

A satisfactory factor of safety for rapid drawdown is 1.2. All of the test results analyzed exceeded that figure. We've enclosed a computer printout of the 1.4 safety factory analysis for your review and records. The analysis was completed using the Modified Bishop method within the STABL mainframe computer program developed by Purdue University.

If you have any questions or need any more information, please feel free to call me at 610-774-4135.

Sincerely,

Andrew D. Spear, P.E.
Senior Engineer
Engineering & Technical Services

ADS68-ol.doc (g:letter)

Enclosure

P.S. Please note Item 9 on page 48 of 55 of the permit that requests a revision to Drawing D-242663, Sh. 10. The permit area is already delineated on the drawing. North and south ends can be identified, but, "showing the site berms/dikes that may not be covered with waste" is unclear as to what you want. I left a message with Jim Berger regarding this but I wanted to bring it to your attention.

```
09/15/99                    I N P U T   L I S T I N G                    PAGE  1.

         1111111111222222222233333333334444444444555555555566666666667777777778
1234567890123456789012345678901234567890123456789012345678901234567890123456789

PROFIL                                                                 00000010
MCSES ASH BASIN NO. 1 FLOOD IMPACT - MIN STRENGTHS                     00000020
4 3                                                                    00000030
0. 30. 30. 30. 1                                                       00000040
30. 30. 100. 60. 1                                                     00000050
100. 60. 130. 60. 1                                                    00000060
0. 0. 80. 0. 2                                                         00000110
SOIL                                                                   00000120
2                                                                      00000130
110. 120. 150. 30. 0. 0. 1                                             00000140
150. 150. 500. 30. 0. 0. 1                                             00000160
WATER                                                                  00000170
1 0.                                                                   00000180
4                                                                      00000190
0. 30.                                                                 00000200
30. 30.                                                                00000201
45. 45.                                                                00000202
130. 45.                                                               00000210
LIMITS                                                                 00000240
1 1                                                                    00000250
0. 0. 150. 0.                                                          00000260
CIRCL2                                                                 00000270
10 10                                                                  00000280
25. 35. 90. 110.                                                       00000290
10. 5. -10. -45.                                                       00000300

         1111111111222222222233333333334444444444555555555566666666667777777778
1234567890123456789012345678901234567890123456789012345678901234567890123456789
USING A PRE-ALLOCATED DATASET ON FORTRAN UNIT 98
THE DATASET SHOULD BE META.DATA
```

--SLOPE STABILITY ANALYSIS--
SIMPLIFIED JANBU METHOD OF SLICES
IRREGULAR FAILURE SURFACES

PROBLEM DESCRIPTION MOSES ASH BASIN NO. 1 FLOOD IMPACT - AVE STRENGTHS 00000020

BOUNDARY COORDINATES

3 TOP BOUNDARIES
4 TOTAL BOUNDARIES

BOUNDARY NO.	X-LEFT (FT)	Y-LEFT (FT)	X-RIGHT (FT)	Y-RIGHT (FT)	SOIL TYPE BELOW BND
1	0.0	30.00	30.00	30.00	1
2	30.00	30.00	100.00	60.00	1
3	100.00	60.00	130.00	60.00	1
4	0.0	0.0	80.00	0.0	2

ISOTROPIC SOIL PARAMETERS

2 TYPE(S) OF SOIL

SOIL TYPE NO.	TOTAL UNIT WT. (PCF)	SATURATED UNIT WT. (PCF)	COHESION INTERCEPT (PSF)	FRICTION ANGLE (DEG)	PORE PRESSURE PARAMETER	PRESSURE CONSTANT (PSF)	PIEZOMETRIC SURFACE NO.
1	110.0	120.0	150.0	30.0	0.0	0.0	1
2	150.0	150.0	600.0	30.0	0.0	0.0	1

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

UNITWEIGHT OF WATER = 62.40

PIEZOMETRIC SURFACE NO. 1 SPECIFIED BY 4 COORDINATE POINTS

POINT NO.	X-WATER (FT)	Y-WATER (FT)
1	0.0	30.00
2	30.00	30.00
3	65.00	45.00
4	130.00	45.00

SEARCHING ROUTINE WILL BE LIMITED TO AN AREA DEFINED BY 1 BOUNDARIES
OF WHICH THE FIRST 1 BOUNDARIES WILL DEFLECT SURFACES UPWARD

BOUNDARY NO.	X-LEFT (FT)	Y-LEFT (FT)	X-RIGHT (FT)	Y-RIGHT (FT)
1	0.0	0.0	130.00	0.0

```
A CRITICAL FAILURE SURFACE SEARCHING METHOD, USING A RANDOM
TECHNIQUE FOR GENERATING CIRCULAR SURFACES, HAS BEEN SPECIFIED.

100 TRIAL SURFACES HAVE BEEN GENERATED.

 10 SURFACES INITIATE FROM EACH OF 10 POINTS EQUALLY SPACED
ALONG THE GROUND SURFACE BETWEEN  X =  25.00 FT.
                             AND  X =  30.00 FT.

EACH SURFACE TERMINATES BETWEEN   X =  90.00 FT.
                            AND   X = 110.00 FT.

UNLESS FURTHER LIMITATIONS WERE IMPOSED, THE MINIMUM ELEVATION
AT WHICH A SURFACE EXTENDS IS  Y = 10.00 FT.

 5.00 FT. LINE SEGMENTS DEFINE EACH TRIAL FAILURE SURFACE.

RESTRICTIONS HAVE BEEN IMPOSED UPON THE ANGLE OF INITIATION.
THE ANGLE HAS BEEN RESTRICTED BETWEEN THE ANGLES OF -45.0 AND -10.0 DEG.
```

```
FOLLOWING ARE DISPLAYED THE TEN MOST CRITICAL OF THE TRIAL
FAILURE SURFACES EXAMINED.  THEY ARE ORDERED - MOST CRITICAL
FIRST.

SAFETY FACTORS ARE CALCULATED BY THE MODIFIED BISHOP METHOD.

FAILURE SURFACE SPECIFIED BY 17 COORDINATE POINTS

  POINT       X-SURF      Y-SURF
   NO.         (FT)        (FT)

    1          26.11       30.00
    2          30.93       28.67
    3          35.85       27.77
    4          40.83       27.31
    5          45.83       27.30
    6          50.81       27.73
    7          55.73       28.60
    8          60.56       29.91
    9          65.25       31.64
   10          69.77       33.77
   11          74.09       36.30
   12          78.16       39.21
   13          81.95       42.46
   14          85.45       46.04
   15          88.61       49.91
   16          91.41       54.05
   17          93.87       57.85

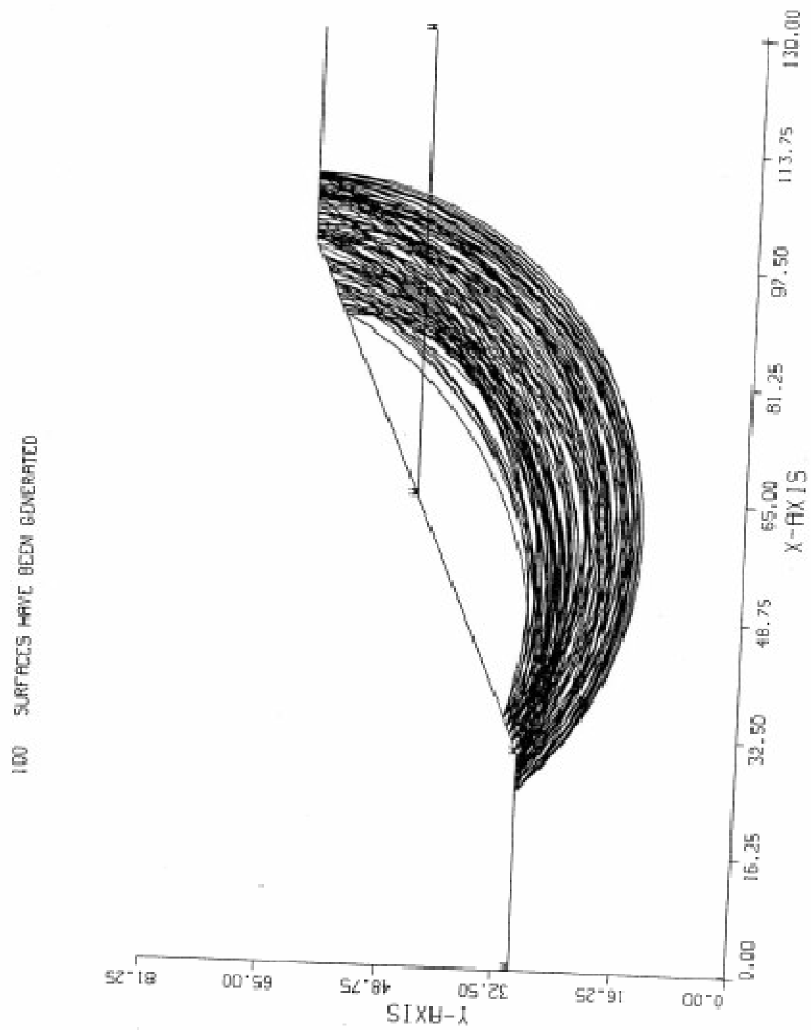
***            1.401 ***

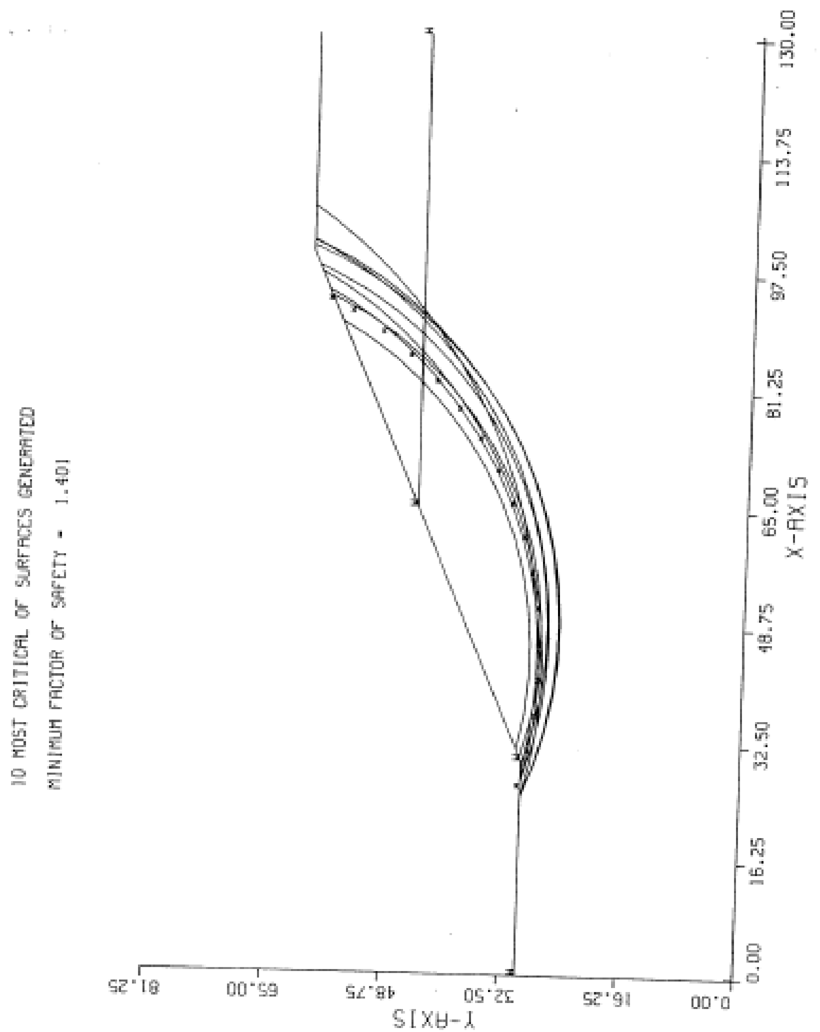
FAILURE SURFACE SPECIFIED BY 17 COORDINATE POINTS

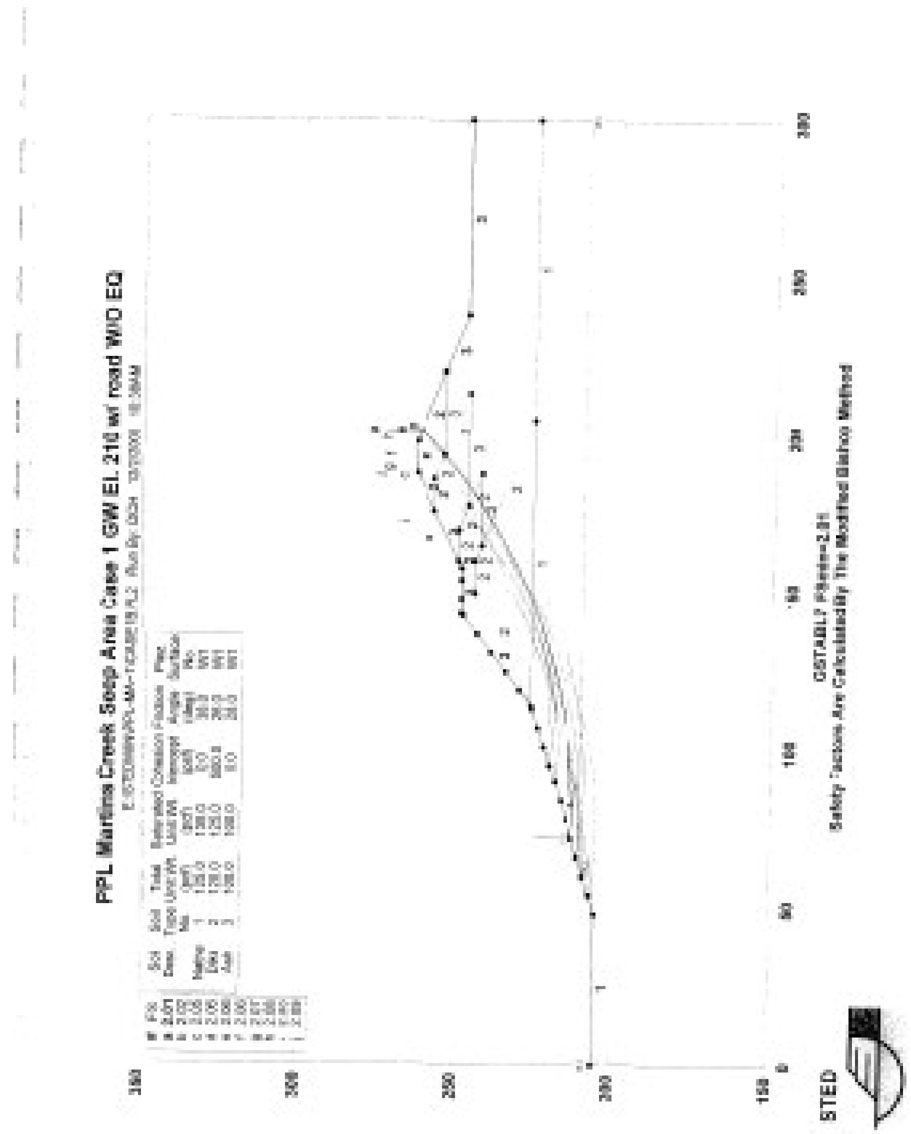
  POINT       X-SURF      Y-SURF
   NO.         (FT)        (FT)

    1          27.22       30.00
    2          32.09       28.87
    3          37.04       28.15
    4          42.03       27.86
    5          47.03       27.97
    6          52.00       28.51
    7          56.91       29.46
    8          61.72       30.82
    9          66.41       32.57
   10          70.92       34.71
   11          75.25       37.21
   12          79.34       40.09
   13          83.19       43.29
   14          86.75       46.80
   15          90.01       50.59
   16          92.93       54.64
   17          94.82       57.78

***            1.404 ***
```


100 SURFACES HAVE BEEN GENERATED
X-AXIS
0.00
16.25
32.50
48.75
65.00
81.25
97.50
113.75
130.00
Y-AXIS
0.00
16.25
32.50
48.75
65.00
81.25


10 MOST CRITICAL OF SURFACES GENERATED
MINIMUM FACTOR OF SAFETY = 1.401
X-AXIS
0.00
16.25
32.50
48.75
65.00
81.25
97.50
113.75
130.00
Y-AXIS
0.00
16.25
32.50
48.75
65.00
81.25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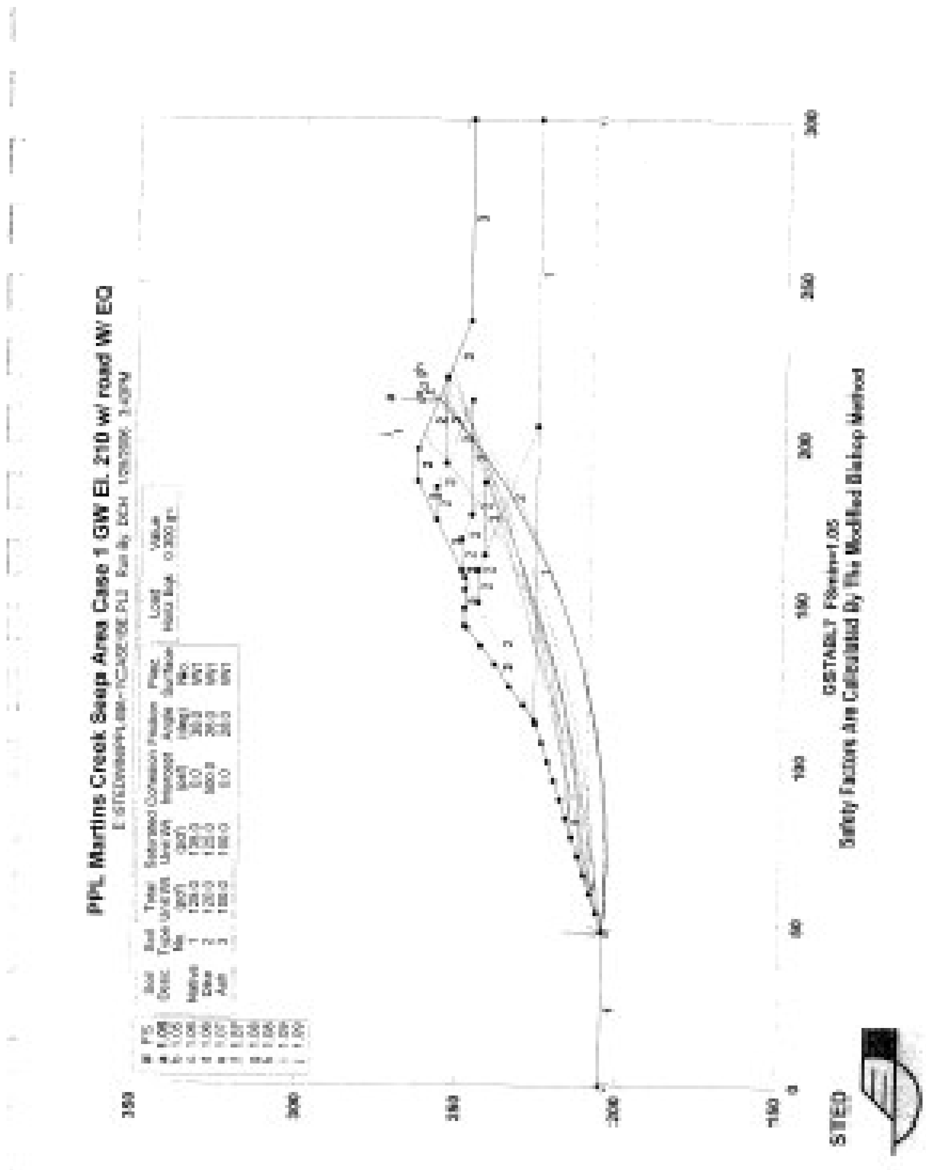
GSTABL7 FSmin=2.81
Safety Factors Are Calculated By The Modified Bishop Method
STED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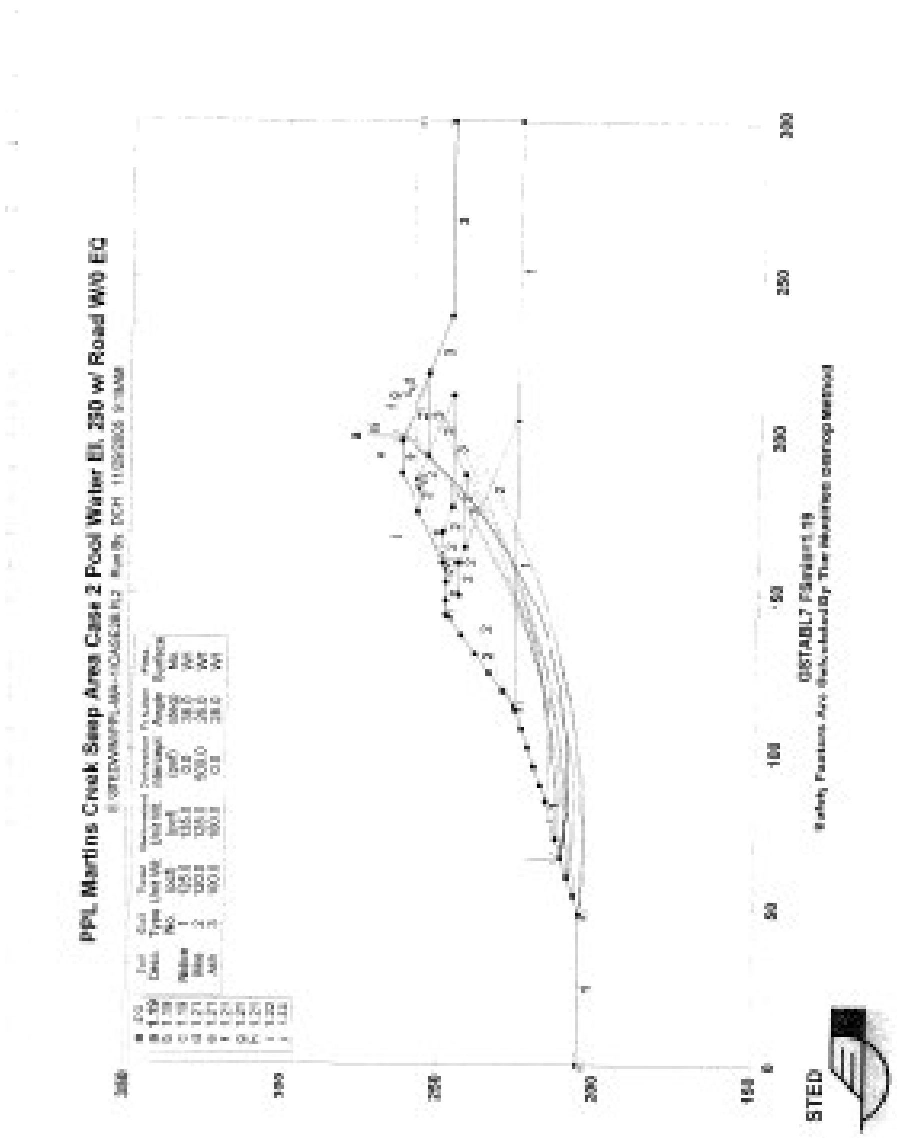
Safety Factors Are Calculated By The Modified Bishop Method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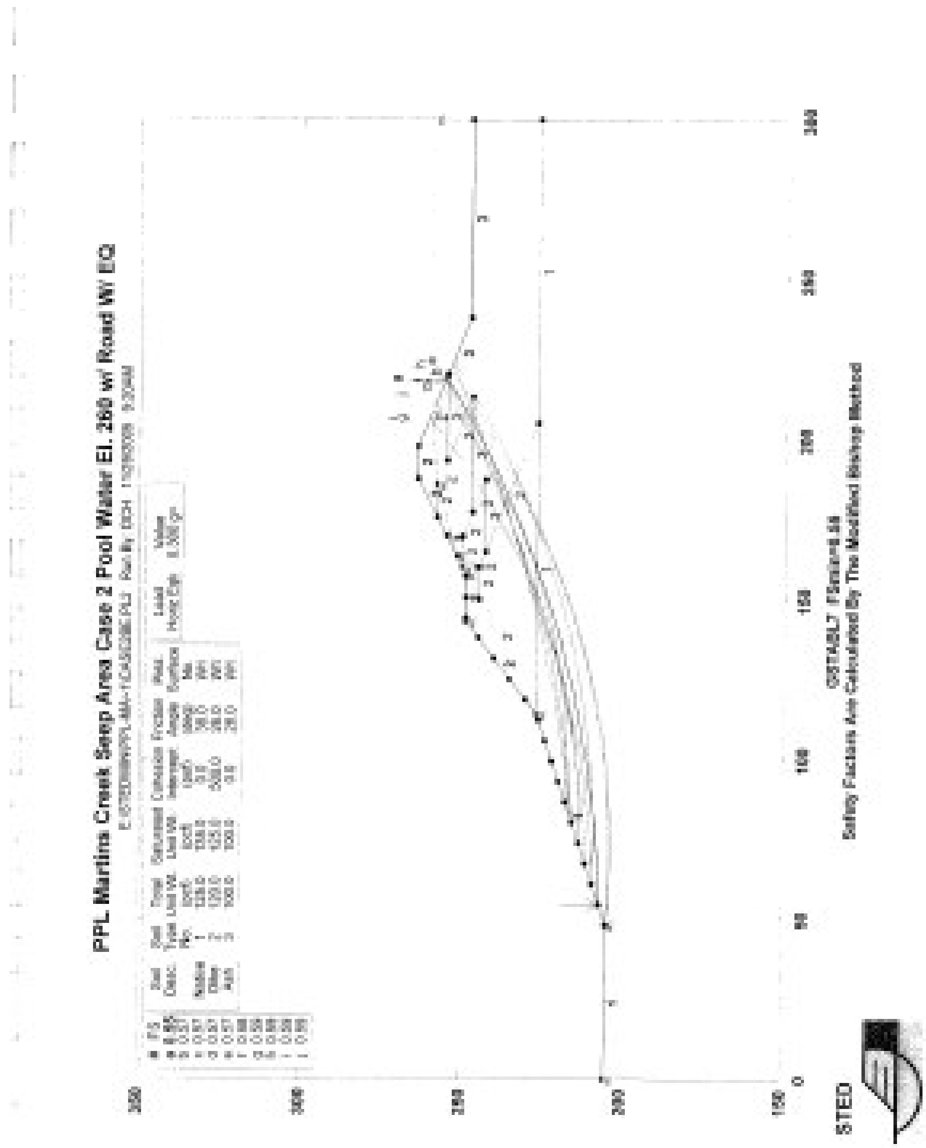
STED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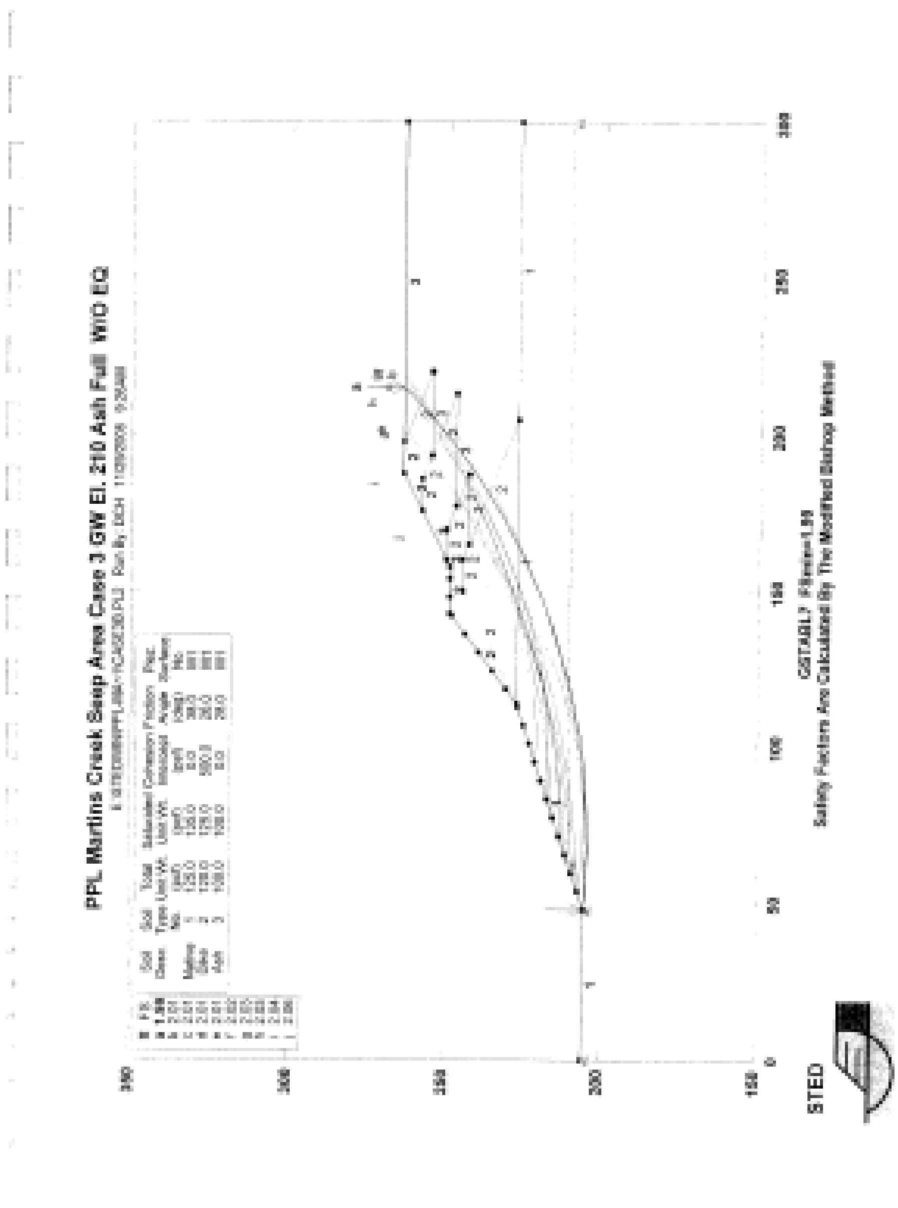
Safety Factors Are Calculated By The Modified Bishop Method
STED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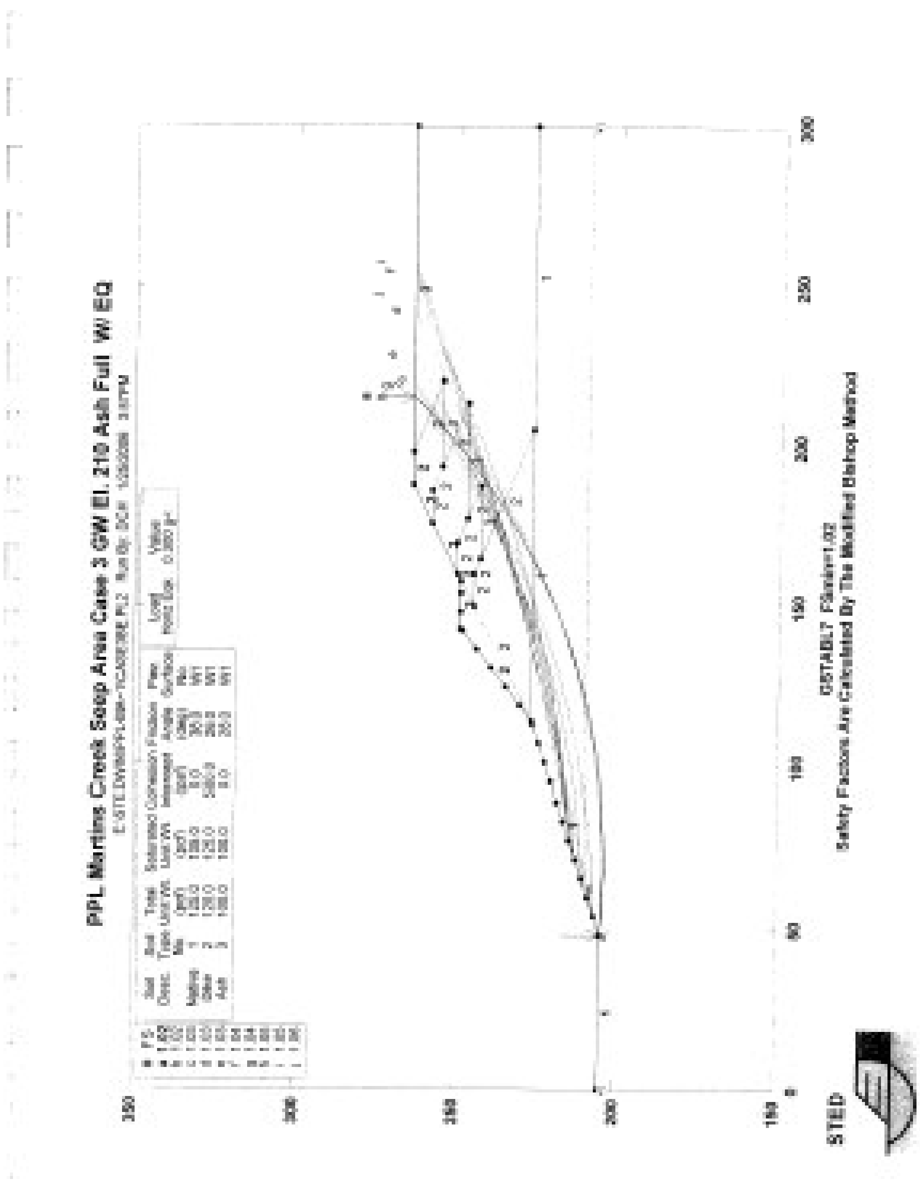
GSTABL7 FSmin=1.89
Safety Factors Are Calculated By The Modified Bishop Method
STED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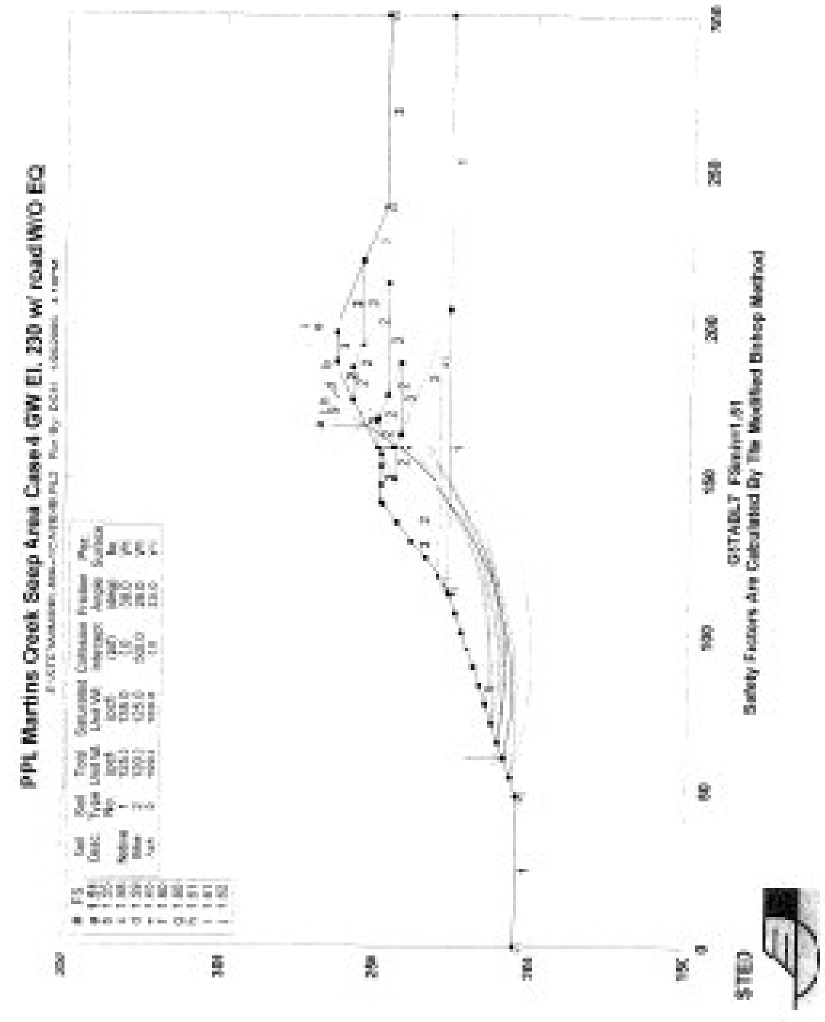
GSTABL7 FSmin=1.02
Safety Factors Are Calculated By The Modified Bishop Method
STED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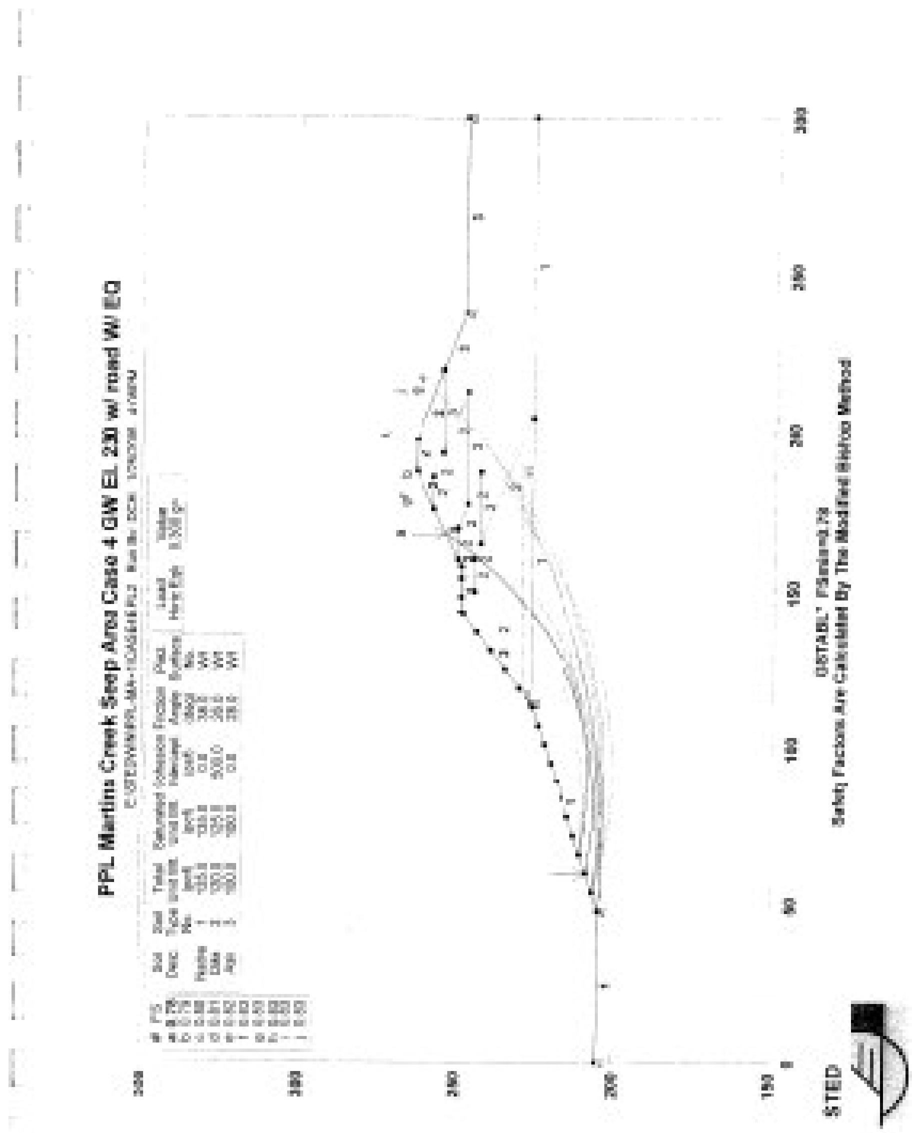
Safety Factors Are Calculated By The Modified Bishop Method


PPL Martins Creek Seep And Case 4 GW EL 230 w/ road W/ EQ
Safety Factors Are Calculated By The Modified Bishop Method

Appendix A

Test Boring Logs

Drilling Log

Shaw® Shaw Environmental & Infrastructure, Inc

Monitoring Well **PZ-1-10**

Page: 1 of 2

Project: Basin 1 Groundwater Assessment		Owner: PPL	
Location: Martins Creek		Proj. No. 117779-10000000	
Surface Elev.	Total Hole Depth: 36.0 ft	North	East
Top of Casing: NA	Water Level Initial: ∇ 26.0 ft	Static: NA	Diameter: 8 in.
Screen: Dia: 2 in.	Length: 10 ft	Type/Size: PVC/0.020 in.	
Casing: Dia: 2 in.	Length: 27 ft	Type: PVC	
Fill Material: Sand		Rig/Core	
Drill Co.: Eichelbergers		Method: Air Rotary / Stradex	
Driller: J. Trish	Log By: M. Tucker	Date: 9/15/05	Permit #: NA
Checked By: R. Wardrop		License No. PG000157G	

COMMENTS

Depth (ft.)	Well Completion	PID (ppm)	Sample ID % Recovery	Blow Count Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Geologic Descriptions are Based on the USCS
0–2.5						Fill	Reddish-brown, GRAVEL with Sand and Cobbles, dry
2.5–4						Fill	Grayish-brown, silty fine SAND, dry
4–16						Fill	Brown, silty fine SAND, dry
16–20						SW	Brown, fine to coarse SAND with fine Gravel, dry
20–25						GW	Brown, fine to coarse GRAVEL with Sand, dry; small boulder at 24 ft

Continued Next Page

Drilling Log

Shaw® Shaw Environmental & Infrastructure, Inc.

Monitoring Well **PZ-1-10**

Page: 2 of 2

Project: Basin 1 Groundwater Assessment Owner: PPL

Location: Martins Creek Proj. No. 117779-10000000

Depth (ft.)	Well Completion	PID (ppm)	Sample ID % Recovery	Blow Count Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Geologic Descriptions are Based on the USCS.
							Continued
26–35						GW	Brown, fine to coarse GRAVEL with Sand, wet
35–36						GP	Grayish-brown, coarse GRAVEL, wet

Depth scale: 26, 28, 30, 32, 34, 36, 38, 40, 42, 44, 46, 48, 50, 52, 54, 56, 58

SHAW ENVIRONMENTAL & INFRASTRUCTURE Rev. 7/17/03 PPL MARTINS CREEK.GPJ IT CORP.GDT 12/1/10

Shaw® Shaw Environmental & Infrastructure, Inc.

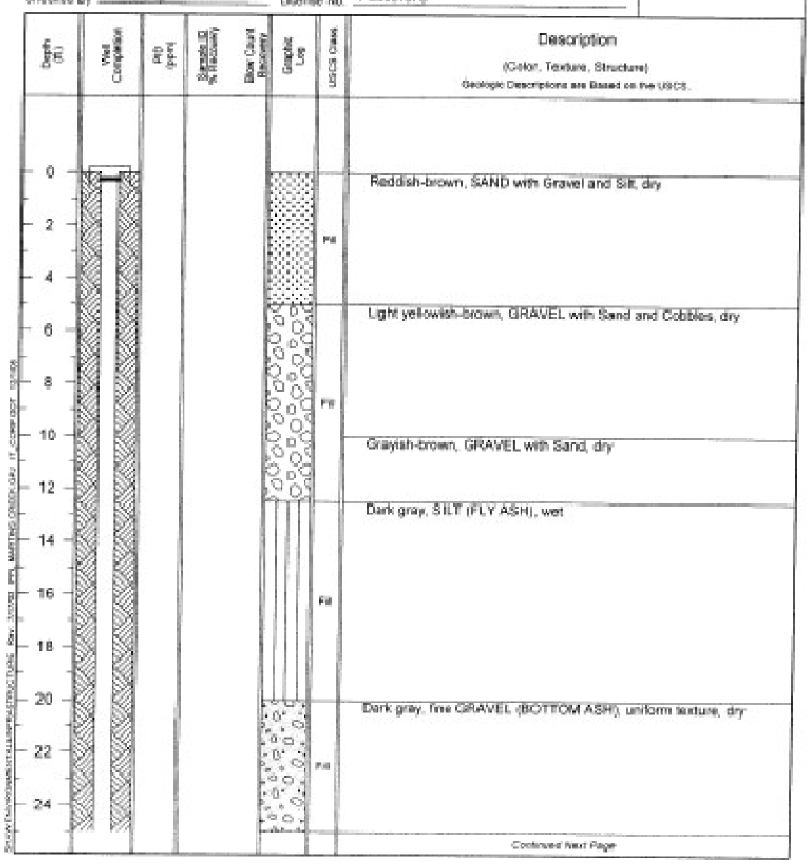
Drilling Log

Monitoring Well PZ-1-11

Page: 1 of 3

Project: Basin 1 Groundwater Assessment   Owner: PPL
Location: Martins Creek   Proj. No.: 117779-10000000
Surface Elev.: ____   Total Hole Depth: 82.0 ft.   North: ____   East: ____
Top of Casing: N/A   Water Level Initial: ▽ 55.4 ft.   Static: N/A   Diameter: 6 in.
Screen: Dia 2 in.   Length: 50 ft.   Type/Size: PVC/0.020 in.
Casing: Dia 2 in.   Length: 32 ft.   Type: PVC
Fill Material: Sand   Rig/Core: ____
Drill Co.: Eichelbergers   Method: Air Rotary / Stradex
Driller: J. Trish   Log By: M. Tucker   Date: 9/20/05   Permit #: N/A
Checked By: R. Wardrop   License No.: PG000157G

COMMENTS



Continued Next Page

Drilling Log

Shaw Environmental & Infrastructure, Inc

Monitoring Well **PZ-1-11**

Page: 2 of 3

Project: Basin 1 Groundwater Assessment Owner: PPL

Location: Martins Creek Proj. No. 117779-10000000

Depth (ft)	Well Completion	PID (ppm)	Sample ID % Recovery	Blow Count Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Geologic Descriptions are Based on the USCS.
26–36						FF	Continued Dark gray, SILT and black water, some fine gravel-size cinder-like material; FLYASH, some bottom ash
36–38							Dark gray, SILT with Shale chips
38–41						SP	Dark gray, coarse SAND
41–45						GW	Reddish-brown, GRAVEL with Sand
45–56						SP	Reddish-brown, fine SAND
56–59						GW	Reddish-gray, fine GRAVEL with Sand, wet

Depth scale: 26, 28, 30, 32, 34, 36, 38, 40, 42, 44, 46, 48, 50, 52, 54, 56, 58

Continued Next Page

Shaw Shaw Environmental & Infrastructure, Inc.

Drilling Log

Monitoring Well **PZ-1-11**

Page: 3 of 3

Project *Basin 1 Groundwater Assessment* Owner *PPL*

Location *Martins Creek* Proj. No. *117779-10000000*

Depth (Ft)	Well Completion	PID (ppm)	Sample ID % Recovery	Blow Count Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Geologic Descriptions are Based on the USCS.
							Continued
60						GW	
62						GP	Dark greenish-gray, coarse GRAVEL, clean, wet
64							
66							
68							
70							
72							
74							
76							
78							
80							
82							
84							
86							
88							
90							

SHAW ENVIRONMENTAL & INFRASTRUCTURE Rev. 7/11/03 PPL MARTINS CREEK.GPJ IT_CORP.GDT 12/1/03

Drilling Log

Shaw™ Shaw Environmental & Infrastructure, Inc.

Monitoring Well **PZ/TB 1-8**

Page: 1 of 2

Project	Basin 1 Geotechnical Assessment			Owner	PPL
Location	Martins Creek			Proj. No.	117779.2D
Surface Elev.		Total Hole Depth	45.0 ft.	North	
				East	
Top of Casing	NA	Water Level Initial	▽ 36.0 ft.	Static	NA
				Diameter	8.5 in.
Screen: Dia	2 in.	Length	10 ft.	Type/Size	PVC/0.010 in.
Casing: Dia	2 in.	Length	33 ft.	Type	PVC SCH 40
Fill Material	Sand			Rig/Core	
Drill Co.	Eichelbergers, Inc.	Method	HSA/SPT		
Driller	Will Deininger	Log By	M. Shaheen	Date	10/10/08
				Permit #	NA
Checked By	R. Wardrop	License No.	P000001570		

COMMENTS

Depth (ft.)	Well Completion	PID (ppm)	Sample ID % Recovery	Blow Count Recovery	Graphic Log	USCS Class	Description (Color, Texture, Structure) Geologic Descriptions are Based on the USCS.
0			70%	11 50			
2							
4							Moderate Brown SILTY SAND and Cobbles, moist, trace CLAY.
6			100%	23 50		GW GM	
8							
10			40%	5 31 50			
12			90%	5 13 13			Yellowish Brown SILTY Fine SAND, medium dense, moist.
14							
16			65%	11 23 50		SM	Moderate Brown SILTY Fine SAND and GRAVEL, very dense, moist.
18			0%	28 31 50			
20							

Continued Next Page

Drilling Log

Shaw Environmental & Infrastructure, Inc.

Monitoring Well **PZ/TB 1-8**

Page: 2 of 2

Project: Basin 1 Geotechnical Assessment
Owner: PPL
Location: Martins Creek
Proj. No. 117779.20

Depth (ft.)	Sample ID % Recovery	Blow Count Recovery	USCS Class.	Description (Color, Texture, Structure) Geologic Descriptions are Based on the USCS.
20				Continued
22	100%	11, 12, 14		Yellowish Brown SILTY Fine SAND, medium dense, moist.
24	100%	8, 9, 10		
28	100%	5, 5, 10	SM	
30	100%	3, 3, 6		Loose, moist.
34	100%	3, 2, 5		Yellowish Brown Fine SAND, little SILT, loose, moist.
36	100%	6, 11, 37		Wet.
40	5%	1, 3, 18	GW	Yellowish Brown SAND and GRAVEL, little SILT, medium dense, saturated.
46				Bottom of Boring at 45 Feet.

SHAW ENVIRONMENTAL&INFRASTRUCTURE Rev. 7/17/03 MARTINS CREEK.GPJ IT_CORP.GDT 12/2/05

Drilling Log

Shaw® Shaw Environmental & Infrastructure, Inc.

Monitoring Well **PZ/TB 1-17**

Page: 1 of 3

Project	Basin 1 Geotechnical Assessment	Owner	PPL		
Location	Martins Creek	Proj. No.	117779.20		
Surface Elev.		Total Hole Depth	62.0 ft.	North	
East		Top of Casing	NA	Water Level Initial	52.7 ft.
Static	NA	Diameter	8.5 in.	Screen: Dia	2 in.
Length	10 ft.	Type/Size	PVC/0.020 in.	Casing: Dia	2 in.
Length	50.5 ft.	Type	PVC SCH 40	Fill Material	Sand
Rig/Core		Drill Co.	Eichelbergers, Inc.	Method	HSA/SPT
Driller	Will Deininger	Log By	M. Shaheen	Date	10/28/08
Permit #	NA	Checked By	R. Wardrop	License No.	PG0001573

COMMENTS

Depth (ft.)	Sample ID % Recovery	USCS Class.	Description (Color, Texture, Structure) Geologic Descriptions are Based on the USCS.
0 – 2.5	100%, 90%	ML	Medium Dark Gray SILT (FLY ASH), very loose, little Organic Material, wood chips, moist.
2.5 – 8.5	55%, 55%, 65%, 65%	SM	Grayish Brown Wood Mulch and SILTY Fine SAND, dry to moist.
8.5 – 18	55%, 45%, 45%, 50%, 20%, 5%	GM	Pale Brown SILT and FMC GRAVEL, medium dense, dry to moist.
18 – 19.5	100%	ML	Medium Gray SILT (FLY ASH), medium dense, wet to moist.
19.5 – 20		SM/ML	Moderate Brown SILTY FM SAND, dense, moist to very moist.

Blow Count: 1, 9, 9, 0, 4, 5, 3, 4, 7, 2, 3, 8, 2, 3, 4, 1, 2, 12, 5, 4, 5, 3, 7, 10, 8, 3, 4, 2, 4, 7, 8, 5, 7, 4, 3, 4, 7, 9, 24, 5

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Drilling Log

Shaw® Shaw Environmental & Infrastructure, Inc.

Monitoring Well **PZ/TB 1-17**

Page: 2 of 3

Project: *Basin 1 Geotechnical Assessment* Owner: *PPL*

Location: *Martins Creek* Proj. No. *117779.20*

Depth (ft)	Well Completion	PID (ppm)	Sample ID % Recovery	Blow Count Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Geologic Descriptions are Based on the USCS.
							Continued
20			100%	18, 20, 5		SP	Brownish Gray SILT, trace Fine GRAVEL, very moist. Medium Dark Gray SILT (FLY ASH) to Brownish Gray Fine SAND, little course SAND, moist.
22			70%	5, 8, 3		SW	Moderate Brown to Brownish Balck FM SAND (BOTTOM ASH), moist, loose.
24			90%	3, 6, 3			
			100%	4, 4, 2		ML	Dark Gray SILT to Very Fine SAND (FLY ASH), loose, moist.
26			100%	3, 5, 2			
28			100%	3, 4, 1			
			80%	1, 3, 1			Brownish Gray SILT (FLY ASH), loose, moist.
30			100%	2, 6, 1			
32			95%	2, 6, 2		SW	Brownish Gray to Medium Dark Gray To Brownish Black SILT to Very Fine SAND to FM SAND, little Fine GRAVEL, moist, very loose.
34			100%	2, 4, 3			Brownish Gray to Dark Gray SILT, some very fine SAND, very loose, moist.
36			100%	2, 3, 2			
			100%	2, 4, 5			
38			95%	3, 6, 1		ML	Dark Gray SILT (FLY ASH).
40			100%	3, 4			Wet to moist, very loose.
42			100%	2, 2, 12			
44						SM	Moderate Brown SILTY Fine SAND, medium dense, moist.
46			95%	5, 7, 16			

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Shaw Environmental & Infrastructure, Inc.

Drilling Log

Monitoring Well **PZ/TB 1-17**

Page: 3 of 3

Project: *Basin 1 Geotechnical Assessment* Owner: *PPL*

Location: *Martins Creek* Proj. No. *117779.20*

Depth (ft.)	Well Completion	PID (ppm)	Sample ID % Recovery	Blow Count Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Geologic Descriptions are Based on the USCS.
							Continued
48						SM	
50				9			
			65%	20			
				10			
52							Moderate Brown FMC SAND and Coarse rounded GRAVEL, dense, moist.
54							
				12			
56			38%	12		GW	Yellowish Brown FMC GRAVEL and SAND, medium dense, saturated.
				8			
58							
60							
62							
							Auger Refusal on boulder at 62 Feet.
64							
66							
68							
70							
72							

SHAW ENVIRONMENTAL AND INFRASTRUCTURE_Env 7/17/03 MARTINS CREEK.GPJ IT_CORP.GDT 12/3/05

Drilling Log

Shaw® Shaw Environmental & Infrastructure, Inc.

Soil Boring TB 1-1
Page: 1 of 2

Project: Basin 1 Geotechnical Assessment		Owner: PPL	
Location: Martins Creek		Proj. No.: 117779.30	
Surface Elev.:	Total Hole Depth: 19.8 ft	North:	East:
Top of Casing: NA	Water Level Initial: NA	Static: NA	Diameter: 8.5 in.
Screen: Dia: NA	Length: NA	Type/Size: NA	
Casing: Dia: NA	Length: NA	Type: NA	
Fill Material: Sand		Rig/Core:	
Drill Co.: Eichelbergers, Inc.	Method: HSA/SPT		
Driller: Will Dewinger	Log By: M. Shaheen	Date: 10/17/05	Permit #: NA
Checked By: R. Wardrop	License No.: PG000157G		

COMMENTS

Depth (ft)	PID (ppm)	Sample ID % Recovery	Blow Count Recovery	Graphic Log	USCS Class	Description (Color, Texture, Structure) Geologic Descriptions are Based on the USCS
0 – 7.5		5%, 45%, 80%, 100%, 70%			GW GM	Light Brown CLAYEY SILT with GRAVEL and COBBLES, some sand. Medium – Dense, moist.
7.5 – 9.5		85%			SP	Moderate Brown Fine SAND, Medium - Dense, moist.
9.5 – 18		100%, 70%, 60%, 55%, 60%, 50%			SW	Blackish Red Fine to Medium SAND, little Fine to Medium GRAVEL, Dense, dry to moist.
18 – 20		50%			ML	Dark Gray SILT (FLY ASH), Loose, moist.

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Drilling Log

Shaw® Shaw Environmental & Infrastructure, Inc.

Soil Boring **TB 1-1**

Page: 2 of 2

Project: *Basin 1 Geotechnical Assessment* Owner: *PPL*

Location: *Martins Creek* Proj. No. *117779.20*

Depth (ft)	USCS Class.	Description (Color, Texture, Structure) Geologic Descriptions are Based on the USCS.
		Continued
20	SW	Bottom ASH
	ML	Dark Gray SILT (FLY ASH), Loose, moist.
22–40	SW	Medium to Dark Gray Medium to Coarse SAND (BOTTOM ASH), little Fine to Medium GRAVEL, dry to moist.
		Wet from 36.5' to 37'.
	ML	Moderate Brown SILT, some CLAY, moist.
42	SM	Moderate Brown SILTY Fine SAND, wet.
	GW	Yellowish Brown Fine to Medium SAND and Cobble, Greenish Gray Medium to Course rounded GRAVEL, dry to moist.
46		Bottom of Boring at 45 Feet.

Drilling Log

Shaw® Shaw Environmental & Infrastructure, Inc

Monitoring Well **TB 1-2**

Page: 1 of 3

Project: *Basin 1 Geotechnical Assessment* Owner: *PPL*
Location: *Martins Creek* Proj. No.: *117779.20*
Surface Elev.: ____ Total Hole Depth: *53.0 ft.* North: ____ East: ____
Top of Casing: *NA* Water Level Initial: ∇ *52.9 ft.* Static: *NA* Diameter: *8.5 in.*
Screen: Dia: *2 in.* Length: *10 ft.* Type/Size: *PVC/0.020 in.*
Casing: Dia: *2 in.* Length: *51 ft.* Type: *PVC SCH 40*
Fill Material: *Sand* Rig/Core: ____
Drill Co.: *Eichelbergers, Inc.* Method: ____
Driller: *Wil Deininger* Log By: *M. Shaheen* Date: *10/19/05* Permit #: *NA*
Checked By: ____ License No.: ____

COMMENTS

Depth (ft.)	Well Completion	PID (ppm)	Sample ID % Recovery	Blow Count Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Geologic Descriptions are Based on the USCS.
0				14			Brownish Black SILT (FLY ASH).
			66%	17			
				28			
2				17			
			90%	12			
				30			
				18			
4			35%	35			
				50			
				9			
			55%	35			Yellow Brown CLAYEY SILT. Some Fine SAND and GRAVEL/COBBLES, moist and very dense.
6				53			
				30			
			100%	39			
				50			
				13			
8			45%	10		GW GM	
				20			
				13			
10			45%	15			
				57			
				12			
			45%	32			
12				50			
				11			
			45%	24			
				50			
14				8			
			65%	23			
				50			
				41			
16			60%	39			
				53			
				25			
			65%	12			
18				18			
				12		SW	
			90%	8			Brownish Black FMC SAND (BOTTOM ASH), little FMC GRAVEL, medium dense, dry.
				7			
20				3			

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SHAW ENVIRONMENTAL&INFRASTRUCTURE Rev. 7/17/03 MARTINS CREEK.GPJ IT_CORP.GDT 12/1/05

Drilling Log

Shaw Shaw Environmental & Infrastructure, Inc.

Monitoring Well **TB 1-2**

Page: 2 of 3

Project: Basin 1 Geotechnical Assessment Owner: PPL

Location: Martins Creek Proj. No. 117779.20

Depth (Ft.)	Sample ID % Recovery	USCS Class	Description (Color, Texture, Structure) Geologic Descriptions are Based on the USCS.
20			Continued
	80%		
22	95%	SW	
	70%		
24	58%		
			Medium Gray SILT (FLY ASH), very loose, moist.
26	100%		
28	100%		Dark Gray to Medium Gray SILT (FLY ASH) to very fine SAND, moist to wet, trace to little M/C SAND, loose.
	100%		
30	80%	ML	
32	100%		
34	80%		
	100%		Dark Gray SILT (FLY ASH), very loose, very wet.
36	80%		
38	100%	SP	Fine to Medium SAND, moist.
40	40%	ML	Dark Gray SILT (FLY ASH), very loose, wet.
	100%		
42	100%	SW	FMC SAND, wet.
44	100%		
46	75%	GW	Moderate Brown FMC SAND and GRAVEL, dense, moist

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Drilling Log

Shaw Environmental & Infrastructure, Inc.

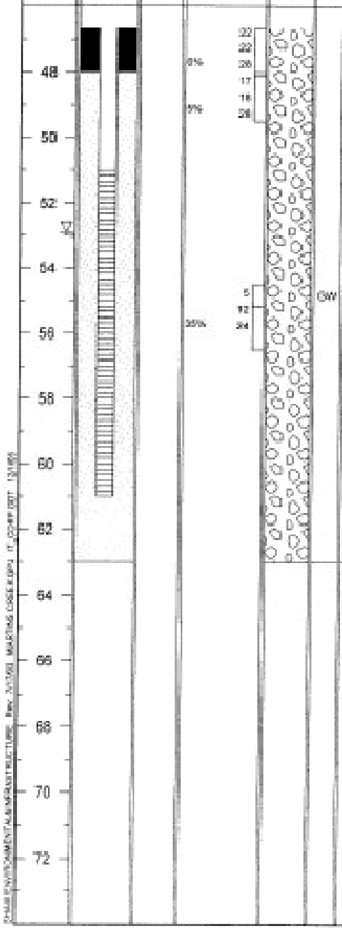
Monitoring Well **TB 1-2**

Page: 3 of 3

Project: Basin 1 Geotechnical Assessment   Owner: PPL

Location: Martins Creek   Proj. No. 117779.20

Depth (ft)	Well Completion	PID (ppm)	Sample ID % Recovery	Blow Count Recovery	Graphic Log	USCS Class	Description (Color, Texture, Structure) Geologic Descriptions are Based on the USCS
							Continued



Dark Yellowish Brown Coarse SAND and GRAVEL, some FM SAND and GRAVEL, dense, saturated

Bottom of Boring at 63 Feet.

Drilling Log

Shaw™ Shaw Environmental & Infrastructure, Inc.

Monitoring Well TB 1-3

Page: 1 of 2

Project	Basin 1 Geotechnical Assessment	Owner	PPL		
Location	Martins Creek			Proj. No.	117779.20
Surface Elev.		Total Hole Depth	45.0 ft.	North	East
Top of Casing	NA	Water Level Initial	Dry	Static NA	Diameter 8.5 in.
Screen: Dia	2 in.	Length	10 ft.	Type/Size	PVC/0.010 in.
Casing: Dia	2 in.	Length	25 ft.	Type	PVC SCH 40
Fill Material	Sand			Rig/Core	
Drill Co.	Eichelbergers, Inc.	Method	HSA/SPT		
Driller	Will Deitsinger	Log By	M. Shaheen	Date 10/24/05	Permit # NA
Checked By	R. Wardrop	License No.	PG000157G		

COMMENTS

Depth (ft.)	Sample ID % Recovery	USCS Class.	Description (Color, Texture, Structure) Geologic Descriptions are Based on the USCS.
0	80%	SM	Brownish Black SILTY FMC SAND (FLY ASH), loose, moist.
2	45%		Moderate Brown to Yellowish Brown CLAYEY SILT, some FMC GRAVEL and SAND, medium dense, moist.
4	55%		
6	90%		
8	100% / 80%	GM	Yellowish Brown Coarse GRAVEL and SILT, very dense, dry to moist.
10	95%		
12	0%		
14	10%		
16	100%		Yellowish Brown to Grayish Brown SILTY Fine SAND and FMC GRAVEL, very dense, moist.
18	65% / 70%	SW	
20			

Blow Count Recovery: 1, 2, 4, 4, 5, 6, 8, 10, 16, 4, 8, 24, 28, 32, 40, 2, 21, 5, 15, 47, 50, 33, 50, 7, 58, 14, 28, 41, 15, 24, 23, 18, 18, 13, 9

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SHAW ENVIRONMENTAL&INFRASTRUCTURE, Rev. 01/09 MARTINS CREEK.GPJ IT_CORP.GDT 12/2/05

Drilling Log

Shaw® Shaw Environmental & Infrastructure, Inc.

Monitoring Well **TB 1-3**

Page: 2 of 2

Project: Basin 1 Geotechnical Assessment Owner: PPL

Location: Martins Creek Proj. No. 117779.20

Depth (ft)	Well Completion	PID (ppm)	Sample ID % Recovery	Blow Count Recovery	Graphic Log	USCS Class	Description (Color, Texture, Structure) Geologic Descriptions are Based on the USCS.

Continued

Depth (ft)	% Recovery
20–22	80%
22–24	70%
24–26	35%
26–28	80%
28–30	55%
30–32	80%
32–34	80%
34–36	100%
36–38	100%
38–40	100%
40–42	100%
42–44	40%
44–46	100%
46–48	55%
48–50	45%
50–52	30%
52–54	45%

USCS Class	Description
SW	Brownish Black FMC SAND (BOTTOM ASH) with little FM GRAVEL, medium dense, moist
ML	Brownish Gray SILT (FLY ASH), very loose, very wet to moist
SW	Blackish Brown FMC SAND (BOTTOM ASH) little Fine (Cinder) GRAVEL, moist
ML	Medium Dark Gray SILT (FLY ASH), loose, wet to moist
ML	SAA, Very Wet
GW	Yellowish Brown to Yellow SILTY Fine SAND, little CLAY, wet to moist
GW	Grayish Red and White Coarse GRAVEL and Yellowish Brown FMC SAND, very dense, moist
	Bottom of Boring at 45 Feet

Depth scale (ft): 20, 22, 24, 26, 28, 30, 32, 34, 36, 38, 40, 42, 44, 46

Drilling Log

Shaw® Shaw Environmental & Infrastructure, Inc.

Soil Boring **TB 1-3I**

Page: 1 of 2

Project: Basin 1 Geotechnical Assessment		Owner: PPL	
Location: Martins Creek		Proj. No.: 117779.30	
Surface Elev.:	Total Hole Depth: 49.3 ft	North:	East:
Top of Casing: NA	Water Level Initial: NA	Static: NA	Diameter: 8.5 in.
Screen: Dia: NA	Length: NA	Type/Size: NA	
Casing: Dia: NA	Length: NA	Type: NA	
Fill Material: Sand		Rig/Core:	
Drill Co.: Eichelbergers, Inc.	Method: HSA/SPT		
Driller: Will Deininger	Log By: M. Shaheen	Date: 10/20/08	Permit #: NA
Checked By: R. Wardrop	License No.: PG000157G		

COMMENTS

Depth (ft.)	PID (ppm)	Sample ID % Recovery	Blow Count Recovery	USCS Class.	Description (Color, Texture, Structure) Geologic Descriptions are Based on the USCS.
0		40%	1, 0, 0, 2, 3	SW	Brownish Gray FMC SAND (BOTTOM ASH), very loose, moist.
2		85%	5, 6, 5, 7		Light Brown SILTY CLAY.
4		80%	11, 10, 13, 26		Yellowish Brown CLAYEY SILT and FMC GRAVEL, some FMC SAND, medium dense, moist.
6		35%	12, 10, 13, 6	GM	
8		45% 0%	6, 7, 4		
10		0%	13, 21, 4, 19		Moderate Brown CLAYEY SILT and FM GRAVEL, moist.
12		85% 80%	20, 8, 6, 7		Brownish Black FMC SAND (BOTTOM ASH), medium dense, moist, trace cinders.
14		75%	5, 6, 7, 2		
16		60%	3, 4, 4, 5		
18		60% 100%	4, 4, 5, 5	SW	Blackish Brown FMC SAND (BOTTOM ASH), loose, moist, trace Fine GRAVEL.
20		65%	6, 7, 12, 5		
22		70% 80%	5, 6, 5, 3		
24		10%	4, 1, 1, 1	ML	Dark Gray SILT (FLY ASH), wet.

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Drilling Log

Shaw® Shaw Environmental & Infrastructure, Inc.

Soil Boring **TB 1-3I**
Page: 2 of 2

Project: Basin 1 Geotechnical Assessment
Owner: PPL
Location: Martins Creek
Proj. No.: 117779.20

Depth (ft)	PID (ppm)	Sample ID % Recovery	Blow Count Recovery	Graphic Log	USCS Class	Description (Color, Texture, Structure) Geologic Descriptions are Based on the USCS
						Continued
					ML	
26		90%			SW	Brownish Black FMC SAND (BOTTOM ASH), little Fine Cinder GRAVEL, moist.
28		100%				
30		96%				Light Gray to Medium Gray SILT (FLY ASH) to Very Fine SAND, very loose, moist.
		65%				
32		78%				Very wet.
34		70%				Medium Dark Gray Very Fine SAND and SILT (FLY ASH), very loose, moist.
		10%			ML	
36		45%				Light Gray to Brownish Gray SILT (FLY ASH), moist to wet in zones.
38		100%				
40		55%				Medium Dark Gray SILT and Very Fine SAND (FLY ASH), very loose, wet to moist.
		95%				
42		85%				Brownish Black FMC SAND (BOTTOM ASH)
44		80%			SW	Brownish Black FMC SAND (BOTTOM ASH), trace Red Cinders, moist to very moist, loose, few 0.1" thick SILT layers.
46		100%			ML	Medium to Dark Gray SILT (FLY ASH), very loose, very wet.
		1.5%			SW	Moderate Brown, SILTY MC SAND, little Fine SAND and FM GRAVEL, moist.
48		58%	13, 35, 50		GW	Coarse GRAVEL, some FM GRAVEL and FMC SAND, dry to moist.
50						
52						Bottom of Boring at 49.5 Feet.
54						
56						
58						

Drilling Log

Shaw Environmental & Infrastructure, Inc.

Soil Boring TB 1-4
Page: 1 of 2

Project	Basin 1 Geotechnical Assessment	Owner	PPL		
Location	Martins Creek			Proj. No.	117779.20
Surface Elev.		Total Hole Depth	49.0 ft.	North	East
Top of Casing	NA	Water Level Initial	NA	Static: NA	Diameter: 8.5 in.
Screen: Dia	NA	Length	NA	Type/Size	NA
Casing: Dia	NA	Length	NA	Type	NA
Fill Material	Sand			Rig/Core	
Drill Co.	Eichelbergers, Inc.	Method	HSA/SPT		
Driller	Will Deininger	Log By	M. Shaheen	Date: 10/20/05	Permit #: NA
Checked By	R. Wardrop	License No.	PG000157G		

COMMENTS

Depth (ft.)	PID (ppm)	Sample ID % Recovery	USCS Class	Description (Color, Texture, Structure) Geologic Descriptions are Based on the USCS
0		100%	SM	
2		100%	SM	Yellowish Brown CLAYEY SILT, some FMC GRAVEL and SAND, very dense, moist.
4		100%	SM	
6		90%	SM	
8		80% / 100%	SM	Grayish Brown SANDY SILT and FM rounded GRAVEL, moist.
10		40%	SM	
12		50% / 50%	SM	Moderate Brown SILTY SAND and Light Gray Coarse GRAVEL, dense, moist.
14		80%	SM	
16		100%	SM	Yellowish Brown SILT and GRAVEL, some SAND, very dense, moist.
18		10% / 10%	SM	
20		58%	SW	
22		85%	SW	Blackish Red FMC SAND (BOTTOM ASH), little FM GRAVEL, medium dense, moist.
24		55% / 50%	SW	Dark Gray FMC SAND (BOTTOM ASH), little FM GRAVEL cinders, moist, loose.

Blow Count Recovery (top to bottom): 19, 33, 52, 26, 36, 52, 18, 32, 32, 11, 22, 50, 42, 42, 50, 7, 16, 17, 12, 18, 12, 15, 19, 37, 24, 30, 22, 12, 14, 19, 7, 19, 42, 16, 16, 23, 15, 13, 17, 6, 7, 8, 4, 5, 7, 3, 3, 5, 3, 4

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Shaw® Shaw Environmental & Infrastructure, Inc.

Drilling Log

Soil Boring **TB 1-4**

Page: 2 of 2

Project: *Basin 1 Geotechnical Assessment* Owner: *PPL*

Location: *Martins Creek* Proj. No.: *117779.20*

Depth (ft)	PID (ppm)	Sample ID % Recovery	Blow Count Recovery	Graphic Log	USCS Class	Description (Color, Texture, Structure) Geologic Descriptions are Based on the USCS.
						Continued
26		100%	4, 1, 3, 6		ML	Dark Gray SILT (FLY ASH), loose, moist.
					SP	Fine SAND, moist.
			9		SW	Medium Gray FMC SAND, trace Fine GRAVEL.
28		85%	3, 2, 2, 2		SP	Medium to Light Gray Fine SAND (FLY ASH), moist.
30		90%	2, 2, 1, 1			Medium to Light Gray SILT (FLY ASH), wet, very loose.
32		80%	4, 2, 2, 5			Brownish Gray Very Fine SAND (FLY ASH), moist.
34		85%	2, 3, 5, 1			
36		100%	7, 3, 1, 1		ML	Medium to Dark Gray SILT (FLY ASH), very loose, wet to very wet, a couple of Fine SANDY Layers.
38		100%	1, 1, 1, 1			
		100%	1, 1, 0, 1			
40		20%	0, 0, 1, 1			
42		100%	1, 2, 4, 3			Dark Yellowish Brown CLAY, very soft.
		100%				
44		55%	8		SM	Moderate Brown SILTY Fine SAND.
46		45%	27, 12, 21, 27, 13		GW	Moderate Brown to Yellowish Brown FM SAND and FM rounded GRAVEL, dense, moist.
48		60%	7, 11		SP	Moderate Brown Medium Sand, medium to dense, well sorted, moist.
50						Bottom of Boring at 48 Feet.
52						
54						
56						
58						

Drilling Log

Shaw® Shaw Environmental & Infrastructure, Inc.

Monitoring Well **TB 1-5**

Page: 1 of 2

Project	Basin 1 Geotechnical Assessment	Owner	PPL		
Location	Martins Creek	Proj. No.	117779.20		
Surface Elev.		Total Hole Depth	53.0 ft.	North	
East					
Top of Casing	NA	Water Level Initial	Dry	Static	NA
Diameter	8.5 in.				
Screen: Dia	2 in.	Length	7 ft.	Type/Size	PVC/0.010 in.
Casing: Dia	2 in.	Length	17.5 ft.	Type	PVC SCH 40
Fill Material	Sand	Rig/Core			
Drill Co.	Eichelbergers, Inc.	Method	HSA/SPT		
Driller	Will Deininger	Log By	M. Shaheen	Date	10/4/05
Permit #	NA				
Checked By	R. Wardrop	License No.	PG000157G		

COMMENTS:

Depth (ft.)	Well Completion	PID (ppm)	Sample ID % Recovery	Blow Count Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Geologic Descriptions are Based on the USCS.
0							
2							
4			100%	7 13 19		GM	Dark Gray SILT (FLY ASH), little FMC rounded GRAVEL, trace SAND, dry, moist.
6			100%	4 5 9			Dark Gray SILT (FLY ASH) moist, medium dense, a small interval of CLAYEY SILT.
8							
10			35%	1 1 1			
12			100%	1 1 1		ML	Brownish Gray SILT (FLY ASH), very loose, saturated.
14							
16			100%	1 1 1			
18			100%	11 23 17			
20						GW	Moderate Brown FMC SAND, and FMC rounded GRAVEL, dense, moist.
22			100%	4 6 10			
24			35%	7 7		ML	Dark Gray SILT (FLY ASH), medium dense, moist to wet.

Continued Next Page

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Drilling Log

Monitoring Well **TB 1-5**

Page: 2 of 2

Project: *Basin 1 Geotechnical Assessment* Owner: *PPL*

Location: *Martins Creek* Proj. No. *117779.20*

Depth (ft.)	Well Completion	PID (ppm)	Sample ID % Recovery	Blow Count Recovery	Graphic Log	USCS Class	Description (Color, Texture, Structure) Geologic Descriptions are Based on the USCS.
							Continued
26				7			
28			100%	3 4 5			
30			100%	3 3 4			
32							
34			100%	1 2 5		ML	
36			80%	1 1 5			Brownish Black SILT (FLY ASH), loose, moist to wet, some FM SAND.
38							
40			100%	1 2 6			
42			100%	2 15 50			
44							
46			38%	9 7 9			Moderate Brown to Green Medium SAND and Course GRAVEL, very dense, moist.
48						GW	
50							
52			0%	15 13 22			Moderate Brown FMC SAND and FC GRAVEL, some SILT, dry to moist.
			38%	50 33 50			
54							Bottom of Boring at 52.6 Feet.
56							
58							

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Drilling Log

Shaw® Shaw Environmental & Infrastructure, Inc.

Soil Boring **TB 1-6**

Page: 1 of 2

Project	Basin 1 Geotechnical Assessment	Owner	PPL		
Location	Martins Creek			Proj. No.	117779.20
Surface Elev.		Total Hole Depth	20.5 ft	North	
East					
Top of Casing	NA	Water Level Initial	NA	Static	NA
Diameter	8.5 in.				
Screen: Dia	NA	Length	NA	Type/Size	NA
Casing: Dia	NA	Length	NA	Type	NA
Fill Material	Sand	Rig/Core			
Drill Co.	Eichelbergers, Inc.	Method	HSA/SPT		
Driller	Will Deininger	Log By	M. Shaheen	Date	10/6/05
Permit #	NA				
Checked By	R. Wardrop	License No.	PG000157G		

COMMENTS

Depth (ft.)	PID (ppm)	Sample ID % Recovery	Blow Count Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Geologic Descriptions are Based on the USCS.
0		85%	4, 54, 13			FMC rounded GRAVEL and Yellowish Brown SILT, some FMC SAND, dry to moist, medium dense.
2						FMC rounded GRAVEL and Yellowish Brown SILT, some FMC SAND, dry to moist, medium dense.
4						Cobbles
6		5%	20, 50		GM	FMC rounded GRAVEL and Yellowish Brown SILT, some FMC SAND, dry to moist, medium dense.
8						
10		100%	6, 12, 32			Dark Gray SHALE.
12		75%	9, 12, 14			
14					ML	

Continued Next Page

SHAW ENVIRONMENTAL & INFRASTRUCTURE Rev. 3/17/03 MARTINS CREEK.GPJ IT_CORP.GDT 12/2/05

Drilling Log

Shaw Environmental & Infrastructure, Inc.

Soil Boring **TB 1-6**
Page: 2 of 2

Project: Basin 1 Geotechnical Assessment   Owner: PPL
Location: Martins Creek   Proj. No. 117779.20

Depth (ft)	PID (ppm)	Sample ID % Recovery	Blow Count Recovery	Graphic Log	USCS Class	Description (Color, Texture, Structure) Geologic Descriptions are Based on the USCS
16		40%	2 1 1		ML	Continued Brownish Gray to Dark Gray SILT (FLY ASH), trace to little CLAY, wet, trace SAND.
18		92%	6 14		SM	Moderate Brown Silty Fine SAND, trace to little FMC GRAVEL, dense, moist.
20 22 24		40% 35%	22 8 9 8 28 19 34		GW	Brown Fine SAND to COBBLES, Medium dense, moist, trace to little CLAY and SILT.
26 28 30 32 34						Bottom of Boring at 25.5 Feet.

Drilling Log

Shaw Shaw Environmental & Infrastructure, Inc.

Soil Boring **TB 1-7**

Page: 1 of 1

Project	Basin II Geotechnical Assessment	Owner	PPL				
Location	Martins Creek	Proj. No.	117279.20				
Surface Elev.		Total Hole Depth	10.0 ft	North		East	
Top of Casing	NA	Water Level Initial	NA	Static	NA	Diameter	
Screen: Dia	NA	Length	NA	Type/Size	NA		
Casing: Dia	NA	Length	NA	Type	NA		
Fill Material	Sand	Rig/Core					
Drill Co.	Eichelbergers, Inc.	Method	Hand Auger				
Driller	Will Deiningor	Log By	M. Shaheen	Date	10/18/05	Permit #	NA
Checked By	R. Wardrop	License No.	PG000157G				

COMMENTS

Depth (ft.)	PID (ppm)	Sample ID % Recovery	Blow Count Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Geologic Descriptions are Based on the USCS.
0		100%			ML	Brownish Gray Fine SAND (FLY ASH), loose, moist. Some roots and rootlets.
						Medium to Dark Gray SILT (FLY ASH), very moist.
2		50%			SP	Medium to Dark Gray FM SAND, moist.
						Brownish Gray to Dark Gray Fine SAND (FLY ASH).
4		35%				Dark Gray SILT (FLY ASH), moist, trace rootlets.
6		25%			ML	Dark Gray SILT to Medium Light Gray SAND (FLY ASH).
8		20%				Dark Gray SILT (FLY ASH), loose, moist to very moist, trace rootlets.
10						Bottom of Boring at 10 Feet.
12						
14						

Drilling Log

Shaw® Shaw Environmental & Infrastructure, Inc.

Soil Boring TB 1-9

Page: 1 of 2

Project: Basin 1 Geotechnical Assessment | Owner: PPL
Location: Martins Creek | Proj. No. 117779.20
Surface Elev. ____ | Total Hole Depth: 37.5 ft. | North ____ | East ____
Top of Casing: NA | Water Level Initial: NA | Static: NA | Diameter: 8.5 in.
Screen: Dia NA | Length NA | Type/Size NA
Casing: Dia NA | Length NA | Type NA
Fill Material: Sand | Rig/Core ____
Drill Co. Eichelbergers, Inc. | Method: HSA/SPT
Driller: Will Deininger | Log By: M. Shaheen | Date: 10/11/05 | Permit # NA
Checked By: R. Wardrop | License No. PG000157G

COMMENTS

Depth (ft.)	PID (ppm)	Sample ID % Recovery	Blow Count Recovery	Graphic Log	USCS Class	Description (Color, Texture, Structure) Geologic Descriptions are Based on the USCS.
0		95%	6, 6, 11			
2						
4		90%	9, 17, 47			FMC GRAVEL and SILT, some SAND, little CLAY, moist, medium dense.
6		80%	17, 45, 50		GW	
8						
10		70%	8, 28, 33			GRAVEL, Cobbles, SAND, and SILT, very dense, moist.
12		65%	10, 10, 10			Yellowish Brown FMC SAND and GRAVEL, some SILT, medium dense, moist.
14						
16		100%	4, 1, 4		ML	Dark Gray SILT (FLY ASH), very loose, moist.
18		80%	6, 12, 50		GW	SAND, GRAVEL, Cobble
20						

Continued Next Page

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Drilling Log

Soil Boring **TB 1-9**
Page: 2 of 2

Project: Basin 1 Geotechnical Assessment   Owner: PPL
Location: Martins Creek   Proj. No. 117728.20

Depth (ft)	PID (ppm)	Sample ID % Recovery	Blow Count Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Geologic Descriptions are Based on the USCS.
20		65%				Continued
22		20%	16, 20, 20			Medium Gray SAND (BOTTOM ASH)
24		60%	2, 2, 5			Dark Gray SILT (FLY ASH), loose, moist to wet.
26–28		55%	6, 6, 8		ML	
30		65%				Dark Fray SILT (FLY ASH), medium dense, Very Fine sandy texture.
32–34		100%	1, 1, 4			
36		83%	4, 12, 31		SM	Yellowish Brown SILTY Fine to Medium SAND, dense, moist.
38–46						Bottom of Boring at 37.5 Feet

Drilling Log

Shaw Environmental & Infrastructure, Inc.

Monitoring Well **TB 1-12**

Page: 1 of 2

Project: Basin 1 Geotechnical Assessment Owner: PPL

Location: Martins Creek Proj. No. 117779.20

Surface Elev.: ____ Total Hole Depth: 45.0 ft North: ____ East: ____

Top of Casing: NA Water Level Initial: Dry Static: NA Diameter: 8.5 in.

Screen: Dia: 2 in. Length: 10 ft Type/Size: PVC/0.010 in

Casing: Dia: 2 in Length: 25 ft Type: PVC SCH 40

Fill Material: Sand Rig/Core: ____

Drill Co.: Eichelbergers, Inc. Method: HSA/SPT

Driller: Will Deiringer Log By: M. Shaheen Date: 10/12/05 Permit #: NA

Checked By: R. Wardrop License No.: PG0001.57G

COMMENTS

Depth (ft.)	Sample ID % Recovery	Blow Count Recovery	USCS Class.	Description (Color, Texture, Structure) Geologic Descriptions are Based on the USCS.
0	65%	18, 20, 17, 21	GW/GM	FMC (SHALE and SS) GRAVEL and Yellowish Brown SAND, some SILT, little CLAY, moist, dense.
2	55%	20, 29, 11, 58		
4	50%	10, 14		Yellowish Orange SILT and FMC SS and SH GRAVEL, some SAND, little CLAY, very dense, moist.
6	100%	46, 136, 47, 50		
8	100% / 80%	12, 42, 50		GRAVEL with Cobbles and Yellowish Brown SILT, little to some SAND and CLAY, very dense, moist.
10	90%	3, 4		Dark Gray SILT (FLY ASH), loose, moist.
		7, 1	SW	Grayish Black FMC SAND (BOTTOM ASH), loose, moist.
12	65%	4, 3		
		4	ML	Dark Gray SILT (FLY ASH)
	90%	2, 7	SP	Grayish Black Fine SAND (BOTTOM ASH), loose, moist.
14	60%	6, 4, 3	ML	Dark Gray SILT (FLY ASH), loose, moist.
		4	CL	Brownish Yellow SANDY CLAY, some Fine GRAVEL, wet.
16	65%	5	SW	Blackish Red FMC SAND, trace to little Coal Fragments and Cinder (BOTTOM ASH).
		9, 16	SP SM	Medium Dark Gray Very Fine SAND.
	100%	8, 12	SW	Blackish Red FMC SAND (BOTTOM ASH), moist to dry.
18	100%	3, 3, 5, 2		Medium Dark to Dark Gray FMC SAND (BOTTOM ASH), moist to dry.
20				

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Shaw Environmental & Infrastructure, Inc.

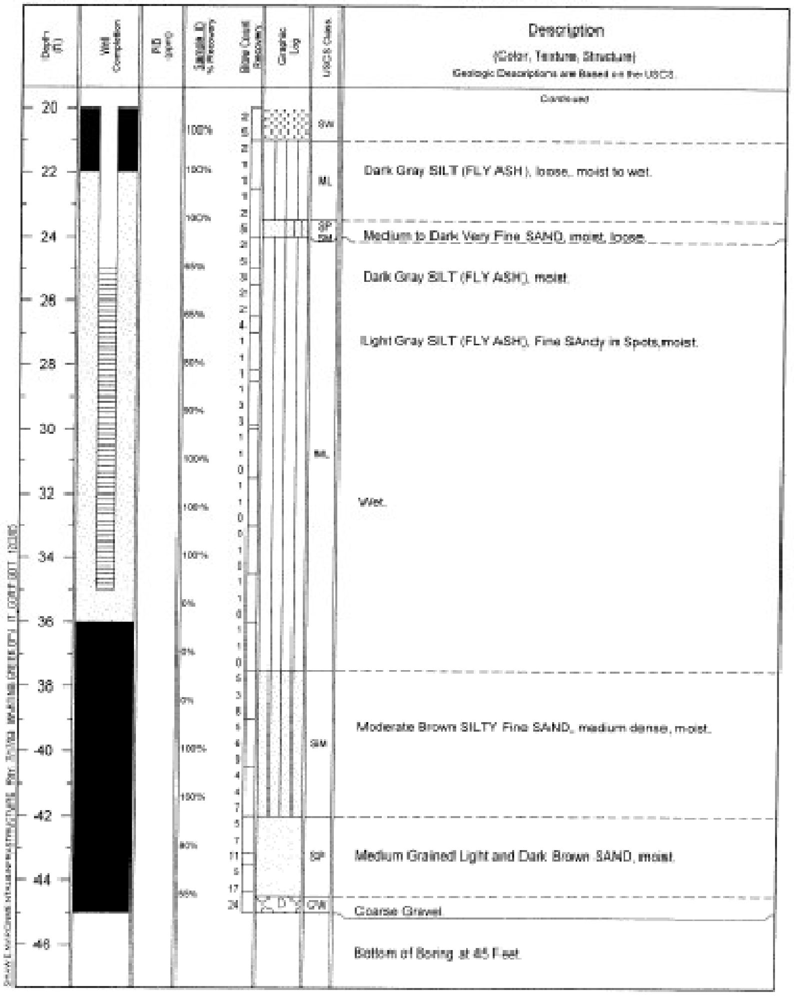
Drilling Log

Monitoring Well **TB 1-12**

Page: 2 of 2

Project: *Basin 1 Geotechnical Assessment* Owner: PPL

Location: *Martins Creek* Proj. No. 117779.20



Drilling Log

Shaw® Shaw Environmental & Infrastructure, Inc.

Soil Boring TB 1-13

Page: 1 of 2

Project: Basin 1 Geotechnical Assessment		Owner: PPL	
Location: Martins Creek		Proj. No.: 117779.20	
Surface Elev.:	Total Hole Depth: 45.0 ft	North:	East:
Top of Casing: NA	Water Level Initial: NA	Static: NA	Diameter: 8.5 in
Screen: Dia: NA	Length: NA	Type/Size: NA	
Casing: Dia: NA	Length: NA	Type: NA	
Fill Material: Sand		Rig/Core:	
Drill Co.: Eichelbergers, Inc.	Method: HSA/SPT		
Driller: Will Deininger	Log By: M. Sheehan	Date: 10/14/05	Permit #: NA
Checked By: R. Wardrop	License No.: PG000157G		

COMMENTS

Columns: Depth (ft.) | PID (ppm) | Sample ID % Recovery | Blow Count Recovery | Graphic Log | USCS Class | Description (Color, Texture, Structure) Geologic Descriptions are Based on the USCS

Depth (ft.): 0, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20

Sample ID % Recovery: 90%, 40%, 0%, 60%, 20%, 20%, 100%, 85%, 90%, 90%, 75%, 75%

Blow Count: 10, 41, 50, 25, 25, 45, 19, 23, 27, 7, 18, 50/, 21, 26, 25, 5, 5, 6, 1, 2, 3, 2, 3, 4, 1, 2, 3, 8, 12, 16, 8, 6, 11, 7, 8, 10, 7

USCS Class	Description
GW-GM	Moderate to Reddish Brown SILT and FMC GRAVEL, very dense, wet at top, little SAND, trace CLAY.
	Yellowish Brown SILT and GRAVEL, very dense, little SAND and CLAY, dry to moist.
ML	Dark Gray to Brownish Gray SILT (FLY ASH), loose, moist to wet
SM / ML	Very Fine SANDY interval.
SP	Brownish Black Fine to Medium SAND (BOTTOM ASH), loose, dry to moist.
ML / SP	Interval of Dark Gray SILT (FLY ASH).
SW	Reddish Black FMC SAND (BOTTOM ASH), medium dense, Trace to little Coal Fragments and Cinders, dry to moist.
ML	Dark Gray SILT (FLY ASH), moist.
SW	Blackish Red FMC SAND and Fine Gravel/pebbles, some Coal Fragments

Continued Next Page

Drilling Log

Shaw® Shaw Environmental & Infrastructure, Inc.

Soil Boring TB 1-13
Page: 2 of 2

Project: Basin 1 Geotechnical Assessment — Owner: PPL
Location: Martins Creek — Proj. No. 117779.30

Depth (ft)	USCS Class	Description (Color, Texture, Structure) Geologic Descriptions are Based on the USCS.
20	SW	Continued: and Cinders (BOTTOM ASH), dry to moist, medium dense.
21–23.7	ML	Brownish Gray SILT and Fine SAND (FLY ASH), dry to moist.
23.7–31.5	SW	Medium Dark to Brownish Gray FMC SAND, little Cinders, Fine GRAVEL, dry to moist. FMC SAND and some Fine Gravel Cinders (BOTTOM ASH).
31.5–36	ML	Medium Dark Gray SILT (FLY ASH), wet to moist.
36–39	SM	Medium Brown SILTY Fine SAND, moist.
39–40.5	ML	Dark Gray Very Fine Sand to SILT (FLY ASH), moist to wet, loose.
40.5–42	SM	Medium Brown SILTY Fine SAND, medium dense, moist.
42–45	GW	Moderate Brown FMC SAND and rounded GRAVEL, very dense, moist.
45		Bottom of Boring at 45 Feet.

Drilling Log

Shaw® Shaw Environmental & Infrastructure, Inc.

Soil Boring **TB 1-14**

Page: 1 of 3

Project	Basin 1 Geotechnical Assessment	Owner	PPL		
Location	Martins Creek	Proj. No.	117779.20		
Surface Elev.		Total Hole Depth	64.0 ft	North	East
Top of Casing	NA	Water Level Initial	NA	Static: NA	Diameter: 8.5 in.
Screen: Dia	NA	Length	NA	Type/Size: NA	
Casing: Dia	NA	Length	NA	Type: NA	
Fill Material	Sand	Rig/Core			
Drill Co.	Eichelbergers, Inc.	Method	HSA/SPT		
Driller	Will Deisinger	Log By	M. Shaheen	Date: 10/5/05	Permit #: NA
Checked By	R. Wardrop	License No.	PG000157G		

COMMENTS

Depth (ft.)	PID (ppm)	Sample ID % Recovery	Blow Count Recovery	USCS Class.	Description (Color, Texture, Structure) Geologic Descriptions are Based on the USCS.
0		65%	6 15 19		Yellowish Brown SILT, SAND and FMC GRAVEL, dense, dry to moist.
2					
4		100%	23 19 50		Light Brown SILT, some FMC SAND and GRAVEL, little coarse GRAVEL, moist, very dense.
6		0%	50		
8					
10		38%	9 9 12	GM	Quartzite and Shale GRAVEL and Yellowish Brown FMC SAND, some SILT, dry to moist.
12		65%	6 16 13		FMC GRAVEL and Moderate Brown SILT, some FMC SAND, medium dense, moist.
14					
16		65%	17 15 14		Moderate Brown Clayey SILT and FMC GRAVEL, medium dense, moist.
18		65%	5 18 16	SW	
20					

Continued Next Page

Drilling Log

Shaw Environmental & Infrastructure, Inc.

Soil Boring TB 1-14
Page: 2 of 3

Project: *Basin 1 Geotechnical Assessment* Owner: *PPL*
Location: *Martins Creek* Proj. No. *117779.20*

Depth (ft.)	PID (ppm)	Sample ID % Recovery	Blow Count Recovery	Graphic Log	USCS Class	Description (Color, Texture, Structure) Geologic Descriptions are Based on the USCS.
20						Continued
22		60%	17 11 22		SW	Blackish Red FMC SAND (BOTTOM ASH), trace Coal Fragments, dense, dry.
24		65%	5 3 3			
26						Light Brownish Gray to dark Gray Gray SILT (FLY ASH) loose, wet to moist.
28		90%	3 2 4			
30		90%	1 3 5			Dark Gray SILT, some Fine SAND (FLY ASH), loose, moist.
32						
34		100%	1 6 5		ML	
36		100%	2 3 4			Dark Gray SILT to SANDY SILT (FLY ASH), loose, wet.
38						
40		100%	2 3 8			
42		100%	2 2 6			Dark Gray SILT (FLY ASH), loose, wet.
44						
46		100%	4 5 10		SP	

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Shaw Shaw Environmental & Infrastructure, Inc.

Drilling Log

Soil Boring **TB 1-14**

Page: 3 of 3

Project *Basin 1 Geotechnical Assessment* Owner *PPL*

Location *Martins Creek* Proj. No. *117779.20*

Depth (ft)	PID (ppm)	Sample ID % Recovery	Blow Count Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Geologic Descriptions are Based on the USCS.
						Continued
					SP	Medium Brown, fine SAND, medium dense, moist.
48			50			
		0%				
50						Coarse Gravel and Cobbles/Boulders, White and Greenish Gray SANDSTONE Fragments, moist, very dense.
			34			
52		35%	64			
						Light Gray to Medium Dark Gray Coarse Grained QUARTZITE and Greenish Gray and Grayish Red SANDSTONE.
54						
56					GW	
58		50%				
60						
62						
64						
						Bottom of Boring at 64 Feet.
66						
68						
70						
72						

SHAW ENVIRONMENTAL&INFRASTRUCTURE Rev. 1/17/03 MARTINS CREEK.GPJ IT_CORP.GDT 12/2/05

Drilling Log

Shaw Environmental & Infrastructure, Inc.

Soil Boring **TB 1-15**

Page: 1 of 1

Project	Basin 1 Geotechnical Assessment	Owner	PPL		
Location	Martins Creek	Proj. No.	117779.20		
Surface Elev.		Total Hole Depth	10.0 ft	North		East	
Top of Casing	NA	Water Level Initial	NA	Static	NA	Diameter	
Screen: Dia	NA	Length	NA	Type/Size	NA		
Casing: Dia	NA	Length	NA	Type	NA		
Fill Material	Sand	Rig/Core			
Drill Co.	Eichelbergers, Inc.	Method	Hand Auger		
Driller	Will Deininger	Log By	M. Shaheen	Date	10/18/05	Permit #	NA
Checked By	R. Wardrop	License No.	PG000157G		

COMMENTS

Depth (ft.)	PID (ppm)	Sample ID % Recovery	Blow Count Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Geologic Descriptions are Based on the USCS.
0		100%			ML	Dark Gray SILT (FLY ASH), little to some FM SAND, wet.
2		100%				Dark Gray to Brownish Gray FMC SAND, little Fine GRAVEL, Coal Fragmets and Cinders (BOTTOM ASH), moist.
4		100%				Brownish Gray FM SAND (BOTTOM ASH), moist, loose.
6		100%			SP SM	
						Brownish Gray FM SAND (BOTTOM ASH), trace to little SILT, loose, wet.
8		100%				
10						Bottom of Boring at 10 Feet.
12						
14						

SHAW ENVIRONMENTAL&INFRASTRUCTURE Rev. 1/1/03 MARTINS CREEK PPL IT_CORP.GDT 12/6/05

Drilling Log

Shaw® Shaw Environmental & Infrastructure, Inc.

Soil Boring TB 1-16

Page: 1 of 1

Project: Basin 1 Geotechnical Assessment	Owner: PPL		COMMENTS
Location: Martins Creek	Proj. No.: 117779.20		
Surface Elev.:	Total Hole Depth: 10.0 ft	North:	East:
Top of Casing: NA	Water Level Initial: NA	Static: NA	Diameter:
Screen: Dia: NA	Length: NA	Type/Size: NA	
Casing: Dia: NA	Length: NA	Type: NA	
Fill Material: Sand	Rig/Core:		
Drill Co.: Eichelbergers, Inc.	Method: Hand Auger		
Driller: W.W. Devalinger	Log By: M. Shaheen	Date: 10/18/05	Permit #: NA
Checked By: R. Wardrop	License No.: PG000157G		

Depth (ft.)	PID (ppm)	Sample ID % Recovery	Blow Count Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Geologic Descriptions are Based on the USCS.
0		100%				Brownish Gray Fine to Very Fine SAND (FLY ASH), moist, very loose, trace leaves, rootlets.
2		100%				Dark Gray to Medium Light Gray SILT (FLY ASH), moist, loose, trace roots.
4		100%			ML	
6		100%				Dark Gray SILTY Very Fine SAND (FLY ASH), moist, loose.
8		100%				Brownish Gray to Medium Light Gray to Dark Gray SILT and some Fine SAND (FLY ASH), moist to wet.
10						Bottom of Boring at 10 Feet.
12						
14						

WORK PLAN OUTLINE FOR PERMIT-RELATED ACTIVITIES
AT BASINS 1 AND 4
TO SUPPORT MAJOR PERMIT MODIFICATION APPLICATION
PP&L MARTINS CREEK STEAM ELECTRIC STATION
LOWER MT. BETHEL TOWNSHIP, NORTHAMPTON COUNTY, PA

Prepared for:

Pennsylvania Power and Light
Allentown, Pennsylvania

Prepared by:

Nittany Geoscience, Inc.
State College, Pennsylvania

Project No. 057-030/d.01/057-030

May 1998

1.0 INTRODUCTION

1.1 Purpose and Objectives

The purpose of this work plan is to describe the activities that will be conducted by Pennsylvania Power and Light (PP&L) in response to the Department of Environmental Protection's (DEP's) Pre-Denial Letters for the permitting of the Martins Creek SES Basin 1, dated January 20, 1998, and Basin 4, dated January 13, 1998. The activities address two concerns that DEP voiced in those letters:

1. that a liner waiver at Basin 1 cannot be addressed due to hydrogeological uncertainty, and
2. that a sinkhole contingency plan must be developed for Basin 4, which addresses how a potential sinkhole will be evaluated.

The tasks described in this work plan have been developed to collect the necessary information to verify a conceptual model of the hydrogeology of Basin 1, which is the basis for an appropriate groundwater monitoring network, and to develop a sinkhole contingency plan for Basin 4.

1.2 Organization of Report

1.3 Project Background

- Basin History
- Historic Quarterly Sampling Program
- Application for Permit

2.0 SITE DESCRIPTION

- Basin Setting

  Climate

  Soils

  Geologic Setting

  Regional Geology

  Site Geology

  Regional Hydrogeology

2.1 Basin 1

- Basin Construction and Operations

- Local Hydrogeology - 2 Units
  - Sand and Gravel Aquifer

    Unit 1 - Sand and gravel aquifer and weathered top of bedrock
  - Bedrock Aquifer

    Unit 2 - Fractured bedrock
    - Address interconnection of 2 units
    - Background Groundwater Quality
- Leachate Chemistry
- Conceptual Model
  - Description of the use of ash chemistry as a tracer to verify that the material sluiced into the basin and discharging to the groundwater would be intercepted by monitoring wells (particularly MW 1-8).
  - Address proximity of Delaware River, vertical and horizontal gradients, and potential impact of the river on the groundwater configuration (See Section 3 and Figure 1)
- Monitoring Well Network
  - Justification of monitoring well placement

    4 Criteria

    1. Downgradient of basin
    2. Approximately even distribution of wells
    3. Located on known zones of weakness, where identified
    4. Produced significant quantity of water when drilled, showing interconnection
  - Recommendation of two additional bedrock monitoring wells and one additional overburden monitoring well in the vicinity of MW 1-8, and aquifer testing of two wells (one of the new bedrock unit wells and the new sand and gravel unit well).

2.2 Basin 4

- Basin Construction and Operations
- Local Hydrogeology
  - Fractured Jacksonburg Formation limestone bedrock aquifer overlain by bedrock residuum soil.
  - Background Groundwater Quality
- Monitoring Well Network

3.0 FIELD ACTIVITIES FOR BASIN 1

3.1 Well Location Justification

Three new wells will be constructed as part of the investigation: one overburden pumping well, one bedrock pumping well, and one bedrock monitoring well. Existing overburden monitoring well MW 1-8 will be utilized as an overburden monitoring well. The new bedrock monitoring well should be located within 15 feet of the existing well MW 1-8 for several reasons:

1. The source of indicator parameters, representative of on-going activities, to the overburden aquifer is the northeastern portion of the basin where ash sluiced with water infiltrates into the overburden aquifer. As shown on Figure 2, the concentration of alkalinity, which can be used as an indicator parameter for ash related constituents, is highest in the portion of the overburden directly below the inflow. Flow lines in the overburden aquifer are toward MW 1-8 (see Figure 3).
2. The source of indicator parameters, representative of on-going activities, to the bedrock aquifer is the affected portion of the overburden aquifer. A pathway for indicator parameters to impact the bedrock aquifer is only present if a downward gradient exists between the overburden and bedrock aquifers. Because of the groundwater mound created by the inflow to the basin, a downward gradient is likely to be most significant in the northeastern portion of the basin, in the vicinity of MW 1-8.
3. Fractures have been identified by aerial photography review in the vicinity of MW 1-8, likely increasing the local permeability of the aquifer and controlling the local direction of groundwater flow (see Figure 3).
4. Well MW 1-8 is screened entirely to the overburden, making it a suitable observation point for the overburden aquifer test. Using MW 1-8 as the overburden observation point is a cost-effective alternative, reducing the number of new wells from four to three.

3.2 Well Construction

- A six-inch diameter bedrock pumping well, to a depth of approximately 100 feet, in the vicinity of MW 1-8; a two-inch diameter bedrock monitoring well, also to a depth of approximately 100 feet, and a six-inch diameter overburden pumping well, to a depth of approximately 50 feet. The locations of these wells are shown on Figure 1. The objectives of these wells are as follow:
  1. To perform aquifer testing on the six-inch wells, using the two-inch bedrock well and existing monitoring well MW 1-8 as observation points.
  2. To determine the vertical gradient between the two aquifer units.

3. To measure water quality of the bedrock aquifer downgradient of Basin 1.

- Construction Specifications (see attached construction diagrams).

	Six-Inch Bedrock Well (MW 1-9b)	Two-Inch Bedrock Well (MW 1-9)	Six-Inch Overburden Well (MW 1-8b)
Total Depth	100 feet	100 feet	To bedrock (Approx. 50 feet)
Borehole Diameter	Ten inch to 80 feet Six inch to 100 feet	Six inch	Ten inch
Casing	80 feet of six-inch steel	80 feet of two-inch PVC	20 feet of six-inch PVC
Screen	open	20 feet of two-inch PVC	30 feet of six-inch PVC

3.3 Aquifer Testing of Selected Wells

- The new six-inch bedrock well will be tested to develop aquifer parameters for the bedrock aquifer. The new two-inch bedrock well will be used as the observation well. The new bedrock well will accommodate a pump with a capacity of greater than 100 gallons per minute, if necessary.
- The new overburden well will be tested to develop aquifer parameters for the overburden aquifer. Monitoring well MW 1-8 will be used as the observation well. The new overburden well will accommodate a pump with a capacity of greater than 100 gallons per minute, if necessary.
- All three non-pumping wells will be used as observation points for the pumping tests. This will help to assess the hydraulic connection between the aquifer units.
- The new six-inch-diameter wells may be abandoned after aquifer testing.

4.0 BASIN 4 - TIERED SINKHOLE CONTINGENCY PLAN

4.1 Objectives

To estimate the size and likelihood of a potential failure.

To develop a monitoring program that, in the event of a failure, would determine the direction, rate, and concentration of basin-related constituents.

4.2 Failure Identification

- Site engineering geologic and hydrogeologic conditions
- Likely failure character
  - 100-foot diameter or less
  - Total loss of basin water over days
  - Loss of ash in vicinity of failure only
  - Potential Receptors

    Residential Well Users

    Oughoughton Creek

    Delaware River
- Periodic Inspections
  - Quarterly inspection and documentation by site personnel
  - Yearly aerial photography with independent review
- Quarterly groundwater monitoring of characteristic chemistry (specific conductance, calcium, and sulfate) and data review to identify potential releases

4.3 Failure Monitoring Program

The following monitoring program is recommended in the event of a basin failure to determine the fate of the ash.

- Monitoring Program for Impacts, if a failure occurs:

  Note: DEP has suggested dye testing as a means of predetermining direction of Basin liquids if a failure occurs. In this terrain, only injection of dye through the liner in a section that would eventually fail would provide a representative test. Specific conductance, calcium, and sulfate will be useful, easily tracked tracers if a failure occurs.

  - Monitor specific conductance, calcium, sulfate and visual indications of ash at site monitoring wells, residential wells, seeps, Oughoughton Creek, and Delaware River at outlet of Oughoughton Creek.
  - Daily for one week, monitor all points for specific conductance and visual indications of ash. If no impact is indicated, reduce monitoring to weekly

- Weekly for one month, monitor all points for specific conductance, calcium, and sulfate. If no impact is indicated, reduce monitoring to monthly
- Monthly for six months, monitor all points for specific conductance, calcium, and sulfate. If no impact is indicated, reduce monitoring to quarterly (current monitoring schedule).
- If at any time an impact of a residential supply well is indicated, a temporary supply will be provided immediately and sampling for all ash-related parameters will be conducted.
- If at any time monitoring indicates an impact at any monitoring point, notify DEP and initiate clock to submit corrective action plan to DEP in 60 days. Corrective action plan may have one or more of the following components.

  Remediation of residential wells may require individual treatment systems or permanent replacement of the water supplies.

  Remediation of the stream may require stream vacuuming

  Remediation of the aquifer may require a groundwater investigation to delineate the plume and pumping to remediate the aquifer. Discharge from pumping could go to Basin 4 or another basin.

  All remediations will require monitoring to demonstrate effectiveness.

5.0 QUALITY ASSURANCE PROJECT PLAN

6.0 HEALTH AND SAFETY PLAN

7.0 REFERENCES

APPENDIX A SUMMARY OF PREVIOUS GEOPHYSICAL AND ENVIRONMENTAL INVESTIGATIONS

d.01/000-000

FIGURES

FIGURE 1
Location of monitoring wells at Basin No. 1,
PP&L Martin's Creek SES, Northampton County, PA.

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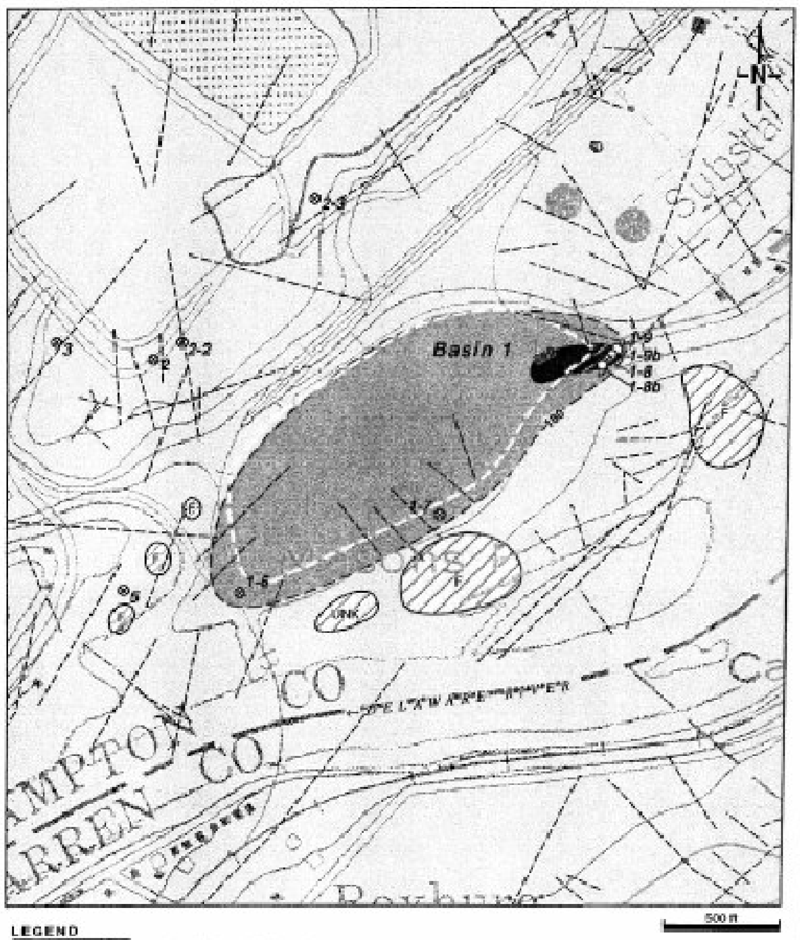

LEGEND

- Approximate location of existing monitoring well
- Alkalinity > 200 ppm
- Alkalinity < 200, >180 ppm
- Electromagnetic Anomolies (Delta Geophysical Services, 1986)
- Fracture Traces from aerial photo review (NG-S, 1993)
- F Fractures
- UNK Unknown

FIGURE 2
Contour map of December 1997 alkalinity on compilation of previous investigations, PP&L Martin's Creek SES, Northampton County, P.A.

15/067-030

NITTANY GEOSCIENCE INC

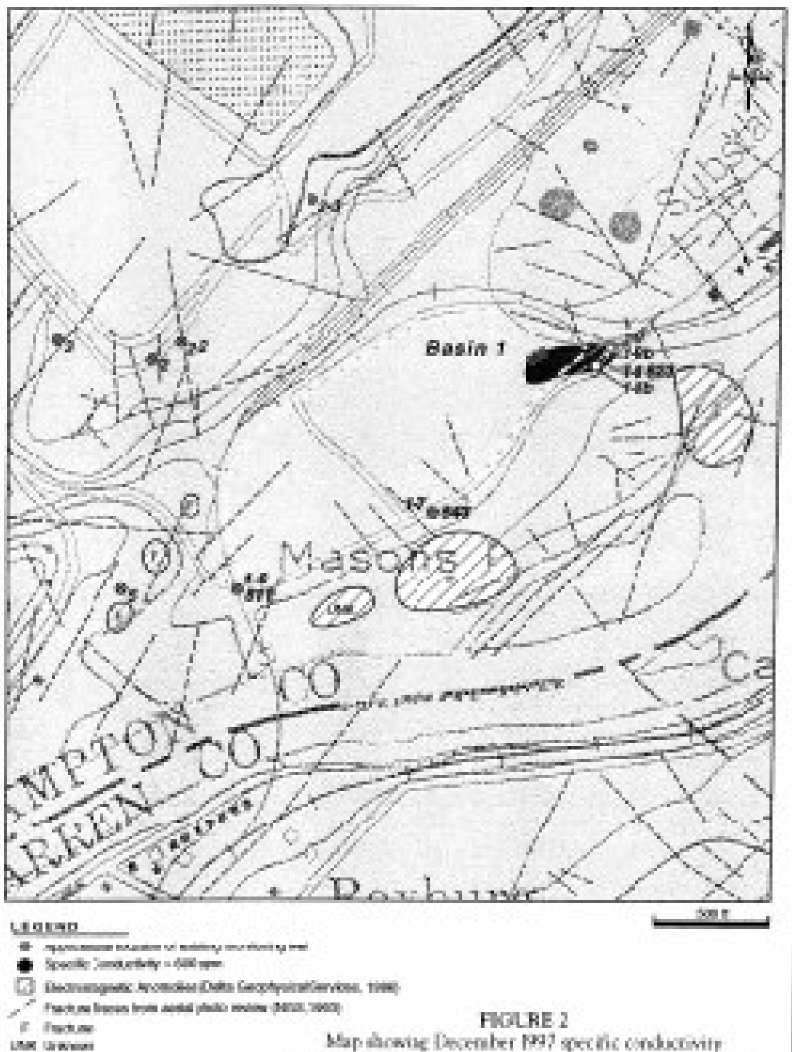

FIGURE 2
Map showing December 1997 specific conductivity
at Basin 1 wells with a compilation of previous investigations.
PP&L Martin's Creek SES, Northampton County, PA.

NITTANT GEOSCIENCE inc

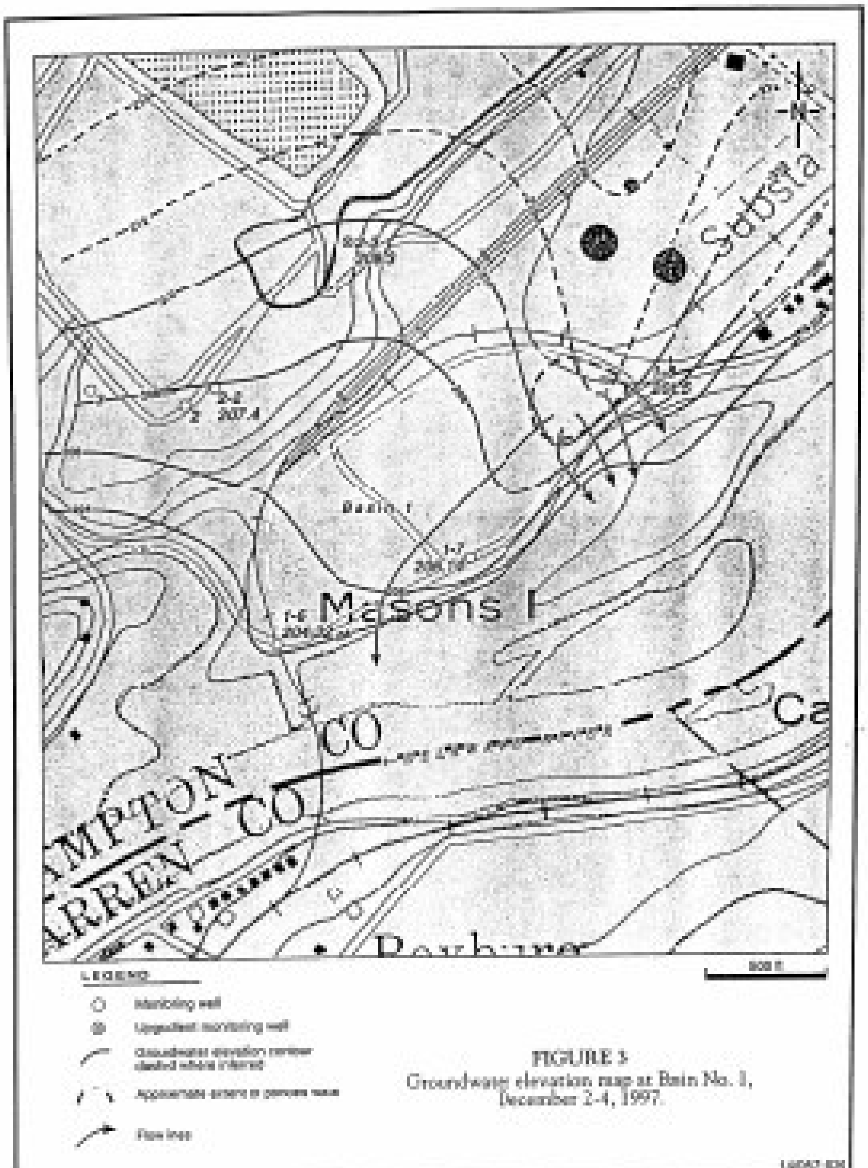

FIGURE 3
Groundwater elevation map at Basin No. 1,
December 2-4, 1997.

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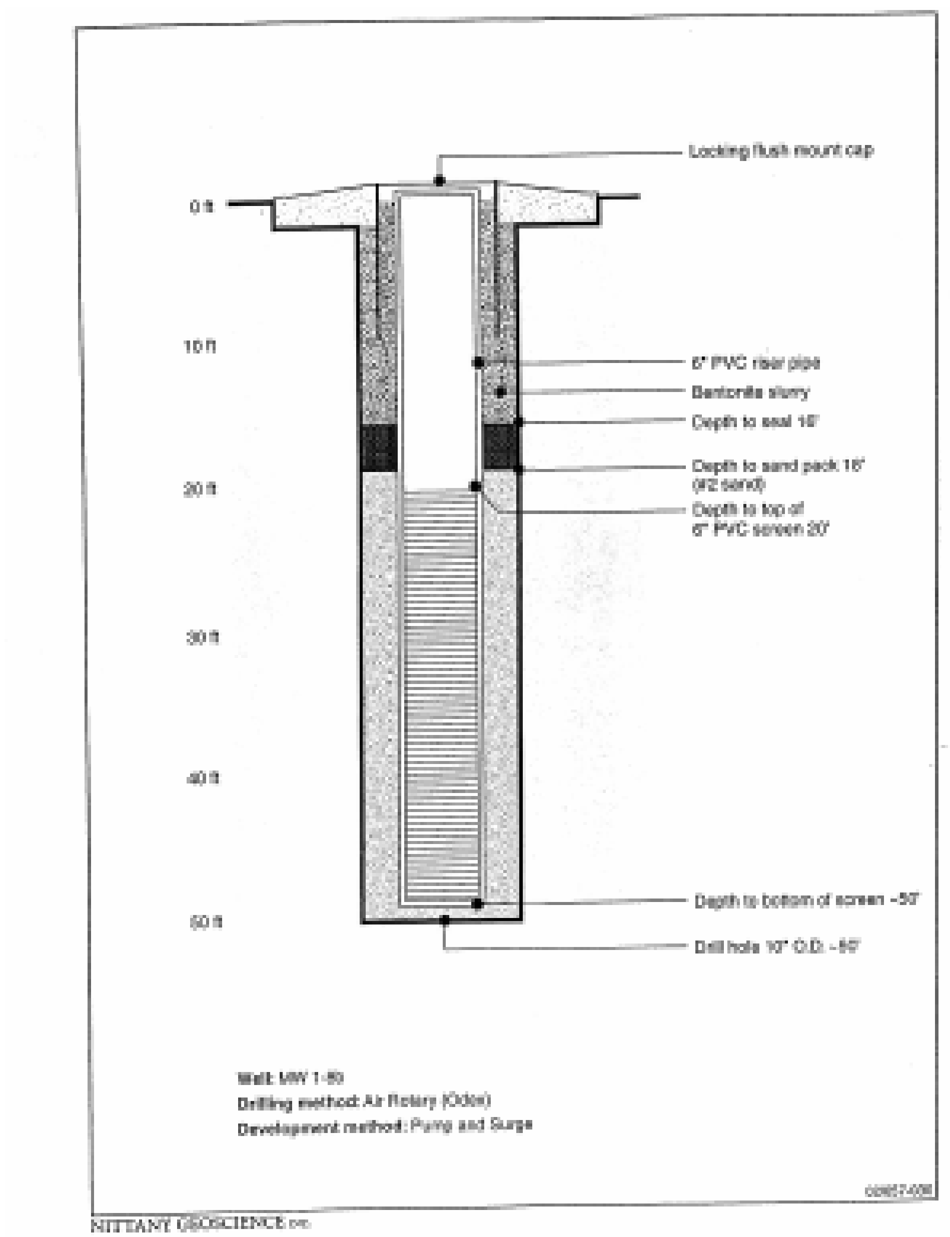
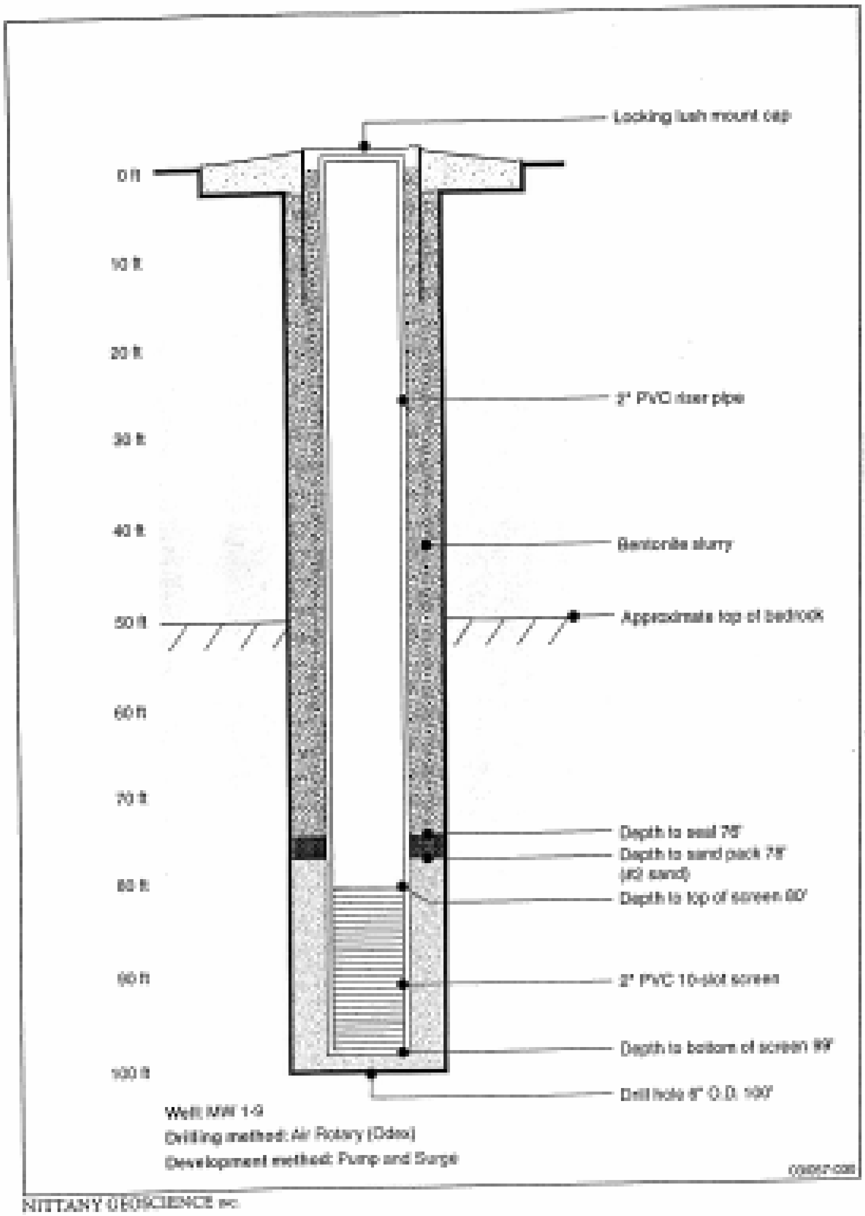
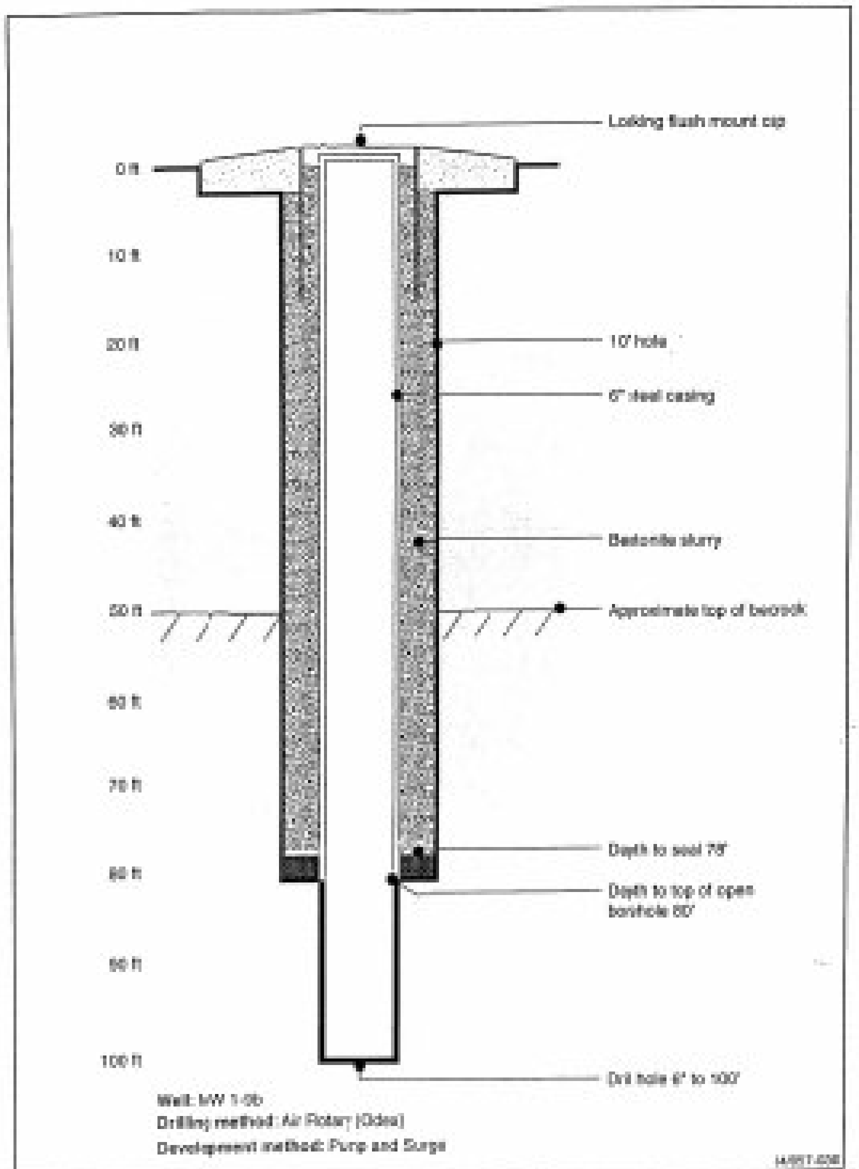
Well. Construction Diagram


Locking flush mount cap
0 ft
10 ft
20 ft
30 ft
40 ft
50 ft
6" PVC riser pipe
Bentonite slurry
Depth to seal 16'
Depth to sand pack 18'
(#2 sand)
Depth to top of
6" PVC screen 20'
Depth to bottom of screen ~50'
Drill hole 10" O.D. ~50'
Well: MW 1-50
Drilling method: Air Rotary (Odex)
Development method: Pump and Surge
NITTANY GEOSCIENCE INC.


Locking flush mount cap
0 ft
10 ft
20 ft
30 ft
40 ft
50 ft
60 ft
70 ft
80 ft
90 ft
100 ft
2" PVC riser pipe
Bentonite slurry
Approximate top of bedrock
Depth to seal 76'
Depth to sand pack 78'
(#2 sand)
Depth to top of screen 80'
2" PVC 10-slot screen
Depth to bottom of screen 99'
Drill hole 6" O.D. 100'
Well: MW 1-9
Drilling method: Air Rotary (Odex)
Development method: Pump and Surge
NITTANY GEOSCIENCE inc.



NITTANY GEOSCIENCE inc.

NITTANY GEOSCIENCE INC. MEMORANDUM

TO: Lisa Hannigan
FROM: Shana Tritsch
DATE: May 14, 1998
SUBJECT: Summary and timeline of field activities to be completed at the PP&L Martins Creek SES

In order to collect the necessary data to complete Forms 6R, Geologic Information, and 7R, Hydrogeologic Information, for PP&L Martin Creek SES Basin 1, the following field activities are proposed:

1. A field meeting will be conducted at the PP&L Martins Creek Basin 1 on Friday, May 15, at 10:30 AM, to site the well locations. PP&L, DEP, Eichelberger, and Nittany Geoscience will all be present at the meeting.

2. A bedrock monitoring well (MW 1-9) will be drilled to a depth of 100-feet below ground surface (bgs). The well will be logged as it is drilled and the depth and approximate yield of water bearing zones will be recorded.

3. A bedrock pumping well (MW 1-9b) will be drilled to a depth of 100-feet bgs. The well will be logged as it is drilled and the depth and approximate yield of water bearing zones will be recorded. The yield of the well will be estimated and a pumping rate for future testing will be determined. If the well does not intercept sufficient bedrock water-bearing zones, it will be backfilled to the bedrock surface and reconstructed as the overburden pumping well. If so, the well will be redesignated MW 1-8b and MW 1-9b will be drilled as the bedrock pumping well at an alternative location.

4. An overburden pumping well (MW 1-8b) will be drilled to bedrock (estimated to be at approximately 30-feet bgs). The well will be logged as it is drilled and the yield of the well will be estimated to determine the pumping rate for future testing.

5. A round of water levels will be measured in MW 1-8, MW 1-7, MW 1-6, MW 2-2, MW 2-3, and the new wells each day during the drilling to establish baseline conditions prior to the pumping test. In addition, a staff gauge will be placed in pooled water at the northeast end of Basin 1 and the level in the basin will be monitored periodically. A round of measurements will also be collected prior to the start of each pumping test.

6. Stage data for the Delaware River at Belvidere, NJ, will be obtained from the USGS home page, and weather data will be obtained from the NOAA home page, for the days on which water-level monitoring has occurred. In addition, data concerning the ash sluicing schedule for Basin 1 will be requested from the plant.

7. After the three wells have been constructed, an 8-hour pumping test will be conducted on MW 1-9b. The rate will be selected based on the blown yield of the well measured during drilling. Adjustments will be made early in the test, if necessary, in order to pump the well at a sustainable rate estimated to induce sufficient drawdown. Prior to the pumping test, pressure transducers with dataloggers will be placed in the bedrock pumping well and the bedrock observation well. Frequent hand measurements will be collected as a back up in both wells, and in MW 1-4 (the existing overburden monitoring well). Periodic hand measurements will be collected from the other MW 1-6, MW 1-7, MW 2-2 and MW 2-3, and stage at Basin 1. At the end of the pumping test, a sample will be collected from the pumping well for analysis of parameters stipulated in the residual waste regulations.

8. After the pumping test in the bedrock well has been completed, a 12-hour pumping test will be conducted on MW 1-8b. The rate will be selected based on the blown yield of the well measured during drilling. Adjustments will be made early in the test, if necessary, in order to pump the well at a sustainable rate estimated to induce sufficient drawdown. Prior to the pumping test, pressure transducers with dataloggers will be placed in the overburden pumping well and the overburden observation well. Frequent hand measurements will be collected as a back up in both wells, and in MW 1-9 (the bedrock monitoring well). Periodic hand measurements will be collected from the other Basin 1 wells and MW 2, MW 2-2, MW 2-3, and stage at Basin 1. At the end of the pumping test, a sample will be collected from the pumping well for analysis of parameters stipulated in the residual waste regulations.

The above items are proposed with the objective of calculating the parameters necessary for the Forms 6R and 7R. An estimated schedule is attached. If at any time, a change of work scope is required to obtain the necessary data, DEP will be notified. Please call Shana Tritsch, at 814-231-2170 if you have any questions. During the field activities, I will call in daily to receive messages, or you could try me at 814-571-8408 (car phone).

cc. Don Ottolo, PP&L
Larry LaBar, PP&L

NITTANY GEOSCIENCE INC. MEMORANDUM

TO: Lisa Hannigan
FROM: Shana Tritsch
DATE: May 26, 1998
SUBJECT: Summary of field activities completed at the PP&L Martins Creek SES during the week of May 18, 1998

In order to collect the necessary data to complete Forms 6R, Geologic Information, and 7R, Hydrogeologic Information, for PP&L Martin Creek SES Basin 1, the following field activities were completed during the week of May 18, 1998:

1. A field meeting was conducted at the PP&L Martins Creek Basin 1 on Friday, May 15, at 10:30 AM, to site the well locations. PP&L, DEP, Eichelberger, and Nittany Geoscience were all present at the meeting.

2. A bedrock pumping well (MW 1-9b) was started on May 18, 1998, at 13:00 using Cable-Tool drilling. The well was drilled to a depth of 67 feet using Cable-Tool drilling and was completed to 123 feet with Air Rotary. The well was logged as it was drilled and the depth and approximate yield of water bearing zones were recorded. For the interval drilling with the Cable-Tool rig the cuttings were bailed every 5 feet. Gravels and cobbles were crushed with the tool before they were bailed, so their in-situ size and shape is not known. A detailed geologic and construction log will be provided in the Report. A drilling log summary is as follows:

Interval	Description
0-6	Dark brown silty-gravelly sand. Well-graded sand and small (<1/2-inch) multimectic gravels Railroad tie encountered at 2-foot
6-18	Same as above, less silt, lighter color Some larger gravels.
18-35	Well-graded sand with small broken gravel and quartzite cobbles
35-47	Same as above with more silt
47-56	Broken gravels and cobbles, variety of lithologies including red, green, and gray sandstone, and gray quartzite
56-63	Small (<1/4 inch) rounded to angular sandstone, as described above, with subangular, weathered dolostone gravels and some dark dolostone chips.
63-67	Dolostone sand, very hard drilling with Cable-Tool rig
67-120	Light and medium gray microcrystalline dolostone, with red-brown clay Fractures: 65-70 78-85

91-94
101-103
106-120
120-123 Same colorstone as above, with pieces of coarse-grained light gray limestone.

Construction

10-inch casing was driven to 67 feet below ground surface
10-inch hole drilled to 90 feet and 6-inch casing installed
7-foot bentonite seal from 90 to 83 feet
6-inch open hole to 123 feet below ground surface

* Next week the annulus between the 6 and 10-inch casings will be grouted with cement grout and the 10-inch casing will be pulled.

Notes

- At 56 feet, the water in the borehole could not be bailed down indicating that the yield was between 50 to 100 gallons per minute.
- The water was not cased off by the 10-inch casing and continued to increase during the 10-inch drilling. After the 6-inch casing was installed the water was shut off until 92 feet, when approximately 100 gallons per minute were encountered. At 123 feet, the flow was measured at 150 gallons per minute. Some of this water may be shut off when the 6-inch casing is grouted, but it is predicted that at least 50 gallons per minute will remain, likely more.
- The well was developed for 75 minutes, at which time the water had cleared significantly.
- The water levels in both MW 1-8 and MW 1-9 were monitoring during the development of MW 1-9B. The water level in MW 1-9 dropped rapidly at the start of pumping, more than one inch in 5 seconds. After one hour of pumping, the water level in MW 1-9 had dropped almost four feet. The water level in MW 1-8 also dropped, but very slowly and at the end of the hour it had dropped only 0.6 feet.
- MW 1-9B was drilled into a heavily fractured zone of rock. This accounts for the frequently encountered fractured zones between solid zones and the high clay content of the cuttings.
- The static water level in MW 1-9B recovered to a level corresponding to that of MW 1-9 (presumably local bedrock level) in less than 15 minutes.

3. A bedrock monitoring well (MW 1-9) will was drilled on May 19, 1998, to a depth of 121-feet below ground surface using 6-inch simultaneous-casing drilling until competent rock was reached at 74 feet, and completed with 5-inch air-rotary. The well was logged as it was drilled and the depth and approximate yield of water bearing zones was recorded. A detailed geologic and construction log will be provided in the Report. A summary is as follows:

Interval	Description
0-18	Fine brown, poorly graded sand with approx. 10% silt and an occasional rounded gravel Cobbles and a little water at 18 feet
18-23	Brown sand with small (<1/4-inch) angular red, green, and gray sandstone gravel and larger (1/2-inch-3-inch) rounded red, green, gray sandstone, and gray quartzite gravel (river pebbles)
23-28	Primarily rounded gravel with some sand
28-38	Approx. 50% gravel, 50% sand
38-56	Primarily rounded gravel with some sand
56-65	Broken, angular weathered light-gray dolostone (1-1/2 inch pieces)
65-81	Competent medium-dark gray dolostone with some calcite and light-gray pieces (1/2-inch angular). Medium-gray dolostone is microcrystalline with a concoidal fracture.
81-121	Thinly-bedded, interbedded medium-dark gray and very light-gray dolostone with some muddy brown interbeds.
100	Fractures with some red-brown mud. Approximately 10-12 gallons per minute.
105-107	Very fractured zone of brown dolostone and mud. Approximately 30-40 gallons per minute.

Construction

6-inch casing was driven using simultaneous-casting drilling to 174 feet.

5-inch open hole was drilled to 121 feet

40-foot 2-inch-PVC 10-slot screen

80-foot 2-inch-PVC riser

5-foot bentonite seal

Grouted with bentonite slurry

2-foot stickup with locking cap

2-foot-diameter, 18-inch-thick pad was installed around casing

* Next week the 6-inch casing will be pulled and a 5-foot section of protective 6-inch casing will be installed.

Notes

Because the simultaneous casing sealed off water-bearing zones as they were drilled, a good estimate of the yield of the overburden and weathered rock zones was not available. At least 10 gallons per minute were encountered at the base of the overburden.

The depths to water measured on May 20, 21, and 22, 1998, were very similar in MW 1-8 and MW 1-9. The elevations of the wells will need to be surveyed to ascertain the gradient, but it is very slight indicating that very little vertical flow is occurring, either up or down.

4. An overburden pumping well (MW 1-8b) was drilled on May 20 and 21, 1998, to bedrock using cable-tool drilling. The first 20 feet of drilling and casing were set using the air-rotary rig. The well was logged as it is drilled and the

yield of the well was estimated. A detailed geologic and construction log will be included in the Report. A summary is as follows:

Interval	Description
0-18	Fine brown, poorly graded sand with approx. 10% silt and an occasional rounded gravel
18-25	Sand with silt and rounded sandstone and quartzite pebbles, red, green, and gray.
25-50	Pebbles with some sand and silt, lenses of silty sand occasionally encountered.
50-53	Dolostone sand (pulverized by bit)

Construction

- Because the hole was drilled three feet into bedrock, it will be backfilled with bentonite to 50 feet and then constructed with 15 feet of 6-inch 20-slot PVC screen and 35 feet of 6-inch PVC riser. The 10-inch casing will be pulled as the well is constructed and grouted. A sand pack will extend 2 feet above the top of the screen, topped with a 2-foot seal of bentonite and grouted to the surface.

5. Baseline water levels was measured in MW 1-8, MW 1-7, MW 1-6, MW 2-2, MW 2-3, MW 2-4, and the new wells during the drilling to establish baseline conditions prior to the pumping test. All of the wells have shown a gradual decline of water levels last week. According to PP&L personnel, no ash was sluiced into Basin 1 the week of May 18, 1998. Levels of water in the basin will be observed during the construction and water levels in the monitoring wells will be monitored for any apparent effect of the sluicing on the ambient water levels.

Based on the activities completed thus far, it is estimated that the overburden pumping well construction will be completed by Friday, May 29, 1998, and the pumping tests can be initiated at any time following the completion of the wells.

cc. Don Ondko, PP&L
Larry LaBuz, PP&L
Steve Holler, PP&L
Richard Wardrop, NGS

NITTANY GEOSCIENCE INC. MEMORANDUM

TO: Lisa Hannigan
FROM: Shana Tritsch
DATE: June 10, 1998
SUBJECT: Summary of field activities completed at the PP&L Martins Creek SES during the weeks of May 26 and June 1, 1998

In order to collect the necessary data to complete Forms 6B, Geologic Information, and 7B, Hydrogeologic Information, for PP&L Martin Creek SES Basin 1, the following field activities were completed during the weeks of May 26 and June 1, 1998:

1. The bedrock pumping well (MW 1-9B) was completed by pulling the 10-inch steel casing to 60 feet below the ground surface, at which point the casing broke below the ground surface and the casing could not be pulled any further. The 10-inch casing had been pulled out of the bedrock and into the overburden, bentonite hole-plug was installed from 90 feet bgs to 77.5 feet bgs, and the well was grouted with bentonite slurry grout to the surface. The open hole portion of the well was effectively sealed off from the overburden. The broken piece of casing was replaced in the well prior to grouting, and a two-foot stick up and locking cap were installed. The construction diagram for this well is attached. The well was completed on May 28, 1998.
2. A bedrock monitoring well (MW 1-9) was damaged when the 6-inch steel casing was pulled on May 29, 1998. All construction materials were removed from the well and it was reconstructed on June 2, 1998. A five foot section of protective 6-inch steel casing was installed with a locking cap. The construction diagram for this well is attached.
3. An overburden pumping well (MW 1-8B) was completed by pulling the 10-inch steel casing on May 27, 1998. Five feet of protective 10-inch steel casing was installed, with a locking cap. The construction diagram for this well is attached.
4. Baseline water levels was measured in MW 1-8, MW 1-7, MW 1-6, MW 2-2, MW 2-3, MW 2-4, and the new wells during the week of May 26, 1998, establish baseline conditions prior to the pumping test. All of the wells showed a gradual decline of water levels that week.
5. An 84-hour pumping test was conducted on MW 1-9B on June 3, 1998, beginning at 11:00. The pumping test was completed at a pumping rate of 80 gallons per minute. At 15:15 on June 2, 1998, pressure transducers with dataloggers were placed in the MW 1-9, MW 1-9B, MW 1-8, and MW 1-8B. Frequent hand measurements were collected as a back up for all of these wells. Periodic hand measurements were collected from the other wells (MW 1-6, MW 1-7, MW 2-2, MW 2-3, and MW 2-4) and at the staff gauge in Basin 1.

At the end of the pumping test, a sample was collected from the pumping well for analysis of parameters on PP&L's annual monitoring list.

6. A 12-hour pumping test was conducted on MW 1-8B on June 4, 1998, beginning at 07:00. The pumping test was initiated at 88 gallons per minute, and after 90 minutes was reduced to 81 gallons per minute because drawdown was occurring too rapidly and would reach the pump within the 12 hours of the test. The pressure transducers were not removed from the wells between the two pumping tests, recording recovery and background the night of June 3, 1998. Frequent hand measurements were collected as a back up in all wells. Periodic hand measurements were collected from the other Basin 1 wells and MW 2, MW 2-2, MW 2-3, MW 2-4, and the staff gauge in Basin 1. At the end of the pumping test, a sample was collected from the pumping well for analysis of parameters on PP&L's annual monitoring list.

7. Pressure transducers were removed from the wells and a round of water levels were measured in the surrounding wells on June 5, 1998, at approximately 09:00, at which time the wells were locked and all debris and equipment was removed from the site.

cc. Don Ostiko, PP&L
Larry LaBuz, PP&L
Steve Holler, PP&L
Richard Wardrop, NGS

APPENDIX B

Summary of Previous Geophysical and Environmental Investigations

NITTANY GEOSCIENCE INC.

B-1.0 PREVIOUS GEOPHYSICAL STUDIES

A number of geophysical surveys have been conducted in areas of the Martins Creek SES. The earliest survey was conducted by Weston Observatory in 1951 and utilized seismic refraction and correlative borings to determine the depth to bedrock and type of overburden material (Weston Observatory, 1951). This study was used to locate plant structure sites.

In 1969, Weston Geophysical conducted geophysical investigations and borings to evaluate the suitability of the area northwest of the current SES for a nuclear facility. The survey resulted in the delineation of an area of desirable bedrock depths and rock conditions for the construction of the power plant. The profile sections resulting from the survey show a characteristically pinnacled bedrock surface (Weston Geophysical Engineers Inc., 1969; Weston Geophysical Research, Inc., 1969). Ultimately, the area was determined to not be suitable for a nuclear facility, and two additional oil generators. An extensive boring program was conducted by Gilbert Associates in 1971 and 1972 in the vicinity of the proposed generator buildings and cooling towers.

Several more recent investigations have been conducted in support of industrial waste and ash basin siting, construction, and monitoring. In 1975, borings were drilled to investigate the site of proposed Industrial Waste Basin #3.

An electrical resistivity survey and fracture trace analysis was conducted on the lower terrace (Basin No. 1) and the upper terrace (Basins 2 and 3) of the site. The purpose of the survey was to study subsurface conditions within and adjacent to the bottom ash basin at the site with the potential environmental impact of possible seepage of particular concern. The study concluded that the weathered bedrock surface beneath the northern portion of the bottom ash basin was at depths ranging from 56 to 71 feet and that the weathered horizon is approximately 50 feet thick. In addition, several areas of low resistivity, representative of weathered bedrock, possible sinkholes or depressions were detected beneath the northern portion of the basin. Fracture traces were identified on aerial photographs which correlated with the resistivity lows (International Exploration, Inc., 1982).

In 1986, Skelly and Loy were contracted to conduct investigations and geophysical studies the purpose of which was to investigate the appropriateness of five fly ash disposal areas, one of which was ultimately selected and Basin 4 was constructed.

Geophysical surveys, drilling and overburden sampling programs, and on-site geohydrological investigations were conducted at each of the preselected sites. The preferred location had was described as follows:

> Overburden Thickness: Geophysical investigations and the drilling program conducted on this site confirm that the overburden within this site is uniformly thick and in excess of 50 feet.
>
> Soil Characteristics: Laboratory results indicate surface soils to a depth of three feet have excellent qualities and quantity for use in embankment construction.
>
> Bedrock Permeability: Bedrock is at a depth such that the rock permeability is not an important factor.
>
> Geologic Considerations: No geologic impacts were identified within this site during the investigation.
>
> Hydrologic Considerations: Wells in the general vicinity are in excess of 200 feet and should not be impacted by the location or construction of the ash disposal basin on-site.
>
> Other Considerations: The only detrimental property identified at the site is the high coefficient of permeability exhibited by a remolded soil sample, which could be lowered to meet the standard by increasing compaction during the placement of the clay liner (Skelly and Loy, February 1986).

Also in 1986, electromagnetic (EM) and resistivity methods were used to evaluate subsurface conditions downgradient of Basin No. 1. Anomalous zones were identified by the EM survey. Anomalous zones interpreted as indicating areas with fractured limestone were correlated with fracture traces identified in a previous study and the previous resistivity profiling. An anomalous zone was classified as possible contamination (near abandoned MW-8). An anomalous zone was classified as "unknown" (located between abandoned MW-6 and MW-7, on the lower terrace) may have been due to buried metal or may represent an area of fractured limestone. Resistivity vertical soundings were located on the anomalous zones identified by the EM survey. Two additional downgradient monitoring wells were recommended (Delta Geophysical Services, September 1986).

In 1986 Weston Geophysical Corporation conducted a geophysical investigation of the proposed Ash Basin No. 4. The investigation identified numerous areas of weathered or solutioned bedrock in the southeast portion of the area and significantly less weathering on the northwest side of the area, where Basin 4 was ultimately constructed.

B-2.0 PREVIOUS ENVIRONMENTAL STUDIES

Aquifer Characteristics and Sampling Procedures, September 1987, Dunn Geoscience Corporation.

The purpose of the investigation was to collect data to determine the purging protocol and aquifer characteristics proximal to four newly installed monitoring wells, three of which peripheral to Basin 3 (MW 3-1, 3-2, and 3-3) and MW-1-8 at Basin No. 1. The results of this investigation were that all four wells would produce a representative groundwater sample. The parameters measured, temperature, pH, and specific conductivity, stabilized after eight to nine well volumes of water were pumped from the well. Neither the pumping/recovery testing nor the slug/bailing testing was not successful because sufficient drawdown could not be obtained to interpret the results.

Summary of Environmental Assessment of Groundwater and Surface Water Quality, March 1994, Nittany Geoscience, Inc.

Because monitoring had suggested that groundwater degradation may have been occurring in the vicinity of the Basin, the Pennsylvania Residual Waste Regulations required that an assessment of the possible impacts be conducted. The *Summary of Environmental Assessment of Groundwater and Surface Water Quality* presented the results of the assessment. The conclusions of the assessment are summarized below.

1. The monitoring well system was evaluated and found to be suitable for detecting groundwater degradation, and with minor exceptions, to be in compliance with the Residual Waste Regulations.
2. There have been very few exceedances of groundwater parameters at Basin No. 1 monitoring wells, and no exceedances since 1983. None of the exceedances prior to 1983 have clearly been caused by the operation of Basin No. 1.
3. Impacts at downgradient wells which appear to be related to operation of the Basin are slightly elevated (above background levels) concentrations of boron, selenium, and strontium. Neither boron nor strontium has exceeded their groundwater parameter. Selenium has exceeded its groundwater parameter, but the exceedance was likely due to past ash-handling practices.

There are no residential wells downgradient of Basin No. 1, and the residential wells nearest the basin, which are voluntarily monitored, had not shown an impact from the basin.

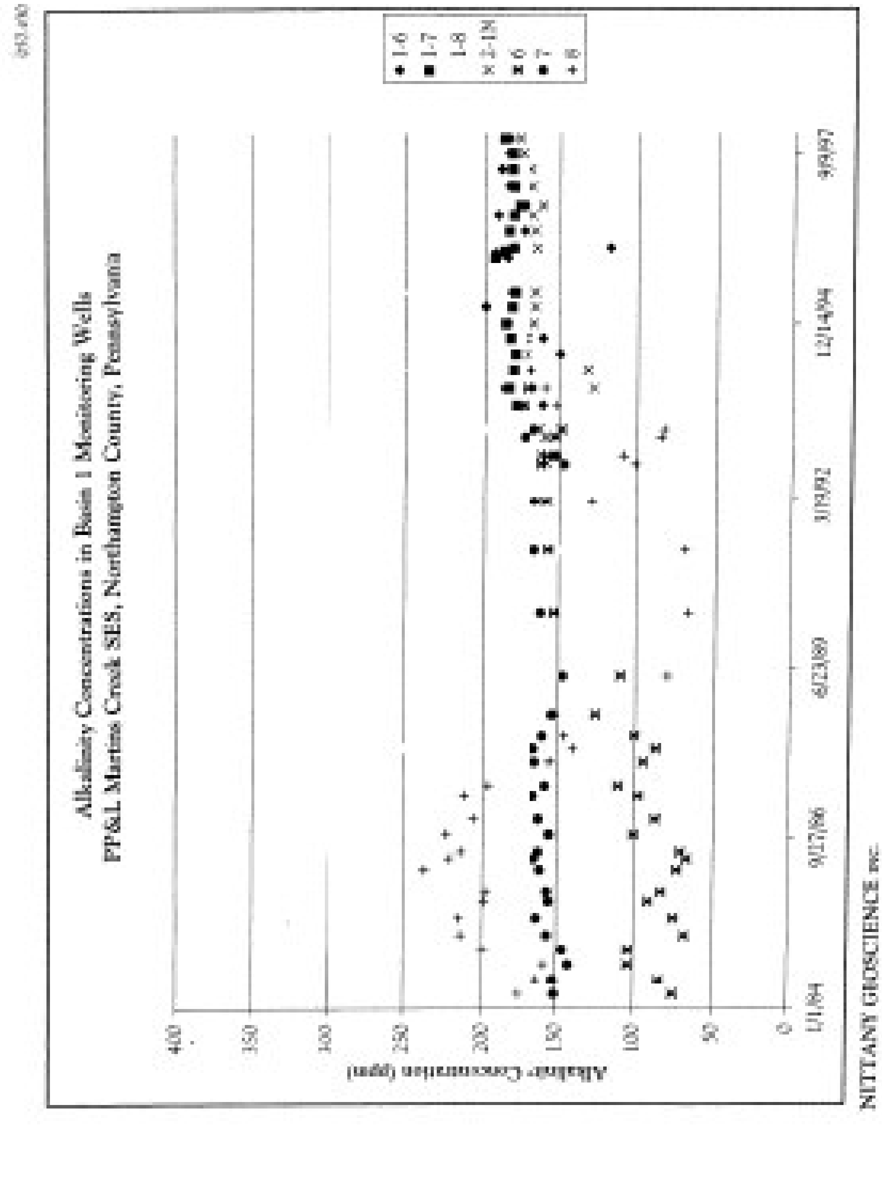
Impacts to surface water from Basin seepage were not found. Groundwater that has been impacted by the Basin could adversely affect aquatic life, although this is unlikely due to the high dilution, and the infrequent exceedance of water quality standards for fish and aquatic life. (Nittany Geoscience, Inc., March 1994).

4.01/057.030

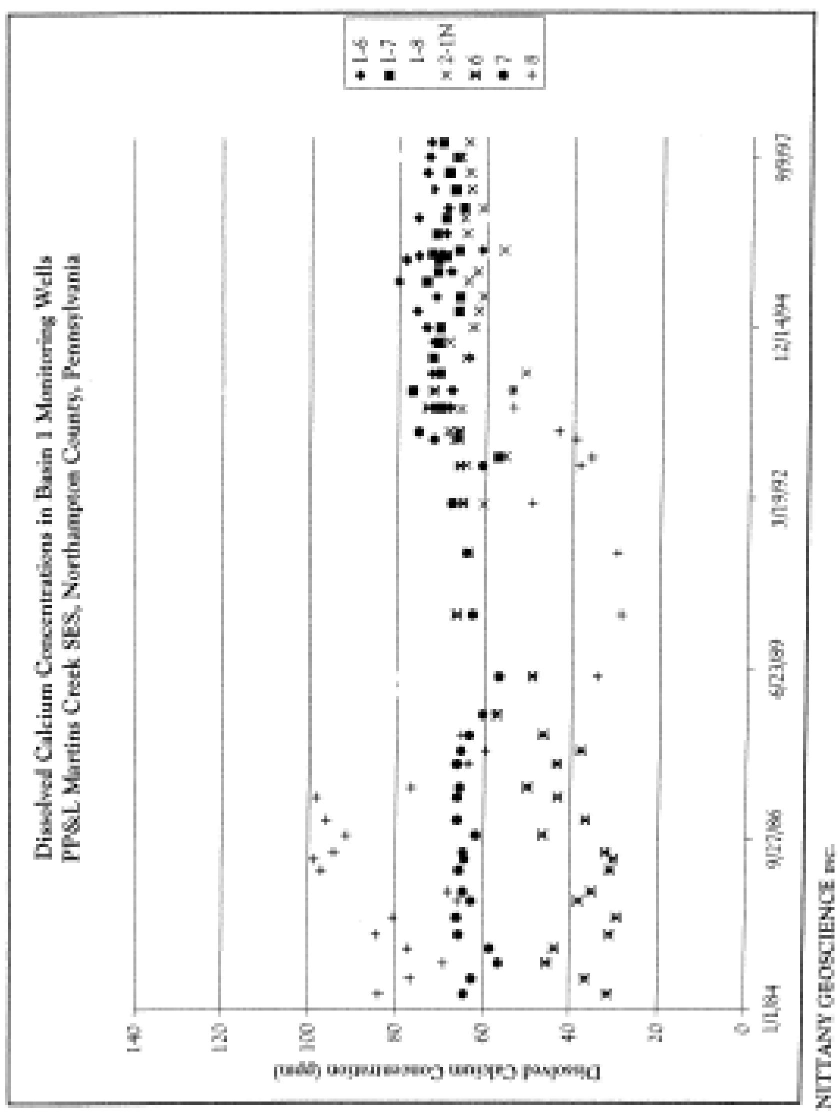
APPENDIX C

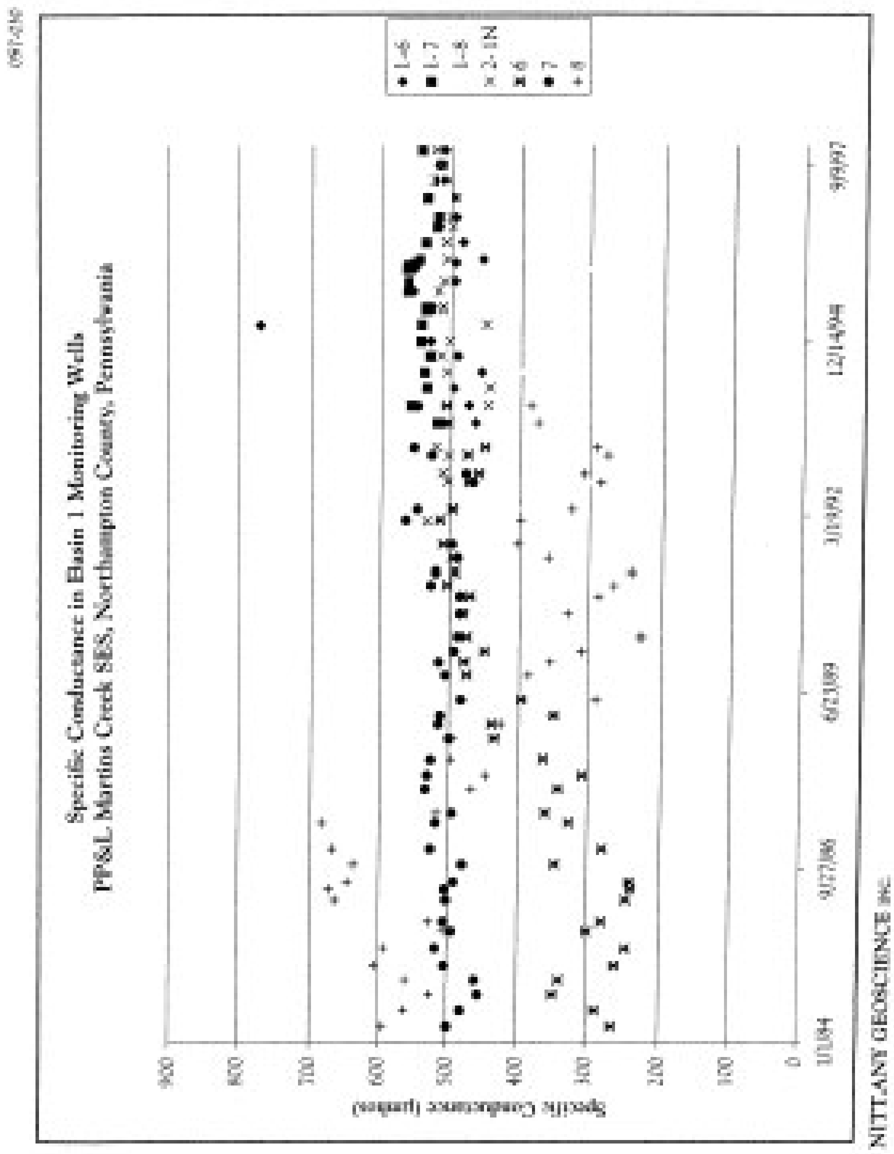
Graphs of Indicator Parameters in Basin No. 1 Monitoring Wells

NITTANY GEOSCIENCE INC.

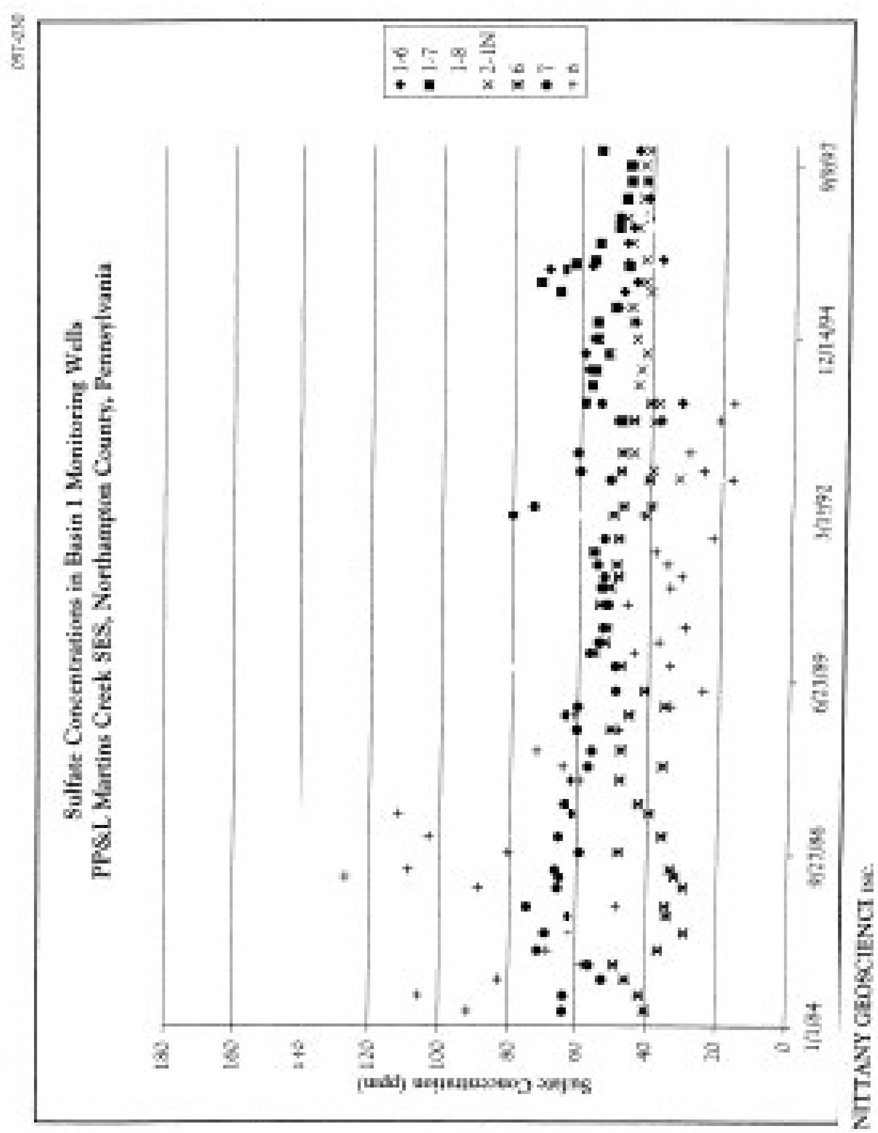


Alkalinity Concentrations in Basin 1 Monitoring Wells
PP&L Martins Creek SES, Northampton County, Pennsylvania
Alkalinity Concentration (ppm)
1/1/84
9/17/86
6/23/89
3/19/92
12/14/94
9/9/97
NITTANY GEOSCIENCE inc.


Dissolved Calcium Concentrations in Basin 1 Monitoring Wells
PP&L Martins Creek SES, Northampton County, Pennsylvania
Dissolved Calcium Concentration (ppm)
1/1/84
9/27/86
6/23/89
3/19/92
12/14/94
9/9/97
NITTANY GEOSCIENCE inc.



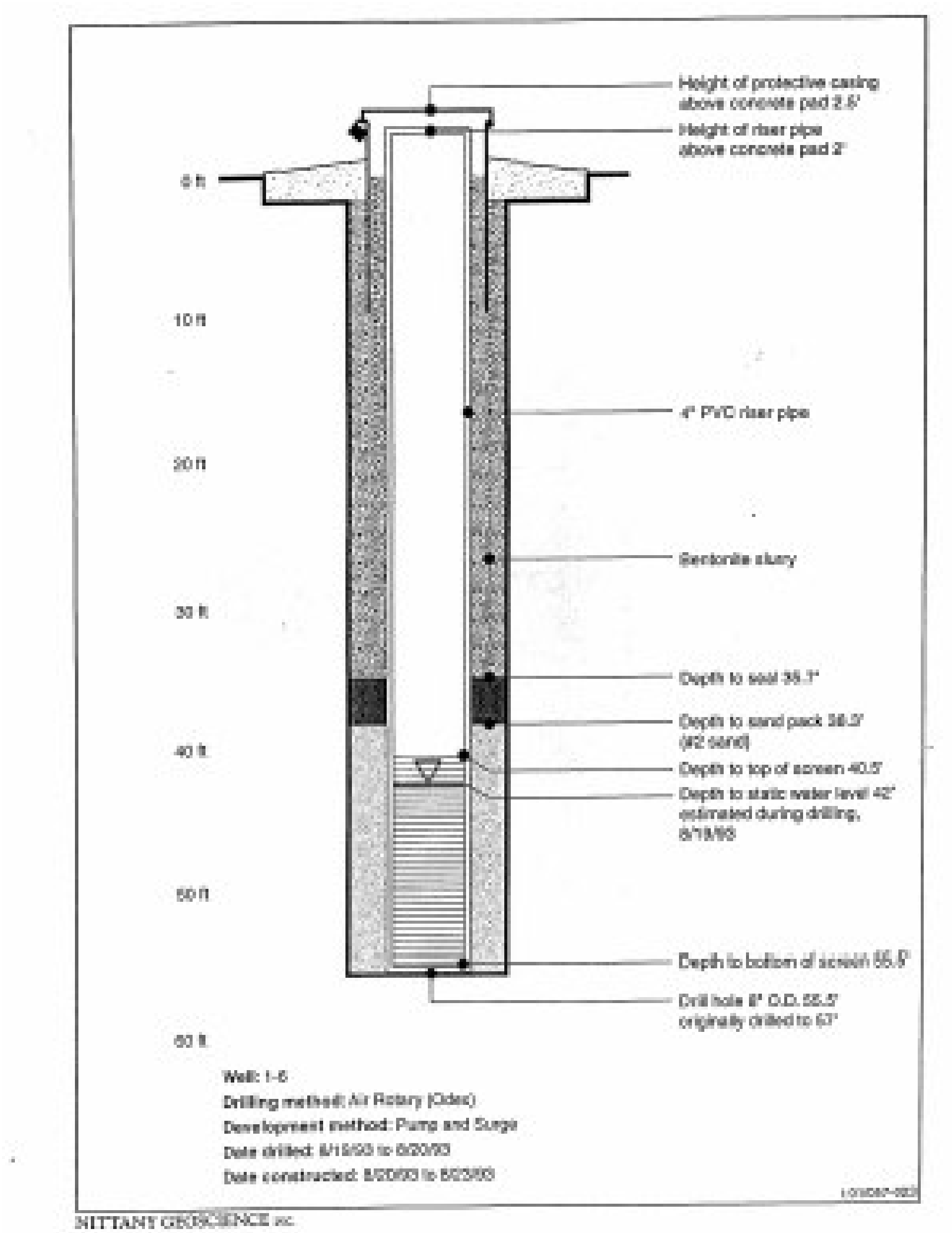
Specific Conductance in Basin 1 Monitoring Wells
PP&L Martins Creek SES, Northampton County, Pennsylvania
Specific Conductance (µmhos)
900
800
700
600
500
400
300
200
100
0
1/1/84
9/27/86
6/23/89
3/19/92
12/14/94
9/9/97
I-6
I-7
I-8
2-1N
6
7
8
NITTANY GEOSCIENCE INC

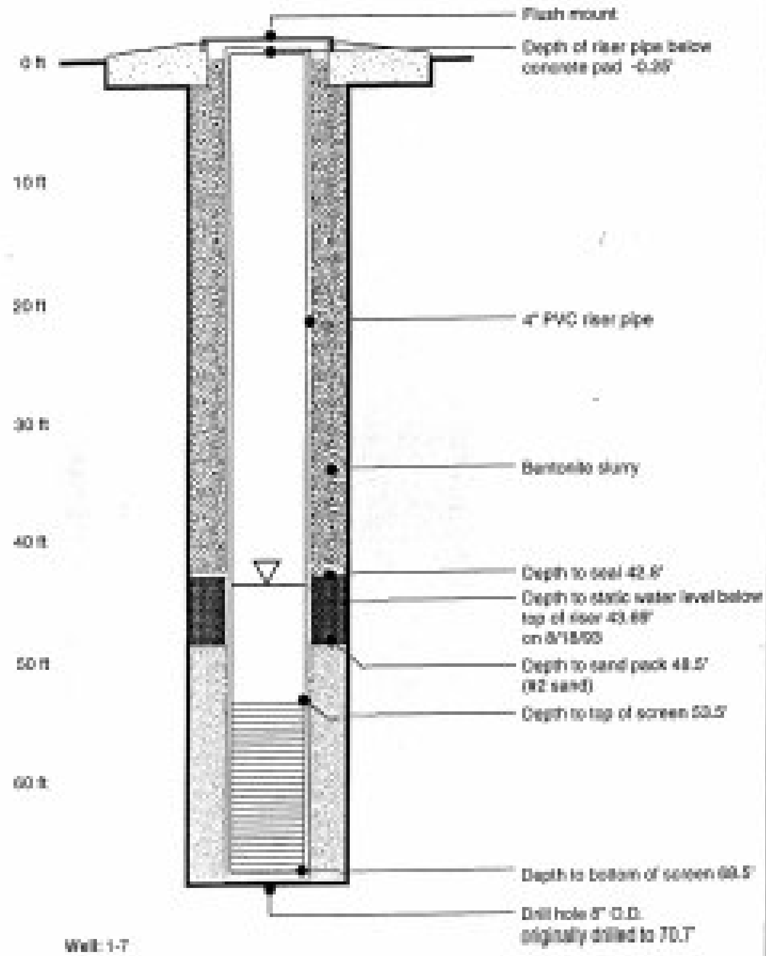

Sulfate Concentrations in Basin 1 Monitoring Wells
PP&L Martins Creek SES, Northampton County, Pennsylvania
Sulfate Concentration (ppm)
1/1/84
9/23/86
6/23/89
3/31/92
12/14/94
9/9/97
1-6
1-7
1-8
2-1N
6
7
8
NITTANY GEOSCIENCE inc.

APPENDIX D

Well Logs and Construction Diagrams for Basin No. 1 Wells

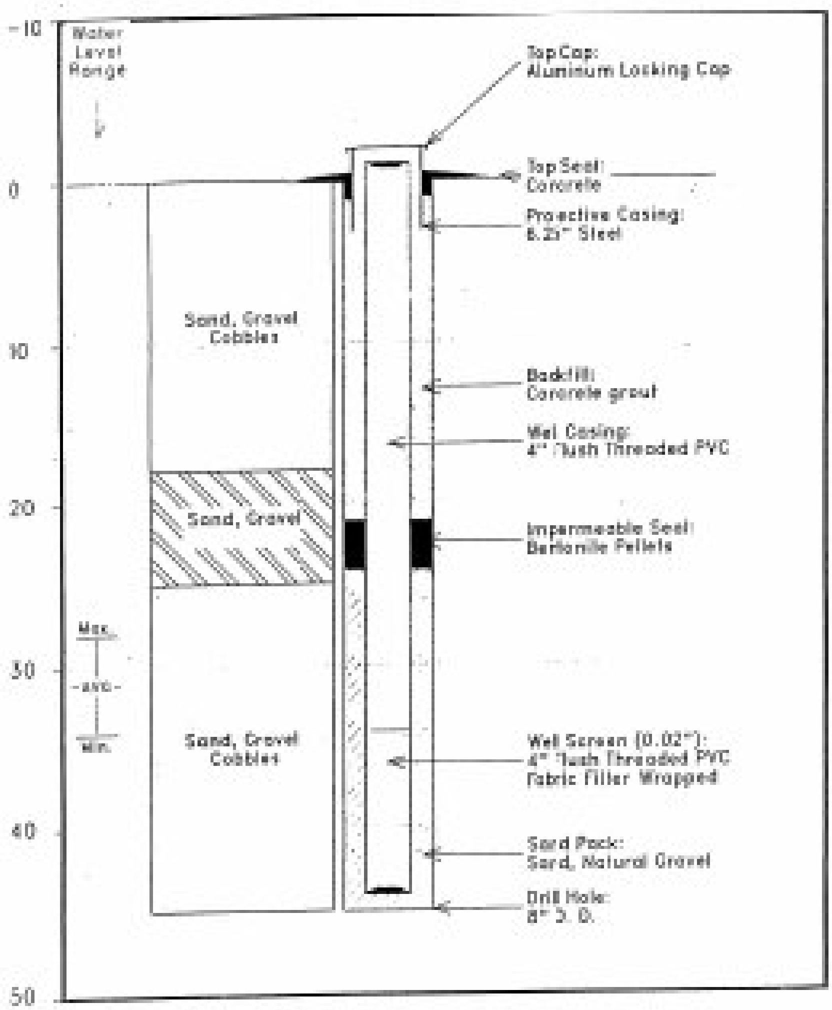
NITTANY GEOSCIENCE INC.


Height of protective casing above concrete pad 2.5'
Height of riser pipe above concrete pad 2'
0 ft
10 ft
4" PVC riser pipe
20 ft
Bentonite slurry
30 ft
Depth to seal 35.7'
Depth to sand pack 38.5' (#2 sand)
40 ft
Depth to top of screen 40.5'
Depth to static water level 42' estimated during drilling, 8/19/93
50 ft
Depth to bottom of screen 55.5'
Drill hole 8" O.D. 55.5' originally drilled to 67'
60 ft
Well: 1-6
Drilling method: Air Rotary (Odex)
Development method: Pump and Surge
Date drilled: 8/19/93 to 8/20/93
Date constructed: 8/20/93 to 8/23/93
NITTANY GEOSCIENCE INC.

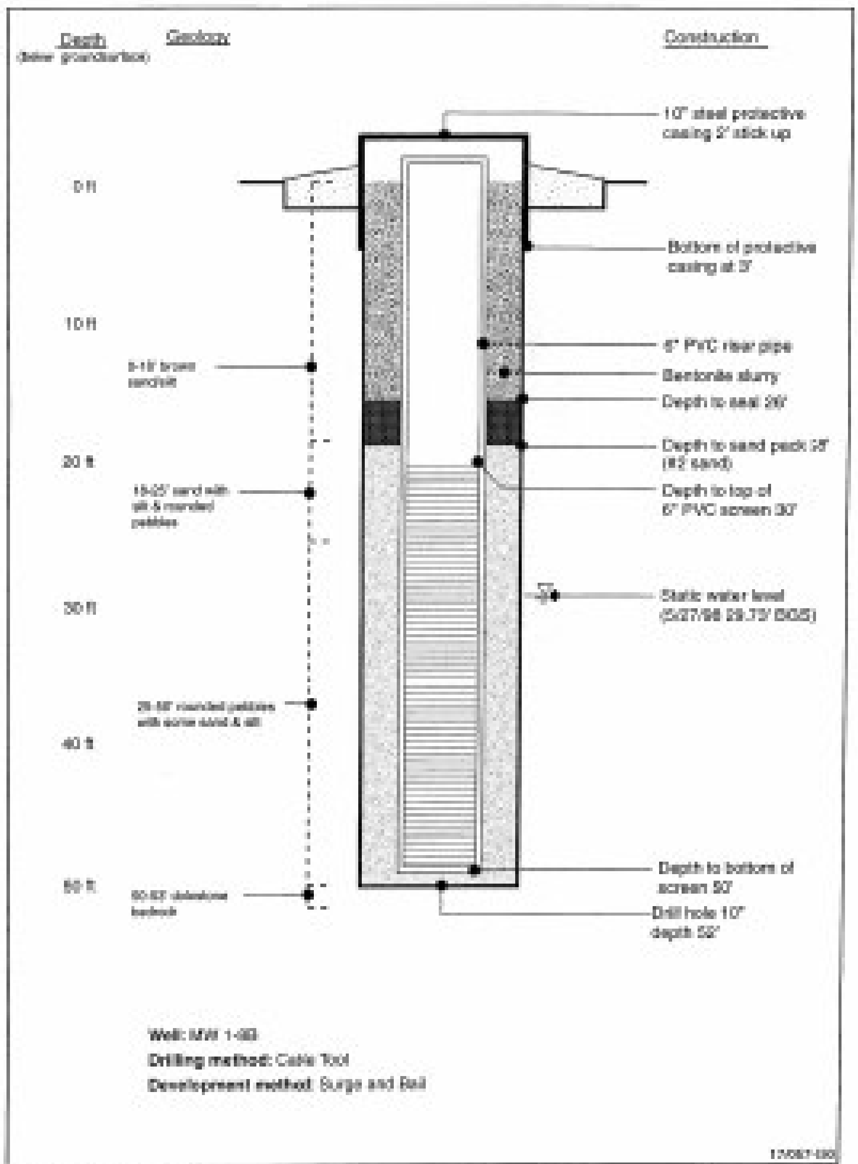


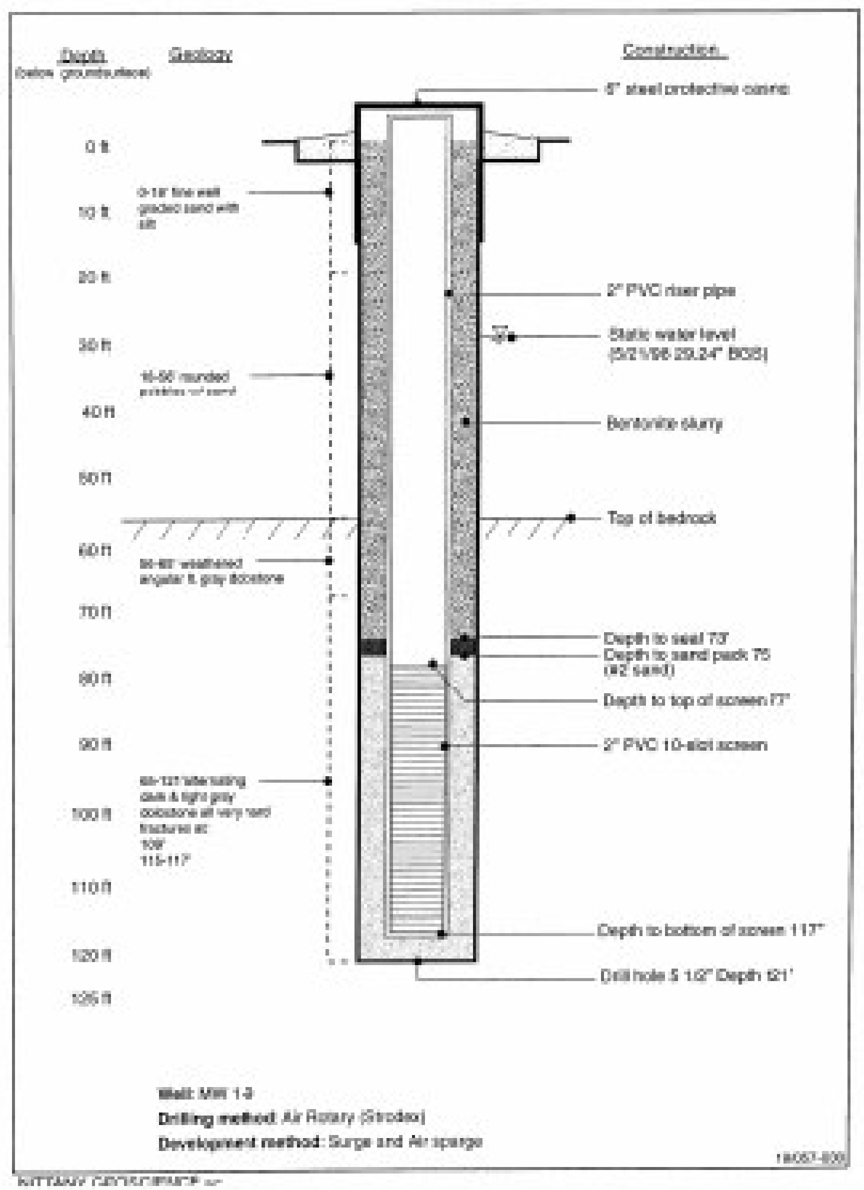
Well: 1-7
Drilling method: Air Rotary (Odex)
Development method: Pump and Surge
Date drilled: 8/17/93 to 8/18/93
Date constructed: 8/18/93 to 8/19/93

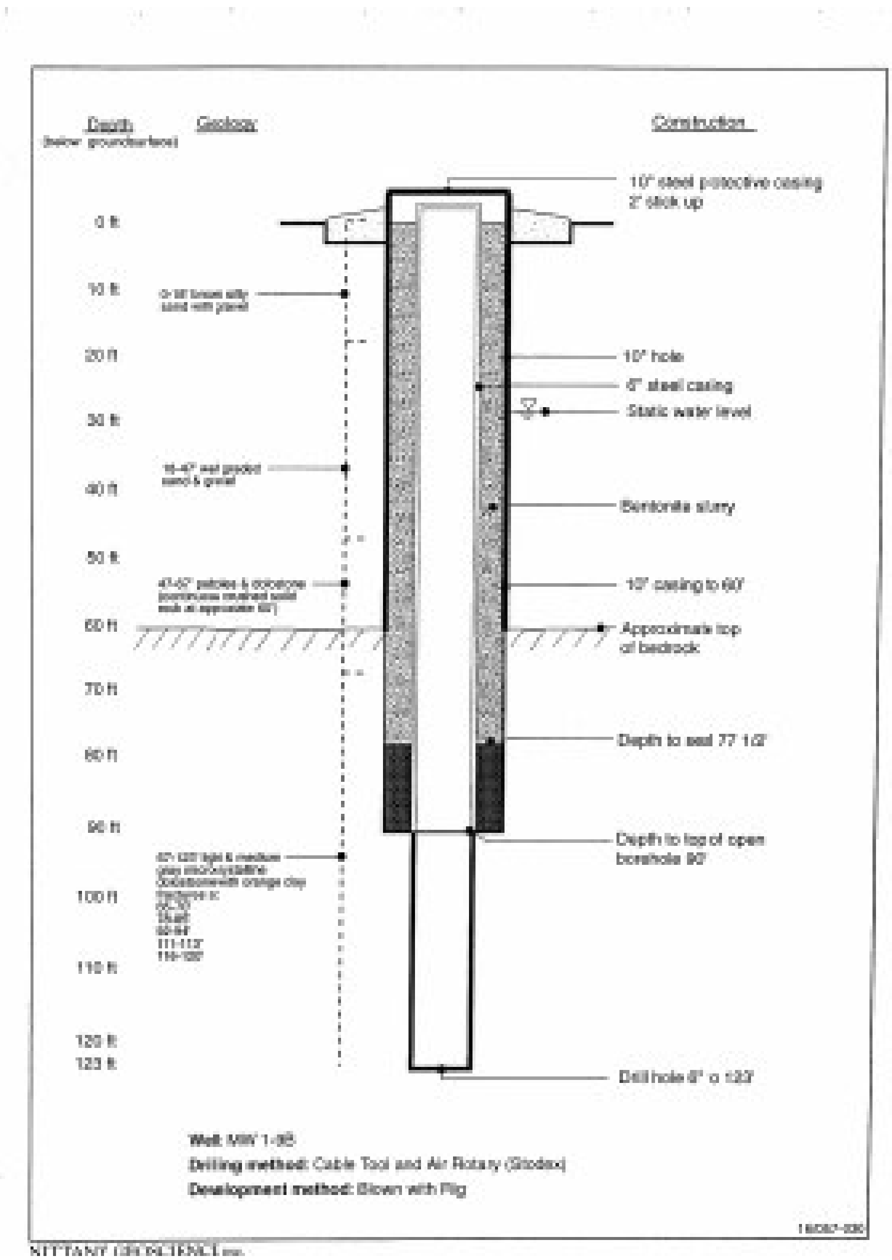
PP&L
MARTINS CREEK S.E.S.
MONITORING WELL CONSTRUCTION DETAIL
GWMW 1-8



Installation Date: 11/05/86


Depth
Geology
Construction
0 ft
10 ft
20 ft
30 ft
40 ft
50 ft
10" steel protective casing 2' stick up
Bottom of protective casing at 3'
6" PVC riser pipe
Bentonite slurry
Depth to seal 26'
Depth to sand pack 28' (#2 sand)
Depth to top of 6" PVC screen 30'
Static water level (5/27/98 29.75' BGS)
Depth to bottom of screen 50'
Drill hole 10" depth 52'
Well: MW 1-98
Drilling method: Cable Tool
Development method: Surge and Bail


Depth
(below groundsurface)
Geology
Construction
0 ft
10 ft
20 ft
30 ft
40 ft
50 ft
60 ft
70 ft
80 ft
90 ft
100 ft
110 ft
120 ft
125 ft
6" steel protective casing
2" PVC riser pipe
Static water level
Bentonite slurry
Top of bedrock
Depth to seal 73'
Depth to sand pack 75
(#2 sand)
Depth to top of screen 77'
2" PVC 10-slot screen
Depth to bottom of screen 117'
Drill hole 5 1/2" Depth 121'
Drilling method: Air Rotary
Development method: Surge and Air sparge



Depth
(below groundsurface)
Geology
Construction
10" steel protective casing
2' stick up
0 ft
10 ft
20 ft
30 ft
40 ft
50 ft
60 ft
70 ft
80 ft
90 ft
100 ft
110 ft
120 ft
123 ft
10" hole
6" steel casing
Static water level
Bentonite slurry
10" casing to 60'
Approximate top
of bedrock
Depth to seal 77 1/2'
Depth to top of open
borehole 90'
Drill hole 6" o 123'
Well: MW 1-95
Drilling method: Cable Tool and Air Rotary (Stodex)
Development method: Blown with Rig

AIR-ROTARY DRILLING LOG

Client: PP&L Martins Creek S.E.S.

Project No. 93506 Phase Task

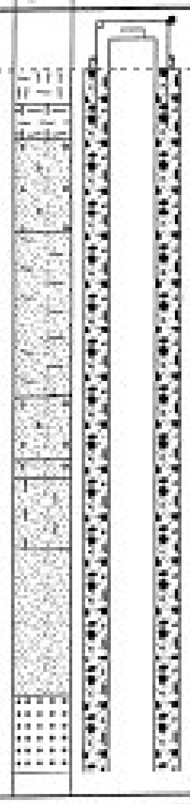
Boring No. MW 2-1M Piezometer No.

Location

Surface Elev. FT.

Page 1 of 2

Depth Feet	Blow Counts	Sampler	Recovery/RQD	Overburden/Lithologic Description	PID (ppm)	Graphic Log	Well Construction Graphics	Depth Feet	Well Construction Details
									T.O.C. Elev.
0	Ground Surface			Silty Clay: reddish-brown, trace gravel, slightly moist.				0	
				Clayey Silt: brown, trace gravel, slightly moist.					
5				Silty Sand: brown, 10% moderately well rounded gravel, trace clay, slightly moist. 40% gravel at 11'				5	
10								10	
15				Silty Sand: brown, fine-grained, 10% moderately well rounded gravel, trace clay, trace wood fragments, slightly moist.				15	
20								20	Bentonite Grout
25								25	
30				Sandy Gravel: medium grey, coarse, well rounded, trace clay, slightly moist.				30	
35				Gravelly Sand: brown, fine-grained, 40% well rounded gravel, slightly moist.				35	
				Clayey Sand: reddish-brown, fine-grained, slightly moist.					
40				Sand: brown, fine-grained, 10% moderately well rounded gravel, trace clay, slightly moist.				40	6" protective steel casing to 12 ft
45								45	
50				40% well rounded gravel at 49'				50	
55				Gravel: grey, well rounded, trace fine-grained sand, slightly moist to moist.				55	
60								60	



Continued Next Page

Driller Miller Pump Service

Logged By D. Brandon (RSG&R)

Drilling Started 12/4/91

Drilling Completed 12/4/91

Construction Completed 12/4/91

Development Completed 12/10/91

Water Bearing Zones 80' and 115'

Blown/Bailed Yield > 10 gpm

Well Casing 4" Dia. 0.0' to 85.0'

Casing Type Schedule 40 PVC

Well Screen 4" Dia. 85.0' to 125.0'

Screen Type Schedule 40 PVC

Slot Size 0.020"

Drilling Mud N/A

Grout Type 5% Bentonite Grout

Bentonite Seal 71.5-80.0'

Filter Pack Qty 4 cu.ft

Filter Pack Type/Morie #0 sand

Static Water Level MSL

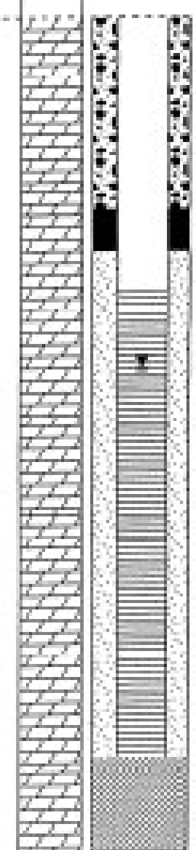
Date

Notes:

Form

Client: PP&L Martins Creek S.E.S.
Project No: 52580 Phase Task
Surface Elev. ??, Page 2 of 2

Depth Feet	Blow Count	Sampler No.	Recovery/ RQD	Overburden/Lithologic Description	PID (ppm)	Graphic Log	Well Construction Graphics	Depth Feet	Well Construction Details
				Continued from previous page					
				Dolomite: dark grey, finely crystalline, argillaceous, abundant fractures filled with calcite					
				Fracture at 67'					
				Dolomite: dark grey, finely crystalline, argillaceous.					
				Fracture at 75'					
				Dolomite: medium grey, finely crystalline, argillaceous, abundant fractures filled with calcite, trace chert.					Bentonite Seal
				Water bearing fracture zone at 88'					
				Dolomite: dark grey, medium crystalline, trace fractures filled with calcite, trace chert.					Marie #0 sand pac:
				Dolomite: dark grey, finely crystalline, argillaceous, abundant fractures filled with calcite, trace chert.					
				Water bearing fracture zone at 115'					
									Cavings
									Total depth 131.8



Form Wel-LC-1 ???

r.e. wright associates, inc.

PPL Martins Creek Basin #1

Tables

Table 1: Well, Piezometer, and Test Boring Characteristics

Location Number	Ground Elevation (ft msl)	Total Depth (ft bgs)	Depth to Top of Sand Pack (ft bgs)	Depth to Bottom of Sandpack (ft bgs)	Length of Sand Pack (feet)	Screen & Riser Diameter (inches)	Screen Slot size (inches)	Screened Media	Lithology
Monitoring Wells									
MW 1-6	242.046	57.0	38.3	57.0	18.7	4	Unknown	Overburden/Bedrock	Unknown
MW 1-7	247.372	70.7	48.5	70.7	22.2	4	Unknown	Overburden/Bedrock	Unknown
MW 1-8	242.295	45.0	24.0	45.0	21.0	4	0.02	Overburden	Sand, gravel, and cobbles
MW 1-9	241.996	121.0	75.0	121.0	46.0	2	0.01	Bedrock	Dolostone
MW 1-10	213.546	22.5	10.0	22.5	12.5	4	0.01	Overburden	Gravel, sand, and boulders
MW 1-11	221.36	23.5	10.5	23.5	13.0	4	0.01	Overburden	Gravel, with clay
Piezometers									
PZ/TB 1-2	264.27	63.0	48.0	63.0	15.0	2	0.02	Berm Subgrade	Sand and gravel
PZ/TB 1-3	264.211	45.0	23.0	36.0	13.0	2	0.01	Berm	Fly ash, with bottom ash
PZ/TB 1-5	265.17	53.0	11.0	23.0	12.0	2	0.01	Basin Material	
PZ/TB 1-8	245.33	45.0	31.0	43.0	12.0	2	0.01	Berm Subgrade	Sand and gravel
PZ 1-10	236.747	36.0	23.0	36.0	13.0	2	0.02	Overburden	Gravel with sand
PZ 1-11	263.985	62.0	50.0	62.0	12.0	2	0.02	Berm Subgrade	Gravel with sand
PZ/TB 1-12	263.604	45.0	22.0	36.0	14.0	2	0.01	Berm	Silty Sand
PZ/TB 1-17	265.813	62.0	46.0	58.5	12.5	2	0.02	Basin Subgrade	Sand and gravel with silt
MC 1	265.337	23.7	Unknown	Unknown	Unknown	Unknown	Unknown	Basin Material	Unknown
MC 3	247.712	36.7	Unknown	Unknown	Unknown	Unknown	Unknown	Basin Material	Unknown
Test Borings									
TB 1-1	264.32	45.0	NA	NA	NA	NA	NA	NA	NA
TB 1-3l	263.824	49.5	NA	NA	NA	NA	NA	NA	NA
TB 1-4	264.624	48.0	NA	NA	NA	NA	NA	NA	NA
TB 1-6	244.39	25.5	NA	NA	NA	NA	NA	NA	NA
TB 1-7	241.352	10.0	NA	NA	NA	NA	NA	NA	NA
TB 1-9	264.172	37.5	NA	NA	NA	NA	NA	NA	NA
TB 1-13	262.971	45.0	NA	NA	NA	NA	NA	NA	NA
TB 1-14	264.064	64.0	NA	NA	NA	NA	NA	NA	NA
TB 1-15	254.014	10.0	NA	NA	NA	NA	NA	NA	NA
TB 1-16	249.991	10.0	NA	NA	NA	NA	NA	NA	NA

NA = Not available.

Table 2: Water Level Elevations

Location Number	Measure Pt. Elevation (ft msll)	Date of Water Level Measurement											
		11/3/2005		11/10/2005		11/16/2005		11/22/2005		12/14/2005		12/20/2005	
		Depth to Water (feet)	Water Level Elevation (ft msll)	Depth to Water (feet)	Water Level Elevation (ft msll)	Depth to Water (feet)	Water Level Elevation (ft msll)	Depth to Water (feet)	Water Level Elevation (ft msll)	Water (feet)	Water Level Elevation (ft msll)	Water (feet)	Water Level Elevation (ft msll)
Monitoring Wells													
MW 1-6	244.35	38.51	205.84	39.09	205.26	39.34	205.01	38.95	205.40	39.62	204.73	38.95	205.40
MW 1-7	247.37	39.71	207.66	40.24	207.13	40.49	206.88	40.19	207.18	40.35	207.02	40.14	207.23
MW 1-8	242.30	30.8	211.50	31.77	210.53	32.22	210.08	31.86	210.44	31.95	210.35	31.78	210.52
MW 1-9	242.00	30.87	211.13	31.74	210.26	32.18	209.82	31.78	210.22	31.86	210.14	31.7	210.30
MW 1-10	213.55	9.3	204.25	9.64	203.91	10.02	203.53	9.58	203.97	9.95	203.60	9.35	204.20
MW 1-11	220.75	15.45	205.30	15.65	205.10	16.02	204.73	15.4	205.35	NM	NM	15.42	205.33
Piezometers													
PZ 1-3S	264.49	35.58	228.91	Dry	NA	Dry	NA	34.58	229.91	33.43	231.06	34.14	230.35
PZ 1-2D	264.55	53.53	211.02	54.39	210.16	54.82	209.73	54.44	210.11	54.91	209.64	54.39	210.16
PZ 1-5S	265.45	Dry	NA	Dry	NA	Dry	NA	Dry	NA	Dry	NA	Dry	NA
PZ 1-10	236.75	24.42	212.33	25.36	211.39	25.89	210.86	25.46	211.29	25.58	211.17	25.36	211.39
PZ 1-11	263.99	51.96	212.03	52.86	211.13	53.4	210.59	52.95	211.04	53.09	210.90	52.88	211.11
PZ 1-12S	263.88	Dry	NA	Dry	NA	Dry	NA	Dry	NA	NM	NM	Dry	NA
PZ 1-17D	266.09	54.84	211.25	55.78	210.31	56.31	209.78	55.84	210.25	55.95	210.14	55.7	210.39
PZ 1-8D	245.61	35.04	210.57	35.64	209.97	36.29	209.32	35.69	209.92	35.72	209.89	35.37	210.24
MC 1	265.337	NM	NM	Dry	NA	Dry	NA	Dry	NA	Dry	NA	Dry	NA
MC 3	247.712	NM	NM	36.62	211.09	Dry	NA	Dry	NA	Dry	NA	Dry	NA

NA = Not available.
NM = Not measured.

Permit No.	301256
Dated Issued	October 30, 2000
Date Expires	August 12, 2009

PART III

Permit Conditions Specific to the Ash Basin No. 1 Disposal Impoundment

I. General Conditions:

1. This permit authorizes the operation of a local, captive Class II residual waste disposal impoundment, identified as Ash Basin No. 1, by PPL Martins Creek, LLC which consists of a 13.2 acre disposal area (a/k/a North End) inside a 30 acre permit area within a 860 acre property, pursuant to the Approved Application. The Ash Basin No. 1 permit area is depicted on Drawing D242663, Sheet 5 entitled "Martins Creek S.E.S. Ash Basin No. 1 and 4 Permit Modification Drawing Property Plan" signed and sealed by Andrew Spear, P.E., received 9/10/97. The non-disposal area (a/k/a South End) of 9 acres to be closed is depicted on Drawing D242663 (South End Closure Plan), Sheet 8, received 6/15/98. The North End and South End are separated by an existing internal berm/access road that divides the basin into two areas, which is depicted on Drawing D242663, Sheet 2 (Ash Surface Conditions 1994), received 9/10/97. The 13.2 acre North End disposal area is depicted in closed condition on Drawing D242633, Sheet 10 (Closure Plan North End), received 6/15/98. Disposal outside the North End area depicted on Drawing D242633, Sheet 10 is forbidden.

2. This approval, herein granted, is limited to the disposal of coal ash and other approved residual wastes meeting the minimum acceptability criteria set forth in 25 PA Code §289.523 from the PPL Martins Creek, LLC Martins Creek Steam Electric Station power plant located in Lower Mount Bethel Township, Northampton County, Pennsylvania.

3. This approval is limited to the following categories of waste:

   a. Bottom ash
   b. Fly ash, if approved by the Department
   c. Uncontaminated, nonwaste, river sediment from the Martins Creek Steam Electric Station's water intakes

Permit No.	301256
Dated Issued	October 30, 2000
Date Expires	August 12, 2009

No other waste types are approved for this facility.

4. This Waste Management permit application was prepared by Andrew D. Spear, P.E. for PPL Martins Creek, LLC, and submitted to the Northeast Regional Office: The approved application consisted of the following submittals:

   a. Permit Reissuance Application:

      1. Cover Letter(s) and Attachments (received 12/29/99, 1/12/2000, 2/2/2000, 6/7/2000, 7/6/2000 and 7/17/2000)
      2. Draft Public Notice (received 2/2/2000)
      3. Permit Application – General Information (received 1/12/2000, revised 2/2/2000)
      4. Form A – Application for Residual Waste Permit (received 12/29/99, revised 2/2/2000)
      5. Form B – Professional Certification (received 6/7/2000)
      6. Form B1 – Application for Certification (1/12/2000)
      7. Form HW-C – Compliance History (received 12/29/2000)
      8. Form C1 – Compliance History Certification (2/2/2000)
      9. Form E – Contractual Consent of Landowner (received 12/29/99)
      10. Drawing D242663 Sheet 3 (Ash Basin No. 1 Permit Modification Drawing Property, Lithology & Wetlands Plan) (received 12/29/99)
      11. Drawing D242663 Sheet 5 (Ash Basin No. 1 & 4 Permit Modification Drawing Property Plan) (received 6/7/2000)

   b. The Application for Minor Permit Modification, approved 6/27/2000, is incorporated by reference.

Permit No.	301256
Dated Issued	October 30, 2000
Date Expires	August 12, 2009

c. Original Permit Application:

1. Permit Application - General Information (received 8/9/96, revised 9/10/97)
2. Form A - Application for RSW Permit (received 8/9/96, revised 9/10/97, & 6/15/98)
3. Form B - Professional Certification (received 8/9/96, 9/10/97)
4. Form B1 - Application for Certification (received 8/9/96)
5. Form C-1 - Compliance History Certification (received 8/9/96)
6. Form D - Environmental Assessment (received 8/9/96, revised 9/10/97)
7. Form E - Contractual Consent of Landowner (received 8/9/96)
8. Form F - Soils Information Phase I (received 8/9/96, revised 9/10/97)
9. Form H - Revegetation (received 8/9/96, revised 9/10/97)
10. Form I - Soil Erosion and Sedimentation Controls (received 8/9/96, revised 9/10/97, 6/15/98)
11. Form J - Soils Information Phase II (received 8/9/96, revised 9/10/97)
12. Form L - Contingency & PPC Plan (received 8/9/96, revised 9/10/97 & 6/15/98)
13. Form Q - Equivalency for 1 foot final cover (received 8/9/96)
14. Form R - Waste Analysis & Classification Plan (received 8/9/96)
15. Form U - Request to Dispose of Residual Waste (received 8/9/96)
16. Form 1R - Facility Plan (received 8/9/96, revised 9/10/97)
17. Form 2R - Map Requirements Phase I (received 8/9/96)
18. Form 3R - Map Requirements Phase II (received 8/9/96, revised 9/10/97)
19. Form 6R - Geologic Information (received 8/9/96, revised 9/10/97, 7/23/98)
20. Form 7R - Hydrogeologic Information (received 8/9/96, revised 9/10/97, 7/23/98)
21. Form 11R - Alternative Water Supply (received 8/9/96)
22. Form 12R - Operation Plan (received 8/9/96, revised 9/10/97)
23. Form 13R - Water Quality Monitoring System (received 8/9/96, revised 9/10/97, 7/23/98)
24. Form 18R - Closure/Post-Closure Land Use Plan (received 8/9/96, revised 9/10/97)

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25. Form 21R - Groundwater Assessment Plan (received 8/9/96)
26. Form 24R - Residual Waste Disposal Impoundments (received 8/9/96, revised 9/10/97)
27. Form 25R - Source Reduction Strategy (received 8/9/96)
28. Bonding Worksheets (received 8/9/96, revised 9/10/97, 6/15/98)
29. Various attachments (received 8/9/96, 9/10/97, 6/15/98, 8/18/98)
30. Request for Closure Cap Waiver (received 10/15/98)
31. Reports received 9/10/97 including:

    (a) "Investigation and Geophysical Study of Five Flyash Disposal Areas for the Martins Creek Steam Electric Station" prepared by Skelly and Loy, February 1986.
    (b) "Seismic Survey Martins Creek Site Steam Electric Station, Lower Mount Bethel Township" prepared by Weston Geophysical Engineers, 10/24/69.
    (c) "Aquifer Characteristic and Sampling Procedures Martins Creek Steam Electric Station" prepared by Dunn Geoscience Corporation, 9/17/87.
    (d) "Martins Creek Site Geology Compilation" prepared by Weston Geophysical Corporation, November 1983.
    (e) "Electrical Resistivity Surveys Martins Creek Steam Electric Station" prepared by International Exploration, Inc., December 1982.
    (f) "Updated Geologic Compilation for the Martins Creek Steam Electric Station, Lower Mount Bethel Township, Pennsylvania" prepared by Weston Geophysical Corporation, December 1987.
    (g) "Geophysical Investigation Martins Creek Steam Electric Station, Lower Mount Bethel Township", prepared by Delta Geophysical Science, September 1986.
    (h) "Seismic Survey of Martins Creek Site No. 2, Lower Mount Bethel Township, Pennsylvania" prepared by Weston Observatory, November 1951.
    (i) "Geophysical Investigation Proposal Ash Basin No. 4, Martins Creek Steam Electric Station", prepared by Weston Geophysical Corporation, January 1987.

32. Reports received 6/15/98, including:

    (a) "Monitoring Well Network and Hydrogeological Evaluation for Basin No. 1, June 1998", prepared by Nittany Geoscience, Inc.
    (b) "Evaluation of Sinkhole Development Potential - Martins Creek Ash Basin No. 1, May 1, 1998", prepared by Van Ness & Associates.

33. "Environmental Assessment of Groundwater and Surface Water Quality - Basin No. 1 Martins Creek SES March 1994", prepared by Nittany Geoscience, Inc. received 8/9/96, incorporated by reference.
34. Erosion and Sediment Control Plans, submitted to Northampton County Conservation District, received 6/15/98.
35. Ponding Calculations around Closure Drainage Grating, received 6/15/98.
36. Martins Creek Ash Basin No. 1 Internal Stability Analysis (received 6/15/98).
37. Environmental Monitoring and Surveillance Program - Delaware River in the Vicinity of Martins Creek Steam Electric Station - 1989 Studies, prepared by ERM Inc., received 8/9/96, incorporated by reference.
38. Revegetation and Alternative Soil Cover Plan, prepared by Civil & Environmental Consultants, Inc. (received 8/9/96).
39. Modeling for Ash Basin Closure Study excerpt, prepared by Tetra Tech, Inc. (received 8/2/96).
40. Groundwater Sampling Analysis Plan (received 9/10/97).
41. Geophysical Survey Report (received 9/10/97).
42. Sinkhole Contingency Plan report and plan (received 6/15/98, revised 7/24/98).
43. Summary of Water Level Data (received 8/18/98).
44. Assorted cover letters dated 8/2/96, 9/10/97 and 6/15/98.
45. Form T1 (received 5/1/96).

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46. 6/14/99 Application for Cap Waiver Submittal incorporated into this permit including:

    (a) Cover letter with narrative response to the 2/5/99 Department letter
    (b) General Information-Permit Application form
    (c) Form A - Application for Residual Waste Permit (without fee)
    (d) Form B - Professional Certification
    (e) Form B1 - Application for Certification
    (f) Form C1 - Compliance History Certification
    (g) Form 18R - Closure/Post-Closure Land Use Plan
    (h) "Report on the Status of the Plant/Soil Ecosystem in the Downstream Impoundment Area of Ash Basin 1 at the Pennsylvania Power & Light Martins Creek Steam Electric Station as of May 1999" prepared by Bryce Payne, Soil Scientist
    (i) Copy of Permit for the PP&L Shamokin Dam Ash Basin No.1 (ID#301306) in Monroe Township, Snyder county plus attached "Conceptual Closure Plan" Drawing 237086, Sheet 1, Revision 3. This basin receives ash from the Sunbury Station
    (j) 7/26/99 PP & L letter containing corrections to the Payne Report
    (k) "Modeling for Ash Basin Closure Study Excerpts From Final Report Martins Creek SES Ash Basin No.1 Major Permit Modification" prepared by Tetra Tech Inc., May 1994
    (l) "Environmental Monitoring and Surveillance Program Delaware River Northampton County, PA in the vicinity of PP&L Martins Creek Steam Electric Station 1989 Studies" prepared by ERM Inc.
    (m) "Martins Creek SES 1998 Annual Groundwater Summary" dated March 1999
    (n) Drawings: See subsection (o) on following page.

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(o) Assorted drawings including:

1. D242663, Sheet 1 (Location Plan and Water Users), received 8/9/96, revised 6/14/99
2. D242663, Sheet 2 (Ash Condition in 1994), received 8/9/96, revised 9/10/97
3. D242663, Sheet 3 (Property Lithology and Wetland), received 8/9/96
4. D242663 Sheet 4 (Groundwater Elevation Map), received 8/9/96
5. D242663, Sheet 5 (Property Plan), received 9/10/97, revised 6/14/99
6. D242663, Sheet 6 (Conceptual Closure Plan), received 9/10/97
7. D242663, Sheet 7 (Closure Details), received 9/10/97, revised 6/15/98
8. D242663, Sheet 8 (South End Closure Plan), received 6/15/98
9. D242663, Sheet 9 (Closure Plan, Regulatory Cap), received 6/15/98
10. D242663, Sheet 10 (Closure Plan, North End 1foot Cap), received 6/15/98
11. D242663, Sheet 11 (North and South End Closures Sections and Details), received 6/15/98
12. D242663, Sheet 12 (South End Closure "As Is" Conditions 1999), received 6/14/99
13. A-242626, Sheet 1 (Soil Survey Map), received 9/10/97
14. A-242626, Sheet 2 (Floodplain Map), received 9/10/97
15. E-202466-1 (Site Study of 19 and 20), received 9/10/97
16. E-237628, Sheets 1 through 6 (Profiles and Cross-sections), received 8/9/96
17. E-237630, Sheet 4 (Ash Basin No.1 Borrow Area), received 8/9/96
18. E-237631 (Ash Basin No. 1 Borrow Area Cross-sections), received 8/9/96
19. E-208327-2 (PPC Plan Site Plan), received 9/10/97

5. Approved Liner System: The Liner System and Leachate management requirements for a Class II residual waste impoundment have been modified per 25 PA Code Chapter 287.115.c (Modification) based on the approved application meeting the requirements specified therein. The modification of the liner system requirements and leachate treatment requirements are contingent upon the continued stability of the basin dikes, and the absence of groundwater degradation. If these conditions change, the Department reserves the authority to revoke these waivers. Therefore, the approved existing liner system and leachate management requirements consist of:

   a. Coal bottom ash structural fill/subgrade.
   b. No Liner.
   c. Earthen base composed of in-place river sands.
   d. Earthen dikes.
   e. No leachate detection zone.
   f. No leachate collection or treatment except as required for NPDES discharge permit.

6. Hours of Operation: The impoundment may be filled by sluicing at any time. Truck delivered waste may be disposed during daylight hours only.

7. The impoundment may be filled by sluicing at any time, but no truck delivered waste may be disposed without written approval by the Department indicating the date and time of disposal during daylight hours only.

8. Weight Measurement: The permittee will calculate the disposal volume for coal ash by multiplying the coal tonnage burned at the Martins Creek Steam Electric Station by ash percentage from the analytical results monthly. Any trucked wastes shall be measured at a scale capable of accurate measurement.

9. Daily Volumes:

   a. The approved Average Daily Volume is 45 (dry) tons per day/0.288 MGD. The Average Daily Volume will be calculated by averaging the daily disposal volume over the days of operation for that Quarter.

b. The approved Maximum Daily Volume is 60 (dry) tons per day/0.384 MGD except in event of emergency use of the Basin following notification to the Department.

10. Variances: No variance except as allowed by 25 PA Code §287.115.c was granted.

11. Other Activities:

a. Ash Basin No. 1's North End may be utilized as a source and stockpile area for bottom ash used for beneficial use. Bottom ash to be utilized for beneficial use must be segregated from other wastes. This activity may not allow ash to be tracked outside the disposal area. This activity must be monitored by the permittee to ensure that the operations and/or construction of the Basin are not affected. Non-bottom ash waste materials may not be removed from this basin without written Department approval.

b. The use of this facility and/or its structures within the permitted area for any usage other than identified in the approved application will require written Department approval.

12. Consolidated Application: One complete, consolidated copy of the approved application must be submitted to the Department within one hundred twenty (120) days of permit issuance. Obsolete or inaccurate information is to be deleted from the consolidated application or explicitly marked as obsolete and/or inaccurate.

13. The bond of $3,290,030 between PPL Martins Creek, LLC and the Department is hereby approved as part of this permit. This bond must be updated within ninety (90) days of receipt of written correspondence from the Department in accordance with 25 PA Code §287.375.

14. The permittee must designate a full time management team (including the contact person) for site operations and site construction/closure and provide a breakdown of the duties and authority of each position of the management team within thirty (30) days of permit issuance or as otherwise approved by the Department. The occupants of these management positions will be provided with the following:

a. The personnel and material resources to accomplish his/her task;

b. The full managerial authority to accomplish his/her task. In particular, the following authorities will be assigned to these positions:

1. The authority to hire and fire (and/or replace or reassign);

2. The authority to make immediate purchases where needed;

3. The authority to issue directives and completely control on site operational activity and/or construction activity;

4. The authority to control access to all areas of the site;

5. The authority to completely control all wastestreams received at the site, including the authority to reject such streams. The occupant of this position will not be in charge of other duties which will detract from the performance of the duties and authorities described herein;

6. The authority to authorize expenditure and hire outside contractors as needed;

7. The authority to revise the site PPC Plan; and

8. The authority to address operational/construction/closure problems caused or affected by the contractors operating on site.

c. A contact person will be based either onsite or at the Martins Creek Steam Electric Station. This contact person will maintain all required records and permit documents at his office in a readily available format. This person or a designated standby person with all necessary access and authority will be available to meet Department personnel during regular business hours or during any site emergency. This contact person will have authority to correct any construction or operations problems onsite.

15. Authorized employees or agents of the Department, without advance notice or search warrant, upon presentation of appropriate credentials and without delay, shall have access to and to inspect all areas on which solid waste management activities are being, will be, or have been conducted. This authorization and consent shall include consent to collect samples of waste, solid, water, or gases; to take photographs; to perform measurements, surveys, and other test; to inspect any monitoring equipment, to inspect the methods of operation; and to inspect and/or copy documents, books and papers required by the Department to be maintained. This permit condition is referenced in accordance with Section 608 and 610(7) of The Solid Waste Management Act, 35 P.S. Section 6018.608 and 6018.610(7). This condition in no way limits any other powers granted under the Solid Waste Management Act.

16. Sinkhole Contingency Plan:

    a. In the event of sinkhole development, the permittee will implement the sinkhole contingency plan as modified below.

    b. The basin's lined area, dikes and immediately adjacent area will be inspected for evidence of subsidence, sinkhole development, animal burrows, and/or liner damage on a quarterly basis at minimum. Written notification including location, dimensions and proposed corrective actions will be submitted to the Department within seven (7) days of detection of possible subsidence, sinkhole development or liner damage. Animal burrows on the dikes shall also be corrected.

    c. In event of potential subsidence or sinkhole development, the suspect area will be monitored daily until the corrective action is completed. The corrected area will be monitored weekly until the Department approves an alternate frequency in writing.

    d. Within thirty (30) days of detection of subsidence or sinkhole development, the permittee will submit an analysis of the potential impact of the subsidence and/or sinkhole development on the stability of the dikes. This analysis will include evaluation of the potential growth of a developing sinkhole, and potential for additional sinkhole formation. If the factor of safety for the berms/dikes is below those required by 25 Pa. Code Chapter 289.271.a.3, then the permittee shall either submit a permit modification including measures to increase the stability of the dikes to the regulatory requirement within sixty (60) days, or close the facility.

e. In the event that the subsidence or sinkhole threatens the basin or its dikes, the permittee will take whatever action is required to minimize the hazards to the public health, welfare, safety and the environment posed by potential failure. The Department retains the right to require closure of this basin if needed to protect the public health, welfare, safety or environment.

f. In the event that Ash Basin 4 cannot be used due to sinkhole development, the permittee may temporarily use Ash Basin No. 1 as a disposal area upon Department approval of the connection to Ash Basin No. 1. A permit modification must be submitted for any proposed usage of Ash Basin No. 1 for disposal of Ash Basin No. 4 waste for more than six (6) months. All disposal of non-bottom ash wastes not explicitly authorized in this permit must cease within one year unless the Department approves a permit modification for this activity.

g. In the event of a liner breach, the Department reserves the right to modify the time-frame and scope of the sinkhole contingency plan and/or groundwater assessment investigation to determine the impact of the breach on groundwater. Conducting a dye tracer test may be required. If an impact is identified, the Department reserves the right to modify the corrective action plan.

II. Additional Operational Requirements:

1. Prior to any contractor working onsite, the operator must verify that the contractor has prepared an adequate health and safety plan consistent with the site PPC Plan. The site PPC Plan must be updated as needed at that time. The PPC Plan must also be updated if fuels or chemicals are stored onsite during construction and operations.

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2. The permittee shall re-evaluate the dust control plan for adequacy whenever the waste is placed above the surrounding site berms. The operator will notify the Department if operational changes are required.

3. In event of a change in the source or type of coal that is burned at the permittee-owned Martins Creek Power Station, or the addition of new fuel types, the operator will notify the Department. This notification will include an evaluation of the ash to determine if the ash chemical parameters have been affected.

4. The Department shall be notified in event that the NPDES permit requires additional treatment of impoundment effluent. A minor permit modification application shall be submitted in event of design or construction changes required by the NPDES permit.

5. In the event of any flooding of the Ash Basin No. 1, the permittee shall notify the Department of the event, the areas affected, and any required corrective action plus schedule within seven (7) days after the flooding has subsided. The Department retains the right to require re-evaluation of dike stability.

6. No borrow area except as identified in the Ash Basin No. 4 permit area (I.D. #301257) may be utilized without written Department authorization.

7. Revegetated ash may not be used as intermediate cover.

8. The permittee will retain records, showing location of disposal of non-bottom ash waste in Ash Basin No. 1.

9. Within thirty (30) days of permit issuance, the permittee will submit a revised Drawing D242663, Sheet 10 (Ash Basin No. 1 Closure Plan) that delineates the permit area, the North End disposal area, the South End area to be closed and the site berms/dikes that may not be covered by waste.

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III. Construction Requirements:

1. The operator will notify the Department concerning proposed major construction activities two weeks prior to starting the activities. The operator shall submit a certification by a registered professional engineer on forms provided by the Department upon completion of each major construction activity identified in the permit for each phase or sequence of construction/closure at the facility. Major construction activities include but are not limited to:

   Construction of site access service roads; site erosion and sedimentation controls; the facility structures; stages of closure; groundwater abatement system; sections of individual cap section construction; sinkhole contingency plan construction activities.

   This certification shall describe construction activity in the phase or sequence of construction being certified using drawings and plans where appropriate. This certification shall state that the actual construction was observed by the engineer or persons under his direct supervision and that the supervision was carried out in a manner that is consistent with the approved permit. The construction certification shall include test reports and documentation that all of the other requirements of the QA/QC plan have been met.

   Upon completion of each construction activity described above, the operator shall notify the Department that the construction activity is ready for inspection by Department staff.

2. All supplemental information on any design shall be certified by a registered professional engineer and submitted for final design review by the Department at least 30 days prior to actual construction.

3. Any use of bottom ash to construct site roads shall conform with all requirements of 25 Pa. Code §287.665.b.4. Any use of coal ash as structural fill shall conform with all requirements of 25 Pa. Code §287.661 (use of coal ash as structural fill).

4. North End Closure:

   a. No closure cap waiver is granted for the authorized disposal area (a/k/a North End).
   b. Within six months of North End closure, the permittee shall submit for approval, an updated closure plan/closure schedule addressing all regulatory requirements including erosion and sedimentation control requirements. This revised closure plan will address all requirements of the 10/31/96 Department Bureau of Dams, Waterways and Wetlands letter, located in Attachment 1, which is hereby incorporated by reference. This closure plan will include an evaluation of the adequacy of the soils in meeting regulatory performance requirements. This updated closure plan will also include a "stand alone" Construction Quality Assurance plan addressing all materials of construction. The closure plan will include a waste solidification plan if needed.
   c. No non-bottom ash may be used as fill to reach closure grades without written Department approval.
   d. The Department reserves the authority to require placement of intermediate cover in event of dust problems during closure.
   e. Final cover soils will be placed within one year of reaching final grades, or within one year of cessation of ash disposal at this impoundment.
   f. During closure, the permittee will prevent contaminated runoff from leaving the disposal area.

5. South End Area Experimental Process:

   a. The permittee will implement the recommendations of the "Report on the Status of the Plant/Soil Ecosystem in the Downstream Impoundment Area of Ash Basin 1 at the Pennsylvania Power & Light Martins Creek Steam Electric Station as of May 1999" prepared by Bryce Payne, Soil Scientist within one (1) year of issuance of this permit for the South End Area. This requirement includes blocking lower tier of drain pipes between the North End and South End areas.
   b. The Department retains authority to revoke this approval of this experimental project and to require implementation of the 1 foot final cover/regrading option alternative set forth in the approved application and permit Condition 8 below.

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c. A schedule for implemetation of the Payne Report recommendation shall be submitted within sixty (60) days of permit issuance.

d. The permittee will retain a soil scientist to evaluate the South End Area on an annual basis to determine if the goals of a developing soil profile, ecological establishment, and proper vegetation are achieved and/or to propose additional measures as needed. These report shall also evaluate whether the soil conditions and available plant species plus ecological development status will maintain adequate nutrients, low salinity and acceptable pH conditions for the long-term post-closure time-frame.

e. These reports shall be submitted annually on December 31st unless the Department modifies this due date or frequency of reporting in writing.

f. These reports must meet the following requirements:

1. All reports must be prepared and certified by a Soil Scientist including the Form 19R construction certification for implementation of the Payne report recommendations.
2. All reports must identify all required actions including implementation of the Payne Report recommendations plus any follow-up actions such as additional soil amendments, additional revegetation activities, or other investigation/activities needed to correct any problems with plant development, soil development or development of the ecosystem.
3. These reports will also include the following:

   (a) Results of annual inspections of the berms until final closure.

   (b) Copies of any reports regarding discharges from the South End Area submitted per NPDES requirements.

   (c) PA Surveyor signed and sealed annual topographic maps showing site conditions at the time of the required report with scale, & grid system tied to permanent benchmarks. The maps shall identify all areas that lack proper vegetation per 25 PA Code Chapters 289.244 & 289.245 along with a narrative & schedule for corrective action. The maps should also show any area where erosion has been a significant problem in affecting soil/plant development or where rills/gullies conflict with the 25 PA Code Chapter 289.252.c standard plus the corrective action.

(d) An evaluation the diversity of the plant life (and whether the plant life shows evidence of stress), progress of soil formation at representative locations such as at different representative grades and/or the explicitly identified areas in the Payne Report. The causes of any stressed vegetation should be discussed in the report. This information should be put into a format such as drawings that will allow the Department to correlate data to location in the South End area.

(e) An evaluation of developing soil gradations, total and inorganic soil nitrogen, pH, nutrient value, cation exchange capacity, salinity and waterholding capacity plus the estimated rate of soil formation. The "humic/fulvic acid extraction test" (used in lieu of the typical "Soil Organic Matter" evaluation method).

(f) An evaluation of the annual biomass production per unit area.

(g) The reports shall determine the ability of the ash and/or developing soils to withstand erosion should also be evaluated on an annual basis.

(h) Any other information required by the Department in writing.

(i) At time of final closure, the permittee shall consolidate all reports into a single report correlating the data from all reports into a single report.

(j) The permittee may expand the scope of this project to include a more extensive evaluation to determine what would be an acceptable methodology for development of soils and a working ecology on ash newly placed upon written Department approval.

6. South End Closure:

a. Upon written Department notification, the permittee will close the South End by regrading and placement of one foot of revegated final cover. This cap waiver authorization does not cover the repermitted North End disposal area covered this permit. The Department retains its authority to require a greater thickness of cover soils if the final cover fails to meet the performance standards of 25 PA Code 289.242.d

(Cover) or is subject to excessive erosion, including rills or gullies deeper than nine (9) inches.

b. In the event of the Department's notification, the Form 18R Construction Quality Assurance Plan will be implemented for the South End area closure as modified below:

1. Final Cover soil stockpiles shall be composite sampled with a minimum of 12 subsamples per every 5000 cubic yards of soils or visible change in soil type via ASTM D-422.

2. Fertility Analysis shall be conducted at a minimum frequency of one composite sample per every 5000 cubic yards of soils or visible change in soil type. The composite sample shall consist of a minimum of 12 subsamples.

3. Lift Thickness: The in-place lift thickness of the in-place soils shall be greater than 12 inches after compaction. The lift thickness shall be checked at a minimum of once per acre.

4. Carbonate Content: The soils shall be tested for carbonate content at a minimum frequency of every 5,000 cubic yards or visible change in soil type. If carbonate content is above 5%, then the final cover thickness must be increased to ensure that the long-term soil thickness will remain greater than 12 inches.

5. Gradation: The permittee shall utilize commercial borrow areas in the event that the approved borrow area cannot provide the sandy loam, loam, sandy clay loam, silty clay loan and silt loam soils approved. Gravelly soil types are not approved as final cover at this facility.

6. The permittee will retain the capability to test soils for lift thickness, erodability, gradation, fertility, permeability and moisture content upon Department request until the closure certification is approved.

7. Within sixty (60) days of permit issuance, the permittee will provide stability calculations for the Ash Basin No. 1 external dikes subjected to the external loading of a 100 year flooding event.

IV. Water Quality

Monitoring Points.

1. The groundwater monitoring system for Basin 1 consists of the following monitoring wells:

   Downgradient Wells: 1-6, 1-7, 1-8 and the new monitoring well 1-9.

   Background Well: 2-1N. Well 2-3 provides additional upgradient water quality data.

2. The list of required groundwater monitoring locations may not be modified without prior written approval from the Department.

3. If the permittee proposes to eliminate an existing approved monitoring point, a proposal must be submitted to the Department for approval that includes:

   a. A map depicting the location.
   b. A narrative describing the reason for the proposal to eliminate the point.
   c. Details regarding the method for decommissioning.
   d. A schedule for decommissioning the monitoring point.

   If the permittee proposes to eliminate monitoring point 2-1N, 1-6, 1-7, 1-8, or 1-9 without substituting a replacement, a major permit modification application must be filed.

4. If the permittee proposes the abandonment of the Basin 1 observation wells, items c and d listed above must be submitted for approval.

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Groundwater Sampling:

1. The permittee will conduct quarterly and annual sampling of the monitoring wells for the parameters listed on Form 14R with the following modifications: Boron, magnesium, and lithium will be analyzed quarterly. All metals will be analyzed for total and dissolved concentrations. Annual volatile organic analysis will be performed for the following parameters: Tetrachloroethene, trichloroethene, 1,1,1-trichloroethane, 1,1-dichloroethene, cis-1-2 dichloroethene, trans-1,2-dichloroethene, 1,1-dichloroethane, 1,2-dichloroethane, and vinyl chloride. Any changes in the list of required analyses must be approved by the Department in writing. If it can be demonstrated that current water quality data from Well 1-9 consistent with the other downgradient monitoring wells, routine testing may continue. If not, Well 1-9 should be analyzed for the Form 8R parameters with the listed modifications for four consecutive quarters.

2. Water quality monitoring reports must be submitted to the Department for all approved monitoring points. The Reports shall be complete and accurate and shall also include, at a minimum:

   a. A cover letter identifying the facility and sampling event. The cover letter shall describe anything unusual or noteworthy about the sampling and analysis. Changes in sampling personnel or the laboratory performing the chemical analysis should be noted in the cover letter.
   b. One original and one copy of each quarterly report must be submitted to the attention of the Program Manager of Land Recycling and Waste Management Program within 60 days of sampling or 15 days after analysis, whichever is sooner, unless otherwise approved by the Department.
   c. One copy of the actual lab analysis report must accompany submission of the annual analysis.

3. The permittee shall submit an updated groundwater sampling and analysis plan within 90 days following issuance of the permit. All monitoring points for any waste management regulated unit at the facility shall be included. The plan shall also include a monitoring point location map, a list of testing parameters, and a table providing a synopsis of individual

monitoring well performance during sampling (i.e., purge volume and rate, dewater and recovery time). The plan must be available to personnel performing the sampling during each sampling event.

4. The permittee may revise the sampling and analysis plan but significant changes such as changes in purge volumes, sampling devices or analytical methods will require Department approval.

5. A report shall be submitted annually (within 90 days after the annual sampling event) which evaluates water quality (through data trends and statistical methods) at the facility. A contour map of water table elevations shall be included with this report. Analytical data from monitoring wells 2-3, 2-4, 2-5, and 2-6 should also be summarized.

MARTINS CREEK STEAM ELECTRIC STATION
ASH BASIN NO. 4
INDUSTRIAL WASTE DISCHARGE/INCIDENT
FINAL TECHNICAL REPORT

BY: ANDREW D. SPEAR, P.E.
SENIOR ENGINEER

PPL CORPORATION
TWO NORTH NINTH STREET
ALLENTOWN, PA 18101
SEPTEMBER 23, 2005
REVISED NOVEMBER, 2005
FINAL REVISION JANUARY 30, 2006

INTRODUCTION

This report has been prepared and certified by Andrew D. Spear, a professional engineer licensed in Pennsylvania, who is employed by PPL Corporation as a Senior Engineer. All of the work discussed in this report was either done by Mr. Spear, done under the direct supervision of Mr. Spear, or done by other Professional Engineers reporting to Mr. Spear.

The intent of this report is to:

1.) Describe the design and operation of Martins Creek Ash Basin No. 4
2.) Present the details of the incident and its impacts as they are known now.
3.) Explain the permanent modifications that have been installed, accompanied with certified drawings and calculations.
4.) Provide the operating plan necessary to place the basin back in service and ensure its future safe operation.
5.) Document the start-up and test procedures performed as the basin was brought back into service.

This report is being submitted to the Pennsylvania DEP as required by Residual Waste Regulations Section 289.274(b) and by the Basin's permit. This report, in a previous version, provided information that, in part, allowed DEP to approve placing Ash Basin No.4 back in service in a permit modification dated December 27, 2005. The permit followed a failure of a stop log in the discharge structure on August 23, 2005. This final version has been modified in accordance with the permit modification condition 3. Note that three full sized drawings and a report by Cianbro are referenced herein and should accompany this report.

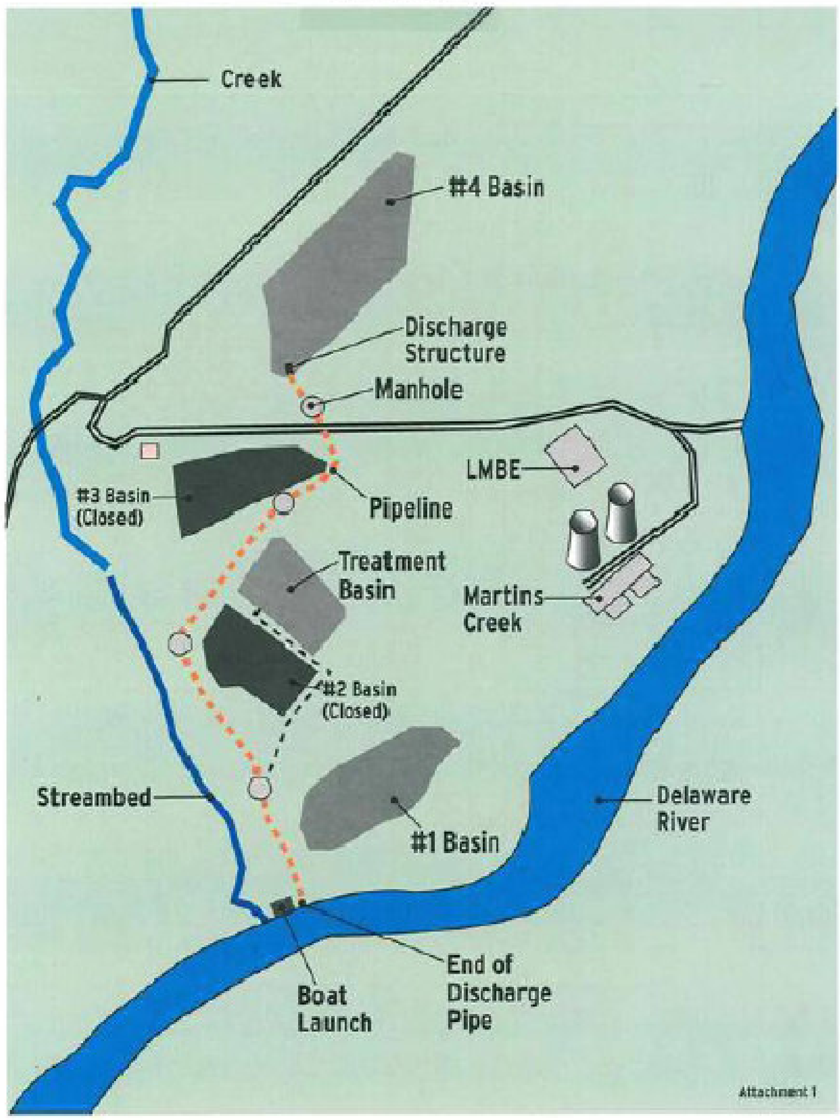
I, Andrew D. Spear, do hereby certify pursuant to the penalties of 18 Pa.C.S.A. Sec. 4904 to the best of my knowledge, information and belief, that the information contained in this report has been prepared in accordance with accepted engineering practice, is true and correct, and is in conformance with the rules and regulations of the Department of Environmental Protection and specifically with 25 Pa Code 289.254 (Discharge Structures).

ORIGINAL FACILITY DESIGN

Martins Creek Ash Basin #4 is a man-made basin about 40 acres in area and maximum depth of 65 feet. The basin is primarily used to dispose of fly ash produced from burning coal in Units 1 and 2 to make electricity. Basin #4 was designed, and is operated and inspected, under permits approved by the PADEP. Operation of the basin consists of mixing fly ash with water at the plant and pumping the slurry to the basin. The fly ash settles in the basin and the remaining water flows to the discharge structure where it enters a 33 inch diameter pipe. The pipe is approximately 1¼ miles long and has several manholes in it. The water is eventually discharged to the Delaware River upstream of the confluence with the Oughoughton Creek. Figure 1 shows the plant area and the location of the Delaware River and Oughoughton Creek.

The discharge structure at Ash Basin #4 is a 45-foot high concrete tower that is divided into two chambers. At the time of the incident, water entered the first chamber and was held back by a wall consisting of wooden stop logs stacked on top of each other, each about 9 inches high, 7 inches wide and 7 ½ feet long. Figure 2 shows the flow-through arrangement of the discharge structure (prior to any modifications). The stop logs were fitted into a steel reinforced channel in the concrete tower discharge structure and held in place by the structure. The stop logs were treated with creosote to prevent underwater deterioration. The design of the stop log wall allowed operators to add or remove stop logs to adjust the water level in the basin. This ensured that the fly ash deposited in the basin remained submerged to prevent dusting and to allow for proper settling of the sluiced ash. There was also the occasional need to adjust the level of the basin to allow maintenance on the basin liner. Under normal operation, as water and ash were pumped into the basin, the water flowed under a metal skimmer plate (used to block any floating material), then over the stop log wall into the second chamber of the discharge structure. There it entered the pipe that discharges to the Delaware River.

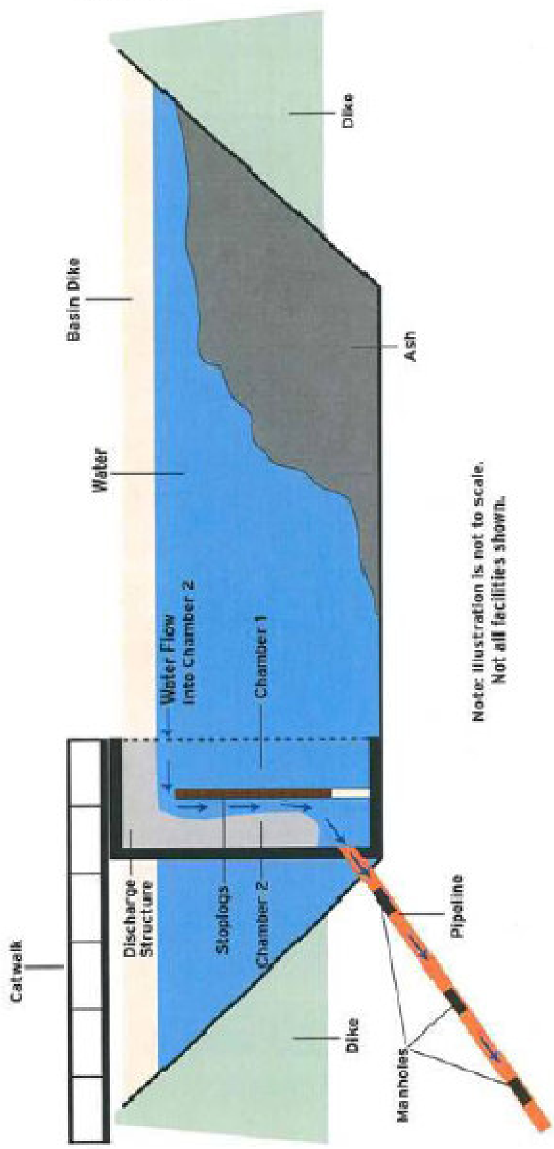
FIGURE 1



Creek
#4 Basin
Discharge
Structure
Manhole
LMBE
#3 Basin
(Closed)
Pipeline
Treatment
Basin
Martins
Creek
#2 Basin
(Closed)
Streambed
Delaware
River
#1 Basin
End of
Discharge
Pipe
Boat
Launch
Attachment 1

FIGURE 2

Normal Flow in #4 Basin



DISCUSSION OF INCIDENT

On Tuesday, August 23, 2005, at approximately 8:45 PM, an operator on rounds observed water flowing across DePues Ferry Road near Martins Creek #4 Ash Basin. The Supervisor of Operations – Pete Giella and the Supervisor-Safety, Health and Environmental Resources – John Drabic were notified of the incident. Initially, the water was thought to be coming from the ash slurry line from the plant to the basin. An initial call to the PA DEP reported the leak as a possible fly ash line leak, but that further investigation was needed to determine the source of the water running across the roadway. The water source was later identified as coming from manhole covers in the Ash Basin 4 discharge pipeline. Water from the discharge crossed over part of DePues Ferry Road and also part of DePues Road and ran into adjacent fields and eventually into the Oughoughton Creek.

The water release eventually began carrying out fly ash from the basin and a large amount of basin water mixed with fly ash was released from the manholes onto the roadways, fields and into the Oughoughton Creek, as well as into the Delaware River through the discharge pipe. Numerous efforts were made over the ensuing days to stop the leakage. The leak was reduced in flow through these efforts, but leakage continued until 1:20 AM Saturday, August 27, when the leak was stopped.

The water level in the basin at the time of the failure was approximately 35 feet above the bottom of the discharge structure. There were about 40 logs stacked in the discharge structure to control the water to this level. The first log from the bottom was fitted with a rubber gasket to seal the log against the concrete bottom of the discharge structure. The second log from the bottom was the log that failed and allowed water to escape from the basin. A contract diver hired by PPL inspected the structure after the basin flow was stopped and noted that the second log was completely dislodged from the wall and the third log was deformed.

Upon observing the leak, PPL immediately began taking measures to identify the source and, once identified, to stop the leak. Through extensive efforts, PPL removed ash deposited on PPL's lands, the Oughoughton Creek bed, and adjacent properties. PPL also removed ash captured by booms placed in the Delaware River, has and is continuing to remove ash deposits from the Delaware riverbed in three areas identified by divers as having larger amounts of ash deposits, and cleaned ash from boats and docks of any downstream property owners who requested it. PPL has undertaken a comprehensive program of sampling the river water, ash deposits in the river, residential wells and the water supply for the Easton Water Authority. Finally, PPL retained Normandeau Associates to research the biological impacts of the release and has requested the Academy of Natural Sciences to oversee a program to assess both the short-term and long-term impacts of the leak on the Delaware River.

DETAILED DESCRIPTION OF PERMANENT MODIFICATIONS TO ASH BASIN NO. 4 DISCHARGE SYSTEM

The Ash Basin 4 discharge structure has been modified to have four levels of protection, each one capable of stopping or significantly reducing the flow out of the basin through that structure and the discharge pipe. These modifications are shown in miniature on the following schematic (Figure 3) and Drawing E-323319 (Figure 4). A full sized copy of Drawing E-323319 and D-323326 Sheets 1 and 2 accompanies this report. The modifications are as follows:

1. STEEL REINFORCED SKIMMER SLOT PLATES

Steel reinforced skimmer slot gates were designed by Kleinschmidt Energy and Water Resource Consultants from Pittsfield, Maine and were manufactured by Bass Mechanical of Elizabethtown, Pa. They consist of 8 (eight) four-foot high, 0.5 inch thick plates, 7 feet - 2.5 inches long. Each plate is reinforced on the downstream side with two W8x28x6'11" steel beams and on the upstream side with 5 stiffners (1/2x 4x 3'11"). The plates are installed in the skimmer slot beneath the skimmer and will extend up to elevation 347. The skimmer can be lowered on top of the plates to provide an additional four feet of water retention depth.

These plates are not intended to be 100% water tight. They are intended to slow down water flow in the event of a downstream failure.

2. CONCRETE PANELS AND STOP LOGS

Reinforced concrete panels and stop logs were designed by Kleinschmidt and fabricated by Atlantic Metrocast of Portsmouth, Virginia. The panels and stop logs replaced the wooden stop logs originally used in the discharge structure to hold back the water. The panels are five feet high, 7 inches thick, and 7 feet – 5.5 inches long. Each panel is reinforced with #5 bars on five inch centers horizontally and #4 bars on six inch centers vertically. They are made of 8000 PSI concrete. The stop logs are of similar design except they are only 12 inches high. They are reinforced with #5 bars horizontally and #3 bars vertically.

The panels were placed on the concrete sill at the bottom of the stop log slots and extend up to elevation 340. The stop logs are placed on top of the panels to control the water level above 340. The normal operating water level for the basin will be between elevations 348 and 350. Note the top of the basin dike is elevation 355. Both the panels and stop logs were designed assuming water up to Elevation 355.

A structural steel frame was added to the downstream side of the bottom two concrete panels. The frame provides additional support to the bottom two concrete panes, since they are under the highest stress. The steel frame extends up from the still at the bottom of the stop log slots (elevation 320') to elevation 330'.

The one foot stop logs are used to set the water elevation in the basin and, along with the concrete panels, are the primary barrier for holding the basin water at the discharge structure.

FIGURE 3

Permanent Barriers in #4 Basin

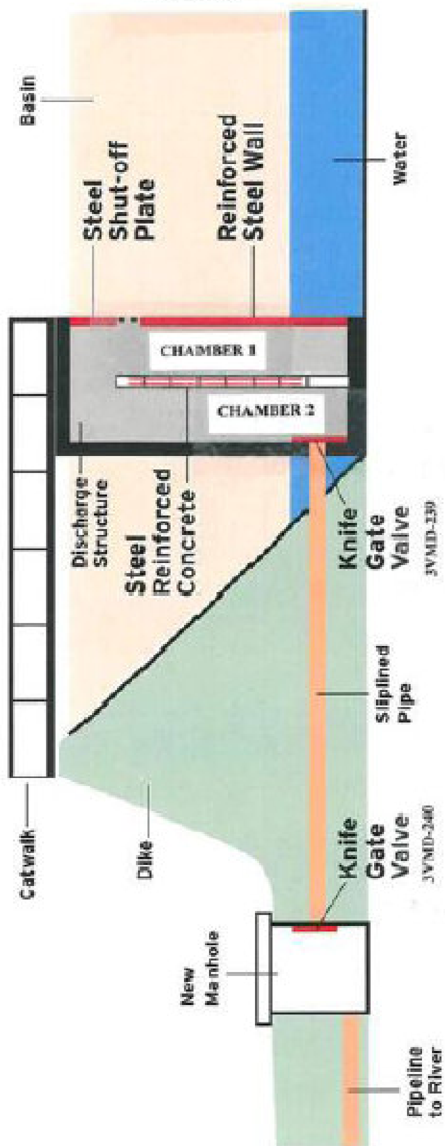
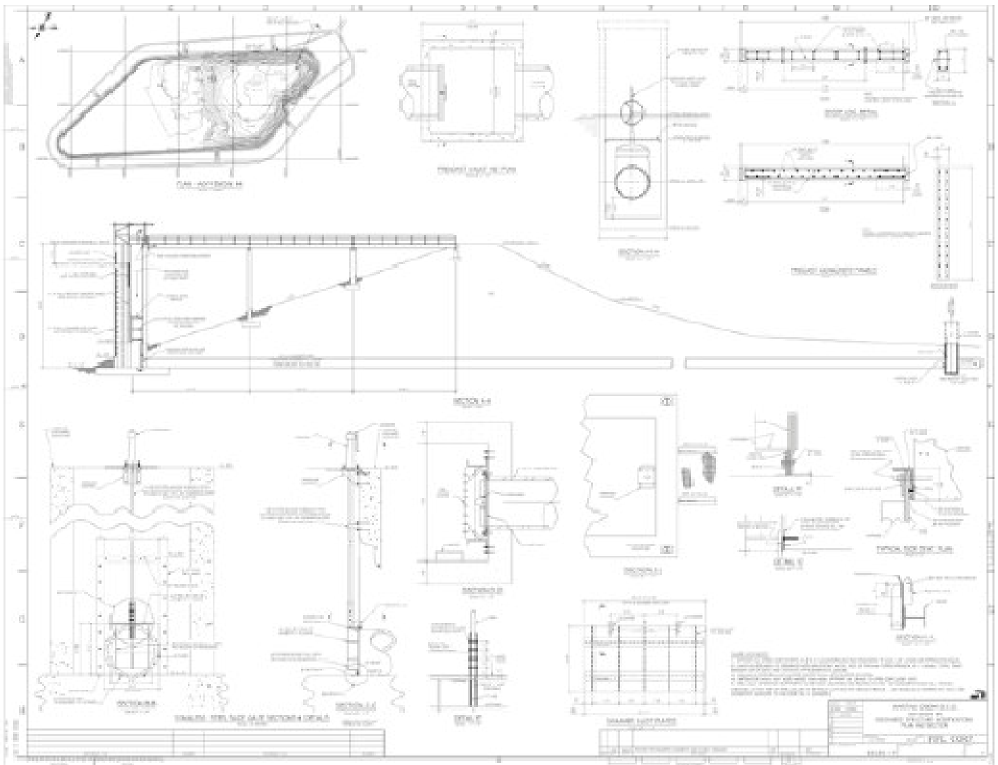


Figure 4:



3. SLIDE GATE

Kleinschmidt designed a stainless steel slide (knife) gate that was placed over the inlet to the discharge pipe leaving the discharge structure. Cianbro Corporation manufactured the gate. The gate is 39 inches wide, to cover the 33 inch diameter discharge pipe. The gate plating is 1" thick with stiffeners in the horizontal and vertical dimension. The gate seats against a rubber strip on top of a 3/8" thick, steel plate. The gate is controlled from above manually. A 1.5 inch diameter steel gate stem runs from the gate to a wheel operator at the top. The stem is supported up the inside concrete face of the discharge structure with stiffeners.

The gate is not designed to have 100% shut-off capabilities. Since it is custom designed, some leakage is expected – approximately 100 gpm or less.

The design of the above three items has been detailed and certified in a report prepared by Cianbro entitled 'Martins Creek Facility, Allentown, Pa QA/QC Report (Design, Fabrication, and Installation of Redesigned Discharge Structure Modifications', dated January 12, 2005, which accompanies this report.

4. VAULT AND KNIFE GATE VALVE

A vault was installed along the discharge line just outside the Ash Basin No. 4 dike. The reinforced concrete vault is five feet square, inside dimensions, and houses a cast iron and stainless steel knife gate valve assembly installed to block flow before it enters the vault. The vault bisects the discharge pipe line such that flow will enter the vault past the gate valve (when opened) and exit out the downstream end of the vault. The vault was supplied by Rahns Precast. The knife gate valve was supplied by the Red Valve Company.

5. SLIP LINING OF DISCHARGE PIPE

The steel-reinforced, concrete discharge pipe between the discharge structure and the vault was slip-lined with a heat hardened plastic liner installed by Insituform. The joints of the pipe were not originally designed to remain water tight under the static water pressure of a full basin. This situation could arise if the knife gate valve was closed when the water level within the discharge structure was at full height. The lining ensures that the joints will remain water tight under full head from a maximum basin water level. A letter from Insituform Technologies is included in Appendix A indicating that the liner has been designed to accommodate an excess of 45 feet of water head, which corresponds to a water elevation of 355’, the top of the basin dikes.

6. WATER LEVEL INDICATORS

Water level indicators have been placed at the discharge structure to monitor water levels in the basin. A pressure transducer is mounted in chamber 1 between the steel wall and the top logs. This level indicator transmits the basin water level to the control house at the basin and is also telemetered to the plant’s control room. A float switch is mounted in chamber 2 between the stop logs and the slide gate. The float will detect high flow in chamber 2 and signal an alarm to the plant’s control room. A staff gage is mounted on the outside of the wall of the discharge structure. The gage allows visual verification of the electronic device readings. Details and certification of the water level monitoring system were submitted under separate cover.

Startup and Test Plan for the Ash Basin #4 Discharge Barriers

Prior to filling the basin and placing it back in service, the modifications to the discharge structure and outlet pipe had to be tested under full head conditions and approved by the PA. DEP. Appendix B has a description of the testing that occurred on December 15 with various regulatory and municipal representatives on hand when the basin was not entirely filled and Appendix C has another description of the post-filling tests that were run in January, 2006.

OPERATIONS PLAN FOR ASH BASIN NO. 4

1. PPL has installed local level controls on Ash Basin No. 4 discharge structure
2. PPL has established a remote monitoring device to provide signal back to plant control room for monitoring Ash Basin No. 4 level.
3. PPL will follow the steps outline below in the event of a problem at the Ash Basin No. 4 discharge
   a. Upon receipt of a level alarm or observations at basin 4 the ash slurry system will be shutdown.
   b. Discharge gate valve in the basin discharge structure shall be closed
   c. Slide gate on skimmer wall will be closed.
   d. PPL will monitor manhole to ensure that flow is under control
   e. Valve in manhole will be closed if flow is still detected.
4. PPL will submit a revised SPCC/PPC contingency plan to PADEP with appropriate changes regarding notification lists.
5. As per this report and its attachments, PPL is submitting to the department PE certification that all repairs have been completed according to all approved drawings and basin is ready for return to service.

APPENDIX A

INSITUFORM SLIP LINING LETTER

Insituform Technologies, Inc.

Worldwide Pipeline Rehabilitation

1770 Blair Drive, Suite G
Odenton, MD 21113
410.674.0369
www.insituform.com

September 21, 2005

P P and L Corporation
2 North 9th Street
Allentown, Pennsylvania 18101

Attention: Mr. Andrew D. Spear

Subject: Insituform Reconstruction of the 33 Inch Diameter Martins Creek Line Section

Enclosures: (1) "Insituform is your source for pipe rehabilitation"
(2) "Why Insituform is Better"
(3) ASTM F-1216-98 Standard Practice for Rehabilitation of Existing Pipelines and Conduits by the Inversion and Curing of a Resin –Impregnated Tube

Dear Mr. Spears,

This letter responds to your request to Mr. Robert Varkonyi of Insituform Technologies, Inc for assurance that the Insituform Product will seal the pipe joints under full hydrostatic head in the above referenced pipeline. The Insituform Pipeline Rehabilitation Process utilizes Cured in Place Pipe (CIPP) technology to provide a seamless, jointless liner inside the host pipe, which is designed to seal out infiltration and prevent exfiltration of the effluent flowing through the pipe line. Please refer to enclosures 1, 2, and 3 for additional information on the Insituform Process and Product. Our design calculations for your application indicate that for a partially deteriorated design condition, where the host pipe is structurally sound, the required Insituform design thickness for a 45 foot external head condition equals 20.2 mm. We are planning to install a 22.5 mm Insitutube in the above referenced line section. I trust the design information provided above and the enclosed documents provide assurance that the Insituform Product will seal the pipe joints in the 33 inch diameter Martins Creek line section. Should you have any further questions, please do not hesitate to contact Mr. Robert Varkonyi or myself.

Sincerely,

Greg Laszczynski
District Manager – Atlantic
Insituform Technologies, Inc

CC: Mr. Robert Varkonyi
Contract File

APPENDIX B

INITIAL DISCHARGE BARRIER TEST SUMMARY

PPL Martins Creek, LLC
Ash Basin #4
Discharge Barrier Test Summary

December 16, 2005

On December 15, 2005 testing was done at Ash Basin #4 on the newly installed discharge barriers. All barriers performed as designed.

The purpose of the testing was to prove that the discharge barriers worked well while under hydraulic pressure. The barriers tested include the steel skimmer slot plates (to elevation 339 ft.), the concrete panels / stop logs / steel bracing, the slide gate valve located in the discharge structure, and the gate valve located in the first manhole downstream of Ash Basin #4. The testing was done in accordance with the PPL Martins Creek, LLC, Startup and Test Plan for Ash Basin #4 Discharge Barriers (Appendix B-1 of this document) dated November 8, 2005.

Participants witnessing all or part of the test included: Jim Berger (DEP, Water Management), Mike Sames (DEP, representing Dam Safety), Steve Pletchan (DEP, Water Management), Tim Edinger (Base Engineering, representing Lower Mount Bethel Township), and Nevitt Duveneck (Finelli Consulting, representing Harmony Township)

The first major part of the testing was to fill Chamber 1 of the discharge structure with water (see Figure 1 in Appendix B-1) to an elevation of approximately 347 ft. and then inspect the downstream side of the concrete stop panels, logs and steel bracing while under hydraulic load. The inspection of the concrete panels and logs showed no visible defects in the structural integrity of the concrete panels, logs, discharge structure or the steel bracing. A small, garden hose type, leak was noted. The leak is located on the north side of the bottom concrete stop panel where the panel fits into the discharge structure slot. The leak has been deemed negligible due to its size and location. No further action will be taken. Some leakage around the panels (especially where they fit into the slot) is expected. This part of the testing was successful.

The next major part of the test was to fill Chamber 2 of the discharge structure with water (see Figure 1 in Appendix B-1) to elevation 347 ft., while keeping the slide gate valve closed. A measurement of the rate of decrease in water level of Chamber 2 was done to calculate leakage through the slide gate valve. The leakage rate through the slide gate valve was calculated at 49 gallons per minute. The actual leakage rate for this valve is probably much less. The hoses used to fill Chamber 2 siphoned some water from Chamber 2 back to the basin, causing the leakage rate to look higher than actual. Due to the design of this valve, leakage was expected. It was deemed that 100 gpm or less leakage is acceptable. This part of the testing was successful.

The next major part of the test was to release water from Chamber 2 to the closed gate valve located in the first manhole downstream of Ash Basin #4, then fill Chamber 2. This purpose of this part of the testing was to observe the gate valve for leakage. No leakage was observed. Less than 100 gpm would have been acceptable. This part of the testing was successful.

The last step of the testing was to measure the rate of decrease in water level in Chamber 2 with the slide gate open and the gate valve closed. This portion of the testing was to test for leakage in the slip lined pipe between the discharge structure and the first downstream manhole. Over the 15-minute test, the leakage rate was calculated at approximately 22 gpm. Based on this leakage rate and the amount of error that can go into the measurement of the rate of decrease, all witnesses present concurred that it was acceptable. In addition, during the 15-minute testing, a differential of approximately one foot was noticed between Chamber 1 and Chamber 2, with the level in chamber 2 being higher. Some of the decrease in Chamber 2 can be attributed to a small amount of leakage from Chamber 2 to Chamber 1 during the timed testing. Observation of the level in Chamber 2 once Chamber 1 was filled equal to Chamber 2 showed no decrease in water level over a period of approximately 30 minutes. The slip lined pipe test was deemed successful.

In addition to the barrier test, the response time of a plant operator after the operator received a high water alarm from the basin was tested. As part of the modifications, water level monitors have been installed in the basin discharge structure. During the test, the water level in Chamber 2 was increased, triggering the alarm. The operator arrived in about three minutes and would have been able to quickly close the valves if necessary.

In summary, testing has proved that the discharge barriers in Ash Basin #4 can adequately withstand the hydraulic load of basin operations and control/stop flow. All witnesses present at the conclusion of the testing were in agreement that all of the barriers performed adequately and as designed.

Prepared by:

John William Herring, III, P.E.
Senior Engineer
PPL Martins Creek, LLC

Appendix B-1:

PPL Martins Creek, LLC
Ash Basin #4
Startup and Test Plan for the Ash Basin #4 Discharge Barriers

November 8, 2005

This document details the startup and test activities to field test the adequacy of the newly installed discharge barriers. Representatives from the PA DEP, NJ DEP, Lower Mount Bethel Township Engineer and the Harmony Township Engineer will be invited to witness the startup and test activities as they desire. If any problems are found during any of the steps below, then the process will be stopped to evaluate and to make the necessary repairs. A pre-test of the components will be conducted by PPL prior to the official witnessed startup and test/

Nomenclature (See Figure 1):

- ☐ Chamber #1 – The discharge structure chamber located between the skimmer plates and the stop logs
- ☐ Chamber #2 – The discharge structure chamber located between the stop logs and the discharge structure slide gate.
- ☐ Valve 3VMD-239 - The discharge structure slide gate
- ☐ Valve 3VMD-240 - The gate valve located at the base of the ash basin #4 dike in the new manhole.

Sequential Checklist for Startup and Test of the Basin #4 Discharge Barriers:

- ☐ Divers onsite to seal stop logs and do any other structure repairs.
- ☐ Eight skimmer plates installed. (seven - 4ft plates from bottom and one – 4ft plate lifted and skimming the water) (Top of seventh plate is at Elevation 343ft.)
- ☐ Stop Panels / Stop Logs installed to 347ft level. ((4)- 5ft Panels and (7) - 1ft Logs)
- ☐ Valve 3VMD-239 closed
- ☐ Valve 3VMD-240 closed
- ☐ Have a vacuum truck staged at the discharge of 3VMD-240 incase the valves don't hold. The vacuum truck can remove water from the manhole if there is a leak.

Stop Panel / Stop Log Inspection and Test

- ☐ Check that the stop logs are installed to the 347ft. level. ((4)- 5ft Panels and (7) - 1ft Logs)
- ☐ Check that eight skimmer plates are installed.
- ☐ Check for any cracks or defects in the stop logs. Note anything found.
- ☐ Pump water into chamber #1. Fill chamber #1 until the water level is at the top stop log. (Approximately 9,400 gallons)
- ☐ Check sealing of concrete stop panels and stop logs.
    - Diver to go below water level in chamber #1 and seal, as much as practical, the leaking joints with oakum and/or epoxy.
    - Note: leakage between end of stop logs and channel is expected.

☐ Visually inspect the downstream side of the stop panels/ stop logs from the access ladder downstream of the stop panels for defects under load. Keep chamber #2 dewatered (drop pump into chamber #2 if necessary)
☐ Visual Inspection Ok
☐ **Stop Panel / Stop Log Inspection and Test Complete**

<u>Discharge Structure Slide Gate Leak Test (3VMD-239)</u>
☐ Check 3VMD-239 closed.
☐ Check 3VMD-240 closed.
☐ Fill chamber #2 with water. **ENSURE THAT THE WATER LEVEL IN CHAMBER #1 IS EQUAL TO THE WATER LEVEL IN THE BASIN. ENSURE THAT THE WATER LEVEL IN CHAMBER #1 IS EITHER EQUAL TO OR GREATER THAN THE LEVEL IN CHAMBER #2 AT ALL TIMES. IF CHAMBER #1 CANNOT BE KEPT FULL DUE TO LEAKAGE, THEN ABORT FILLING CHAMBER #2.**
☐ Fill chamber #2 with water until the water level is equal to the level in chamber #1. (Approximately 9,500 gallons)
☐ A leakage rate less than or equal to 100 GPM (5% of average basin inlet flow) is considered acceptable. This value will be confirmed or re-evaluated during the pre-test.
  - Mark the water level and record the time. Time: _________
  - Wait 15 minutes and mark the water level once again. What is the difference in water level? Difference In Water Level:____in /_____GPM {GPM = ((Difference (in) x 22) / 15)} Leakage of 100GPM will yield a level drop 68 in.

☐ **Discharge Structure Slide Gate Leak Test Complete**

<u>Discharge Line Upstream Gate Valve (3VMD-240) / Slip Lining Leak Test</u>
☐ Once the slide gate test is complete the slide gate (3VMD-239) can be opened slowly to the 10% open position.
☐ Observe the discharge of 3VMD-240 for leakage.
☐ Proceed by filling Chamber #2 with water until the water level is equal to that in Chamber #1. (In total, the discharge line and chamber #2 will hold approximately 24,000 gallons of water)
☐ A leakage rate less than or equal to 100 GPM considered acceptable.
  - Mark the water level and record the time. Time: _________
  - Wait 15 minutes and mark the water level once again. What is the difference in water level? Difference In Water Level:____in /_____GPM {GPM = ((Difference (in) x 22) / 15)} Leakage of 100GPM will yield a level drop 68 in.
  - Determine the leakage from 3VMD-240 in the new manhole by measuring the depth of flowing water in the discharge pipe connected to the downstream side of the new manhole______in. GPM = _________ (See Chart 1 below for conversion) A leakage rate less than or equal to 100gpm or 0.9 inches of depth in the pipe is acceptable.

☐ The slip lining is tested for leakage by determining the difference between the valve leakage and the leakage determined by the rate of water decent in chamber #2. The difference should be zero plus or minus 20 GPM for error.
  - Difference: ________GPM

☐ **Gate Valve / Slip Lining Test Complete**

☐ Ash Basin #4 ready for discharge.
☐ Confirm 3VMD-239 open 40%.
☐ Confirm 3VMD-240 open 40%.

- ☐ Check that Skimmer Plates are installed to correct level (seven - 4ft plates from bottom and one – 4ft plate lifted and skimming the water) (Top of seventh plate is at Elevation 343ft.)
- ☐ Proceed with filling the Ash Basin #4 to Elevation 341ft. (2 ft from the top of the seventh skimmer plate).

Post Basin Startup Test Plan:

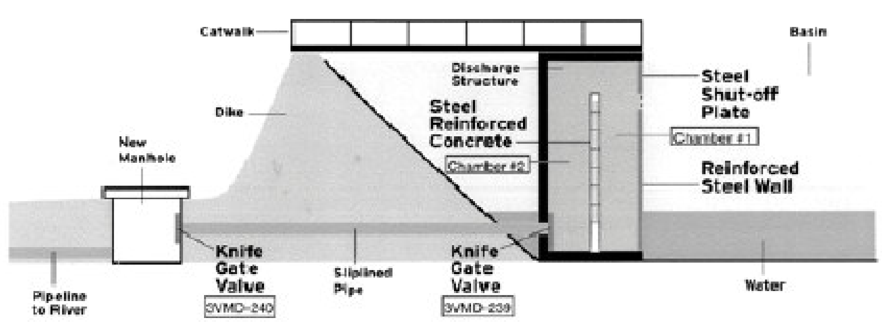
Skimmer Plate Inspection and Test (To be done when basin level reaches approximately 2ft from the top of the seventh skimmer plate (Elevation 341ft.))

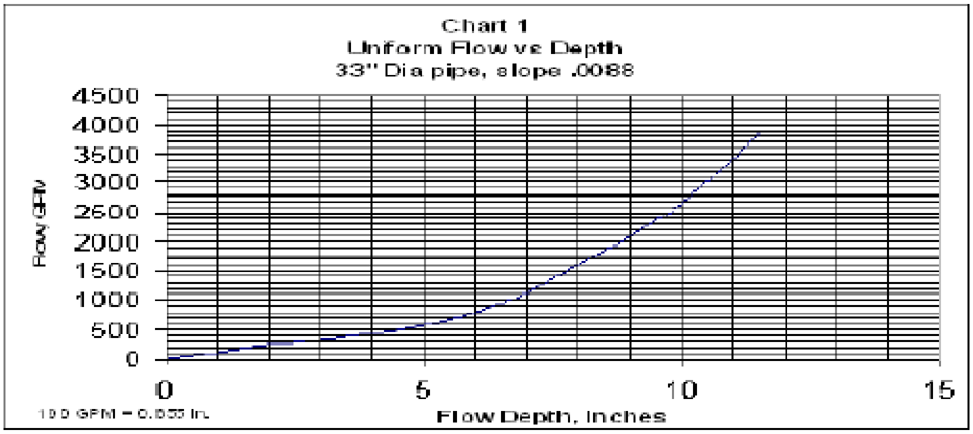
- ☐ Divers onsite to seal skimmer plate leaks as much as practical.
- ☐ Drop the top skimmer plate to prevent discharge from Ash Basin #4.
- ☐ Dewater Chamber #1 by placing a pump in chamber #1 and directing the discharge of the pump to the basin.
- ☐ Check sealing of skimmer plates.
    - o Diver to go below water level on the basin side and seal the leaking joints with epoxy.
    - o Note: Leakage between the end of the skimmer plates and channel is expected.
- ☐ Visually inspect the downstream side of the skimmer plates from the access ladder for defects or bulging under load. Keep chamber #1 dewatered (drop pump into chamber #1 if necessary)
- ☐ Visual Inspection Ok
- ☐ **Skimmer Plate Inspection and test Complete**
- ☐ Remove pumps from discharge structure
- ☐ Proceed with filling the Ash Basin #4 to normal operating level.
- ☐ Check TSS of Ash Basin #4 water at the discharge structure. Ensure that it is within allowable limits before discharging.

-

Figure 1

Permanent Barriers in #4 Basin





APPENDIX C
DISCHARGE BARRIER TEST SUMMARY
PHASE 2 – FULL BASIN TESTING

PPL Martins Creek, LLC
Ash Basin #4
Discharge Barrier Test Summary – Phase 2
Post Basin Startup Test Plan

January 25, 2006

This summary describes the testing done on the Ash Basin #4 discharge structure to complete the Post Basin Startup Test Plan as outlined in Attachment A - Startup and Test Plan for the Ash Basin #4 Discharge Barriers (Appendix B-1). The purpose of this testing is to ensure that the steel skimmer slot plates are adequately sealed and are free from defects. Execution of this part of the test plan was delayed until the basin had enough time to reach elevation 347 feet.

On January 12, 2006 divers were onsite to conduct final sealing of the steel skimmer slot plates and the concrete stop logs. From the basin side of the steel wall, divers applied epoxy sealant to all of the joints on the steel plates. The divers also applied additional sealant to the concrete panels in an attempt to stop a "garden hose" type leak that was found during the first phase of the discharge structure testing. The sealant was then allowed to cure overnight with water on both sides of the steel wall.

On January 13, 2006 divers were onsite again to conduct final sealing of the steel wall. Water from chamber 1 was pumped into the basin. As water was being pumped from chamber 1, the divers applied additional epoxy sealant to areas where leaks were noticed. After several hours of sealing, chamber 1 was de-watered. Some small weeping leaks still exist. It is not practical or reasonable to expect the steel wall to be completely water tight.

With chamber 1 de-watered, the steel wall was inspected for structural integrity. The concrete structure was also inspected. No defects or abnormalities were found in the steel plates or surrounding structure.

Over the next several days the pumps were removed from chamber 1 and the basin was allowed to fill to normal operating level. An additional concrete stop log was added to allow the basin level to increase to elevation 348' before discharging. Past experience has shown that TSS levels tend to be better when operating the basin at 348' or higher.

In preparation for discharge, the basin discharge valves were positioned to their normal position (40% open). TSS samples were taken from the basin around the discharge structure to help determine if TSS would be a problem for first discharge. TSS levels were found to be in compliance with the plant's NPDES limits.

On January 23, 2006 the level of ash basin #4 rose to an elevation where is started to discharge. All NPDES parameters including the additional parameters for metals from the NPDES amendment were sampled and sent for analysis once discharge began.

Prepared by:

John William Herring III

John William Herring, III, P.E.
Senior Engineer
PPL Martins Creek, LLC

EMERGENCY ACTION PLAN

SURVEILLANCE, WARNING AND EVACUATION PROCEDURES

MARTINS CREEK SES ASH BASIN NO. 4 DAM

DEP NUMBER D48-149

LOCATED IN NORTHAMPTON COUNTY, LOWER MT. BETHEL TOWNSHIP

LATITUDE 40°-48'-30" LONGITUDE 75°-07'-00"

OPERATED BY:	**SHIFT SUPERVISOR, PPL MARTINS CREEK LLC STEAM ELECTRIC STATION BANGOR, PA 18013**
TELEPHONE:	**WORK: (610) 498-2282 24- HOUR: (610) 498-2282**

OWNED BY:	**PPL GENERATION, LLC**
ADDRESS:	**2 N. 9TH ST. ALLENTOWN, PA 18101**
TELEPHONE:	**WORK: (610) 774-5151**

DATE: 7-28-05

REVISED: 8-4-06

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PROMULGATION AND CONCURRENCE

We, the undersigned, on date indicated, have reviewed the requested support activity in the Emergenc Action Plan for MARTINS CREEK SES ASH BASIN NO. 4 DAM. Our support action will be executed in accordance with existing Standard Operating Procedures and/or municipal or county emergency operation plans.

Dennis J Murphy | 07/18/2005
D. J. MURPHY, PPL GENERATION LLC, VP/COO
EASTERN FOSSIL & HYDRO (DAM OWNER AND OPERATOR)
DATE

T G Eppehimer | 7/6/05
T. G. EPPEHIMER, PPL MARTINS CREEK LLC,
MANAGER – FOSSIL GENERATION ASSETS
DATE

7/19/05
N ICK TYLENDA
NORTHAMPTON COUNTY EMA
DATE

Jeffery W. Larrison Jr. | 7/19/05
MARVIN MCCAMMON
LOWER MT. BETHEL TWP EMA COORD.
DATE

Jeffery W. Larrison Jr. | 7/19/05
JEFFERY LARRISON
LOWER MT. BETHEL/SANDTS EDDY FIRE COMPANY
DATE

7/19/05
TROOP M
PA STATE POLICE – BELFAST BARRACKS
DATE

Cordelia E. Miller | 7/28/05
LEHIGH VALLEY RED CROSS CHAPTER
DATE

Page ii

for GERALD FRY
PENNDOT

3/19/08
DATE

Page iii

PEMA AND DEP APPROVALS

The Pennsylvania Emergency Management Agency, hereby finds the Emergency Action Plan contains [redacted] elements for an effective warning and evacuation plan.

Coordinator, PEMA Eastern Area Office **Date** 2/16/06

The Department of Environmental Protection, Bureau of Waterways Engineering, Division of Dam Safety, hereby approves the Emergency Action Plan for MARTINS CREEK SES ASH BASIN NO. 4 DAM (D48-149).

Chief, Division of Dam Safety **Date** 2/24/06

1. **PURPOSE AND SCOPE**

A. To safeguard the lives as well as to reduce property damage of the citizens living within the dam's potential downstream flood or inundation area.

B. To provide for effective dam surveillance, prompt notification to local emergency management agencies citizen warning and evacuation response, when required.

C. To assign emergency actions to be taken by the dam operator/owner, public officials, emergency personnel, and to outline response by residents in the event of a potential or imminent failure of the dam

2. **SITUATION**

A. The dam is a 43-foot high 5,740 foot long earthen embankment dam, maintaining a normal pool of 250 acre-feet of water (above grade) with a maximum pool capacity of 325 acre-feet (above grade).

B. The dam is located across a tributary to Oughoughton Creek on the west bank of the Delaware River in Northampton County, Pennsylvania, about 2 miles east of the town of Martins Creek, PA. Refer to Location Map at ***Attachment B.***

C. The inundation area resulting from a sudden dam failure extends approximately 6,000 feet from the dam to the Delaware River. Several hundred feet of the Martins Creek-Belvidere Highway and Depue Ferry Road would be inundated. See Inundation Map at ***Attachment A.***

The inundation area includes a 350 acre tract of open ground immediately surrounding the Ash Basin just south of the Martins Creek-Belvidere Highway as well as the lower 1 ½ miles of the Oughoughton Creek valley leading to the Delaware River.

D. Within the inundation area are approximately 50 residents, 14 homes, no businesses, no schools , no hospitals, no nursing homes and no day care centers. Refer to the Inundation Map at ***Attachment A.***

3. **CONCEPT OF OPERATIONS**

A. SURVEILLANCE - (DAM OWNER OR OPERATOR)

1. Normal Conditions

a. The Manager – Fossil Generation Assets of the Martins Creek Steam Electric Station (SES) will send a dam inspector to conduct an on-site visual inspection of the dam, the dam's spillway(s), control systems, and the toe area below the dam at a minimum of once every quarter. Any abnormal or questionable conditions will be immediately brought to the attention of PPL Generation LLC's Generation Technical Support group and the Division of Dam Safety of DEP.

b. If any condition is found during a normal inspection which meets or exceeds Section 4.A.2., Responsibilities and Duties - Dam Owner, the Manager – Fossil Generation Assets of the Martins Creek SES, or his representative, will immediately notify the

Northampton County 911 Center and Department of Environmental Protection's Northeast Regional Office.

2. Unusual Event Conditions

a. Possible failure of this dam is most likely to occur during severe thunderstorms, heavy rains with local flood warnings, tropical storms and hurricanes, or heavy rains with frozen ground and/or snow cover.

b. The Manager – Fossil Generation Assets of the Martins Creek SES, or his representative, will commence 24-hour continuous around-the-clock surveillance of conditions at the dam site:

(1) when 3 inches or more of rain occurs in one hour or less, or is predicted by the Weather Service, or

(2) when the National Weather Service issues a flash flood watch and conditions warrant,

(3) when any conditions listed in paragraph 4.A.2. below are observed during a routine dam inspection or maintenance,

(4) following the occurrence of an earthquake in the general region of the dam, or

(5) in the event of a sinkhole forming near the basin dike.

3. Termination of Surveillance

a. The Manager – Fossil Generation Assets of the Martins Creek SES will terminate 24-hour surveillance of dam site conditions when:

(1) The National Weather Service ends a flash flood warning.

(2) Heavy rains have ended and the water level in the basin has dropped 4 ½ *feet* below the top of the dam (to El. 350.5).

(3) After personal inspection by a knowledgeable professional engineer of the dam site, following an earthquake, overtopping of the dam, or an evacuation of the inundation area as a result of this EAP, or other serious problems resulting in a notification of a dam site emergency.

B. NOTIFICATION

The Manager – Fossil Generation Assets of the Martins Creek SES will initiate the warning notification to the Northampton County 911 Center (or Northampton County EMA, ph # 610-759-2600) and Department of Environmental Protection's Northeast Regional Office. Warning will be relayed from the Northampton County 911 Center to all emergency responders.

C. WARNING

1. When the situation meets the criteria under the surveillance guidelines, presented in Section 4.A.2, indicating a failure of the dam is possible or a significant threat condition is developing, the Manager – Fossil Generation Assets of the Martins Creek SES, or his representative, will relay warning communications to Northampton County 911 Center and Department of Environmental Protection's Northeast Regional Office.

2. Warning notification will be relayed from the Northampton County 911 Center to all emergency responders and designated government officials and agencies.

3. Emergency management officials will accomplish the needed actions which are explained in this EAP, in accordance with their existing Standard Operating Procedures and existing municipal or county emergency action plans.

D. EVACUATION

Evacuation or pre-evacuation warning of the public may commence upon notification by the Manager – Fossil Generation Assets of the Martins Creek SES of a potential or imminent failure of the dam. Emergency responders will initiate action in accordance with the plan outline and any existing internal organizational Standard Operating Procedures (SOP), and existing municipal or county action plans.

4. RESPONSIBILITIES AND DUTIES - EMERGENCY RESPONSE

A. DAM OWNER (SURVEILLANCE- DAM SITE EMERGENCY)

1. The Manager – Fossil Generation Assets of the Martins Creek SES will provide for 24-hour on site dam surveillance and monitoring.

2. PPL Corporation's Generation Technical Services Group, working at the request of the Manager – Fossil Generation Assets of the Martins Creek SES, is responsible for determining the dam's threat potential. The following conditions constitute a dam emergency and require notification to the Northampton County 911 Center:

   a. The water level in the impoundment area has reached the threshold level of El. 352.5, which is 2 ½ *feet* below the top the dam.

   b. Imminent failure of this dam might be indicated by observance of one or more of the following conditions at the dam site.

      (1) The basin or pond level is at or near the top of the dam and water is flowing, or about to flow, over the top of the dam.

(2) The overflow pipe or spillway is damaged, clogged with debris or ice which is resulting in a rapid rise in the lake or pond level.

(3) The emergency spillway is experiencing heavy flows which are causing severe erosion to the spillway or the dam embankment.

(4) Any structural movement or failure of the concrete (masonry) spillway or the spillway abutment walls.

(5) Any sloughing or sliding of the embankment upstream or downstream slope.

(6) Subsidence, sinkholes or cracks found in any part of the dam's embankment or abutting slopes.

(7) Any new discharge of water is observed through the dam's embankment or abutting slopes, adjacent to any conduit outlets, or under the dam, which appears as a boil along the downstream toe. Should such a discharge occur and the water is cloudy or muddy in color, then a very serious problem exists.

3. The Manager – Fossil Generation Assets of the Martins Creek SES is responsible for initiating warning notification to the Northampton County 911 Center and Department of Environmental Protection's Northeast Regional Office.

B. COUNTY 911 CENTER

1. The Northampton County 911 Center will notify the following:
(Telephone numbers and points of contact are listed in ***Attachment C***)

a. Northampton County EMA

b. Lower Mt. Bethel/Sandts Eddy Fire Company

c. Goodwill Fire Company (Belvidere, NJ)

d. PA State Police – Belfast Barracks

e. Medic 9 Ambulance Service

f. Northampton County PennDOT

C. COUNTY EMA

1. The Northampton County EMA will contact the following personnel and agencies (See ***Attachment C***):

a. Lower Mt. Bethel Township EMA

b. Media – Advisory and/or Warning (Activate EAS). Refer to ***Attachment D***

4

c. Northampton County EOC staff, as necessary

d. American Red Cross – Lehigh Valley Chapter (when mass care or family assistance is required). Coordinate sheltering per Annex K of County EOP.

e. Northampton County elected officials

f. Pennsylvania Emergency Management Agency

g. Bangor School District

3. The Northampton County EMA will ascertain and report to PEMA any unmet need and requirements.

4. The Northampton County EMA will initiate Damage Assessment and Recovery procedures as the situation requires.

D. MUNICIPAL EMA

1. LOWER MT. BETHEL TOWNSHIP.

a. Notify municipal elected officials.

b. Advise municipal services (water, sewer, road crews, etc.).

c. Keep the County EMA apprised of the situation.

d. Coordinate the evacuation (where appropriate).

e. Perform initial damage assessment.

E. FIRE DEPARTMENT

1. LOWER MT. BETHEL/SANDTS EDDY FIRE COMPANY

a. Provide citizen notification and route alerting to advise residents living within their jurisdiction (See Inundation Map – Attachment A).

b. Assist in evacuation

c. Establish traffic control points (TCP) at predetermined locations (See Inundation Map). Establish access control points (ACP) at pre-designated locations (See Inundation Map).

d. Assist Police and EMS as requested.

e. Provide communications support if feasible and requested.

F. POLICE SERVICES

1. PA STATE POLICE - BELFAST BARRACKS

a. Assist evacuation traffic flow (See Inundation Map).

b. Prevent unauthorized entry into emergency areas (See Inundation Map).

c. Provide assistance with route alerting, if requested.

d. Provide Emergency Preparedness Liaison Officer (EPLO) at the Northampton County EOC to coordinate all Law Enforcement activities.

G. EMERGENCY MEDICAL SERVICES (EMS)

1. MEDIC 9 AMBULANCE SERVICE and LOWER MT. BETHEL/SANDTS EDDY FIRE COMPANY

a. Provide evacuation transportation assistance and coordinate with designated fire service agencies for transportation of persons with disabilities and any special needs.

b. Assist fire and police departments as requested.

c. Provide EMS support to any mass care center as requested.

H. AMERICAN RED CROSS

1. LEHIGH VALLEY CHAPTER (As requested by County EMA)

a. Alert person(s) responsible to set-up and operate the following reception/mass care centers:

- Lower Mt. Bethel Township Municipal Building

b. Support operations of the reception center and activate mass care center staff.

c. Maintain operations of reception center/mass care center as requested by EMA officials until final disposition of evacuees is completed.

I. PENNSYLVANIA DEPARTMENT OF TRANSPORTATION (PennDOT)

1. Provide services, signs, barricades and guidance on roads and bridges affecting the evacuation and recovery.

5. ADMINISTRATION AND LOGISTICS

A. Notices (see *Attachment E*) will be posted at the following public places:

1. Lower Mt. Bethel Township Municipal Building
2. Lower Mt. Bethel/Sandts Eddy Fire Company
3. Goodwill Fire Company (Belvidere, NJ)
4. PPL Martins Creek LLC, Martins Creek Steam Electric Station
5. Northampton County Tax Office
6. PA State Police, Belfast Barracks

B. The Notice (see *Attachment E*) must state that copies of the Emergency Action Plan for this dam are available for inspection at the following locations (include address):

1. Northampton County Emergency Management Agency Office, Greystone Building, Gracedale Complex, Nazareth, Pa 18064-9278
2. Lower Mt. Bethel Township EMA Office, 201 Johnson Rd., Bangor, PA 18013
3. PPL Martins Creek LLC, Martins Creek Steam Electric Station, 6605 Foul Rift Road, Bangor, PA 18013-4857

C. New Notices will be sent to those agencies in paragraph "A" above whenever Plan is revised.

6. AUTHORITY AND REFERENCES

A. AUTHORITY

1. The Dam Safety and Encroachments Act (32 P.S. sections 693.1-693.27), May 16, 1985.
2. The Pennsylvania Code - Title 25, Chapter 105 Dam Safety and Waterways Management, Section 105.63 and 105.134.
3. Emergency Management Services Code, 35 Pa C.S. Section 7101 et seq.: as amended.

B. REFERENCES

1. Emergency Action Planning Guidelines for Dams. Subcommittee on Emergency Action Planning, Inter-agency Committee on Dam Safety, February 1985.

2. Manual for the Inspection, Maintenance and Operation of Dams in Pennsylvania, Prepared by th Department of Environmental Protection, Water Management, Bureau of Waterways Engineering, Division of Dam Safety, 1986.

3. Northampton County Emergency Operations Plan.

7. DEFINITIONS

A. **ABUTMENT** - The part of the valley's hillside against which the dam abutts. Right and left abutments are those on respective sides of the dam as an observer looks downstream.

B. **BOIL** - A disturbance in the surface layer of soil caused by water escaping under pressure from behind a water-retaining structure such as a dam or a levee. The boil may be accompanied by deposition of soil particles (usually sand or silt) in the form of a ring (miniature volcano) around the area where the water escapes.

C. **BREACH** - An opening or a breakthrough of a dam sometimes caused by rapid erosion of a section of earth embankment by water.

D. **CONDUIT** - A pipe used to convey water through or around or under a dam.

E. **CONTROL TOWER** - A structure in the dam or reservoir used to control withdraw of water from the reservoir thru pipes or culverts.

F. **CREST OF DAM** - The crown of an overflow section of the dam. In the United States, the term "crest of dam" is often used when "top of dam" is intended. To avoid confusion, the terms **crest of spillway** and **top of dam** should be used for referring to the overflow section and dam proper, respectively.

G. **CULVERT** - (a) A drain or waterway structure built transversely under a road, railway, or embankment. A culvert usually comprises a pipe or a covered channel of box section. (b) A gallery or waterway constructed through any type of dam, which is normally dry but is used occasionally for discharging water; hence the terms scour culvert, drawoff culvert and spillway culvert.

H. **DAM** - A barrier built across a watercourse for impounding or diverting the flow of water.

I. **DAM FAILURE** - The uncontrolled release of a dam's impounded water. It is recognized that there are degrees of failure. Any malfunction or abnormality, outside the design assumptions and parameters which adversely affect a dam's primary function of impounding water is properly considered a failure. Minor malfunctions or abnormalities can result in a sudden failure of a dam.

J. **EARTH DAM (EARTHFILL DAM)** - An embankment dam in which more than 50% of the total volume is formed of compacted fine-grained earth.

K. **EMBANKMENT** - Fill material, usually earth or rock, placed with sloping sides.

L. **EMERGENCY** - A condition of serious nature which develops unexpectedly and endangers the structural integrity of a dam or endangers downstream property and human life. An emergency requires immediate action.

M. **EMERGENCY ACTION PLAN (EAP)** - A formal plan of procedures designed to minimize consequences to life and property in the event of an emergency at a dam.

N. **FACE** - With reference to a structure, the external surface that limits the structure, e.g., the face or a wa or dam.

O. **FAILURE** - An incident resulting in the uncontrolled release of water from an operating dam. See "Dam Failure".

P. **FOUNDATION OF DAM** - The natural material on which the dam structure is placed.

Q. **GROIN** - That area along the contact (or intersection) of the face of a dam with the abutment.

R. **HAZARD** - A situation which creates the potential for adverse consequences such as loss of life, property damage, and adverse social and environmental impacts. Impacts may be for a defined area downstream of a dam from flood-waters released through spillways and outlet works of the dam or waters released by partial or complete failure of the dam. They may also be for an area upstream of the dam from effects of backwater flooding or effects of landslides around the reservoir perimeter.

S. **INUNDATION AREA** - The downstream area that would be flooded or other wise affected by the failure of a dam or large flows. This area can be subject to a fast moving flood wave, 20 to 50 MPH is common, with a height of 1 foot to tens of feet

T. **INUNDATION MAP** - A map delineating the area that would probably be flooded in the event of a dar failure. This map must be prepared by a registered professional engineer.

U. **NOTIFICATION** - To promptly inform appropriate individuals or emergency agency about an emergency condition so they can initiate appropriate actions.

V. **NORMAL WATER LEVEL (NORMAL WATER POOL)** - For reservoir with a fixed overflow spillway crest, it is the lowest level of that crest.

W. **OPERATOR** - The person or position in a company or organization, who is responsible for a dam's operation and surveillance.

X. **OUTLET** - A constructed opening through which water can be safely discharged for a particular purpose from a reservoir.

Y. **OWNER** - Any person, authority or agency that manages a dam or reservoir.

Z. **SEEPAGE** - The movement of water that might occur through the dam, its foundation or its abutments. Small amounts of clear water seepage is normal. Increase in the amount of water flow or change in color is a concern for a dam's safety.

AA. **SLIDE** - The movement of a mass of earth and/or down a slope. In embankments and abutments, this involves the separation of a portion of the slope from the surrounding materials.

BB. **SPILLWAY** - A structure over or through which flows are discharged. If the flow is controlled by gates, it is considered a controlled spillway; if the elevation of the spillway crest is the only control, it is considered an uncontrolled spillway.

CC. **SPILLWAY CHANNEL** - A channel conveying water from the spillway crest to the river downstream.

DD. **TOE OF DAM** - The junction of the downstream face of a dam with the ground surface. Also referr to as downstream toe. For an embankment dam, the junction of the upstream face with ground surface called the upstream toe.

EE. **TOP OF DAM** - The elevation of the uppermost surface of a dam, usually a road or walkway, excludi any parapet wall, railings, etc.

8. EXERCISE AND TRAINING

The dam owner will advise and cooperate with the Northampton County EMA of any exercises scheduled, and coordinate with the Northampton County EMA to exercise all or portions of this EAP as part of the county's all hazard exercise program schedule.

9. PLAN MAINTENANCE

A. This Plan will be reviewed every two years by the owner or the owner's engineer.

B. During the two year review:

1. The owner's engineer will field review the flood (inundation) area for any increase in downstrea development and revise the Inundation Map, if needed.

2. The owner's engineer will review and revise surveillance conditions as needed.

3. The owner will coordinate with Northampton County EMA if population increase or development within the inundation area could affect the emergency response requirements. If so, a new or revised plan should be developed.

4. The owner will obtain concurrence from emergency response agency officials attesting to their continued understanding of their role(s).

5. The owner will submit revised plan to DEP for approval.

ATTACHMENTS:

ATTACHMENT A - DOWNSTREAM FLOOD AREA (INUNDATION) MAP
ATTACHMENT A-1 - ROAD CLOSURES AND ACCESS CONTROL POINTS
ATTACHMENT B - LOCATION MAP
ATTACHMENT C - TELEPHONE ROSTER
ATTACHMENT D- MEDIA ANNOUNCEMENT
ATTACHMENT E - POSTING NOTICE

ATTACHMENT A

INUNDATION MAP

ATTACHMENT A-1

ROAD CLOSURES AND ACCESS CONTROL POINTS

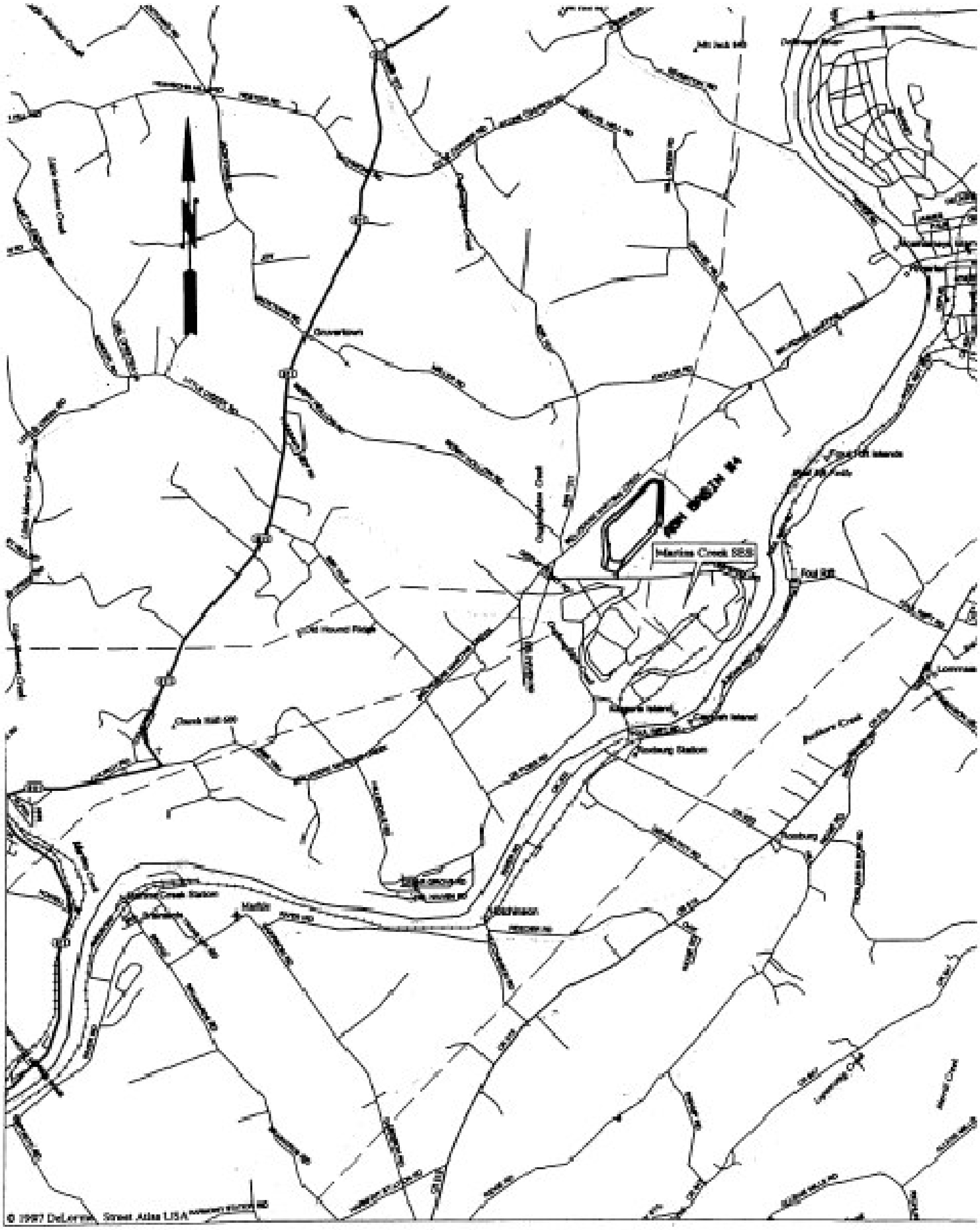
1.	TCP #1	On Richmond Rd., south of the intersection of Miller Rd. and Richmond Rd. **Assigned to:** Lower Mt. Bethel/Sandts Eddy Fire Co. – Station #26
2.	TCP #2	On Berry Hollow Rd., 1 3/4 miles Southeast of the intersection of Berry Hollow Rd. and Route 611. **Assigned to:** Lower Mt. Bethel/Sandts Eddy Fire Co. – Station #26
3.	TCP #3	On Belvidere Highway, Northeast of the intersection of Mt. Pleasant Rd. and Belvidere Highway. **Assigned to:** Lower Mt. Bethel/Sandts Eddy Fire Co. – Station #26
4.	TCP #4	On DePues Rd., at the intersection of Del Haven Rd. and DePues Rd. **Assigned to:** Lower Mt. Bethel/Sandts Eddy Fire Co. – Station #26
5.	TCP #5	On DePue Ferry Rd., about 1 mile East of the intersection of DePue Ferry Rd. and Belvidere Highway. **Assigned to:** Lower Mt. Bethel/Sandts Eddy Fire Co. – Station #26
6.	ACP #1	On Belvidere Highway, 100 ft. West of the intersection of Kaylor Rd. and Belvidere Highway. **Assigned to:** Lower Mt. Bethel/Sandts Eddy Fire Co. – Station #26

ATTACHMENT B

LOCATION MAP

Directions to Martins Creek Ash Basin No. 4 Dam:

1. North on Rt. 611 from Easton, PA;
2. At town of Martins Creek, PA, Rt. 611 North makes right turn;
3. Proceed north on Rt . 611 for approx. 1 mile past Martins Creek;
4. At top of hill near church, proceed straight ahead on Martins Creek-Belvidere Highway;
5. Go 3 miles, make right turn to Depues Ferry Rd.
6. Go ¼ mile, Ash Basin No. 4 Dam is on the left.


Martins Creek SES
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PPL Martins Creek, LLC
Ash Basin #4
<u>Maintenance Plan</u>

1/10/2009

The purpose of this report is to define the measures that PPL intends to incorporate into the Daily, Quarterly and Annual observations and inspections of Ash Basin #4.

The following documents are included:

Attachment A – **PPL Martins Creek Discharge Structure and Outlet Pipe Maintenance Program**
Attachment A is a summary of the Daily, Quarterly and Annual observations and maintenance activity as it relates to the Ash Basin 4 discharge structure and outlet pipe.

Attachment B – **Ash Basin #4 Daily Operations Log Sheet**
Attachment B is a copy of the Operations log sheet that will be used to document the daily observations of Ash Basin #4.

Attachment C – **Ash Basin #4 Quarterly Inspection Checklist**
Attachment C is a copy of the checklist that is to be used during the quarterly inspections.

Attachment D – **Ash Basin #4 Annual Inspection Checklist**
Attachment D is one of two checklists that are to be used during the quarterly inspections.

Attachment E – **Ash Basin #4 Annual Inspection Checklist**
Attachment E is one of two checklists that are to be used during the quarterly inspections.

Attachment A

PPL Martins Creek Discharge Structure and Outlet Pipe Maintenance Program

MARTINS CREEK BASIN 4
DISCHARGE STRUCTURE AND OUTLET PIPE
MAINTENANCE PROGRAM

Equipment	Maintenance Requirement	Method	Interval	Documentation
Concrete Structure	Exterior& interior - look for cracking or spalling	O	Q	QDSI
	Divers to conduct under water inspection. Look for cracking or other defects in the structure.	O	A	ADSI
Walkway	Look for rusting, loose grating or handrail - beams, grating, handrail	O	Q	QDSI
Skimmer Plate	Look for bulging, deformation, seating in the guide slats.	O	D & Q	DOLS & QDSI
	Lower the top skimmer, dewater the downstream chamber, run lights down and observe downstream face from the top of the structure or from the ladder that goes down into the structure. Inspect for abnormalities in the skimmer slot structure.	O	A	ADSI
Stoplogs	Look for abnormalities in flow over the top stoplog, turbulence, spraying	O	D & Q	DOLS & QDSI
	Add stoplogs, stop overflow, observe downstream face - look for bulging, cracking, skewed logs, deformation, looking by lowering a light and observing from the top of the structure or from the ladder that goes down into the structure.	T	Q	QDSI
	Dewater the upstream chamber and observe upstream face by lowering a light and observing from the top of the structure. Also look for abnormalities in the slot structure.	T	A	ADSI
Lifting Mechanism stoplogs & skimmer	Look for rust, damage	O	Q	QDSI
	Verify that lifting mechanism is lubricated	T	Q	QDSI
	Operate two full revolutions - note ease of operation	T	Q	QDSI
Valve @ discharge	Operate open to close to open, lubricate actuator, look for rusting/corrosion	T	Q	QDSI
	Close valve and check for leaks at downstream manhole (up to 100 gpm acceptable)	T	A	ADSI
Valve @ manhole	Operate open to close to open actuator, lubricate, look for rusting/corrosion	T	Q	QDSI
	Close valve and check for leaks (up to 100 gpm acceptable)	T	A	ADSI
Outlet pipe	Walkdown pipeline from basin to river - look for abnormal vegetation, wet spots, sinkholes.	T	Q	QDSI
Staff gage	Look for rusting, corrosion, securely fastened	O	Q	QDSI
Pressure sensor	Check operation, verify with control room and staff gage	T	D & Q	DOLS & QDSI
Control room	Check operation	O	D & Q	DOLS & QDSI
	Verify accuracy with pressure sensor and staff gage	T	D & Q	DOLS & QDSI

Method
O = Observation
T = Test

Interval
D = Daily
Q = Quarterly
A = Annually

Documentation
DOLS = Daily Operations Log Sheet
QDSI = Quarterly Dam Safety Inspection
ADSI = Annual Dam Safety Inspection

Attachment B

Ash Basin #4 Daily Operations Log Sheet

Ash Basin #4
Daily Operations Log Sheet

MC-101

Operators Name: ____________________

Date: ___________

Dayshift or Nightshift

The Following checklist and information is to be taken during routine basin observations.
This sheet is to be submitted daily to the plant Environmental Engineer.

Discharge Structure:

Skimmer Plate Observation:

Does the skimmer plate appear to be bulging or deformed?
Yes ___ No ___

If Yes Describe and Notify the Shift Supervisor Immediately:

____

____

Is there any abnormal turbulence in and around the skimmer plate?
Yes ___ No ___

If Yes Describe and Notify the Shift Supervisor Immediately:

____

____

Does the skimmer plate appear to be seated
in the guides properly? Yes ___ No ___

If No Describe and Notify the Shift Supervisor Immediately:

____

____

Stop Log Observation:

Are there any abnormalities in the flow
Over the top stop log? (turbulence, spraying, etc.) Yes ___ No ___

If Yes Describe and Notify the Shift Supervisor Immediately:

____

____

Is there an abnormal differential between the first and second
Chamber? Yes ___ No ___

If Yes Describe and Notify the Shift Supervisor Immediately:

____

____

Discharge Structure Observation:

Are there any abnormalities in the discharge structure?
(Cracks in structure) Yes ___ No ___

If Yes Describe and Notify the Shift Supervisor Immediately:

____

____

1 of 2

Ash Basin #4
Daily Operations Log Sheet

MC-101

Basin Level Readings:

	Time	Reading
Staff Gage		
Local Indication		
Control Room Indication		

Note: If level in the basin reaches or exceeds 350 ft. Report it immediately to the Shift Supervisor and Refer to Section 4.A.2 of the Basin #4 Emergency Action Plan for the further action that must take place.

Note: A noticeable difference in these readings or other abnormalities should be reported to the Shift Supervisor immediately.

Dike Observations:

Operations is to patrol or respond to the Ash Basin #4 Dike during daylight hours when weather permits and anytime there is level alarm or increase / decrease of level noticed by the control room operators.

Dike Observations:

Is there any sloughing or sliding of the embankment upstream or downstream slope? Yes ___ No ___

If Yes Describe and Notify the Shift Supervisor Immediately:

____

____

Check for any subsidence, sinkholes or cracks in any part of the dam's embankment or abutting slopes. Are there any? Yes ___ No ___

If Yes Describe and Notify the Shift Supervisor Immediately:

____

____

Any there new discharge of water is observed through the dam's embankment or abutting slopes, adjacent to any conduit outlets, or under the dam, which appears as a boil along the downstream toe? Yes ___ No ___

If Yes Describe and Notify the Shift Supervisor Immediately:

____

____

(Should such a discharge occur and the water is cloudy or muddy in color, then a very serious problem exists.)

Note: If any of the above answers regarding the dike observation were answered yes, then immediately report it to the Shift Supervisor and Refer to Section 4.A.2 of the Basin #4 Emergency Action Plan for the further action that must take place.

2 of 2

Attachment C

Ash Basin #4 Quarterly Inspection Checklist

BASIN 4 QUARTERLY INSPECTION CHECKLIST

INSPECTED BY: **DATE:** **WEATHER:**

For "Condition" show: S = Satisfactory
C = Satisfactory but check carefully next inspection
M = Requires action this season
A = Requires immediate action

Mail checklist to John Cincilla GENPL6

		CONDITION	MAINTENANCE FACTORS (USE FACTOR #'S)	FOOTNOTE NUMBER*
EMBANKMENT				
Embankment Integrity Inside Slope	(1) Cracks; (2) Erosion; (3) Sinkholes; (4) Piping (muddy seepage flows); (5) Seepage; (6) Puddles; (7) Settlement; (8) Sliding/Sloughing; (9) Other (explain)			
Outside Slope				
Top of Dike				
Outside Toe				
Vegetation Outside Slope	(1) Lush Vegetation; (2) Dead Vegetation; (3) Trees; (4) Shrubs; (5) Bare Spots; (6) Other (explain)			
Top of Dike				
APPURTENANCES				
Inlet Pipe (Short Line)	(1) Causing Erosion; (2) Cracked; (3) Sinking; (4) Insufficiently Moored; (5) Obstructed; (6) Other (explain)			
Floating Pipeline				
Outlet Facility Concrete Structure	(1) Cracked; (2) Spalled; (3) Damaged; (4) Leaking; (5) Obstructed; (6) Loose; (7) Other (explain)			
Skimmer Assembly				
Walkway	(1) Rusting; (2) Loose grating, beams or handrail			
Hypalon Liner	(1) Sagging; (2) Bulging; (3) Ripped; (4) Depressions; (5) Weathered; (6) Damaged; (7) Air Pockets; (8) Vegetation; (9) Other (explain)			
Access Road	(1) Inaccessible; (2) Eroded; (3) Overgrown; (4) Other (explain)			
Valve @ Discharge	Operate open to close to open; (1) Rusting/Corrosion; (2) Inadequate Lubrication			
Valve @ Manhole	Operate open to close to open actuator; (1) Rusting/Corrosion; (2) Inadequate Lubrication			
Outlet Pipe to River	Walk along outlet pipe from Basin 4 to the River; (1) Sinkholes; (2) Water Flow			
Stoplogs Lifting Mechanism	Operate two full revolutions; (1) Rust Damage; (2) Inadequate Lubrication			
Skimmer Lifting Mechanism	Operate two full revolutions; (1) Rust Damage; (2) Inadequate Lubrication			
Staff Gage	(1) Rusting/Corrosion; (2) Not Securely Fastened			
Skimmer Plate	(1) Bulging; (2) Deformation; (3) Proper Seating			
Stop Logs	(1) Abnormalities in Flow; (2) Structural abnormalities			
Staff Gage/Level Indication	(1) Do local level indication, Control Room level indication and staff gage agree?			

FOOTNOTES:

* NOTES CAN ALSO BE INCLUDED ON THE ATTACHED SITE PLAN

Attachment D

Ash Basin #4 Annual Inspection Checklist

INSPECTION CHECKLIST

VISUAL INSPECTION

PHASE III

PPL OWNED DAMS AND RELATED FACILITIES

FORMALIZED INSPECTION PROGRAM

NAME OF FACILITY ______ MARTINS CREEK SES ASH BASIN NO. 4 LOCATION ______ MARTINS CREEK, PA

PURPOSE OF FACILITY ______ FLY ASH DISPOSAL AND COOLING TOWER BLOWDOWN TYPE OF FACILITY ______ EARTHEN DIKE/HYPALON LINER

HAZARD POTENTIAL INDEX ______ 1 DATE OF INSPECTION ______

WEATHER ______ TEMPERATURE ______

INSPECTION PERSONNEL:

______

______

______

______

______

______ RECORDER

1. GENERAL APPEARANCE

MARTINS CREEK ASH BASIN NO. 4
INSPECTION OF
PAGE 1 OF 10

ITEM OBSERVED	OBSERVATIONS	RECOMMENDATIONS OR COMMENTS
VEGETATION		
Presence or absence of vegetation		
Type of vegetation		
Locations of different types		
BASIN DESCRIPTION		
Geometrical layout	PARALLELOGRAM-SHAPED BASIN WITH EARTHEN DIKES.	
Portion filled with ash/water		
Presence of swales or diversion dikes	NONE PRESENT.	
FREEBOARD		
Amount and change in amount (if freeboard varies within basin)		

MARTINS CREEK ASH BASIN NO. 4
INSPECTION OF
PAGE [illegible] OF [illegible]

I. GENERAL APPEARANCE

ITEM OBSERVED	OBSERVATIONS	RECOMMENDATIONS OR COMMENTS
ACCESS ROAD		
Condition, vehicle restrictions		
Length road is passable and/or explanation of observation	.	
VANDALISM		
Damage to basin (i.e., instrumentation, structures, etc.)		
Misuse of basin		
OTHER		
Ponded water on dike		

MARTINS CREEK ASH BASIN NO. 4
INSPECTION OF
PAGE 3 OF 10

I. GENERAL APPEARANCE

ITEM OBSERVED	OBSERVATIONS	RECOMMENDATIONS OR COMMENTS
BASIN LINER		
Type	HYPALON FLEXSEAL.	
Problems		
PRESENT CONDITION		

MARTINS CREEK ASH BASIN NO. 4
INSPECTION OF
PAGE 4 OF 18

II. EMBANKMENT AND ABUTMENT STABILITY

ITEM OBSERVED	OBSERVATIONS	RECOMMENDATIONS OR COMMENTS
SETTLEMENTS OR HORIZONTAL MOVEMENTS		
Location and extent of noticeable movements on embankment, abutment or their proximity.		.
CRACKS		
Location and extent of cracks on embankment, abutment, or their proximity. Also, any explanation of possible cause.		
BULGES		
Location and extent of bulging on embankment, abutment, or their proximity. Also, any explanation of possible cause.		
SLUMPING		
Location and extent of slumping occurring on embankment, abutment or their proximity. Also, any explanation of possible cause.		

II. EMBANKMENT AND ABUTMENT STABILITY

MARTINS CREEK ASH BASIN NO. 4
INSPECTION OF
PAGE 5 OF 10

ITEM OBSERVED	OBSERVATIONS	RECOMMENDATIONS OR COMMENTS
ANIMAL BURROWS		
Location		
Extent of Burrowing		
TREE GROWTH		
Location		
Size		

MARTINS CREEK ASH BASIN NO. 4
INSPECTION OF
PAGE 6 OF 12

III. SEEPAGE

ITEM OBSERVED	OBSERVATIONS	RECOMMENDATIONS OR COMMENTS
PHREATIC SURFACE		
Location		
SOFT/WET AREAS		
Location and Size		
Source of water, flow rate, and quality of water.		
Danger to dike stability		
SPRINGS		
Location		
Source and discharge point		
Flow rate and water quality		
DOWNSTREAM PONDED WATER		
Location		
Size and depth of pond		

III. SEEPAGE

MARTINS CREEK ASH BASIN NO. 4
INSPECTION OF
PAGE 7 OF 10

ITEM OBSERVED	OBSERVATIONS	RECOMMENDATIONS OR COMMENTS
PONDED WATER (CONTINUED)		
Source and discharge point		
Danger to dike stability		
SEEPAGE CONTROL EQUIPMENT		
Type	HYPALON FLEXSEAL LINER.	
Location	COVERS ENTIRE BASIN SURFACE AREA.	
Effectiveness		

IV. EROSION

ITEM OBSERVED	OBSERVATIONS	RECOMMENDATIONS OR COMMENTS
OUTWARD SLOPES		
Location of erosion scars		
Extent of erosion into dike		
Cause of erosion		
Activity stage of erosion process		
POND SLOPES		
Location of erosion scars		
Extent of erosion into dike		
Cause of erosion		
Activity stage of erosion process		
ASH INLET AREA		
Effect of inflow on surrounding dike area		

MARTINS CREEK ASH BASIN NO. 4
INSPECTION OF
PAGE 9 OF 10

V. APPURTENANCES

ITEM OBSERVED	OBSERVATIONS	RECOMMENDATIONS OR COMMENTS
MONITORING DEVICES (Staff Gage and Pressure Sensor)		
Location		
Type		
Physical Condition		
Frequency at which readings are taken		
INLET STRUCTURE(S)		
Location(s)		
Condition		
OUTLET STRUCTURE(S)		
Concrete		
Walkway Grating		
Railings		
Skimmer Plate		
Stop Logs/ Leakage		
Outlet slide gate		
Slide Gate Mechanism		
Lifting Mechanisms		
Downstream Knife Valve Gate		
Valve Gate Operating Mechanism		
Valve Vault		

Inside of outlet structure will be dewatered and inspected every time pond.

V. APPURTENANCES

ITEM OBSERVED	OBSERVATIONS	RECOMMENDATIONS OR COMMENTS
DOWNSTREAM CONDITIONS		
Location of residence		
Location of roads		
Location of obstructions		
New pH control tank - southeast corner		

Attachment E

Ash Basin #4 Annual Inspection Checklist

DAM INSPECTION CHECKLIST
PENNSYLVANIA DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF DAM SAFETY

NAME OF DAM: Martins Creek Ash Basin No. 4 DEP I.D. NO.: 39D-149

LOCATION: Lower Mount Bethel Township (township) Northampton (county)

DEP CLASSIFICATION DATA: ______ (size) ______ (hazard)

PHYSICAL DATA: Earthen (type of dam) 35 Ft. (above grade) (height of dam) 1,420 Ac-Ft. (when full) (normal pool storage capacity)

ELEVATIONS: ______ (normal pool) ______ (pool at inspection) N/A (tailwater at inspection)

PERSONS PRESENT AT INSPECTION

NAME	TITLE/POSITION	REPRESENTING

DATE OF INSPECTION: ______

WEATHER: ______

TEMPERATURE: ______

This is to certify that the above dam has been inspected and the following are the results of this inspection.

______
SIGNATURE OF REGISTERED PROFESSIONAL ENGINEER

NAME OF DAM: Martins Creek Ash Basin No. 4
Annual Inspection

DEP I.D. NO.: D48-149

INSPECTION DATE:

EMBANKMENT
1 of 2

AREA INSPECTED	ITEM NO.	CONDITION	OBSERVATIONS	CHECK (✓) ACTION NEEDED: MONITOR	INVESTIGATE	REPAIR
CREST	1	SURFACE CRACKING				
	2	SINKHOLE, ANIMAL BURROW				
	3	LOW AREA(S)				
	4	HORIZONTAL ALIGNMENT				
	5	RUTS AND/OR PUDDLES				
	6	VEGETATION CONDITION				
	7					
	8					
UPSTREAM SLOPE	9	LINER CONDITION				
	10	TURNAROUND AREA		x		
	11	EROSION ON/UNDER LINER				
	12	RAMPS				
	13	LINER ATTACHMENTS TO RAMPS/INTAKE STRUCTURE				
	14	INLET STRUCTURES				
	15					
	16					

ADDITIONAL COMMENTS: REFER TO ITEM NO. IF APPLICABLE

NAME OF DAM: Martins Creek Ash Basin No. 4 Annual Inspection   DEP I.D. NO.: D48-149   INSPECTION DATE:

EMBANKMENT

2 of 2

AREA INSPECTED	ITEM NO.	CONDITION	OBSERVATIONS	CHECK ( ) ACTION NEEDED: MONITOR	INVESTIGATE	REPAIR
DOWNSTREAM SLOPE	17	WET AREA(S) (NO FLOW)				
	18	SEEPAGE				
	19	SLIDE, SLOUGH, SCARP				
	20	EMB.-ABUT. CONTACT				
	21	SINKHOLE, ANIMAL BURROW				
	22	EROSION				
	23	UNUSUAL MOVEMENT				
	24	VEGETATION CONTROL				
	25					
	26					
INSTRUMENTATION	27	PIEZOMETERS/OBSERV. WELLS				
	28	STAFF GAUGE & RECORDER				
	29	PRESSURE SENSOR				
	30	SURVEY MONUMENTS				
	31	DRAINS				
	32	FREQUENCY OF READINGS				
	33	LOCATION OF RECORDS				
	34					
	35					

ADDITIONAL COMMENTS: REFER TO ITEM NO. IF APPLICABLE

NAME OF DAM: Martins Creek Ash Basin No. 4 Annual Inspection   DEP I.D. NO: D48-149   INSPECTION DATE:

DOWNSTREAM AREA AND MISC.

1 of 1

AREA INSPECTED	ITEM NO.	CONDITION	OBSERVATIONS	MONITOR	INVESTIGATE	REPAIR
DOWNSTREAM AREA	36	ABUTMENT LEAKAGE				
	37	FOUNDATION SEEPAGE				
	38	SLIDE, SLOUGH, SCARP				
	39	DRAINAGE SYSTEM				
	40					
	41					
	42	DOWNSTREAM HAZARD DESCRIPTION				
	43	DATE OF LAST UPDATE OF EMERGENCY ACTION PLAN				
MISCELLANEOUS	44					
	45	ACCESS ROADS				
	46	SECURITY DEVICES				
	47					
	48					
	49					
	50					

CHECK ( ) ACTION NEEDED

ADDITIONAL COMMENTS: REFER TO ITEM NO IF APPLICABLE

NAME OF DAM: Martins Creek Ash Basin No. 4 Annual Inspection   DEP I.D. NO.: D48-149   INSPECTION DATE:

AREA INSPECTED	OUTLET WORKS 1 of 1			CHECK ( ) ACTION NEEDED		
	ITEM NO.	CONDITION	OBSERVATIONS	MONITOR	INVESTIGATE	REPAIR
DOWNSTREAM SLOPE	70	INTAKE STRUCURE				
	71	TRASHRACK				
	72	SKIMMER PLATE				
	73	STOPLOGS				
	74	OUTLET SLIDE GATE				
	75	CONTROL MECHANISM				
	76	DOWNSTREAM KNIFE GATE				
	77	OUTLET PIPE & HEADWALL				
	78	EROSION ALONG DAM TOE				
	79	SEEPAGE				
	80	UNUSUAL MOVEMENT				
	81	STOP LOG LIFTING MECHANISM				
	82	DEWATER UPSTREAM CHAMBER (5 YR INSPECTION)				
	83	DEWATER LOWER CHAMBER (5 YR INSPECTION)				

ADDITIONAL COMMENTS: REFER TO ITEM NO. IF APPLICABLE

Martins Creek SES Ash Basin #4 Release

Root Cause Analysis Report

November 11, 2005

INTRODUCTION

On Tuesday, August 23, 2005, the failure of a wooden stop log (stop log #2) in the discharge structure of Martins Creek Ash Basin #4 resulted, over a three-day period, in the release of approximately 100 million gallons of water and fly ash into the Delaware River and surrounding public and plant property.

At the request of the president of PPL Generation LLC, a multi-disciplinary team (Team) was formed to conduct an analysis of the event to determine its root cause and to assess the adequacy and effectiveness of plant emergency response procedures.

The Team also was charged with recommending changes to reduce the likelihood of future events with adverse environmental consequences.

To strengthen its independence and objectivity, the Team was placed under the direction of Corporate Audit Services, which reports directly to PPL Corporation's chairman and chief executive officer.

The Team was composed of individuals with backgrounds in fossil plant engineering, fossil plant operations, environmental management, nuclear operations and internal auditing. The Team retained an outside expert in failure analysis to assist in determining the cause of the stop log failure.

The Team interviewed individuals involved in the design, operation, maintenance, inspection and environmental audits of Martins Creek Ash Basin #4 as well as other individuals involved in the response to the event.

The Team also reviewed design drawings, standards, engineering and construction files, operating and maintenance records and Martins Creek emergency response guidelines.

EXECUTIVE SUMMARY

Overview

The Team concluded that stop log #2 failed due to fabrication defects that date back to the basin construction in the late 1980s. The root cause analysis explored why these defects were not detected and why a single stop log failure resulted in a major environmental event. The analysis considered the extent to which these factors contributed to the problem:

- Design of the stop logs and discharge structure
- Quality inspection and construction oversight
- Periodic dam inspections
- Operation & maintenance of the basin
- Emergency response
- Repair procedures

The Team's analysis determined the PPL personnel involved had not anticipated the potential for this event. This fact adversely influenced the original design, periodic inspections, maintenance and, eventually, the emergency response to the failure.

Results of Root Cause Analysis

Based on information gathered by the Team during its interviews and document reviews, the Team developed three problem statements. These problem statements and related causal factors follow.

Problem Statement #1:

Approximately 100 million gallons of water containing fly ash was accidentally discharged into the Delaware River and surrounding public and plant property from Martins Creek Ash Basin #4.

Primary Causal Factors Related to Problem Statement #1:

1. Fabrication defects led to the failure of stop log #2 (second log from the bottom of a stack of about 40 logs) in the Ash Basin #4 discharge structure. These defects were not identified during periodic dam inspections.
2. There was no shutoff valve in the discharge pipe or other secondary barrier to prevent the release of water when the stop log failed.
3. Even though plant personnel worked around the clock, attempting several different methods of repair, it took three days to stop the release of water and ash.
4. While plant personnel took actions to mitigate the impact of the release of water and fly ash during the event, those efforts were minimally effective.

Problem Statement #2:

In some instances, the timing of communications with government and regulatory agencies, the general public and internal PPL management did not meet expectations. Also, initial reports lacked appropriate content to convey the full scope of the situation.

Primary Causal Factors Related to Problem Statement #2:

1. When Martins Creek plant personnel identified the leak on Tuesday evening, August 23, it was not immediately considered an emergency. Certain emergency notification actions were not initiated until Thursday, August 25. Until Thursday, the event was treated as an environmental incident with limited potential impact – one that plant personnel believed was manageable with local resources.

2. Martins Creek had several emergency response plans, but none specific to a major fly ash basin release. The contact lists in two of the plans were used as guides to make notifications based on judgments of who would be impacted, but not all of the listed contacts were notified.

Problem Statement #3:

The potential for this event was not identified during the design, operation, maintenance, inspection or environmental audits of Martins Creek Ash Basin #4.

Primary Causal Factors Related to Problem Statement #3:

1. Within the fossil generation function and the Environmental Management Department, environmental risk identification had been primarily experienced-based, i.e. based on events that have occurred in the past. The Ash Basin #4 stop log failure had no known, directly comparable, precedent. Therefore, the impact of such a failure had not been analyzed.

Recommendations

As a result of its findings, the Team has made ten recommendations to prevent a recurrence of such an event:

1. **Existing Basin Discharge Structures** - PPL Generation (Generation) should review the design and operation of all other ash basins and impoundments, and assess the need for additional discharge structure barriers. The review should identify and mitigate single contingency equipment failures and operating errors that could result in significant adverse environmental events.

2. **Critical Systems Environmental Risk Assessment** - Generation should conduct a review of its other facilities and systems to identify those with the potential to have a significant adverse environmental impact. For critical facilities and systems, the review should examine 'what if' scenarios to identify potential design and/or operational weaknesses that could cause significant environmental events. Criteria should be developed for what constitutes significant events, e.g. unimpeded, undetectable, substantial releases to the environment. Options to eliminate or mitigate potential risks should be developed, evaluated, prioritized and implemented as appropriate. This review should include outside resources with expertise in hazard identification and mitigation.

3. **Emergency Response Plans** - Generation should review the Emergency Response plans at each of its facilities and take steps to ensure that:

   a. There is an Integrated Emergency Response Plan (IERP), which includes procedures for hazardous and non-hazardous materials that pose a potential significant environmental risk.
   b. The response plans mandate the establishment of a command center and organization with clearly identified roles and responsibilities, provide for logistics, contingency planning, external communications and notifications, and the potential acquisition of external resources including services and equipment.
   c. The IERP addresses training, internal and external drills, and deadlines for plan updates and refresher training. Training should include the identification and recognition of significant events.
   d. Multiple Emergency Plans, Procedures, and Instructions are physically grouped together and indexed, with an overlay developed to guide the user to the applicable portions of each plan.
   e. There are procedures for a Generic Emergency Response which would guide the response to an unanticipated non-specified emergency. It should describe the items listed in (b) above.
   f. Responsibility for readiness planning, maintaining, updating and communicating these requirements is clearly assigned.

4. **Internal Communications** - Generation should review internal notification and communications requirements that are not specifically part of the emergency response plans to consolidate, where possible, various memos, instructions and guidelines to help ensure consistency and clarity. The communications requirements should be reviewed with managers and supervisors to help ensure that employees understand their individual roles and responsibilities.

5. **Future Use of Stop Logs** - Generation should develop guidelines for the future use of stop logs. These guidelines should consider the use of alternative materials. Provisions should be included in the design to facilitate removal of the stop logs for inspection and replacement as necessary. The guidelines should include inspection criteria as well as inspection and preventive maintenance schedules.

6. **Construction Quality Control** - Generation should review existing procedures associated with construction oversight and quality control to ensure that the appropriate level of review and oversight is exercised prior to project acceptance.

7. **Significant Event Analysis Process** - Generation should review its significant event process to ensure that unusual internal and external industry events are documented and evaluated, with appropriate corrective action taken, and that the results are communicated and addressed appropriately throughout the organization.

8. **Dam Inspections** - Generation should review its dam surveillance and inspection procedures to ensure that they contain appropriate inspection criteria, and that they adequately document observations and required maintenance.

9. **Design Process** - Generation should review its design and engineering process to ensure that designs are based on appropriate standards, receive appropriate review and are adequately documented, and that design documents are retained appropriately.

10. **Ash Basin Operating Plans** - Generation should review the operating plans for each of its ash basins to ensure that the plans contain appropriate guidelines for the operation of the basin and that the operation is consistent with the basin's design.

BACKGROUND

Ash Basin #4

Martins Creek Ash Basin #4 is a 40 acre basin used to dispose of fly ash produced from burning coal in Units #1 and #2. See **Exhibit A** for a diagram of the Martins Creek Site Layout.

The basin was designed by PPL starting in 1986. PPL contracted for the construction of the basin including all excavation, basin embankments, drainage facilities and the discharge structure in April 1988. The basin was placed in service in December 1989.

Ash Basin #4 was designed, and is operated and inspected, under permits approved by the Pennsylvania Department of Environmental Protection (PA DEP). The basin was constructed with a geotextile fabric and hypalon liner to help ensure that water does not leak from the basin. There are several monitoring wells around the basin to check for potential leaks into groundwater.

Operation of the basin consists of mixing fly ash with water at the plant and pumping the slurry mixture to the basin. A floating ash line is used to deposit the slurry at different locations within the basin to achieve a relative uniform layering of sediment. The fly ash settles into the basin and the remaining water flows to the discharge structure where it enters a 33-inch diameter pipe. The underground pipe is approximately 1½ miles long and discharges to the Delaware River upstream of the confluence with the Oughoughton Creek.

On each work shift, a plant employee checks the basin, looking for unusual conditions. Quarterly, plant personnel perform an inspection of the basin to assess its condition and complete an inspection sheet. Annually, technical personnel from Allentown conduct a dam safety inspection, as required by the Dam Safety Permit issued by the PA DEP. As a result of that inspection, a Dam Safety Inspection Report is prepared and is sent to the PA DEP and plant management.

Discharge Structure and Stop Logs

The discharge structure at Ash Basin #4 is a 45 foot high concrete tower that is divided into two chambers. During normal operation, water laden with fly ash is pumped into the ash basin at the far end of the basin away from the discharge structure. The fly ash settles out of the water into the basin. The water flows under a metal skimmer plate (used to block any floating material) and then over a stop log wall into the second chamber of the discharge structure. The stop logs are added or removed from this wall to adjust the level of the water in the ash basin. The water then enters into the discharge pipe and flows into the Delaware River. See **Exhibit B** for a diagram of normal water flow at the discharge structure.

The design specified that the stop logs be made of select structural grade yellow pine cut to dimensions of 9 inches high, 7 inches wide and 7 feet 5½ inches long. To prevent underwater deterioration, the stop logs were specified to be treated with creosote according to American Wood Preservers Association standards for Timbers in Marine Construction.

The stop logs were specified to have two u-bolts attached to the top off the log to be used for lifting or lowering the logs into position. To accommodate the u-bolts of the log below it, there were cutouts on the bottom of each log. The cutouts were specified to be located on the centerline of the log with dimensions of 3 inches wide, 4 inches deep and 12 inches long.

The stop logs were fitted into a steel reinforced channel in the concrete tower discharge structure and held in place by the structure. The design of the stop log wall allows plant operators to add or remove stop logs to adjust the water level in the basin. This ensures that the fly ash deposited in the basin remains submerged to prevent dusting and to allow for the ash to properly settle out of the water.

Description of Event

On Tuesday, August 23, 2005, at approximately 6:45 p.m., PPL employees observed water flowing across DePues Ferry Road near Martins Creek Ash Basin #4. Initially, the water was thought to be coming from the ash slurry line from the Martins Creek plant to Ash Basin #4. Plant personnel called the Pennsylvania Department of Environmental Protection (PA DEP) Northeast Regional Office (Bethlehem) to report the leak as a possible fly ash line leak.

After further investigation, the water was identified as coming from manholes in the Ash Basin #4 discharge pipeline. It was concluded that stop logs in the Ash Basin #4 discharge structure were leaking, allowing an excessive discharge of water from the basin into the discharge pipeline, and out of the first two manhole covers in the pipeline.

The water crossed over DePues Ferry Road, part of DePues Road, ran into adjacent fields and eventually into the Oughoughton Creek bed. In addition, the discharge pipe was flowing at maximum capacity into the Delaware River. Eventually, the water began carrying fly ash from the basin. See **Exhibit C** for a diagram of the water flow from the basin when the stop log failed.

Over the ensuing three days, PPL personnel, working around the clock, attempted several different repair methods to stop the leak. These efforts included:

- Pounding down on the top of the stop logs to reseat them.
- Fabrication and insertion of steel sheets in front of the leaking stop logs.
- Sealing the entrance of the discharge pipe with additional wooden stop logs lowered down on conduit rails.
- Use of a heavy-lift helicopter to set a modified river intake panel and one-ton sand bags in front of the entrance to the discharge pipe.
- Dropping small sandbags in front of the entrance to the discharge pipe.
- Inserting inflatable plugs into the discharge pipe through the manhole after the flow was reduced.

During the course of the event, PPL support and Plant personnel:

- Notified government agencies, property owners and downstream water users.
- Implemented plant emergency procedures.
- Secured additional PPL resources and external contractors to assist with repair methods.
- Secured external contractors to assist with environmental mitigation and remediation.

These efforts were ultimately successful in reducing the flow of the leak. On Saturday, August 27, at 1:30 a.m., on the second attempt, an inflatable bladder was used to seal the discharge pipe.

As a result of this event, approximately 100 million gallons of water and fly ash were released into the Delaware River and surrounding public and plant property. See **Exhibit D, Page 1** for a photo of Ash Basin #4 after the release.

FINDINGS

Problem Statement #1

Approximately 100 million gallons of water containing fly ash was accidentally discharged into the Delaware River and surrounding public and plant property from Martins Creek Ash Basin #4.

Causal Factor #1.1

Fabrication defects led to the failure of stop log #2 (second log from the bottom of a stack of about 40 logs) in the Ash Basin #4 discharge structure. These defects were not identified during periodic dam inspections.

- The stop logs were specified to be pressure creosote-treated select grade yellow pine, 9 inches high, 7 inches wide and 7 feet 5 ½ inches long. Each log had two steel handles attached to its top to enable the logs to be installed in the discharge structure. Each log had two cutouts on its bottom to allow the handles from the log below to rest when the logs were stacked on top of each other. The size and location of these cutouts were specified on design drawings.

- The Team and its consultant were unable to identify design standards specific to the design and maintenance of wooden stop logs. The design of wooden structures is governed by the National Design Specification (NDS) for Wood Construction by American Forest and Paper Association (AF&PA). The Team was unable to verify the use of these standards in the design of the stop logs, because the design calculations for the stop logs could not be located.

- The creosote treatment was specified to be in accordance with the American Wood Preserver's Association's specifications C-18, C1, and M2. These specifications require that the details of manufacture be inspected for conformance with design drawings prior to treatment, and the logs be re-inspected after treatment. The specifications do not address maintenance requirements. The specifications also require a hammer-stamp to be imprinted on the logs to verify their inspection, and an inspector's report. The Team found no hammer-stamps on the logs and no inspector's report in the project files.

- Cores taken from three stop logs, including stop log #2, indicated the penetration of wood preservative to be at least three inches. There were no detectable signs of decay in these stop logs. Subsequent to when the cores were taken, the other 34 stop logs stored on-site were examined, and one log indicated some possible decay.

- All of the stop logs were constructed with handle cutouts larger than specified. The degree of overcut varied among the stop logs. The overcuts in stop log #2 were the most significant, with the depth of the cutout on one side extending through the top of the log. See **Exhibit D, Page 2** for a photo of the defective cutout in stop log #2.

- Stress analysis of the as-built stop log #2 showed that its strength was compromised by these defects, which caused the log to fail under hydrostatic pressure at a water depth of about 27.5 feet at the time of failure.

- Stress analysis of an as-designed stop log #2 (i.e. a log conforming to the design drawings) indicated that it would have withstood the hydrostatic pressure at a water depth of 27.5 feet. Both of these stress analyses used allowable stresses from the NDS for Wood Construction.

- Other possible, but minor, contributing factors to the failure of stop log #2 include: additional hydrodynamic pressures resulting from movements of sub-aqueous ash mounds during deposition, the time dependency of the strength of wood, and the slight raising of the basin water level in order to free a slurry discharge line some weeks before the failure. Wood-decay, surface wave action, partial submersion of the stop logs, water seeping between stop logs, and precipitation did not contribute to the failure.

- Based on a basin topographic survey, it did not appear that there was any ash build up against the face of" the stop logs prior to the event. However, had the basin been operated in a manner whereby significant quantities of ash were deposited against the stop logs, this could have overstressed the stop logs. There were no written operating guidelines identifying and cautioning against this possibility.

- Stop log #3 was also observed to be bowed and splintered but it had not ruptured. It is possible that the damage to stop log #3 occurred as a result of the failure of stop log #2.

- In regard to the fabrication and installation of the stop logs, the Team was unable to determine:

  - If the logs were shop or field fabricated.
  - Who fabricated them.
  - If the creosote was shop or field applied.
  - If inspections were conducted on the stop logs when they were fabricated, accepted or installed.
  - If the stop logs were installed prior to the initial operation of the basin in December 1989, or afterwards.
  - If the construction contractor installed the original logs or if PPL installed them.

- The stop log defects were not identified during periodic Dam Safety Inspections. After the stop logs were installed, the defects were hidden from view by the stacked arrangement of the stop logs in the discharge structure. Furthermore, while the stop log stack was generally observed during dam inspections, individual stop logs were not inspected. The arrangement of the discharge structure and the flow of water in the discharge structure limited visibility to only the top logs in the stack.

- The logs were expected to last the life of the basin (28 years), and there were no plans or provisions in the design to facilitate periodic log removal and inspection. This expectation was based on favorable experience with stop logs on previous PPL ash basins. There was no prior occurrence of a wooden stop log failure at a PPL ash basin. The Team's technical consultant indicated that the service life of treated wood stop logs has been reported in the technical literature to be as long as 60 years, with many reports of 30-plus years of longevity.

- There was a failure of a wooden stop log in a canal connected to PPL's recreational Lake Took-A-While in 2000. Prior to failure, the failed log exhibited bowing and deterioration. The failures at the Lake Took-A-While canal and Martins Creek Ash Basin #4 are not directly comparable because of differences in stop log dimensions, material, treatment, and operating environments. The stop log failure at the Lake Took-A-While canal, however, can be considered a missed opportunity to identify the potential for a failure at other PPL facilities using wooden stop logs.

Causal Factor #1.2

There was no shutoff valve in the discharge pipe or other secondary barrier to prevent the release of water when the stop log failed.

- The design for the Ash Basin #4 discharge structure was based on the design of Ash Basin #3, which was based on that of Ash Basin #2. Ash Basin #2 was designed in June 1972 by an engineering firm hired by PPL. It did not include a secondary shutoff valve.

- Shutoff valves were not common in PPL's ash basin discharge structures. Shutoff valves were not included because they were not viewed as necessary for normal operation and prior to the current event, there had been no significant issues with the reliability or integrity of discharge structures. Additionally, shutoff valves had not been required by regulatory or licensing agencies.

- The Team and its technical consultant were unable to identify design standards specific to the use of shutoff valves in discharge structures.

- Industry practices regarding the use of stop logs and discharge shutoff valves appears to be diverse. The Team solicited information from two industry associations whose membership includes more than 80 utility operating companies. Eleven responses were received, with eight utilities reporting basins with discharges. Seven of these reported using stop logs: three used wood (one also used stainless steel), three used concrete, and one used aluminum. Four companies reported they did not use discharge shutoff valves, including two companies that use wooden stop logs. One company reported it used shutoff valves on all its basins. Three companies reported they use shutoff valves on some basins but not others. One of these companies uses wooden stop logs on its smaller basins without a shutoff valve.

- The Team identified two prior events involving stop log discharges and a recent study relating to the potential installation of a discharge pipe shutoff valve:
  - During 1987, plant personnel inserted a plate in front of the discharge pipe at Martins Creek Ash Basin #3 in order to repair leakage between stop logs.
  - In 1995, plant personnel removed a stop log too quickly from Martins Creek Ash Basin #4, causing a rapid increase in the discharge flow. This lifted the lid off the first manhole in the discharge pipe.
  - In July 2005, Generation personnel conducted an analysis of Martins Creek Ash Basins #1 and #4 to identify potential changes to the basins prior to their relicensing in 2008. The analysis identified the installation of a positive shutoff valve in the Ash Basin #4 discharge pipe as an opportunity for improvement. The shutoff valve was seen as a means to avoid possible non-compliant discharges, such as a pH excursion, during abnormal operations. The analysis did not consider the possibility of a stop log failure. The analysis was part of an ongoing company-wide study to be completed with recommendations to management by the end of 2005.

Causal Factor #1.3

It took over three days to stop the release of water and ash from Martins Creek Ash Basin #4.

- It took approximately 10 hours to fully diagnose the problem.
  - The leak was initially suspected to be a fly ash line leak. This was ruled out when shutting down fly ash slurry pumps and rerouting cooling tower blowdown to the industrial waste treatment basin failed to stop the leak.
  - Leakage through the upper level of the stop logs was observed and plant staff attempted to eliminate these leaks by pounding down the top stop logs.
  - Darkness, leakage through the upper logs, and poor visibility due to the arrangement of the structure hindered diagnosis until daylight on Wednesday August 24.

- It took several attempts over the next 66 hours to stop the leak.
  - Numerous approaches were considered. Among those actually attempted were:
    1. Fabrication and insertion of steel sheets in front of the leaking stop logs.
    2. Sealing the entrance of the discharge pipe with additional wooden stop logs lowered on conduit.
    3. Use of a heavy-lift helicopter to set a modified river intake panel and one-ton sand bags in front of the entrance to the discharge pipe.
    4. Dropping small sandbags in front of the entrance to the discharge pipe.
  - None of these methods were successful individually, but collectively, they reduced the flow to the point where an inflatable plug could be inserted through the manhole cover, and expanded to stop the leak.
  - There was no advance preparation for this type of failure – e.g. preplanned methods of repair, pre-fabricated equipment, prior arrangements for long-lead-time equipment (crane, helicopter).
  - Accessibility and weight limitations of the catwalk, combined with rigging limitations of the discharge structure, limited options that could be used, complicating the repairs. See **Exhibit D, Page 3** for a photo of the discharge structure after the release.

- Plant staff, believing the situation was manageable, did not initially request assistance from PPL General Office and contract engineering resources. These resources were not fully involved in the repair efforts until Thursday, August 25.
- There was some confusion regarding what repairs should be undertaken, in what order and who was directing the repairs.

Causal Factor #1.4

Plant personnel took actions to mitigate the impact of the release of water and fly ash during the event, but these efforts were minimally effective.

- During the first 12 to 15 hours, when the discharge water was reported to look clear, efforts were focused on addressing the flooding – traffic control and notifying nearby residents.

- On Thursday, August 25, straw bales were deployed in an effort to prevent the fly ash discharge from reaching the Oughoughton Creek bed and neighboring properties.

- An environmental response firm was contacted the morning of Thursday, August 25. Their subcontractor did not have equipment designed for containing a fly ash discharge to the river (e.g. turbidity curtains). They deployed straw bales and floating booms.

Problem Statement #2:

In some instances, the timing of communications with government and regulatory agencies, the general public and internal PPL management did not meet expectations. Also, initial reports lacked appropriate content to convey the full scope of the situation.

Some internal notification procedures were not strictly followed.

Key internal communications were not timely and did not:
- Fully describe the problem, its severity and potential worst-case impact.
- Convey a sense that an emergency situation could be imminent if the initial repairs were unsuccessful.

Some external notifications occurred after the event was reported in the newspaper, and not all of the notifications identified in the existing emergency plans were made.

Causal Factor #2.1

The event was not immediately identified as an emergency and certain emergency notification actions were not initiated until Thursday, August 25. Until then, the event was treated as an environmental incident with limited potential impact and one that plant personnel believed was manageable with local resources.

- The initial assessment of the situation on Wednesday morning (August 24) focused on the immediate problem – the non-permitted discharge of clear water and associated flooding. This was the basis of Wednesday's response and associated communications. The initial assessment did not address the potential for the discharge of large quantities of fly ash.

- Three factors appear to have contributed to the shortcomings in the initial assessment and associated communications:

  - The water coming from the manhole cover was initially clear.
  - The belief that the leak would be stopped by Wednesday afternoon (August 24).
  - The uniqueness of the event.

- While the situation continued during the day and difficulties were encountered in the attempted repair, there was no reassessment of the situation until Wednesday evening. Several key managers were off-site for various periods during the day.

Causal Factor #2.2

Martins Creek had several emergency response plans, but none specific to a major fly ash basin release. The contact lists in two of the plans were used as guides in making notifications, but not all of the listed contacts were notified.

- At the time of the event there were six emergency response plans and guides that were either approved or waiting for approval. They contained response plans for a dike failure, spills of hazardous materials, and oil and chemical spills. The release of fly ash from an ash basin was not addressed.

- The Comprehensive Spill Prevention and Response Plan (CSPRP) was the approved plan for dealing with spills of hazardous materials. It was to be replaced by the Integrated Contingency Plan (ICP), which was waiting for approva by the Environmental Protection Agency (EPA). Each plan contained somewhat different emergency notification lists. Plant personnel used the lists from both plans as guides to determine who was notified based on their judgment of who would be impacted by the fly ash release. Not all ofthe organizations on these lists were contacted.
- Prior table-top drills associated with an oil spill were not adequate and effective preparation for this event.

Problem Statement #3

The potential for this event was not identified during the design, operation, maintenance, inspection, or environmental audits of Martins Creek Ash Basin #4.

Causal Factor #3.1

Within the fossil generation function and the Environmental Management Department, environmental risk identification had been primarily experienced-based, i.e. based on events that have occurred in the past. The Ash Basin #4 stop log failure had no known, directly comparable, precedent. Therefore, the impact of such a failure had not been analyzed.

- The Environmental Management System contains two program elements pertaining to facility operations, Environmental Audits and Environmental Aspec Analyses. Environmental Audits have been directed towards operational compliance and Environmental Aspect Analyses have been utilized to assess and prioritize environmental impacts associated with normal operations. These program elements have not been directed towards identifying a latent operational failure like the Ash Basin #4 stop log failure.

- Within Generation the Technical Inspection Program (TIP) has been directed towards identifying and preventing large impact events similar to the stop log failure. The program's focus has been to identify potential failures before they occur through routine inspections. Ash Basin #4 was not part of the TIP program because it was covered by the Dam Safety Inspections.

See Pages 4 and 5 of the report for a list of recommendations to address the issues identified during the root cause analysis, including recommendations to prevent a recurrence of a similar event in the future.

Exhibit A

Martins Creek SES Ash Basin #4 Release

Martins Creek SES Site Layout

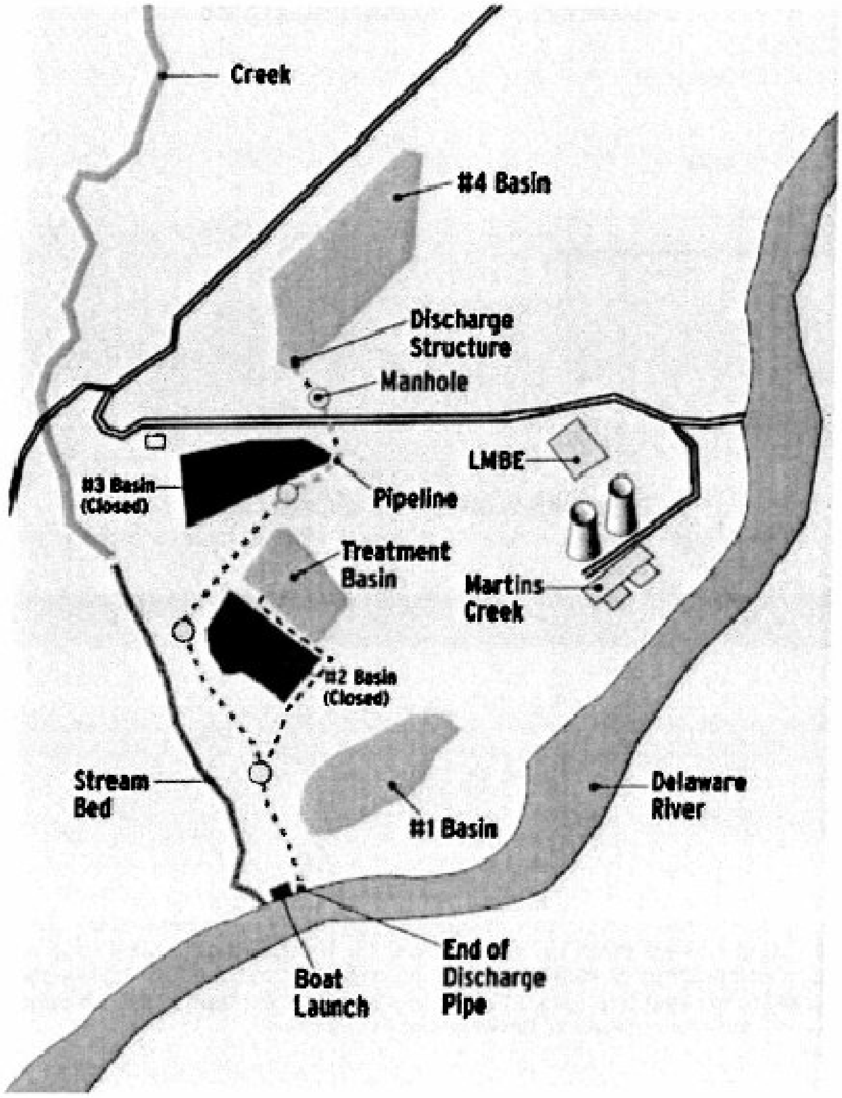
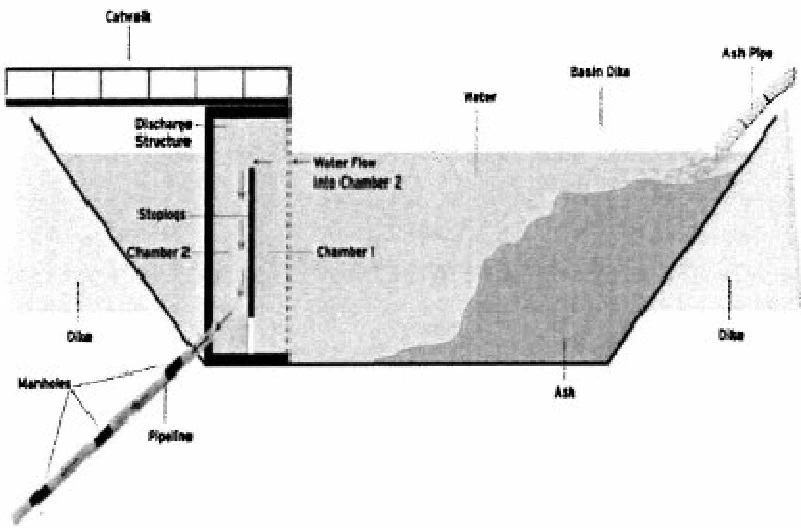


Exhibit B

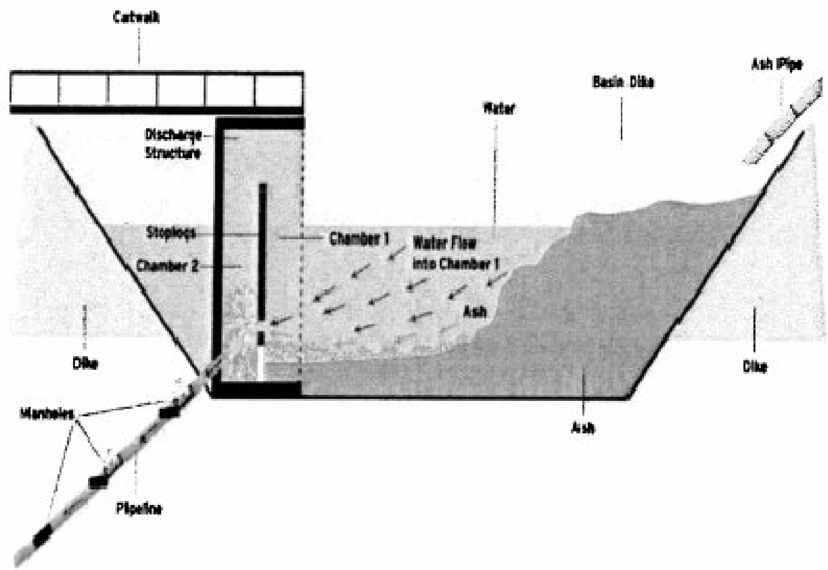
Martins Creek SES Ash Basin #4 Release
Normal Flow in Ash Basin #4



During normal operation, a mixture of coal ash and water is pumped into the ash basin from the Martins Creek plant. The ash settles to the bottom, and the clear water runs over a wooden wall made up of stop logs, which resemble railroad ties. The clear water is then discharged to the river through a 1 ¼ mile pipeline under the terms of PPL's permit from the Pennsylvania Department of Environmental Protection.

Exhibit C

Martins Creek SES Ash Basin #4 Release
Flow in Ash Basin #4 When the Stop Log Failed

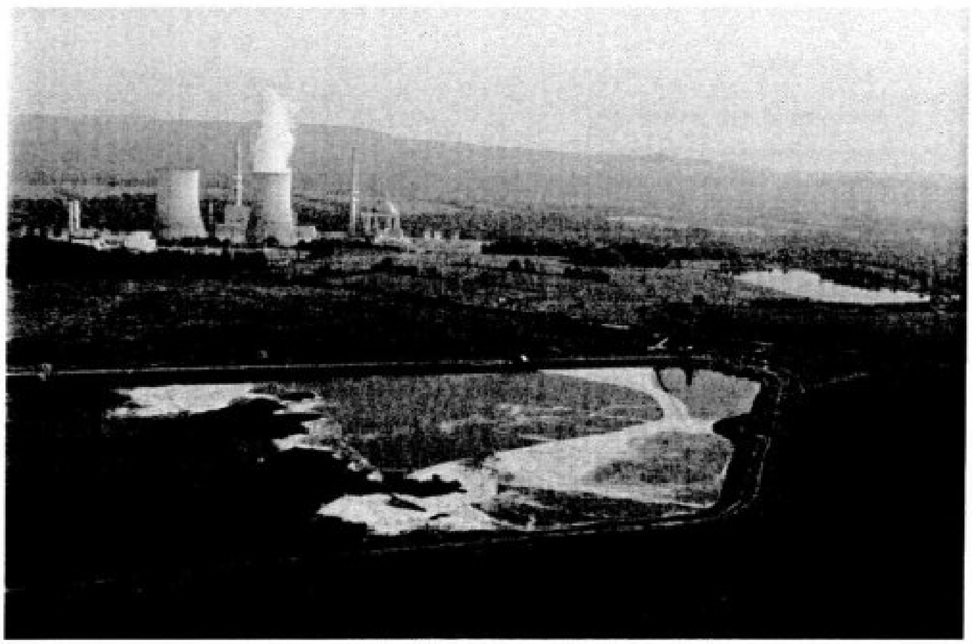


When the stop log failed near the bottom of the discharge structure, water and eventually ash flowed to the river through the discharge pipeline. The pressure lifted manhole covers along the pipeline, allowing the ash and water to spill out onto roads and fields on plant property.

EXHIBIT D
Page 1 of 3

Martins Creek SES Ash Basin #4 Release

AERIAL VIEW OF ASH BASIN #4



Martins Creek SES Ash Basin #4 Release

PHOTO OF PORTION OF FAILED STOP LOG # 2
(Evidence of over-cuts in handle cutout)

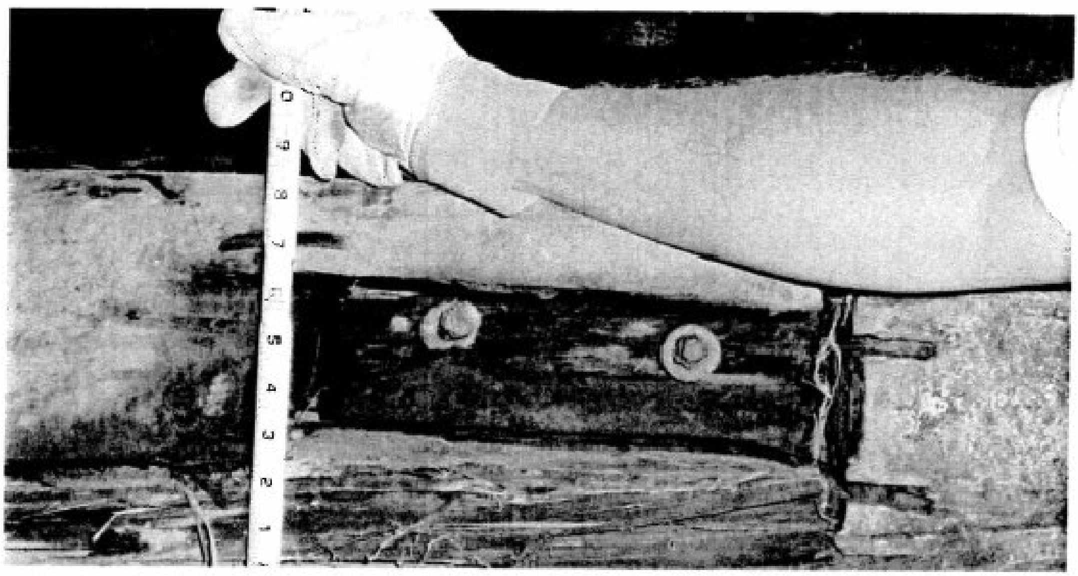
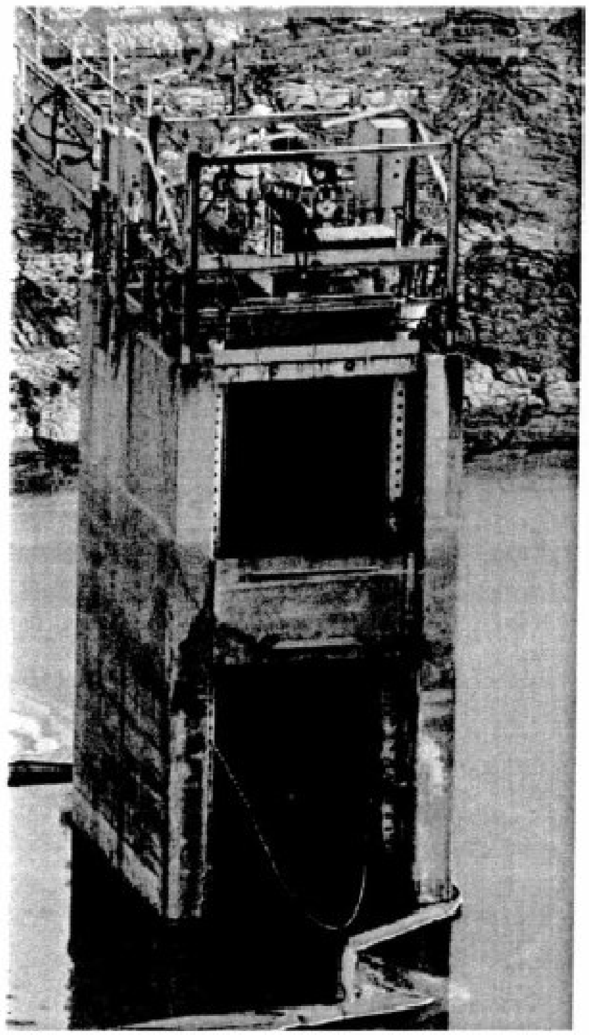


EXHIBIT D
Page 3 of 3

Martins Creek SES Ash Basin #4 Release

PHOTO OF ASH BASIN #4 DISCHARGE STRUCTURE



COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL PROTECTION
BUREAU OF WASTE MANAGEMENT

Date Prepared/Revised
4/30/09
DEP USE ONLY
Date Received

FORM 16R
LINER SYSTEM - PHASE II

This form must be fully and accurately completed. All required information must be typed or legibly printed in the spaces provided. If additional space is necessary, identify each attached sheet as Form 16R, reference the item number and identify the date prepared. The "date prepared/revised" on any attached sheets needs to match the "date prepared/revised" on this page.

General References: 288.412, 288.431, 288.531, 289.412, 289.431, 289.531

SECTION A. SITE IDENTIFIER

Applicant/permittee: PPL Martins Creek, LLC

Site Name: Martins Creek Steam Electric Station Ash Basin 4

Facility ID (as issued by DEP): 243186

SECTION B. LINER SYSTEM

Liner System is for:

☐ Residual Waste Landfill	☐ Residual Waste Disposal Impoundment
☐ Class I	☐ Class I
☐ Class II	☒ Class II
☐ Class III	

SECTION C. LOCATION

County: Northampton Municipality: Lower Mount Bethel Township

Total Acreage of Site: 63.1 acre Residual Waste Permit Boundary Acreage of Disposal Area: 40 existing, 31.5 proposed

SECTION D. LINER SYSTEM COMPONENTS

Liner System Components are:			Area (ft^2)	Is Equivalency Review Being Requested (Y/N)
☐	1.	Subbase.	1,370,259	
☐	2.	Secondary Liner.		
☐	3.	Leachate Detection Zone.		
☐	4.	Primary Liner.	1,370,259	
☐	5.	Protective Cover.		
☐	6.	Leachate Collection System (within Protective Cover).		
☐	7.	Cap	1,370,259	
☐	8.	Natural Attenuation		
☐	9.	Composite Liner Primary or Secondary (circle one)		

SECTION E. SUPPORTING DATA

Supporting Data:

The following information must be submitted along with this form. For information not appended to this form, indicate below where in the specifications or drawings the required information is located.

		(Drawing)	(Specification)
1.	Design of Liner System. (Refer to Part II.)	No changes proposed	No changes proposed
2.	Liner Installation Plan. (Refer to Part III)	No changes proposed	No changes proposed
3.	Compatibility of Liner to Leachate. (Refer to Part IV)	No changes proposed	No changes proposed
4.	Physical, Chemical, Mechanical, and Thermal Properties of Liners. (Refer to Part V)	No changes proposed	No changes proposed
5.	Quality Assurance Plan for Construction and Installation of Liners. (Refer to Part VI)	N/A Liner system already installed	N/A Liner system already installed
6.	Quality Control Plan for construction and installation of liners	N/A Liner system already installed.	N/A. Liner system already installed.
7.	Slope Stability Analysis	No changes proposed	No changes proposed

Previously submitted forms are attached for reference.

PART II. DESIGN OF LINER SYSTEM

SECTION A. PROJECT SPECIFICATIONS

Project Specifications		Subbase	Secondary Liner	Leachate Detection Zone	Primary Liner	Leachate Collection Zone	Protective Cover	Cap
Thickness (inches or mils)		No changes	N/A	N/A	No changes	N/A	N/A	24 inches
Maximum Particle Size (inches)		No changes	N/A	N/A	N/A	N/A	N/A	3/4 inch or 6 inches
Standard Proctor Density (percent)	FIELD	No changes	N/A	N/A	N/A	N/A	N/A	to be determined during construction
	LAB	No changes	N/A	N/A	N/A	N/A	N/A	to be determined during construction
Bearing Capacity (minimum) (lb/ft^2)		No changes	N/A	N/A	N/A	N/A	N/A	N/A
Total Applied Load (lb/ft^2)		No changes	N/A	N/A	N/A	N/A	N/A	N/A
Permeability (cm/s)	FIELD	No changes	N/A	N/A	N/A	N/A	N/A	1 x 10^-7
	LAB	No changes	N/A	N/A	N/A	N/A	N/A	1 x 10^-7
Slope (percent)	MINIMUM	No changes	N/A	N/A	N/A	N/A	N/A	1.5% typical
	MAXIMUM	No changes	N/A	N/A	N/A	N/A	N/A	5H:1V

Geosynthetics:	Where synthetic liners, geonets, geotextiles, or other geosynthetic materials are to be used, provided information as to the manufacturer, trade name, type, specifications and composition of each product.
Non-Synthetic Liners:	Where clay or other soils will be used as the liner, provide information on the Atterberg Limits, soil density, moisture relationship moisture content, and sieve analysis to be maintained at the time of installation.
Drainage System:	Where piping is installed as part of the leachate detection, Leachate collection or gas disposal system submit plans and profile drawings of each level, cell or zone which clearly illustrates the: slope, spacing, diameter and schedule of all piping to be installed.

SECTION B. DESIGN BASIS

For each major element of the liner system outlined above, provide the following information which supports the basis for the design. Include copies of the results of all tests conducted at the site, assumptions, and calculations used in the design. The stability of the landfill site and design is to be determined at critical sections. This is to include any below grade excavations/embankments or berms that may be critical. Consideration must be given to long and short term stresses, equipment loadings, filling sequence, and the possibility of earthquakes. Where geosynthetics are used, a veneer stability analysis should be performed on the interfaces of the material and the soil or aggregates. A puncture analysis is to be included where a geosynthetic is used to protect a geomembraine. Include test results of all liner interfaces for friction angles. Following information is to be attached to this form and referenced to the appropriate section.

1. Subbase: NO CHANGES
   i. Submit detailed information on how the subbase was sized and located, including the minimum and maximum depths to seasonal high water table and regional groundwater table. Be sure all elevations are tied to projects grid system and benchmarks. Explain this bases for the subbase size and materials selected.
   ii. Describe how the subbase will bear the weight of the liners, leachate detection and collection systems, wastes, cover material, and operations equipment without causing or allowing any failure of the liner system. Explain what evaluations were conducted at the site and of the subgrade materials to ensure adequacy for the projected loads.
   iii. Discuss the potential for subsidence and the liner systems ability to allow for settlement.
2. Secondary Liner: NOT APPLICABLE
   i. Describe the physical, chemical, and thermal properties taken into consideration in selecting the secondary liner.
   ii. Submit and discuss the results of any testing conducted on the liner material which ensures it will not be adversely affected, both chemically and structurally, by the chemical characteristics of the waste or leachate.

SECTION B. DESIGN BASIS (con't)

3. Leachate Detection Zone: NOT APPLICABLE
   - i. Describe the physical, chemical, and thermal properties taken into consideration in selecting materials.
   - ii. Submit and discuss the results of any testing conducted on the detection zone materials which ensures they will not be adversely affected, both chemically and structurally, by the chemical characteristics of the waste or its leachate.
   - iii. Describe the methods for cleaning and maintaining pipes, including methods for testing installed pipes for leakage.
   - iv. Describe how the leachate detection zone will support the primary liner without causing punctures in the event of subsidence.
4. Primary Liner: NO CHANGES
   - i. Describe the physical, chemical and thermal properties taken into consideration in selecting the primary liner.
   - ii. Submit and discuss the results of any testing conducted on the liner material which ensures it will not be adversely affected, both chemically and structurally, the by chemical characteristics of the waste or its leachate.
5. Protective Cover: NOT APPLICABLE
   - i. Provide a detailed description of the physical and structural aspects of the protective cover. Include information on the size, types, dimensions and depths of all materials used, slopes, calculations on anticipated stresses and loads from wastes and operating equipment. Describe how the cover material will protect the primary liner from physical damage from stresses and disturbances from overlying wastes, cover materials, and equipment operations.
   - ii. Describe how the protective cover will allow the continuous and free flow of leachate. Describe the possibility and effects of subsidence should it occur.
6. Leachate Collection System within Protective Cover: NOT APPLICABLE
   - i. Provide a detailed description of the physical and structural aspects of the proposed leachate detection system. Include information on the size, types, dimensions and depths of all materials used, slopes, calculations on anticipated bearing loads (wastes and equipment), and leachate detection capabilities. Indicate which drawings and sections of the specifications contain the information on layout and material requirements.
   - ii. Provide a description of how the system will detect, collect, and transmit leachate. Briefly describe the leachate treatment facilities and approvals obtained.
   - iii. Describe the methods for cleaning and maintaining pipes, including methods for testing installed pipes for leakage.
   - iv. Provide an evaluation of geotextiles used as filters for filtration and clogging.
   - v. Provide an evaluation for the transmissivity of geonets.
7. Cap: SEE DRAWINGS AND SPECIFICATIONS
   - i. Provide a detailed description of the chemical and structural characteristics of the materials to be used for the final cover. Be sure to indicate the minimum and maximum size of materials allowed, sieve sizes, USDA Texture Class, and any other significant distinguishing characteristics.
   - ii. Provide a description of how the materials are to be placed and compacted, with details on maximum slopes, minimum depths, and acceptable bearing loads.

PART III. LINER INSTALLATION PLAN

NO CHANGES

SECTION A. SUBBASE

1. Information on the maximum depth of earth moving activities and the site preparation procedures to be followed prior to the installation of any subbase materials.
2. Information on the selection of subbase materials, their grading and tests to be conducted to ensure uniformity.
3. Information on how the subbase materials are placed, graded, compacted, and tested for proper installation.

SECTION B. LINERS

1. For synthetic liners, provide all information supplied by the manufacturer as to required handling and installation procedures.
2. For non-synthetic liners, information on the minimum acceptable characteristics (i.e. moisture content, etc.) are to be provided.
3. For synthetic and non-synthetic liners, information as to the equipment required, pre and post installation testing is to be provided.

SECTION C. LEACHATE DETECTION AND COLLECTION ZONES

1. Provide details on how the detection and collection zones will be installed with specific information as to what materials and construction techniques will be used to construct each zone.
2. Describe the sequence of construction and equipment used.
3. Describe the sequence for installing the sump and all monitoring or gas venting facilities.

SECTION D. PROTECTIVE COVER

1. Describe where the cover materials will come from, and how they are transported and placed at the site.
2. Provide details on how the cover materials will be routinely tested for conformance with design specifications.

SECTION E. FINAL COVER AND GRADING

1. Provide a detailed description of how the final cover material is to be placed, compacted, and graded.
2. Describe the proposed final layout for the area with specific reference to any drainage facilities which will remain.

SECTION F. ATTENUATING SOIL BASE (CLASS III RESIDUAL WASTE LANDFILLS)

1. Describe the Class of soils to be used as classified by the United State Department of Agriculture.
2. Indicate where in the specifications and quality control procedures the requirements for attenuating soil, as contained in Section 288.624(b) of the residual waste regulations, are contained.
3. Describe the proposed sequence for placement of waste and attenuating soils.

SECTION G. HIGHWALLS

1. Describe how the liner or barrier materials will be installed to prevent the migration of leachate from the disposal area.
2. Provide information on each type of barrier material to be used and its minimum thickness. Include appropriate information on the physical and chemical characteristics of the material, and proof the material is not adversely affected by solid waste, leachate, or its constituents.
3. Provide detailed information on the different seams or outcrops at the proposed site and how they will be isolated from wastes.
4. Explain how groundwater and surface water drainage will be controlled and eliminated.
5. Submit a plan for controlling damage from subsidence or the collapse of highwalls.

SECTION H. LIMITATIONS

1. Provide appropriate information on any land use restrictions or limitations that should be followed during and after closure of the facility.

PART IV. COMPATIBILITY OF LINER TO LEACHATE NO CHANGES
A sampling plan for each component of the liner system, including sample size, methods for determining sample locations, sampling frequency, acceptance and rejection criteria, and methods for ensuring that corrective measures are implemented is to be included with this form.
SECTION A.
Information must be submitted which demonstrates that leachate will not adversely affect the physical or chemical characteristics of the liner system, or inhibit the liner's ability to restrict the flow of solid waste, solid waste constituents, or leachate, based on EPA or ASTM guidelines approved by the Department.
SECTION B.
Attach a copy of the chemical analysis of the leachate used in determining the above results.
SECTION C.
Where appropriate, attach an analysis of the current leachate emanating from this landfill.

PART V - PROPERTIES OF SYNTHETIC LINERS

Supply the following physical, chemical, mechanical, and thermal properties for liners, based on ASTM methods where appropriate. Additional information may be submitted.

	Results with Units of Measurement	ASTM Method
1. Thickness	No changes	No changes
2. Tensile Strength at Yield		
3. Elongation at Yield		
4. Elongation at Break		
5. Density		
6. Tear Resistance		
7. Carbon Black Content		
8. Puncture Resistance		
9. Seam Strength (% of Liner Strength)		
10. Ultraviolet Light Resistance		
11. Carbon Black Dispersion		
12. Permeability		
13. Liner Friction Angle in Degrees		
14. Stress Crack Resistance		
15. Oxidative Induction Time		
16. Chemical Compatibility		
17. Percent Recycled Materials		

PART VI. QUALITY ASSURANCE PLAN FOR CONSTRUCTION AND FOR INSTALLATION OF LINERS

The following information shall be submitted on separate pages and referenced to the appropriate section. For each Section A summary table is to be provided which explains the procedures, the frequency for each test, and the pass/fail criteria which must be met.

SECTION A.

Qualifications of independent QA personnel (describe experience and training). SEE CQAP

SECTION B. SUBBASE

1. Provide design summary of procedures used to assure objectives are met: NO CHANGES
   a. Outline tests and observations to ensure quality of compacted fill.
   b. Explain observations to ensure removal of objects or undesirable materials.
   c. Discuss observations and tests that ensure that the surface is compacted, smooth, uniform, and consistent with design grades.
   d. Summarize surveying to ensure that facility dimensions, side slopes, and bottom slopes are as specified in design.
   e. Summarize review of Quality Control information.

SECTION C. NON-SYNTHETIC LINERS

1. Discuss inspection procedures of liner materials and test fill compaction. Properties to be tested should include: permeability, soil density/moisture content relationships, maximum clod size, particle size distribution, natural water content, Atterberg limits. NO CHANGES
2. Outline procedures and methods for observing and testing liner materials before and after placement to ensure:
   a. Removal of roots, rocks, etc.
   b. Identification of changes in soil characteristics causing a change in construction specifications.
   c. Adequate spreading and incorporation of water to obtain full penetration through clods ad uniform distribution of the specified water content.
   d. Maintaining optimum water content throughout wet and dry periods and during construction.

SECTION D. SYNTHETIC AND GEOSYNTHETIC LINERS

Outline Procedures For: NO CHANGES

1. Inspection of product quality, the review of manufacturers control procedures and any other observations related to transporting, storing, and handling.
2. Inspection of foundation preparation and equipment.
3. Observations of liner placement.
4. Need and availability of manufacturers representative.
5. Observations of weather conditions.
6. Observations and measurements of anchor trench to ensure that it is as specified in design drawings.
7. Observations and tests to confirm that all designed liner penetrations and liner connections are installed as specified.
8. Visual inspection for tears, punctures, or thin spots during placement.
9. Inspections during and after liner seaming.
10. Observations and tests to assure that seals around liner penetrations are of sufficient strength and are impermeable to leachate.

SECTION E. PROTECTIVE COVER

Outline Procedures For: NO CHANGES

1. Tests to ensure that the cover material meets design specifications, including permeability and clogging potential.
2. Observations that the cover material is free from objects that could damage the liner.
3. Observations to ensure that equipment used to place cover does not damage liner.
4. Measurements to ensure that entire liner is covered with specified thickness of cover material.

SECTION F. LEACHATE DETECTION AND COLLECTION SYSTEM

Discuss how the following activities will be conducted: NOT APPLICABLE

1. Observations and measurements to ensure that materials are of specified size and strength, and that pipe perforations are sized and spaced as specified.
2. Observations and tests to ensure that soils to be used are of proper size and gradation.
3. Method of placing bedding and inspection to ensure the pipes are bedded correctly and not susceptible to movement.
4. Observations and measurements to ensure that pipes are placed at specified locations, at specified grades, and are joined together as specified.
5. Observations and tests to ensure that backfilling is completed as specified in design, in all areas, including areas where a liner connects to a structure.
6. Testing of pipe joints and testing of solid wall pipes to ensure that there is no leakage.
7. Observations and tests of the granular drainage layer to ensure that the material meets the specifications of design (including permeability and clogging potential to geosynthetics).
8. Synthetic drainage layers: Observations to ensure proper placement, correct seaming, and allowable weather conditions.
9. Geotextiles: Observations of placement to ensure that specifications are followed, adequate overlap or seaming, and that there is no damage.
10. Sumps: Observations to ensure that structures are of specified dimensions, material, and capacity.
11. Mechanical and electrical equipment installation: Observations to ensure that equipment is in accordance with design specifications and manufacturer's recommendations.

SECTION G. FINAL COVER SYSTEM

Discuss who and how following activities will be conducted: SEE DRAWINGS, SPECIFICATIONS AND CQAP

1. Observations and tests to evaluate stability of cover system foundation.
2. Observations and testing as necessary to confirm that soil materials meet specified design.
3. Non-synthetic component: Monitor soil type, moisture content, density, compaction, lift thickness, clod size, uniformity of compaction, completeness of coverage, and permeability.
4. Tests for seals around penetrations such as gas vent pipes to ensure that they do not leak.
5. Inspections for perimeter of cover, where the soil component joins or overlies the liner system, to ensure that it is installed according to specifications.
6. Liners used in the capping system shall follow guidelines for synthetic liners.
7. Observations for a protective layer, such as a geotextile, which is placed above the liner as protection from drainage layer, to ensure proper placement to avoid damage to the liner.
8. Drainage and gas venting layer placement: The gas discharge layer is placed below the synthetic liner and the water drainage layer is placed above the synthetic liner. Guidelines for the leachate collection and detection zone will be followed. Inspections of the installation of the drainage layers around the perimeter of the cover system is important, for it is here that the system connects to the surface drainage facilities. Ensure that design specifications, particularly dimensions and slopes, are achieved. Controlled gas discharge or collection systems are checked for proper installation and function.
9. Filter layer used above or below drainage layer to stop migration or piping of fine materials should be tested for any clogging potential. During construction of filter layer, inspection will include monitoring of particle size (for soil materials) or geotextile type and certification, seaming or overlap for geotextiles, slope of surface, and coverage.
10. Topsoil layer placement: Monitor uniformity of application process, observations to ensure that soil is not overly compacted, and measurements of thickness and slope of topsoil layer.
11. Topsoil seeding: Inspection of seeding process, measurement of tilling depth, application rate of additives should be monitored for consistency with design specifications. Application equipment will be appropriate. Verify that all vents and standpipes or other penetrations through cover are not damaged by tilling and application process. Weather conditions are to be appropriate. Post-construction: Slopes will be surveyed and any unusual depressions noted and corrected.
12. Review of Quality Control information.

FORM 16R – NARRATIVE

The existing liner system will be modified by removing the liner system from the existing anchor trench, and placing the liner system in the proposed anchor trench at the reduced top of berm. No other changes are proposed for the existing liner system at Ash Basin 4.

The proposed cap will consist of, from top to bottom, vegetative cover, 4 inches topsoil, 20 inches cover soil, geocomposite drainage layer, 60 mil PVC geomembrane, geotextile (contingency). The proposed cap is shown on the enclosed Drawings.

The enclosed Specifications provide additional detail of cap materials.

Quality Assurance during construction will be conducted in accordance with the attached Construction Quality Assurance Plan.

F:\OFFICE\AGC\PROJECTS\Files\2008-223\Permits\Residual Waste\FORM 16R Narrative.doc

2540-PM-BWM0385 6/2005

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL PROTECTION
BUREAU OF WASTE MANAGEMENT

Date Prepared/Revised 4/30/09
DEP USE ONLY
Date Received

FORM 18R
CLOSURE/POST-CLOSURE LAND USE PLAN

This form must be fully and accurately completed. All required information must be typed or legibly printed in the spaces provided. If additional space is necessary, identify each attached sheet as Form 18R, reference the item number and identify the date prepared. The "date prepared/revised" on any attached sheets needs to match the "date prepared/revised" on this page.

General References: **287.117, 288.181-2, 288.291-2, 289.171-2, 289.311-2, 295.142**

SECTION A. SITE IDENTIFIER

Applicant/permittee: PPL Martins Creek, LLC

Site Name: Martins Creek Steam Electric Station Ash Basin 4

Facility ID (as issued by DEP): 243186

SECTION B. CLOSURE PLAN

Identify location of the closure plan in Application: attached

Instructions: Narrative shall be submitted describing the activities that are proposed to occur during the post-closure period. Attach appropriate documentation referencing "Form 18R; Closure." The plan shall include:

☒ 1. Plan for decontamination and removal of equipment, structures, and related materials from the facility.

☒ 2. An estimate of the year in which final closure will occur, including an explanation of the basis for the estimate.

☐ 3. If the facility will close in stages, a description of how and when the facility will begin and implement partial closure (schedule for closure). SEE NARRATIVE

☐ 4. A description of the steps necessary for closure if the facility closes prematurely. SEE NARRATIVE

☒ 5. A narrative description, including a schedule, of measures that are proposed to be carried out after closure at the facility, including measures relating to:
   a. Water quality monitoring.
   b. Gas control and monitoring.
   c. Leachate collection, treatment, and pumping.
   d. Erosion and sedimentation control.
   e. Revegetation including maintenance of the final cover.
   f. Access control.
   g. Other maintenance activities.

☒ 6. Description of means by which funds will be made available to cover cost of post closure operations, which shall include an assessment of projected post-closure maintenance costs, a description of how the necessary funds will be raised, a description of relevant legal documents, and a description of how the funds will be managed prior to closure.

☒ 7. The name, address, and telephone number at which the operator can be reached during the post-closure period.

SECTION C. POST-CLOSURE LAND USE PLAN

Identify location of post-closure land use plan in Application: attached

Instructions: Narrative shall be submitted which contains a detailed description of the proposed use of the proposed facility following closure, including a discussion of the utility and capacity of the revegetated land to support a variety of alternative uses, and the relationship of the use to existing land use policies and plans. Attach appropriate documentation referencing "Form 18R; Closure."

☒ 1. How the proposed post-closure land use is to be achieved and the necessary support activities which may be needed to achieve the proposed land use.

☒ 2. The consideration which has been given to making the proposed post-closure land use consistent with landowner plans and applicable State and local land use plans and programs.

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FORM 18R – NARRATIVE

B. Closure Plan

General

The enclosed drawings and specifications describe the proposed closure activities.

Phase 1

Water over the ash will be removed by pumping. The ash will be dewatered to the extent needed to make the ash workable and capable of supporting cap loads. Dewatering will occur using progressive trenching techniques by excavating trenches which allow water to flow from the north to south end of the basin.

The cap subgrade will be graded to drain to swales within the berm. The cap subgrade will be graded to the typical slope shown on the Drawings and minimum strength of 1.5 tsf (21 psi). Saturated areas which cannot be dewatered by gravity will be solidified in-place with additives such as lime, Stable Fill ®, crushed brick, cement kiln dust, Portland cement, fly ash, or lime kiln dust or other similar products. Soil may also be used to solidify ash. Fill from demolition of Unit 1 and 2 will be placed within Ash Basin 4 to aid in solidification of ash or provide access to the work area. Analytical data for the Unit 1 and 2 debris is enclosed. The location of Unit 1 and 2 debris placed in Ash Basin 4 will be documented. A minimum of 12 inches of soil or ash will be placed over the brick.

PPL may also create the desired cap subgrade by placing soil fill in lieu of regrading the ash.

Ash Basin 4 berms will not be disturbed during Phase 1.

Phase 2

The Ash Basin 4 berm will be reduced in height; however, a 4 ft freeboard will be maintained above final cap grades. PPL may elect to remove less berm height than the grades shown on the Drawings. The existing liner system will be removed from the liner anchor trench and will be temporarily laid back while the berm is reduced in height. The liner system will be trimmed and re-installed in a new anchor trench at the proposed top of berm.

The berm soils, on-site borrow area soils or imported soils will be used to construct the cap. Cap components, from top to bottom, will include vegetative cover, 4 inches topsoil, 20 inches of cover soil, geocomposite drainage layer, 60 mil PVC geomembrane, and a geotextile (contingency).

A cap perimeter drain will be installed over the geomembrane in the swales within the berm. The cap perimeter drain will collect flow from the cap drainage layer and will discharge to the southeast at the location shown on the Drawings.

A 22 ft wide access road will be constructed at the proposed top of berm and at the crest of the cap.

Stormwater runoff from the final cap surface will drain to swales within the berm and discharge at a low point at the southeast end of the basin. A 42-inch diameter pipe will be installed to discharge water from the low point of the cap, through the Ash Basin 4 berm to the existing 33 inch diameter Ash Basin 4 discharge pipe. The pipe and discharge structure were designed to convey a 24-hour 25-year storm event without ponding on the cap. Adequate capacity is present in the existing 33-inch diameter discharge pipe to convey peak flows from the 2 through 10 year storm events to the Delaware River. A surge basin will be constructed to temporarily store excess flow from the 25, 50 and 100 year storm events and limit the head pressure on the existing pipe. The surge basin will discharge to the existing 33-inch diameter pipe once capacity is available. During the 100-year storm, the surge basin emergency spillway will overflow to the adjacent permanent stormwater basin. The length and quantity of flow is not expected to impact overall stormwater management. Details are provided on the enclosed Drawings.

Water Management

Prior to installation of the cap, water on the surface of the ash (contact water) will be collected at the southern end of Ash Basin 4. The water will be pumped, treated as necessary and discharged in accordance with the existing NPDES Industrial Permit. PPL may elect to pump to the IWTB, prior to discharge.

Following completion of the cap subgrade but prior to installation of the cap installation, stormwater runoff will be collected at Ash Basin 4, removed by pumping, treated and discharged to either the IWTB or pumped into the existing underground piping system which discharges at outfall 013 (Delaware River) in accordance with the existing NPDES Industrial Permit. The existing 10 inch HDPE pipe or existing 33 inch Ash Basin 4 discharge line will be used to transfer the water.

Following completion of cap installation, but prior to establishment of vegetation, stormwater runoff from the cap will be collected at Ash Basin 4, removed by pumping, treated and discharged to the IWTB in accordance with the existing NPDES Industrial Permit. The existing 10 inch HDPE pipe or existing 33 inch Ash Basin 4 discharge line will be used to transfer the water.

Following establishment of vegetation on the cap and after Owner and QA Official/Engineer approval to use the Ash Basin 4 endwall for discharge, stormwater runoff will be discharged to Outfall 013 (Delaware River) via the proposed endwall, existing 33 inch Ash Basin 4 discharge line and surge basin.

Sequencing

It is anticipated that berm modification and cap installation will be conducted in a sequence proceeding from the north end to the south end of the basin. Sequencing will allow the overall schedule to be as short as possible.

B.1 The existing discharge structure will be abandoned by grouting and will be reduced in height to below the cap. The existing catwalk will be removed. The berms will be reduced in height. The water level monitoring devices will be removed, and water levels will be monitored by visual inspection.

B.2 Phase 1 (cap subgrade) is scheduled to occur in 2009 and 2010, pending NPDES and township permit approvals. Phase 2 (cap, berm reduction and permanent stormwater management features) is scheduled to occur in 2010, pending Residual Waste and Dam Office approvals.

B.3 Not applicable.

B.4 Not applicable.

B.5 a. No changes to the groundwater monitoring are proposed. Groundwater monitoring will continue in accordance with the residual waste regulations. Monitoring results will continue to be submitted to PADEP as required. The former basin discharge structure will be removed from service; therefore, NPDES Industrial Discharge Permit monitoring of discharge through the former basin discharge structure is not applicable.

b. Not applicable.

c. Leachate collection and treatment is not required.

d. Erosion and sediment control will be conducted as presented in the enclosed Erosion and Sediment Control Plan included in the NPDES Permit application. Control measures will remain in-place until the site is vegetated and stabilized.

e. Revegetation will be conducted as presented in the Erosion and Sediment Control Plan and the Post-Construction Stormwater Management Plan included in the NPDES permit application. The basin is located on plant property and will continue to be maintained by plant personnel.

f. Access to the site is restricted by the existing gate.

g. No changes to access restrictions are proposed. Vehicular access control consists of gates across the driveways leading to the basin berm. The gates will remain in place.

B.6 No changes are proposed. PPL will continue to own its closed residual waste disposal facilities. PPL will include budgeted money for maintenance of the facility each year. It is expected that maintenance costs will be less for the facility after it is closed than when it was in service. Current maintenance costs budgeted exceed $50,000 per year. Operating costs, primarily related to monitoring groundwater wells, will continue to be PPL's responsibilities.

B.7 Operator Address

Martin's Creek Steam Electric Station
T-661, PO Box 257
Martins Creek, Pennsylvania 18063
Attn: Mr. Steve Holler
Senior Engineer
610-498-6200

C. Post-Closure Land Use Plan

The post-closure land use has not changed. Once the basin is closed, the site will be reserved as a meadow wildlife preserve. PPL may propose alternate land uses in the future. Details would be provided at that time.

Post-closure inspections and operations will include the following:

- The valve at Manhole AE will be maintained in the open position, unless an emergency situation with stormwater quality arises and it is necessary to cease stormwater discharge to maintain compliance with the NPDES Industrial Discharge permit. If the Manhole AE valve is closed, stormwater will accumulate in the surge basin and overflow to the adjacent stormwater management basin at the existing low area and 24-inch diameter pipe.

- Daily operational records will be prepared for each day of monitoring or post-closure activity. Daily records will not be prepared on days when no work is performed.

- Inspections each shift will cease once closure is complete, with the exception of significant rain events. Plant personnel will continue to inspect Ash Basin 4 to evaluate the visual quality of stormwater entering the discharge pipe following significant rain events and as part of routine plant activities.

- Annual reports will cease once closure is complete.

- Quarterly sinkhole inspections will continue.

ONE COMPANY | *Many Solutions*

August 31, 2009

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DRAFT

Mr. G. David Hopfer, P.E.
Senior Engineer - Civil/Structural
Generation Support Services
PPL Generation, LLC
Two North Ninth Street (GENPL6)
Allentown, PA 18101-1179

Subject: **2009 Annual Inspection Report**
Martins Creek Ash Basin No. 4

Dear David:

This letter report presents the findings of the 2009 Annual Inspection for Martins Creek Ash Basin No. 4. This evaluation was performed by HDR|DTA in accordance with Contract 449358, dated March 11, 2009.

1.0 Executive Summary

Martin's Creek Ash Basin No. 4 is no longer in service and is in the process of being closed. The impoundment water level was drawn down approximately 20 feet in the last year and the intent is to maintain the maximum water level within the basin at or below elevation 330 feet, which is 20 feet below the historic full operating level. The ash basin is still classified as a medium-sized, high hazard potential dam by the Pennsylvania Department of Environmental Protection (PADEP) and is therefore required to have annual inspections. PPL is not seeking to have the dam reclassified as part of the closure plan.

The inspection was conducted on June 16, 2009. Significant changes have taken place since the 2008 inspection was performed. The issues identified in the previous report have been addressed. The majority of the items identified previously were maintenance issues which will require continued attention, as long as the dam is considered to have a high-hazard potential. Significant observations are summarized below.

- The embankment was in good condition, with no evidence of seepage, movement, or instability. Wet areas and standing water were observed along the toe of the east and northeast embankments, likely the result of limited drainage. No action is recommended with respect to the wet areas other than continued monitoring.

HDR | DTA
HDR Engineering, Inc.

970 Baxter Boulevard
Suite 301
Portland, ME 04103-5346

Phone: (207) 775-4495
Fax: (207) 775-1031
www.hdrinc.com

- The water level at the time of the inspection was 328.4 feet, and the plan is to maintain the free water surface at or below elevation 330 feet. Although the phreatic surface is not known in the northern part of the impoundment where the ground surface is above the free water level, the overall reduction in water level represents a significant increase in the stability and security of the embankment with respect to dam safety issues.
- Lowering of the impoundment has exposed ash within the majority of the impoundment. PPL is in the process of stabilizing the exposed ash by a process of installing drainage and covering it. PPL is taking measures to prevent windblown ash dust or turbid rainwater runoff from being released.
- A number of woodchuck burrows identified in last year's inspection had been filled with expansive polyurethane foam. Over a dozen new animal burrows were observed during the inspection, with others obscured by vegetation. These holes had apparently formed between June 1, 2009, when PPL completed filling 35 previously identified holes, and June 16, 2009, when this inspection was conducted. Eradication of burrowing animals and filling of animal burrows will be a continuing maintenance issue. Keeping the vegetation cut closely will discourage burrowing animals. It is essential to relocate or eradicate the animals prior to filling burrows, or they will dig another burrow nearby. The long-term stability of the foam used to fill the burrows should be verified before its use is continued. The effective life of the foam needs to be compatible with that of the embankment for at least as long as the dam is considered to be a high-hazard structure. The use of grout or flowable fill injected from the base of the burrow may be necessary if the service life of the foam is found to be limited. Burrow holes were marked with flagging tape.
- The embankment vegetation had been cut approximately 1 month prior to the site visit. While this was a significant improvement from the previous year, the knee- to chest-high vegetation was still high enough to interfere with observations, both with respect to the height and also the concentration of thorn bushes. We recommend that vegetation control efforts be continued, with the emphasis on areas where clear observations are critical. This includes the sections of the embankment below the proposed free water surface elevation of 330 feet or the ash surface elevation, whichever is higher. In addition, a 100-foot-wide swath should be maintained in a closely trimmed state along the centerline of the low-level outlet alignment where it penetrates the embankment. The intent of vegetation cutting in these areas would be to maintain vegetation at or below knee height to allow for monitoring personnel to be able to identify any dam safety issues relatively quickly. The slope tends to be flatter in these areas, so that it may be easier to mow. It is unlikely that a seepage or slope stability issue will develop above the free water or phreatic surface within the embankment, although vegetation should still be trimmed on at least an annual basis.
- A number of holes were observed in the liner. These were almost all small, and all were located above elevation 330 feet. Holes below elevation 328 feet would not have been visible. The majority of these holes do not need to be repaired. Hoses, cables, and other hardware were in direct contact with the liner in places, all of which have the potential to puncture or abrade the liner. Softeners should be added under hardware, and any holes in the membrane should be repaired where fill will be placed over the membrane as part of the closure. The road base includes sharp pieces of shale, which tends to erode onto the

liner. Steps should be taken to clean off the sharp gravel, particularly before burying sections of the liner.

- Several slumps were observed in the earth slope under the liner. It is not clear what caused these, but paint marks on the liner indicate that at least one slump was observed in 1995. Several other areas were observed where the liner was suspended above the ground surface. No action in either of these areas is necessary except that the liner should be cut to relieve tension and then patched in any areas that are to be filled.
- The discharge structure was being worked on during the inspection. The concrete and bridge were in good condition. PPL previously installed an additional low-level control gate and typically inspects the gates and the interior of the outlet structure annually.

A discussion of these items and recommendations are summarized in the following sections.

2.0 Project Description and History

Martins Creek Ash Basin No. 4 is an inactive fly ash impoundment with a 36-mil, synthetic, reinforced-rubber (Hypalon) liner system covering the entire basin. A berm extends completely around the facility, and there is no surface runoff entering the embankment. The basin is located on the west side of the Delaware River in Northampton County and can be located on the Belvidere, NJ-PA USGS 7.5 Minute Quadrangle Map at 40°48'14" north, 75°07'00" west. The Dam is classified as a Class 2 (medium-sized) High Hazard potential structure.

Fly ash slurry was previously sluiced into the basin. The basin has a maximum depth of 65 feet, with a maximum berm height of 43 feet. The top of the berm is at elevation 355 feet. The discharge (outlet) structure is 9.67 feet by 10.33 feet in plan and 43.5 feet deep. The discharge structure is located near the southeast corner of the basin and is equipped with a skimmer plate and stoplogs to control the water surface elevation. Discharge is released through a 33-inch RCP discharge pipe. The outlet structure is accessed by a 110-foot-long footbridge. The outlet control was recently upgraded as the result of a stoplog failure. The pipe was slip-lined, and additional flow control was added at the upstream and downstream ends.

The ash basin is in the process of being closed. The previous normal water surface elevation was 350 feet when the basin was in operation. The normal surface elevation will be at or below 330 feet in the future. This substantially increases the effective width of the embankment and the length of seepage paths.

3.0 Site Visit

The site visit was conducted on June 16, 2009 with the reservoir at elevation 328.4 feet, 21.6 feet below the previous normal maximum pool level of 350 feet, and 19.8 feet below the

2008 inspection elevation of 348.2 feet. The site was visited by Adam Jones, P.E. and Robert Reed, P.E. of HDR|DTA. Dane Devanney and Dave Hopfer of PPL were present during part of the inspection. The weather during the inspection was overcast with a temperature of approximately 60 to 70 degrees. It had rained during the night prior to the inspection. The grass was wet and the ground was damp in places as a result of the rain, but this dampness did not interfere with the inspection.

The inspections were documented with field notes, sketches, and photographs. The layout of the basin can be seen on the project drawing in Appendix A, and inspection observations are noted on this drawing. Inspection checklists, in accordance with PADEP's outline, are provided in Appendix B. Photographs are provided in Appendix C, including Photo 1, an aerial photo of the site.

Embankments

East Embankment

The downstream slope of the east embankment can be seen in Photos 2 and 3 and appeared to be in good condition with little to no evidence of movement, sinkholes, distress, seepage, wet areas, or erosion. The downstream slope consists of a compound slope, with the upper one-half graded between 2H:1V (horizontal to vertical) and 2.25H:1V, and the lower half graded at approximately 4.25H:1V. Vegetation varied from knee to chest high. While this did not prevent an assessment of the slope, it did complicate viewing. The 2-foot-deep, shallow slough observed in 2008 approximately 1,100 feet north of the discharge structure was not observed in 2009. The downstream toe of the embankment was generally dry with wet areas and standing water observed along the west ditch of the access road in places. Wet areas and stagnant standing water were observed along and downstream of the toe starting at about Sta 14+50 at the outside of the bend between the east and northeast embankment sections. This appeared to be the result of lack of drainage and no active seeps were observed.

Several animal burrows were observed on the downstream slope, and PPL reported that approximately ten burrows on the east embankment were repaired shortly before the inspection.

The upstream slope is graded at approximately 3H:1V and was observed to be in good condition, as seen in Photo 4. Approximately 450 feet north of the outlet structure, a 25-foot-long bulge was observed in the liner at the water line, as seen in Photo 5, which is indicative of a shallow slough in the underlying embankment soils. Between Stations 8+00 and 12+00 a bulge up to 2 feet high was observed in the upstream slope under the liner, as seen in Photos 6 and 7. The cause of these slumps was not obvious, but they did cause the liner to be suspended above ground and in tension. Since the observed slumps were above the planned water level, they do not have any impact on future liner performance, provided that fill is not placed on the suspended sections as part of the closure. No other evidence of slope irregularities that would indicate piping, erosion, or stability concerns was observed on either the upstream or downstream slopes. Several woodchuck burrows were observed.

The liner was generally found to be in good condition on this section of the embankment. PPL reported that the holes marked in 2008 had been repaired. A number of additional small holes, tears, and seam delaminations were observed, which are summarized in Table 1 in Appendix B. In some areas the liner surface appeared to be wrinkled and or weathered, and more prone to holes, as seen in Photos 8 and 9. These wrinkles tended to increase the wear in the liner. The majority of these holes were small and all were above the current peak water level of 330 feet. PPL was in the process of sluicing ash that had accumulated on the membrane into the impoundment and had cleaned off the membrane along the east embankment. There were several hoses, cables, and other hardware in direct contact with the membrane, all of which have the potential to puncture and abrade the membrane. Softeners should be added to pad the hardware. Other than that, no action is necessary unless fill is to be placed over the liner in these areas.

The crest of the embankment is approximately 15 feet wide and consists of gravelly soil. No evidence of movement, settlement, cracking, or other distress was observed. The road base includes sharp pieces of shale which have washed onto the liner in places, as seen in Photo 10, which has the potential to puncture the liner.

Northeast Embankment

The downstream slope of the northeast embankment can be seen in Photos 11 and 12 and appeared to be in good condition with little to no evidence of movement, sinkholes, distress, or erosion. Vegetation conditions were similar to the east embankment. Vertical strips of dead vegetation were observed, apparently the result of tractor tracks. Wet areas were observed along and downstream of the toe extending from Sta 14+50, the bend at the junction with the east embankment, to 17+50, as seen in Photo 13. These wet areas are likely the result of inadequate drainage and were not observed last year. No active seepage was observed. The damp areas observed last year at the north end of the embankment were not evident this year, although some differences in vegetation were observed. The downstream toe of the embankment was otherwise observed to be dry.

The upstream slope and liner were in generally good condition over this section of embankment. As the embankment makes the sharp bend near the northwest end, near the intersection with the west embankment, wrinkling and tension in the fabric was observed as seen in Photo 14, which tended to increase the number of fabric tears that were observed. At the north end of the embankment, the impoundment fill was within 10 feet of the crest.

No other evidence of slope irregularities that would indicate piping, erosion, or stability concerns was observed on either the upstream or downstream slopes. There was no evidence of movement, settlement, cracking, or other distress in the 15-foot-wide gravel-surfaced crest.

West Embankment

The downstream slope of the west embankment can be seen in Photos 16 and 17 and appeared to be in good condition with little to no evidence of movement, sinkholes, distress, or erosion. The downstream slope is graded between 2H:1V and 2.5H:1V. Thick, knee- and chest-high vegetation was observed which included thorn bushes. Some moss and wetland vegetation was observed at the toe of the embankment at the north end of this embankment although there was no evidence of wet or damp areas noted in previous reports. A small wet area at the base of the slope was observed at Sta 36+00, consistent with previous reports of a change in vegetation. No other wet areas were observed. Several woodchuck burrows were observed.

The upstream slope and liner were generally in good condition, as seen in Photo 18. Several 1-foot -high slumps extending about 200 feet were observed at Sta 34+30. Some weathered sections of liner with concentrated holes were observed. No other evidence of slope irregularities that would indicate piping, erosion, or stability concerns was observed on either the upstream or downstream slopes. There was no evidence of movement, settlement, cracking, or other distress in the 15-foot-wide gravel-surfaced crest.

Southwest Embankment

The downstream slope of the southwest embankment appeared to be in good condition with no evidence of movement, sinkholes, distress, erosion, seepage, or wet areas. The downstream slope is graded between 2H:1V and 2.25H:1V. The downstream slope can be seen in Photo 20. A stone-lined channel was observed on the downstream slope opposite a truck turn-around seen in Photo 20. Immediately to the northwest, a 1-foot-deep rill was observed downslope of the truck turnaround, as seen in Photo 21. Several active woodchuck burrows were observed as well as the animals themselves.

The liner was found to be in generally good shape on this embankment, as seen in Photo 22. Accelerated weathering and concentrated holes were observed adjacent to the truck turnaround area, seen in Photo 23.

No other evidence of slope irregularities that would indicate piping, erosion, or stability concerns was observed on either the upstream or downstream slopes. There was no evidence of movement, settlement, cracking, or other distress in the 15-foot-wide gravel-surfaced crest.

Impoundment

The impoundment had been drained prior to the inspection, and PPL reported that a limited amount of drawdown was to be completed following the inspection. The intent is to leave a small 3 to 4 acre area inundated as a settling basin to treat rainwater discharge. PPL was in the midst of capping the ash basin, which can be seen in several of the embankment photos. Ditches had been cut in the fill to increase drainage, as seen in Photo 24.

Outlet/Discharge Structure

The discharge structure concrete, grating, and gate/stoplog support and lift structure were all in good condition. The access footbridge was in good condition, although the paint was beginning to deteriorate. The bridge supporting piers were in good condition. The outlet structure can be seen in Photo 25. PPL typically performs an interior inspection of the structure annually. Dave – has this been done?

Instrumentation

PPL noted that a number of monitoring wells were planned in the impoundment as part of the closure plan, although these had not been installed. PPL monitors the impoundment water level and the turbidity of the effluent from the outlet structure. Monitoring equipment is located in the small building adjacent to the outlet structure and is shown in Photo 26. This equipment is monitored full time by the Martins Creek Steam Electric Station system operator.

4.0 Recommendations

The following recommendations should be implemented as part of the closure plan. These recommendations can be revisited as the plan is finalized.

- *Burrowing Animals* – PPL should continue efforts to eradicate burrowing animals and fill burrows. Keeping the vegetation cut closely will discourage burrowing animals. It is essential to relocate or eradicate the animals prior to filling burrows, or they will dig another burrow nearby. The long-term stability of the foam used to fill the burrows should be verified before its use is continued. The effective life of the foam needs to be compatible with that of the embankment, for at least as long as the dam is considered to be a high-hazard structure. The use of grout or flowable fill injected from the base of the burrow may be necessary if the service life of the foam is found to be limited. Animal activity is often concentrated around structures, utility poles, or signs. These areas should be closely inspected and vegetation trimmed to discourage this.
- *Vegetation Control* – Vegetation should be trimmed for as long as the ash basin is considered to have a high hazard potential. Vegetation should be maintained in a closely trimmed state, preferably knee high or lower, along the slopes below the impoundment phreatic surface and downstream of the toe, as well as along a 100-foot width centered over the low-level outlet piping. This will allow for the prompt observation of seepage or changes in embankment conditions, as well as discouraging burrowing animals. The upper section of the embankment can be trimmed on a less frequent basis, but should be trimmed at least annually.

- *Fabric Liner Condition* – There is no need to repair the upstream fabric in areas above the impoundment phreatic surface. Areas that are below the free water surface, or that are to be buried as part of the closure, should be repaired. This includes holes, weathering that threatens the liner performance, and sections where the liner is in tension and may tear at a later time. Note that the crest road base contained sharp shale gravel, which may pose a continuing liner puncture hazard.
- *Toe Dampness* – Historic damp/wet areas at the toe of the embankment should be monitored for change. Installation of drainage measures does not appear necessary or practical at this time.

5.0 Closure

HDR|DTA appreciates the opportunity to perform this work for PPL. If you have any questions or comments, please contact us.

Sincerely,

HDR ENGINEERING, INC.

Adam N. Jones, P.E.
Project Engineer

ANJ/jkr
Appendix A: Project Drawing
Appendix B: Inspection Checklists
Appendix C: Inspection Photographs

cc: File

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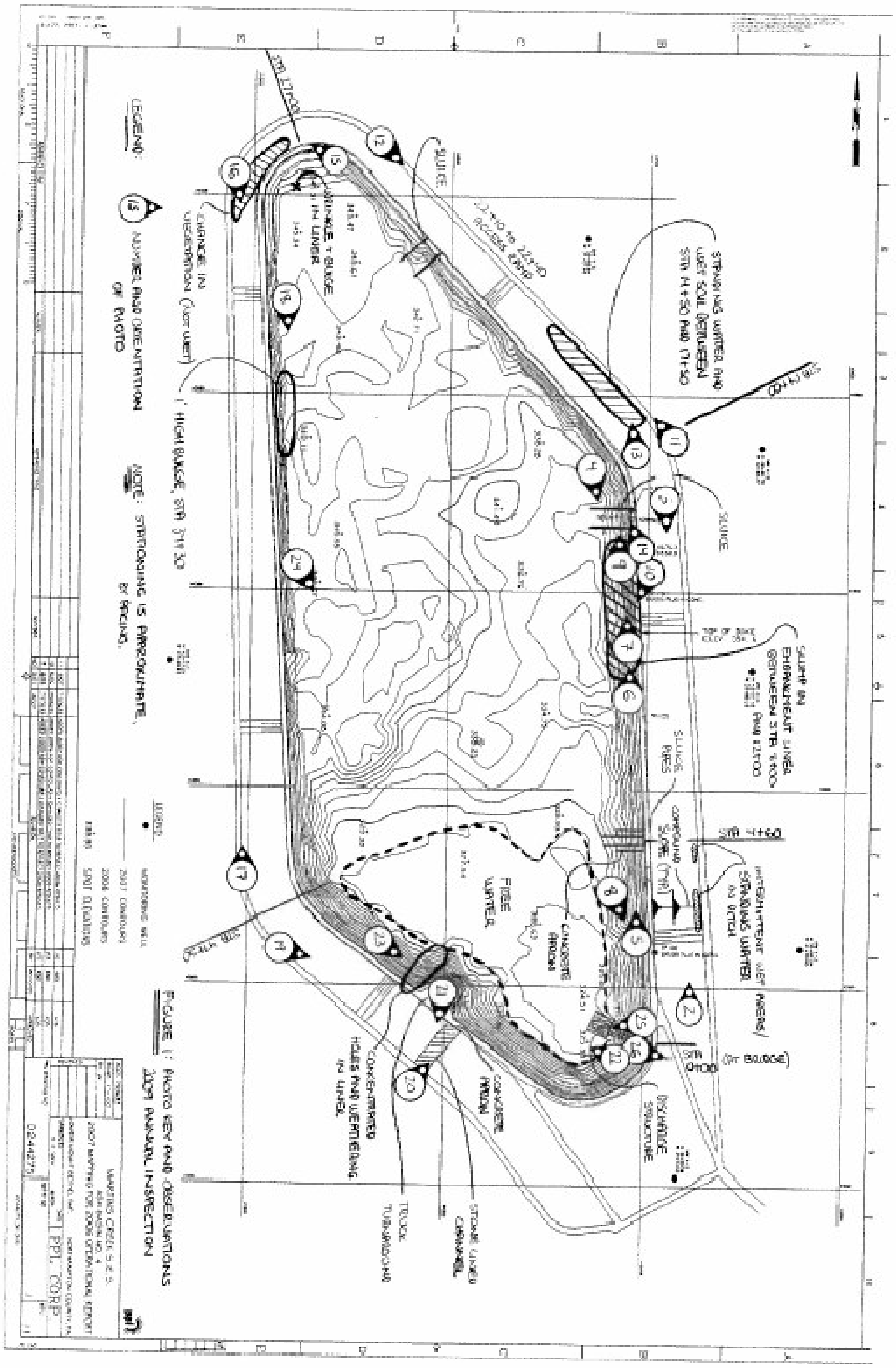
APPENDIX A

PROJECT DRAWINGS

HDR | DTA
HDR Engineering, Inc.



APPENDIX B

INSPECTION CHECKLISTS

HDR | DTA
HDR Engineering, Inc.

DAM INSPECTION CHECKLIST
Department of Environmental Protection
Bureau of Waterways Engineering
Division of Dam Safety

NAME OF DAM: Martins Creek Ash Basin No. 4 **DEP DAM NO.:** D48-149

LOCATION: **Municipality:** Lower Mount Bethel **County:** Northhampton

DEP CLASSIFICATION DATA: **Size:** Class B **Hazard:** 2 High

PHYSICAL DATA:
Type of Dam: Earth Embankment **Height of Dam:** 43 feet **Normal Pool Storage Capacity:** ?

ELEVATIONS:
Normal Pool: 330 **Pool at Inspection:** 328.4 **Tailwater at Inspection:** N/A

DAM OWNER: PPL Generation, LLC **OPERATOR:** PPL Generation, LLC

ADDRESS: Two North Ninth Street (GENPL6), Allentown, PA 18101-1179

PHONE: 610-774-6816 **FAX NO.:** 610-774-4622 **E-MAIL ADDRESS:** gdhopfer@pplweb.com

A completed and signed Dam Owners Notice Checklist is to accompany this Inspection Checklist.

PERSONS PRESENT AT INSPECTION:

Name	Title/Position	Representing
Adam Jones	Senior Struct/Geotech Engineer	HDR|DTA
Rob Reed	Structural Engineer	HDR|DTA
Dane Devanney		PPL
Dave Hopfer		PPL

DATE OF INSPECTION: 6/16/2009

WEATHER: Overcast

TEMPERATURE: 60° at 9:15 am; 70° at 5:45 pm

This is to certify that the above dam has been inspected and the following are the results of this inspection.

Signature of Registered Professional Engineer
(P.E. Seal Required)

8/28/09
Date

Date Revised: 7/31/2009

NAME OF DAM: Martins Creek Ash Basin No. 4	DEP DAM NO.: D48-149	DATE: June 16, 2009

ITEM	CONDITION	COMMENTS	MONITOR	INVESTIGATE	REPAIR
EMBANKMENT: CREST					
1	Surface Cracking	None	☐	☐	☐
2	Sinkhole, Animal Burrow	None	☐	☐	☐
3	Low Area(s)	None	☐	☐	☐
4	Horizontal Alignment	OK	☐	☐	☐
5	Ruts and/or Puddles	Minor	☐	☐	☐
6	Vegetation Condition	None - gravel	☐	☐	☐
7	Warning Signs	Road is gated	☐	☐	☐
8			☐	☐	☐
9			☐	☐	☐

Additional Comments (Refer to item number if applicable):

ITEM	CONDITION	COMMENTS	MONITOR	INVESTIGATE	REPAIR
EMBANKMENT: UPSTREAM FACE					
10	Slide, Slough, Scarp	Irregularities under liner – Sta 4+30, 8+00, 27+00, 34+30	☒	☐	☐
11	Slope Protection	Hypalon liner	☒	☐	☒
12	Sinkhole, Animal Burrow	None	☐	☐	☐
13	Emb.-Abut. Contact	N/A	☐	☐	☐
14	Erosion	None	☐	☐	☐
15	Vegetation Condition	None, except on impoundment	☒	☐	☒
16			☐	☐	☐
17			☐	☐	☐

Additional Comments (Refer to item number if applicable):
Note 11 Numerous holes, tears, weathered areas and places where fabric is in tension. Repair below El 330 feet, or where fabric is to be buried.

NAME OF DAM: Martins Creek Ash Basin No. 4	DEP DAM NO.: D48-149	DATE: June 16, 2009

ITEM	CONDITION	COMMENTS	MONITOR	INVESTIGATE	REPAIR
	EMBANKMENT: DOWNSTREAM FACE				
18	Wet Area(s) (No Flow)		☒	☐	☐
19	Seepage		☐	☐	☐
20	Slide, Slough, Scarp	None observed -- but vegetation thick	☐	☐	☐
21	Emb. - Abut. Contact	N/A	☐	☐	☐
22	Sinkhole, Animal Burrow	No sinkholes, approximately 12 burrows	☒	☐	☒
23	Erosion	Minor at truck turnaround, southwest embankment	☐	☐	☐
24	Unusual Movement	None observed	☐	☐	☐
25	Vegetation Control	Recently cut, but still thick enough to interfere with inspection	☒	☐	☒
26			☐	☐	☐
27			☐	☐	☐

Additional Comments (Refer to item number if applicable):
Note 18 Standing water at access road, Sta 0+00 to 4+00, toe Sta 14+50 to 17+50, and wet area Sta 36+00

ITEM	CONDITION	COMMENTS	MONITOR	INVESTIGATE	REPAIR
	EMBANKMENT: INSTRUMENTATION				
28	Piezometers/Observ. Wells	None	☐	☐	☐
29	Staff Gauge and Recorder	Recorder at gate tower – does this still function?	☐	☐	☐
30	Weirs	None	☒	☐	☐
31	Survey Monuments	None	☐	☐	☐
32	Drains	None	☒	☐	☐
33	Low Flow Release	None	☐	☐	☐
34	Frequency of Readings	Reservoir level and discharge turbidity monitored continuously	☐	☐	☐
35	Location of Records	Allentown	☐	☐	☐
36			☐	☐	☐
37			☐	☐	☐

Additional Comments (Refer to item number if applicable):

NAME OF DAM: Martins Creek Ash Basin No. 4	DEP DAM NO.: D48-149	DATE: June 16, 2009

ITEM	CONDITION	COMMENTS	MONITOR	INVESTIGATE	REPAIR
	DOWNSTREAM AREA				
38	Abutment Leakage	Not applicable	☐	☐	☐
39	Foundation Seepage	None	☐	☐	☐
40	Slide, Slough, Scarp	None	☐	☐	☐
41	Drainage System	None	☐	☐	☐
42	Boils	None	☐	☐	☐
43	Wet Areas	See downstream embankment notes	☐	☐	☐
44	Reservoir Slopes	Basin full and being capped, flat - adjacent slopes gentle, except at trenches	☐	☐	☐
45	Access Roads	Along crest and along toe	☐	☐	☐
46	Security Devices	Gate at road	☐	☐	☐
47	Act 91 Run-of-the-River Signs or Bouys	Not applicable	☐	☐	☐
48			☐	☐	☐
49			☐	☐	☐

Additional Comments (Refer to item number if applicable):

ITEM	CONDITION	COMMENTS	MONITOR	INVESTIGATE	REPAIR
	SPILLWAYS: ERODABLE CHANNEL				
50	Slide, Slough, Scarp		☐	☐	☐
51	Erosion		☐	☐	☐
52	Vegetation Condition		☐	☐	☐
53	Debris		☐	☐	☐
54			☐	☐	☐
55			☐	☐	☐

Additional Comments (Refer to item number if applicable):

SECTION NOT APPLICABLE

NAME OF DAM: Martins Creek Ash Basin No. 4	DEP DAM NO.: D48-149	DATE: June 16, 2009

ITEM	CONDITION	COMMENTS	MONITOR	INVESTIGATE	REPAIR
SPILLWAYS: NON-ERODABLE CHANNEL					
56	Sidewalls		☐	☐	☐
57	Channel Floor		☐	☐	☐
58	Unusual Movement		☐	☐	☐
59	Approach Area		☐	☐	☐
60	Weir or Control		☐	☐	☐
61	Discharge Channel		☐	☐	☐
62	Boils		☐	☐	☐
63			☐	☐	☐
64			☐	☐	☐

Additional Comments (Refer to item number if applicable):

SECTION NOT APPLICABLE

ITEM	CONDITION	COMMENTS	MONITOR	INVESTIGATE	REPAIR
SPILLWAYS: DROP INLET					
65	Intake Structure	Good condition	☐	☐	☐
66	Trashrack	Not visible	☐	☐	☐
67	Stilling Basin	Not applicable	☐	☐	☐
68			☐	☐	☐
69			☐	☐	☐

Additional Comments (Refer to item number if applicable):

SECTION NOT APPLICABLE

NAME OF DAM: Martins Creek Ash Basin No. 4	DEP DAM NO.: D48-149	DATE: June 16, 2009

ITEM	CONDITION	COMMENTS	MONITOR	INVESTIGATE	REPAIR
	OUTLET WORKS				
70	Intake Structure	Concrete tower, low level outlet	☐	☐	☐
71	Trashrack	Could not see	☐	☐	☐
72	Stilling Basin	None	☐	☐	☐
73	Primary Closure	Gates	☐	☐	☐
74	Secondary Closure	Valve and skimmer	☐	☐	☐
75	Control Mechanism	Hoist on intake deck	☐	☐	☐
76	Outlet Pipe	Buried	☐	☐	☐
77	Outlet Tower		☐	☐	☐
78	Outlet Structure		☐	☐	☐
79	Seepage		☐	☐	☐
80	Unusual Movement		☐	☐	☐
81	Condition	Good	☐	☐	☐
82			☐	☐	☐

Additional Comments (Refer to item number if applicable):

ITEM	CONDITION	COMMENTS	MONITOR	INVESTIGATE	REPAIR
	CONCRETE/MASONRY DAMS: UPSTREAM FACE				
83	Surface Conditions		☐	☐	☐
84	Condition of Joints		☐	☐	☐
85	Unusual Movement		☐	☐	☐
86	Abutment-Dam Contacts		☐	☐	☐
87			☐	☐	☐
88			☐	☐	☐

Additional Comments (Refer to item number if applicable):

SECTION NOT APPLICABLE

NAME OF DAM: Martins Creek Ash Basin No. 4	DEP DAM NO.: D48-149	DATE: June 16, 2009

ITEM	CONDITION	COMMENTS	MONITOR	INVESTIGATE	REPAIR
CONCRETE/MASONRY DAMS: DOWNSTREAM FACE					
89	Surface Conditions		☐	☐	☐
90	Condition of Joints		☐	☐	☐
91	Unusual Movement		☐	☐	☐
92	Abutment-Dam Contacts		☐	☐	☐
93	Drains		☐	☐	☐
94	Leakage		☐	☐	☐
95			☐	☐	☐
96			☐	☐	☐

Additional Comments (Refer to item number if applicable):

SECTION NOT APPLICABLE

ITEM	CONDITION	COMMENTS	MONITOR	INVESTIGATE	REPAIR
CONCRETE/MASONRY DAMS: CREST					
97	Surface Conditions	Good	☐	☐	☐
98	Horizontal Alignment	Good	☐	☐	☐
99	Vertical Alignment	Good	☐	☐	☐
100	Condition of Joints	Good	☐	☐	☐
101	Unusual Movements	None	☐	☐	☐
102			☐	☐	☐
103			☐	☐	☐

Additional Comments (Refer to item number if applicable):

SECTION NOT APPLICABLE

NAME OF DAM: Martins Creek Ash Basin No. 4	DEP DAM NO.: D48-149	DATE: June 16, 2009

ITEM	CONDITION	COMMENTS	MONITOR	INVESTIGATE	REPAIR
RESERVOIR AREA					
104	Sedimentation	Basin has been filled and is in the process of being closed.	☐	☐	☐
105	Slope Stability	OK	☐	☐	☐
106	Sinkholes	None	☐	☐	☐
107	Fractures	None	☐	☐	☐
108	Unwanted Growth	None	☐	☐	☐
109	Storage Gage		☐	☐	☐
110			☐	☐	☐
111			☐	☐	☐

Additional Comments (Refer to item number if applicable):

Final Comments:

DAM OWNERS NOTICE CHECKLIST
Department of Environmental Protection
Bureau of Waterways Engineering
Division of Dam Safety

NAME OF DAM: Martins Creek Ash Basin No. 4 | **DEP DAM NO.:** D48-149

This is to certify that both the Downstream Hazard Description is accurate and the Posted Notice locations listed below have been inspected and the following are the results of these inspections.

D.J. Murphy, PPL Generation LLC
VP & COO

Name of Dam Owner — Signature of Dam Owner — Date

This Dam Owners Notice Checklist is to accompany the Inspection Checklist filed by the Engineer.

EMERGENCY ACTION PLAN

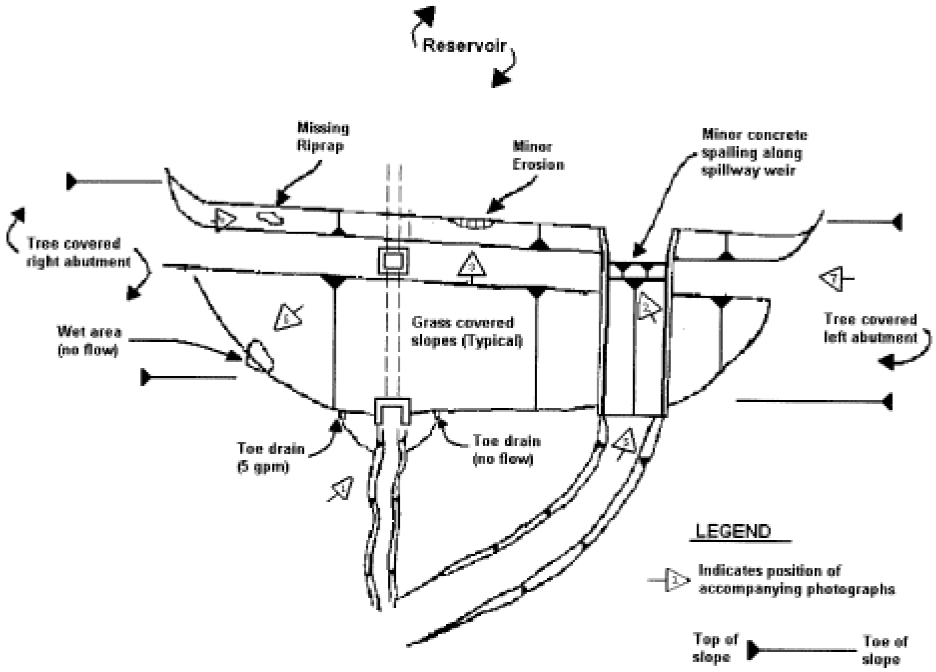
Date of Last Update of Emergency Plan:

Downstream Hazard Description (Refer to sections II.C and II.D in the EAP), additionally, specify any new developments, structures, etc. downstream within the inundation area:
N/A

POSTED NOTICES (Refer to section V.A in the EAP)

ITEM	DATE INSPECTED	LOCATION	COMMENTS	EXISTING	MISSING	REPLACED
1		N/A		☐	☐	☐
2				☐	☐	☐
3				☐	☐	☐
4				☐	☐	☐
5				☐	☐	☐
6				☐	☐	☐
7				☐	☐	☐
8				☐	☐	☐
9				☐	☐	☐
10				☐	☐	☐
11				☐	☐	☐
12				☐	☐	☐

Additional Comments (Refer to item number if applicable):



TYPICAL FIELD SKETCH

TABLE 1
Martin's Creek Ash Basin - Liner Hole Inventory

	Pinhole	Riip	Tear	Abrasion	Loose Patch	Worn Liner	Comment
2+00	1						
6+50					2		Gaps between patches
12+50	1						
15+60		2					
18+25	2						
19+15	1						
20+15	1						
20+15		1					
20+30				1			
20+40	4						
21+50		1					
21+60		1					
21+95		1					
25+95		1					
26+25		2					
26+50		2					
26+55					1		Wet area at loose end
32+25		2					
33+15						1	
37+00	1						
42+50	1						
44+85		2					
44+90	2						
44+95		1					
46+50					1		
46+80				1			
47+00	1						
47+50					1		
48+50	1						
48+55	1						
52+05					1		
52+50						1	Heavily worn area of liner
Totals:	17	16	0	2	6	2	

P:\PPL_PA\106864 2009 Ash Basin Inspections\WordProcessing\Reports\Martins Creek\
Martins Creek Observed Liner Defects-090831.xls

APPENDIX C

INSPECTION PHOTOGRAPHS

HDR | DTA
HDR Engineering, Inc.

Photo 1 - Aerial Photo of Martins Creek Ash Basin No. 4.

Photo 2 - Downstream slope of east embankment,
looking north from toe access road near Sta 0+00.

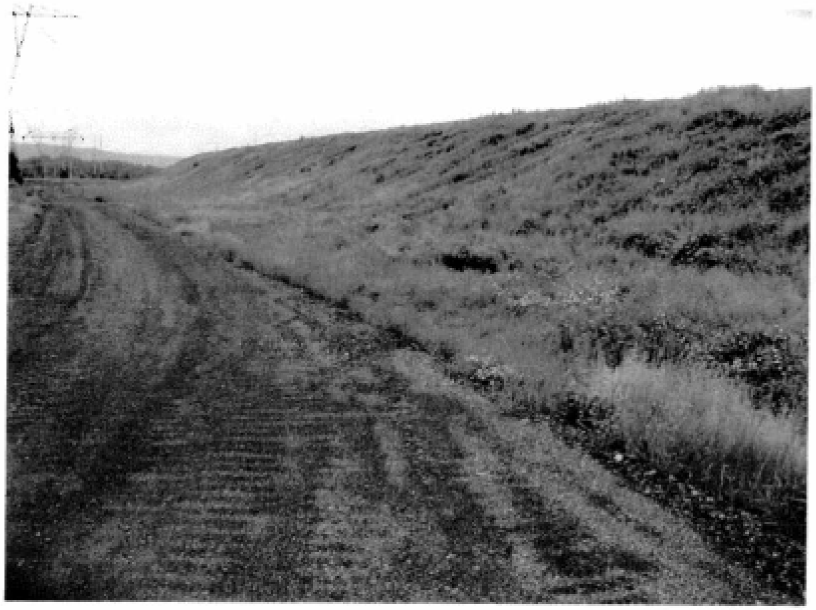


Photo 3 - Downstream slope of east embankment, looking south from bend at Sta 14+50.

Photo 4 - Upstream slope of east embankment, looking south from Sta 15+00.

Photo 5 - Bulge in liner along upstream slope of east embankment, looking north from Sta 4+30.

Photo 6 - Bulge in liner north of Station 8+00, looking north.

Photo 7 - Bulge in liner at Sta 9+75, looking north.

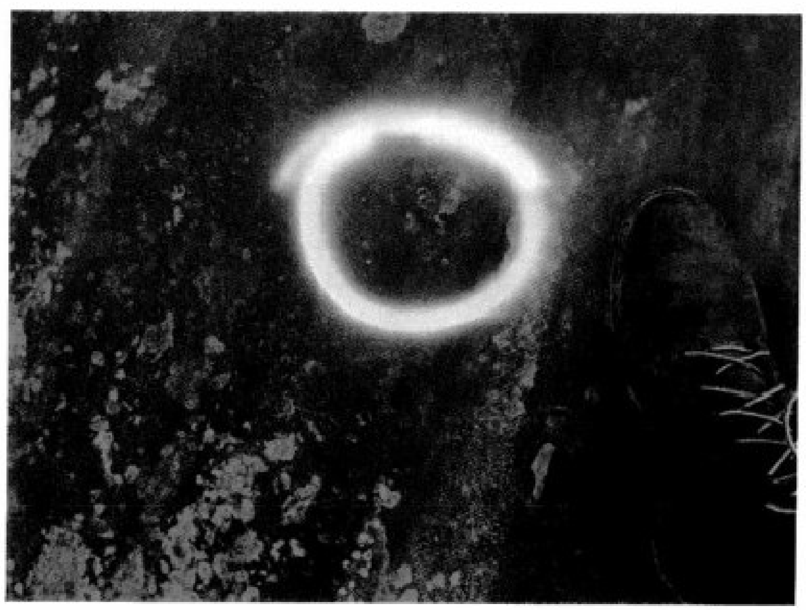


Photo 8 - Weathered section of liner with small hole.

Photo 9 - Wrinkling of the upstream liner near the concrete loading ramp, Sta 13+50.

Photo 10 - Roadway gravel on top of liner.

Photo 11 - Northeast embankment, looking north from Sta 14+50.

Photo 12 - Northeast embankment, looking south from Sta 25+00.

Photo 13 - Standing water and wet areas along the toe of the northeast embankment between Sta 14+50 and 17+50.

Photo 14 - Fabric wrinkle at northwest end of northeast embankment Sta 27+00.

Photo 15 - Downstream slope of west embankment, looking south.

Photo 16 - Downstream slope of west embankment, looking north.

Photo 17 - Upstream face of west embankment, looking south.

Photo 18 - Downstream face of southwest embankment, looking south from Sta 48+00.

Photo 19 - Stone-lined channel opposite truck turnaround area on southwest embankment.

Photo 20 - Crest erosion near truck turnaround area on the southwest embankment.

Photo 21 - Upstream face of southwest embankment, looking west from south end of impoundment.

Photo 22 - Weathering and concentrated holes in liner north of truck turnaround on southwest embankment.

Photo 23 - A drainage ditch cut through the impoundment ash near the west embankment.

Photo 24 - The discharge tower and bridge, looking west.

Photo 25 - Discharge monitoring instrumentation.

Field Checked by: John Herring

MARTINS CREEK STEAM ELECTRIC STATION
ASH BASIN #4

PURPOSE:

To describe the operation of Ash Basin #4

REFERENCE:

- Ash Basin 4 Emergency Action Plan (EAP)
- Integrated Contingency Plan (ICP)
- Integrated Emergency Response Plan (IERP) (H&S Memo 32)

RESPONSIBLE INDIVIDUAL:

The on duty Shift Supervisor is the initial point of contact for Ash Basin #4 unusual events or emergencies. Any unusual events or abnormalities are to be immediately reported to the on duty Shift Supervisor. The on duty Shift Supervisor will serve as the initial qualified person (incident commander) for handling emergencies associated with Ash Basin #4.

SUMMARY OF OPERATION:

Martins Creek Ash Basin #4 is a man-made basin about 40 acres in area and maximum depth of 65 feet. The basin is primarily used to dispose of fly ash produced from burning coal in Units 1 and 2 to make electricity. Basin #4 was designed, and is operated and inspected, under permits approved by the PADEP. Operation of the basin consists of mixing fly ash with water at the plant and pumping the slurry to the basin. The fly ash settles in the basin and the remaining water flows to the discharge structure where it enters a 33 inch diameter pipe. The pipe is approximately 1¼ miles long and with several manholes. The water is eventually discharged to the Delaware River upstream of the confluence with the Oughoughton Creek.

The maximum design operating level for Ash Basin #4 is 355.0 feet. However, in accordance with the current Ash Basin #4 EAP, a pool elevation of 352.5 ft. is the trigger point for initiating warning notifications.

DISCHARGE STRUCTURE DESCRIPTION:

The discharge structure at Ash Basin #4 is a 45-foot high concrete tower that is divided into two chambers. Water from the basin passes through a steel skimmer box and enters the first chamber after passing over steel reinforced plates. The steel plates are fitted into a steel reinforced channel in the concrete tower discharge structure and held in place by the structure. At this area, a skimmer plate is held from the structure to prevent centospheres from escaping the basin. Once the water enters chamber one, it then flows over steel reinforced concrete stop logs. The stop logs are fitted into a steel reinforced channel in the concrete tower discharge structure and held in place by the structure. The design of the stop log wall allows operators to add or remove stop logs to adjust the water level in the basin. This ensures that the fly ash deposited in the basin remaines submerged to prevent dusting and to allow for proper settling of the sluiced ash. There is also the occasional need to adjust the level of the basin to allow maintenance on the basin liner. Once in the second chamber, water flows through a slide gate valve (3VMD-239) and then into a reinforced 33 inch discharge pipe. The pipe runs under the basin dike to a manhole where a second gate valve (3VMD-240) is located. The concrete pipe between the basin discharge structure and the gate valve is reinforced to withstand the stresses generated by the head pressure from the basin when the gate valve (3VMD-240) is closed.

Under normal operation, as water and ash is pumped into the basin, it will pass through a steel skimmer box over the steel reinforced plates, under a metal skimmer plate (used to block any floating material), then over the stop log wall into the second chamber of the discharge structure. There, it passes through a slide gate valve to a reinforced 33 inch pipe then goes to a manhole with another gate valve located at the base of the dike. From there it enters the pipe that discharges to the Delaware River.

The Ash Basin #4 discharge structure is equipped with level indication. A pressure switch is used to determine the pool level in the basin. This level is recorded locally in the discharge structure building and is also telemetered to the computer system in the Units 3&4 control room. In addition, a float type alarm switch is located in the chamber between the stop logs and the slide gate. The alarm switch will determine if level in this chamber has increased. The alarm signal is telemetered to the Units 3&4 control room where a panel alarm will appear when activated. A staff gage has also been installed for additional local indication of basin level. The staff gage is attached to the discharge structure and easily read from the dike of the basin.

TYPICAL OPERATION:

Ash basin #4 is to be operated within the limits of its discharge permit. Normal pool elevation is estimated to be between approximately 347 and 348 ft. The pool elevation is adjusted by adding or removing stop logs to set the desired elevation. Changes in elevation are to be directed at the discretion of the plant environmental engineer. The maximum pool elevation for the basin is 355.0 feet.

**Note: It is estimated that (4) – five foot tall stop panels and (7) - one foot tall stop logs will be required to maintain a pool elevation of 347 to 348 ft.

To put the basin in service with slide gate 3VMD-239 and gate valve 3VMD-240 closed, use the following sequential procedure:

Contact the Results Analyst prior to putting the basin in service. This is required for verification of basin discharge pH and CO2 controls.

Open the red gae valve (3VMD-240) located at the base of the Ash Basin #4 dike to 40%. The stem of the gate valve is marked to show the 40% open position.

Next, open the slide gate (3VMD-239) located in the Ash Basin #4 discharge structure to 40%. The stem of the gate valve is marked to show the 40% open position.

Complete the checklist located on the Ash Basin #4 Daily Operations Log Sheet (Form 101).

Field Checked by: John Herring

The slide gate (3VMD-239), located in the Ash Basin #4 discharge structure, is to be kept 40% open unless notified otherwise by the plant environmental engineer. The stem of the gate valve is marked to show the 40% open position.

The gate valve (3VMD-240), located in the manhole at the base of the Ash Basin #4 dike, is to be kept 40% open unless notified otherwise by the plant environmental engineer. The stem of the gate valve is marked to show the 40% open position.

**Note: The positions of the slide gate (3VMD-239) and the gate valve (3VMD-240) are to be verified anytime stop logs are added or removed.

DAILY OPERATIONS CHECKS:

Operations personnel are to patrol Ash Basin #4 one time per shift (approximately every 12 hours), weather permitting. If weather and daylight permit, additional patrols may be done. The operator conducting the patrol is to observe the basin, the dike and the discharge structure for any abnormalities such as excessive flow, leakage, structural damage, etc

During dayshift, operations personnel are to complete the "Ash Basin #4 – Daily Operation Log Sheet" (MC-101). The sheet contains a checklist to be used when observing the basin discharge structure, skimmer plates, stop logs and level indication. The log sheet is to be completed in full and then submitted daily to the plant environmental engineer. Any abnormalities are to be reported to the Shift Supervisor immediately.

In addition to the operations activity stated above, operators in the units 3&4 control room are to monitor basin level and the high level alarm. Should an abnormal increase or decrease in basin level occur or a high level alarm occur then the control room operator is to immediately inform the Shift Supervisor and immediately have an operator respond to the basin to inspect for abnormalities and take appropriate action.

INVESTIGATING AND REPORTING ALARMS AND ABNORMALTIES:

Upon receiving a high level alarm an operator is to immediately report to Ash Basin #4, observe the flows in both chambers of the discharge structure and the manhole that houses 3VMD-240. If higher than normal flow is observed, the operator is to immediately close slide gate 3VMD-239 and then gate valve 3VMD-240. Verify discharge flow has discontinued downstream of gate valve 3VMD-240. Then, the operator is to immediately inform the controls rooms on 1&2 and 3&4 to stop sending ash sluice and/or cooling tower blow down to the ash basin pending further investigation. During the process, the shift supervisor is also to be informed of the situation.

A pool elevation of 352.5 ft. is the trigger point for initiating warning notifications. If the pool elevation in Ash Basin #4 reaches or exceeds 352.5 ft, the on duty shift supervisor is to take emergency action as outlined in the EAP and the ICP.

Operating Instruction
File Section: PCO/UMS
File No.: UMS 12-52/TPO 34-40
Page 4 of 5
Issued: December 12, 2005
Revised: August 17, 2006

Field Checked by: John Herring

EMERGENCY ACTION:

If high flow is observed and the actions described above in "Investigating and Reporting Alarms and Abnormalities" do not stop the flow, then implement the procedures and notifications as outlined in the ICP and IERP.

If during an inspection any abnormal condition is found which could result in potential or imminent failure of the basin, operations is to immediately implement the notifications and response procedures as outlined in the Ash Basin #4 Emergency Action Plan (EAP) and the Integrated Contingency Plan (ICP).

SURVEYLANCE DURING UNUSUAL EVENT CONDITIONS:

Per the EAP, the below conditions require notification to the Manager – Fossil Generation Assets and commencement of 24 – hour continuous around-the-clock surveillance of conditions at Ash Basin #4.

1. When 3 inches or more of rain occurs in one hour or less, or is predicted by Weather Service, or
2. When National Weather Service issues a flash flood watch and conditions warrant,
3. when any abnormal conditions listed in (MC-101) Ash Basin #4 Daily Operations Logsheet are observed, or when a routine dam inspection or maintenance uncovers an abnormality,
4. following the occurrence of an earthquake in the general region of the dam, or
5. in the event of a sinkhole forming near the basin dike.

Prepared by:

John Herring
Senior Engineer

Approved by:

Peter Giella

Operating Instruction
File Section: PCO/UMS
File No.: UMS 12-52/TPO 34-40
Page 5 of 5
Issued: December 12, 2005
Revised: August 17, 2006

Field Checked by: John Herring

Manager – Fossil Generation Assets

Groundwater Assessment of
Ash Basin 4 Drainage and Sinkholes
PPL - Martins Creek

Prepared for:
PPL Services Group
Allentown, Pennsylvania

Prepared by:

Shaw® Shaw Environmental, Inc.

Shaw Environmental, Inc.
State College, Pennsylvania
Project No. 117779.5000000
March 2006

By affixing my seal to this document, I am certifying that the information is true and correct. I further certify I am licensed to practice in the Commonwealth of Pennsylvania and that it is within my professional expertise to verify the correctness of the information.

Richard T. Wardrop

Richard T. Wardrop, P. G.
Lic. No. PG000157G

COMMONWEALTH OF PENNSYLVANIA
REGISTERED PROFESSIONAL
RICHARD T. WARDROP
GEOLOGIST
PG-000157-G

Signed and sealed this day March 13, 2006.

Table of Contents

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List of Appendices

1.0 Introduction

1.1 Background

The purpose of this report is to provide the Pennsylvania Department of Environmental Protection (PADEP) with a report of the findings of the groundwater assessment focused on any potential impacts to groundwater from the release of fly ash-laden water that flowed across the ground surface from Ash Basin 4 (Basin 4) and the reported development of three sinkholes that accepted a small portion of the flow at the PPL– Martins Creek power generation station (see Figure 1). Representatives of PPL, Shaw Environmental, Inc. (Shaw), and PADEP met at the site to discuss the location of monitoring wells and the sampling program for this assessment. Subsequent to that meeting, the scope work for the assessment was provided in a letter to the PADEP dated October 24, 2005 (see Appendix A). The number and locations of monitoring wells were selected by plotting site geology, sinkhole locations, and historic water table contours on a single map (see Figure 2). From this exercise, it was decided to install two new monitoring wells (MW 3-11 and MW 3-12) and utilize an existing monitoring well (MW 2-1N) for the assessment. One of the new wells (MW 3-11) was located in the historic downgradient direction of groundwater flow from the sinkholes labeled "1" and "2." The second new monitoring well (MW 3-12) was located near the east bank of Oughoughton Creek in line with the locations of sinkholes 2 and 3, and generally along the regional strike of bedrock. MW 2-1N is located within the drainage where ash-laden water traveled after the release from Basin 4.

The assessment plan proposed that sampling of MW 2-1N and the two new wells would occur on a weekly basis for four consecutive weeks, then monthly thereafter, for the same assessment Analytical Parameter List as was agreed to with PADEP for the ongoing assessment of Ash Basin 1 (see Table 1). Due to competing PPL resources dedicated to addressing other Basin 4 release issues, to some extent foul weather, and the end of the year holidays, the first four sampling events for MW 3-11 and MW 3-12 occurred on December 7, 2005; December 21, 2005; January 5, 2006; and February 6, 2006. The first four sampling events for MW 2-1N occurred on November 2, 2005; December 7, 2005; January 19, 2006; and February 8, 2006. For two of the four events, Well MW 2-1N was sampled during different weeks because that well was being sampled for other projects within the time frame of the assessment.

Lastly, the letter of October 24, 2005 stated that, based on the results of the first four sampling events, PPL would develop a comprehensive assessment plan for submittal to PADEP. That assessment plan is provided in Section 4.0 of this report – Conclusions and Recommendations.

1.2 Site Hydrogeology

The Martins Creek site is located within the Great Valley Section of the Valley & Ridge Physiographic Province. The Great Valley is characterized by folded and faulted Paleozoic sedimentary rocks that range in age from Cambrian to Ordovician. Karstic terrain is prominent in the southern half of the region, as evidenced by the presence of sinkholes. The topography has been formed by the processes of fluvial erosion, some periglacial mass wasting, glacial erosion and deposition, and the dissolution of carbonate rock.

Glacial activity of Wisconsinian and Illinoian age has partially remolded the topography through erosion and the deposition of unconsolidated deposits in the extreme northeast portions of the Great Valley. Glacial advances from the north, and subsequent retreats, have deposited till on the uplands (where the sinkholes of interest occurred) and outwash deposits on the valley floors.

The site is located along a northeast-trending overturned anticline. Bedrock underlying the area of interest is identified as the Lower Ordovician Beekmantown Group, in particular, the Epler and Jacksonburg limestone formations (cement limestone facies). Bedding across the site is variable and depends upon the position with respect to the limbs of the folds within the area. Drake, et. al. (1969) shows a strike and dip measurement from an outcrop near sinkhole 3 along Oughoughton Creek trending northeast with a dip of 27 degrees north. Approximately 40 to 70 feet of glacial till and outwash overlies bedrock across the area.

The Epler Formation is described as an interbedded, very fine-grained, light to medium gray limestone and fine- to medium-grained, light to dark medium gray dolomite. Nodular and bedded chert and beds and lenses of orthoquartzite occur within the Epler as well. The Epler is approximately 650 to 800 feet thick in this area. Bedding in the Epler is generally moderately well to well developed and thin to flaggy. Fractures in the Epler consist primarily of well to poorly developed, moderately spaced, moderately abundant, open and steeply-dipping joints. Joints, fractures, bedding cleavage, and solutionally enlarged channels provide the Epler with a secondary porosity of low to moderate magnitude and low permeability (Geyer and Wilshusen, 1982).

The Jacksonburg Limestone Formation (cement limestone facies) is mapped by Drake, et. al. (1969) as protruding into the Epler from the northwest. The positions of sinkholes 1 and 2 are approximately shown at the contact between the Epler and Jacksonburg. The cement limestone facies is described as a medium to dark gray, fine- to medium-grained, medium- to thick-bedded, high-calcium limestone, as much as 200 feet thick in the area of interest.

Monitoring wells drilled in the area of interest pass through 40 to 70 feet of glacial material overburden before encountering weathered carbonate rock. The first water-bearing fractures are encountered between 60 and 90 feet below ground surface, and constructed monitoring wells show water level measurements ranging from 5 to 25 feet below the top of weathered rock so the piezometric surface is not confined by the overburden and groundwater is considered under unconfined water table conditions in the area of interest. The direction of groundwater flow is generally south-southeast across the area with a local south-southwest deflection towards Oughoughton Creek in the vicinity of sinkhole 3.

2.0 Methods of Investigation

2.1 Monitoring Well Installations

The two new monitoring wells were drilled, constructed, and developed between November 3, 2005 and November 18, 2005. The wells were installed by Eichelbegers, Inc. of Mechanicsburg, Pennsylvania under the supervision of a Shaw hydrogeologist. To prevent damage to underground utilities, the Pennsylvania One Call System was notified prior to initiating drilling activities, and nearby underground utilities were marked. Additionally, per Shaw's standard underground utility clearing procedure, the borehole for each well location was hand dug to a depth of approximately 4 to 5 feet below ground surface (bgs) using a post-hole digger and hand auger.

Boreholes for the monitoring wells were drilled using a Schramm T555 RotaDrill equipped with a carousel-type rod holder employing 20-foot long drill rods. Temporary surface casing was installed at each of the wells to stabilize overburden soil and cobbles while advancing the well bores. The surface casings were installed using the Stradex drill bit and casing drive system that advances the casing during drill bit advancement. Temporary surface casings were either 10 inches or 8 inches in diameter, depending on the availability of equipment. Following advancement of the steel surface casing through overburden material and into competent rock, the drill bit was retracted and borehole advancement was resumed to the completion depths using an 8-inch rotary air hammer. Surface casings were pulled and removed from the boreholes during installation of the screens, risers, and annular materials.

Lithologic logs for each boring were made by Shaw's hydrogeologist, noting materials encountered in cuttings produced during drill advancement. Depths where voids, fractures, and water-producing zones were encountered were also noted. Drilling logs for each of the wells are presented in Appendix B.

The monitoring wells were constructed using 4-inch diameter polyvinyl chloride (PVC) flush-threaded riser casing and well screens. Upon review of the well logs from existing monitoring wells screened in bedrock at the Martins Creek site, it was decided that the well screens would be 0.010-inch slotted screens, approximately thirty feet long, with a sand pack installed to a few feet above the top of the screen. In general, the screened and sand-packed intervals were constructed to intercept the first water-bearing opening and subsequent additional water-bearing openings with depth for the distance of 30-plus feet. As shown on Table 2, the sand-packed intervals for nearly all of the bedrock monitoring wells built at the Martins Creek station are similarly more than 30 feet long. These lengths are appropriate for purposes of obtaining a representative sample from the carbonate bedrock formations underlying the site. Flow through the carbonate rock underlying the Martins Creek facility is through the secondary porosity created by open fractures and solution openings in the rock. In some cases, the solution openings are fully or partially filled with sediment. The fractures and solution openings in the aquifer are connected to one another to varying degrees. The regional flow that passess through the aquifer, or that which is moving tens to hundreds of feet per year, is passing through a well connected network of openings. Openings that are not well connected to the network can allow less flow or no flow at all. Thus, when attempting to place a screen for a monitoring well intended to collect samples that are representative of water quality affects on the regional flow, it is important to intercept multiple water-producing openings in the upper portion of saturated bedrock with the screen and sand pack. This approach maximizes the ability to collect a sample that is representative of the quality of groundwater moving through the regional system. When monitoring for inorganic constituents, it is less important to monitor the very top of the aquifer because the constituents of interest tend to mix and move within the flow field and, in some instances, sink under the dynamics of a density-driven plume. When drilling and constructing monitoring wells in this kind of bedrock aquifer, there is no practical way of knowing whether any one bedrock opening is connected to the regional network of openings, even if it produces a relatively high sustained yield. It is for these reasons that previous contractors and Shaw decided to use screened and sand-packed intervals that are 30-plus feet long for the bedrock monitoring wells.

The sand pack for each well consisted of Filpro WG No. 1 silica sand placed around the well screens to a point approximately three feet above the tops of the screens. A minimum of 5 vertical feet of bentonite 3/8-inch chips (Hole Plug®) and/or 3/8-inch bentonite pellets were placed on top of the sand packs in the well bores to provide an annular seal around the monitoring well riser casings. Following hydration of the bentonite, a cement-bentonite slurry was tremie-grouted into the annular space from the top of the bentonite seal to near the ground surface. The wells were completed with the tops of the PVC risers approximately 2.5 feet above ground. Ten-inch diameter steel protective casings with locking caps were installed around the tops of the PVC risers and set in 3-foot diameter by 6-inch thick concrete pads.

After the construction of MW 3-11, it was discovered that the 3.5-inch diameter submersible pump to be used for development could not be lowered past 83 feet bgs. There was a great deal of difficulty pulling the surface casing at this well and it was later determined that the PVC riser had been pinched by a unattached subsurface rock mass that had shifted into the well when the surface casing was pulled out. Well MW3-11 was subsequently overdrilled with the 8-inch air hammer and a replacement well was installed without incident. Another problem that was encountered involved using an unusually large volume of sand to bring the sand pack in MW 3-12 up to the proper level in the well annulus. The theoretical amount of filter sand that should have filled the well annulus around the 30-foot long well screen is in the order of fifteen to twenty 40-pound bags. Additional amounts of filter sand over the theoretical amounts were needed at MW 3-11; however, at MW 3-12, approximately 210 bags of filter sand were needed to complete the sand pack to the finished level. A relatively large void must be present in the bottom of the well as the hole accepted more than half the sand to bring the sand pack level up six feet from the bottom of the screen.

2.2 Well Development and Slug Tests

Monitoring well development was conducted using an electric submersible pump that was decontaminated prior to and between each well location. The wells were surged intermittently using the submersible pump and pumped at a rate of approximately 10 gallons per minute until the water was visibly clear and the bottom of the wells were free from sediment.

Slug tests were performed on each of the two new monitoring wells on January 31, 2006. Both slug-in and slug-out tests were run using a stainless steel pipe filled with sand and welded shut on both ends. The pipe is 2.88 inches diameter and 4.0 feet long. The pipe was cleaned with Liquinox-water solution and distilled water rinse before the first test on each well and between wells. A dedicated 1/8-inch nylon cord was used for the tests at each well. The instantaneous change in water level and subsequent rise or fall of water level, back to the static level, were recorded using an InSitu miniTroll transducer/datalogger controlled with a laptop computer. Hydraulic conductivity values were derived using the Bouwer-Rice method for unconfined aquifers. The results of the slug test analyses are included in Appendix C and summarized on Table 3.

2.3 Water Quality Sampling and Analysis

PPL arranged for the installation of dedicated, low flow sampling equipment in each well. The surveying of well locations and all groundwater sampling were performed by PPL using procedures specified in the corporate groundwater monitoring program. Laboratory analyses were performed by PPL's Systems Chemical Laboratory in Hazelton, Pennsylvania. The first of three sampling events was performed 19 days after well development was completed. During these events, each well was sampled for the constituents listed on Table 1. Wells MW 3-11 and MW 3-12 were sampled on December 7, 2005; December 21, 2005; January 5, 2006, and February 7, 2006. Well MW 2-1N was sampled on November 2, 2005; December 7, 2005; January 19, 2006; and February 8, 2006. The sampling dates for existing Well MW 2-1N did not exactly correspond with those for the other two wells because that well was being sampled for other projects at the time, resulting in four relatively closely spaced events within the time frame of the investigation. The laboratory analytical data were provided to Shaw for assessment by PPL as they became available.

The analytical and field parameter data for each sampling event were compared to Act 2 residential groundwater Medium Specific Concentrations (MSCs) (for those parameters that have

Act 2 standards) and to the range of historic values (quarterly data from the third quarter of 2002 through the third quarter of 2005) for MW 4-1, the upgradient monitoring well for Basin 4. In addition, constituent concentrations for each parameter for each of the three sampling events were examined to determine if there were any apparent trends developing of concern. Sampling of the three wells designated for the sinkhole assessment is currently continuing on a monthly basis.

2.4 Water Level Measurements

Water level measurements were obtained during each sampling event and more frequently in support of other projects being conducted simultaneously with the sinkhole assessment. Water level elevation information is provided on Table 4 and a representative water table map of the area of interest is shown on Figure 3 for the February 7, 2006 monitoring event. The water level map illustrates that MW 3-11 is in the immediate downgradient direction of flow from sinkholes 1 and 2, closest to Basin 4. As previously stated, MW 3-12 was sited topographically down-gradient and generally along the assumed strike of bedrock from sinkhole 3. MW 2-1N is located between the two new wells, along the surface drainage through which ash-laden water from Basin 4 traveled on a pathway to Oughoughton Creek (to the west) and the Delaware River.

3.0 Results

3.1 Groundwater Quality Assessment

The groundwater quality data collected during the assessment are provided on tables in Appendix D and are summarized as follows. The data were compared to Act 2 residential groundwater MSCs for those parameters that have Act 2 standards and to the range of historic values for MW 4-1 (quarterly data from the third quarter of 2002 through the third quarter of 2005), the upgradient monitoring well for Basin 4. In addition, the four sampling results for each well were examined to determine if there were any apparent trends developing of concern. There have been no exceedances of the Act 2 MSCs for any of the data points, and none of the major ions or trace metal values for MW 3-11, MW 3-12, and MW 2-1N have exceeded the upper end of the range of historic values for MW 4-1. In fact, many of the value sets were below the bottom of the range. The field and lab pH in MW 3-12 and lab pH in MW 2-1N are all slightly above the maximum historic value for MW 4-1, with the greatest difference being 0.16 standard pH units. However, no other parameter values for these wells were outside of the range that would indicate a potential effect from the ash. Also, examination of the data from the four sampling results showed no trends indicating an impact on groundwater quality.

3.2 Velocity of Groundwater Flow

The velocity of groundwater flow for the bedrock aquifer at MW 3-11 and MW 3-12 was estimated using the hydraulic conductivity (K) values obtained from the slug tests, the gradient (i) from the water level contours on Figure 3, and an assumed range of porosities (n) for karst limestones. These values are listed on Table 5 along with the calculated groundwater flow velocities. Using these values, a conservative estimate of constituent transport time was made assuming no dispersion or chemical reactions with subsurface materials to slow migration of a given constituent. The estimated range of travel times is 21 to 382 days. The physical and chemical mechanisms that would retard transport of any constituent of interest would only serve to lengthen the potential arrival times at the monitoring wells and spread the peaks of the concentrations over time. High-frequency sampling (four events) were conducted within 168 days of the release. From this, it is concluded that the high frequency of monitoring that has been conducted up to this point in time has discounted the possibility of a rapidly moving plume. Given these observations, PPL is requesting that the frequency of sampling be adjusted to quarterly or once every 90 days. Any potential future sign of elevated constituent concentrations related to ash would be spread out over time. In the footnote to the table of parameters in PPL's letter of October 24, 2005, it was stated that total metals would be determined after the fourth sampling event and that the frequency of sampling for total metals would be determined after initial data analysis was completed. At this time, it is recommended that total metals be determined during the first and third quarterly events, once in March 2006 and again in August 2006.

3.3 Conclusions and Recommendations

The following conclusions and recommendations are derived from the results of the sinkhole assessment presented within this report:

1. There is no indication of an adverse effect on groundwater quality from the release of ash-laden waters along the local drainageway near MW 2-1N or from the three sinkholes of interest in the groundwater monitoring data collected over the period of high frequency monitoring through February 8, 2006.

2. It is recommended that the long-term assessment plan for the Basin 4 drainageway and three sinkholes include the following:

   a. Sampling of MW 2-1N, MW 3-11, and MW 3-12 for the list of parameters in Table 1 on a quarterly basis for 2006, with total metals analyses to occur in March 2006 and August 2006.

   b. Quarterly letter reports providing an evaluation of the water quality and water level data collected to date.

   c. If the 2006 groundwater data show no significant impacts, then monitoring Wells MW 3-11 and MW 3-12 should be abandoned, with PADEP's approval, following the agency's well abandonment guidelines.

4.0 References

Drake, A. A., et. al., 1969, MGI Map I-552, Geologic Map and Sections of Parts of the Portland and Belvidere Quandrangles, New Jersey – Pennsylvania, Dept. of the Int. / USGS.

Geyer, A. R., and Wilshusen, J. P., 1982, Engineering Characteristics of the Rocks of Pennsylvania, EGR 1, Pa Dept. of Env. Res. / Bur. of Topo. and Geol. Surv.

Freeze, R. A., and Cherry, J. A., 1979, Groundwater, Prentice-Hall, Inc.

Tables

Table 1
Analytical Parameter List
Basin 4 and Sinkhole Assessment
PPL - Martins Creek

Field Measurements

Total Well Depth

Depth-to-Water Level

Temperature

Field Sp. Conductance

Field pH

Metals (Dissolved)

Arsenic

Barium

Boron

Calcium

Cadmium

Chromium

Copper

Iron

Lead

Lithium

Magnesium

Manganese

Mercury

Nickel

Selenium

Strontium

Zinc

Others

Total Alkalinity (as $CaCO_3$)

Lab Sp. Conductance

Lab pH

Chloride

Nitrate (as N)

Turbidity (NTU) Sulfate

Dissolved Oxygen

ReDox Potential

Table 2
Characteristics of Bedrock Monitoring Wells
PPL - Martins Creek

Well ID	Measuring Poing Eelvation (ft msl)	Depths from Ground Surface (ft)			Length of Sand-Packed Interval (ft)	Screen/Riser Diameter (in)	Lithology
		Total Depth	Top of Sand Pack	Bottom of Sandpack			
MW 3-11	311.29	143.0	108.5	143.0	34.5	4	Dolomite
MW 3-12	293.96	88.5	55.0	88.5	33.5	4	Dolomite
MW 1-9	242.00	121.0	75.0	121.0	46.0	2	Dolomite
MW 2-1N	302.50	131.0	80.0	131.0	51.0	4	Dolomite
MW 2-3	321.35	160.0	127.0	160.0	33.0	4	Limestone
MW 2-4	315.79	110.0	68.0	110.0	42.0	4	Limestone
MW 2-5	313.45	140.0	119.0	140.0	21.0	4	Limestone
MW 2-6	313.37	110.0	81.0	110.0	29.0	4	Limestone
MW 4-1	327.50	88.0	50.0	88.0	38.0	4	Limestone
MW 4-2	312.40	116.0	73.0	116.0	43.0	4	Limestone
MW 4-3	314.00	105.0	69.0	105.0	36.0	4	Limestone
MW 4-4	328.40	127.0	84.0	127.0	43.0	4	Limestone
MW 4-5	334.50	129.0	91.0	129.0	38.0	4	Limestone
MW 4-6	334.00	132.0	85.0	132.0	47.0	4	Limestone
		For all pre-assessment bedrock monitoring wells:		Min	21.0		
				Max	51.0		
				Average	38.9		
				Mode	38.0		

Table 3
Hydraulic Conductivity Values from Slug Test Results
(all values in ft / min)

Well Location	Falling Head Test 1	Falling Head Test 2	Rising Head Test 1	Rising Head Test 2
MW 3-11	0.04	0.039		0.038
MW 3-12	0.069	0.08	0.095	0.146

Table 4
Water Level Elevation Data (ft msl)
PPL - Martins Creek

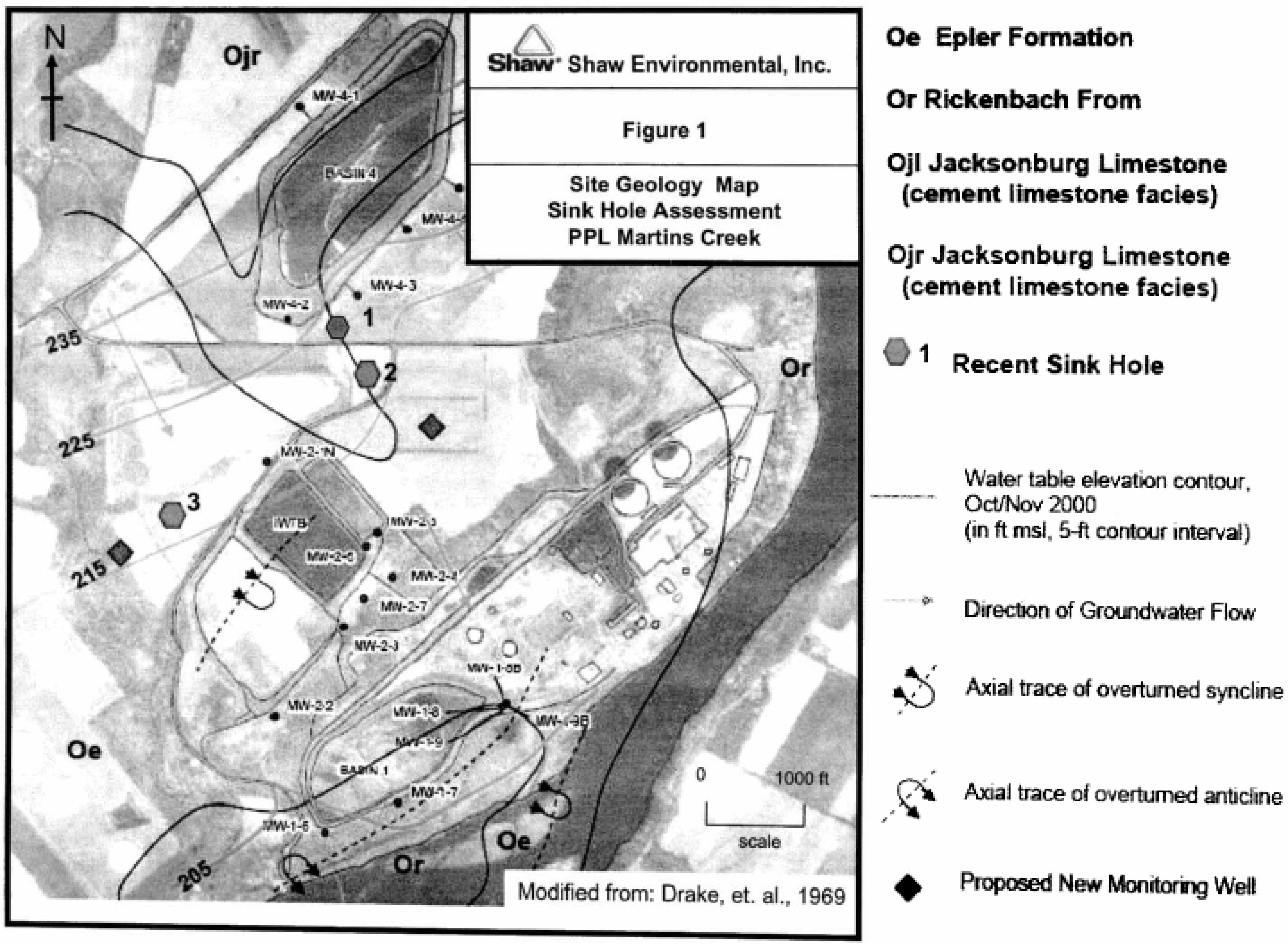
Well ID	Date of Measurement											
	11/3/2005	11/30/2005	12/7/2005	12/14/2005	12/21/2005	12/28/2005	1/5/2006	1/10/2006	1/18/2006	1/25/2006	1/31/2006	2/7/2006
MW 2-1N	230.95	230.05	230.42	230.09	230.33	230.4	231.15	NM	231.88	NM	NM	233.19
MW 2-2	213.71	213.64	213.35	212.37	213.38	213.59	NM	NM	214.96	NM	NM	214.18
MW 2-3	216.18	214.42	215.69	214.84	215.89	216	NM	NM	218	NM	NM	217.45
MW 2-4	249.36	248.42	249.66	248.76	251.19	251.15	NM	NM	251.99	NM	NM	251.59
MW 2-5	218.53	217	217.85	217.13	217.34	217.45	NM	NM	219.3	NM	NM	219.94
MW 2-6	218.84	217.31	218.1	217.49	217.62	217.75	NM	NM	219.52	NM	NM	220.17
MW 2-7	NM	246.19	246.52	244.88	249.46	249.75	NM	NM	255.35	NM	NM	252.7
MW 3-11	NM	216.493	217.293	216.673	216.883	216.943	217.943	NM	218.943	NM	NM	219.593
MW 3-12	NM	236.9	236.46	235.75	236.83	237.07	237.53	NM	237.46	NM	NM	237.44
MW 4-1	NM	271.73	NM	272	272.38	272.78	273.42	274.3	275.35	276.42	277.42	277.72
MW 4-2	241.55	242.12	242.15	241.98	242.17	242.24	242.95	243.4	244.38	245.5	246.32	246.9
MW 4-3	240.18	240.42	240.5	240.67	240.42	240.49	241.05	241.7	242.65	243.9	244.56	244.06
MW 4-4	241.11	241.46	NM	241.24	241.47	241.48	241.7	242.8	243.7	245.05	245.78	246.32
MW 4-5	240.4	241.34	NM	241.15	241.34	241.4	241.7	242.7	243.6	245.12	244.78	246.35
MW 4-6	NM	244.68	NM	244.23	244.42	244.38	244.7	245.9	247.11	248.45	249.72	250.58
PZ1-8	210.29	209.66	209.92	209.61	209.96	210.43	NM	NM	212.13	NM	NM	211.13
PZ1-10	212.327	dry	211.857	211.167	211.387	211.477	NM	NM	213.577	NM	NM	213.427
PZ1-17	210.873	209.803	210.463	209.863	210.113	all mud	NM	NM	212.813	NM	NM	211.813

NM = Not measured.

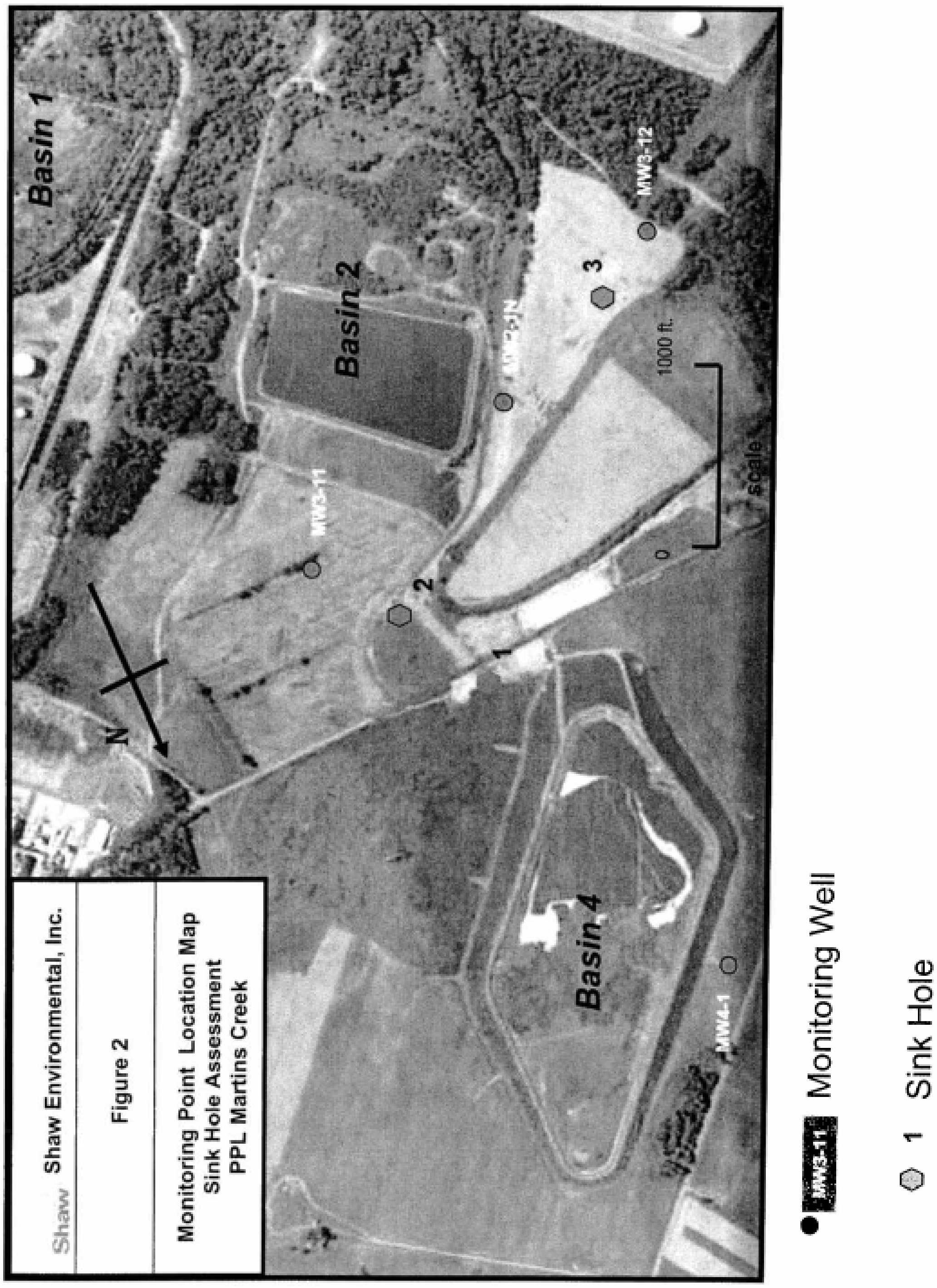
Table 5
Estimated Parameter Arrival Times Assuming Conservative Transport
PPL - Martins Creek

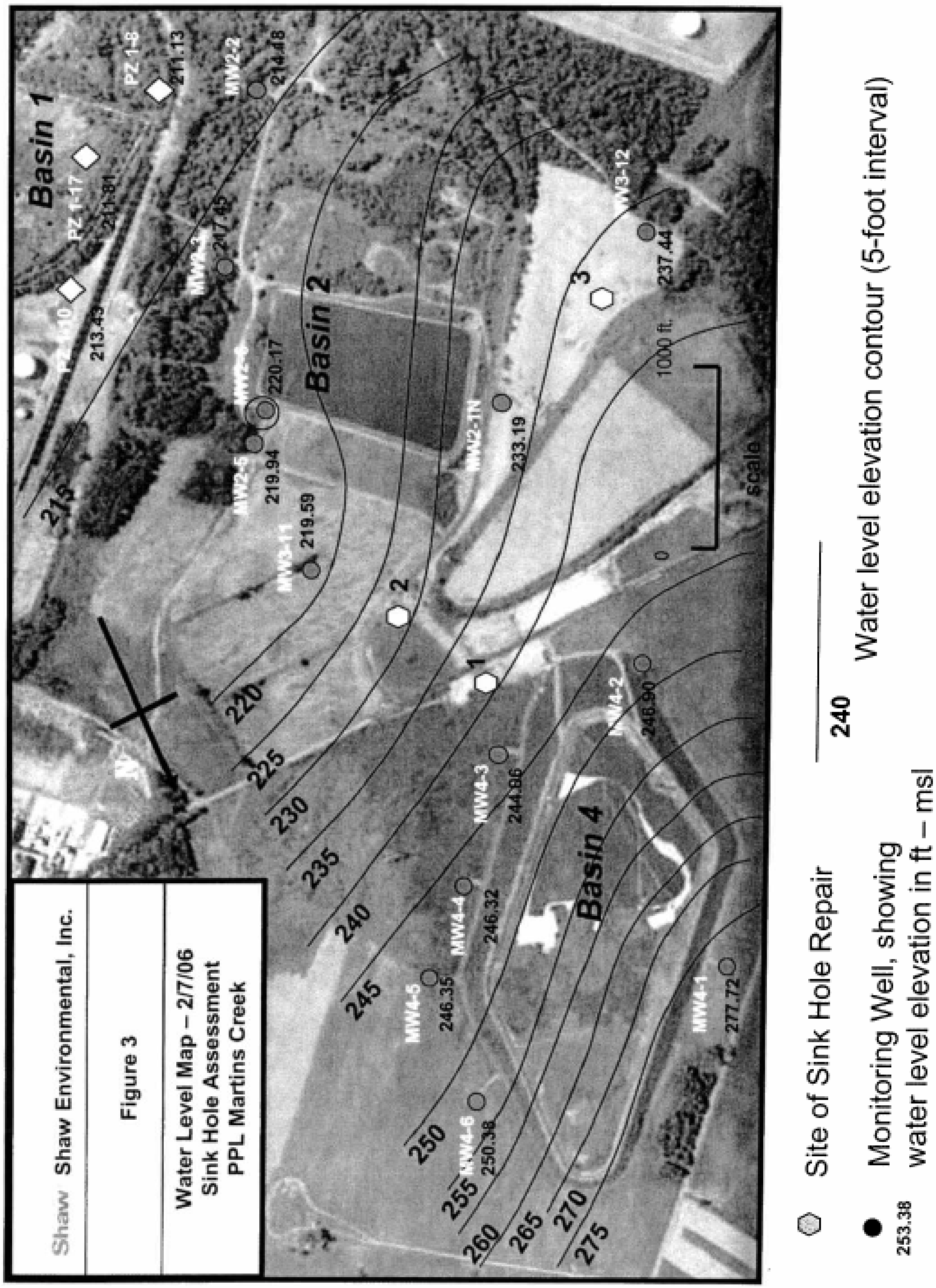
		Monitoring Well	
		MW 3-11	MW 3-12
Gradient		0.0225	0.005
Average Hydraulic Conductivity (ft/min)		0.039	0.081
Assumed effective porosity for Karst Limestone	Min	0.05	0.05
(Cherry & Freeze, 1979)	Max	0.50	0.50
Velocity of Groundwater Flow (ft/min)	Max	0.0176	0.0081
	Min	0.0018	0.0008
Velocity of Groundwater Flow (ft/day)	Max	25.272	11.664
	Min	2.5272	1.1664
Approx. Distance from Closest Sink hole to Well (feet)		520	445
Conservative Transport Travel Time (days)	Min	21	38
	Max	206	382
Estimated Range of Arrival Dates After Release	Min	9/12/2005	9/30/2005
8/23/2005	Max	3/16/2006	9/8/2006

Figures



Shaw Shaw Environmental, Inc.
Figure 1
Site Geology Map
Sink Hole Assessment
PPL Martins Creek
N
Ojr
Or
Oe
235
225
215
205
1
2
3
BASIN 4
BASIN 1
IWTB
MW-4-1
MW-4-2
MW-4-3
MW-2-1N
MW-2-3
MW-2-4
MW-2-7
MW-2-2
MW-1-8
MW-1-9
MW-1-7
MW-1-6
0
1000 ft
scale
Modified from: Drake, et. al., 1969
Oe Epler Formation
Or Rickenbach From
Ojl Jacksonburg Limestone (cement limestone facies)
Ojr Jacksonburg Limestone (cement limestone facies)
1 Recent Sink Hole
Water table elevation contour, Oct/Nov 2000 (in ft msl, 5-ft contour interval)
Direction of Groundwater Flow
Axial trace of overturned syncline
Axial trace of overturned anticline
Proposed New Monitoring Well


Shaw
Shaw Environmental, Inc.
Figure 2
Monitoring Point Location Map
Sink Hole Assessment
PPL Martins Creek
Basin 1
Basin 2
Basin 4
MW3-12
MW3-11
MW4-1
N
1
2
3
0
1000 ft.
scale
MW3-11 Monitoring Well
1 Sink Hole


Shaw Shaw Environmental, Inc.
Figure 3
Water Level Map – 2/7/06
Sink Hole Assessment
PPL Martins Creek
Basin 1
Basin 2
Basin 4
PZ 1-10
213.43
PZ 1-17
211.81
PZ 1-8
211.13
MW2-2
214.48
217.45
MW2-6
220.17
MW2-5
219.94
MW3-11
219.59
MW2-1N
233.19
MW3-12
237.44
MW4-2
246.90
MW4-3
244.86
MW4-4
246.32
MW4-5
246.35
MW4-6
250.38
MW4-1
277.72
1
2
3
1000 ft.
scale
0
215
220
225
230
235
240
245
250
255
260
265
270
275
Site of Sink Hole Repair
Monitoring Well, showing water level elevation in ft – msl
253.38
240
Water level elevation contour (5-foot interval)

Appendix A

PADEP Correspondence

Glenn P. Amey
Sr. Environmental Professional
Environmental Management Department
Tel. 610-774-6316 Fax 610-774-5930
E-mail: gpamey@pplweb.com

PPL Services Corp
Two North Ninth Street, GENTW-17
Allentown, PA 18101-1179
http://www.pplweb.com/

October 24, 2005

Lisa Hannigan
DEP Northeast Regional Office
2 Public Square
Wilkes-Barre, PA 18711-0790

Re: Basin 4 Groundwater Quality Assessment Plan
PPL – Martins Creek

Dear Ms. Hannigan:

In the Department's letter of October 3, 2005, PPL was requested perform an assessment that addresses the impact to groundwater from the release of fly ash laden water that flowed across the ground surface from Basin 4, and the reported development of sinkholes. PPL staff has initiated the following steps to define the full scope of assessment work that will be required to determine the potential impacts associated with the release and sinkholes.

1. Plotting of site geology, sinkhole locations and historic water table contours on a single map to determine the most appropriate number and location of new monitoring wells to perform the assessment (see attached figure).
2. Selection and installation of two new downgradient monitoring wells.
    a. One located in the historic downgradient direction of groundwater flow (as derived from the contouring of water level data), from the recent sinkhole that developed south of exiting monitoring well MW 4-3, positioned due southeast of the sinkhole.
    b. One located near the east bank of Oughoughton Creek in line with the locations of the two recent sinkholes and general regional strike of bedrock.
3. Sampling of MW2-1N and the two new wells on a weekly basis for four consecutive weeks for the same assessment Analytical Parameter List as was agreed to with PADEP for the ongoing assessment of Ash Basin 1 (see Attachment A).
4. Based on the results of 1 through 3, PPL will develop a comprehensive assessment plan for submittal to PADEP.

PROJECT EARTH

Please contact me at the number referenced above if you have any questions.

Sincerely,

Glenn P. Amey
Senior Environmental Professional
PPL Services

Cc: John Drabic, PPL Martins Creek
Craig Shamory, PPL Environmental Management
Richard Wardrop, Shaw Environmental

Attachment A

Basin No. 4 Release Analytical Parameter List for Assessment – October 2005

List A

Total Well Depth (Feet)	Total Alkalinity (as $CaCO_3$)
Depth-to-Water Level (Feet	Lab Sp. Conductance µmhos/cm)
Temperature (°C, Field	Lab pH (s.u.)
Field Sp. Conductance (µmhos/cm)	Chloride
Field pH (s.u.)	Nitrate (as N)
Turbidity (NTU)	Sulfate
Dissolved Oxygen (mg/l)	
ReDox Potential (Mv)	

Metals (Dissolved)

Arsenic
Barium
Boron
Calcium
Cadmium
Chromium
Copper
Iron
Lead
Lithium
Magnesium
Manganese
Mercury
Nickel
Selenium
Strontium
Zinc

NOTE:

Analyze parameters weekly for 4 weeks and then monthly thereafter until assessment complete.

Total metals shall be determined after the 4th sampling event. Frequency of sampling for total metals will be determined after initial data analysis is competed.

Appendix B

Well Logs

Drilling Log

Shaw® Shaw Environmental & Infrastructure, Inc.

Monitoring Well **MW 3-11**

Page: **1** of 3

Project: Sinkhole Assessment	Owner: PPL
Location: Martins Creek	Proj. No.: 117779.50
Surface Elev.:	Total Hole Depth: 143.0 ft.
North:	East:
Top of Casing: NA	Water Level Initial: 116.0 ft.
Static: 92.0 ft.	Diameter: 10.75/8.75 in.
Screen: Dia: 4 in.	Length: 30 ft.
Type/Size: PVC/0.010 in.	
Casing: Dia: 4 in.	Length: 111 ft.
Type: PVC SCH 40	
Fill Material: Sand	Rig/Core: Schramm/Schramm T555 RotaDrill
Drill Co.: Eichelbergers, Inc.	Method: 10" Stradex/ 8" Air Hammer
Driller: Dwayne Cobie	Log By: M. Shaheen
Date: 11/3/05	Permit #: NA
Checked By: R. Wardrop	License No.: PG000157G

COMMENTS

Depth (ft.)	Well Completion	PID (ppm)	Sample ID % Recovery	Blow Count Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Geologic Descriptions are Based on the USCS.
0						SM/ML	Moderate Brown SANDY SILT and Cobbles, moist.
5–10							Yellowish Brown SANDY CLAY and Cobbles, wet.
20						SP SC	Yellowish Brown SANDY CLAY and Shale/GRAVEL, some Light to Medium to Brownish Gray flat smooth shale fragments.
40							

Continued Next Page

SHAW ENVIRONMENTAL&INFRASTRUCTURE Rev. 7/17/03 MARTINS CREEK.GPJ IT_CORP.GDT 12/1/05

Shaw® Shaw Environmental & Infrastructure, Inc.

Drilling Log

Monitoring Well **MW 3-11**

Page: 2 of 3

Project *Sinkhole Assessment* Owner *PPL*

Location *Martins Creek* Proj. No. *117779.50*

Depth (ft.)	Well Completion	PID (ppm)	Sample ID % Recovery	Blow Count Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Geologic Descriptions are Based on the USCS.
40							*Continued*
45						SP SC	
50							
55							Moderate Brown Clayey SILT, Medium Gray Shale Fragments, moist.
60						CL ML	
65							
70							Weathered LIMESTONE.
75							Dark Gray Microcrystalline DOLOMITE, some Yellowish Brown to Brownish Gray, hard.
80							
85						ML	Yellowish Brown SILT and Broken LIMESTONE, moist.
90						CL	Very Soft CLAY.

Continued Next Page

SHAW ENVIRONMENTAL&INFRASTRUCTURE Rev: 7/17/03 MARTINS CREEK.GPJ IT_CORP.GDT 12/1/05

Drilling Log

Shaw® Shaw Environmental & Infrastructure, Inc.

Monitoring Well **MW 3-11**

Page: 3 of 3

Project: *Sinkhole Assessment* Owner: *PPL*

Location: *Martins Creek* Proj. No.: *117779.50*

Depth (ft.)	Well Completion	PID (ppm)	Sample ID % Recovery	Blow Count Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Geologic Descriptions are Based on the USCS.
							Continued
95							LIMESTONE, some DOLOMITE.
						SP SC	Brownish Yellow SANDY CLAY and LIMESTONE GRAVEL, wet.
100						ML	SILT and Broken LIMESTONE, dry to moist.
105							
110							Medium Dark Gray Hard LIMESTONE.
115							114-115' - fracture
120							120-121' - fracture, producing at 10-12 gpm
125							Dark Gray DOLOMITE. 127' - fracture
130							
135							
140							140-141' - void 141-143' - competent rock
145							Bottom of Boring at 143 Feet.

SHAW ENVIRONMENTAL&INFRASTRUCTURE Rev. 7/17/03 MARTINS CREEK.GPJ IT_CORP.GDT 12/1/05

Drilling Log

Shaw® Shaw Environmental & Infrastructure, Inc.

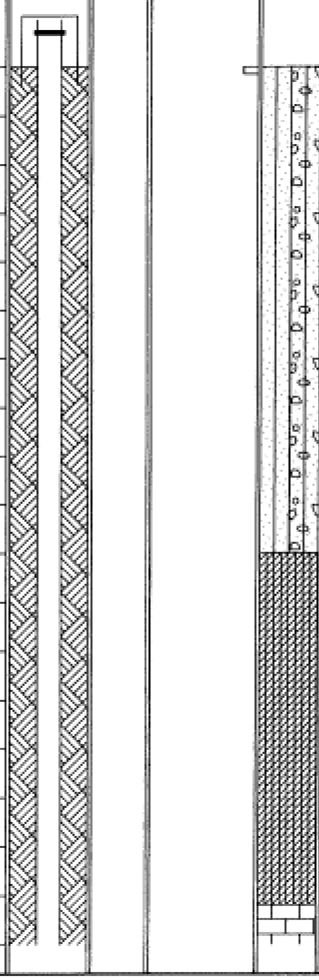
Monitoring Well **MW 3-12**

Page: 1 of 2

Project	*Sinkhole Assessment*	Owner	*PPL*		
Location	*Martins Creek*	Proj. No.	*117779.50*		
Surface Elev.		Total Hole Depth	*101.0 ft.*	North	East
Top of Casing	*NA*	Water Level Initial	*NA*	Static *NA*	Diameter *10.75/8.75* in.
Screen: Dia	*4 in.*	Length	*30 ft.*	Type/Size	*PVC/0.010 in.*
Casing: Dia	*4 in.*	Length	*61 ft.*	Type	*PVC SCH 40*
Fill Material	*Sand*	Rig/Core	*Schramm/Schramm T555 RotaDrill*		
Drill Co.	*Eichelbergers, Inc.*	Method	*10" Stradex/ 8" Air Hammer*		
Driller	*Dwayne Cobie*	Log By	*M. Shaheen*	Date *11/8/05*	Permit # *NA*
Checked By	*R. Wardrop*	License No.	*PG000157G*		

COMMENTS

Depth (ft.)	Well Completion	PID (ppm)	Sample ID % Recovery	Blow Count Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Geologic Descriptions are Based on the USCS.
0							Yellowish Brown SILTY MC SAND, and FMC GRAVEL, some Cobbles, moist, trace CLAY.
5							Yellowish Brown MC SAND and FMC GRAVEL, little to some SILT, trace Cobbles, moist.
10							SILTY SAND and GRAVEL.
15						SM/SP	
20							
25							Moderate Reddish Brown SILTY CLAY, some FMC SAND and FM GRAVEL, moist.
30							
35						CL ML	
40							
45							



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SHAW ENVIRONMENTAL &INFRASTRUCTURE Rev: 7/17/03 MARTINS CREEK.GPJ IT_CORP.GDT 12/1/05

Drilling Log

Shaw® Shaw Environmental & Infrastructure, Inc.

Monitoring Well **MW 3-12**

Page: 2 of 2

Project *Sinkhole Assessment* Owner *PPL*

Location *Martins Creek* Proj. No. *117779.50*

Depth (ft.)	Well Completion	PID (ppm)	Sample ID % Recovery	Blow Count Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Geologic Descriptions are Based on the USCS.
							Continued
45							clay and rock
50							
55							Light Olive Gray weathered LIMESTONE.
60							
65							
70							68' - water 68-79' - broken rock, producing 15-20 gpm
75							
80							DOLOMITE, competent
85							85-89' - void
90							91-92' - fracture, with clay 92-95' - broken rock and voids
95							
100							
105							Bottom of Boring at 101 Feet.

SHAW ENVIRONMENTAL &INFRASTRUCTURE Rev: 7/17/03 MARTINS CREEK.GPJ IT CORP.GDT 12/1/05

AIR-ROTARY DRILLING LOG

Client: PP&L Martins Creek S.E.S.

Project No: 91580 Phase Task

Boring No. MW 2-1AA Piezometer No.

Location

Surface Elev. FT.

Page 1 of 2

Dep. Feet	Blow Count	Sampler	Re-covery/ ROD.	Overburden/Lithologic Description	FID (ppm)	Graphic Log	Well Construction Graphics	Depth Feet	Well Construction Details
									T.O.C. Elev.
0	Ground Surface		FEET					0	
0–3				Silty Clay: reddish-brown, trace gravel, slightly moist.					
				Clayey Silt: brown, trace gravel, slightly moist.					
				Silty Sand: brown, 10% moderately well rounded gravel, trace clay, slightly moist. 40% gravel at 11'					
15				Silty Sand: brown, fine-grained, 10% moderately well rounded gravel, trace clay, trace wood fragments, slightly moist.				20	Bentonite Grout
30				Sandy Gravel: medium grey, coarse, well rounded, trace clay, slightly moist.					
35				Gravelly Sand: brown, fine-grained, 40% well rounded gravel, slightly moist.					
				Clayey Sand: reddish-brown, fine-grained, slightly moist.				40	6" protective steel casing to 63 ft
40				Sand: brown, fine-grained, 10% moderately well rounded gravel, trace clay, slightly moist. 40% well rounded gravel at 49'					
55				Gravel: grey, well rounded, trace fine-grained sand, slightly moist to moist.					
60				Continued Next Page				60	

Driller Miller Pump Service

Logged By D. Breedon (REWAI)

Drilling Started 12/4/91

Drilling Completed 12/4/91

Construction Completed 12/4/91

Development Completed 12/10/91

Water Bearing Zones 90' and 115'

Blown/Bailed Yield > 10 gpm

Well Casing 4" Dia. 0.0' to 83.0'

Casing Type Schedule 40 PVC

Well Screen 4" Dia. 83.0' to 123.0'

Screen Type Schedule 40 PVC

Slot Size 0.020"

Drilling Mud N/A

Grout Type 5% Bentonite Grout

Bentonite Seal 76.5-80.0'

Filter Pack Qty. 6 cu.ft

Filter Pack Type Morie #0 sand

Static Water Level MSL

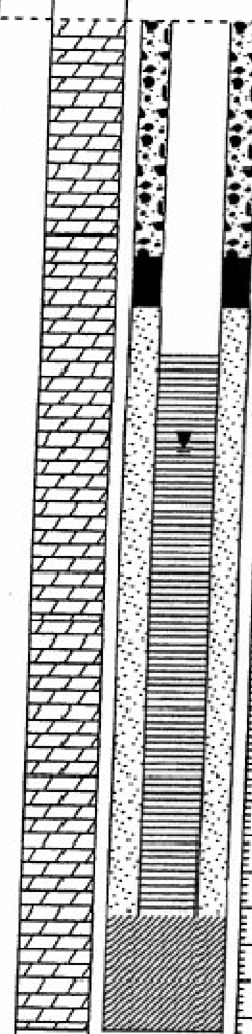
Date

Notes:

Form #wl-sc-1 (02/90)

Client: PP&L Martins Creek S.E.S.
Project No: 91580 Phase Task
Location
Surface Elev. FT.

Depth Feet	Blow Count	Sampler	Re-covery/ RQD.	Overburden/Lithologic Description	FID (ppm)	Graphic Log	Well Construction Graphics	Depth Feet	Well Construction Details
				Continued from previous page					
60				**Dolomite**: dark grey, finely crystalline, argillaceous, abundant fractures filled with calcite.				60	
				Fracture at 67'					
70				**Dolomite**: dark grey, finely crystalline, argillaceous.				70	
75				Fracture at 75'				75	
				Dolomite: medium grey, finely crystalline, argillaceous, abundant fractures filled with calcite, trace chert.				80	Bentonite Seal
90				Water bearing fracture zone at 90'				90	
95				**Dolomite**: dark grey, medium crystalline, trace fractures filled with calcite, trace chert.				100	Morie #0 sand pack
105				**Dolomite**: dark grey, finely crystalline, argillaceous, abundant fractures filled with calcite, trace chert.				105	
115				Water bearing fracture zone at 115'				115	
125								125	Cavings
130								130	Total depth 131.0
135								135	
140								140	

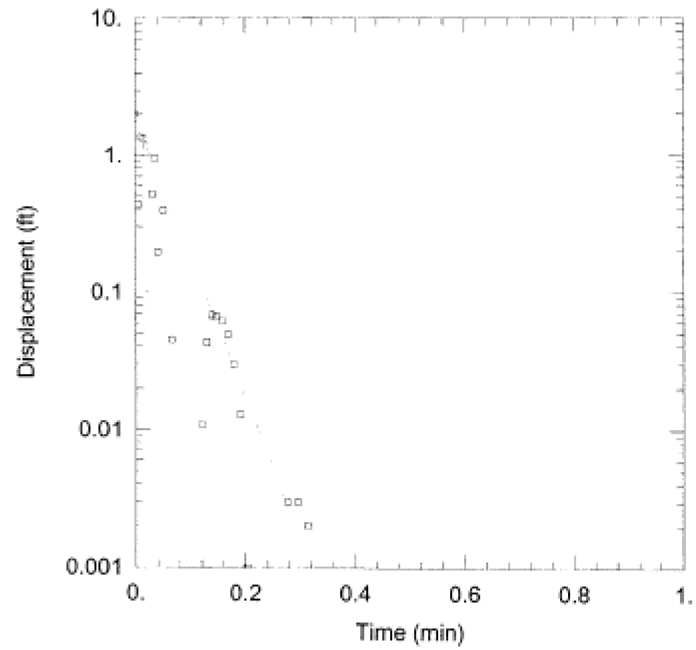


Form #wl-sc-1 (02/90)

r.e. wright associates, inc.

Appendix C

Slug Test Results



MW3-11 FALLING HEAD TEST #1

Data Set: C:\...\MW3-11 falling1.aqt
Date: 02/01/06 Time: 17:24:57

PROJECT INFORMATION

Company: Shaw Environmental, Inc.
Client: PPL-Martins Creek
Project: 117779
Test Location: Martins Creek, PA
Test Well: MW3-11
Test Date: 1/31/2006

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

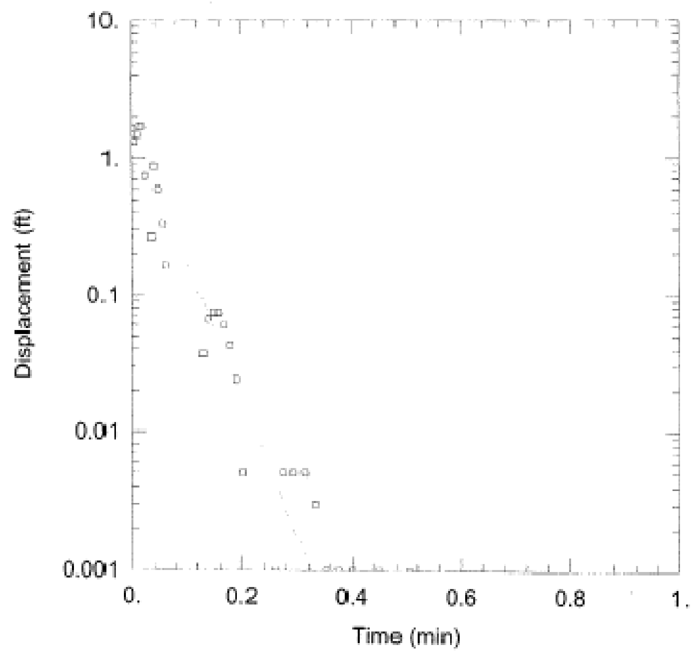
K = 0.04029 ft/min
y0 = 1.86 ft

AQUIFER DATA

Saturated Thickness: 48.5 ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW3-11)

Initial Displacement: 2.01 ft
Casing Radius: 0.1667 ft
Screen Length: 30. ft
Water Column Height: 48.5 ft
Wellbore Radius: 0.36 ft



MW3-11 FALLING HEAD TEST #2

Data Set: C:\...\MW3-11 falling2.aqt
Date: 02/28/06 Time: 08:40:17

PROJECT INFORMATION

Company: Shaw Environmental, Inc.
Client: PPL-Martins Creek
Project: 117779
Test Location: Martins Creek, PA
Test Well: MW3-11
Test Date: 1/31/2006

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

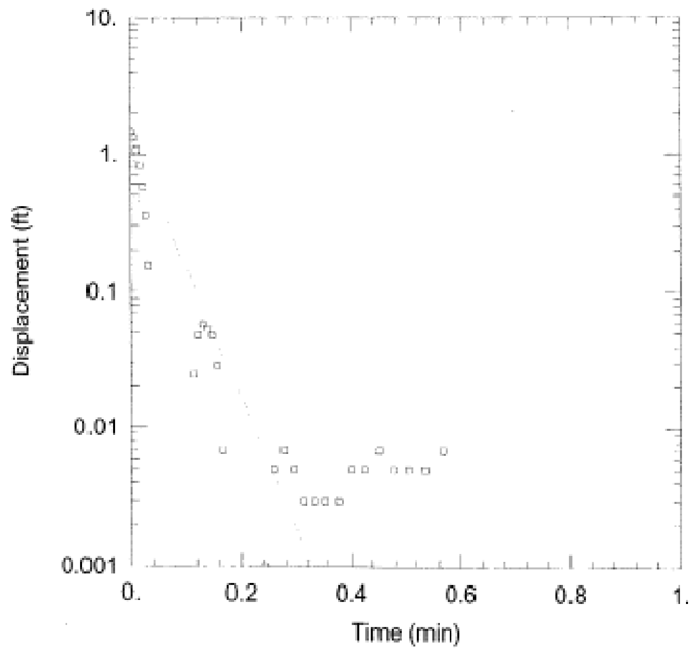
K = 0.0392 ft/min
y0 = 1.682 ft

AQUIFER DATA

Saturated Thickness: 48.5 ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW3-11)

Initial Displacement: 1.65 ft
Casing Radius: 0.1667 ft
Screen Length: 30. ft
Water Column Height: 48.5 ft
Wellbore Radius: 0.36 ft



MW3-11 RISING HEAD TEST #2

Data Set: C:\...\MW3-11 rising2.aqt
Date: 02/28/06 Time: 08:42:02

PROJECT INFORMATION

Company: Shaw Environmental, Inc.
Client: PPL-Martins Creek
Project: 117779
Test Location: Martins Creek, PA
Test Well: MW3-11
Test Date: 1/31/2006

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

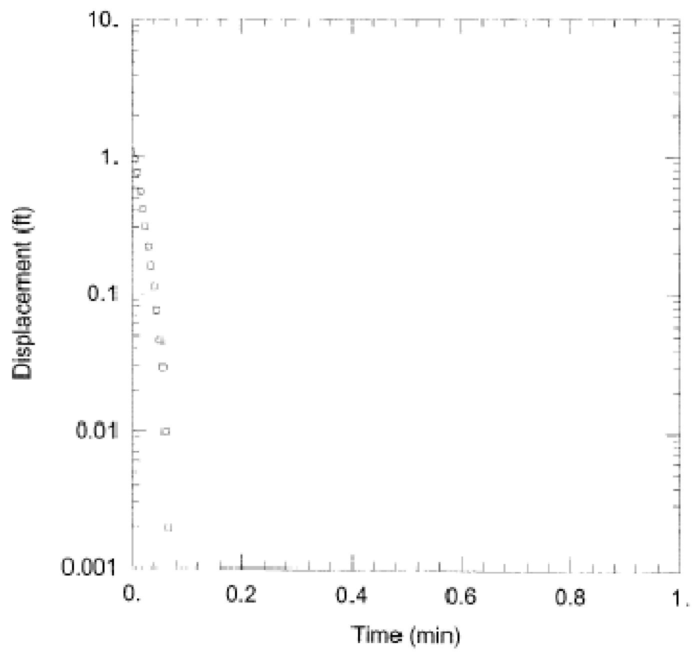
K = 0.03772 ft/min
y0 = 1.35 ft

AQUIFER DATA

Saturated Thickness: 48.5 ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW3-11)

Initial Displacement: 1.44 ft
Casing Radius: 0.1667 ft
Screen Length: 30. ft
Water Column Height: 48.5 ft
Wellbore Radius: 0.36 ft



MW3-12 RISING HEAD TEST #1

Data Set: C:\...\MW3-12 rising1.aqt
Date: 02/01/06 Time: 17:43:22

PROJECT INFORMATION

Company: Shaw Environmental, Inc.
Client: PPL-Martins Creek
Project: 117779
Test Location: Martins Creek, PA
Test Well: MW3-12
Test Date: 1/31/2006

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

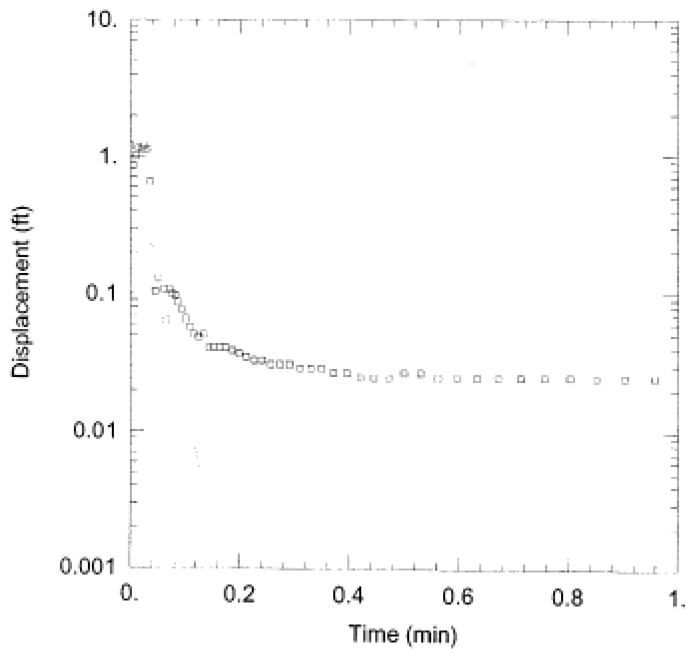
K = 0.09469 ft/min
y0 = 1.25 ft

AQUIFER DATA

Saturated Thickness: 34.7 ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW3-12)

Initial Displacement: 1.09 ft
Casing Radius: 0.1667 ft
Screen Length: 30. ft
Water Column Height: 34.7 ft
Wellbore Radius: 0.36 ft



MW3-12 FALLING HEAD TEST #1

Data Set: C:\...\MW3-12 falling1.aqt
Date: 02/01/06 Time: 17:38:07

PROJECT INFORMATION

Company: Shaw Environmental, Inc.
Client: PPL-Martins Creek
Project: 117779
Test Location: Martins Creek, PA
Test Well: MW3-12
Test Date: 1/31/2006

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

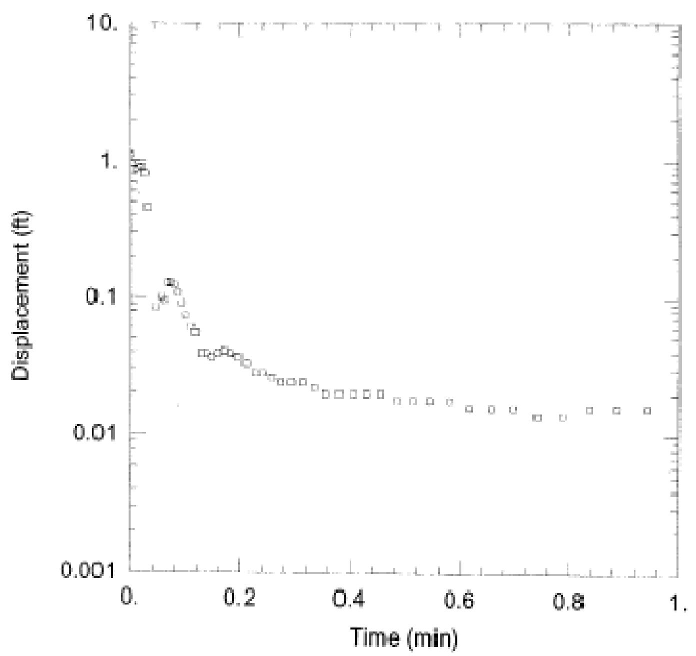
K = 0.06867 ft/min
y0 = 1.155 ft

AQUIFER DATA

Saturated Thickness: 34.7 ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW3-12)

Initial Displacement: 1.19 ft
Casing Radius: 0.1667 ft
Screen Length: 30. ft
Water Column Height: 34.7 ft
Wellbore Radius: 0.36 ft



MW3-12 FALLING HEAD TEST #2

Data Set: C:\...\MW3-12 falling2.aqt
Date: 02/01/06 Time: 17:39:57

PROJECT INFORMATION

Company: Shaw Environmental, Inc.
Client: PPL-Martins Creek
Project: 117779
Test Location: Martins Creek, PA
Test Well: MW3-12
Test Date: 1/31/2006

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

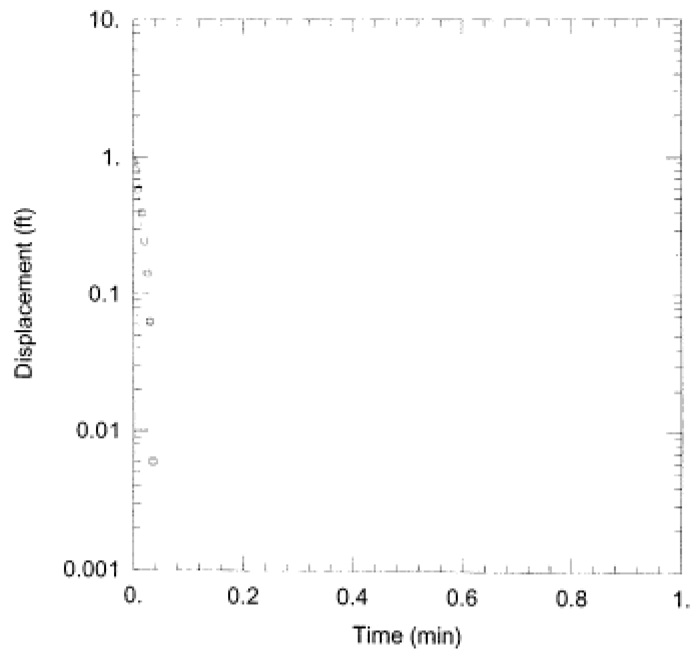
K = 0.08011 ft/min
y0 = 1.25 ft

AQUIFER DATA

Saturated Thickness: 34.7 ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW3-12)

Initial Displacement: 1.11 ft
Casing Radius: 0.1667 ft
Screen Length: 30. ft
Water Column Height: 34.7 ft
Wellbore Radius: 0.36 ft



MW3-12 RISING HEAD TEST #2

Data Set: C:\...\MW3-12 rising2.aqt
Date: 02/28/06 Time: 08:42:49

PROJECT INFORMATION

Company: Shaw Environmental, Inc.
Client: PPL-Martins Creek
Project: 117779
Test Location: Martins Creek, PA
Test Well: MW3-12
Test Date: 1/31/2006

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 0.1459 ft/min
y0 = 1.192 ft

AQUIFER DATA

Saturated Thickness: 34.7 ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW3-12)

Initial Displacement: 0.92 ft
Casing Radius: 0.1667 ft
Screen Length: 30. ft
Water Column Height: 34.7 ft
Wellbore Radius: 0.36 ft

Appendix D

Groundwater Quality Monitoring Data

MW 3-11 Water Quality Data

Field Sample ID Sampled On Date Sampled At Time	Units	Pa Act 2 Residential Groundwater MSCs for TDS< 2500 mg/L		MW 3-11 12/7/2005 1215	MW 3-11 12/21/2005 1113	MW 3-11 1/5/2006 1145	MW 3-11 2/7/2006 1327	Historic Range of Values for Upgradient Well MW 4-1 MIN	MAX
Depth to Water	ft			94	94.46	93.35	91.7		
Sampling Depth	ft			125	125	125	125		
Well Depth	ft			139.1	142.2	144.7	139.2		
Conductivity - Field	µmhos			546	546	544	531	496	746
Conductivity - Lab	µmhos			556	554	546	548	544	739
pH Field				7.39	7.37	7.52	7.43	6.82	7.54
pH Lab				7.76	7.67	7.7	7.7	7.33	7.83
Field Temperature	degrees C			11.08	10.49	11.13	11.3	10.53	18.68
Dissolved Oxygen	mg/L			11.26	11.09	10.33	9.81	8.69	17.91
Redox Potential ORP	mV			324	413	452	348	250	405
Turbidity Field	NTU			0.4	0.1	0.1	0.2	0.1	10.6
Chloride	mg/L	250	S	13.3	13.9	14	15.7	9.1	43.7
Nitrate as NO_3	mg/L			41.6	41.1	40.5	40.1	29.2	82.5
Nitrate as N	mg/L	10		9.4	9.3	9.1	9.1	6.6	18.6
Sulfate	mg/L	500		39.5	37.9	38.8	39.4	27.7	50
PHT Alkalinity	mg/L			0	0	0	0	N.D.	N.D.
Total Alkalinity	mg/L			190	192	190	190	180	220
Arsenic, Dissolved	µg/L	10		N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Barium, Dissolved	µg/L	2000		15	15	15	14	14	17
Boron, Dissolved	µg/L	600		23	29	21	30	33	43
Cadmium, Dissolved	µg/L	5		N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Calcium, Dissolved	mg/L			66.3	65.3	66.6	65.8	71.8	86
Chromium, Dissolved	µg/L	100		N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Copper, Dissolved	µg/L	1000		N.D.	<10	N.D.	N.D.	N.D.	N.D.
Iron, Dissolved	mg/L	0.3	S	<0.02	N.D.	N.D.	N.D.	N.D.	N.D.
Lead, Dissolved	µg/L	5		N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Lithium, Dissolved	µg/L			N.D.	N.D.	N.D.	<10	N.D.	N.D.
Magnesium, Dissolved	mg/L			26.1	26	26.5	26.3	21.5	32.4
Manganese, Dissolved	µg/L	50	S	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Mercury, Dissolved	µg/L	2		N.D.	N.D.	N.D.	<0.4	N.D.	N.D.
Nickel, Dissolved	µg/L	100		N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Selenium, Dissolved	µg/L	50		N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Strontium, Dissolved	µg/L			182	181	184	179	166	277
Zinc, Dissolved	µg/L	2000		N.D.	N.D.	N.D.	N.D.	N.D.	N.D.

Notes: **181** indicates exceedance of Act 2 MSC
S indicates secondary Act 2 MSC

MW 3-12 Water Quality Data

Field Sample ID Sampled On Date Sampled At Time	Units	Pa Act 2 Residential Groundwater MSCs for TDS< 2500 mg/L		MW 3-12 12/7/2005 1048	MW 3-12 12/21/2005 1007	MW 3-12 1/5/2006 0857	MA 3-12 2/7/2006 1305	Historic Range of Values for Upgradient Well MW 4-1 MIN	 MAX
Depth to Water	ft			57.5	57.15	56.43	56.52		
Sampling Depth	ft			76	76	76	76		
Well Depth	ft			91.5	91.6	91.6	91.8		
Conductivity - Field	µmhos			296	290	285	304	496	746
Conductivity - Lab	µmhos			301	295	286	304	544	739
pH Field				7.7	7.6	7.65	7.61	6.82	7.54
pH Lab				7.91	7.85	7.91	7.88	7.33	7.83
Field Temperature	degrees C			10.59	8.74	8.51	8.67	10.53	18.68
Dissolved Oxygen	mg/L			10.36	11.11	9.64	11.07	8.69	17.91
Redox Potential ORP	mV			316	398	474	271	250	405
Turbidity Field	NTU			1	0.7	0.9	2.2	0.1	10.6
Chloride	mg/L	250	S	10.6	11.8	12	11.3	9.1	43.7
Nitrate as NO_3	mg/L			24.5	24.8	24.2	24.8	29.2	82.5
Nitrate as N	mg/L	10		5.5	5.6	5.5	5.6	6.6	18.6
Sulfate	mg/L	500		30.3	28.3	27.8	27.7	27.7	50
PHT Alkalinity	mg/L			0	0	0	0	N.D.	N.D.
Total Alkalinity	mg/L			78	73	75	85	180	220
Arsenic, Dissolved	µg/L	10		N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Barium, Dissolved	µg/L	2000		12	11	11	12	14	17
Boron, Dissolved	µg/L	600		<20	<20	22	22	33	43
Cadmium, Dissolved	µg/L	5		N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Calcium, Dissolved	mg/L			35.7	34.6	34.8	36.8	71.8	86
Chromium, Dissolved	µg/L	100		N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Copper, Dissolved	µg/L	1000		N.D.	<10	<10	N.D.	N.D.	N.D.
Iron, Dissolved	mg/L	0.3	S	<0.02	N.D.	N.D.	N.D.	N.D.	N.D.
Lead, Dissolved	µg/L	5		N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Lithium, Dissolved	µg/L			N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Magnesium, Dissolved	mg/L			9.29	9.16	9.21	9.92	21.5	32.4
Manganese, Dissolved	µg/L	50	S	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Mercury, Dissolved	µg/L	2		N.D.	N.D.	N.D.	<0.4	N.D.	N.D.
Nickel, Dissolved	µg/L	100		N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Selenium, Dissolved	µg/L	50		N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Strontium, Dissolved	µg/L			103	100	101	105	166	277
Zinc, Dissolved	µg/L	2000		N.D.	N.D.	N.D.	N.D.	N.D.	N.D.

Notes: **181** indicates exceedance of Act 2 MSC
S indicates secondary Act 2 MSC

MW 2-1N Water Quality Data

Field Sample ID Sampled On Date Sampled At Time	Units	Pa Act 2 Residential Groundwater MSCs for TDS< 2500 mg/L		MW 2-1N 11/2/2005 1141	MW 2-1N 12/7/2005 1155	MW 2-1N 1/19/2006 0839	MW 2-1N 2/8/2006 0810	Historic Range of Values for Upgradient Well MW 4-1 MIN	 MAX
Depth to Water	ft			68.83	69.25	67.79	66.48		
Sampling Depth	ft			101	101	101	101		
Well Depth	ft			126.6	120	119.9	124.6		
Conductivity - Field	µmhos			502	455	511	502	496	746
Conductivity - Lab	µmhos				520	518	511	544	739
pH Field				7.46	7.5	7.48	7.65	6.82	7.54
pH Lab				7.92	7.85	7.83	7.86	7.33	7.83
Field Temperature	degrees C			12.75	11.77	10.48	11.08	10.53	18.68
Dissolved Oxygen	mg/L			10.33	9.32	10.52	10.49	8.69	17.91
Redox Potential ORP	mV			519	462	428	334	250	405
Turbidity Field	NTU			4.4	1.2	1.9	0.4	0.1	10.6
Chloride	mg/L	250	S	12.3	13.2	12.6	14.2	9.1	43.7
Nitrate as NO_3	mg/L			43.4	42.8	42.6	42.5	29.2	82.5
Nitrate as N	mg/L	10		9.8	9.7	9.6	9.6	6.6	18.6
Sulfate	mg/L	500		42.3	43.6	42.8	43	27.7	50
PHT Alkalinity	mg/L			0	0	0	0	N.D.	N.D.
Total Alkalinity	mg/L			168	171	167	167	180	220
Arsenic, Dissolved	µg/L	10		N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Barium, Dissolved	µg/L	2000		14	14	14	14	14	17
Boron, Dissolved	µg/L	600		22	24	26	26	33	43
Cadmium, Dissolved	µg/L	5		N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Calcium, Dissolved	mg/L			63.1	62.1	62.1	63.4	71.8	86
Chromium, Dissolved	µg/L	100		N.D.	N.D.	N.D.	<10	N.D.	N.D.
Copper, Dissolved	µg/L	1000		N.D.	N.D.	<20	N.D.	N.D.	N.D.
Iron, Dissolved	mg/L	0.3	S	N.D.	N.D.	N.D.	<0.02	N.D.	N.D.
Lead, Dissolved	µg/L	5		N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Lithium, Dissolved	µg/L			N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Magnesium, Dissolved	mg/L			24.9	24.2	24.3	24.8	21.5	32.4
Manganese, Dissolved	µg/L	50	S	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Mercury, Dissolved	µg/L	2		N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Nickel, Dissolved	µg/L	100		N.D.	N.D.	N.D.	N.A.	N.D.	N.D.
Selenium, Dissolved	µg/L	50		N.D.	N.D.	<2.0	N.D.	N.D.	N.D.
Strontium, Dissolved	µg/L			206	207	211	209	166	277
Zinc, Dissolved	µg/L	2000		N.D.	N.D.	N.D.	N.D.	N.D.	N.D.

Notes:

181	indicates exceedance of Act 2 MSC
S	indicates secondary Act 2 MSC
N.D.	Not detected
N. A	Not analyzed

Historic Water Quality Data for Monitoring Well MW 4-1

Well No.	4-1	4-1	4-1	4-1	4-1	4-1	4-1	4-1	4-1	4-1	4-1	4-1	4-1		
Date Collected	8/14/2002	11/14/2002	3/18/2003	5/21/2003	8/12/2003	11/18/2003	2/23/2004	5/17/2004	8/16/2004	11/16/2004	2/8/2005	5/3/2005	8/9/2005		
Time Collected	1444	1139	1110	903	1116	1019	837	929	1351	942	1254	1046	1049		
Water Elev. (ft-MSL)	251.8	204.29	272.5	268.89	274.25	277.86	276.95	273.75	260.7	277.07	278.4	281.25	256.88		
Analysis by	PPL	PPL	PPL	PPL	PPL	PPL	PPL	PPL	PPL	PPL	PPL	PPL	PPL		
Parameter														MIN	MAX
1 Cond., lab, umhos/cm	568	553	544	555	576	640	733	627	573	739	632	710	612	544	739
2 Cond., fld., umhos/cm	505	539	530	521	532	634	721	597	518	746	626	690	496	496	746
3 Temp., H2O, C	18.68	12.07	11.26	11.09	14.12	11.28	10.53	11.93	12.9	11.03	11.07	11.76	14.57	10.53	18.68
4 Turb., NTU	10.6	0.1	6.3	6	1.1	0.4	0.9	0.4	2.2	0.9	0.3	0.4	1.2	0.1	10.6
5 pH, fld., s.u.	7.4	7.54	7.46	7.46	7.37	7.29	7.3	7.51	7.32	6.82	7.25	7.16	7.37	6.82	7.54
6 pH, lab, s.u.	7.71	7.6	7.58	7.55	7.61	7.36	7.33	7.6	7.72	7.39	7.54	7.71	7.83	7.33	7.83
7 Alk.,m.o.,CaCO3,mg/l	197	198	180	186	194	201	220	208	192	199	196	212	206	180	220
8 Alk.,pht.,CaCO3,mg/l	0	0	0	0	0	0	0	0	0	0	0	0	0	N.D.	N.D.
9 NH3-N, mg/l	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	N.D.	<0.10	<0.10	N.D.	N.D.
10 NO3-IC, mg/l	50.9*	29.2	43.6	37.7	45.4	76.6	66.7	61.5	58.8	82.5	73.1	71.3	51.4	29.2	82.5
11 NO3-N, mg/l	11.5*	6.6	9.9	8.5	10.3	17.3	15.1	13.9	13.3	18.6	16.5	18.1	11.6	6.6	18.6
12 Org. C, tot., mg/l	1.48	1.21	1.04	1.56	0.96	1.4	1.99	1.39	0.92	0.57	<0.50	0.54	0.53	0.53	1.99
13 Sol., dis.@180C,mg/l	317	320	316	324	315	368	412	360	321	412	343	402	341	315	412
14 Ag, dis., ug/L			N.D.			N.D.	N.D.				N.D.			N.D.	N.D.
15 Ag, tot., ug/L			N.D.				N.D.				N.D.			N.D.	N.D.
16 Al, dis., ug/L	N.D.	N.D.	<50	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
17 As, dis., ug/l			N.D.				<1.0				<1.0			N.D.	N.D.
18 As, tot., ug/l			<1.0				N.D.				<1.0			N.D.	N.D.
19 B, dis., ug/L	<20	N.D.	<20	<20	<20	43	<20	<20	<20	<20	<20	33	<20	33	43
20 Ba, dis., ug/L			14				17				16			14	17
21 Ba, tot., ug/L			13				17				16			13	17
22 COD, mg/L	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	<10	N.D.	<10	N.D.	<10	<10	N.D.	N.D.
23 Ca, dis., mg/L	75.6	75.7	71.8	72.8	76.2	83.8	86	77.2	72	81.2	73.4	81.1	75.4	71.8	86
24 Ca, tot., mg/L	76.4	77	71	74.6	76.6	84.2	86.1	77.5	71.8	80.6	74.3	81.5	75.6	71	86.1
25 Cd, dis., ug/l			N.D.				N.D.				N.D.			N.D.	N.D.
26 Cd, tot., ug/l			N.D.				N.D.				N.D.			N.D.	N.D.
27 Cr, dis., ug/L			N.D.				N.D.				N.D.			N.D.	N.D.
28 Cr, tot., ug/L			N.D.				<10				N.D.			N.D.	N.D.
28.5 Cl-IC, mg/l	11.2	9.1	20.1	18.1	22.8	15	43.7	23.8	20.3	36.7	21.7	26	21.7	9.1	43.7
29 Cu, dis., ug/L			N.D.				N.D.				N.D.			N.D.	N.D.
30 Cu, tot., ug/L			N.D.				N.D.				N.D.			N.D.	N.D.
31 Dis. O2, fld., mg/l	8.69	10.68	12.56	16.06	10.05	12.29	11.51	17.91	9.57	10.33	10.86	11.46	10.21	8.69	17.91

	Well No.	4-1	4-1	4-1	4-1	4-1	4-1	4-1	4-1	4-1	4-1	4-1	4-1	4-1		
	Date Collected	8/14/2002	11/14/2002	3/18/2003	5/21/2003	8/12/2003	11/18/2003	2/23/2004	5/17/2004	8/16/2004	11/16/2004	2/8/2005	5/3/2005	8/9/2005		
	Time Collected	1444	1139	1110	903	1116	1019	837	929	1351	942	1254	1046	1049		
	Water Elev. (ft-MSL)	251.8	204.29	272.5	268.89	274.25	277.85	276.95	273.75	260.7	277.07	278.4	281.25	256.88		
	Analysis by	PPL	PPL	PPL	PPL	PPL	PPL	PPL	PPL	PPL	PPL	PPL	PPL	PPL		
	Parameter														MIN	MAX
32	F-IC, mg/l	N.D.	<0.1	N.D.	N.D.	<0.05	<0.05	<0.05	<0.05	0.06	<0.05	<0.10	N.D.	<0.20	0.06	0.06
33	Fe, dis., mg/L	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
34	Fe, tot., mg/L	0.23	N.D.	0.08	0.17	<0.02	<0.02	<0.02	<0.02	0.02	<0.02	<0.02	N.D.	0.02	0.02	0.23
35	HCO3, mg/l	240	242	220	227	237	245	268	254	234	243	238	259	250	220	268
36	Hg, dis., ug/l			<0.2				<0.3				N.D.			N.D.	N.D.
37	Hg, tot., ug/l			<0.2				N.D.				N.D.			N.D.	N.D.
38	K, dis., mg/L	1.3	2.39	1.4	1.53	1.69	0.76	0.8	3.04	2.55	0.84	0.71	1.69	2.43	0.71	3.04
39	K, tot., mg/L	1.4	2.42	1.39	1.57	1.7	0.77	0.81	3.02	2.56	0.84	0.73	0.81	2.46	0.73	3.02
40	Li, dis., ug/L	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	<10	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
42	Mg, dis., mg/L	24.6	21.8	21.5	21.7	22.2	28	32.4	24.8	22.6	30.5	26.3	28.5	24.9	21.5	32.4
43	Mg, tot., mg/L	24.9	22.1	21.2	22.1	22.2	28.3	32.4	24.8	22.6	30.3	26.6	28.6	24.7	21.2	32.4
44	Mn, dis., ug/L	<2	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
45	Mn, tot., ug/L	9	N.D.	3	11	<2	N.D.	<2	<2	<2	N.D.	N.D.	N.D.	<2	3	11
46	Mo, dis., ug/L	<20	<20	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	<20	N.D.	N.D.
48	Na, dis., mg/L	5.51	5.42	7.11	7.33	7.81	4.97	13	9.37	8.34	19.7	13.1	15.9	10.9	4.97	19.7
49	Na, tot., mg/L	5.62	5.5	7.05	7.36	7.84	4.97	13	9.35	8.37	19.6	13.2	16	10.8	4.97	19.6
50	Ni, dis., ug/L	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
51	Redox, mv	294	332	365	405	324	290	396	336	298	356	363	403	338	250	405
52	SO4-IC, mg/l	43.1	39.8	31.9	27.7	33.5	50	42.7	32.7	33.8	41.9	40.5	48.5	36	27.7	50
53	Se, dis., ug/l			N.D.				<1.0				<1.0			N.D.	N.D.
54	Se, tot., ug/l			N.D.				<1.0				<1.0			N.D.	N.D.
55	Sr, dis., ug/L	245	218	241	264	277	174	194	274	254	194	166	187	232	166	277
57	Pb, dis., ug/l			<3				N.D.				N.D.			N.D.	N.D.
57.5	Pb, tot., ug/l			N.D.				N.D.				N.D.			N.D.	N.D.
58	Zn, dis., ug/L			N.D.				N.D.				N.D.			N.D.	N.D.
59	Zn, tot., ug/L			N.D.				N.D.				N.D.			N.D.	N.D.
60	1,1-Cl2-ethane, ug/l			N.D.				N.D.				N.D.			N.D.	N.D.
61	1,1-Cl2-ethene ug/l			N.D.				N.D.				N.D.			N.D.	N.D.
62	1,2-Cl2-ethane, ug/l			N.D.				N.D.				N.D.			N.D.	N.D.
63	1-Cl3-ethane, ug/l			N.D.				N.D.				N.D.			N.D.	N.D.
64	Cl4-ethene, ug/l			N.D.				N.D.				N.D.			N.D.	N.D.
65	cis-1,2-Cl2-C2H			N.D.				N.D.				N.D.			N.D.	N.D.
66	t-1,2-Cl2-C2H2			N.D.				N.D.				N.D.			N.D.	N.D.
68	Trichloroethene			N.D.				N.D.				N.D.			N.D.	N.D.
69	Vinyl chloride			N.D.				N.D.				N.D.			N.D.	N.D.

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COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL RESOURCES
BUREAU OF WASTE MANAGEMENT

Coordination #

FORM 6R
GEOLOGIC INFORMATION

This form must be fully and accurately completed. All required information must be typed or legibly printed in the spaces provided herein. Improperly completed forms may be rejected by the Department, may be considered to be violations of the Department's Rules and Regulations, and may result in assessment of fines and penalties.

DER USE ONLY

Application or Facility ID# ____________
(Assigned by DER)

Stamp Date Application Received

WASTE MANAGEMENT
COUNTY:
SEP 10 1997
CODE:

SECTION A. APPLICANT IDENTIFIER

Applicant Name: Pennsylvania Power & Light Company

SECTION B. PROJECT LOCATION

Facility Name: Martins Creek SES Ash Basin No. 4

County: Northampton

Municipality: Lower Mount Bethel

Instructions: All plans, cross-sections, and maps submitted to complement the descriptions required from the applicant in this portion of the application shall be on a scale of one inch equals no more than 200 feet on the base map so that all maps and cross-sections may be readily compared. The application shall contain a comprehensive narrative-type description of the geology in the proposed permit area and adjacent areas. Information (excepting maps and cross-sections) must be submitted on attached 8 1/2 x 11 inch sheets.

SECTION C. STRATIGRAPHY/LITHOLOGY See Attached Narrative

The narrative description should include information with regard to glacial, colluvial, alluvial, and lacustrine deposition including the range in thickness. Rock unit groups and formations should also be identified and development of any saprolite should be noted. The narrative description must be correlated with and be complementary to the base map, one copy of which must include geologic details.

1. Correlation of all strata (a minimum of two cross-sections or fence diagrams) including lithology, stratigraphy, existing ground surface, and all aquifers to be encountered or affected is required. Horizontal scale should be the same as the base map.

2. Geologic logs of all boreholes and core borings should use the format on page 3 of this form. Log description should include the actual surveyed surface elevation, bottom elevation, elevation of static ground water level, the date measured, and method of water level measurement. The lithologic description and thickness of each strata encountered must be detailed. The comments column should address moisture conditions, fractures, etc. PP&L requests a waiver for the requirement to use their forms. Boring logs were prepared years ago, not on DEP forms.
   A minimum of three boreholes is required, at least one of which shall be a core boring. Boring logs are attached for 6 monitoring wells. Dwg. E-209426 shows test boring logs. (Also Attached)

3. For any boring or coring not cased and capped or not to be used for ground water monitoring, plans for grouting or otherwise sealing the borehole must be submitted for Department approval.

SECTION D. STRUCTURE See Attached Narrative

Applicants must submit a 1 inch equals 200 feet geologic map with an adequate number of me[illegible]ments to fully characterize the structural features of the proposed permit area. The locations of all bedding planes, jointing, cleava[illegible] [illegible]ault measurements must be shown on the map. All data should be based upon field measurements. The narrative must discuss the [illegible]ing:

1. Geologic structure within the proposed permit area in relation to regional geolo[illegible] [illegible]ucture.

2. Folding, fractures, joints, faults, bedding planes, and their control on the mo[illegible]nt of ground water (spacing, width, filling, openness, etc.).

3. Local structure in detail (using cross-sections to enhance the description):

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SECTION D. (Continued)

4. Folding as it applies to the site; using cross-sections (above) which should include a profile of the fold axis: or axes (if any): ____________

Strike of the fold axis or axes: ____________

Plunge of axis or axes: ____________

Location of the proposed site in relation to the local structure: ____________

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Borehole Number: ____

Surface Elevation (Ft/MSL): ____ (ft)

`orehole Diameter: ___ inches, From ___ To ___

___ inches, From ___ To ___

Total Depth: ____ (ft)

Depth to Static Ground Water Level (SWL): ____ (ft)

Date SWL Measured: ____ (mm/dd/yy)

Drilling Method: ____

Date Drilled: ____ (mm/dd/yy)

Drilled By: ____

Drillers License Number: ____

Logged By: ____

County: ____

Township or Municipality: ____

Depth (Ft)	Lithologic Description	Plot	Ground Water* Observations	Samples No.	Samples Rec** / Att	Comments	Well/Piezometer Construction	Depth (Ft)

* ▽ Encountered Ground Water ▼ Composite Static Water Level ** Recovered/Attempted

Use additional sheets with this format as necessary

Recycled Paper

MARTINS CREEK SES
ASH BASIN NO. 4
FORM 6R
GEOLOGIC INFORMATION

NARRATIVE

1. SOILS

The Soil Survey of Northampton County, Pennsylvania, identifies soils in the vicinity of Ash Basin No. 4 as those of the Conotton-Red Hook-Urban land association. This soil association typically occurs in nearly level to moderately steep elongate bands along streams and the Lehigh and Delaware Rivers in Northampton County. These deep, well-drained to somewhat poorly drained soils develop from underlying sand and gravel on terminal moraines, kames, eskers, out-wash terraces, and flood plains.

The Basin is surrounded entirely by Conotton soils. Any soil on the Basin site was excavated for Basin dike construction. The Conotton series is described as nearly level to very steep, deep, well-drained fine gravelly silt loam, gravelly loam, and very gravelly loam soils typically occurring on gravelly out-wash terraces, in valley fill and kames, and on terminal moraines. These rapidly permeable soils develop in stratified glacial drift containing many kinds of parent material. The average silt and clay content in the subsoils of the Conotton range from 17 percent to 25 percent, with average clay content in the range of 3 percent to 13 percent.

2. GEOLOGIC SETTING

2.1 Regional Geology

The Martins Creek SES and Ash Basin No. 4 are located within the Great Valley Section of the Valley and Ridge Physiographic Province. The Great Valley is characterized by folded and faulted Paleozoic sedimentary rocks, predominantly shale and sandstone in the northern half, and limestone and dolomite in the southern half. These rocks range in age from Cambrian to Ordovician (570 million to 438 million years). The Great Valley is characterized by a broad, moderately dissected, undulating surface with low to moderate relief. Karstic terrain is prominent in the southern half of the region, as evidenced by the presence of sinkholes. The topography has been formed by the processes of fluvial erosion, some periglacial mass wasting, glacial erosion and deposition in the north and east, and the dissolution of carbonate rocks.

Glacial activity of Wisconsinan and Illinoian age (28,000-75,000 and 350,000-550,000 years, respectively) has partially remolded the topography through erosion, and the deposition of unconsolidated deposits in the extreme northeast portion of the Great Valley. Glacial advances from the north, and subsequent retreats, have deposited till on the uplands and out-wash deposits along valley floors.

2.2 Site Geology

The Ash Basin No. 4 site is predominantly underlain by Jacksonburg limestone with a delineation just northwest between the cement limestone and cement rock facies.

Cement Limestone Facies[1]

The cement limestone facies is composed of medium- to dark-gray, bedded limestone which throughout the area mapped maintains a thickness of 275 feet to 375 feet. A basal conglomerate occurs in New Jersey and in the eastern part of Northampton County. West of this the lower contact is placed at the top of the uppermost dolomite bed.

In fresh exposures, the cement limestone is thickly bedded (beds up to 5 feet thick) and bedding planes are easily recognized. The rock is compact, ranges in color from medium gray to black, and fractures into angular blocks. Hand specimens of fractured rock almost invariably sparkle in direct light due to reflections from the cleavage surfaces of the larger calcite grains (up to 2 millimeters in diameter).

Many of the thick beds contain thin argillaceous layers spaced several inches to 1 foot apart, which are visible only in weathered exposures. Differential weathering of the argillaceous layers and the relatively pure limestone causes the more resistant limestone layers to project from the weathered surface, imparting a ribbed appearance to the rock. Further weathering causes disintegration of the argillaceous layers, leaving limestone slabs. Fossils stand out in relief on the slab surfaces. These weathered slabs occur at Alpha quarry No. 3 at Martins Creek where the best preserved Jacksonburg fossils in Pennsylvania have been collected.

The limestones of the cement limestone facies are calcarenites with allochemical grains ranging from .1 millimeter to 2 millimeters. Allochemical constituents are about equally divided between intraclasts and comminuted fossils. Cloudy carbonate particles devoid of diagnostic internal structure comprise the intraclast fraction.

Fragments of bryozoa make up most of the recognizable fraction of the comminuted fossils. The orthochemical constituent is sparry calcite cement. The texture in all thin sections studied is cataclastic. Rotation, crushing, and recrystallization have obliterated the original sedimentary features.

[1] Ref. Structure of the Jacksonburg formation in Northampton and Lehigh Counties, Pennsylvania - PA General Geology Report G45, 1964.

The total carbonate fraction of the cement limestone facies varies between 70 percent and 90 percent. X-ray and thin section analyses show dolomite to be present in minor amounts. According to Ray and Gault (1961), the non-carbonate minerals in the Jacksonburg include quartz, feldspar, pyrite, non-graphitic carbon, illite, muscovite, chlorite and montmorillonite.

Cement Rock Facies

As previously stated, the cement rock facies in the area studied can be subdivided into a thick argillaceous limestone unit with two mappable crystalline limestone units occurring within the argillaceous limestone sequences. These crystalline units are thickest near the Delaware River.

The best exposed section of the cement rock facies in the area of study is located at Mud Run, 2 miles southeast of Martins Creek. This section traverses the Jacksonburg nearly at right angles to the strike and includes exposures in the quarries of the Lehigh Portland Cement Company as well as exposures along the stream banks and road cuts at Black Hill. The entire cement rock facies is estimated to be 830 feet thick in this section. The cement limestone-cement rock contact, as is characteristic throughout the area, is conformable and gradational.

Epler Formation

The Epler Formation occurs beneath the southeastern one-third of Ash Basin No. 4. The Epler is described as an interbedded, very fine grained to cryptogranular, light- to medium-gray limestone and fine- to medium-grained, light- to dark-medium-gray dolomite. Nodular and bedded chert, and beds and lenses of orthoquartzite are observed within this Formation. The Epler has a total thickness of approximately 650 to 800 feet in this area (Drake, Epstein, and Aaron, 1969). The Epler Formation lies conformably above the Rickenbach Formation to the south and east, with the contact described as gradational from the predominantly limestone of the Epler to the dolomite of the Rickenbach (Hobson, 1963). Limestone in the lower part of the Epler is cryptogranular with large amounts of dolomite mottling, especially at the limestone-dolomite contacts. In the upper portions of the Formation, the limestone is characterized by large amounts of calcarenite intermixed with limestone pebbles and invertebrate remains. The dolomite is mostly microcrystalline to finely megacrystalline, and is common throughout the formation, occurring primarily as mottling and beds. The bedded dolomite is especially common in the lower one-half of the formation and near the contacts with adjacent formations (Hobson, 1963). Bedding is generally moderately well to well developed, and thin to flaggy. Fractures in the Epler Formation consist primarily of well to poorly developed, moderately spaced, moderately abundant, open and steeply-dipping to vertical joints (Geyer and Wilshusen, 1982). Well-developed cleavage has been identified in the area of Martins Creek, and measured to have a dip of approximately 45° (Weston Geophysical, 1987). Joints, fractures, bedding, cleavage, and solutionally-enlarged channels provide the Epler Formation with a secondary porosity of low to moderate magnitude, and low permeability (Geyer and Wilshusen, 1982).

Drawing D-242664, sheet 2 shows the geologic lithology beneath the Basin. Drawing E-209426 shows the location and logs of the Basin No. 4 test borings. Drawing E-208109 shows the extent of the geophysical study done at the site.

ADS1.ol(G:misc)

Monitoring Well Installation Data Sheet

Site: Martins Creek SES
Facility: Ash Basin No. 4
Number: 4-1
PP&L Supervisor: Craig S. Shamory

Drilling Company: Bellview Pump (215)767-8483
Driller(s): Dave Kyper

Drilling Log

Date: 6/18/88 8"-bit, 6/22/88 6"-bit, 6/23/88 8"-bit (78' to 125')

Interval (ft)	Strata Characteristics	Comments
0 : 2	Dark brown topsoil	Damp
2 : 15	Brown gravel, cobbles, sand & clay	Damp/moist
15 : 27	Brown gravel, cobbles, sand & silt	Damp, slow drilling
27 : 42	Grey gravel, cobbles, sand & silt	Dusting
42 : 50	Grey cobbles (l.s.), gravel, & silt	Dusting
50 : 78	Cobbles, gravel, broken l.s. & silt	No cuttings
78 : 85	Same	Water @ 78'
85 : 92	Fairly competent l.s.	Water/mud returns
92 : 117	Broken l.s. w/ silt and gravel	Water/mud returns
117 : 118	Fairly competent l.s.	Water/mud returns
118 : 125	Broken l.s. w/ silt and gravel	Water/mud returns

Notes:
6/18/88 Drilled to 42' w/ 8"-bit. Chain broke on rig; shut down for repairs.
6/24/88 Water @ 62 ft., open to 67 ft. Set 6" steel casing to 100 ft.
6/27/88 Set 4" PVC screen w/ filter wrap & casing through 6" steel casing. PVC casing broke off when pulling up 6" steel casing. 8' of screen lost. Steel casing had hole drilled through side, and PVC was set through that hole.
6/28/88 Pulled 6" steel casing and opened hole w/ 10 5/8"-bit. Started setting 8" steel casing.
6/29/88 Finished setting steel casing to 82 ft. Hole open to 88 ft, and water @ 64 ft. Will set 4" PVC sreen w/ filter wrap and casing.

Monitoring Well Installation Data Sheet

Page 2

Site: Martins Creek
Facility: Ash Basin No. 4
Number: 4-1
PP&L Supervisor: Craig S. Shamory

Drilling Company: Bellview Pump
(215)767-8483
Driller(s): Dave Kyper

Completion Details

Date: 6/29/88

```
 1.5 ft. _____          ____________Stick-up Height
               |*******|------------Locking Well Cap
               | |---|<-|------------Slip-on PVC Top Cap
           ___| |   | |____ <-------Cement Well Pad
 0.0 ft.__/__|| |   | ||___\_______Ground Surface
             || |   | ||
             || |   | ||-----------6-Inch I.D. Protective Steel Casing
             || |   | ||           (10 feet Long)
             || |   | ||
 8.0 ft.____ |__|   |__|___________Start of Cement Grout to Surface
             |  |   | <-|----------Backfill with Drill Cuttings
             |  |   |  |
             |  |   |<--|----------4-Inch I.D. PVC FJT Schedule 40 Casing
             |  |   |  |
             |  |   |  |
40.0 ft.____ |__|   |__|___________Top of Bentonite Seal ( 2  buckets)
             |**|   |**|
             |**|   |**|
             |**|   |**|
50.0 ft.____ |__|   |__|___________Top of Sand Pack ( 18 bags & natural pack)
55.0 ft.____ |__|___|__|___________Top of Screen
             |  |---|  |
             |  |---|  |
             |  |---|  |
             |  |---|  |
             |  |---|<-|-----------4-Inch I.D. 0.02" Slot Size PVC FJT
             |  |---|  |           Schedule 40 Screen
             |  |---|  |           with 35 micron filter sock
             |  |---|  |
             |  |---|  |
             |  |---|  |
             |  |---|  |
             |  |---|  |
86.0 ft.____ |  |***|<-|-----------Screw-on PVC Bottom Cap
88.0 ft.____ |         |___________Total 8-Inch Borehole Depth
             ..........
```

Monitoring Well Installation Data Sheet

Site: Martins Creek SES
Facility: Ash Basin No. 4
Number: 4-2
PP&L Supervisor: Craig S. Shamory

Drilling Company: Bellview Pump
(215)767-8483
Driller(s): Dave Kyper

Drilling Log

Date: 6/02/88 @ 1330

Interval (ft)	Strata Characteristics	Comments
0 - 1	Dark brown topsoil	Moist
1 - 2	Clayish subsoil w/ brown gravel	Moist
2 - 12	Brown clayish sand w/ gravel & cobbles	Damp
12 - 30	Brown sand w/ gravel & cobbles	Dry/dusting
30 - 43	Brown sand w/ gravel & cobbles	Dry/dusting
43 - 47	Grey l.s. layer or boulder?	Dry/dusting
47 - 55	Broken l.s. w/ clayish sand & gravel	Damp
55 - 70	Broken l.s. w/ clayish sand & gravel	Moist
70 - 72	Fairly competent l.s.	Moist
72 - 80	Broken l.s. w/ clayish sand & gravel	Damp
80 - 90	Fairly competent l.s.	Dusting
90 - 100	Slightly broken l.s.	Water @ 92 ft.
100 - 124	Slightly broken l.s.	Flowing @ 10gpm

Notes:
6/02/88 Limestone not as fractured/broken as in first hole 4-2. Water @ 78', and open hole to 116 ft.

Monitoring Well Installation Data Sheet

Page 2

Site: Martins Creek
Facility: Ash Basin No. 4
Number: 4-2
PP&L Supervisor: Craig S. Shamory

Drilling Company: Bellview Pump
(215)767-8483
Driller(s): Dave Kyper

Completion Details

Date: 6/02/88 @ 1645

```
  1.3 ft. _____           ____________Stick-up Height
                |=======|------------Locking Well Cap
                | |---|<|------------Slip-on PVC Top Cap
             ___| |   | |____ <------Cement Well Pad
  0.0 ft.__/__|| |   | ||___\_______Ground Surface
              || |   | ||
              || |   | ||------------6-Inch I.D. Protective Steel Casing
              || |   | ||            (10 feet long)
              || |   | ||
  8.0 ft.____ |__|   |__|____________Start of Cement Grout to Surface
              |  |   | <|------------Backfill with Drill Cuttings
              |  |   |  |
              |  |   |<-|-----------4-Inch I.D. PVC FJT Schedule 40 Casing
              |  |   |  |
              |  |   |  |
 68.0 ft.____ |__|   |__|____________Top of Bentonite Seal ( 2 buckets)
              |**|   |**|
              |**|   |**|
              |**|   |**|
 73.0 ft.____ |__|   |__|____________Top of Sand Pack ( 10 bags)
 75.0 ft.____ |__|___|__|____________Top of Screen
              |  |---|  |
              |  |---|  |
              |  |---|  |
              |  |---|  |
              |  |---|<-|------------4-Inch I.D. 0.02" Slot Size PVC FJT
              |  |---|  |            Schedule 40 Screen
              |  |---|  |
              |  |---|  |
              |  |---|  |
              |  |---|  |
              |  |---|  |
              |  |---|  |
115.0 ft.____ |  |===|<-|------------Screw-on PVC Bottom Cap
116.0 ft.____ |         |____________Total 8-Inch Borehole Depth
              -----------
```

Monitoring Well Installation Data Sheet

Site: Martins Creek SES
Facility: Ash Basin No. 4
Number: 4-3
PP&L Supervisor: Craig S. Shamory

Drilling Company: Bellview Pump
(215)767-8483
Driller(s): Dave Kyper

Drilling Log

Date: 5/26/88 @ 1100

Interval (ft)	Strata Characteristics	Comments
0 - 1	Dark brown topsoil	Moist
1 - 5	Clayish subsoil w/ red/brown gravel	Wet
5 - 20	Brown clayish sand w/ gravel & cobbles	Moist
20 - 50	Brown sand w/ gravel & cobbles	Moist slow drilling
50 - 67	Brown sand w/ gravel & cobbles	Moist slow drilling
67 - 68	Grey l.s. layer or boulder?	Moist
68 - 74	Brown clay, silt, cobbles & gravel	Damp
74 - 80	Broken l.s.	Dry
80 - 81	Clay layer	Moist
81 - 92	More Competent l.s.	Dry
92 - 105	Fairly competent l.s.	Dusting
105 - 130	Slightly broken l.s.	No cuttings
130 - 150	Slightly broken l.s.	No cuttings

Notes:
5/26/88 Water @ 83 ft.; set PVC casing the next day.
5/27/88 Hole open to 105 ft.; water @ 79 ft.

Monitoring Well Installation Data Sheet

Page 2

Site: Martins Creek
Facility: Ash Basin No. 4
Number: 4-3
PP&L Supervisor: Craig S. Shamory

Drilling Company: Bellview Pump
(215)767-8483
Driller(s): Dave Kyper

Completion Details

Date: 5/27/88 @ 0830

```
  1.3 ft. _____            ____________Stick-up Height
              |=======|------------Locking Well Cap
              | |---|<|------------Slip-on PVC Top Cap
           ___| |   | |____ <------Cement Well Pad
  0.0 ft.__/__|| |   | ||___\_______Ground Surface
             || |   | ||
             || |   | ||-----------6-Inch I.D. Protective Steel Casing
             || |   | ||            (10 feet long)
             || |   | ||
  8.0 ft.____ |__|   |__|___________Start of Cement Grout to Surface
             |  |   | <|-----------Backfill with Drill Cuttings
             |  |   |  |
             |  |   |<-|-----------4-Inch I.D. PVC FJT Schedule 40 Casing
             |  |   |  |
             |  |   |  |
 64.0 ft.____ |__|   |__|___________Top of Bentonite Seal ( 3 buckets)
             |**|   |**|
             |**|   |**|
             |**|   |**|
 69.0 ft.____ |__|   |__|___________Top of Sand Pack ( 16 bags)
 73.8 ft.____ |__|___|__|___________Top of Screen
             |  |---|  |
             |  |---|  |
             |  |---|  |
             |  |---|  |
             |  |---|<-|-----------4-Inch I.D. 0.02" Slot Size PVC FJT
             |  |---|  |            Schedule 40 Screen
             |  |---|  |
             |  |---|  |
             |  |---|  |
             |  |---|  |
             |  |---|  |
             |  |---|  |
103.0 ft.____ |  |===|<-|-----------Screw-on PVC Bottom Cap
105.0 ft.____ |        |___________Total 8-Inch Borehole Depth
              ..........
```

Monitoring Well Installation Data Sheet

Site: Martins Creek SES
Facility: Ash Basin No. 6
Number: 4-4
PP&L Supervisor: Craig S. Shamory

Drilling Company: Bellview Pump
(215)767-8483
Driller(s): Dave Kyper

Drilling Log

Date: 6/03/88 @ 0915

Interval (ft)	Strata Characteristics	Comments
0 - 1	Dark brown topsoil	Moist
1 - 4	Orange brown clayish subsoil	Wet
4 - 18	Orange brown clay w/ sand & gravel	Moist
18 - 27	Brown clayey sand/ gravel & cobbles	Wet
27 - 32	Cobbles & Boulders (l.s. & quartzite)	Dry
32 - 38	Grey l.s. layer or boulder?	Dry/dusting
38 - 42	Void/Cave	Lost Circulation
42 - 52	Broken l.s.	No cuttings
52 - 80	Broken l.s.	No cuttings
80 - 92	Broken l.s.	No cuttings
92 - 95	Void filled with clay	No cutting
95 - 100	Broken l.s.	No cuttings
100 - 125	Slightly broken l.s.	Few cuttings
125 - 130	Fairly competent l.s.	Water returns
130 - 140	Fairly competent l.s.	Flowing @ 8 gpm

Notes:

6/03/88 Water @ 93 ft.; hole open to 109 ft. Overdrill w/ 12"-bit to set 8" steel casing to get hole open to 125 ft.

6/06/88 Finished overdrilling w/ 12"-bit and set 8" steel casing to 110 ft.

6/07/88 Drill out to 125 ft. and drove casing to 120 ft. Hole open to 124'; water at 92 ft.

Monitoring Well Installation Data Sheet

Page 2

Site: Martins Creek
Facility: Ash Basin No. 4
Number: 4-4
PP&L Supervisor: Craig S. Shamory (6/8,9)
David A. Stoner (6/10)

Drilling Company: Bellview Pump
(215)767-8483
Driller(s): Dave Kyper

Completion Details

Date: 6/08/88 @ 0800 Ran out of sand at void (90 bags used to 88 ft.)
6/09/88 Finished sandpack and bentonite seal. Backfilled to 58 ft.;
ran out of cuttings. 6/10/88 Finished backfilling and completed well.

```
  1.4 ft. _____           ____________Stick-up Height
               |*******|------------Locking Well Cap
               |  |--+|<|------------Slip-on PVC Top Cap
            ___|  |   | |____ <-------Cement Well Pad
  0.0 ft.__/__||  |   | ||___\_______Ground Surface
             ||  |   | ||
             ||  |   | ||------------6-Inch I.D. Protective Steel Casing
             ||  |   | ||             (10 feet long)
             ||  |   | ||
  8.0 ft.____ |__|   |__|___________Start of Cement Grout to Surface
              |  |   | <|-----------Backfill with Drill Cuttings
              |  |   |  |
              |  |   |<-|-----------4-Inch I.D. PVC FJT Schedule 40 Casing
              |  |   |  |
              |  |   |  |
 82.0 ft.____ |__|   |__|___________Top of Bentonite Seal ( 3 buckets)
              |**|   |**|
              |**|   |**|
              |**|   |**|
 84.0 ft.____ |__|   |__|___________Top of Sand Pack ( 96 bags)
 86.0 ft.____ |__|___|__|___________Top of Screen
              |  |---|  |
              |  |---|  |
              |  |---|  |
              |  |---|  |
              |  |---|<-|-----------4-Inch I.D. 0.02" Slot Size PVC FJT
              |  |---|  |            Schedule 40 Screen
              |  |---|  |
              |  |---|  |
              |  |---|  |
              |  |---|  |
              |  |---|  |
              |  |---|  |
126.0 ft.____ |  |***|<-|-----------Screw-on PVC Bottom Cap
127.0 ft.____ |         |___________Total 8-Inch Borehole Depth
              ...........
```

Monitoring Well Installation Data Sheet

Site: Martins Creek SES
Facility: Ash Basin No. 4
Number: 4-5
PP&L Supervisor: Craig S. Shamory

Drilling Company: Bellview Pump
(215)767-8483
Driller(s): Dave Kyper

Drilling Log

Date: 6/08/88 @ 1340 to 77 ft.
6/09/88 @ 1300 completed drilling

Interval (ft)	Strata Characteristics	Comments
0 - 1	Dark brown topsoil	Moist
1 - 2	Orange brown clayish subsoil	Moist
2 - 17	Orange brown clay w/ sand & gravel	Damp
17 - 21	Broken l.s. w/ clay, sand & gravel	Dry & Dusting
21 - 30	Slightly broken l.s.	Dry & Dusting
31 - 65	Grey l.s. fairly competent	Dry/dusting
65 - 66	Very broken l.s. w/ clayey sand	Damp, not dusting
66 - 71	Grey l.s. fairly competent	Damp
71 - 73	Very broken l.s. w/ clayey sand	Damp
73 - 77	Grey l.s. fairly competent	Damp
77 - 83	Grey l.s. fairly competent	Damp
83 - 95	Very broken l.s. w/ clayey sand	Damp
95 - 96	Grey l.s. fairly competent	Damp
96 - 101	Very broken l.s. w/ clayey sand	Water @ 100 ft.
101 - 105	Fairly competent l.s.	No returns
105 - 120	Broken l.s.	Water returns @ 110'
120 - 126	Fairly competent l.s.	Water returns @ 110'
126 - 128	Broken l.s.	Water returns @ 110'
128 - 145	Fairly competent l.s.	No returns

Notes:
6/03/88 Quit drilling early since out of sand to complete hole.
6/06/88 by 1630 hole open to 128 ft.; water @ 99 ft. Large cobble logged in hole had to clean out again to 129 ft. by 1800.

Monitoring Well Installation Data Sheet

Page 2

Site: Martins Creek
Facility: Ash Basin No. 4
Number: 4-5
PP&L Supervisor: Craig S. Shamory (6/9)
David A. Stoner (6/10)

Drilling Company: Bellview Pump
(215)767-8483
Driller(s): Dave Kyper

Completion Details

Date: 6/09/88 @ 1930 Ran out of sand (31 bags used to 110 ft.)
6/10/88 Finished sandpack and rest of completion.

```
  1.4 ft. _____          ____________Stick-up Height
               |=======|------------Locking Well Cap
               | |---|<|------------Slip-on PVC Top Cap
           ___| |   | |____ <------Cement Well Pad
 0.0 ft.__/__|| |   | ||___\_______Ground Surface
             || |   | ||
             || |   | ||-----------6-Inch I.D. Protective Steel Casing
             || |   | ||           (10 feet long)
             || |   | ||
 8.0 ft.____ |__|   |__|___________Start of Cement Grout to Surface
             |  |   | <|-----------Backfill with Drill Cuttings
             |  |   |  |
             |  |   |<-|-----------4-Inch I.D. PVC FJT Schedule 40 Casing
             |  |   |  |
             |  |   |  |
88.0 ft.____ |__|   |__|___________Top of Bentonite Seal ( 3 buckets)
             |**|   |**|
             |**|   |**|
             |**|   |**|
91.0 ft.____ |__|   |__|___________Top of Sand Pack ( 41 bags)
97.0 ft.____ |__|___|__|___________Top of Screen
             |  |---|  |
             |  |---|  |
             |  |---|  |
             |  |---|  |
             |  |---|<-|-----------4-Inch I.D. 0.02" Slot Size PVC FJT
             |  |---|  |           Schedule 40 Screen
             |  |---|  |
             |  |---|  |
             |  |---|  |
             |  |---|  |
             |  |---|  |
             |  |---|  |
127.0 ft.____ |  |***|<-|-----------Screw-on PVC Bottom Cap
129.0 ft.____ |        |___________Total 8-inch Borehole Depth
             ...........
```

Monitoring Well Installation Data Sheet

Site: Martins Creek SES
Facility: Ash Basin No. 4
Number: 4-6
PP&L Supervisor: David A. Stoner (6/10)
Craig S. Shamory (6/14)

Drilling Company: Bellview Pump
(215)767-8483
Driller(s): Dave Kyper

Drilling Log

Date: 6/08/88 @ 1520 to 77 ft.
6/09/88 @ 0825 completed drilling 71' to 145'

Interval (ft)	Strata Characteristics	Comments
0 - 2	Dark brown topsoil	Damp
2 - 4	Brown silty, clayey subsoil	Damp
4 - 15	Sand, silt, gravel & cobbles (l.s.)	Damp
15 - 17	Sand, silt, gravel & cobbles (l.s.)	Dry
17 - 20	Weathered l.s. w/ gravel & cobbles	Dry
20 - 30	Sand, gravel & cobbles (l.s.)	Damp
30 - 42	Weathered l.s. w/ sand & cobbles	Dry
42 - 48	Weathered l.s.	Dry
48 - 55	Weathered l.s. w/ sand & gravel	Dry
55 - 77	Sand, silt, gravel & cobbles (l.s.)	Damp
71 - 80	Sand, silt, gravel & cobbles (l.s.)	Damp
80 - 100	Fairly competent l.s.	Dry
100 - 126	Very broken l.s.	Water @ 106 ft.
126 - 128	Very broken l.s./ clay zone ?	No returns
128 - 145	Fairly competent l.s.	No returns

Notes:
6/10/88 Quit drilling early to not encounter water zone until after weekend.
6/06/88 Hole filled in 6 ft. over weekend. Completed drilling by 1030. Hole open to 132 ft., and water at 98 ft.

Monitoring Well Installation Data Sheet

Page 2

Site: Martins Creek
Facility: Ash Basin No. 4
Number: 4-6
PP&L Supervisor: Craig S. Shamory

Drilling Company: Bellview Pump
(215)757-8483
Driller(s): Dave Kyper

Completion Details

Date: 6/14/88 @ 1045

```
  1.4 ft. _____            ____________Stick-up Height
               |=======|------------Locking Well Cap
               | |---|<-|------------Slip-on PVC Top Cap
            ___| |   | |____ <------Cement Well Pad
  0.0 ft.__/__|| |   | ||___\_______Ground Surface
              || |   | ||
              || |   | ||-----------6-Inch I.D. Protective Steel Casing
              || |   | ||           (10 feet long)
              || |   | ||
  8.0 ft.____ |__|   |__|___________Start of Cement Grout to Surface
              |  |   | <|-----------Backfill with Drill Cuttings
              |  |   |  |
              |  |   |<-|----------4-Inch I.D. PVC FJT Schedule 40 Casing
              |  |   |  |
              |  |   |  |
 80.0 ft.____ |__|   |__|___________Top of Bentonite Seal ( 2 buckets)
              |**|   |**|
              |**|   |**|
              |**|   |**|
 85.0 ft.____ |__|   |__|___________Top of Sand Pack ( 27.5 bags)
 90.0 ft.____ |__|___|__|___________Top of Screen
              |  |---|  |
              |  |---|  |
              |  |---|  |
              |  |---|  |
              |  |---|<-|-----------4-Inch I.D. 0.02" Slot Size PVC FJT
              |  |---|  |           Schedule 40 Screen
              |  |---|  |
              |  |---|  |
              |  |---|  |
              |  |---|  |
              |  |---|  |
130.0 ft.____ |  |===|<-|-----------Screw-on PVC Bottom Cap
132.0 ft.____ |         |___________Total 8-Inch Borehole Depth
              ...........
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Test Boring Report

Weather ______

Date 3/25/87 PA Power & Light Co. Sheet 1 of 2

Boring Location Martins Creek, Ash Basin 4, ER 103080 STA. 38+79N - 44+20W

Project No.	J-1975
Boring No.	TB-1
Ftg. Soil	75.0'
Ftg. Rock	5.0'
Driller B.Bender	

Spoon O.D. 3"		
Hammer	300#	Fall 18
Casing Dia. 4"		
Hammer	300#	Fall 18
Core Size NX		Bit No.

Ground Elev.	321.2
Depth Ground Water	
Elev. Ground Water	
Depth Sound Rock	
Elev. Sound Rock	

Elev.	Depth	Blows Casing	Blows Spoon	Sample / Run No.	Rock Rec.	Rock Lost	Description of Materials & Remarks
	0-1		2-3	S-1			0.0' to 1.0' TOPSOIL
	1-2		3	0.0'-1.5'			1.0' to 4.5' Light & Dark Brown Silty CLAY with
	2-3						SHALE Fragments, Trace of GRAVEL-Medium Stiff
	3-4		4-7	S-2			
	4-5		6	3.0'-4.5'			4.5' to 11.0' Light & Dark Brown Silty SAND with
	5-6						Trace of SHALE Fragments & River GRAVEL, COBBLES-
	6-7		7-9	S-3			Medium Dense
	7-8		11	6.0'-7.5'			
	8-9						
	9-10		11-10	S-4			
	10-11		8	9.0'-10.5'			
	11-12						11.0' to 39.0' Cored thru SANDSTONE Boulders &
	12-13		50/.0	S-5 (No Recovery)			River COBBLES, Large & Small GRAVEL, Very Compact
	13-14			12.0'			
	14-15						NOTE: No Recovery on spoon 12.0' to 39.0'
	15-16		50/.0	S-6 (No Recovery)			
	16-17			15.0'			
	17-18						
	18-19		50/.0	S-7 (No Recovery)			
	19-20			18.0'			
	20-21						
	21-22		50/.0	S-8 (No Recovery)			
	22-23			21.0'			
	23-24						
	24-25		50/.0	S-9 (No Recovery)			
	25-26			24.0'			
	26-27						
	27-28		50/.0	S-10 (No Recovery)			
	28-29			27.0'			
	29-30						
	30-31		50/.0	S-11 (No Recovery)			
	31-32			30.0'			
	32-33						
	33-34		50/.0	S-12 (No Recovery)			
	34-35			33.0'			
	35-36						
	36-37		50/.0	S-13 (No Recovery)			
	37-38			36.0'			
	38-39						
	39-40		16-19	S-14			39.0' to 45.0' Light & Dark Brown Silty CLAY
	40-41		17	39.0'-40.5'			with Trace of GRAVEL & River COBBLES, Weathered
	41-42						DOLOMITE-Medium Stiff
	42-43		12-15	S-15			
	43-44		16	42.0'-43.5'			
	44-45						

BORINGS, SOILS AND TESTING COMPANY

TEST BORING REPORT

Weather ____

Date 3/26/87 PA Power & Light Co. Sheet 2 of ____

Boring Location Martins Creek, Ash Basin 4, ER 103080 STA. 38+79N - 44+20W

Project No.	J-1975
Boring No.	TB-1
Ftg. Soil	75.0'
Ftg. Rock	5.0'
Driller	B. Bender

Spoon O. D. 3"		
Hammer 300#	Fall 18"	
Casing Dia. 4"		
Hammer 300#	Fall 18"	
Core Size NX	Bit No.	

Ground Elev.	321.2
Depth Ground Water	
Elev. Ground Water	
Depth Sound Rock	
Elev. Sound Rock	

Elev.	Depth	Blows Casing	Blows Spoon	Sample or Run No.	Rock Recov'd	Rock Lost	Description of Materials & Remarks
	45-46		12-17	S-16			45.0' to 69.0' Light & Dark Brown Silty SAND with
	46-47		19	45.0'-46.5'			Layer of CLAY Seams, Trace of GRAVEL & River
	47-48						COBBLES-Medium Dense
	48-49		15-15	S-17			
	49-50		16	48.0'-49.5'			
	50-51						
	51-52		12-12	S-18			
	52-53		14	51.0'-52.5'			
	53-54						
	54-55		15-13	S-19			
	55-56		11	54.0'-55.5'			
	56-57						
	57-58		10-13	S-20			
	58-59		13	57.0'-58.5'			
	59-60						
	60-61		14-13	S-21			
	61-62		14	60.0'-61.5'			
	62-63						
	63-64		17-17	S-22			
	64-65		15	63.0'-64.5'			
	65-66						
	66-67		16-19	S-23			
	67-68		22	66.0'-67.5'			
	68-69						
	69-70		50/.0	S-24 (No Recovery)			69.0' to 75.0' Badly Weathered DOLOMITE with Sma
	70-71			69.0'			CLAY seams, Very Hard-Hard to take spoon sample.
	71-72						
	72-73		50/.0	S-25 (No Recovery)			REFUSAL at 75.0' Started to Core 75.0'
	73-74			72.0'			
	74-75						75.0' to 80.0' Gray DOLOMITE, Broken-Medium Hard
	75-76		50/.0	S-2? (No Recovery)			
	76-77			75.0'			
	77-78						
	78-79			Run-1	5.0"	0.0'	
	79-80			75.0'-80.0'			End of Boring 80.0'
	80-81			RQD=61%			
	81-82						GWL at Completion 70.0'
	82-83						Completed 3/30/87
	83-84						
	84-85						
	85-86						NOTES: Hole stopped, could not get back down
	86-87						past 72.0'
	87-88						1 Bag Sample (1.0'-11.0')
	88-89						

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Test Boring Report

Weather ______

Date 3/23/87 PA Power & Light Co. Sheet 1 of 2

Bori Location Martins Creek, Ash Basin 4, ER 103080 STA. 39+15N-42+37W

Project No.	J-1975
Boring No.	TB-2
Ftg. Soil	70.0'
Ftg. Rock	10.0'
Driller B.Bender	

Spoon O.D. 3"	
Hammer 300#	Fall 18
Casing Dia. 4"	
Hammer 300#	Fall 18
Core Size NX	Bit No.

Ground Elev.	318.1
Depth Ground Water	
Elev. Ground Water	
Depth Sound Rock	
Elev. Sound Rock	

Elev.	Depth	Blows Casing	Blows Spoon	Sample / Run No.	Rock Rec.	Rock Lost	Description of Materials & Remarks
	0-1		3-6	S-1			0.0' to 1.0' TOPSOIL
	1-2		6	0.0'-1.5'			1.0' to 21.5' Light & Dark Brown Silty CLAY with
	2-3						Trace of GRAVEL & ROCK Fragments-Medium Stiff
	3-4		9-11	S-2			
	4-5		10	3.0'-4.5'			
	5-6						
	6-7		12-13	S-3			
	7-8		11	6.0'-7.5'			
	8-9						
	9-10		14-19	S-4			
	10-11		13	9.0'-10.5'			
	11-12						
	12-13		19-21	S-5			
	13-14		23	12.0'-13.5'			
	14-15						
	15-16		26-21	S-6			
	16-17		21	15.0'-16.5'			
	17-18						
	18-19		27-32	S-7			
	19-20		36	18.0'-19.5'			
	20-21						
	21-22		31-26	S-8			21.5' to 26.0' Light & Dark Brown Fine & Coarse
	22-23		21	21.0'-22.5'			SAND with River GRAVEL & COBBLES-Medium Dense
	23-24						
	24-25		35-31	S-9			
	25-26		28	24.0'-25.5'			
	26-27						26.0' to 30.0' Light & Dark Brown Silty CLAY &
	27-28		14-14	S-10			SAND with Trace of GRAVEL
	28-29		12	27.0'-28.5'			
	29-30						
	30-31		14	S-11			30.0' to 30.5' Shelby Tube Sample
	31-32		12-12	30.5'-32.0'			30.5' to 70.0' Light & Dark Brown Silty SAND
	32-33						with Trace of CLAY & GRAVEL, Weathered ROCK
	33-34		10	S-12			Fragments-Medium Dense
	34-35		14-11	33.5'-[illegible].0'			
	35-36						
	36-37		10	S-13			
	37-38		11-15	36.5'-38.0'			
	38-39						
	39-40		11	S-14			
	40-41		11-10	39.5'-41.0'			
	41-42						
	42-43		12	S-15			
	43-44		16-15	42.5'-44.0'			
	44-45						

BORINGS, SOILS AND TESTING COMPANY

TEST BORING REPORT

Weather ____

Date 3/24/87 PA Power & Light Co. Sheet 2 of __

Boring Location Martins Creek Ash Basin 4, ER 103080 STA. 39+15N - 42+37W

Project No.	J-1975
Boring No.	TB-2
Ftg. Soil	70.0'
Ftg. Rock	10.0'
Driller	B. Bender

Spoon O. D.	3"		
Hammer	300#	Fall	18 "
Casing Dia.	4"		
Hammer	140#	Fall	18 "
Core Size	NX	Bit No.	

Ground Elev.	318.1
Depth Ground Water	
Elev. Ground Water	
Depth Sound Rock	
Elev. Sound Rock	

Elev.	Depth	Blows Casing	Blows Spoon	Sample or Run No.	Rock Recov'd	Rock Lost	Description of Materials & Remarks
	45-46		14	S-16			30.5'-70.0' Light & Dark Brown Silty SAND with
	46-47		14-13	45.5'-47.0'			Trace of CLAY & GRAVEL, Weathered ROCK Fragments
	47-48						Medium Dense
	48-49		13	S-17			
	49-50		11-11	48.5'-51.0'			
	50-51						
	51-52		10	S-18			
	52-53		9-11	51.5'-53.0'			
	53-54						
	54-55		12	S-19			
	55-56		12-14	54.5'-56.0'			
	56-57						
	57-58		13	S-20			
	58-59		13-13	57.5'-59.0'			
	59-60						
	60-61		15	S-21			
	61-62		15-18	61.5'-63.0'			
	62-63						
	63-64		17	S-22			
	64-65		17-18	64.5'-66.0'			
	65-66						
	66-67		15	S-23			
	67-68		17-16	67.5'-69.0'			
	68-69						REFUSAL at 70.0' Started to Core 70.0'
	69-70			Run-1	5.0'	0.0'	
	70-71			70.0'-75.0'			70.0' to 80.0' Light & Dark Gray DOLOMITE with
	71-72			RQD=85%			Some Weathered Seams, Badly Broken-Very Hard
	72-73						
	73-74			Run-2	5.0'	0.0'	
	74-75			75.0'-80.0'			
	75-76			RQD=91%			End of Boring 80.0'
	76-77						
	77-78						GWL at Completion 73.0'
	78-79						Completed 3/24/87
	79-80						
	80-81						24 Hour GWL 74.5'
	81-82						
	82-83						NOTES: Lost wash water at 49.0'
	83-84						Drilled in 70.0' NW Casing.
	84-85						Sink-hole 25.0' west of this boring.
	85-86						
	86-87						1 Bag Sample (1.0'-21.5')
	87-88						
	88-89						

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Test Boring Report

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Date 3/19/87 PA Power & Light Co. Sheet 1 of 1

Bor Location Martins Creek, Ash Basin 4, ER 103080 STA. 39+64 - 39+53W

Project No.	J-1975
Boring No.	TB-3
Ftg. Soil	40.0
Ftg. Rock	5.0
Driller B. Bender	

Spoon O.D. 3"	
Hammer 300 #	Fall 18
Casing Dia. 4"	
Hammer 300 #	Fall 18
Core Size NX	Bit No.

Ground Elev.	318.3
Depth Ground Water	
Elev. Ground Water	
Depth Sound Rock	
Elev. Sound Rock	

Elev.	Depth	Blows Casing	Blows Spoon	Sample / Run No.	Rock Rec.	Rock Lost	Description of Materials & Remarks
	0-1		3-4	S-1			0.0'-1.5' Dark Brown TOPSOIL
	1-2		7	0.0'-1.5'			1.5'-10.0' Light & Dark Brown Silty SAND w/SHALE
	2-3		6-8	S-2			Fragments & River COBBLES & GRAVEL - Medium Dens
	3-4		9	3.0'-4.5'			
	4-5						
	5-6		10-9	S-3			
	6-7		9	6.0'-7.5'			
	7-8						
	8-9		8-15	S-4			
	9-10		17	9.0'-10.5'			10.0'-15.0' Light & Dark Brown Silty SAND w/Trac
	10-11						of Fine & Medium Coarse River GRAVEL & COBBLES -
	11-12		10-13	S-5			Medium Dense
	12-13		13	12.0'-13.5'			
	13-14						
	14-15		12-12	S-6			15.0'-40.0' Light & Dark Brown Silty SAND & Laye
	15-16		13	15.0'-16.5'			of Silty CLAY w/River GRAVEL, COBBLES & DOLOMIT
	16-17						Fragments - Medium Dense
	17-18		14-14	S-7			
	18-19		12	18.0'-19.5'			
	19-20						
	20-21		17-17	S-8			
	21-22		16	21.0'-22.5'			
	22-23						
	23-24		15-11	S-9			
	24-25		18	24.0'-25.5'			
	25-26						
	26-27		16-16	S-10			
	27-28		19	27.0'-28.5'			
	28-29						
	29-30		26-32	S-11			
	30-31		31	30.0'-31.5'			
	31-32						
	32-33		26-29	S-12			
	33-34		29	33.0'-34.5'			
	34-35						REFUSAL at 40.0' Started to Core 40.0'
	35-36		31-30	S-13			40.0'-45.0' Light & Dark Gray DOLOMITE w/Weather
	36-37		25	36.0'-37.5'			Seams & Small CLAY Seams - Very Hard
	37-38						
	38-39		15-60	S-14			End of Boring 45.0'
	39-40			39.0'-40.0'			
	40-41			Run-1	5.0'	0.0'	GWL at Completion 36.5'
	41-42			40.0'-45.0'			Completed 3/19/87
	42-43			RQD= 81%			24 Hour GWL Dry
	43-44						Note: Lost Wash Water at 40.0'
	44-45						1 Bag Sample (1.5'-30.0')

G.W.L. Depth Time Date Inspector

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Test Boring Report

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Date 3/18/87 PA Power & Light Co. Sheet 1 of 1

Bori Location Martins Creek, Ash Basin 4, ER 103080 STA. 40+15N - 36+70W

Project No.	J-1975
Boring No.	TB-4
Ftg. Soil	34.0
Ftg. Rock	10.0
Driller B. Bender	

Spoon O.D. 3"			
Hammer 300 #		Fall	18
Casing Dia. 4"			
Hammer 300 #		Fall	18
Core Size NX		Bit No.	

Ground Elev.	317.0
Depth Ground Water	
Elev. Ground Water	
Depth Sound Rock	
Elev. Sound Rock	

Elev.	Depth	Blows Casing	Blows Spoon	Sample / Run No.	Rock Rec.	Rock Lost	Description of Materials & Remarks
	0-1		4-3	S-1			0.0'-7.0' Light & Dark Brown Silty SAND w/River
	1-2		3-4	0.0'-2.0'			GRAVEL & COBBLES - Medium Dense
	2-3		7	S-2			
	3-4		6-6	3.5'-5.5'			
	4-5		7				
	5-6						
	6-7		9-11	S-3			7.0'-10.5' Light & Dark Brown Silty SAND w/Small
	7-8		11-8	7.0'-9.0'			Size GRAVEL - Medium Dense & Wet
	8-9						
	9-10		10	S-4			
	10-11		14-11	10.5'-12.0'			10.5'-21.0' Light & Dark Brown & Gray Silty SAND
	11-12						Some River COBBLES & GRAVEL - Medium Dense
	12-13		10	S-5			
	13-14		11-9	13.5-15.0'			
	14-15						
	15-16		7	S-6			
	16-17		9-8	16.5'-18.0'			
	17-18						
	18-19		14	S-7			
	19-20		16-15	19.5'-21.0'			
	20-21						21.0'-30.0' Light & Dark Brown Silty SAND w/Layer
	21-22		10	S-8			of CLAY Seams & Fine GRAVEL - Medium Dense
	22-23		8-8	22.5'-24.0'			
	23-24						
	24-25		8	S-9			
	25-26		7-7	25.5'-27.0'			
	26-27						
	27-28		7	S-10			
	28-29		8-8	28.5'-30.0'			30.0'-32.0' Took Shelby Tube
	29-30						32.0'-34.0' Light & Dark Brown Silty SAND w/River
	30-31						GRAVEL w/Layers of Badly Weathered LIMESTONE Sea
	31-32		6-14	S-11			Medium Dense
	32-33		19	32.0'-33.5'			
	33-34			Run-1	3.0'	0.0'	REFUSAL at 34.0' Started to Core 34.0'
	34-35			34.0'-37.0'			34.0'-44.0' Li[illegible] & Dark Gray DOLOMITE w/Broken
	35-36			RQD= 29%			Seams, Small [illegible]thered Seams-Med. Hard
	36-37			Run-2	5.0'	0.0'	
	37-38			37.0'-42.0'			
	38-39			RQD= 58%			End of Boring 44.0'
	39-40						
	40-41						GWL at Completion 41.0'
	41-42			Run-3	2.0'	0.0'	Completed 3/18/87
	42-43			42.0'-44.0'			24 Hour GWL Dry
	43-44			RQD= 100%			Note: Lost Wash Water 35.0'
	44-45						1 Bag Sample (1.0'-34.0')

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Date 3/24/87 PA Power & Light Co. Sheet 1 of 1

Bori Location Martins Creek Ash Basin 4, ER 103080 STA. 43+10N - 42+68W

Project No.	J-1975	Spoon O.D.	3"			Ground Elev.	323.1
Boring No.	TB-5	Hammer	300#	Fall	18	Depth Ground Water	
Ftg. Soil	35.0'	Casing Dia.	4"			Elev. Ground Water	
Ftg. Rock	10.0'	Hammer	300#	Fall	18	Depth Sound Rock	
Driller	R.Neidlinger	Core Size	NX	Bit No.		Elev. Sound Rock	

Elev.	Depth	Blows Casing	Blows Spoon	Sample / Run No.	Rock Rec.	Rock Lost	Description of Materials & Remarks
	0-1		2-6	S-1			0.0' to 15.0' Brown Sandy SILT with ROCK Fragments
	1-2		5	0.0'-1.5'			Medium Stiff, Loose-Moist
	2-3						
	3-4		4-4	S-2			
	4-5		4	3.0'-4.5'			
	5-6						
	6-7		5-5	S-3			
	7-8		9	6.0'-7.5'			
	8-9						
	9-10		7-10	S-4			
	10-11		10	9.0'-10.5'			
	11-12						
	12-13		10-12	S-5			
	13-14		10	12.0'-13.5'			
	14-15						
	15-16		22-14	S-6			15.0' to 27.0' Brown SAND & GRAVEL, Medium Stiff,
	16-17		12	15.0'-16.5'			Loose-Moist
	17-18						
	18-19		9-7	S-7			
	19-20		7	18.0'-19.5'			
	20-21						
	21-22		14-21	S-8			
	22-23		18	21.0'-22.5'			
	23-24						
	24-25		15-18	S-9			
	25-26		23	24.0'-25.5'			
	26-27						
	27-28		3-4	S-10			27.0' to 30.0' Brown Silty CLAY, Medium Stiff,
	28-29		4	27.0'-28.5'			Firm-Moist
	29-30						30.0' to 31.5' Shelby Tube Sample
	30-31						31.5' to 35.0' Brown Sandy SILT with ROCK Fragment
	31-32						Medium Stiff, Loose-Moist
	32-33						
	33-34		3-4	S-11			REFUSAL at 35.0' Started to Core 35.0'
	34-35		5	33.0'-34.5'			
	35-36						35.0' to 45.0' Gray DOLOMITE, Broken-Very Hard
	36-37			Run-1	4.4'	0.6'	
	37-38			35.0'-40.0'			
	38-39			RQD=54%			End of Boring 45.0'
	39-40						
	40-41			Run-2	4.7'	0.3'	GWL at Completion 31.0'
	41-42			40.0'-45.0'			Completed 3/25/87
	42-43			RQD=94%			
	43-44						1 Bag Sample (1.0'-15.0')
	44-45						NOTE: Lost wash water at 30.0'

bst borings, soils & testing co.

Test Boring Report

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Bor. Location Martins Creek Ash Basin 4, ER 103080 STA. 43+63N - 39+80W

Project No.	J-1975
Boring No.	TB-6
Ftg. Soil	23.0'
Ftg. Rock	10.0'
Driller	R.Neidlinger

Spoon O.D. 3"
Hammer 300# Fall 18
Casing Dia. 4"
Hammer 300# Fall 18
Core Size NX Bit No.

Ground Elev.	319.2
Depth Ground Water	
Elev. Ground Water	
Depth Sound Rock	
Elev. Sound Rock	

Elev.	Depth	Blows Casing	Blows Spoon	Sample / Run No.	Rock Rec.	Rock Lost	Description of Materials & Remarks
	0-1		4-18	S-1			0.0' to 20.0' Brown Silty SAND & GRAVEL with ROC
	1-2		14	0.0'-1.5'			Fragments, Medium Stiff, Loose-Moist
	2-3						
	3-4		5-6	S-2			
	4-5		8	3.0'-4.5'			
	5-6						
	6-7		7-5	S-3			
	7-8		3	6.0'-7.5'			
	8-9						
	9-10		8-9	S-4			
	10-11		9	9.0'-10.5'			
	11-12						
	12-13		24-12	S-5			
	13-14		12	12.0'-13.5'			
	14-15						
	15-16		20-18	S-6			
	16-17		19	15.0'-16.5'			
	17-18						
	18-19		6-10	S-7			
	19-20		40	18.0'-19.5'			
	20-21						20.0' to 23.0' Triconed thru COBBLES & BOULDERS
	21-22						
	22-23						REFUSAL at 23.0' Started to Core 23.0'
	23-24			Run-1	4.6'	0.4'	
	24-25			23.0'-28.0'			23.0' to 33.0' Gray DOLOMITE, Broken-Very Hard
	25-26			RQD=84%			
	26-27						
	27-28						
	28-29			Run-2	4.5'	0.5'	
	29-30			28.0'-33.0'			
	30-31			RQD=70%			
	31-32						
	32-33						
	33-34						End of Boring 33.0'
	34-35						
	35-36						GWL at Completion 27.0'
	36-37						Completed 3/25/87
	37-38						
	38-39						
	39-40						1 Bag Sample (1.0'-23.0')
	40-41						
	41-42						
	42-43						
	43-44						
	44-45						

bst borings, soils & testing co.

Test Boring Report

Weather ______

Date 3/26/87 PA Power & Light Co. Sheet 1 of 1

Bori Location Martins Creek Ash Basin 4, ER 103080 STA. 44+18N - 36+86W

Project No.	J-1975
Boring No.	TB-7
Ftg. Soil	13.0'
Ftg. Rock	15.5'
Driller	R.Neidlinger

Spoon O.D. 3"		
Hammer 300#	Fall 18	
Casing Dia. 4"		
Hammer 300#	Fall 18	
Core Size NX	Bit No.	

Ground Elev.	320.3
Depth Ground Water	
Elev. Ground Water	
Depth Sound Rock	
Elev. Sound Rock	

Elev.	Depth	Blows Casing	Blows Spoon	Sample / Run No.	Rock Rec.	Rock Lost	Description of Materials & Remarks
	0-1		4-10	S-1			0.0' to 4.0' Brown Silty CLAY with ROCK Fragmen
	1-2		12	0.0'-1.5'			Medium Stiff, Firm-Moist
	2-3						
	3-4		4-5	S-2			
	4-5		7	3.0'-4.5'			4.0' to 13.0' Brown Silty SAND with ROCK Fragme
	5-6						& GRAVEL, Medium Stiff, Loose-Moist
	6-7		10-10	S-3			
	7-8		10	6.0'-7.5'			
	8-9						
	9-10		11-7	S-4			
	10-11		8	9.0'-10.5'			
	11-12			S-5 (No Recovery)			REFUSAL at 13.0' Started to Core 13.0'
	12-13		31-50/	12.0'-13.0'			
	13-14		.5				13.0' to 22.5' Gray DOLOMITE, Broken-Medium Har
	14-15			Run-1	3.0'	0.0'	
	15-16			13.0'-16.0'			
	16-17			RQD=0%			
	17-18			Run-2	5.0'	0.0'	
	18-19			16.0'-21.0'			
	19-20			RQD=76%			
	20-21						
	21-22			Run-3	1.3'	0.2'	
	22-23			21.0'-22.5'			22.5' to 23.5' Brown Sandy SILT with Decomposed
	23-24			RQD=65%			DOLOMITE
	24-25			Run-4	4.9'	0.1'	NOTE: Used 2" Spoon 22.5'-23.5'
	25-26			23.5'-28.5'			
	26-27			RQD=48%			23.5' to 28.5' Gray DOLOMITE, Broken-Medium Har
	27-28						
	28-29						
	29-30						End of Boring 28.5'
	30-31						
	31-32						GWL at Completion 24.0'
	32-33						Completed 3/26/87
	33-34						
	34-35						
	35-36						1 Bag Sample (1.0'-13.0')
	36-37						
	37-38						
	38-39						
	39-40						
	40-41						
	41-42						
	42-43						
	43-44						
	44-45						

bst borings, soils & testing co.

Test Boring Report

Weather ______

Date 3/26/87 PA Power & Light Co. Sheet 1 of 1

Bori Location Martins Creek, Ash Basin 4, ER 103080 STA. 46+86N - 42+96W

Project No.	J-1975
Boring No.	TB-8
Ftg. Soil	21.0'
Ftg. Rock	15.5'
Driller	R.Neidlinger

Spoon O.D. 3"		
Hammer 300 #	Fall 18	
Casing Dia. 4"		
Hammer 300 #	Fall 18	
Core Size NX	Bit No.	

Ground Elev.	327.
Depth Ground Water	
Elev. Ground Water	
Depth Sound Rock	
Elev. Sound Rock	

Elev.	Depth	Blows Casing	Blows Spoon	Sample / Run No.	Rock Rec.	Rock Lost	Description of Materials & Remarks
	0-1		3-4	S-1			0.0' to 6.0' Brown Sandy SILT with ROCK Fragmen
	1-2		7	0.0'-1.5'			& GRAVEL, Trace of CLAY, Medium Stiff, Loose-Moi
	2-3						
	3-4		8-10	S-2			
	4-5		30	3.0'-4.5'			
	5-6						
	6-7		5-6	S-3			6.0' to 21.0' Brown SAND & GRAVEL with Trace of
	7-8		6	6.0'-7.5'			SILT, Medium Stiff, Loose-Moist
	8-9						
	9-10		8-4	S-4			
	10-11		7	9.0'-10.5'			
	11-12						
	12-13		25-25	S-5			
	13-14		31	12.0'-13.5'			
	14-15						
	15-16		19-21	S-6			
	16-17		19	15.0'-16.5'			
	17-18						
	18-19		23-27	S-7			
	19-20		28	18.0'-19.5'			REFUSAL at 21.0' Started to Core 21.0'
	20-21						
	21-22			Run-1	2.0'	0.5'	21.0' to 23.5' Gray DOLOMITE, Broken-Very Hard
	22-23			21.0'-23.5'			
	23-24		3	S-8 (No Recovery)			23.5' to 26.5' Silty SAND Seam, No Recovery,
	24-25		2-1	25.0'			Used 2" Spoon - 140# hammer
	25-26						
	26-27						26.5' to 36.5' Gray DOLOMITE, Broken-Badly Broke
	27-28						Medium Hard
	28-29						
	29-30						
	30-31			Run-2	5.0'	0.0'	End of Boring 36.5'
	31-32			26.5'-31.5'			
	32-33			RQD=15%			GWL at Completion 33.0'
	33-34						Completed 4/1/87
	34-35						
	35-36			Run-3	4.4'	0.6'	
	36-37			31.5'-36.5'			1 Bag Sample (1.0'-21.0')
	37-38			RQD=22%			
	38-39						
	39-40						
	40-41						
	41-42						
	42-43						
	43-44						
	44-45						

bst borings, soils & testing co.

Test Boring Report

Weather ______

Date 4/1/87 PA Power & Light Co. Sheet 1 of 2

Bor. Location Martins Creek, Ash Basin 4, ER 103080 STA. 48+12N - 36+10W

Project No.	J-1975
Boring No.	TB-9
Ftg. Soil	42.0'
Ftg. Rock	23.0'
Driller	R.Neidlinger

Spoon O.D. 3"	
Hammer 300#	Fall 18
Casing Dia. 4"	
Hammer 300#	Fall 18
Core Size NX	Bit No.

Ground Elev.	323.[illegible]
Depth Ground Water	
Elev. Ground Water	
Depth Sound Rock	
Elev. Sound Rock	

Elev.	Depth	Blows Casing	Blows Spoon	Sample / Run No.	Rock Rec.	Rock Lost	Description of Materials & Remarks
	0-1		2-2	S-1			0.0' to 16.0' Brown Silty CLAY with ROCK Frag-
	1-2		7	0.0'-1.5'			ments, Medium Stiff, Firm-Moist
	2-3						
	3-4		3-6	S-2			
	4-5		7	3.0'-4.5'			
	5-6						
	6-7		16-15	S-3			
	7-8		16	6.0'-7.5'			
	8-9						
	9-10		14-13	S-4			
	10-11		15	9.0'-10.5'			
	11-12						
	12-13		4-3	S-5			
	13-14		7	12.0'-13.5'			
	14-15						
	15-16						
	16-17						16.0' to 18.0' Cored thru BOULDERS
	17-18		9-14	S-6			
	18-19		9	18.0'-19.5'			18.0' to 33.0' Brown Silty CLAY with ROCK Frag-
	19-20						ments, Medium Stiff, Firm-Moist
	20-21		2-4	S-7			
	21-22		7	21.0'-22.5'			
	22-23						
	23-24		2-5	S-8			
	24-25		5	24.0'-25.5'			
	25-26						
	26-27		2-6	S-9			
	27-28		5	27.0'-28.5'			
	28-29						
	29-30		2-7	S-10			
	30-31		8	30.0'-31.5'			
	31-32						
	32-33						
	33-34						33.0' to 35.0' Attempted Shelby Tube Sample -
	34-35						No Recovery
	35-36		3-7	S-11			35.0' to 42.0' Brown Clayey SILT with ROCK Frag-
	36-37		5	35.0'-36.5'			ments, Medium Stiff, Firm-Moist
	37-38						
	38-39		4-6	S-12			
	39-40		9	38.0'-39.5'			REFUSAL at 42.0' Started to Core 42.0'
	40-41			S-13			
	41-42		3-50/	41.0'-42.0'			42.0' to 65.0' Gray DOLOMITE with Many Sandy SIL
	42-43		.5	Run-1	1.9	1.1	Seams, Pinnacle of ROCK, Broken
	43-44			42.0'-45.0'			
	44-45			RQD=53%			

BORINGS, SOILS AND TESTING COMPANY

TEST BORING REPORT

Weather ______

Date 4/2/87 PA Power & Light Co. Sheet 2 of __

Boring Location Martins Creek, Ash Basin 4, ER 103080 STA. 48+12N - 36+10W

Project No.	J-1975
Boring No.	TB-9
Ftg. Soil	42.0'
Ftg. Rock	23.0'
Driller	R.Neidlinger

Spoon O. D.	3"		
Hammer	300#	Fall	18 "
Casing Dia.	4"		
Hammer	300#	Fall	18 "
Core Size	NX	Bit No.	

Ground Elev.	323.4
Depth Ground Water	
Elev. Ground Water	
Depth Sound Rock	
Elev. Sound Rock	

Elev.	Depth	Blows Casing	Blows Spoon	Sample or Run No.	Rock Recov'd	Rock Lost	Description of Materials & Remarks
	45-46			Run-2	1.9'	3.1'	
	46-47			45.0'-50.0'			(42.0'-65.0' Gray DOLOMITE with Many Sandy SILT
	47-48			RQD=22%			Seams, Pinnacle of ROCK, Broken)
	48-49						
	49-50			Run-3	0.9'	4.1'	
	50-51			50.0'-55.0'			
	51-52			RQD=0%			
	52-53						
	53-54						
	54-55			Run-4	1.4'	3.6'	
	55-56			55.0'-60.0'			
	56-57			RQD=24%			
	57-58						
	58-59						
	59-60			Run-5	1.0'	4.0'	
	60-61			60.0'-65.0'			
	61-62			RQD=0%			
	62-63						
	63-64						
	64-65						
	65-66						End of Boring 65.0'
	66-67						
	67-68						GWL at Completion Dry
	68-69						Completed 4/2/87
	69-70						
	70-71						
	71-72						
	72-73						1 Bag Sample (1.0'-33.0')
	73-74						
	74-75						
	75-76						
	76-77						
	77-78						
	78-79						
	79-80						
	80-81						
	81-82						
	82-83						
	83-84						
	84-85						
	85-86						
	86-87						
	87-88						
	88-89						
	89-90						

bst borings, soils & testing co.
Test Boring Report

Weather ______

Date 3/23/87 PA Power & Light Co. Sheet 1 of 1

Bor Location Martin Creek, Ash Basin 4, ER 103080 STA. 54+75N - 43+48W

Project No.	J-1975
Boring No.	TB-10
Ftg. Soil	27.0
Ftg. Rock	10.0
Driller R. Neidlinger	

Spoon O.D.	3"
Hammer 300 #	Fall 18
Casing Dia.	4"
Hammer 300 #	Fall 18
Core Size NX	Bit No.

Ground Elev.	335.[illegible]
Depth Ground Water	
Elev. Ground Water	
Depth Sound Rock	
Elev. Sound Rock	

Elev.	Depth	Blows Casing	Blows Spoon	Sample / Run No.	Rock Rec.	Rock Lost	Description of Materials & Remarks
	0-1		2-3	S-1			0.0'-3.0' Brown Silty CLAY w/ROCK Fragments -
	1-2		3-3	0.0'-1.5'			Moist & Firm-Medium Stiff
	2-3		2-3	S-2			
	3-4		3-3	3.0'-4.5'			3.0'-15.0' Brown Silty SAND & GRAVEL - Moist &
	4-5		4-9				Loose-Medium Stiff
	5-6		8-7	S-3			
	6-7		9-8	6.0'-7.5'			
	7-8		9				
	8-9		5-9	S-4			
	9-10		11	9.0'-10.5'			
	10-11						
	11-12		8-16	S-5			
	12-13		25	12.0'-13.5'			
	13-14						
	14-15						15.0'-18.0' Cored thru COBBLES & BOULDERS
	15-16						
	16-17						
	17-18		60-28	S-6			18.0'-24.0' Brown SAND & GRAVEL - Wet & Loose-
	18-19		30	18.0'-19.5'			Medium Stiff
	19-20						
	20-21		18-30	S-7			
	21-22		50	21.0'-22.5'			
	22-23						
	23-24						24.0'-27.0' Brown SAND & GRAVEL - Wet & Loose-
	24-25		12-80	S-8			Medium Stiff
	25-26		50	25.0'-26.5'			
	26-27			Run-1	4.8'	0.2'	REFUSAL at 27.0' Started to Core 27.0'
	27-28			27.0'-32.0'			27.0'-37.0' Gray DOLOMITE, Broken-Very Hard
	28-29			RQD= 48%			
	29-30						
	30-31						
	31-32			Run-2	4.7'	0.3'	End of Boring 37.0'
	32-33			32.0'-37.0'			
	33-34			RQD= 54%			GWL at Completion 26.0'
	34-35						Completed 3/24/87
	35-36						
	36-37						
	37-38						
	38-39						Note: Lost Water at 27.0'
	39-40						1 Bag Sample (1.0'-15.0')
	40-41						
	41-42						
	42-43						
	43-44						
	44-45						

2540-PM-WM0366 1/95

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL RESOURCES
BUREAU OF WASTE MANAGEMENT

Coordination #

FORM 7R
HYDROGEOLOGIC INFORMATION

This form must be fully and accurately completed. All required information must be typed or legibly printed in the spaces provided herein. Improperly completed forms may be rejected by the Department, may be considered to be violations of the Department's Rules and Regulations, and may result in assessment of fines and penalties.

DER USE ONLY

Application or Facility ID # ______
(Assigned by DER)
Stamp Date Application Received

WASTE MANAGEMENT
COUNTY:
SEP 10 1997
CITY:
CODE:

SECTION A. APPLICANT IDENTIFIER Martins Creek Ash Basin No. 4

Applicant Name: Pennsylvania Power & Light Co.

County: Northampton

Municipality: Lower Mount Bethel Township

Instructions: A narrative description of the general characteristics of the hydrogeology at the proposed site and contiguous properties (down to and including the lowest aquifer that may be affected by the facility) must be submitted, as well as the characteristics listed below. Information, except maps, may be provided on attached 8 1/2 x 11 inch sheets as needed.

SECTION B. HYDROLOGIC CHARACTERIZATION See Attached Narrative

General References: Sections 288.121, 288.122, 288.125, 289.121, 289.122, 289.125, 291.105 and 291.106

Hydrologic characterization of each aquifer will be based upon multiple well aquifer tests when possible; the following determinations must be made and calculations included:

a. Hydraulic conductivities.
b. Storage coefficients for confined aquifers and specific yield for unconfined.
c. Transmissivities.
d. Hydraulic gradients.
e. Ground water velocities.
f. Number of wells, borings, or test pits used.
g. Maximum depth to regional water table or piezometric surface within the site with date of measurement.
h. Minimum depth to regional water table or piezometric surface within the site with date of measurement.
i. Twelve month characterization of regional water table fluctuations, within the uppermost aquifer (four consecutive quarters).
j. Description of perched or special water table conditions including seasonal high water table.
k. Minimum depth to any perched water. N/A
l. Effects of any deep mines in the area. N/A
m. Directions of ground water movement (shown on Phase I base maps) including description of how determined.
n. Uses of aquifers.
o. Ground water divides (shown on Phase 1 base maps)
p. Three-dimensional ground water flow with discharge/recharge characteristics.

SECTION C. PROPOSED GROUND WATER QUALITY MONITORING POINTS

Proposed Ground Water Quality Monitoring Points (wells, piezometers, etc.) must be described in the following format and are s[illegible] to Department approval. Proposed monitoring points are to be permanently numbered in consecutive order. A "U" or "D" should b[illegible] ed to the monitoring point number to identify upgradient/downgradient. For existing monitoring points, information is to be base[illegible] on data obtained at completion; for new monitoring points, construction information is to be based upon specifications. Monitoring wells will be designed, constructed, and maintained in accordance with Sections 288.251, 291.521 and 289.261 (relating to general requirement(s)), Sections 288.252, 292.522 and 289.262 (relating to number, location and depth), and Sections 288.253, 291.523 and 289.263 (relating to standards for casing of wells) and consistent with the requirements of Form R18 (relating to Phase II Water Quality Monitoring System Information). Any proposed surface water monitoring point must have adequate flow to allow sampling even in the driest quarter of the year.

SECTION C. (Continued)

ALL MONITORING POINTS MUST HAVE AN ASSOCIATED LATITUDE AND LONGITUDE DETERMINED ACCURATELY TO THE NEAREST ONE TENTH OF A SECOND (DD° MM' SS.S")

Wells and Piezometers

Monitoring Point Number	Drilling Method	Depth (ft)	Borehole Diameter (in.)	Casing		Location		Measuring Point Elevation (Ft/MSL)
				Diameter (in.)	Screened Interval (ft)	Latitude	Longitude	
4-1	Rotary	88	8	4	31	40°48'31"	75°07'00"	327.5
4-2	Rotary	116	8	4	40	40°48'14"	75°07'09"	312.40
4-3	Rotary	105	8	4	30	40°48'14"	75°07'00"	314.00
4-4	Rotary	127	8	4	40	40°48'14"	75°07'00"	328.40
4-5	Rotary	129	8	4	30	40°48'19"	75°06'45"	334.50
4-6	Rotary	132	8	4	40	40°48'33"	75°06'43"	334.00

Springs, Streams, Other Surface Water

Monitoring Point Number (Spring or Surface Water)	Elevation (Ft/MSL)	Flow Rate (GPM)	Date of Measurement	Location	
				Latitude	Longitude

SP - Spring
ST - Stream
S.W. - Surface Water

SECTION D. GROUND WATER QUALITY DESCRIPTION SEE ATTACHED NARRATIVE

Items 3 and 4 (below) pertain only to Residual Waste Landfills and Disposal Impoundments and Land Application Sites; not to Composting Facilities, Transfer Stations, Storage Facilities, Incinerators or other Processing Facilities.

An application for a residual waste landfill or disposal impoundment must contain a description of the chemical characteristics of each aquifer in the proposed permit area and adjacent area, based upon at least two quarters of monitoring data, one of which shall be in the season of highest local groundwater levels of monitoring data. This requires at least two (2) sets of analyses on approximately a 90 day interval in the format of Form 8R. Proposed Mandatury Abatement Trigger Levels must be indicated in the designated column of Form 8R.

An application for a residual waste land application site may, at the Department's discretion, require a description of the chemical characteristics of each aquifer in the proposed permit area and adjacent area based upon at least two (2) sets of analyses for consecutive quarters (except land disposal) in the format of Form 9R. For land disposal, three consecutive sets of analyses on monthly intervals are required. Proposed Mandatory Abatement Trigger Levels must be indicated in Form 9R.

Recycled Paper

SECTION E. SURFACE WATER INFORMATION See Attached Narrative

The application must contain a description of surface waters in the proposed permit area and adjacent areas including the questions posed below. The surface water information shall be based on a sufficient number of observations, calculations, weir, or flow meter readings and sample analyses to allow an accurate characterization of the physical, chemical, and biological characteristics of the surface waters.

Does the application include a description and map of the watershed in which the proposed permit area is located and other watersheds which may be affected by the proposed facility (including streams, springs, or wetlands that are representative of the surface and ground water system of the general area)?

Are surface elevations and rates of flow of streams, springs, seeps, and mine discharges in the proposed permit area and adjacent area included?

Is a description of the quality of surface waters which will receive flows from the surface or ground water of the proposed permit area included?

The following is not required for land application sites.

Has a description of the in-stream macroinvertebrate community in surface waters above and below the proposed permit area (within appropriate limits) been attached? Survey methods should follow the Department's Standardized Benthic Macroinvertebrate Field Collection Methods. The survey report should include the name and address of the biologist performing the survey.

See Attached Narrative

MARTINS CREEK SES
ASH BASIN NO. 4
FORM 7R
HYDROGEOLOGIC INFORMATION

NARRATIVE

Monitoring wells installed around Ash Basin No. 4 were not hydraulically tested and therefore most of the information requested in Section 1 is unavailable. The following section on hydrogeology provides regional and local information that is available. Drawing E-208987 is a project site plan showing the monitoring wells. Drawing D-242664, Sheet 3, shows the ground water contours across the site which in turn display that the Basin has one upgradient well and four downgradient wells. Ground water monitoring information has been submitted quarterly to the Department for years.

1.0 HYDROGEOLOGY

1.1 Regional Hydrogeology

Ground water in the Valley and Ridge Physiographic Province is generally a subdued replica of the surface topography, with ground water flowing from recharge zones at higher elevations (greater potential) to discharge zones at lower elevations (less potential). Ground water may either eventually discharge to the surface as seeps, springs, and/or streams, or continue flowing as a component of deeper flow in a larger ground water system.

The flow of ground water in the folded bedrock of the Great Valley Section of the Valley and Ridge Province is controlled primarily by joints, faults, and bedding plane partings. Enlargement of both primary and secondary openings may occur through dissolution or chemical weathering of the rock material, which is the case in the carbonate rocks that underlie Basin No. 1 and the surrounding area.

Vertical to sub-vertical planes of fracture concentration are present in the Paleozoic rocks underlying the site. These zones often represent discrete pathways for enhanced ground water movement. Because they are nearly vertical, their expression on the land surface is a linear feature, regardless of the local topographic relief. Fracture traces, visible on air photographs, are natural linear-drainage, soil-tonal, and topographic alignments which are probably the surface manifestation of underlying zones of bedrock fracture (Lattman & Parizek, 1964). Interconnection of these fractures with bedding plane apertures provides reservoirs for ground water storage and pathways for ground water migration. Figure 2-5 illustrates fracture traces which were mapped in the SES and surrounding area.

Ground water levels fluctuate in response to the relative amounts of recharge to, and discharge from, the ground water flow system. Water levels generally peak in the early spring months following the spring thaw, late February to

FIGURE 2-5
Regional fracture traces on 1991 base-photo of the Martins Creek SES.

01/057-15

March, and preceding the onset of vigorous plant growth in April and May. Water levels steadily decline through the summer to October, the time of the first killing frost, as increased evapotranspiration inhibits recharge to the ground water system. Recharge may then occur until the ground freezes, therefore inhibiting the infiltration of precipitation.

There is one major aquifer controlling ground water flow and movement in the vicinity of Ash Basin No. 4, termed the "bedrock aquifer," consisting of relatively competent fractured bedrock of various lithologies.

1.2 Local Hydrogeology

Surface Soils

Test borings and basin excavation have shown that the ground water table is located below the bedrock surface. The cover soils consist of widely varying depths of sands and gravels with some clay lenses and nested weathered bedrock boulders. Pinnacles of limestone have been found throughout the site, the most shallow of which (approximately 10 feet) was found in the adjacent soil borrow area to the east. One test boring exceeded 100 feet and didn't hit competent rock.

Generally, the soils are free draining and ponding and puddles are very short lived. Table 2-1 gives an idea of the hydrostratigraphic units identified around the Martins Creek plant.

TABLE 2-1

Hydraulic Characteristics of the
Hydrostratigraphic Units
Martins Creek SES, Ash Basin No. 1

Unit	Hydraulic Conductivity (ft/day)*	Porosity (%)*
Sand and Gravel	10^{-1} to 10^{5}	25 - 40
Limestone/Dolomite	10^{-4} to 10^{+4}	5 - 50

* *Values obtained from Freeze and Cherry, 1979*

Bedrock Aquifer

Occurring directly beneath the mixed coarse sediment deposits is weathered bedrock, containing rock fragments, open fractures, and sediments derived from weathered parent material. The parent bedrock underlying the basin consists of limestone. The depth of weathering varies. An extensive geophysical program done by Weston Geophysical was done using seismic and resistivity methods that showed a highly weathered bedrock zone under the northeast corner of the site. PP&L had that area grouted before beginning basin construction.

Drawing D-242664, Sheet 1 is a ground water elevation map of the Ash Basin No. 4 area, constructed from water level data of May 1996. The monitoring well system contains one upgradient well (MW 4-1) and five downgradient wells (MW 4-2 through 4-6). All monitoring wells are screened below the zone of seasonal and yearly ground water fluctuation. This indicates that well position and screen length were adequately chosen to monitor the aquifer. Ground water contours indicate that the downgradient wells are indeed downgradient.

This aquifer is composed of generally steeply dipping, southwest-northeast striking, competent limestone and dolomite. Bedrock beneath the majority of the basin consists of limestone (Jacksonville Limestone). The remaining southeastern third of the basin is underlain by limestone and interbedded limestone (Epler Formation). Site-specific hydraulic parameters are lacking because hydraulic testing of the monitoring wells has not been performed.

1.3 Regional and Background Ground Water Quality

In order to accurately determine the effect of the basin on ground water, it is first necessary to characterize the upgradient (background) water quality. Well 4-1 is the upgradient well. Ground water data for all of Basin No. 4's wells has been collected and submitted to the state. The basin has no impact on the ground water quality.

These data were compared to regional water quality data for the aquifers which underlie the basin. The carbonate aquifers yield hard to very hard, slightly alkaline water with appreciable calcium, bicarbonate, sulfate, iron, manganese nitrate, sodium, and moderate dissolved solids. The wells, like residential wells PP&L tests around this area, show impacts from local farming (nitrates, etc.), but no impact from Basin No. 4.

2.0 SURFACE WATER QUALITY

PP&L, in cooperation with DER, has conducted annual environmental monitoring studies of the Delaware River to determine the effect of the entire Martins Creek SES on river quality. None of these surface water studies specifically target the area around the Basin No. 4 discharge to the river near Basin No. 1. The scope of these studies was to assess the overall impact of the Martins Creek SES on water quality and biota of the Delaware River in the vicinity of the SES. Some sampling points in the broader studies were located near the basin discharge and can be used to categorize water quality in the vicinity of the basin (data sheets attached).

Surface water quality results collected concurrently with biological sampling indicated that chemical impacts on water quality due to Martins Creek SES operations were not significant.

A biological survey of the Delaware River in the vicinity of the Martins Creek SES was conducted in August 1989 (most recent data available) during low flow conditions.

Results of the survey concluded that discharges from the Martins Creek SES were not adversely affecting the fish community or benthic fauna of the Delaware River in the vicinity of Martins Creek SES.

A copy of the study report "Environmental Monitoring and Surveillance Program - Delaware River in the Vicinity of Martins Creek Steam Electric Station - 1989 Studies" is included with this application. This report documents the results of biological studies along the river near the plant.

In addition, the latest surface water sampling data for the river is appended to this narrative.

ADS6.ol(G:misc)

Attachments

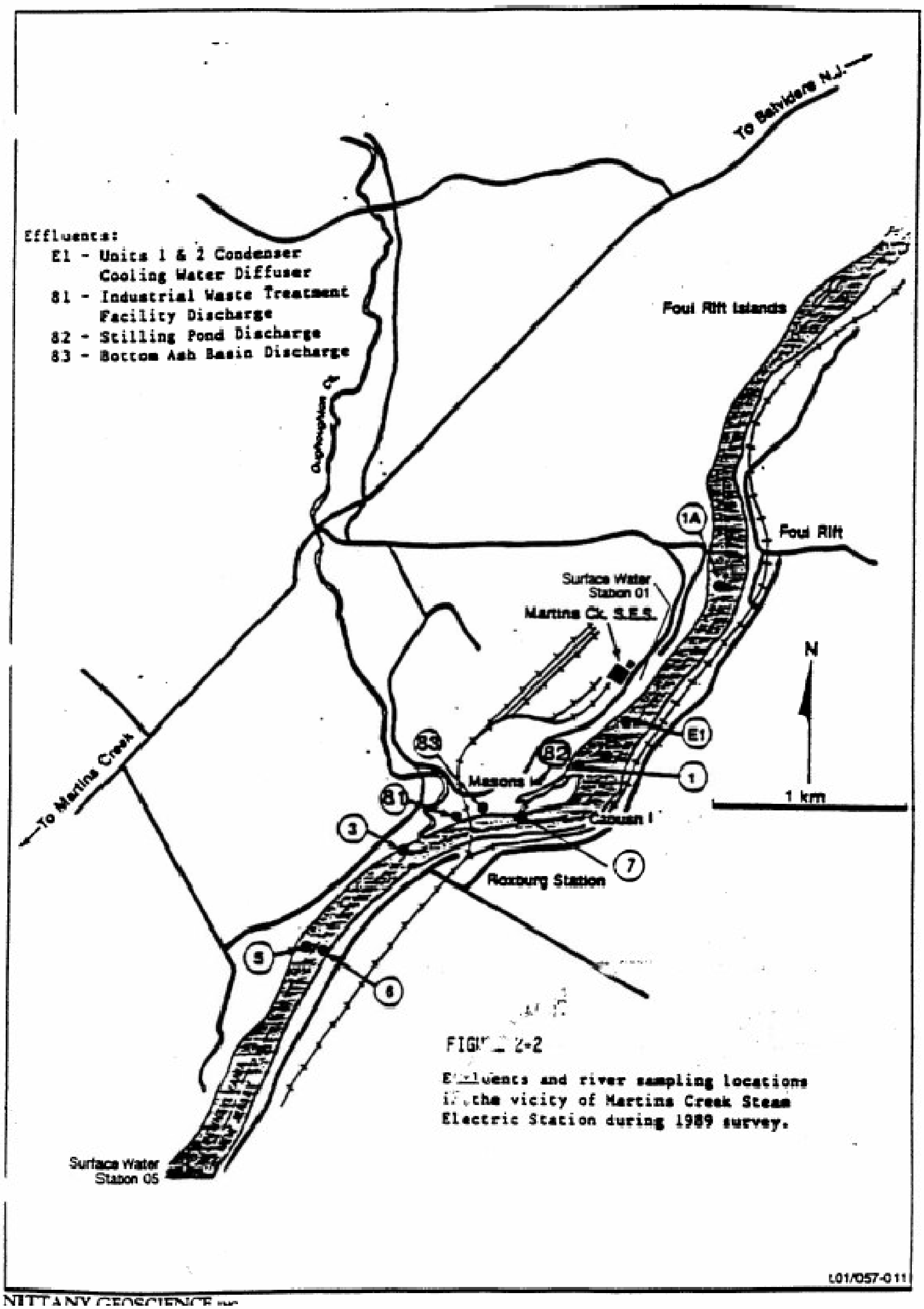


FIG__ 2-2

E__luents and river sampling locations i_ the vicity of Martins Creek Steam Electric Station during 1989 survey.

Martins Creek SES Surface Water Site 3
Analytical Results from Station 81
Unless otherwise noted, units in mg/L

Station	Date	Aluminum-Tot	Ammonia, as N	Arsenic-Tot	Beryllium-Dis	Beryllium-Tot	Calcium-Dis	Cadmium-Tot	Chloride-Tot	Chromium-Tot
81	7/21/86	0.2	0.28	0.001		-0.001	13.7	0.00033	7.9	-0.01
81	7/28/87	0.8	0.15	0.095	-0.001		47.4	-0.0002	17.6	
81	8/21/89	0.76	0.32	0.127			24.3	0.0002	14.6	-0.004

Station	Date	Chromium (VI)	Copper-Tot	Iron-Tot	Lead-Tot	Magnesium-Dis	Manganese-Tot	Nickel-Tot	Nitrate, as N	Nitrate-Tot
81	7/21/86		0.013	3.17	-0.004	2.7	0.18	0.095	0.63	
81	7/28/87	-0.01	-0.01	0.26	0.0045	4.9	0.02	-0.025	0.09	0.41
81	8/21/89		-0.05	0.24	-0.004	4.5	0.02	-0.05	0.29	1.28

Station	Date	Nitrite, as N	Phosphorus-Tot	Potassium-Dis	Selenium-Tot	Sodium-Dis	Sulfate-Tot	Thallium-Dis	Thallium-Tot
81	7/21/86		0.03		-0.006		98.2		-0.3
81	7/28/87		0.51		0.0265		83	-0.3	0
81	8/21/89	0.012	0.21	2.4	0.008	26.3	53.1		-0.1

Station	Date	Zinc-Tot	Acid, as CaCO3	Air Temperature °C	Alkalinity, methyl orange, CaCO3	Alkalinity, phenolphthalein, CaCO3	Alkalinity-Tot	Dissolved Oxygen, Field	Collection Time in hours
81	7/21/86	-0.050	3.4	28	1			7.2	1035
81	7/28/87	-0.01	0		56	2		7.4	928
81	8/21/89	0.01		26.8	49	4	48	7.6	1135

Station	Date	Color, pt-c.	Field pH	Hardness as CaCO3	Hardness, as Calcium	Lab pH	Solids, Dissolved estimated	Solids, Dissolved 105 °C
81	7/21/86		6.1	45.4		13		
81	7/28/87		7.9	139.7	118.5	17.6		260
81	8/21/89	-5	7.[illegible]	79.3	60.8	8	191.1	217

Station	Date	Solids, Dissolved 180 °C	Solids-[illegible]	Specific Conductance Field, umhos/cm	Specific Conductance Lab, umhos/cm	Suspended Solids	Turbidity, as NTU	Water Temperature °C
81	7/21/86	84.2	81.9	158	321	7.7	8	28.5
81	7/28/87		276	362	711	18	9.5	26.5
81	8/21/89		226	280	280	11.4	8.2	24.4

Note: Blank = not analyzed
ND = not detected, detection limit unknown
Negative values indicate non detects (values correspond to detection limits)

v

Martins Creek SES Surface Water Site 3

Analytical Results from Stations 3, 5, 6, 7, 1A, 82

Unless otherwise noted, units in mg/l.

Station	Date	Aluminum-Tot	Ammonia, as N	Arsenic-Tot	Beryllium-Dis	Beryllium-Tot	Cadmium-Tot	Calcium-Dis	Chloride-Tot	Chromium-Tot	Chromium (VI)	Copper-Tot
03	5/12/86	-0.2	0.03	0.025		-0.001	-0.0002		8.5		-0.01	-0.01
03	7/21/86	0.3	0.05	0.22		-0.001	-0.0002	38.2	11.5	-0.01		-0.01
03	7/28/87	-0.2	0.09	0.041	-0.001		-0.0002	14.8	9.7		-0.01	-0.01
03	8/21/89	0.34	0.23	0.031			-0.0002	19.8	12.1	-0.004		-0.05
05	5/12/86	-0.2	0.04	0.006		-0.001	-0.0002		8.5		-0.01	-0.01
05	7/21/86	-0.2	0.05	0.003		-0.001	-0.0002	11.4	8.5	-0.01		-0.01
05	7/28/87	-0.2	0.09	0.013	-0.001		-0.0002	12.2	9.7		-0.01	-0.01
05	8/21/89	0.16	0.22	0.003			-0.0002	15.2	29.7	-0.004		-0.05
06	5/12/86	-0.2	0.02	-0.001		-0.001	-0.0002		9.1		-0.01	-0.01
06	7/21/86	-0.2	0.06	-0.001		-0.001		11.3	7.9	-0.01		-0.01
06	7/28/87	-0.2	0.1	-0.001	-0.001		-0.0002	11.3	9.7		-0.01	-0.01
06	8/21/89	-0.15	0.22	-0.001			-0.0002	14.8	11.5	0.0045		-0.05
07	5/12/86	-0.2	0.03	-0.001		-0.001	-0.0002		9.1		-0.01	-0.01
07	7/21/86	-0.2	0.08	-0.001		0.004	-0.0002	10.8	8.5	-0.01		0.034
07	7/28/87	-0.2	0.09	-0.001	-0.001		0.0002	11.4	9.1		-0.01	-0.01
07	8/21/89	0.19	0.21	-0.001			-0.0002	14.7	10.3	-0.004		-0.05
1A	5/12/86	-0.2	0.03	-0.001		0.001	-0.0002		9.1		-0.01	-0.01
1A	7/21/86	-0.2	0.05	-0.001		-0.001	-0.0002	11.4	7.9	-0.01		-0.01
1A	7/28/87	-0.2	0.08	-0.001	-0.001		0.00041	11.2	9.7		-0.01	-0.01
1A	8/21/89	0.23	0.22	-0.001			-0.0002	14.7	17.6	-0.004		-0.05
82	5/12/86	-0.2	0.03	0.002		-0.001	-0.0002		21.8		-0.01	-0.01
82	7/21/86	-0.2	0.21	0.001		0.001	-0.0002	17.6	15.2	-0.01		0.012
82	7/28/87	0.2	0.16	0.002	-0.001		0.00034	27.9	19.4		-0.01	-0.01
82	8/21/89	0.22	0.24	-0.001			-0.0002	14.8	10.9	-0.004		-0.05

e: Blank = not analyzed

= not detected, detection limit unknown

ative values indicate non detects (values correspond to detection limits)

Martins Creek SES Surface Water Site 3 (cont)
Analytical Results from Stations 3, 5, 6, 7, 1A, 82
Unless otherwise noted, units in mg/L

Station	Date	Iron-Tot	Lead-Tot	Magnesium-Dis	Manganese-Tot	Nickel-Tot	Nitrate, as N	Nitrate-Tot	Nitrite, as N	Phosphorus-Tot	Potassium-Dis	Selenium-Tot	Sodium-Dis
03	5/12/86	0.12	-0.004		0.03	-0.025	1.05			0.061		-0.006	
03	7/21/86	0.3	-0.004	6.5	0.04	0.089	1.3			0.17		0.0145	
03	7/28/87	0.07	-0.004	3.4	0.03	-0.025	0.23	1				-0.006	
03	8/21/89	0.14	-0.004	5	0.02	-0.05	0.59	2.62	0.004	0.06	1.4	0.003	11.9
05	5/12/86	0.11	-0.004		0.02	-0.025	0.82			0.054		-0.006	
05	7/21/86	0.16	-0.004	2.9	0.05	0.046	0.39			0.06		-0.006	
05	7/28/87	0.07	-0.004	2.9	0.03	-0.025	0.16	0.7				-0.006	
05	8/21/89	0.13	-0.004	4.1	0.03	-0.05	0.39	1.72	0.006	0.06	1.1	-0.001	8.1
06	5/12/86	0.1	-0.004		0.03	-0.025	0.82			0.06		-0.006	
06	7/21/86	0.17	-0.004	3	0.05	0.039	0.39			0.05		-0.006	
06	7/28/87	0.07	-0.004	2.9	0.03	-0.025	0.13	0.58				-0.006	
06	8/21/89	0.1	-0.004	4.1	0.03	-0.05	0.37	1.62	0.004	0.06	1	-0.001	7.9
07	5/12/86	0.12	-0.004		0.03	-0.025	0.68			0.055		-0.006	
07	7/21/86	0.15	-0.004	2.7	0.04	0.088	0.35			0.05		-0.006	
07	7/28/87	0.07	-0.004	2.9	0.03	-0.025	0.11	0.5				-0.006	
07	8/21/89	0.09	-0.004	3.9	0.03	-0.05	0.28	1.26	0.004	0.06	1	-0.001	7.9
1A	5/12/86	0.49	-0.004		0.04	-0.025	0.88			0.052		-0.006	
1A	7/21/86	0.13	-0.004	2.9	0.05	0.036	0.35			0.05		-0.006	
1A	7/28/87	0.08	-0.004	2.7	0.03	-0.025	0.09	0.41				-0.006	
1A	8/21/89	0.11	-0.004	3.9	0.03	-0.05	0.31	1.35	0.008	0.05	1	-0.001	7.7
82	5/12/86	0.68	-0.004		0.03	-0.026	2.04			0.126		-0.006	
82	7/21/86	0.26	-0.004	3.9	0.05	0.085	1.55			0.1		-0.006	
82	7/28/87	0.18	0.0042	5.2	0.03	-0.025	0.5	2.23		0.07		-0.006	
82	8/21/89	0.22	-0.004	3.8	0.02	-0.05	0.34	1.5	0.004	0.07	1	-0.001	7.8

te: Blank = not analyzed
) = not detected, detection limit unknown
gative values indicate non detects (values correspond to detection limits)

Martins Creek SES Surface Water Site 3 (cont)
Analytical Results from Stations 3, 5, 6, 7, 1A, 82
Unless otherwise noted, units in mg/l.

Station	Date	Sulfate-Tot	Thallium-Dis	Thallium-Tot	Zinc-Tot	Acid, as CaCO3	Air Temperature °C	Alkalinity-Tot	Alkalinity, methyl orange CaCO3	Alkalinity, phenolphthalein, CaCO3	Collection Time in hours
03	5/12/86	47.5		-0.3	-0.01		15		36		950
03	7/21/86	68		-0.3	0.034	1.1	28		57		1005
03	7/28/87	14	-0.3		-0.01	2.3			32	0	1015
03	8/21/89	22.9		-0.1	0.01		24.8	40	46	0	1110
05	5/12/86	26.6		-0.3	-0.01		18.5		32		934
05	7/21/86	13		-0.3	0.02	1.1	28		25		940
05	7/28/87	12	-0.3		-0.01	1.1			28	0	940
05	8/21/89	10.6		-0.1	0.01		24.8	38	39	0	1025
06	5/12/86	27		-0.3	-0.01		15		33		939
06	7/21/86	13		-0.3	0.017	1.1	27		25		950
06	7/28/87	10	-0.3		-0.01	2.3			29	0	946
06	8/21/89	10.3		-0.1	-0.01		24.8	38	38	0	1045
07	5/12/86	2		-0.3	-0.01		15		30		1046
07	7/21/86	-10		-0.3	0.046	1.1	28		24		1015
07	7/28/87	9.4	-0.3		-0.01	2.3			27	0	1020
07	8/21/89	10.5		-0.1	-0.01		29.8	38	27	1	1250
1A	5/12/86	25.5		-0.3	-0.01		23		35		1235
1A	7/21/86	12		-0.3	0.014	1.1	29		26		1145
1A	7/28/87	9	-0.3		-0.01	1.1			26	0	1128
1A	8/21/89	9.7		-0.1	-0.01		29.8	38	37	0	1400
82	5/12/86	68		-0.3	-0.01		20.6		61		1116
82	7/21/86	38.8		-0.3	0.042	1.1	29		37		1110
82	7/28/87	25	-0.3		-0.01	1.1			59	0	1016
82	8/21/89	10.1		-0.1	0.01		27.4	38	36	0	1220

Note: Blank = not analyzed
ND = not detected, detection limit unknown
Negative values indicate non-detects (values correspond to detection limits)

Martins Creek SES Surface Water Site 3 (cont)
Analytical Results from Stations 3, 5, 6, 7, 1A, 82

Unless otherwise noted, units in mg/L

Station	Date	Color, pt-c.	Field pH	Dissolved Oxygen, Field	Hardness as CaCO3	Hardness, as Calcium	Lab pH	Solids, Dissolved estimated	Solids, Dissolved at 105 °C	Solids, Dissolved at 180 °C	Solids-Tot
03	5/12/86		7.8	9.6	68		7.4			99.2	101
03	7/21/86		7.65	7.8	122.3		7.8			181.2	186
03	7/28/87		8.1	7	51	37	7.8		100		108
03	8/21/89	10	7.25	8.1	70.1	49.5	7.6	132	102		102
05	5/12/86		7.5	9.4	49.2		7.5			75.8	77.3
05	7/21/86		7.4	7.4	40.4		7.45			68.2	70.1
05	7/28/87		8.1	7	42.4	30.5	7.9		94		104
05	8/21/89	-5	6.81	7.6	54.9	38	7.7	100.8	100		100
06	5/12/86		7.35	9.2	50.2		7.4			75.4	77.5
06	7/21/86		7.25	7.3	40.6		7.3			65.8	69.5
06	7/28/87		6.7	7.1	40.2	28.3	7.2		78		88
06	8/21/89	10	6.83	7.6	53.9	37	7.15	98.8	98		98
07	5/12/86		7.8	9.7	46.8		7.5			72	73.4
07	7/21/86		7.8	8.2	38.1		7.8			63.2	66.4
07	7/28/87		8.5	7.2	40.4	28.5	7.8		88		94
07	8/21/89	-5	7.38	8.2	52.9	36.8	7.3	97.5	78		78
1A	5/12/86		7.6	11.2	54.1		7.5			77.8	79.3
1A	7/21/86		7.25	7.8	40.4		7.7			63.2	65.6
1A	7/28/87		6.8	7.8	39.1	28	7.7		72		84
1A	8/21/89	15	6.96	8.5	52.9	36.8	7.6	97.5	130		130
82	5/12/86		8.8	10	104		8.3			167.4	178
82	7/21/86		7.6	7.4	60.1		7.9			98.2	102.9
82	7/28/87		7.15	7.6	91.2	69.8	8.1		176		190
82	8/21/89	15	6.83	7.6	52.7	37	8.1	97.5	100		100

Note: Blank = not analyzed
ND = not detected, detection limit unknown
Negative values indicate non-detects (values correspond to detection limits)

Martins Creek SES Surface Water Site 3 (cont)
Analytical Results from Stations 3, 5, 6, 7, 1A, 82
Unless otherwise noted, units in mg/l.

Station	Date	Specific Conductance Field, umhos/cm	Specific Conductance Lab, umhos/cm	Suspended Solids	Turbidity, as NTU	Water Temperature °C
03	5/12/86	135	358	1.8	1.6	19
03	7/21/86	290	660	4.8	4	23
03	7/28/87		292	8	1.5	29
03	8/21/89	160	170	3.5	1.9	25.8
05	5/12/86	110	288	1.5	1	17.5
05	7/21/86	115	258	3.9	1.8	25
05	7/28/87		256	10	1	29
05	8/21/89	149	155	2	1.5	24.5
06	5/12/86	110	284	2.1	0.9	16
06	7/21/86	122	250	3.7	1.6	24
06	7/28/87		237	10	0.7	31.5
06	8/21/89	141	150	1.5	1.3	24
07	5/12/86	112	271	1.4	0.7	18.5
07	7/21/86	112	236	3.2	1.6	26
07	7/28/87		245	6	0.8	31.5
07	8/21/89	152	150	1.3	1.2	27
1A	5/12/86	120	265	1.5	0.8	17
1A	7/21/86	115	241	2.4	1.4	26.5
1A	7/28/87	120	233	12	0.8	27
1A	8/21/89	142	145	1.3	1.7	25.2
82	5/12/86	230	608	10.6	3	17.5
82	7/21/86	120	309	4.7	2.6	27
82	7/28/87	257	509	14	2	26
82	8/21/89	140	155	2.6	2.2	23.8

Note: Blank = not analyzed
ND = not detected, detection limit unknown
Negative values indicate non-detects (values correspond to detection limits)

Martins Creek SES Surface Water Site 39 (cont)

Analytical Results from Station 1

Unless otherwise noted, units in mg/L

Station	Date	Aluminum-Dis (COL)	Aluminum-Tot	Ammonia, as N	Bicarbonate Ion	Cadmium-Tot	Calcium-Dis	Chloride-Tot	Chloride, as NaCl	Chromium-Tot	Copper-Tot	Iron-Tot	Magnesium-Dis	Manganese-Tot	Nickel-Dis	Nitrate-Total
01	1/16/90	0.01	-0.2	0.14	32.9	-0.01	11.1	14	23	-0.05	0.02	0.11	4	0.02	-0.06	0.97
01	2/27/90		-0.2	0.1	19.5	-0.01	8.7	8.5	14	-0.05	-0.02	0.15	2.1	0.04	-0.06	2.29
01	3/27/90		-0.2	0.1	17.1	-0.01	8.2	8.5	15	-0.05	0.02	0.16	1.8	0.03	-0.05	2.24
01	6/26/90		-0.2	0.13	37.9	-0.01	12.6	4.9	8	-0.05	-0.02	0.2	3.5	0.05	-0.05	0.84
01	7/31/90		-0.2	0.15	41.5	-0.01	13.6	10.9	18	-0.05	-0.02	0.15	3.8	-0.02	-0.06	1.27
01	8/26/90		-0.2	0.21	39.9	-0.01	11.7	8.7	16	-0.05	-0.02	0.22	3	0.04	-0.06	1.34
01	1/23/91		-0.2	0.11	39.1	-0.01	10.4	8.7	16	-0.05	-0.02	0.09	2.7	0.03	-0.06	2.21
01	4/4/91		-0.2	0.07	35.9	-0.01	9.1	8.5	14	-0.05	-0.02	0.15	2.4	0.05	-0.05	2.22
01	5/31/91		-0.2	0.14	37.9	-0.01	11.1	8.7	16	-0.05	-0.02	0.13	3.3	0.06	-0.05	2.1
01	6/26/91		-0.2	0.07	39	-0.01	11.3	10.9	18	-0.05	-0.02	0.28	3.4	0.07	-0.05	1.5
01	7/23/91		-0.2	0.07		-0.01	10.2	10.3	17	-0.05	-0.02	0.06	3	0.03	-0.05	1.27
01	8/26/91		-0.2	0.06	31.7	-0.01	10.6	10.9	18	-0.05	-0.02	0.06	2.9	0.04	-0.05	0.97
01	12/18/91		-0.2	0.14	19.5	-0.01	9	8.5	14	-0.05	-0.02	0.14	2.2	0.03	-0.06	2.18
01	1/30/92		-0.2	0.12	19.5	-0.01	9	10.3	17	-0.05	-0.02	0.1	2.3	0.02	-0.05	2.11
01	3/31/92		-0.2	0.09	17.1	-0.01	7.8	9.1	15	-0.05	-0.02	0.18	2	0.04	-0.05	1.85
01	5/8/92		-0.2	0.1	22	-0.01	8.6	8.5	14	-0.05	-0.02	0.21	2.2	0.05	-0.05	1.89
01	7/22/92		-0.2	0.12	31.7	-0.01	11	8.7	16	-0.05	-0.02	0.21	3	0.06	-0.05	1.89
01	10/26/92		-0.2	0.1	34.2	-0.01	10.7	8.7	16	-0.05	-0.02	0.07	2.8	-0.02	-0.05	0.43

Note: Blank = not analyzed

ND = not detected, detection limit unknown

Negative values indicate non detects (values correspond to detection limits)

Martins Creek SES Surface Water Site 39

Analytical Results from Station 1

Unless otherwise noted, units in mg/L.

Station	Date	Aluminum-Dis (COL)	Aluminum-Tot	Ammonia, as N	Bicarbonate Ion	Cadmium-Tot	Calcium-Dis	Chloride-Tot	Chloride, as NaCl	Chromium-Tot	Copper-Tot	Iron-Tot	Magnesium-Dis	Manganese-Tot	Nickel-Dis	Nitrate-Total
01	1/2/85	0.01	[illegible]	0.14	40.4	-0.01	17.8	14.8		-0.03	0.08	0.18	4.5	0.03	-0.03	4.18
01	2/27/85	0.01	-0.3	0.18	13.6	-0.01	7.5	7.3		-0.03	0.02	0.43	1.7	0.07	-0.03	2.86
01	3/7/85	0	-0.3	0.08	25.8	-0.01	11	8.1		-0.03	0.01	0.18	2.7	0.05	-0.03	2.12
01	4/30/85	0	-0.3	0.08	29.3	-0.01	11.5	8.5		-0.03	0.01	0.17	2.8	0.06	0.03	1.48
01	6/26/85	0	-0.3	0.08	30	-0.01	13.2	8.7		-0.03	0.02	0.17	3.4	0.04	0.03	4.5
01	8/25/85	0.01	-0.3	0.13	37.8	-0.01	12.8	12.1		-0.03	0.02	0.08	3	0.04	-0.03	8.3
01	10/22/85	0.02	-0.3	[illegible]	26.1	-0.01	11.4	7.8		-0.03	0.03	0.2	2.7	0.03	-0.05	0.88
01	1/30/86	0.02	-0.2	0.14	34.2	-0.01	10.3	14.6		-0.05	-0.02	0.28	3.4	0.06	-0.05	4.24
01	3/7/86	0.01	-0.2	0.08	30.8	-0.01	14.1	11.5		-0.05	-0.02	0.38	3	0.07	-0.05	5.01
01	4/7/86	0.01	-0.2	0.1	17.1	-0.01	8	8.1		-0.05	-0.02	0.18	1.8	0.03	-0.05	0.86
01	5/7/86	0.01	-0.2	0.04	36.4	-0.01	12.1	8.1		-0.05	-0.02	0.25	3.1	0.05	-0.05	2.38
01	6/16/86	0.01	-0.2	0.18	18.3	-0.01	7.5	8.5		-0.05	-0.02	0.28	1.7	0.05	-0.05	0.86
01	7/31/86	0.01	-0.2	0.12	24.4	-0.01	8.8	7.8		-0.05	0.03	0.35	2.3	0.07	-0.05	1.87
01	8/26/86	0.01	-0.2	0.13	37.6	-0.01	12.8	8.7		-0.05	0.02	0.18	3.4	0.03	-0.05	1.48
01	9/2/86	0.01	-0.2	0.08	34.2	-0.01	12.2	10.3		-0.05	-0.02	0.1	3.4	0.03	-0.05	2.04
01	10/7/86	0.01	-0.2	0.08	30.8	-0.01	11.3	8.7		-0.05	-0.02	0.1	2.8	0.02	-0.05	0.8
01	11/26/86	0.01	-0.2	0.08	30.7	-0.01	8.8	7.3		-0.05	0.02	0.27	2	0.06	-0.05	2.33
01	1/28/87	0.02	-0.2	0.18	30	-0.01	10.2	12.7		-0.05	-0.02	0.32	5.6	0.04	-0.05	3.16
01	2/26/87	0.01	-0.2	0.08	40.4	-0.01	15.4	12.1		-0.05	0.08	0.25	4	0.15	-0.05	0.6
01	4/22/87	0.01	-0.2	0.11	24.4	-0.01	8.4	7.3		-0.05	-0.02	0.21	2.4	0.06	-0.05	1.8
01	5/18/87	0.01	-0.2	0.14	40.4	-0.01	14.7	10.9		-0.05	0.02	0.18	4.3	0.04	-0.05	1.75
01	6/17/87	0.01	-0.2	0.12	31.7	-0.01	11.5	8.7		-0.05	-0.02	0.1	3	0.04	-0.05	3.1
01	7/31/87	0	-0.2	0.08	32.8	-0.01	11.3	8.5		-0.05	-0.02	0.15	2.7	0.05	-0.05	0.84
01	9/28/87	0.01	-0.2	0.18	29.8	-0.01	8.8	7.3		-0.05	-0.02	0.23	2.4	0.07	-0.05	1.25
01	11/23/87	0	-0.2	0.1	30.8	-0.01	11.5	7.8		-0.05	-0.02	0.11	2.8	0.03	-0.05	1.1
01	1/27/88	0.01	-0.2	0.1	42.7	-0.01	10.1	18.8		-0.05	-0.02	0.18	3.8	0.03	-0.05	3.15
01	2/23/88	0.01	-0.2	0.17	26.1	-0.01	11.3	12.7		-0.05	-0.02	0.2	3	0.04	-0.05	2.34
01	3/10/88	0	-0.2	0.1	24.4	-0.01	10.4	11.5		-0.05	0.02	0.34	2.8	0.07	-0.05	1.8
01	5/17/88	0.01	-0.2	0.14	32.8	-0.01	11.6	9.5		-0.05	-0.02	0.18	3.2	0.07	-0.05	1
01	6/13/88	0.01	-0.2	0.1	40.3	-0.01	13.2	10.3		-0.05	-0.02	0.12	3.8	0.03	-0.05	0.88
01	7/28/88	0.02	-0.2	0.17	31.7	-0.01	11.8	10.0		-0.05	-0.02	0.25	3.3	0.06	-0.05	1.44
01	8/29/88	0.01	-0.2	0.08	36.4	-0.01	11.7	10.3		-0.05	-0.02	0.21	3.2	0.05	-0.05	0.81
01	9/20/88	-0.01	-0.2	0.08	32.8	-0.01	11.9	10.1		-0.05	-0.02	0.06	3	0.03	-0.05	0.86
01	10/26/88	0	-0.2	0.08	38.5	-0.01	10.9	10.3		-0.05	-0.02	0.21	2.8	-0.02	-0.05	0.88
01	11/15/88	0.01	-0.2	0.13	28.8	-0.01	10.4	9.1		-0.05	-0.02	0.1	2.6	0.02	-0.05	1.6
01	1/18/89	0.01	-0.2	0.12	34.9	-0.01	13.2	10.4		-0.05	0.02	0.09	3.5	0.02	-0.05	2.35
01	2/3/89	0	-0.2	0.12	37.8	-0.01	13.8	14.8		-0.05	-0.02	0.08	3.8	0.02	-0.05	2
01	3/9/89	0.01	-0.2	0.08	30.8	-0.01	11.6	14.0		-0.05	-0.02	0.11	3.1	0.05	-0.05	1.78
01	4/26/89	0.01	-0.2	0.14	31.7	-0.01	11.2	12.1		-0.05	0.02	0.17	3	0.06	-0.05	1.26
01	5/23/89	0	-0.2	0.11	30.7	-0.01	8.7	7.3		-0.05	-0.02	0.35	2	0.06	-0.05	1.6
01	6/21/89	0.01	-0.2	0.12	29.3	-0.01	10.8	8.8		-0.05	-0.02	0.45	2.8	0.07	-0.05	1.7
01	7/25/89	0.01	-0.2	0.15	40.3	-0.01	12.8	9.1		-0.05	-0.02	0.17	3.3	0.04	-0.05	1.78
01	8/15/89	0.01	-0.2	0.08	32.8	-0.01	11.4	10.3		-0.05	-0.02	0.06	3	0.03	-0.05	1.46
01	10/18/89	0.01	-0.2	0.26	45.1	-0.01	14.3	10.3		-0.05	-0.02	0.23	4.1	0.03	-0.05	1.18
01	11/28/89	0	-0.2	0.15	31.7	-0.01	11.1	9.5		-0.05	0.02	0.13	2.8	0.02	-0.05	3.04
01	12/27/89	0	-0.2	0.25	42.7	-0.01	14.8	10.9		0.05	0.03	0.08	4	0.02	-0.05	2.66

Martins Creek SES: Surface Water Site 39 (cont)
Analytical Results from Station 1
(Unless otherwise noted, units in mg/L)

Station	Date	Potassium-Dis	Silicon Dioxide	Sodium-Dis	Sulfate-Tot	Zinc-Tot	Alkalinity, methyl orange, CaCO3	Alkalinity, phenolphthalein, CaCO3	CO3	Hardness as CaCO3	Hardness, as Calcium	Hardness as Magnesium	Lab pH	PO4-P	Specific Conductance Lab, umhos/cm	Suspended Solids
01	1/28/85	1.3	3.22	9.1	10.2	0.01	30	0	0	61.5			15		180	2.1
01	2/27/85	0.8	3.06	4	9.5	0.01	11			25.8			14.7		82	10.2
01	3/26/85	0.5	1.50	5.7	10.8	0.01	31			36.8			18.2		114	1.4
01	4/30/85	1	1.41	5.6	12	0.01	24	0	0	40.7			14.3		114	2.8
01	6/26/85	1	1.47	6.1	10.6	0.02	32			47			7.6		130	2
01	8/25/85	1.3	[illegible]	7.5	11.5	0.01	31	0	0	44.4			7.7		131	2
01	10/22/85	1	2.8	6.5	10.4	0.01	23			38.8			14.8		110	1.4
01	1/30/86	1.2	6.05	5.8	21	0.02	28			54.8			14.8		164	5.6
01	2/27/86	1	4.52	7	14	0.03	25			47.8			14.8		135	7.4
01	4/29/86	0.4	2.15	4.4	10.3	0.02	14			27.8			14.55		84	3.6
01	5/22/86	1	2.09	6.3	12	0.01	29	0	0	43			7.4		120	7.7
01	6/18/86	0.6	2.37	3.7	9.8	0.01	15	0	0	25.3			14.75		77.5	7.2
01	7/31/86	0.7	2.40	5	9.8	0.02	30	0	0	34			15		88	12.7
01	8/26/86	1	1.81	6.5	17.4	0.01	31	0	0	45.5			7.6		125	2
01	9/29/86	1.1	2.15	6.8	9	0.01	28	0	0	44.5			15.5		128	1.8
01	10/29/86	1	0.9	6.3	10.6	0.01	25	0	0	38.8			15.1		118	5.8
01	11/26/86	1	3.9	4.5	12.4	0.01	17			32.7			14.7		85.8	6.5
01	1/26/87	1.1	4.18	6.4	10.2	0.02	32	0	0	64.2			15.1		165	4.5
01	2/26/87	0.8	3.33	7.6	12.2	0.23	30	0	0	55			14.2		150	22.3
01	4/22/87	0.8	2.2	4.7	10	0.02	29	0	0	33.4			14.7		94	5.8
01	5/19/87	0.8	1.24	7	11	0.01	36	0	0	64.5	38.8		7.5		147	2.8
01	6/17/87	0.8	1.47	6.2	9	0.02	36	0	0	41.2	28.6		7.4		115	3.7
01	7/31/87	0.8	1.36	6.3	10	0.02	27	0	0	38.4	28.2		7.7		115	3
01	8/28/87	0.8	2.66	4.8	9	0.01	22	0	0	34.7	24.8		6.6		101	6.5
01	11/23/87	0.8	2.15	5.4	10	0.01	25	0	0	40.7	28.6		7.8		113	1.5
01	1/27/88	1	3.8	8.8	13	0.02	36	0	0	56	40.3		7.3		170	2.7
01	2/23/88	0.8	3.06	6.1	10	0.03	23	0	0	40.7	28.3		7.3		127	2.5
01	3/10/88	0.7	3.78	7.2	10	0.02	30	0	0	36.7	28		7.1		118	8
01	5/17/88	0.8	1.36	6.6	11	0.01	27	0	0	42.7	29.5		7.2		130	3.2
01	6/13/88	0.8	0.99	7.1	11	0.01	33	0	0	46.7	33		7.2		137	8.1
01	7/26/88	1	3.27	7.1	11	0.01	30	0	0	43.1	29.5		7		130	8.1
01	8/29/88	1.1	1.78	7	11	0.01	29	0	0	42.5	29.3		7.2		130	3.3
01	9/20/88	1	1.21	6.1	10	0.01	27	0	0	42.2	29.6		7.4		130	1
01	10/26/88	1.1	1.75	6.6	10	0.01	35	0	0	38.2	27.3		6.8		190	0.6
01	11/15/88	0.8	2.46	6.3	11	0.01	32	0	0	38.7	28		7.8		118	1
01	1/18/89	0.8	2.73	10.1	11.8	0.03	29	0	0	47.4	55		7.4		155	0.7
01	2/3/89	1.1	1.96	6	10.8	0.01	31	0	0	46.7	34		7.5		155	0.8
01	3/9/89	0.8	2.07	4.4	11	0.03	35	0	0	41.8	28		7.4		130	1.5
01	4/26/89	0.8	1.26	6.6	10.6	0.01	26	0	0	40.4	28		7.5		128	3.8
01	5/23/89	0.8	2.46	5.2	9.3	0.02	37	0	0	30	21.8		7.5		84.7	10.8
01	6/21/89	0.8	2.77	6	9.8	0.03	34	0	0	38.8	27.3		7.1		110	13
01	7/25/89	0.8	2.34	6.6	10.6	0.02	33	0	0	45.1	31.5		7.2		138	1.3
01	8/15/89	1.1	1.52	7	9.3	0.01	27	0	0	40.8	28.5		7.2		125	2.5
01	10/16/89	1.2	2.8	6.8	11.4	0.02	37	0	0	52.7	35.8		7		146	6.2
01	11/28/89	0.8	2.08	5.6	10.6	0.04	29	0	0	38.7	27.8		6.5		118	1.3
01	12/27/89	1	2.7	7.2	13.6	0.03	35	0	0	53	30.5		7.2		133	0.5

Martins Creek SES Surface Water Site 39 (cont)
Analytical Results from Station 1
Unless otherwise noted, units in mg/l

Station	Date	Potassium-Dis	Silicon Dioxide	Sodium-Dis	Sulfate-Tot	Zinc-Tot	Alkalinity, methyl orange, CaCO3	Alkalinity, phenolphthalein, CaCO3	CO3	Hardness as CaCO3	Hardness, as Calcium	Hardness as Magnesium	Lab pH	PO4-P	Specific Conductance Lab, umhos/cm	Suspended Solids
01	1/18/90	1	2.7	8.1	12.4	0.02	27	0	0	51.8	35.3	16.6	7.6		150	0.8
01	2/27/90	0.8	3.01	5.4	9.9	0.01	16	0	0	30.8	21.8	8.7	7		95	2.5
01	3/27/90	0.8	2.44	5	9.6	0.05	14	0	0	26.5	20.5	7.6	7.4		99	3.5
01	6/26/90	0.8	1.73	6.7	10.3	0.02	31	0	0	45.9	31.5	14.4	7.4		127	3.9
01	7/31/90	0.9	2.22	6.8	8.1	0.01	34	0	0	46.7	34	15.7	7.3		113.5	1.2
01	8/28/90	1	3.33	6.2	9.3	0.01	30	0	0	41.7	29.3	12.4	7		115	3.6
01	1/23/91	0.8	3.66	5.9	8.7	0.01	23	0	0	37.1	28	11.5	7.6		115	1
01	4/4/91	0.8	2.31	5.1	8.7	0.01	21	0	0	30.2	20.3	9.9	7.7		101	2.8
01	5/31/91	0.9	2.63	6.7	9.8	0.01	31	0	0	41.4	27.8	13.6	7.6		128	3.3
01	6/28/91	1	[illegible]	7.2	10.1	0.07	32	0	0	42.5	28.3	14	7.3		118	2.5
01	7/23/91	1	4.47	6.8	7.1	0.01	29			37.9	25.5	12.4	7.4		120	1.8
01	8/28/91	1.1	4.45	7.8	11.3	0.01	29	0	0	38.4	26.5	11.8	7.5		140	4.6
01	12/18/91	0.8	3.6	[illegible]	10.8	0.02	18	0	0	29.1	20	8.1	7.5		98	1.5
01	1/30/92	0.9	3.42	6	8.7	0.01	18	0	0	32	22.5	9.5	7.3		111	1.1
01	3/31/92	0.7	3.21	5	7.9	-0.01	14	0	0	27.7	19.5	8.2	7.2		94	3
01	5/8/92	0.8	2.17	5.4	8.1	0.06	18	0	0	30.8	21.5	8.1	7.3		99	4.8
01	7/22/92	0.9	2.54	7.2	8.7	-0.01	26	0	0	30.8	27.5	12.4	7.5		122	4.3
01	10/28/92	1	0.85	8.1	7.5	-0.01	29	0	0	38.3	26.8	11.5	7.4		113	0.6

Note: Blank = not analyzed
ND = not detected, detection limit unknown
Negative values indicate non detects (values correspond to detection limits)

Martins Creek SES Surface Water Site 39 (cont)
Analytical Results from Station 1
Unless otherwise noted, units in mg/L

Station	Date	Total Mineral Solids uncorr.	Tot. negative meq/l	Tot. positive meq/l	Turbidity, as NTU	Water Temperature °F
01	1/29/85	110.7			1.4	
01	2/27/85	60.2			2.7	
01	3/29/85	69.1			1.1	
01	4/30/85	73.7			0.8	
01	6/26/85	88			1	
01	8/28/85	83.7			1.1	
01	10/22/85	69.9			0.9	
01	1/30/86	109.7			4.8	
01	2/27/86	80.2			2.9	
01	4/29/86	81.2			2.1	
01	5/22/86	93.5			3.1	
01	6/10/86	90			3	
01	7/31/86	84.2			2.7	
01	8/28/86	86.7			1.2	
01	9/29/86	85.6			1	
01	10/29/86	73.6			1	
01	11/26/86	84			2.6	
01	1/28/87	104.6			1.4	
01	2/26/87	102.6			1	
01	4/22/87	83.2			1.4	
01	6/16/87	84.10			1	
01	6/17/87	78.47			0.9	
01	7/31/87	74.6			1.5	
01	8/28/87	85.2			3	
01	11/23/87	72.3			1	
01	1/27/88	109.3			1	
01	2/23/88	80.2			1.9	
01	3/10/88	72.4			4.3	
01	5/17/88	77.2			1.4	
01	6/13/88	88.2			0.8	
01	7/26/88	91.7			2	
01	8/29/88	82.3			2.1	
01	9/20/88	80.3			1.1	
01	10/20/88	74.3				
01	11/15/88	70.9			1.2	
01	1/18/89	85.2			0.7	
01	2/3/89	94.7			2.3	
01	3/8/89	84			1.2	
01	4/28/89	76.6			1.5	
01	5/23/89	88.2			4.5	
01	6/21/89	71.6			0.7	
01	7/25/89	84.9			1.5	
01	8/15/89	78.4			1	
01	10/18/89	87.4			2.3	
01	11/29/89	78.2			1	
01	12/27/89	89.5			0.7	33

Martins Creek SES Surface Water Site 19 (cont)
Analytical Results from Station 1
Unless otherwise noted, units in mg/l

Station	Date	Total Mineral Solids unsert.	Tot. negative meq/l	Tot. positive meq/l	Turbidity, as NTU	Water Temperature °F
01	1/18/90	85.8			1.1	35
01	2/27/90	80.2			2.3	34
01	3/27/90	55.7			1.7	44
01	6/26/90	79.2			1.8	75
01	7/31/90	80.2			0.8	80
01	8/29/90	82.2			2.2	79.3
01	1/23/91	72.2			1	32.5
01	4/4/91	83.7	0.87624	0.8438	2.1	48
01	5/31/91	84.1	1.13310	1.13084	1.3	78.7
01	6/26/91	85.8	1.18121	1.18215	1.1	80
01	7/23/91			1.07688		
01	8/28/91	78.7	1.07792	1.13478	1.3	80.8
01	12/18/91	61.2	0.82132	0.83877	1.7	33
01	1/30/92	83.4	0.84588	0.83288	1.3	33
01	3/31/92		0.73117	0.81848	2.1	40
01	5/6/92		0.81663	0.86530	2.3	58
01	7/22/92	78.8	1.00417	1.13174	2	82
01	10/28/92	73.2	0.90318	1.05504	1.1	48

Note: Blank = not analyzed
ND = not detected, detection limit unknown
Negative values indicate non detects (values correspond to detection limits)

Martins Creek SES Surface Water Site 39
Analytical Results from Stations 3, 5, 1A
Unless otherwise noted, units in mg/l.

Station	Date	Aluminum-Tot	Ammonia, as N	Antimony-Tot	Arsenic-Tot	Barium-Tot	Beryllium-Tot	Boron-Tot	Calcium-Tot	Cadmium-Tot	Chloride-Tot	Chloride, as NaCl
03	3/12/92	0.64	0.14	-0.7	0.006	0.037	-0.0004	-0.04	10.98	0.0172	11.5	19
03	6/18/92	-0.06	0.13	-0.7	0.0216	0.031	-0.0004	0.066	18.29	-0.0016	8.5	14
03	9/18/92	0.207	0.08	-0.7	0.0782	0.048	-0.0004	0.299	29.2	-0.0016	12.1	20
03	12/11/92	0.322	0.11	-0.7	0.0874	0.036	-0.0004		30.8	-0.0016	9.7	16
05	3/12/92	0.3	0.17	-0.7	0.001	0.028	-0.0004	-0.04	11.42	0.0087	11.5	19
05	6/18/92	-0.06	0.12	-0.7	-0.001	0.022	-0.0004	-0.04	17.72	-0.0016	10.3	17
05	9/18/92	0.06	0.13	-0.7	0.001	0.023	-0.0004	-0.04	17.7	-0.0016	11.5	19
05	12/11/92	3.959	0.22	-0.7	0.0016	0.048	-0.0004		25.3	-0.0016	17.6	29
1A	3/12/92	0.39	0.17	-0.7	0.001	0.032	-0.0004	-0.04	8.67	0.0106	10.3	17
1A	6/18/92	-0.06	0.13	-0.7	-0.001	0.051	-0.0004	-0.04	20.31	-0.0016	19.4	32
1A	9/18/92	-0.06	0.13	-0.7	-0.001	0.024	-0.0004	-0.04	12.3	-0.0016	10.3	17
1A	12/11/92	0.144	0.12	-0.7	-0.001	0.022	-0.0004		11.7	-0.0016	9.7	16

lote: Blank = not analyzed
ID = not detected, detection limit unknown
legative values indicate non detects (values correspond to detection limits)

Martins Creek SES Surface Water Site 39 (cont)
Analytical Results from Stations 3, 5, 1A
Unless otherwise noted, units in mg/L

Station	Date	Chromium-Tot	Copper-Tot	Iron-Tot	Lead-Tot	Lithium-Tot	Magnesium-Tot	Manganese-Tot	Molybdenum-Tot	Nickel-Tot	Nitrate, as N	Nitrate, as NO3
03	3/12/92	-0.011	-0.02	0.69	-0.007	-0.04	2.31	0.14	-0.14	-0.09	0.42	1.88
03	6/18/92	-0.004	-0.02	0.079	-0.01	-0.04	4.77	-0.02	-0.14	-0.09	0.65	2.86
03	9/18/92	0.0285	-0.02	0.17	-0.01	0.047	4.6	-0.02	-0.14	-0.09	1.06	4.69
03	12/11/92	-0.004	-0.02	0.16	-0.01		4.8	0.03		-0.09	0.69	3.04
05	3/12/92	-0.011	-0.02	0.35	-0.007	-0.04	2.53	0.07	-0.14	-0.09	0.69	3.07
05	6/18/92	-0.004	-0.02	0.082	-0.01	-0.04	4.96	-0.02	-0.14	-0.09	1.03	4.57
05	9/18/92	0.0295	-0.02	0.13	-0.01	0.04	5	-0.02	-0.14	-0.09	0.72	3.17
05	12/11/92	-0.004	-0.02	2.66	-0.01		5.9	0.211		-0.09	1.79	7.9
1A	3/12/92	-0.011	-0.02	0.46	-0.007	-0.04	1.78	0.11	-0.14	-0.09	0.35	1.57
1A	6/18/92	-0.004	-0.02	0.093	-0.01	-0.04	5.31	0.052	-0.14	-0.09	0.39	1.73
1A	9/18/92	0.0208	-0.02	0.12	-0.01	-0.04	3.2	0.027	-0.14	-0.09	0.28	1.23
1A	12/11/92	-0.004	-0.02	0.11	-0.01		3.3	0.051		-0.09	0.5	2.22

Note: Blank = not analyzed

ND = not detected, detection limit unknown

Negative values indicate non-detects (values correspond to detection limits)

Martins Creek SES Surface Water Site 39 (cont)
Analytical Results from Stations 3, 5, 1A
Unless otherwise noted, units in mg/L

Station	Date	Potassium-Tot	Selenium-Tot	Silver -Total	Sodium-Tot	Strontium-Tot	Sulfate, as SO4	Thallium-Tot	Vanadium-Tot	Zinc-Tot	Alkalinity, methyl orange, CaCO3
03	3/12/92	1.5	0.002	-0.02	6.7	0.059	15	-0.011	-0.04	0.02	19
03	6/18/92	-2.78	0.0052	-0.02	6.79	0.116	35.3	-0.012	-0.04	-0.04	37
03	9/18/92	-2.78	0.0165	-0.02	32	0.261	62.8	-0.012	0.114	-0.04	61
03	12/11/92	-2.8	0.0115	-0.02	14.2		48.2	-0.012	0.102	-0.04	51
05	3/12/92	1	-0.001	-0.02	6.9	0.051	14.5	-0.011	-0.04	0.04	21
05	6/18/92	-2.78	-0.0005	-0.02	5.74	0.09	35.3	-0.012	-0.04	-0.04	34
05	9/18/92	-2.78	-0.0005	-0.02	8.8	0.096	18.22	-0.012	-0.04	-0.04	42
05	12/11/92	3	-0.0005	-0.02	10.2		28.7	-0.012	-0.04	-0.04	46
1A	3/12/92	0.9	-0.001	-0.02	6.2	0.039	11	-0.011	-0.04	0.02	14
1A	6/18/92	-2.78	-0.0005	-0.02	11.02	0.092	19.8	-0.012	-0.04	-0.04	25
1A	9/18/92	-2.78	-0.0005	-0.02	7.3	0.062	9.7	-0.012	-0.04	-0.04	30
1A	12/11/92	-2.8	-0.0005	-0.02	5.6		10.1	-0.012	-0.04	-0.04	33

Note: Blank = not analyzed
ND = not detected, detection limit unknown
Negative values indicate non-detects (values correspond to detection limits)

Martins Creek SES Surface Water Site 39 (cont)

Analytical Results from Stations 3, 5, 1A

Unless otherwise noted, units in mg/L

tation	Date	Alkalinity, phenolphthalein, CaCO3	Collection Time in hours	Field pH	Dissolved Oxygen, Field	Hardness as CaCO3	Lab pH	Solids, Dissolved estimated	Specific Conductance Field umhos/cm	Specific Conductance Lab umhos/cm
03	3/12/92	0	915	7.1	11.8	38.9	7.4	78.7	80	121
03	6/18/92	0	850	7.4	8.6	65.3	7.9	122.9	235	189
03	9/18/92	5		7.4	4.2		8.9		433	366
03	12/11/92	0	805	6.7	12.6	96.2	7.9	173.6	311	267
05	3/12/92	0	840	6.9	12	38.9	7.5	81.3	75	125
05	6/18/92	0	820	7.2	8.6	64.7	7.7	122.2	184	188
05	9/18/92	0		7.3	6.4	-	7.8		189	189
05	12/11/92	0	905	7.1	13.7	87.5	8	148.2	242	228
1A	3/12/92	0	935	7.1	11	29	7.2	66.3	70	102
1A	6/18/92	0	910	7.4	8.6	72.6	7.5	151.5	233	233
1A	9/18/92	0		7.4	6.3		7.8		141	131
1A	12/11/92	0	825	7.1	13.9	42.8	7.7	83.9	137	129

ote: Blank = not analyzed

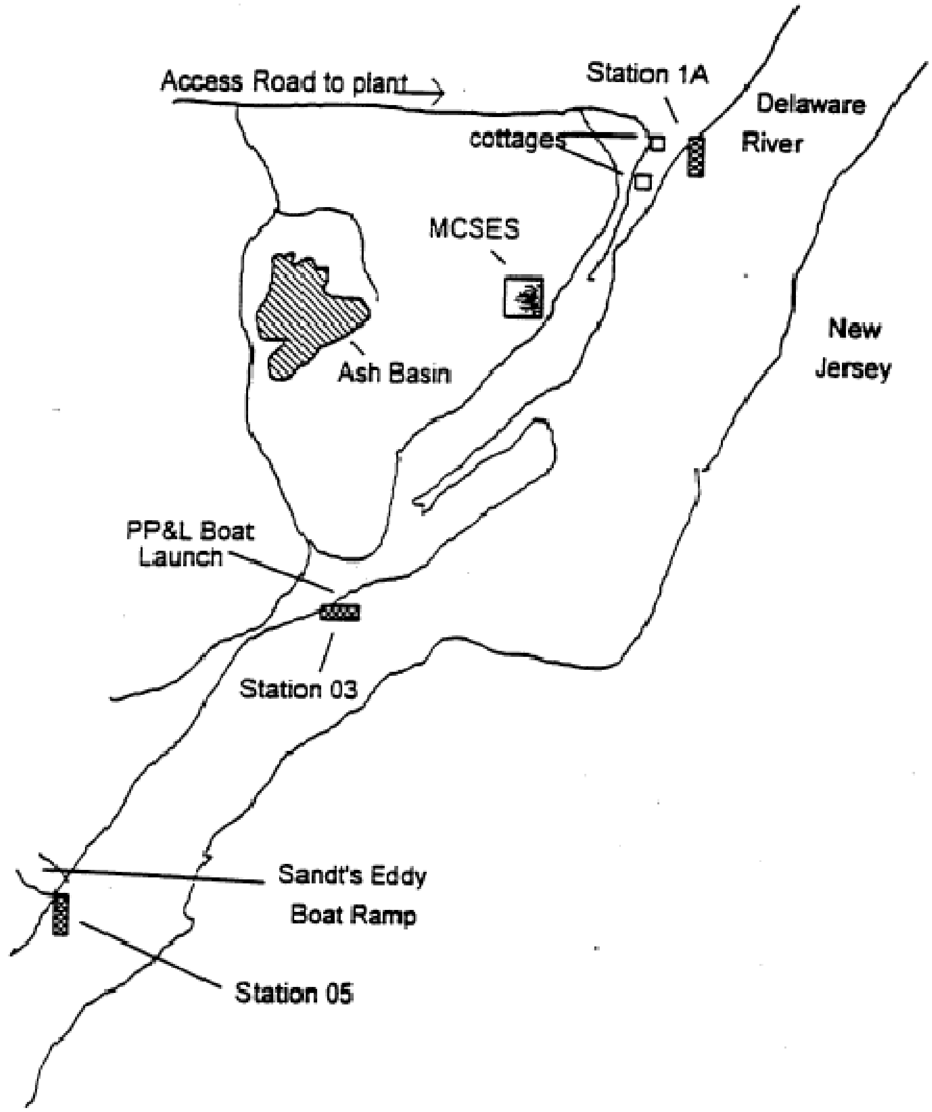
D = not detected, detection limit unknown

egative values indicate non detects (values correspond to detection limits)

Martins Creek SES Surface Water Site 39 (cont)
Analytical Results from Stations 3, 5, 1A
Unless otherwise noted, units in mg/l.

Station	Date	Suspended Solids	Water Temperature °C
03	3/12/92	27.7	5
03	6/18/92	2	21.5
03	9/18/92	9.8	18
03	12/11/92	8.8	5.5
05	3/12/92	15.7	5
05	6/18/92	2.2	19.9
05	9/18/92	0.8	21.4
05	12/11/92	109.2	2.6
1A	3/12/92	22.5	5
1A	6/18/92	3.6	22.3
1A	9/18/92	1.3	22.4
1A	12/11/92	3.3	2.1

Note: Blank = not analyzed
ND = not detected, detection limit unknown
Negative values indicate non-detects
(values correspond to detection limits)



Map 8
Martins Creek SES
Delaware River Stations

Summary of Delaware River Water Quality near PP&L's Martins Creek Steam Electric Station. Data from 1992-95 Surface Water Monitoring Program.

Parameter	STATION 1A Above MSES			Location STATION 03 At MSES			STATION 05 Below MSES		
	Number	Average	Range	Number	Average	Range	Number	Average	Range
Non Metals -									
M.O. Alkalinity, mg/l	16	24	10-41	19	51	9-102	15	50	10-280
Pheno. Alkalinity, mg/l	17	0	0-0	18	0	0-5	16	0	0-0
Field pH, s.u.	17	7.2	6.2-8.5	21	7.9	6.3-9.5	20	7.4	6.1-8.8
Lab pH @ 25 C, s.u.	17	7.5	6.6-8.3	18	8.1	6.4-9.2	16	7.7	6.5-8.4
Ammonia as N, mg/l	17	0.09	0-0.24	18	0.1	0-0.18	16	0.1	0-0.23
Chloride, mg/l	17	10.1	5.43-15.2	18	12.8	5.41-26.4	16	11.4	5.61-17.6
Flouride, mg/l	12	0.00	0-0	12	0.06	0-0.34	11	0.00	0-0
Tot. Hardness, mg/l	16	38.2	22.7-53.8	17	96	21.2-169.1	15	67.8	25.1-152.1
Nitrate as N, mg/l	17	0.27	<0.1-0.5	18	0.85	<0.1-1.45	16	0.91	0.43-1.79
Nitrate as NO3, mg/l	17	1.21	<0.1-2.22	18	3.77	<0.1-6.43	16	4.03	1.92-7.9
Diss. Oxygen, mg/l	10	9.2	6.3-13.9	12	8.6	4.2-12.6	10	8.9	5.8-13.7
Est. Diss. Solids, mg/l	13	77	41-121	14	171	42-334	12	105	49-158
Susp. Solids @ 103 C, mg/l	17	6.9	0-53	18	8.6	0.7-56	16	14.7	0-109.2
Field Cond., umhos/cm	17	122.7	29.8-269	18	336.3	63-810	16	155	22.8-283
Lab Cond., umhos/cm	16	120.1	62-185	18	274.5	65-511	16	166.9	75-241
Sulfate, mg/l	17	11.4	8.5-16.8	18	52.5	9-114	16	22.1	9.8-35.3
Water Temperature, C	17	13.6	1.7-25	18	15.2	3.6-28.3	16	13.9	2.6-25.5
Metals -									
Tot. Aluminum, ug/l	17	239	<200-2558	18	357	<200-2558	18	406.8	<200-3959
Tot. Antimony, ug/l	17	<700	<700-<700	18	<700	<700-4900	16	<700	<700-<700
Tot. Arsenic, ug/l	13	<1	<1-1.4	14	42.4	<1-135	12	<1	<1-1.5
Tot. Barium, ug/l	17	26	22-53	18	37	25-53	16	26	20-48
Tot. Beryllium, ug/l	17	<0.4	<0.4-<0.4	18	<0.4	<0.4-1	16	<0.4	<0.4-<0.4
Tot. Boron, ug/l	3	<40	<40-<40	3	182.5	<40-299	3	<40	<40-<40
Tot. Cadmium, ug/l	17	<1.6	<1.6-10.6	18	<1.6	<1.6-17.2	16	<1.6	<1.6-8.7
Tot. Calcium, mg/l	17	11.1	6.6-15.1	18	29.6	6-54.2	16	17.2	7.1-25.3

Summary of Delaware River Water Quality near PP&L's Martins Creek Steam Electric Station. Data from 1992-95 Surface Water Monitoring Program.

Parameter	Above MSES			At MSES			Below MSES		
	Number	Average	Range	Number	Average	Range	Number	Average	Range
Tot. Chromium, ug/l	16	<4	<4-20.8	18	4.2	<4-28.5	16	<4	<4-29.5
Tot. Copper, ug/l	17	<20	<20-<20	18	<20	<20-<20	18	<20	<20-<20
Tot. Iron, ug/l	17	235	<50-1910	18	266	<50-1920	16	404	<50-2760
Tot. Lead, ug/l	17	<10	<10-<10	18	<10	<10-<10	16	<10	<10-<10
Tot. Lithium, ug/l	[illegible]	<40	<40-<40	3	<40	<40-47	3	<40	<40-40
Tot. Magnesium, mg/l	17	2.7	1.5-3.9	18	5.3	1.5-8.3	16	4.3	1.8-8.1
Tot. Manganese, ug/l	17	55	<20-286	18	41	<20-287	16	54	<20-272
Tot. Molybdenum, ug/l	3	<140	<140-<140	3	<140	<140-<140	3	<140	<140-<140
Tot. Nickel, ug/l	17	<90	<90-<90	18	<90	<90-258	16	<90	<90-<90
Tot. Potassium, mg/l	17	<1.4	<1.4-<1.4	18	<1.4	<1.4-2.3	16	<1.4	<1.4-3.0
Tot. Selenium, ug/l	17	<1	<1-<1	18	6	<1-16.5	16	<1	<1-<1
Tot. Silver, ug/l	17	<20	<20-<20	18	<20	<20-<20	16	<20	<20-<20
Tot. Sodium, ug/l	17	6.1	2.9-8.0	18	15.8	2.9-42.9	16	7.1	3.1-10.2
Tot. Strontium, ug/l	3	53.5	39-62	3	189	59-261	3	93	51-96
Tot. Thallium, ug/l	17	<6	<6-<6	18	<6	<6-<6	16	<6	<6-<6
Tot. Vanadium, ug/l	17	<30	<30-<30	18	45	<30-141	16	<30	<30-<30
Tot. Zinc, ug/l	17	<40	<40-<40	18	<40	<40-101	16	<40	<40-<40

2540-PM-WM0500 1/95

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL RESOURCES
BUREAU OF WASTE MANAGEMENT

Coordination #

FORM 24R
RESIDUAL WASTE DISPOSAL IMPOUNDMENTS

This form must be fully and accurately completed. All required information must be typed or legibly printed in the spaces provided herein. Improperly completed forms may be rejected by the Department, may be considered to be violations of the Department's Rules and Regulations, and may result in assessment of fines and penalties.

DER USE ONLY

Application or Facility ID# ______
(Assigned by DER)

Stamp Date Application Received

WASTE MANAGEMENT
COUNTY:
SEP 10 1997
CODE:

General References: Section 289.114; 289.161; 289.212; 289.271-274.

SECTION A. APPLICANT IDENTIFIER Pennsylvania Power & Light Company

Facility Name: Martins Creek SES Ash Basin No. 4

☐ New ☒ Existing

County: Northampton

Permit No. 0012823 (NPDES)

Municipality: Lower Mount Bethel

SECTION B. IMPOUNDMENT PLAN (See Attached Narrative)

Attach a description of the impoundment plan, including specifications, designs, and cross sections. Describe the design of the impoundment, including the proposed volumetric capacity of each impoundment and schedule for construction and operation.

SECTION C. DESIGN REQUIREMENTS (See Attached Narrative 1-7)

1. Attach a slope stability analysis of the dike system that is proposed to support the impoundment.

2. Attach calculations indicating the freeboard is capable of preventing overtopping, including overtopping caused by the 24-hour precipitation event to be expected once in 25 years.
   Freeboard: ______ inches.

3. Will/does the dike have sufficient structural integrity to prevent failure? What are the minimum safety factors of the dike for dynamic and static loads?

   Safety factor for:
   a. static load: ______
   b. dynamic load: ______

4. Describe how the impoundment is (will be) equipped so that the flow of residual waste into the impoundment can be shut off immediately.

5. Describe how the dikes and berms are (will be) kept free of burrowing mammals and plants with root systems capable of displacing earthen materials upon which the structural integrity of the dikes or berms is dependent.

6. Demonstrate that the impoundment will be surrounded by structures sufficient to prevent surface run off from a 25-year, 24-hour precipitation event from entering the impoundment:

______
______
______

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SECTION C. DESIGN REQUIREMENTS (continued)

7. Describe how odors and the dispersal residual waste or waste constituents by wind and water erosion shall be prevented:

8. Inside slopes (not applicable to impoundments with concrete wall):

   a. What are the inside slopes (%)? 33%

   b. Are the inside slopes designed and constructed with sufficient protective cover to prevent wind and water erosion, and to preserve the structural integrity of the dike? Describe how the inside slopes are designed and constructed:

   The dikes are covered with an exposed hypalon liner. The water level is kept shallow, covering the ash to reduce wave development potential.

9. Outside slopes and terraces:

   a. What are the outside slopes (%)? 50% to 25%

   b. Describe how the outside slopes and terraces of the impoundment are designed, constructed, and operated?

   The outside slopes were built with a two and a quarter horizontal to one vertical slope, were covered with a foot of topsoil and seeded with crown vetch.

   c. How are the outside slopes and terraces of the dike prevented from wind and water erosion to preserve the structural integrity of the dike?

   The crown vetch adequately protects the outside slopes.

SECTION D. WASTE SOLIDIFICATION PLAN

1. Attach a plan, including necessary drawings, designs, specifications, timetables, waste analyses, and narrative descriptions to solidify the waste. The plan shall include laboratory and field test results showing that the waste can be solidified as proposed. N/A

2. Indicate the minimum bearing capacity of the waste in the impoundment after the solidification process: 1.5 tons/ft²

   The ash is already solid. The water within the ash will drain away through the discharge structure at closure. It should be possible to drive on the waste within a month or so after the basin is taken out of service.

- 2 -

MARTINS CREEK SES
ASH BASIN NO. 4
FORM 24R
RESIDUAL WASTE DISPOSAL IMPOUNDMENTS

B. Impoundment Plan

Martins Creek SES Ash Basin No. 4 was constructed in the late 1980's. Its location was chosen after a lengthy siting study which involved the public and considered a couple dozen sites. The basin dikes are built from soils excavated from within the basin and from an adjacent borrow area. Therefore a large portion of the disposal volume is below grade. The basin dikes do extend a maximum of about 30 feet above grade. The basin has no watershed other than itself. The outside dikes are covered with crown vetch. The outside dike slopes are 2.0 horizontal to 1.0 vertical near the top and flatten to 4.0 horizontal to 1.0 vertical at the bottom.

The inside of the basin is lined with a 36 mil reinforced hypalon liner placed on a 16 oz. geotextile which, in turn, was placed on a one foot thick (minimum) layer of bottom ash subgrade. The bottom ash provides additional cushion and reduces the risk of stones from underneath migrating up to the liner. The inside slope is 3.0 horizontal to 1.0 vertical.

Prior to basin construction, an extensive geophysical survey was performed across the site using seismic and resistivity methods to locate any sinkhole prone areas. The northeast corner of the site was found to have highly weathered bedrock indicating a sinkhole prone area. PP&L began an extensive bedrock grouting program that eventually eclipsed $1.5 million dollars in cost. In addition, during basin excavation, any exposed rock was closely inspected and any weathered rock received dental grouting prior to its being covered with subgrade materials. The basin has been in operation for seven years with no sinkholes inside or outside.

Fly ash is sluiced to the basin and distributed via floating pipelines capable of being moved to enable even ash distribution. The basin is also equipped with a truck turnaround where any miscellaneous ash wastes from the plant can be end-dumped. A cooling tower blowdown pipeline also discharges water periodically into the east side of the basin as does a sludge pipeline from the Industrial Waste Treatment Basin.

The basin is equipped with a stoplog discharge structure that is drained via a buried pipeline that runs to the Delaware River after combining with effluent from the Industrial Waste Treatment Basin.

Attached to this narrative are the original project specifications PPC-2345 Earthwork and PPC-2352 Hypalon Liner. Also attached to this permit application (Volume 2) are project drawings:

E-208987
E-208844
E-209505

The liner was manufactured by J. P. Stevens Elastomerics of Northampton, Massachusetts, and was fabricated by Staff Industries out of Detroit, Michigan. The liner was installed by LSCS, Inc. Soils quality control was provided by Allentown Testing Labs and Liner. QA/QC was provided by Westinghouse Environmental and Geotechnical Services, Inc. from Ohio (now out of business). The earthwork contractor was Wayne W. Knorr, Inc. out of Bloomsburg, Pennsylvania.

C. Design Requirements

1. Slope Stability

Ash Basin No. 4 has been in service for 7 years. The basin is lined and its dikes should never have a phreatic surface within them. Widespread leakage would have to occur. That probability lessens as the basin fills with ash.

The files contain stability analyses for the basin. There is also a substantial amount of related soil information. The stability analyses shows that the basin dikes have a factor of safety of over 2.0 without earthquake loading. Rapid drawdown is not applicable. The basin has an individual DER Safety Permit D48-149. Attached are laboratory soils test results and stability analyses results.

Sinkhole potential impact on dike stability has not been analyzed. A contingency plan has been included with the plant's PPC plan.

2. Freeboard/Overtopping

Ash Basin No. 4 has no watershed other than itself. Other inflows are regulated by pump capacities. Two and a half feet of freeboard is maintained in the basin at all times in accordance with its permit. The current freeboard is about fifteen feet. If the total rainfall from a 25-year-24-hour storm (approximately 5 inches) was detained in the basin with no basin discharge, the freeboard would increase less than a foot. The final basin freeboard should be two and a half feet at closing.

3. Factor of Safety

The factor of safety is referenced above. Although dynamic loading due to earthquake was not considered previously, it is known from previous studies that if the static factor of safety exceeds 1.5, the dynamic factor of safety will exceed 1.0, particularly in light of the relatively low design accelerations required east of the Mississippi due to an earthquake.

To confirm these statements relative to dynamic loading, PP&L ran a stability analysis starting with the assumption that the static dike stability was 1.5. This required a soil Ø angle of 26 degrees and a cohesion of 0 psf. Then a vertical and horizontal earthquake acceleration component (0.025, 0.05 respectively) was applied in the analysis and the dynamic factor of safety was more than 1.4. Obviously, not a significant impact and still safe.

4. Flow Shutoff

All flow into the basin is controlled by pumps. If necessary, inflow can be stopped immediately by stopping the pumps.

5. <u>Dam Inspection</u>

PP&L has an acclaimed dam safety program. Ash Basin No. 4 is inspected quarterly in accordance with its Individual Pennsylvania Dam Safety Permit. Inspection items include searching for liner holes, burrowing animals and tree growth. PP&L has a maintenance program designed to eliminate these problems as they arise. Copies of recent correspondence with the Dam Safety Program are attached.

6. <u>Run-on Prevention</u>

The basin is contained by a dike on all sides. No run-on flows into the basin.

7. <u>Odors, Dust, Erosion Control</u>

Fly ash does not generate odors.

Ash deposition is at or below the water surface in all areas. Ash remains moist and doesn't dust. Vegetation and moss will grow in the exposed areas as well, further reducing the dusting potential. During closure, dusting will be controlled using water trucks and during post-closure, dusting will be controlled using mulch and vegetation.

Erosion of the waste is not a concern in the basin.

G:\MISC\ADS28.DWD

~ 5/4/2009 PPL Basin 4 Closure Plan Permit Mod Appl

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PENNSYLVANIA DER

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL RESOURCES
BUREAU OF WASTE MANAGEMENT

Coordination #

FORM 16R
LINER SYSTEM - PHASE II

This form must be fully and accurately completed. All required information must be typed or legibly printed in the spaces provided herein. Improperly completed forms may be rejected by the Department, may be considered to be violations of the Department's Rules and Regulations, and may result in assessment of fines and penalties.

DER USE ONLY

Application or Facility ID# ______
(Assigned by DER)

Stamp Date Application Received

PART I. General Reference: 288.412, 288.431, 288.531, 289.412, 289.431, 289.531

SECTION A. APPLICANT IDENTIFIER Martins Creek Ash Basin No. 4

Applicant Name
Pennsylvania Power & Light Company

SECTION B. LINER SYSTEM

Liner System is for:

- ☐ Residual Waste Landfill
  - ☐ Class I
  - ☐ Class II
  - ☐ Class III
- ☒ Residual Waste Disposal Impoundment
  - ☐ Class I
  - ☒ Class II

SECTION C. LOCATION

County: Northampton

Municipality: Lower Mount Bethel Township

Total Acreage of Site: 60

Acreage of Disposal Area: 40

SECTION D. LINER SYSTEM COMPONENTS

Liner System Components are:

		Area (ft²)	Is Equivalency Review Being Requested (Y/N)
☒	1. Subbase.	1,750,000	N
☐	2. Secondary Liner.		
☐	3. Leachate Detection Zone.		
☒	4. Primary Liner.	1,750,000	*
☐	5. Protective Cover.		
☐	6. Leachate Collection System (within Protective Cover).		
☒	7. CAP	1,750,000	Y
☐	8. Natural Attenuation		
	9. Composite Liner Primary or Secondary (circle one)		

* Waiver requested for liner system.

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SECTION E. SUPPORTING DATA

Supporting Data:

The following information must be submitted along with this form. For information not appended to this form, indicate below where in the specifications or drawings the required information is located.

		(Drawing) (1)	(Specification)
1.	Design of Liner System. (Refer to Part II.)	E 208987	
2.	Liner Installation Plan. (Refer to Part III.)	As built dwgs. in report See Note 3	
3.	Compatibility of Liner to Leachate. (Refer to Part IV)		(2)
4.	Physical, Chemical, Mechanical, and Thermal Properties of Liners. (Refer to Part V)		Included in report See Note 3
5.	Quality Assurance Plan for Construction and Installation of Liners. (Refer to Part VI)		(3)
6.	Quality Control Plan for construction and installation of liners		(3
7.	Slope Stability Analysis		Form 24R

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Footnotes:

1. Drawings can be found in volume 2 of this application package.

2. Not required during initial permitting process - Hypalon liner is not impacted by fly ash leachate and can be left exposed to the environment for many years without losing its strength or integrity. Ash Basin No. 3 had an exposed 30 mil unreinforced Hypalon liner that operated satisfactorily for the life of the facility. The water in Ash Basin No. 4 remains neutral and does not require treatment.

3. Since the basin is already constructed. Plans are not as applicable as the results. Included with this application under separate cover is a "Liner Certification Report" dated February 23, 1990 prepared by Westinghouse Environmental and Geotechnical Services, Inc. who performed liner quality assurance on the project.

   The specification for the Quality Assurance Inspection is attached. PPC 2473.

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PART II. DESIGN OF LINER SYSTEM

SECTION A. PROJECT SPECIFICATIONS

Project Specifications		Subbase	Secondary Liner	Leachate Detection Zone	Primary Liner	Leachate Collection Zone	Protective Cover	CAP
Thickness (inches or mils)		24" min	N/A	N/A	36 mil	N/A	N/A	12"
Maximum Particle Size (inches)		0.5	N/A	N/A	N/A	N/A	N/A	6"
Standard Proctor Density ~~(percent)~~ PCF	FIELD	86 TYP	N/A	N/A	N/A	N/A	N/A	Not tested
	LAB	88 TYP	N/A	N/A	N/A	N/A	N/A	Not tested
Bearing Capacity (minimum) (lb/ft²)		See Narrative	N/A	N/A	N/A	N/A	N/A	N/A
Total Applied Load (lb/ft²)		5,000	N/A	N/A	5,000	N/A	N/A	N/A
Permeability (cm/s)	FIELD	Not tested	N/A	N/A	N/A	N/A	N/A	N/A
	LAB	Not tested	N/A	N/A	N/A	N/A	N/A	N/A
Slope (percent)	MINIMUM	2.0 ±	N/A	N/A	2.0 ±	N/A	N/A	2.0 ±
	MAXIMUM	33.0	N/A	N/A	33.0	N/A	N/A	10.0 ±

Geosynthetics: Where synthetic liners, geonets, geotextiles, or other geosynthetic materials are to be used, provide information as to the manufacturer, trade name, type, specifications, and composition of each product.

Non-Synthetic Liners: Where clay or other soils will be used as the liner, provide information on the Atterberg Limits, soil density, moisture relationship moisture content, and sieve analysis to be maintained at the time of installation.

Drainage system: Where piping is installed as part of the leachate detection, Leachate collection or gas disposal system submit plans and profile drawings of each level, cell or zone which clearly illustrates the: slope, spacing, diameter and schedule of all piping to be installed.

SECTION B. DESIGN BASIS

See Narrative

For each major element of the liner system outlined above, provide the following information which supports the basis for the design. Include copies of the results of all tests conducted at the site, assumptions, and calculations used in the design. The stability of the landfill site and design is to be determined at critical sections. This is to include any below grade excavations/embankments or berms that may be critical. Consideration must be given to long and short term stresses, equipment loadings, filling sequence, and the possibility of earth quakes. Where geosynthetics are used, a veneer stability analysis should be performed on the interfaces of the material and the soil or aggregates. A puncture analysis is to be included where a geosynthetic is used to protect a geomembrane. Following information is to be attached to this form and referenced to the appropriate section.

1. Subbase:

   i. Submit detailed information on how the subbase was sized and located, including the minimum and maximum depths to seasonal high water table and regional groundwater table. Be sure all elevations are tied to projects grid system and benchmarks. Explain this bases for the subbase size and materials selected.

   ii. Describe how the subbase will bear the weight of the liners, leachate detection and collection systems, wastes, cover material, and operations equipment without causing or allowing any failure of the liner system. Explain what evaluations were conducted at the site and of the subgrade materials to ensure adequacy for the projected loads.

   iii. Discuss the potential for subsidence and the liner systems ability to allow for settlement.

2. Secondary Liner:

   i. Describe the physical, chemical, and thermal properties taken into consideration in selecting the secondary liner.

   ii. Submit and discuss the results of any testing conducted on the liner material which ensures it will not be adversely affected, both chemically and structurally, by the chemical characteristics of the waste or it leachate.

SECTION B. DESIGN BASIS (Continued)

3. Leachate Detection Zone:

   i. Describe the physical, chemical, and thermal properties taken into consideration in selecting materials.

   ii. Submit and discuss the results of any testing conducted on the detection zone materials which ensures they will not be adversely affected, both chemically and structurally, by the chemical characteristics of the waste or its leachate.

   iii. Describe the methods for cleaning and maintaining pipes, including methods for testing installed pipes for leakage.

   iv. Describe how the leachate detection zone will support the primary liner without causing punctures in the event of subsidence.

4. Primary Liner:

   i. Describe the physical, chemical, and thermal properties taken into consideration in selecting the secondary liner.

   ii. Submit and discuss the results of any testing conducted on the liner material which ensures it will not be adversely affected, both chemically and structurally, by the chemical characteristics of the waste or its leachate.

5. Protective Cover:

   i. Provide a detailed description of the physical and structural aspects of the protective cover. Include information on the size, types, dimensions and depths of all materials used, slopes, calculations on anticipated stresses and loads from wastes and operating equipment. Describe how the cover material will protect the primary liner from physical damage from stresses and disturbances from overlying wastes, cover materials, and equipment operations.

   ii. Describe how the protective cover will allow the continuous and free flow of leachate. Describe the possibility and effects of subsidence should it occur.

6. Leachate Collection System within Protective Cover:

   i. Provide a detailed description of the physical and structural aspects of the proposed leachate detection system. Include information on the size, types, dimensions and depths of all materials used, slopes, calculations on anticipated bearing loads (wastes and equipment), and leachate detection capabilities. Indicate which drawings and sections of the specifications contain the information on layout and material requirements.

   ii. Provide a description of how the system will detect, collect, and transmit leachate. Briefly describe the leachate treatment facilities and approvals obtained.

   iii. Describe the methods for cleaning and maintaining pipes, including methods for testing installed pipes for leakage.

7. Cap:

   i Provide a detailed description of the chemical and structural characteristics of the materials to be used for the final cover. Be sure to indicate the minimum and maximum size of materials allowed, sieve sizes, USDA Texture Class, and any other significant distinguishing characteristics.

   ii Provide a description of how the materials are to be placed and compacted, with details on maximum slopes, minimum depths, and acceptable bearing loads.

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PART III. LINER INSTALLATION PLAN

See Narrative

SECTION A. SUBBASE

1. Information on the maximum depth of earth moving activities and the site preparation procedures to be followed prior to the installation of any subbase materials.
2. Information on the selection of subbase materials, their grading and tests to be conducted to ensure uniformity.
3. Information on how the subbase materials are placed, graded, compacted, and tested for proper installation.

SECTION B. LINERS

1. For synthetic liners, provide all information supplied by the manufacturer as to required handling and installation procedures.
2. For non-synthetic liners, information on the minimum acceptable characteristics (i.e. moisture content, etc.) are to be provided.
3. For non-synthetic and non-synthetic liners, information as to the equipment required, pre and post installation testing is to be provided.

SECTION C. LEACHATE DETECTION AND COLLECTION ZONES

1. Provide details on how the detection and collection zones will be installed with specific information as to what materials and construction techniques will be used to construct each zone.
2. Describe the sequence of construction and equipment used.
3. Describe the sequence for installing the sump and all monitoring or gas venting facilities.

SECTION D. PROTECTIVE COVER

1. Describe where the cover materials will come from, and how they are transported and placed at the site.
2. Provide details on how the cover materials will be routinely tested for conformance with design specifications.

SECTION E. FINAL COVER AND GRADING

1. Provide a detailed description of how the final cover material is to be placed, compacted, and graded.
2. Describe the proposed final layout for the area with specific reference to any drainage facilities which will remain.

SECTION F. ATTENUATING SOIL BASE (CLASS III RESIDUAL WASTE LANDFILLS)

1. Describe the Class of soils to be used as classified by the United State Department of Agriculture.
2. Indicate where in the specifications and quality control procedures the requirements for attenuating soil, as contained in Section 288.624(b) of the residual waste regulations, are contained.
3. Describe the proposed sequence for placement of waste and attenuating soils.

SECTION G. HIGHWALLS

1. Describe how the liner or barrier materials will be installed to prevent the migration of leachate from the disposal area.
2. Provide information on each type of barrier material to be used and its minimum thickness. Include appropriate information on the physical and chemical characteristics of the material, and proof the material is not adversely affected by solid waste, leachate, or its constituents.
3. Provide detailed information on the different seams or outcrops at the proposed site and how they will be isolated from wastes.
4. Explain how groundwater and surface water drainage will be controlled and eliminated.
5. Submit a plan for controlling damage from subsidence or the collapse of highwalls.

SECTION H. LIMITATION

1. Provide appropriate information on any land use restrictions or limitations that should be followed during and after closure of the facility.

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PART IV. COMPATIBILITY OF LINER TO LEACHATE

A sampling plan for each component of the liner system, including sample size, methods for determining sample locations, sampling frequency, acceptance and rejection criteria, and methods for ensuring that corrective measures are implemented is to be included with this form.

SECTION A. This information is not available.

Information must be submitted which demonstrates that leachate will not adversely affect the physical or chemical characteristics of the liner system, or inhibit the liner's ability to restrict the flow of solid waste, solid waste constituents, or leachate.

Test Method Used: __________

1. Exposure Period (days) __________
2. Temperature of Solution __________
3. Source of Representative Sample of Leachate __________
4. Type of Compound and Construction (Liner Classification: Thermoplastic, Fabric Reinforced, etc.) __________
5. Tensile Properties:
   a. ASTM Method __________
   b. Type of Specimen __________
   c. Speed of Test __________
   d. Values to be Reported: __________

Proof of compatibility is shown by the successful operation of Ash Basin No. 3. In addition, the leachate is benign enough to allow continued operation of unlined basins throughout PP&L's system.

6. Tear Resistance:
   a. ASTM Method __________
   b. Type of Specimen __________
   c. Speed of Test __________

SECTION B. This information is not available.

Attach a copy of the chemical analysis of the leachate used in determining the above results.

SECTION C. This information is not available.

Where appropriate, attach an analysis of the current leachate emanating from this landfill.

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PART V. PROPERTIES OF SYNTHETIC LINERS

Supply the following physical, chemical, mechanical, and thermal properties for liners, based on ASTM methods where appropriate. Additional information may be submitted.

		Results with Units of Measurement	ASTM Method
1.	Thickness		
2.	Tensile Strength at Yield		
3.	Elongation at Yield		
4.	Elongation at Break		
5.	Modulus of Elasticity		
6.	Tear Resistance		
7.	Impact Resistance		
8.	Puncture Resistance		
9.	Seam Strength (% of Liner Strength)		
10.	Ultraviolet Light Resistance		
11.	Operating Temperature Range		
12.	Permeability		
13.	Soil-to-Liner Friction (Angle in Degrees)		
14.	Ozone Resistance		
15.	Water Vapor Transmission		
16.	Coefficient of Linear Thermal Expansion		
17.	Low Temperature/Brittleness		

Liner certification information is contained in Section 1 of Westinghouse's Report. Not all of the requested properties are listed however. Part of the reason for this is that many of these tests were only recently accepted within the geosynthetic society and ASTM.

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PART VI. QUALITY ASSURANCE PLAN FOR CONSTRUCTION AND FOR INSTALLATION OF LINERS See Narrative

The following information shall be submitted on separate pages and referenced to the appropriate section. For each Section A summary table is to be provided which explains the procedures, the frequency for each test, and the pass/fail criteria which must be met.

SECTION A.

Qualifications of independent QA personnel (describe experience and training).

SECTION B. SUBBASE

1. Provide design summary of procedures used to assure objectives are met:
   a. Outline tests and observations to ensure quality of compacted fill.
   b. Explain observations to ensure removal of objects or undesirable materials.
   c. Discuss observations and tests that ensure that the surface is compacted, smooth, uniform, and consistent with design grades.
   d. Summarize surveying to ensure that facility dimensions, side slopes, and bottom slopes are as specified in design.
   e. Summarize review of Quality Control information.

SECTION C. NON-SYNTHETIC LINERS

1. Discuss inspection procedures of liner materials and test fill compaction. Properties to be tested should include: permeability, soil density/moisture content relationships, maximum clod size, particle size distribution, natural water content, Atterberg limits.
2. Outline procedures and methods for observing and testing liner materials before and after placement to ensure:
   a. Removal of roots, rocks, etc.
   b. Identification of changes in soil characteristics causing a change in construction specifications.
   c. Adequate spreading and incorporation of water to obtain full penetration through clods and uniform distribution of the specified water content.
   d. Maintaining optimum water content throughout wet and dry periods and during construction.

SECTION D. SYNTHETIC AND GEOSYNTHETIC LINERS

Outline Procedures For:

1. Inspection of product quality, the review of manufacturers control procedures and any other observations related to transporting, storing, and handling.
2. Inspection of foundation preparation and equipment.
3. Observations of liner placement.
4. Need and availability of manufacturers representative.
5. Observations of weather conditions.
6. Observations and measurements of anchor trench to ensure that it is as specified in design drawings.
7. Observations and tests to confirm that all designed liner penetrations and liner connections are installed as specified.
8. Visual inspection for tears, punctures, or thin spots during placement.
9. Inspections during and after liner seaming.
10. Observations and tests to assure that seals around liner penetrations are of sufficient strength and are impermeable to leachate.

SECTION E. PROTECTIVE COVER

Outline Procedures For:

1. Tests to ensure that the cover material meets design specifications, including permeability and clogging potential.
2. Observations that the cover material is free from objects that could damage the liner.
3. Observations to ensure that equipment used to place cover does not damage liner.
4. Measurements to ensure that entire liner is covered with specified thickness of cover material.

SECTION F. LEACHATE DETECTION AND COLLECTION SYSTEM

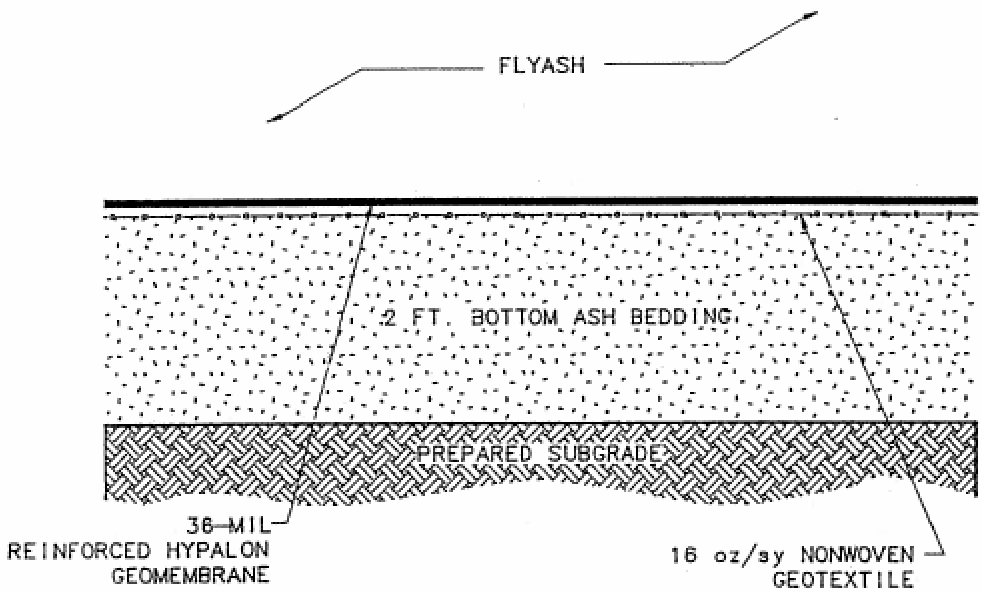
Discuss how the following activities will be conducted.

1. Observations and measurements to ensure that materials are of specified size and strength, and that pipe perforations are sized and spaced as specified.
2. Observations and tests to ensure that soils to be used are of proper size and gradation.
3. Method of placing bedding and inspection to ensure the pipes are bedded correctly and not susceptible to movement.
4. Observations and measurements to ensure that pipes are placed at specified locations, at specified grades, and are joined together as specified.
5. Observations and tests to ensure that backfilling is completed as specified in design, in all areas, including areas where a liner connects to a structure.
6. Testing of pipe joints and testing of solid wall pipes to ensure that there is no leakage.
7. Observations and tests of the granular drainage layer to ensure that the material meets the specifications of design (including permeability and clogging potential to geosynthetics).
8. Synthetic drainage layers: Observations to ensure proper placement, correct seaming, and allowable weather conditions.
9. Geotextiles: Observations of placement to ensure that specifications are followed, adequate overlap or seaming, and that there is no damage.
10. Sumps: Observations to ensure that structures are of specified dimensions, material, and capacity.
11. Mechanical and electrical equipment installation: Observations to ensure that equipment is in accordance with design specifications and manufacturer's recommendations.

SECTION G. FINAL COVER SYSTEM

Discuss who and how following activities will be conducted:

1. Observations and tests to evaluate stability of cover system foundation.
2. Observations and testing as necessary to confirm that soil materials meet specified design.
3. Non-synthetic component: Monitor soil type, moisture content, density, compaction, lift thickness, clod size, uniformity of compaction, completeness of coverage, and permeability.
4. Tests for seals around penetrations such as gas vent pipes to ensure that they do not leak.
5. Inspections for perimeter of cover, where the soil component joins or overlies the liner system, to ensure that it is installed according to specifications.
6. Liners used in the capping system shall follow guidelines for synthetic liners.
7. Observations for a protective layer, such as a geotextile, which is placed above the liner as protection from drainage layer, to ensure proper placement to avoid damage to the liner.
8. Drainage and gas venting layer placement: The gas discharge layer is placed below the synthetic liner and the water drainage layer is placed above the synthetic liner. Guidelines for the leachate collection and detection zone will be followed. Inspections of the installation of the drainage layers around the perimeter of the cover system is important, for it is here that the system connects to the surface drainage facilities. Ensure that design specifications, particularly dimensions and slopes, are achieved. Controlled gas discharge or collection systems are checked for proper installation and function.
9. Filter layer used above or below drainage layer to stop migration or piping of fine materials should be tested for any clogging potential. During construction of filter layer, inspection will include monitoring of particle size (for soil materials) or geotextile type and certification, seaming or overlap for geotextiles, slope of surface, and coverage.
10. Topsoil layer placement: Monitor uniformity of application process, observations to ensure that soil is not overly compacted, and measurements of thickness and slope of topsoil layer.
11. Topsoil seeding: Inspection of seeding process, measurement of tilling depth, application rate of additives should be monitored for consistency with design specifications. Application equipment will be appropriate. Verify that all vents and standpipes or other penetrations through cover are not damaged by tilling and application process. Weather conditions are to be appropriate. Post-construction: Slopes will be surveyed and any unusual depressions noted and corrected.
12. Review of Quality Control information.



TYPICAL LINER DETAIL

NOT TO SCALE

FIGURE 1

TYPICAL LINER SYSTEM DETAIL

MARTINS CREEK SES ASH BASIN NO. 4

LOWER MOUNT BETHEL TOWNSHIP, PENNSYLVANIA

PREPARED FOR

PENNSYLVANIA POWER & LIGHT

ALLENTOWN, PENNSYLVANIA

APPROVED
CHECKED
DRAWN DEB/11MAY94

DRAWING NUMBER 1823001

Earth Sciences Consultants, Inc.

REVISION | DATE | DESCRIPTION

MARTINS CREEK SES
ASH BASIN NO. 4
FORM 16R
LINER SYSTEM - PHASE II
NARRATIVE

GENERAL

Ash Basin No. 4 is a geomembrane lined, earthen diked, impoundment. Soils were excavated down to bedrock from within the center of the basin and used to build the perimeter dikes. Therefore, perhaps thirty to forty percent of the basin's disposal volume is below surrounding grade. The groundwater table is below the bedrock surface.

Even after an extensive geophysical study and subsurface test boring investigation, bedrock was encountered earlier (higher) than expected. As a result, additional borrow soils were obtained from an adjacent soil borrow area to the east and the bottom ash subgrade was thickened considerably in some areas. All dike construction materials were carefully laboratory and field tested by Allentown Testing Laboratories. Their inspector was on-site during all earthwork activities.

The bottom ash subgrade provided a uniformly graded support for the liner with no particles greater than an inch. The ash reduced the possibility of rocks migrating upward from the underlying soils where they existed.

A 16 oz. geotextile manufactured by Bradley Materials Company was placed over the bottom ash for additional cushioning and then a 36 mil reinforced hypalon liner manufactured by J. P. Stevens Elastomerics, Inc., and fabricated by Staff Industries, Inc. The liner was installed by LS/CS. Staff and LS/CS has on-site representation and provided quality control.

Westinghouse Environmental and Geotechnical Services, Inc., was hired by PP&L to provide liner system quality assurance. Their geomembrane installation certification report is included with this permit application package.

PP&L had a construction site superintendent on-site at all times and had field engineering support as necessary. Representatives from DER's Southeast Regional Office provided on-site regulatory review periodically.

Part I

Section D - Liner System Components

Liner System Waiver Request - PP&L is requesting a liner system waiver request in accordance with Section 287.115(c)1 of the regulations. The ash basin meets all of the requirements justifying such a request. The current system has no secondary liner, no composite liner, no leachate collection or detection systems, no protective cover, and the primary liner is 36 mil, not 50. Nevertheless, monitoring wells around the basin show that it is having no impact on the groundwater.

PP&L is expecting permits to continue operating its other ash basins without liners because they have little or no impact on the groundwater. The only reason Ash Basin No. 4 has a liner is to reduce the risk of sinkholes beneath the basin.

Cap - PP&L has provided the appropriate equivalency review forms for the cap with respect to soil thickness. In addition, PP&L has completed studies on all of its unlined ash basins showing that a synthetic cap is not necessary to meet all standards from Environmental Protection. A waiver of the cap components is allowing in accordance with Section 289.242(3)c. A one foot closure cap has been accepted based on these studies by the Williamsport Office thus far for Sunbury Ash Basin No. 2, an unlined impoundment.

The studies were done under partial funding by the Electric Power Research Institute. Existing groundwater and leachate conditions were characterized by Atlantic Environmental Services, Inc., and their results are contained in a report entitled "Ash Impoundment Closure Study." Then these results were input and analyzed by Tetra Tech, Inc., using EPRI groundwater transport computer models MYGRT™ and ROAM™. The conclusion of their report states that the modeling results show that dewatering the basins significantly reduces leachate fluxes and hence downgradient concentrations. Addition of a one foot soil cover is a cost-effective method of further reducing infiltration to ensure the groundwater standards are met. Tetra Tech's final report is entitled "Modeling For Ash Basin Closure Study."

The studies included Martins Creek Ash Basin No. 1 which is mostly a bottom ash basin. Modeling Ash Basin No. 4 would be difficult because there currently is no impact. Model studies of unlined basins would be a worst possible case scenario for Ash Basin No. 4 since it is lined. The model study considered seven unlined basins. Probably Brunner Island Ash Basin No. 7 and Sunbury Ash Basin No. 2 are most applicable since they are purely fly ash disposal basins like Ash Basin No. 4. Excerpts from Tetra Tech's report relating to these basins are included under separate cover as part of this permit application.

Part II - Design of Liner System

Section B. Design Basis

General - Since the basin has operated in stable fashion without incident for seven years thus far, it appears that design assumptions were correct and construction practices were performed well.

The basin design was reviewed and approved by the State Division of Dam Safety, Bureau of Waterway Management in Harrisburg. It has an individual dam safety permit number - D48-149.

1. Subbase: The subbase consists of compacted bottom ash varying in depths with a minimum of one foot placed on bedrock. Since the basin bottom is well below grade, there is no concern for bearing capacity or stability. The bottom ash was compacted at or near maximum density so that any consolidation would be minimal and instantaneous due to the coarser nature of the material (free draining). Bottom ash was used because it is uniform, has no large particles, provides a good cushion for the liner, and was readily available.

Groundwater was not encountered during construction. Drawing D-242664, sheet 3, shows the groundwater contours across the site. The minimum depth below the liner is about 30 feet.

2, 3 (N/A)

4. Primary Liner - A hypalon liner was chosen because of its ability to retain its properties even when it is left exposed. Since there is no operating equipment on the liner and the waste is powder-like, the risk of mechanical damage to the liner is minimal. A 36-mil reinforced liner was chosen because of its high strength that would assist in bridging any small sinkholes should they occur. There are no chemical constituents in ash leachate that can affect the liner and the pH remains in the neutral range. There are no pH control facilities necessary at the basin.

5,6 N/A

7. Cap - The soil characteristics for the cap are detailed in Civil & Environmental's report, "Revegetation and Alternate Soil Cover Plan for the Martins Creek Steam Electric Station Ash Basin No. 4," included with this permit application under separate cover. Once fly ash is dewatered, it will support heavy equipment and lightly loaded structures. Ash Basin No. 3 was closed in similar fashion to that proposed for Ash Basin No. 4. The soils are typically not compacted other than by the spreading equipment. As discussed above, PP&L is requesting a waiver of the impermeable cap and an equivalency for the two foot soil cap thickness.

Part III - Liner Installation Plan

Section A, Subbase - Drawing E-208987 shows the final contours of the basin bottom. Soils were excavated down to bedrock and then bottom ash was used to cover the rock, provide proper positive drainage toward the outlet, and cushion the liner. Bottom ash was compacted using a steel-wheeled roller and was tested for standard Proctor density.

Section B, Liners - The liner certification report by Westinghouse provides the required installation information.

Section C/D - Not applicable

Section E - Final Cover and Grading - The closure plan provided with Form 18 provides this information. Drawing D-242664, Sheet 4, shows the conceptual final grading plan.

Section G/H - Not applicable

Part VI - Quality Assurance Plan for Construction and for Installation of Liners

Section A - Allentown Testing Laboratory personnel provided laboratory and field soil testing and field quality assurance. The qualifications of the inspectors are no longer available, but it is known that they had been employed by the company for years.

Similarly, the qualifications of the liner inspectors are no longer available. PP&L's typical specification for QA liner inspection is at least 0.5 million square feet of experience from a firm with an extensive list of projects for reference. The quality of Westinghouse's report provided some insight into the thoroughness of their work.

Section B - Subbase - The attached project specifications provide the quality control and placement requirements for the earthen dikes and subbase.

Section C - N/A

Section D - Synthetic and Geosynthetic Liners - See the Westinghouse report.

Section E and F - N/A

Section G - Final Cover System - The purpose of a final cover system is merely to eliminate fly ash dusting. Vegetation grows in fly ash. Indeed the water retention capabilities of fly ash exceed that of some soils. PP&L proposes to cover the ash with a minimum of one foot of soil. There will be no concern for impact on cap liners, permeabilities, compaction. Quality control will consist of a PP&L foreman and contractor personnel removing oversized stones (greater than 6 inches) and ensuring that the soil is placed in at least 12 inch lifts. The contractor will provide surveying necessary to ensure proper grading.

PP&L's seeding specifications will be used to ensure proper vegetation. PP&L's type "B" seed mixture is currently used for this project. The attached specifications include the vegetation specifications used for the basin construction. The closure vegetation specifications will be similar.

ADS36.DWD

2540-PM-WM0500 1/95

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL RESOURCES
BUREAU OF WASTE MANAGEMENT

Coordination #

FORM 24R
RESIDUAL WASTE DISPOSAL IMPOUNDMENTS

This form must be fully and accurately completed. All required information must be typed or legibly printed in the spaces provided herein. Improperly completed forms may be rejected by the Department, may be considered to be violations of the Department's Rules and Regulations, and may result in assessment of fines and penalties.

DER USE ONLY

Application or Facility ID# ____________
(Assigned by DER)

Stamp Date Application Received

General References: Section 289.114; 289.161; 289.212; 289.271-274.

SECTION A. APPLICANT IDENTIFIER Pennsylvania Power & Light Company

Facility Name: Martins Creek SES Ash Basin No. 4 ☐ New ☒ Existing

County: Northampton

Municipality: Lower Mount Bethel

Permit No. 0012823 (NPDES)

SECTION B. IMPOUNDMENT PLAN (See Attached Narrative)

Attach a description of the impoundment plan, including specifications, designs, and cross sections. Describe the design of the impoundment, including the proposed volumetric capacity of each impoundment and schedule for construction and operation.

SECTION C. DESIGN REQUIREMENTS (See Attached Narrative 1-7)

1. Attach a slope stability analysis of the dike system that is proposed to support the impoundment.

2. Attach calculations indicating the freeboard is capable of preventing overtopping, including overtopping caused by the 24-hour precipitation event to be expected once in 25 years.
Freeboard: ____________ inches.

3. Will/does the dike have sufficient structural integrity to prevent failure? What are the minimum safety factors of the dike for dynamic and static loads?

   Safety factor for:
   a. static load: ____________
   b. dynamic load: ____________

4. Describe how the impoundment is (will be) equipped so that the flow of residual waste into the impoundment can be shut off immediately.

5. Describe how the dikes and berms are (will be) kept free of burrowing mammals and plants with root systems capable of displacing earthen materials upon which the structural integrity of the dikes or berms is dependent.

6. Demonstrate that the impoundment will be surrounded by structures sufficient to prevent surface run off from a 25-year, 24-hour precipitation event from entering the impoundment:

2540-PM-WM0500 1/95

SECTION C. DESIGN REQUIREMENTS (continued)

7. Describe how odors and the dispersal residual waste or waste constituents by wind and water erosion shall be prevented:

8. Inside slopes (not applicable to impoundments with concrete wall):

   a. What are the inside slopes (%)? 33%

   b. Are the inside slopes designed and constructed with sufficient protective cover to prevent wind and water erosion, and to preserve the structural integrity of the dike? Describe how the inside slopes are designed and constructed:

   The dikes are covered with an exposed hypalon liner. The water level is kept shallow, covering the ash to reduce wave development potential.

9. Outside slopes and terraces:

   a. What are the outside slopes (%)? 50% to 25%

   b. Describe how the outside slopes and terraces of the impoundment are designed, constructed, and operated?

   The outside slopes were built with a two and a quarter horizontal to one vertical slope, were covered with a foot of topsoil and seeded with crown vetch.

   c. How are the outside slopes and terraces of the dike prevented from wind and water erosion to preserve the structural integrity of the dike?

   The crown vetch adequately protects the outside slopes.

SECTION D. WASTE SOLIDIFICATION PLAN

1. Attach a plan, including necessary drawings, designs, specifications, timetables, waste analyses, and narrative descriptions to solidify the waste. The plan shall include laboratory and field test results showing that the waste can be solidified as proposed. N/A

2. Indicate the minimum bearing capacity of the waste in the impoundment after the solidification process: 1.5 tons/ft².

   The ash is already solid. The water within the ash will drain away through the discharge structure at closure. It should be possible to drive on the waste within a month or so after the basin is taken out of service.

- 2 -

MARTINS CREEK SES
ASH BASIN NO. 4
FORM 24R
RESIDUAL WASTE DISPOSAL IMPOUNDMENTS

B. **Impoundment Plan**

Martins Creek SES Ash Basin No. 4 was constructed in the late 1980's. Its location was chosen after a lengthy siting study which involved the public and considered a couple dozen sites. The basin dikes are built from soils excavated from within the basin and from an adjacent borrow area. Therefore a large portion of the disposal volume is below grade. The basin dikes do extend a maximum of about 30 feet above grade. The basin has no watershed other than itself. The outside dikes are covered with crown vetch. The outside dike slopes are 2.0 horizontal to 1.0 vertical near the top and flatten to 4.0 horizontal to 1.0 vertical at the bottom.

The inside of the basin is lined with a 36 mil reinforced hypalon liner placed on a 16 oz. geotextile which, in turn, was placed on a one foot thick (minimum) layer of bottom ash subgrade. The bottom ash provides additional cushion and reduces the risk of stones from underneath migrating up to the liner. The inside slope is 3.0 horizontal to 1.0 vertical.

Prior to basin construction, an extensive geophysical survey was performed across the site using seismic and resistivity methods to locate any sinkhole prone areas. The northeast corner of the site was found to have highly weathered bedrock indicating a sinkhole prone area. PP&L began an extensive bedrock grouting program that eventually eclipsed $1.5 million dollars in cost. In addition, during basin excavation, any exposed rock was closely inspected and any weathered rock received dental grouting prior to its being covered with subgrade materials. The basin has been in operation for seven years with no sinkholes inside or outside.

Fly ash is sluiced to the basin and distributed via floating pipelines capable of being moved to enable even ash distribution. The basin is also equipped with a truck turnaround where any miscellaneous ash wastes from the plant can be end-dumped. A cooling tower blowdown pipeline also discharges water periodically into the east side of the basin as does a sludge pipeline from the Industrial Waste Treatment Basin.

The basin is equipped with a stoplog discharge structure that is drained via a buried pipeline that runs to the Delaware River after combining with effluent from the Industrial Waste Treatment Basin.

Attached to this narrative are the original project specifications PPC-2345. Earthwork and PPC-2352 Hypalon Liner. Also attached to this permit application (Volume 2) are project drawings:

E-208987
E-208844
E-209505

The liner was manufactured by J. P. Stevens Elastomerics of Northampton, Massachusetts, and was fabricated by Staff Industries out of Detroit, Michigan. The liner was installed by LSCS, Inc. Soils quality control was provided by Allentown Testing Labs and Liner. QA/QC was provided by Westinghouse Environmental and Geotechnical Services, Inc. from Ohio (now out of business). The earthwork contractor was Wayne W. Knorr, Inc. out of Bloomsburg, Pennsylvania.

C. **Design Requirements**

1. Slope Stability

Ash Basin No. 4 has been in service for 7 years. The basin is lined and its dikes should never have a phreatic surface within them. Widespread leakage would have to occur. That probability lessens as the basin fills with ash.

The files contain stability analyses for the basin. There is also a substantial amount of related soil information. The stability analyses shows that the basin dikes have a factor of safety of over 2.0 without earthquake loading. Rapid drawdown is not applicable. The basin has an individual DER Safety Permit D48-149. Attached are laboratory soils test results and stability analyses results.

2. Freeboard/Overtopping

Ash Basin No. 4 has no watershed other than itself. Other inflows are regulated by pump capacities. Two feet of freeboard is maintained in the basin at all times in accordance with its permit. Actually, the current freeboard is about fifteen feet. If the total rainfall from a 25-year-24-hour storm (approximately 5 inches) was detained in the basin with no basin discharge, the freeboard would increase less than a foot.

3. Factor of Safety

The factor of safety is referenced above. Although dynamic loading due to earthquake was not considered previously, it is known from previous studies that if the static factor of safety exceeds 1.5, the dynamic factor of safety will exceed 1.0, particularly in light of the relatively low design accelerations required east of the Mississippi due to an earthquake.

To confirm these statements relative to dynamic loading, PP&L ran a stability analysis starting with the assumption that the static dike stability was 1.5. This required a soil Ø angle of 26 degrees and a cohesion of 0 psf. Then a vertical and horizontal earthquake acceleration component (0.025, 0.05 respectively) was applied in the analysis and the dynamic factor of safety was more than 1.4. Obviously, not a significant impact and still safe.

4. Flow Shutoff

All flow into the basin is controlled by pumps. If necessary, inflow can be stopped immediately by stopping the pumps.

5. Dam Inspection

PP&L has an acclaimed dam safety program. Ash Basin No. 4 is inspected quarterly in accordance with its Individual Pennsylvania Dam Safety Permit. Inspection items include searching for liner holes, burrowing animals and tree growth. PP&L has a maintenance program designed to eliminate these problems as they arise.

6. Run-on Prevention

The basin is contained by a dike on all sides. No run-on flows into the basin.

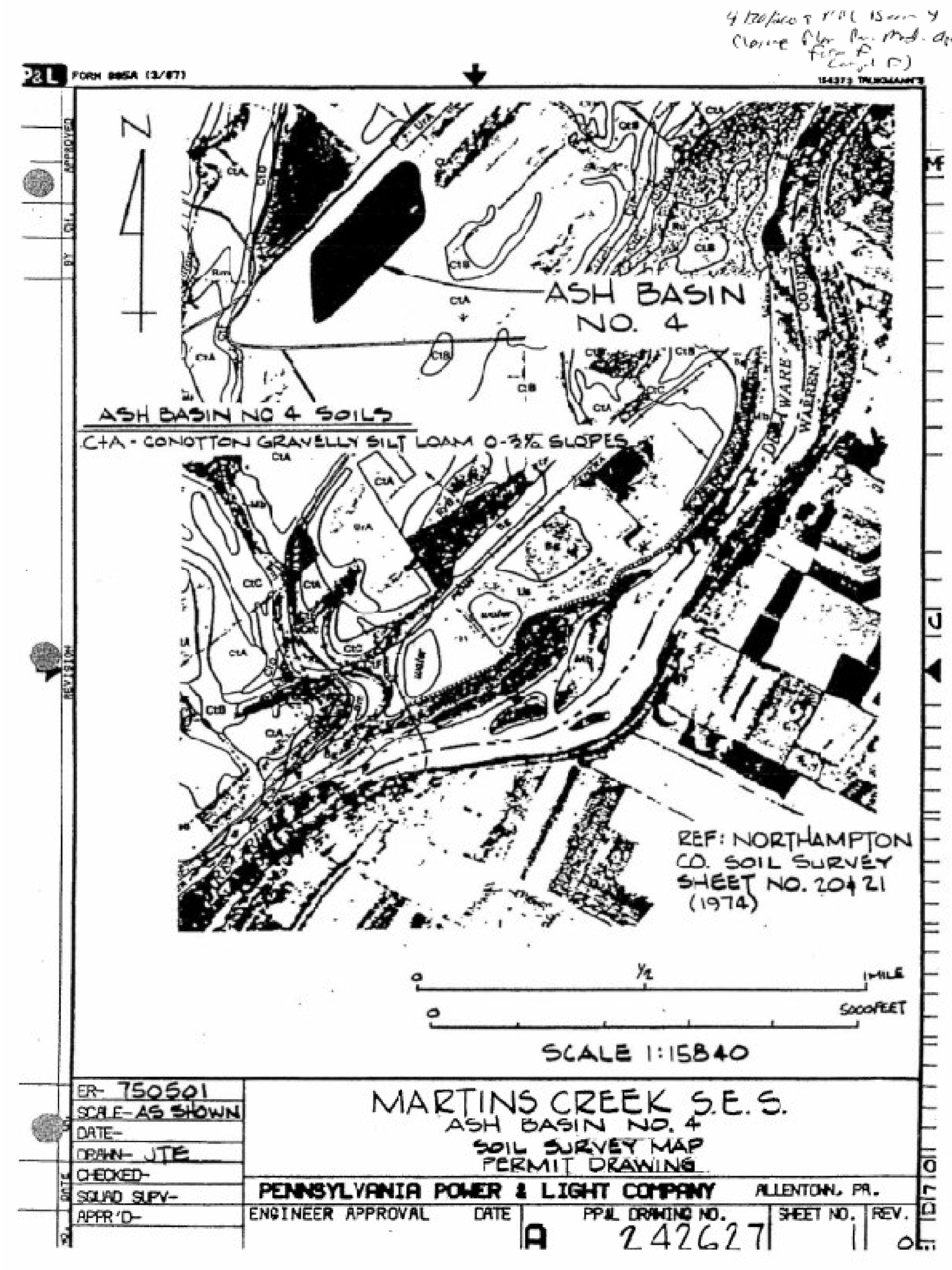
7. Odors, Dust, Erosion Control

Fly ash does not generate odors.

Ash deposition is at or below the water surface in all areas. Ash remains moist and doesn't dust. Vegetation and moss will grow in the exposed areas as well, further reducing the dusting potential.

Erosion of the waste is not a concern in the basin.

G:\MISC\ADS28.DWD



ASH BASIN NO. 4
ASH BASIN NO 4 SOILS
CtA - CONOTTON GRAVELLY SILT LOAM 0-3% SLOPES
DELAWARE
WARREN
REF: NORTHAMPTON CO. SOIL SURVEY SHEET NO. 20 & 21 (1974)
SCALE 1:15840
ER- 750501
SCALE- AS SHOWN
DATE-
DRAWN- JTE
CHECKED-
SQUAD SUPV-
APPR'D-
MARTINS CREEK S.E.S.
ASH BASIN NO. 4
SOIL SURVEY MAP
PERMIT DRAWING
PENNSYLVANIA POWER & LIGHT COMPANY
ALLENTOWN, PA.
ENGINEER APPROVAL
DATE
PP&L DRAWING NO.
A 242627
SHEET NO. 1
REV. 0

Westinghouse Environmental
and Geotechnical Services, Inc.

11785 Highway Drive
Suite 100
Cincinnati, Ohio 45241
(513) 733-9374
FAX (513) 733-8213

February 23, 1990

Pennsylvania Power & Light Company
2 North Ninth Street
Allentown, PA 18101

Attention: Mr. Andrew Spear, P.E.

Regarding: Geomembrane Installation Certification
Martin's Creek SES
Ash Basin No. 4
Project No. 4147-88-259

Gentlemen:

The geomembrane installation for Martin's Creek SES - Ash Basin No. 4 was completed on September 13, 1989. During the geomembrane installation, field observations and laboratory testing were performed to confirm conformance with the plans and specifications prepared by PP&L.

This document presents the results of our field observations and laboratory testing.

With this submittal, Westinghouse Environmental and Geotechnical Services, Inc., (Westinghouse) certifies the geomembrane installation was performed in general accordance with the Contract Drawings and Specifications issued by Pennsylvania Power & Light Company.

If you have any questions concerning this submittal or require additional information, please contact us.

Respectfully submitted,

WESTINGHOUSE ENVIRONMENTAL AND
GEOTECHNICAL SERVICES, INC.

Paula J. Shaffer

Paula J. Shaffer, E.I.T.
Staff Engineer

Reviewed by:

John A. Bove

John A. Bove, P.E.
Geosynthetics Department Manager
PA Reg. No. PE-037152-R

PJS:rp

Attachments

A Westinghouse Electric Corporation subsidiary

I. Geomembrane Manufacturer, Factory Fabrication, and Material Description

The Hypalon geomembrane was manufactured by JPS Elastomerics Corporation. All geomembrane is 36 mil Industrial Grade Reinforced Hypalon Chlorosulfonated Polyethylene (CSPE-R) manufactured in 5.38-ft. wide rolls by Stevens using Dupont's Hypalon 45 resin.

The manufacturer's certification of materials is included as Attachment I. Five rolls of geomembrane were sampled and tested by JPS Elastomerics prior to shipment to Staff Industries for the following properties:

- Thickness - overall and over scrim
- Breaking Strength
- Tear Strength
- Low Temperature Brittleness
- Dimensional Stability
- Volatile Loss
- Resistance to Soil Burial
- Hydrostatic Resistance
- Bursting Strength
- Ply Adhesion

Test data presented in Attachment I indicate that average values for these properties are within the required limits outlined in the project specifications.

The field panels were fabricated by Staff Industries in Detroit, Michigan. The field panels consisted of 8 to 21 sheets of CSPE seamed together in the factory. The field panels ranged in size from 41.2' x 158' to 103' x 283'. A factory visit was made by a Westinghouse representative to observe the fabrication process. A copy of the Geomembrane Fabrication Plant Visit Memorandum is included as Attachment II. All factory seams were completed with solvent adhesive for bonding. One factory seam sample was obtained from Panel "N" and tested in the Westinghouse Geosynthetics Laboratory. This sample passed the bonded shear testing. A copy of the test data is included in Attachment II.

Upon delivery to the project site, the handling and storage conditions were observed and noted by Westinghouse field personnel. Knorr Construction personnel transported the pallets of geomembrane to Ash Basin #4 using an aerial forklift. Individual panels were inspected for signs of abrasions, scratches or other damage caused during offloading, storage or handling of the geomembrane. Any such areas were repaired using a patch or were removed from the panels prior to installation. Several puckers (that is, seam areas where the inside portion of the bottom panel is not bonded to the top panel) were repaired by JPS Elastomerics or LS/CS (the installer) personnel.

II. Subgrade

Prior to deployment of geomembrane, the subgrade surface was visually inspected by a Westinghouse representative. Any areas found to be unsuitable (i.e. rutted, wet or containing potentially damaging gravel) were identified and repaired. The subgrade consisted of ash on the sidewalls and bottom of the basin. All density testing for the subgrade was performed by a representative of Allentown Testing Laboratories contracted by PP&L.

III. Geotextile

A 16 ounce per square yard nonwoven polyester fabric supplied by Bradley Materials Company was used as a cushion for the geomembrane. A copy of the geotextile warranty and certification test data are included in Attachment III. The geotextile was placed under all geomembrane. The geotextile was placed by Knorr Construction personnel. All geotextile was placed with a minimum 12-inch overlap and bonded with plywood adhesive or packing tape.

IV. Geomembrane Panel Placement

As each field panel was placed, a Westinghouse representative recorded the panel identification number and panel dimensions. Panel identification numbers were also marked directly on the panel after deployment. Drawing No. 1 of the As-Built Drawings shows the panel layout locations and identification numbers. The Daily Geomembrane Panel Summaries are included in Attachment IV. The overlap was checked (3-inches minimum) prior to seaming by LS/CS personnel.

The panels were anchored using automobiles, geotextile rolls, and tires. The installer was notified several times that Westinghouse did not approve of driving automobiles on the geomembrane. The Westinghouse representative checked all areas where automobiles were driven for damage, and areas where damage was observed were repaired by the installer. In areas where the subgrade became soft or wet, the panels were folded back and the subgrade was either allowed to dry or was repaired by W. W. Knorr Construction.

IV. Seaming

All seaming of the field panels was completed by LS/CS personnel. All seaming was completed with Hypalon HH630 adhesive or a 2:1 mixture of D-3 adhesive cut down with Stevens Hi-Tuff solvent. Approximately 30 ft. of seam P18/P22 was completed with an ultrasonic seamer on a trial basis. All solvent field seams were completed by the following procedure:

- Place board under seam area
- Wipe area with dry, clean cloth
- Preheat seam area with hot air gun (if necessary)
- Apply adhesive to seam area
- Roll area with hand roller
- Advance board and repeat process

From November 10, 1988 to May 31, 1989, the job was shutdown due to the weather. During this period, the exposed geomembrane went through a "curing" process typical of CSPE. Prior to bonding of "cured" to "new" (uncured) Hypalon, the seam area of the "cured" Hypalon was wiped with Hi-Tuff solvent and seaming was performed in the usual manner.

Each seam was given a number corresponding to the panel numbers being joined. Geomembrane Field Seam History sheets are included as Attachment V. All seaming was observed on a full-time basis by a Westinghouse representative. Special attention was given to distance ahead of seaming that the adhesive was applied so that volatilization did not occur. A visual examination of all seams and in-place material was completed by a Westinghouse representative.

For additional information on seaming procedures, see the Daily Field Reports included in Attachment VI. The field seams are shown on Drawing No. 1 of the As-Built Drawings.

During placement and seaming, the geomembrane was continuously inspected and evidence of loose lips (that is, seam edges or flaps that were not bonded together), punctures or abrasions were recorded on the panel. Punctures and abrasions were repaired with a patch that extended at least 3-inches beyond the area in need of repair on all sides. Loose lips were repaired with Sikaflex 1A Caulk to conform with the project specifications. It should be noted that the "loose lips" were not part of the bond required for water tightness, but were outside the required seam area.

During the seaming process all "fishmouths" were cut and repaired using Hypalon HH630 adhesive and a patch over any portion where the overlap was less than 3-inches.

Factory seams were also inspected by Westinghouse personnel. All areas of questionable quality were repaired as described above for field seams.

V. Connections to Structures

The geomembrane was connected to the three concrete structures with battening. A detail of the battening is included on Figure 1 of the Daily Field Report for June 30, 1989 included in Attachment VI. Sikaflex IA Caulk was used as a sealant between the concrete structure and geomembrane to keep water from getting to the subgrade. The locations of the concrete structures are shown on Drawing 1 of the As-Built Drawings.

VI. Destructive Testing

Samples of field seams were removed by LS/CS from locations selected by Westinghouse personnel at a frequency approximately equal to one sample per acre. The location of all destructive samples is recorded on the Daily Geomembrane Field Sample Summaries included in Attachment VII and shown on

Drawing No. 1 of the As-Built Drawings. An archive sample for each sample removed was retained by Westinghouse for the project record. The archive samples are stored at the Westinghouse Geosynthetics Laboratory in Cincinnati, Ohio and will be forwarded to PP&L.

A total of 20 field seams were sampled and laboratory tested by Westinghouse. The samples were tested for Grab Tensile strength in accordance with ASTM D751. Film Tearing Bond (FTB) and 200 lbs., minimum breaking strength were the criteria used for laboratory testing. Based on the above criteria, two (Samples 2, and 4) were disqualified due to breaking strengths below the minimum value. Sample 10 was of questionable quality due to dirt found in the seam area during laboratory testing. Sample 2 was accepted without additional testing. The areas adjacent to Samples 4 and 10 were resampled and retested (Sample 4R and 10R) and determined satisfactory. All sample areas were repaired by the Installer.

Test summaries for Grab Tensile testing and required retesting are included in Attachment VIII.

VII. Nondestructive Testing

Air Lance nondestructive testing was performed by W. W. Knorr Construction on 100% of each field seam under observation by a Westinghouse representative, who recorded the progress on the Geomembrane Field Seam History sheets included in Attachment V. Any areas where an indication of a leak or loose lips were observed were marked and recorded by the Westinghouse representative for repair. All repairs and patches were successfully tested prior to approval.

VIII. Blister Repair

After installation, small blisters (approximately 0.5 to 2-inch-diameter) were found on several field panels. The blisters were areas where bonding of the upper and lower elements of the CSPE through the scrim reinforcement did not occur. According to JPS Elastomerics, the blisters were caused by a soft area on a roller during the sheet manufacturing process. Two field panels (Panels #54 and #63) were removed after installation and replaced due to the large number of blisters on these panels. All remaining blisters were repaired by JPS and LS/CS individually with a 6-inch-diameter die cut patch. A total of approximately 5100 such repairs were made. For details on the repair method, quantity, and location of repairs, see the Daily Field reports included in Attachment VI. The blister repairs were randomly nondestructively tested by the probe method.

All blister repairs were completed by JPS Elastomerics under observation of a Westinghouse representative. The repairs were made between July 26, 1989 and September 8, 1989. Panels where blisters were repaired are shown on Drawing No. 2, "Blister Repair Area Plan", of the As-Built Drawings included in Attachment IX.

IX. General

The geomembrane was installed between October 10, 1988 and September 13, 1989. No work was performed between November 10, 1988 and May 31, 1989. Prior to winter shutdown, the edges of the installed geomembrane were placed in trenches and ash was placed over the edge to keep surface water from running under the geomembrane. After winter shutdown, the geomembrane was removed from the trenches and the subgrade was repaired before deployment of the remaining geomembrane.

The completed geomembrane was inspected and approved by representatives of Westinghouse, LS/CS, PP&L and the Pennsylvania D.E.R. prior to completion of the installation. The Pennsylvania D.E.R. was on-site September 11, 1989 for approval. The installation was approved by Westinghouse on September 13, 1989 after a complete walkover of the entire geomembrane.

The geomembrane installation as observed by Westinghouse was completed in accordance with the project plans and specifications except where noted herein.

The following Attachments complete this Document:

301257
October 30, 2000
June 6, 2009

PART III

Permit Conditions Specific to the Ash Basin No. 4 Disposal Impoundment

I. General Conditions:

1. This permit authorizes the operation of a local, captive Class II residual waste disposal impoundment, identified as Ash Basin No. 4, by PPL Martins Creek, LLC which consists of a 38.5 acre disposal area inside a 84.7 acre permit area within a 860 acre property pursuant to the Approved Application. The disposal area is depicted on Drawing D242664, Sheet 4, Revision 2 entitled "Martins Creek S.E.S. Ash Basin No 4 Permit Modification Drawing Conceptual Closure Plan" signed and sealed by Andrew Spear, P.E., received 6/15/98.

2. This approval, herein granted, is limited to the disposal of coal ash and other approved residual wastes meeting the minimum acceptability criteria set forth in 25 PA Code Chapter 289.523 from the PPL Martins Creek, LLC Steam Electric Station power plant located in Lower Mount Bethel Township, Northampton County, Pennsylvania.

3. This approval is limited to the following categories of waste:

   a. Fly ash
   b. Bottom ash
   c. Sediment from the Industrial Waste Treatment Basin
   d. Iron sludge from boiler cleaning

   No other waste types are approved for this facility.

4. This Waste Management permit application was prepared by Andrew D. Spear, P.E. for PPL Martins Creek, LLC, and submitted to the Northeast Regional Office: The approved application consisted of the following submittals:

   a. Permit Reissuance Application:
      1. Cover Letter(s) & Attachments (received 12/29/99, 1/12/2000, 2/2/2000, 6/7/2000, 7/6/200 & 7/17/2000)
      2. Draft Public Notice (received 2/2/2000)
      3. Permit Application – General Information (received 1/12/2000, revised 2/7/2000)
      4. Form A – Application for Residual Waste Permit (received 12/29/99, revised 2/2/2000, 6/7/2000)
      5. Form B – Professional Certification (received 6/7/2000)
      6. Form B1 – Application for Certification (1/12/2000)
      7. Form HW-C – Compliance History (received 12/29/2000)
      8. Form E – Contractual Consent of Landowner (received 12/29/99)
      9. Drawing D242664 Sheet 2 (Ash Basin No. 1 Permit Modification Drawing Property & Lithology Plan) (received 12/29/99
      10. Drawing D242663 Sheet 5 (Ash Basin No. 1 & 4 Permit Modification Drawing Property Plan) (received 6/7/2000)

   b. Original Permit Application:

      1. Permit Application - General Information (received 8/2/96, revised 9/10/97)
      2. Form A - Application for RSW Permit (received 8/2/96, revised 9/10/97, & 6/15/98)
      3. Form B - Professional Certification (received 8/2/96, 9/10/97)
      4. Form B1 - Application for Certification (received 8/2/96)
      5. Form C-1 - Compliance History Certification (received 8/2/96)
      6. Form D - Environmental Assessment (received 8/2/96)
      7. Form E - Contractual Consent of Landowner (received 8/2/96, revised 9/10/97)
      8. Form F - Soils Information Phase I (received 8/2/96, revised 9/10/97)
      9. Form H - Revegetation (received 8/2/96, revised 9/10/97)

10. Form I - Soil Erosion and Sedimentation Controls (received 8/2/96, revised 9/10/97, 6/15/98)
11. Form J - Soils Information Phase II (received 8/2/96)
12. Form L - Contingency & PPC Plan (received 8/2/96, revised 9/10/97 & 6/15/98)
13. Form Q - Equivalency (received 8/2/96)
14. Form R - Waste Analysis & Classification Plan (received 8/2/96)
15. Form U - Request to Dispose of Residual Waste (received 8/2/96)
16. Form 1R - Facility Plan (received 8/2/96, revised 9/10/97)
17. Form 2R - Map Requirements Phase I (received 8/2/96)
18. Form 3R - Map Requirements Phase II (received 8/2/96, revised 9/10/97)
19. Form 6R - Geologic Information (received 8/2/96, revised 9/10/97)
20. Form 7R - Hydrogeologic Information (received 8/2/96, revised 9/10/97)
21. Form 11R - Alternative Water Supply (received 8/2/96)
22. Form 12R - Operation Plan (received 8/2/96, revised 9/10/97)
23. Form 13R - Water Quality Monitoring System (received 8/2/96, revised 9/10/97)
24. Form 16R - Liner System (received 8/2/96, revised 6/15/98 & 6/29/98)
25. Form 18R - Closure/Post-Closure Land Use Plan (received 8/2/96, revised 9/10/97)
26. Form 24R - Residual Waste Disposal Impoundments (received 8/2/96, revised 9/10/97)
27. Form 25R - Source Reduction Strategy (received 8/2/96)
28. Bonding Worksheets (received 8/2/96, revised 9/10/97)
29. Various attachments (received 8/2/96, 9/10/97 & 6/15/98)
30. Revegetation and Alternative Soil Cover Plan, prepared by Civil & Environmental Consultants, Inc. (received 8/2/96)
31. Certification of construction, prepared by Westinghouse Environmental & Geotechnical Services, Inc. dated 2/23/90, (received 8/2/96)
32. Modeling for Ash Basin Closure Study excerpt, prepared by Tetra Tech, Inc. (received 8/2/96)
33. Environmental Modeling and Surveillance Program, prepared by ERM Inc. (received 8/2/96)
34. Module 5 and 5a excerpts (received 9/10/97)
35. Groundwater Sampling Analysis Plan (received 9/10/97)
36. Geophysical Survey Report (received 9/10/97)

37. Dam Safety related correspondence (received 9/10/97)
38. Sinkhole Contingency Plan report and plan (received 6/15/98, revised 7/24/98)
39. Grouting History report (received 9/10/97)
40. Ponding calculations (received 6/15/98)
41. Assorted cover letters dated 8/2/96, 9/10/97 and 6/15/98
42. Form T1 (received 7/30/94)
43. Assorted drawings including:

    a. D242664, Sheet 1, received 6/15/98 (Ash Surface Conditions 1997)
    b. D242664 Sheet 4, received 6/15/98 (Conceptual Closure Plan)
    c. D242664, Sheet 2, received 8/2/96 (Lithography)
    d. D242664, Sheet 3, received 8/2/96 (Groundwater Elevations)
    e. D242664, Sheet 5, received 6/15/98 (Closure Sections and Details)
    f. D242664, Sheet 6, received 6/15/98 (Closure Sections and Details)
    g. E208987, Sheets 1 & 2, received 8/2/96 (Geophysical Survey & Borings)
    h. E208109, Sheet 2, received 9/7/97 (Ash Basin Siting Study)
    i. E208844, Sheets 2 & 3, received 9/10/97 (Basin 4 Outlet Works)
    j. E209426, received 9/10/97 (Aerial Site Plan)
    k. E218208, Sheet 1, received 9/10/97 (Basin 4 Borrow Area Reclamation Plan)
    l. E129657, received 9/10/97, (Basin 3 and LVWB Location)
    m. E209505, received 8/2/96 (Effluent Line Profile)
    n. E237630, Sheet 4, received 8/2/96 (Borrow Area)
    o. E237631, received 8/2/96 (Borrow Area Cross-section)
    p. E245198, Sheet 1 (Soil Borrow Area Existing Contours)
    q. E245198, Sheet 2 (Soil Borrow Area Final Grading)
    r. E245198, Sheet 3 (Soil Borrow Area Basin No. 1 and No. 4 Closure Sections and Details).
    s. LE-96047, Sheets 1 & 2, received 9/10/97 (ITWB-related)
    t. Plan Map with Bedrock Geology, received 9/10/97
    u. A242627, Sheet 1, received 9/10/97 (Soil Survey)

5. Approved Liner System: The Liner System and Leachate management requirements for a Class II residual waste impoundment have been modified per 25 PA Code Chapter 287.115.c (Modification) based on the approved application meeting the requirements specified therein. The modification of the liner system requirements and leachate treatment requirements are contingent upon the continued stability of the liner system, and the absence of groundwater degradation. If these conditions change, the Department reserves the authority to revoke these waivers. Therefore, the approved existing liner system and leachate management requirements consist of:

   a. Coal bottom ash structural fill/subgrade
   b. 12 inch minimum coal ash subbase
   c. 16 ounce geotextile
   d. 36 mil noncomposite reinforced hypalon liner
   e. No leachate detection zone except the single liner.
   f. No leachate collection or treatment except as required for NPDES discharge permit.
   g. Existing liner slopes and grades.

6. Hours of Operation: The impoundment may be filled by sluicing flyash at any time. If trucking became necessary the Department would be notified.

7. Weight Measurement: The operator will calculate the daily disposal volume for coal ash disposal by multiplying the daily coal tonnage burned at the Martins Creek Steam Electric Station by the ash percentage from the analytical results. Any trucked wastes shall be measured at a scale capable of accurate measurement.

8. Daily Volumes:

   a. The approved Average Daily Volume is 150 tons per day/3 MGD. The Average Daily Volume will be calculated by averaging the daily disposal volume over the days of operation for that Quarter.
   b. The approved Maximum Daily Volume is 300 tons per day/6 MGD.

9. Variances: No variance except as allowed by 25 PA Code Chapter 287.115.c was granted.

10. Future Activities: The use of this facility and/or its structures within the permitted area for any usage other than identified in the approved application will require written Department approval. The borrow area may be used for farming.

11. Consolidated Application: One complete, consolidated copy of the approved application must be submitted to the Department within one hundred twenty (120) days of permit issuance. This consolidated application shall include all design and operational plans for any treatment system associated with Ash Basin No. 4.

12. The bond of $4,657,510 between "the permittee" and the Department is hereby approved as part of this permit. This bond must be updated within ninety (90) days of receipt of written correspondence from the Department in accordance with 25 PA Code §287.375.

13. The permittee must designate a full time management team (including the contact person) for site operations and site construction/closure and provide a breakdown of the duties and authority of each position of the management team within thirty (30) days of permit issuance or as otherwise approved by the Department. The occupants of these management positions will be provided with the following:

   a. The personnel and material resources to accomplish his/her task;

   b. The full managerial authority to accomplish his/her task. In particular, the following authorities will be assigned to these positions:

      (1) The authority to hire and fire (and/or replace or reassign);

      (2) The authority to make immediate purchases where needed;

      (3) The authority to issue directives and completely control on site operational activity and/or construction activity;

      (4) The authority to control access to all areas of the site;

(5) The authority to completely control all wastestreams received at the site, including the authority to reject such streams. The occupant of this position will not be in charge of other duties which will detract from the performance of the duties and authorities described herein;

(6) The authority to authorize expenditure and hire outside contractors as needed;

(7) The authority to revise the site PPC Plan; and

(8) The authority to address operational/construction/closure problems caused or affected by the contractors operating on site.

c. A contact person will be based either onsite or at the Martins Creek Steam Electric Station. This contact person will maintain all required records and permit documents at his office in a readily available format. This person or a designated standby person with all necessary access and authority will be available to meet Department personnel during regular business hours or during any site emergency. This contact person will have authority to correct any construction or operations problems onsite.

14. Authorized employees or agents of the Department, without advance notice or search warrant, upon presentation of appropriate credentials and without delay, shall have access to and to inspect all areas on which solid waste management activities are being, will be, or have been conducted. This authorization and consent shall include consent to collect samples of waste, solid, water, or gases; to take photographs; to perform measurements, surveys, and other test; to inspect any monitoring equipment, to inspect the methods of operation; and to inspect and/or copy documents, books and papers required by the Department to be maintained. This permit condition is referenced in accordance with Section 608 and 610(7) of The Solid Waste Management Act, 35 P.S. Section 6018.608 and 6018.610(7). This condition in no way limits any other powers granted under the Solid Waste Management Act.

15. Sinkhole Contingency Plan:

a. In the event of sinkhole development, the permittee will implement the sinkhole contingency plan as modified below:
b. The basin's lined area, dikes and immediately adjacent area will be inspected for evidence of subsidence, sinkhole development and/or liner damage on a quarterly basis at minimum. Written notification including location, dimensions and proposed corrective actions will be submitted to the Department within seven (7) days of detection of possible subsidence, sinkhole development or liner damage. Animal burrows on the dikes shall also be corrected.
c. In event of potential subsidence or sinkhole development, the suspect area will be monitored daily until the corrective action is completed. The corrected area will be monitored weekly until the Department approves an alternate frequency in writing.
d. Within thirty (30) days of detection of subsidence or sinkhole development, the permittee will submit an analysis of the potential impact of the subsidence and/or sinkhole development on the stability of the dikes. This analysis will include evaluation of the potential growth of a developing sinkhole, and potential for additional sinkhole formation. If the factor of safety is below those required by 25 Pa. Code Chapter 289.271.a.3, then the permittee shall either submit a permit modification including measures to increase the stability of the dikes to the regulatory requirement within sixty (60) days, or close the facility.
e. In event that the subsidence or sinkhole threatens the basin or its dikes, the permittee will take whatever action is required to minimize the hazards to the public health, welfare safety and the environment posed by potential failure. The Department retains the right to require closure of this basin if needed to protect the public health, welfare, safety or environment.
f. In the event that Ash Basin No. 1 cannot be used due to sinkhole development, PP&L may temporarily use Ash Basin No. 4 as a disposal area upon Department approval of the connection to Ash Basin No. 4. A permit modification must be submitted for any proposed usage of Ash Basin No. 4 for disposal of Ash Basin No. 1 waste for more than six months. All disposal of non-flyash wastes must cease within one year unless the Department approves a permit modification for this activity.

g. In event of a liner breach, the Department reserves the right to modify the time-frame and scope of the sinkhole contingency plan and/or groundwater assessment investigation to determine the impact of the breach on groundwater. Conducting a dye tracer test may be required. If an impact is identified, the Department reserves the right to modify the corrective action plan.

II. Additional Operational Requirements:

1. Prior to any contractor working onsite, the operator must verify that the contractor has prepared an adequate health and safety plan consistent with the site PPC Plan. The site PPC plan must be updated as needed at that time. The PPC Plan must also be updated if fuels or chemicals are stored onsite during construction and operations.
2. In event of a change in the source or type of coal that changes the ash content/characteristics, the operator will notify the Department. This notification will include an evaluation of the ash to determine if the chemical constituents of the ash have been affected.
3. The Department shall be notified in event that the NPDES permit requires additional treatment of impoundment effluent. A minor permit modification application shall be submitted in event of design or construction changes to the current pH adjustment system.

III. Construction Requirements:

1. The operator will notify the Department concerning proposed major construction activities two weeks prior to starting the activities. The operator shall submit a certification by a registered professional engineer on forms provided by the Department upon completion of each major construction activity identified in the permit for each phase or sequence of construction/closure at the facility. Major construction activities include but are not limited to:

   Construction of site access service roads; site erosion and sedimentation controls; the facility structures; stages of closure; groundwater abatement system; sections of individual cap section construction; sinkhole contingency plan construction activities.

This certification shall describe construction activity in the phase or sequence of construction being certified using drawings and plans where appropriate. This certification shall state that the actual construction was observed by the engineer or persons under his direct supervision and that the supervision was carried out in a manner that is consistent with the approved permit. The construction certification shall include test reports and documentation that all of the other requirements of the QA/QC plan have been met.

Upon completion of each construction activity described above, the operator shall notify the Department that the construction activity is ready for inspection by Department staff. No waste may be disposed, processed or stored in the new Cell area until the Department has conducted an inspection and has transmitted its approval to the permittee indicating that construction was done according to the permit.

2. All supplemental information on any design shall be certified by a registered professional engineer and submitted for final design review by the Department at least 30 days prior to actual construction.

3. The permittee shall employ a third party Quality Assurance company to provide services for installation of each cell construction, or with the approval of the Department may retain appropriate quality assurance staff.

4. Prior to closure, the permittee shall have an independent testing laboratory submit to the Department, permeability and grain size tests on the ash, stone and structural fill to be used in the construction.

5. Any use of bottom ash to construct site roads shall conform with all requirements of 25 Pa. Code 287.665.b.4. Any use of coal ash as structural fill shall conform with all requirements of 25 Pa. Code §287.661 (use of coal ash as structural fill)

6. Closure:

   a. No closure cap waiver is granted.
   b. Within six months of closure, "the permittee" shall submit for approval, an updated closure plan/closure schedule addressing all regulatory requirements including erosion and sedimentation control requirements. This revised closure plan will address all requirements of the 10/31/96 Department Bureau of Dams, Waterways and Wetlands letter, located in Attachment 1, which is hereby incorporated by reference. This closure plan will include an evaluation of the adequacy of the soils in meeting regulatory performance requirements. This updated closure plan will also include a "stand alone" Construction Quality Assurance plan addressing all materials of construction. The closure plan will include a waste solidification plan if needed.
   c. No bottom ash may be used as fill to reach closure grades without written Department approval.
   d. The Department reserves the authority to require placement of intermediate cover in event of dust problems during closure.
   e. Final cover soils will be placed within one year of reaching final grades, or within one year of cessation of ash disposal at this impoundment.
   f. During closure, the permittee will prevent contaminated runoff from leaving the disposal area.

7. The Department Waste Management Program is to be notified in regard to any problem or proposed design/operational change associated with the current Ash Basin No. 4 discharge treatment system.

IV. Water Quality:

1. Monitoring Points:

   a. The approved groundwater monitoring system for Basin 4 consists of the following monitoring wells.

      Downgradient Wells: 4-2, 4-3, 4-4, 4-5 and 4-6.

Upgradient Well: 4-1.

b. The list of required groundwater monitoring locations may not be modified without prior written approval from the Department.

2. Groundwater Sampling:

This further describes or modifies Part II, Section VIII of the permit conditions.

a. "The permittee" will conduct quarterly and annual sampling of the monitoring wells for the parameters listed on Form 14R with the following modifications: Boron, magnesium, and lithium will be analyzed quarterly. All metals will be analyzed for total and dissolved concentrations. Annual volatile organic analysis will be performed for the following parameters: Tetrachloroethene, trichloroethene, 1,1,1-trichloroethane, 1,1-dichloroethene, cis-1,2-dichloroethene, trans-1,2-dichloroethene, 1,1-dichloroethane, 1,2-dichloroethane, and vinyl chloride. Any changes in the list of required analyses must be approved by the Department in writing.

b. Water quality monitoring reports must be submitted to the Department for all approved monitoring points shall be complete and accurate and shall also include, at a minimum:

A cover letter identifying the facility and sampling event. The cover letter shall describe anything unusual or noteworthy about the sampling and analysis. Changes in sampling personnel or laboratory performing the chemical analysis should also be included in the cover letter.

c. The permittee shall submit an updated groundwater sampling and analysis plan within 60 days following issuance of the permit. All monitoring points for any waste management regulated unit at the facility shall be included. The plan shall also include a monitoring point location map, a list of testing parameters, and a table providing a synopsis of individual monitoring well performance during sampling (i.e., purge volume and rate, dewater and recovery time). The plan must be available to personnel performing the sampling during each sampling event.

d. "The permittee" may revise the sampling and analysis plan but significant changes such as changes in purge volumes, sampling devices or analytical methods will require Department approval.

e. A report shall be submitted annually (by March 31 for the previous year) which evaluates water quality (through data trends and statistical methods) at the facility. A contour map of water table elevations shall be included with this report. The report shall also include a map detailing land use during the reporting year which would affect the ground water monitoring system.

Pennsylvania Department of Environmental Protection

Rachel Carson State Office Building
P.O. Box 8554
Harrisburg, PA 17105-8554
October 31, 1996

Bureau of Dams, Waterways and Wetlands

Telephone: 717-787-8568
Telecopier: 717-772-5986

Mr. Andrew W. Spear
Senior Project Engineer
Pennsylvania Power & Light Company
Engineering and Technical Services
Two North Ninth Street
Allentown, PA 18101

RE: DEP File Nos. D47-009, D48-149, D55-046, D55-047, D67-496, D67-500

Dear Mr. Spear:

In our October 24, 1996 telephone conversation, we discussed the Division of Dam Safety requirements relating to the abandonment of Pennsylvania Power & Light Company ash basins. Abandonment of any existing ash basin will require a Dam Permit from the Division of Dam Safety. A copy of the current application package is enclosed.

To receive a Dam Permit to abandon a waste impoundment dam, the applicant must submit a reclamation/closure plan approved by all appropriate Department programs. This reclamation/closure plan should include capping, vegetation establishment and erosion control. Storage of surface runoff which could result in percolation through the impoundment cap would not be acceptable. A stability analysis must be included based on properties of the in-situ ash material and embankment material.

In order for the Division of Dam Safety to consider a reclaimed or closed impoundment dam to be abandoned and to eliminate the need to continue with inspections and reporting requirements for operation and maintenance of the dam, the following information is required:

- In-situ sampling of the waste material confirming that the waste material has a moisture content less than the plastic limit.

- If all of the waste material does not have a moisture content below the plastic limit, it may be acceptable to show that all material is at least below the liquid limit. It must be demonstrated by a stability analysis that, should a slope failure of the critical surface of the downstream face of the embankment occur, the <u>remaining</u> portion of the embankment and stored material will have adequate factors of safety to be considered acceptable. This remaining downstream embankment slope must have a factor of safety of 1.5 for the steady state seepage condition and 1.0 for earthquake loading for the closure plan configuration.

- The liquefaction potential of the waste material should be evaluated using the in-situ sampling results and the stability of the dam embankment should be reviewed using current criteria for earthquake analysis.

- Piezometer readings should be continued for a period of time after the closure has been completed in order to evaluate the effectiveness of the cap on the phreatic surface in the embankment.

As with any Dam Permit application, we recommend a pre-application meeting sometime during project design. This will ensure that any design is progressing toward a plan that could be permitted by the Division of Dam Safety. Should you have any questions please contact me at the above telephone number.

Sincerely,

Donald Martino, P.E.
Chief
Division of Dam Safety

Enclosure: Application for Dam Permit

Pennsylvania Department of Environmental Protection

2 Public Square
Wilkes-Barre, PA 18711-0790
December 27, 2005

Northeast Regional Office

570-826-2511
Fax 570-826-5448

PPL Martins Creek, LLC
Two North Ninth Street
Allentown, PA 18101-1179

Attention: Thomas G. Eppehimer, Plant Manager

Re: PPL Martins Creek – Ash Basin No. 4
Permit Modification – Return to Service
Lower Mt. Bethel Township, Northampton County
Facility ID # 301257

Dear Mr. Eppehimer:

Enclosed is a permit modification to Solid Waste Permit # 301257 issued to PPL Martins Creek, L.L.C. for the operation of the Class II Residual Waste Disposal Impoundment known as "Ash Basin No. 4". Ash Basin No. 4 is an existing Class II Residual Waste Disposal Impoundment used for the disposal of coal ash generated from the coal fired electric generating units at the Martins Creek Steam Electric Station in Lower Mount Bethel Township, Northampton County. Ash Basin No. 4 is approximately 40 acres in size, is lined with a 36 mil hypalon liner and has a discharge structure connected to a pipeline that runs to the Delaware River. The enclosed permit modification authorizes design, construction, and operational changes at Ash Basin No 4. following the August 23, 2005 Ash Basin discharge structure failure, and addresses 25 Pa. Code §289.274(b) (Failure) requirements pertaining to the return of Ash Basin No. 4 to normal service. Design and construction changes, along with required repairs, have been made by PPL in order to provide additional safeguards against the recurrence of any similar type of incident. The Operational changes being made include a new site "Integrated Contingency Plan" (ICP) that replaces the previous site "Comprehensive Spill Prevention & Response" (CSRP) plan, and which incorporates modified operating procedures for Ash Basin
No. 4.

The Department is allowing the start-up and operation of Ash Basin No. 4 on the basis of the following changes and understandings:

1. Future Ash Management: The Department understands that PPL desires to return its coal-burning power plant Units Nos. 1 & 2 to service, which requires a means to dispose of the generated coal ash.

   a. Coal-derived "fly" ash: PPL is approved to resume disposal of newly generated coal-derived fly ash (generated by Units Nos. 1 & 2) in Ash Basin No. 4 upon issuance of this permit modification. Conditions of the permit modification identify several future completion dates that are to be completed in accordance with the specified time frame. Ongoing compliance with the revised Integrated Contingency Plan (ICP) is also a continuing requirement.

b. Coal-derived "bottom" ash: The coal-derived bottom ash will be separately managed at a new concrete trough "captive processing" area that will be operated under the 25 Pa. Code §287.102 (Permit-by-Rule "captive processing") provisions, and stored at a location complying with 25 Pa. Code §299.131-299.133 (Storage piles) and 25 Pa. Code §299.153 (Storage and containment of coal ash). The bottom ash was previously managed at Ash Basin No. 1, which is now inactive. The PPL Permit-by-Rule Notification submittals required by 25 PA Code § 287.102(b)(8) were received on November 16, December 2 & 16, 2005.

c. Clean-up/Remediation Wastes: Ongoing disposal of clean-up/remediation wastes from the incident can continue via usage of the approved Ash Basin No. 4 Temporary North Ramp (approved with conditions per the October 14, 2005 Department Letter and certified via 11/10/2005 PPL construction certification), and the pipeline from the ongoing Delaware River clean-up project to Ash Basin No. 4. The North Ramp and pipeline are temporary structures associated with the ongoing clean-up activities, and will be removed when the clean-up activities are completed.

2. Design Changes: PPL has determined that the August incident involved the failure of a wooden "stop log" that was part of a structure (acting like an internal dam/barrier within the Ash Basin No. 4's internal concrete Discharge Structure), with a resultant large-scale release of coal ash & slurry water. In addition to replacing the entire set of logs that were part of the discharge structure, PPL has made various design changes in order to prevent any similar events. The PADEP Bureau of Waterways Engineering, Division of Dam Safety, has reviewed and approved the design changes via a December 14, 2005 PADEP Letter. In addition, PPL hired a technical consultant (Exponent Failure Analysis Associates) to review the design plans on behalf of PPL. On December 15, 2005, the Ash Basin No. 4 modifications underwent a successful field test witnessed by PPL, the Department, and the Engineers for Lower Mt. Bethel Township (PA) and Harmony Township (NJ). The PPL documents relating to the design modifications are listed below and incorporated in the permit conditions. The approved design changes can be summarized as follows:

a. New Concrete Logs/Panels: Replacement of the wooden "stop logs" within the Ash Basin No. 4 internal concrete Discharge Structure by engineered concrete panels and stop logs that can handle much higher pressure loads.

b. Additional Metal Barrier: Installation of a new metal barrier consisting of engineered metal plates within the existing "skimmer plate" structure located within the concrete Discharge Structure. This metal plate barrier can act as a separate barrier to any uncontrolled release from the Basin.

c. New Valve Inside Discharge Structure: Installation of a new slide gate valve within the concrete Discharge Structure that will allow PPL to control discharges from the Ash Basin No. 4.

d. New Manhole with Additional Valve: Installation of a new manhole containing a new gate valve, outside of the Basin, and installation of new "in situ" pipe lining between the Ash Basin No. 4 Discharge Structure and the new manhole. This second valve, in conjunction with the other new valve, will allow for PPL to completely cut-off discharges from the Basin. The new "in situ" pipe lining will protect the existing concrete pipe in event of backpressures generated by valve closure.

e. New Water Level Monitoring Instruments in Discharge Structure: PPL has installed new water level measuring devices that are linked to the PPL Units 3 & 4 Control Room. This allows the PPL control room operators to detect water elevation/level changes within the concrete Discharge Structure's Chamber 1 (between the new metal barrier and the new concrete stop logs) and Chamber 2 (between the new concrete stop logs and valve/gate).

3. Integrated Contingency Plan (ICP): The ICP replaces the previous site "preparedness, prevention, and contingency" plan (known as the "Comprehensive Spill Prevention & Response" a.k.a. CSRP Plan). The PADEP Waste Management Program (with input from other PADEP Programs) has determined that the ICP (as modified by this permit modification) will adequately address the "preparedness, prevention, and contingency" planning requirements for Ash Basin No. 4.

   a. Contents of the ICP: This ICP was prepared per the (Federal) National Response Team's Integrated Contingency Plan Guidance found in the Wednesday, June 5, 1996, Federal Register (Vol. 61, No. 109, pages 28642 through 28664) as modified by additional PA requirements set forth in the PADEP "Guidelines for the Development and Implementation of Environmental Emergency Response Plans" (Document # 400-2200-001, August 6, 2005).

   b. Implementation of the ICP: The ICP is the core "preparedness, prevention, and contingency" (PPC) plan for the site, except in the event of a "dam emergency" as defined by the PADEP Dam Safety Program where provisions of the ICP Annex 9 Dam Emergency Action Plan ("Dam EAP") would take precedence.

   c. Consolidation of Site Contingency Plans: The ICP has consolidated the site contingency plans. The Ash Basin No. 4 Operating Instructions, Ash Basin No. 4 Maintenance Plan (including Inspection requirements), and the Sinkhole Contingency Plan are now incorporated into ICP Annex 9. The finalized Dam EAP must be incorporated into the ICP when it is finalized.

   d. General Improvements to the site contingency plan:

      i. Drawings: Per permit condition, the ICP drawings shall be updated.

      ii. Emergency Coordinator Duties: The duties of the "emergency coordinator" (a.k.a. "Incident Commander") have been clarified.

      iii. Onsite Management During Emergencies: PPL has included a new ICP Annex 9 document (the "IERP" a.k.a. "Integrated Emergency Response Plan") that clarifies how the PPL site management structure will function during an emergency per the Federal Department of Homeland Security's "National Incident Management System" (NIMS) guidance available at the FEMA website (www.fema.gov). The IERP addresses the site's managerial processes, rather than emergency procedures.

      iv. Notification Requirements: PPL has clarified the notification procedures and requirements for emergency contacts including the local communities, and downstream water users. For example, the local municipalities can now contact PPL at 610-498-2282 or 610-498-6200 in event of a complaint on a 24 hour-per-day basis.

e. Modifications to the ICP: The Department has included permit conditions to modify the ICP to address some minor issues. Examples include:

   i. The "preventive maintenance" section of the previous contingency (CSRP) plan was accidentally omitted from the ICP, and has been incorporated by reference.

   ii. The PA PPC Plan Guidelines required "material compatibility" section was also omitted by accident, and must be addressed per permit condition.

   iii. Additional cross-referencing for the benefit of the emergency responders.

   iv. Clarification of the Incident Commander (a.k.a. the emergency coordinator) authority and duties.

f. Sinkhole Contingency Plan: The revised "Sinkhole Contingency Plan" did not contain all previous commitments or relevant information in regard to actions required in event of that contingency. Therefore, the Department is incorporating by reference the "Sinkhole Contingency Plan for Basin No. 4" submitted on 2/8/99 of the (Ash Basin No. 4) Approved Application into the Annex 9 until such time as the Department approves an updated Sinkhole Contingency Plan. In addition, the Department is incorporating by reference the "Section 4.7 Ash Basin Sinkhole Damage Contingency Plan" for Ash Basin No. 1" submitted on 6/15/98 as part of the (Ash Basin No. 1) Approved Application into Annex 9 until such time as the Department approves an updated Sinkhole Contingency Plan or Ash Basin No. 1 closes.

g. Finalized ICP:

   i. When finalized, copies of the ICP must be distributed to the various emergency responders and the PADEP Waste Management Program, Water Management Program, Dam Safety Program, and Storage Tank Program. These other PADEP Programs have overlapping regulatory/permitting involvement in regard to this site contingency plan.

   ii. The ICP is a "living document" that PPL will have to update as needed during the life of the facility. Therefore, PPL has the duty to update the ICP copies distributed to the relevant Department Programs and emergency responders as needed.

This permit modification does not authorize any other change to the facility's construction or operations, and does not address the separate ongoing site & Delaware River clean-up/remediation activities under the jurisdiction of the PADEP Water Management Program, or the ongoing groundwater assessment activities for Ash Basin No. 4, or the compliance/enforcement issues (including future penalty assessment) being pursued through the PA Commonwealth Court per the November 18, 2005 Complaint (No. 584MD2005 Civil Action) filed by the Department.

Please pay special attention to the permit conditions that have been attached to, and which are part of your permit. I also caution you that issuance of this permit modification does not eliminate the need to comply with all applicable federal, state or local requirements at the permitted facility.

Any person aggrieved by this action may appeal, pursuant to Section 4 of the Environmental Hearing Board Act, 35 P.S. Section 7514, and the Administrative Agency Law, 2 Pa. C.S., Chapter 5A, to the Environmental Hearing Board, Second Floor, Rachel Carson State Office Building, 400 Market Street, P.O. Box 8457, Harrisburg, PA 17105-8457, 717-787-3483. TDD users may contact the Board through the Pennsylvania Relay Service, 800-654-5984. Appeals must be filed with the Environmental Hearing Board within 30 days of receipt of written notice of this action unless the appropriate statute provides a different time period. Copies of the appeal form and the Board's rules of practice and procedure may be obtained from the Board. The appeal form and the Board's rules of practice and procedure are also available in Braille or on audiotape from the Secretary to the Board at 717-787-3483. This paragraph does not, in and of itself, create any right of appeal beyond that permitted by applicable statutes and decisional law.

IF YOU WANT TO CHALLENGE THIS ACTION, YOUR APPEAL MUST REACH THE BOARD WITHIN 30 DAYS. YOU DO NOT NEED A LAWYER TO FILE AN APPEAL WITH THE BOARD.

IMPORTANT LEGAL RIGHTS ARE AT STAKE, HOWEVER, SO YOU SHOULD SHOW THIS DOCUMENT TO A LAWYER AT ONCE. IF YOU CANNOT AFFORD A LAWYER, YOU MAY QUALIFY FOR FREE PRO BONO REPRESENTATION. CALL THE SECRETARY TO THE BOARD (717-787-3483) FOR MORE INFORMATION.

If you have any questions, please contact me at the above telephone number.

Sincerely,

Michael D. Bedrin /for

William Tomayko
Program Manager
Waste Management Program

Enclosure

cc: Lower Mt. Bethel Township
Northampton County
PADEP Water Management
PADEP Dam Safety
Patrick Renshaw (PPL)
Harmony Township
Dave Bean: New Jersey DEP
Gary Pearson: New Jersey DEP

bcc: R. Wallace/WM File
J. Leskosky/D. Fisher
R. Ducceschi/T. McGurk/eFACTS
J. Berger
L. Hannigan
Permit Book

WT:lms
WP: WM-282.doc
HP: 12/23/05
TP(F): 12/27/05

ER-WM-38: Rev. 8/86

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL PROTECTION
BUREAU OF WASTE MANAGEMENT

FORM NO. 13-A
MODIFICATION TO SOLID WASTE DISPOSAL AND/OR PROCESSING PERMIT

Under the provisions of Act 97, the Solid Waste Management Act of July 7, 1980, Solid Waste Permit Number 301257 issued on (date original permit was issued) October 30, 2000 to

(permittee) PPL Martins Creek, LLC

(address) Two North Ninth Street
Allentown, PA 18101-1179

is hereby modified as follows:

All conditions of the attached permit modification shall supersede conditions of the original permit to the extent they are inconsistent or in conflict with the original permit and any modifications to that permit that predate the attached permit modification. Conditions contained herein that reference "the Permit" refers to the permit as modified by the attached modification.

Nothing herein shall be construed to supersede, amend or authorize a violation of provisions of any valid and applicable local law, ordinance or regulation, provided that said local law, ordinance or regulation is not preempted by the Pennsylvania Solid Waste Management Act, of July 7, 1980, Act 997, 35 P.S. 60118.101, et seq. and the rules and regulations promulgated thereunder.

The permit conditions are as follows:

1. Design Changes to Ash Basin No. 4:
   b. This permit authorizes the following Ash Basin No. 4 construction modifications as set forth in the approved Certified Technical Report and consisting of installation of the following:
      i. Concrete Logs/Panels in the Discharge Structure
      ii. Additional Metal Skimmer Plate Barrier in the Discharge Structure
      iii. New Knife Gate/Valve within the Discharge Structure
      iv. New Manhole with Additional Knife Gate/Valve outside the Basin disposal area.
      v. Insitu Lining of the Concrete Pipe between the Discharge Structure and new Manhole
      vi. Water Level Monitoring Instruments within the Discharge Structure

This modification shall be attached to the existing Solid Waste Permit described above and shall become a part thereof effective on (date) December 27, 2005.

Michael D. Bedrin FOR WILLIAM TOMAYKO
FOR THE DEPARTMENT OF ENVIRONMENTAL PROTECTION

page 1 of 7

c. Certified Technical Report Contents: The approved "Certified Technical Report" addressing the design modifications to Ash Basin No. 4, and incorporated into the approved application for Ash Basin No. 4, consists of the following:

i. 12/14/2005 PADEP Bureau of Waterways Engineering Letter of Authorization for design modifications to Ash Basin No. 4.

ii. The "Discharge/Incident Technical Report' signed and sealed by Andrew D. Spear, P.E. (received 11/7/2005) including the following sections:

1. Introduction
2. Original Facility Design
3. Discussion of Incident
4. Detailed Description of Permanent Modifications to Ash Basin No. 4 Discharge System
5. Start-up and Test-Plan for the Ash Basin #4 Discharge Barriers
6. Inspection Results
7. Appendix A (Liner Inspection Memorandum)
8. Appendix B (Knife Gate Valve and Vault)
9. Appendix C (Insitu Slip Lining Letter)
10. Cianbro QA/QC Report including:
    a. Scope of Work
    b. Atlantic Metrocast Verification of Material Supplied
    c. Kleinschmidt Design Verification
    d. Cianbro Description of Necessary Field Modification
    e. Cianbro Verification of Field Installation per Design

iii. As-Built Drawings (Revised) (received 11/10/2005) including Drawing E323319 Sheet 1 "Ash Basin #4 Discharge Structure Modifications Plan and Section" signed and sealed by Andrew D. Spear, P.E.

iv. Concrete Stoplog and Panel Documentation (received 12/2/2005) including revised design calculations.

v. Design Review Documentation and Updated Drawings (received 12/2/2005) including:

1. Exponent Letter signed and sealed by Alexander Newman, P.E.
2. Kleinschmidt Drawing 1 "New Gate General Arrangement Details and Gate Notes"
3. Kleinschmidt Drawing 2 "New Gate Sections and Details"
4. Kleinschmidt Drawing PB-1 "Concrete Stoplog Panels Bracing"
5. Kleinschmidt Drawing MC-G-1 "New Steel Skimmer Gate Panel Section and Details"

vi. Martins Creek Ash Basin 4 Level Monitoring System – Design and Operation (received 11/15/2005)

vii. "Potential Impact of Release on Hypalon Liner" Report, prepared by Exponent Failure Analysis Associates, signed and sealed by Alexander Newman, P.E. (received 11/15/2005).

viii. "Ash Basin #4 Discharge Barrier Test Summary" (received 12/16/2005 via e-mail and 12/19/05 letter)

ix. Completion Certification and As-Built Drawings

1. As-Built Drawing and certification that work was completed in accordance with the drawings, signed and sealed by Andrew D. Spear, P.E. (12/15/05 letter)
2. DEP Confirmation that submitted certification is acceptable (R. Adams 12/16/05 e-mail)

2. Integrated Contingency Plan (ICP) Contents: This permit approves the Integrated Contingency Plan (ICP), including operation changes described therein, and incorporates it into the Approved Application for the Ash Basin No. 4:

   b. The approved Integrated Contingency Plan consists of:
      i. The 12/13/2005 ICP Submittal including
         1. Table of Contents
         2. Section I (Plan Introduction)
         3. Section II (Core Emergency Response Action Plan)
         4. Annex 1 (Facility Oil, Chemical and Waste Storage)
         5. Annex 2 (Notifications) (modified 12/16/2005)
         6. Annex 3 (Response Management Plan)
         7. Annex 4 (Incident Documentation)
         8. Annex 5 (Employee Training and Exercises/Drills)
         9. Annex 6 (Plan Review and Amendments)
         10. Annex 7 (Incident Prevention)
         11. Annex 8 (Regulatory Compliance and Cross-references Tables)
         12. Annex 9 (Other Relevant Emergency Response Procedures) as described below.
      ii. The Annex 9 Documents, including but not limited to:
         1. The Draft Dam Emergency Action Plan (EAP) (received 11/7/2005) including Inundation Map (received 11/15/2005) has been incorporated for reference purposes, but is not approved by this permit modification.
         2. Ash Basin No. 4 Operating Instructions (received 12/15/2005)
         3. Ash Basin No. 4 Maintenance Plan (received 12/15/2005) and including Inspection plan & forms.
         4. H&S Memo #32 "Integrated Emergency Response Plan" a.k.a. IERP (dated 10/20/2005, received 11/7/2005)
         5. H&S Memo #51 "Martins Creek Electric Station Emergency Action Plan" (dated 10/05, received via e-mail on 11/1/2005)
         6. PPL "Crisis Communication Communications Plan" September 2005" (received 11/7/2005)
         7. H&S Memo #25 "Ash Disposal Basin Sinkhole Contingency Plan" (received 12/20/2005 via e-mail).
      iii. Figures (received 12/2/2005):
         1. Figure 1 (Site Location Map)
         2. Figure 1A (Aerial Map of Site)
         3. Figure 2 (Site Drainage Diagram)
         4. Figure 3 (Material Storage Diagram)

5. Figure 4 (Evacuation Diagram)
6. Figure 5 (Map of Downstream Intakes and associated contact information)

iv. The following bottom ash management-related Drawings are incorporated by reference, and must be retained with the ICP unless the Department approves replacement drawings in writing:
1. Drawing D323318 Sheet 2 "Bottom Ash Dewatering Trough Location Plan" (received 12/1/2005)
2. Drawing D323318 Sheet 3 "Bottom Ash Dewatering Facility Ash Storage Area Plan and Sections" (received 12/1/2005)
3. Drawing LE-11171002 Sheet 1 "Coal Yard Sump Drains" (received 12/16/2005)
4. Drawing LE-111764 Sheet 1 "Coal Pile Retaining Dike Plan, Profile & Sections" (received 12/16/2005)
5. Drawing LE-111708-4 Sheet 1 "Coal Pile Drainage Settling Pond and Sump"

v. The 12/2/2005 Narrative "Response to Integrated Contingency Plan (ICP) Issues" is incorporated by reference.

vi. The ICP incorporates the CSRP Plan Section 1.8.5 (Preventative Maintenance) by reference.

vii. The ICP incorporates by reference the "Sinkhole Contingency Plan for Basin No. 4" submitted on 2/8/99 and incorporated into the Approved Application.

viii. The ICP incorporates by reference the "Section 4.7 Ash Basin Sinkhole Damage Contingency Plan" for Ash Basin No. 1" submitted on 6/15/98 as part of the (Ash Basin No. 1) Approved Application.

3. Consolidated Certified Technical Report: Within sixty (60) days of this permit modification, PPL shall resubmit a consolidated copy of the "Certified Technical Report" for the Ash Basin No. 4 modifications addressed in this permit modification. The revised document shall exclude any information that has been superceded by subsequent submittal, and incorporate any additional design or construction certification documentation submitted to the PADEP Bureau of Waterway Management. This copy shall include a Form B (Professional Certification) completed by a Pennsylvania Professional Engineer, listing all documents covered by this certification of the Certified Technical Report, and stating that the design modifications meet the requirements of 25 Pa. Code §289.254 (Discharge structure).

4. Construction Certification: Within 30 days of this permit modification, PPL shall submit a Form 19R (Certification of Facility Construction Activity) for the approved modifications to Ash Basin No. 4 (listed above), signed and sealed by a Pennsylvania Professional Engineer verifying that all modifications have been completed per the approved design. This Form 19R shall be accompanied by any updated as-built drawings and photographs documenting the completion of the authorized modifications approved in this permit modification.

5. Integrated Contingency Plan Requirements: Within 60 days of this permit modification, PPL shall submit a consolidated copy of the ICP, including all Annex documents and figures, addressing the following requirements (unless modified by concurrence of the Department):

   a. Table of Contents: The table of contents shall be updated to identify the location of sections addressing "preventive maintenance" and "material compatibility" sections (including "Housekeeping", "External Factor Planning", "Arrangements with Local requirements, to identify the Annex 8 "Additional Information Required by PPC/SPR" Emergency Response Agencies"), and to identify the location of the Dam EAP Inundation Map in Annex 9. The Annex 8 & 9 Cover Sheets shall be likewise updated.
   b. Revised Drawings: The following revised drawings, signed and sealed by a PA Professional Engineer:
      i. Figure 1 (Site Plan) shall be updated to correct the site boundary to include the entirety of Ash Basin No. 4, the existing PPL property boundaries of the site, and the name and contact telephone number for the neighboring property containing a tank farm. The Figure shall also identify the host county and note that there are no private/public water intakes within the depicted area.
      ii. Figure 1A (Aerial Photography) shall be updated to explicitly identify the Ash Basin No. 1, Ash Basin No. 4, the Industrial Waste Treatment Basin, the coal ash captive processing & storage areas, and any onsite tank.
      iii. Figure 2 (Site Drainage Diagram) shall be updated to correct the site boundary to include the entirety of Ash Basin No. 4 & the existing PPL property boundary of the site, and to explicitly identify any critical shut-off valves (including those controlling the Ash Basin No. 4 discharge), the ash slurry pipelines, the pipeline from the Industrial Waste Treatment Basin, the defined NPDES Discharge System (identifying each manhole by designation number), the new concrete troughs processing area, the new ash storage areas, all storage tanks, and groundwater monitoring/residential well locations, any fuel pipeline, the 100 year floodplain boundary, surface drainage ways around Ash Basin No. 4, and the names of the public roads.
      iv. Figure 3 (Material Drainage Diagram) shall be updated to identify all coal ash management areas by name, and the names of the depicted public roads.
      v. Figure 4 (Evacuation Diagram) shall be updated to name the depicted public roads, to directly cross-reference the Dam EAP Inundation Map, and to note that the Dam EAP Inundation Map takes precedence for a dam emergency.
   c. ICP Section II.2.c.2 (Pre-determined Emergency Response Procedures): This section shall be updated to list out the Annex 9 documents pertaining to emergency response procedures.

d. Annex 3 (Response Management Systems):

   i. Annex 3 Section A3.1.i (Incident Commander Duties): The Incident Commander duties description shall be expanded to include the following language:

      1. The Incident Commander makes the determination whether any incident might potentially impact the ground and surface waters of the Commonwealth, and whether regulatory agencies, other emergency responders or downstream water users must be notified.
      2. The Incident Commander has the duty to identify the type of incident, the specific hazards of an incident, the magnitude of the incident, any threatened natural or corporate resources, any need for an exclusion or buffer area, and the need for emergency equipment or supplies during the incident.
      3. The Incident Commander has the duty of determining what sections of the ICP must be implemented in addition to the Dam Emergency Action Plan in event of a dam emergency.
      4. The Incident Commander has the authority to order cessation of disposal at the Ash Basin No. 4 in event of an emergency.

   ii. Annex 3 shall be expanded to have a "preventive maintenance" and "material compatibility" section addressing PPC Plan Guideline Section C.2 (Material Compatibility) and Section C.4 (Preventive Maintenance) requirements.

e. Annex 8 (Regulatory Compliance Checklist): The Annex 8 Reference Chart for PPC/SPR Plan Requirements shall be expanded to identify the location of information addressing the Approved Application Form L (Contingency Plan For Emergency Plan) requirements:

   i. Section C.1 (procedures to minimize potential for fires, explosion or releases) including sinkhole contingency plans
   ii. Section C.2 (location and maintenance of first aid supplies)
   iii. Section C.4 (Up-to-date emergency equipment list)
   iv. Section C.5 (methods to ensure unobstructed access)
   v. Section D (Emergency Coordinator i.e. Incident Commander duties)

f. Annex 9 (Other Relevant Emergency Response Procedures):

   i. ICP Implementation: In cases of discrepancies or conflicts, the ICP Sections I, II, and Annexes 1 through 8 shall take precedence over the Annex 9 documents except in regard to the Dam Emergency Action Plan (EAP).
   ii. Dam Emergency Action Plan (EAP): When finalized, the Dam EAP must be incorporated into Annex 9. The Annex 9 Cover Page must identify the location of the Dam EAP Inundation Map in the Dam EAP. This permit modification does not constitute approval of the Dam EAP.
   iii. Sinkhole Contingency Plan: The Sinkhole Contingency Plan shall be updated to cross-reference the Approved Application documents pertaining to sinkhole contingencies (see above). PPL may submit an updated Sinkhole Contingency Plan for Department approval.
   iv. Integrated Emergency Response Plan (IERP): During an emergency, the Incident Commander will be provided all required authority, assistance, and resources to address his/her duties under the ICP and/or Dam EAP.

v. Maintenance Plan:

1. The Ash Basin No. 4 Discharge Structure shall be annually inspected below the basin's operating water level until Ash Basin No. 4 is closed.
2. The Annex 9 Cover Page and ICP Table of Contents shall be updated to note that the Ash Basin No. 4 Inspection plan is incorporated into the Maintenance Plan.

6. Additional Ash Basin No. 4 Operating Requirements:

a. The PPL Plant Engineer will approve any changes to the configuration of the Ash Basin No. 4 Discharge Structure's concrete stop logs and panels prior to any rearrangement of the existing configuration.

b. PPL shall monitor weekly the groundwater elevations and groundwater chemistry at the Ash Basin No. 4 groundwater monitoring wells until basin water elevation reaches its normal operating level. After the basin reaches normal operating levels weekly groundwater can be reduced to monthly monitoring if the weekly groundwater monitoring results demonstrate no significant change and the Department concurs with reducing the monitoring frequency to monthly. PPL shall have a Pennsylvania Professional Geologist evaluate the data on a weekly basis (& subsequently monthly) unless the Department authorizes another schedule in writing or the Department rescinds or amends this additional groundwater monitoring requirement in writing. Analytical parameters should include those agreed to on the Basin 4 assessment list. Monitoring data should be submitted to the Department monthly. In event of a statistically significant groundwater chemical change or groundwater elevation increase in one or more monitoring well, PPL shall submit a PA Professional Geologist signed and sealed report identifying the cause of the change including supporting groundwater chemistry and water level data and statistical analysis. In event that the cause in groundwater chemistry or water level elevation increase cannot be determined or appears to be related to the Ash Basin No. 4 operations, PPL shall submit a PA Professional Engineer signed and sealed evaluation of the Ash Basin No. 4 liner condition.

c. The Ash Basin No. 4 Permanent (concrete) West Ramp may not be utilized for placement of ash into the Ash Basin No. 4 until PPL verifies that the protective "scrap" hypalon liner, protecting the actual impoundment liner, has been repaired or replaced or that the damage did not impair the protection of the underlying Basin liner in writing.

Dept.

Date 19

Designed by

Approved by

PENNSYLVANIA POWER & LIGHT COMPANY
CALCULATION SHEET

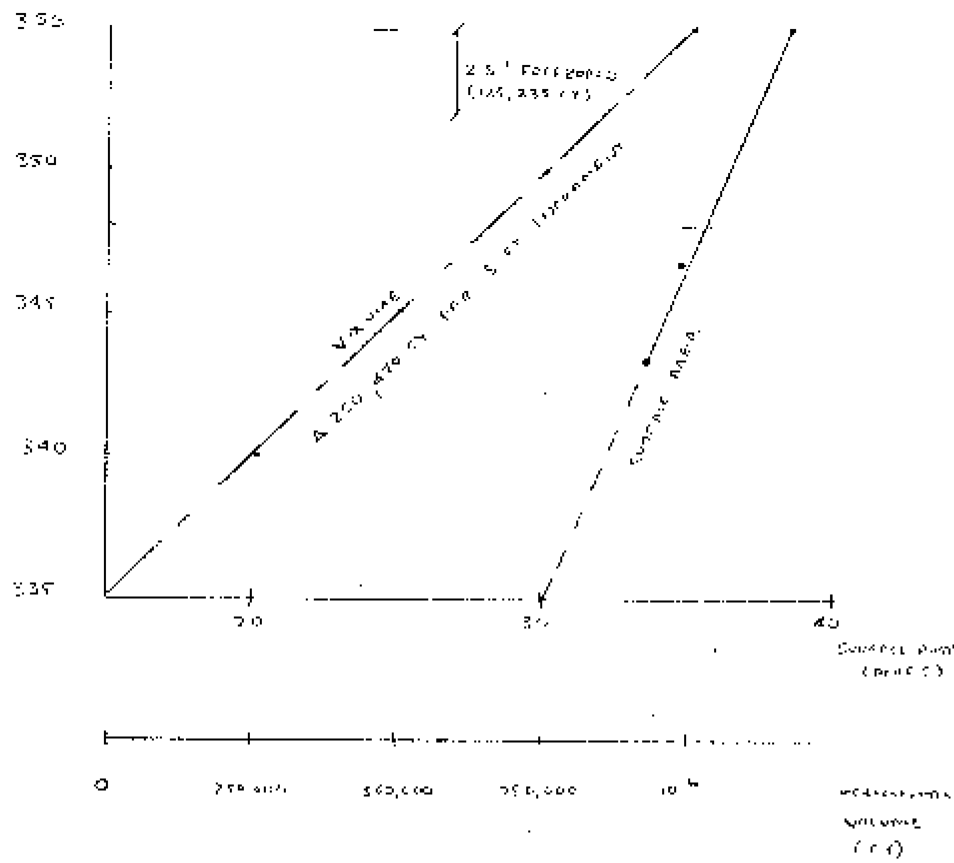
PROJECT

ER No.

Sh. No. of

Acreage of surface ... 343.2 = 33.91 acres

Acreage ... 355 = 38.43 acres



Basin 4

MARTINS CREEK SES
ASH BASIN NO. 4
MAJOR PERMIT MODIFICATION
FINAL VERSION - FEBRUARY 8, 1999

MISCELLANEOUS SUBMITTALS

"Summary of Martins Creek Basin No. 4 Siting Study and Hydrogeologic Data - PA DER Module 5 and 5a - Phase 1" - Submitted to DEP September 8, 1997.

"Sinkhole Contingency Plan for Basin No. 4 - PP&L's Martins Creek Steam Electric Station," June 1998 - Submitted to DEP September 8, 1997.

SINKHOLE CONTINGENCY PLAN FOR BASIN NO. 4
PP&L MARTINS CREEK STEAM ELECTRIC STATION
LOWER BETHEL TOWNSHIP, NORTHAMPTON COUNTY, PA
ID #301256

JUNE 1998

SINKHOLE CONTINGENCY PLAN FOR BASIN NO. 4
PP&L MARTINS CREEK STEAM ELECTRIC STATION
LOWER BETHEL TOWNSHIP, NORTHAMPTON COUNTY, PA
ID #301256

Prepared for:

Pennsylvania Power & Light Company
Allentown, Pennsylvania

Prepared by:

Nittany Geoscience, Inc.
State College, Pennsylvania

Project No. 057-030/d.03/057-030

June 1998

COMMONWEALTH OF PENNSYLVANIA
REGISTERED PROFESSIONAL
RICHARD T. WARDROP
GEOLOGIST
PG-000157-G

Richard T. Wardrop 6/10/98

Richard T. Wardrop, PG-000157-G Date

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1.0 INTRODUCTION

1.1 Purpose and Objectives

The purpose of this plan is to describe the procedures that PP&L would automatically perform if a sinkhole were to develop and affect Ash Basin No. 4 at the Martins Creek Steam Electric Station (SES). These procedures are being submitted in support of the current Basin No. 4 permit modification application and in response to comments issued to PP&L from the Pennsylvania Department of Environmental Protection (PaDEP) in the Pre-Denial Letter of January 13, 1998. Specifically, this contingency plan responds to comments I. Critical Concerns: 1. Item I.1. (Liner Waiver) and 3. Item I.3., III.9.b., and III.16.a. (Sinkhole Contingency) of the Pre-Denial Letter. The procedures put forth in this plan were discussed at a meeting with PaDEP at the Northeast Regional Office in Wilkes-Barre on May 8, 1998.

If a sinkhole occurs at Basin No. 4, causing a loss of basin water and ash to the subsurface, this sinkhole contingency plan would be implemented. The objectives of the plan are:

1. To determine where the lost materials go in the subsurface.
2. To protect human or environmental receptors who may be affected by the loss.

1.2 Basin No. 4 Operation

Ash Basin No. 4 is used for the management of fly ash at the Martins Creek SES and is located as shown on Figure 1. Fly ash collected from the SES stack scrubbers is sluiced into the 40 acre basin with water extracted from the Delaware River. The basin is lined and the sluiced ash settles to the bottom of the impoundment after a period of time. Some of the water remaining above the settled ash either evaporates or is released back to the Delaware River through an impoundment gate via the SES's NPDES permit. The level of liquid in the impoundment is controlled at a gate in the southwest corner of the basin.

1.3 Hydrogeologic Setting

Basin No. 4 is constructed in an area of the SES underlain, from top to bottom, by unconsolidated heterogeneous materials (overburden), weathered bedrock, and competent bedrock (see Figure 2). Unit thicknesses and descriptions are based on test borings performed by Weston Geophysical (1987a) and on the logs for the six monitoring wells surrounding Basin No. 4 (see Appendix A). The unconsolidated materials range in thickness from approximately 10 to over 80 feet. The grain sizes in the unconsolidated materials have a high degree of variability, ranging from clay to boulder size material. This variability is a result of a complex history which includes, glaciation, glacio-fluvial activity, and the weathering of parent bedrock material.

The weathered bedrock zone varies from 3 to over 45 feet thick across the basin site and can be described as fractured bedrock with weathered joint surfaces, bedrock fragments, and rock quality index values of less than 50 percent.

The competent bedrock is the Jacksonburg Limestone. This formation has two units, both of which have been mapped under Basin No. 4, see Figure 3. The lower unit is a medium to dark gray, coarsely crystalline, medium to thickbedded limestone, whereas the upper unit is a dark gray, shaley limestone, exhibiting slaty cleavage. Drake, et. al. (1969) show that bedrock is generally trending northeast with a dip to the north in the vicinity of the basin. Two voids, three and four feet across, were encountered while drilling the monitoring well 4-4 for the basin in the Jacksonburg Limestone.

Historic groundwater elevations in the vicinity of the basin have a high degree of variability, ranging from approximately 275 feet above mean sea level (amsl) to 220 feet amsl. Seasonal water levels generally fluctuate between the competent bedrock and weathered bedrock units. None of the downgradient monitoring wells has had a water level above an elevation of approximately 252 feet (see Figure 4). Figure 5 is a water table map for the December 1997 monitoring event. As is typical, the gradient illustrated is northwest to southeast towards the Delaware River.

1.4 Basin Water Chemistry

A representation of the chemical character of Basin No. 4 water lost to a breach would be the chemistry of leachate generated from flyash from the Martins Creek SES. PP&L made two measures of the chemical character of flyash leach for Martin's Creek SES flyash, one using the ASTM-A leachate generation procedure and one using the FOWL geochemical model (Hostetler, et al., 1990) to predict leachate chemistry. FOWL uses the results of an elemental analysis of Martin's Creek SES flyash as input. The results of the two methods are shown on Table 1.

The results indicate that an elevation in leachate total dissolved solids concentrations is caused by the concentration of calcium and sulfate in the leachate. Thus, specific conductance (a measure of total dissolved solids), calcium, and sulfate are good indicator parameters for the detection of a flyash basin breach.

1.5 Mechanisms for Sinkhole Development

The Jacksonburg Limestone and other carbonate formations in the vicinity of the SES can be susceptible to sinkhole development. Sinkholes form when percolating waters remove soil from the overburden into underlying voids in the bedrock. Soil erosion occurs at the soil/bedrock interface, creating a void that grows upward and is overlain by a soil bridge. As the void enlarges the soil bridge thins until it cannot support its own weight or until the weight of an overlying structure causes the bridge to collapse, causing a sinkhole. The collapse is often sudden.

Sinkholes occur naturally or from the effects of man's activity on the landscape. When the rate of infiltration is increased beyond that which normally occurs there is a greater potential for sinkhole development. Higher percolation velocities can entrain greater amounts of soil particles and more rapidly remove soil. In an impoundment designed to retain liquid, the hydraulic head represented by the difference in elevation between the surface of impoundment water and the impoundment liner can cause rapid percolation if the liner leaks, increasing the likelihood of sinkhole development.

1.6 Anticipated Character of a Basin Breach

It is unlikely that a liner failure would cause complete loss of basin water and ash. First, there is a limit to the typical size of sinkholes observed in the northeastern United States. Kochanov (1986) mapped closed depressions in the vicinity of Basin No. 4, none of which was more than 200 feet across, and it is rare to see a sinkhole in the northeastern United States exceeding more than 100 feet across. If a sinkhole were to occur, it could develop anywhere under Basin No. 4 or its berms. The greatest loss of ash and water would occur if the sinkhole developed at the lowest point in the basin. The loss of ash and water from a breach in other areas would be limited to the amount of ash and water at elevations above the point of failure.

If the liner were to be breached at the lowest point in the basin, fully saturated ash and water would move into the subsurface. In this scenario the amount of water and ash entrained by the moving water draining into the breach would be limited by the size of the void under the basin liner. The loss of water would likely occur over a period of days, not hours. After the water level fell below the level of ash, the material would begin to dewater. Ash which is less than saturated has a degree of cohesiveness as demonstrated by its ability to hold relatively steep scarps. Consequently, the anticipated loss of ash would be limited to the vicinity of the breach.

Ash and basin water lost from a liner breach could impact the quality of local groundwater. Potential receptors that could be affected by a breach include local residential well users and the local streams (Oughoughton Creek and the Delaware River). In a karst terrane it is difficult to predict which way affected groundwaters would move. The direction of movement would depend on the location of the breach at the basin and the network of interconnected secondary porosity established in the carbonate rock local to the basin. If groundwater movement is controlled by the weathering of bedding planes, then movement could be to the northeast or southwest. If groundwater movement is controlled by weathering of fractures in the bedrock, other directions of movement may be established based on the general concept that upgradient is northwest of the basin and downgradient is south to the Delaware River.

2.0 SINKHOLE CONTINGENCY PLAN

The sinkhole contingency plan is based on the discussions presented in Section 1.0. This section presents the steps required to detect a breach, determine the direction of migration of affected groundwater, and protect human health and the environment.

2.1 Tasks for Detecting a Breach

Three tasks will be executed to look for evidence of a sinkhole breach. These tasks include:

1. Quarterly inspections of Basin No. 4 and documentation by site personnel.
2. A yearly aerial photograph of Basin No. 4 coupled with an independent air photo analysis.
3. Quarterly groundwater monitoring is already being performed. PP&L's groundwater sampling program coordinator will review specific

conductance, total dissolved solids, calcium, and sulfate results in a timely manner, after each quarterly sampling event, to determine whether a trend in any of these parameters may be indicating the presence of a breach.

2.2 Determine Location of Affected Groundwater

In the event that a liner breach is detected and ash and/or basin water is lost to the subsurface, PP&L will implement the following monitoring program to determine the location, direction, and rate of contaminant movement associated with the breach. PP&L will monitor for specific conductance, calcium, sulfate and visual indications of ash at site monitoring wells, residential wells, seeps, Oughoughton Creek, and the Delaware River at its convergence with Oughoughton Creek, according to the following schedule:

1. Daily for one week, monitor all points for specific conductance and visual indications of ash; if no impact is indicated, reduce monitoring to weekly.
2. Weekly for four weeks, monitor all points for specific conductance, calcium, sulfate and visual indications of ash; if no impact is indicated, reduce monitoring to monthly.
3. Monthly for six months, monitor all points for specific conductance, calcium, sulfate and visual indications of ash; if no impact is indicated, reduce monitoring to quarterly (the current monitoring schedule).

By July 24, 1998 PP&L will submit to PaDEP a map and listing of all of the monitoring points to be utilized in the contingency monitoring program. The primary work that has to be performed to make this submittal is a residential well inventory to determine, to the extent possible, the location of all residential wells that could be impacted by a liner breach.

2.3 Protection of Human Health and the Environment

If at any time during the monitoring program an impact of a residential supply well is indicated, a temporary supply will be provided immediately and sampling for all ash-related parameters currently sampled for in the quarterly basin sampling program will be conducted (see Table 2).

If at any time during the monitoring program an impact at any monitoring point is indicated, PaDEP and will be notified a corrective action plan will be submitted within 60 days. The corrective action plan may have one or more of the following components.

- Remediation of residential wells may require individual treatment systems or permanent replacement of the water supplies.
- Remediation of the stream may require stream vacuuming.
- Remediation of the aquifer may require a groundwater investigation to delineate the plume and pumping to remediate the aquifer. Discharge from pumping could go to Basin No. 4 or another basin.
- All remediations will require monitoring to demonstrate effectiveness.

3.0 REFERENCES

Drake, A.A. Jr., Epstein, J.B., and Aaron, J.M., 1969, *Geologic map and sections of parts of the Portland and Belvidere Quadrangles*, *New Jersey-Pennsylvania*, U.S. Geological Survey, Map I-552.

Hostetler, C.J., Erikson, R.L. and Kemner, M.L., 1990, FOWL™ Model, IBM PC version 1.12, Electric Power and Research Institute, Environmental Science Department, Palo Alto, California.

Kochanov, W.E., 1986, *Sinkholes and Karst-Related Features of Northampton County, Pennsylvania*, Open File Report 8702, Pa. Bur. of Topo. and Geol. Surv., 9p., 10 plates.

Weston Geophysical Corporation, 1987a, *Updated geologic compilation for the Martins Creek Steam Electric Station, Lower Mount Bethel Township, Pennsylvania.*

Weston Geophysical Corporation, 1987b, *Final Report Geophysical Investigations, Proposed Ash Basin No. 4, Martins Creek Steam Electric Station.*

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FIGURES

NITTANY GEOSCIENCE INC.

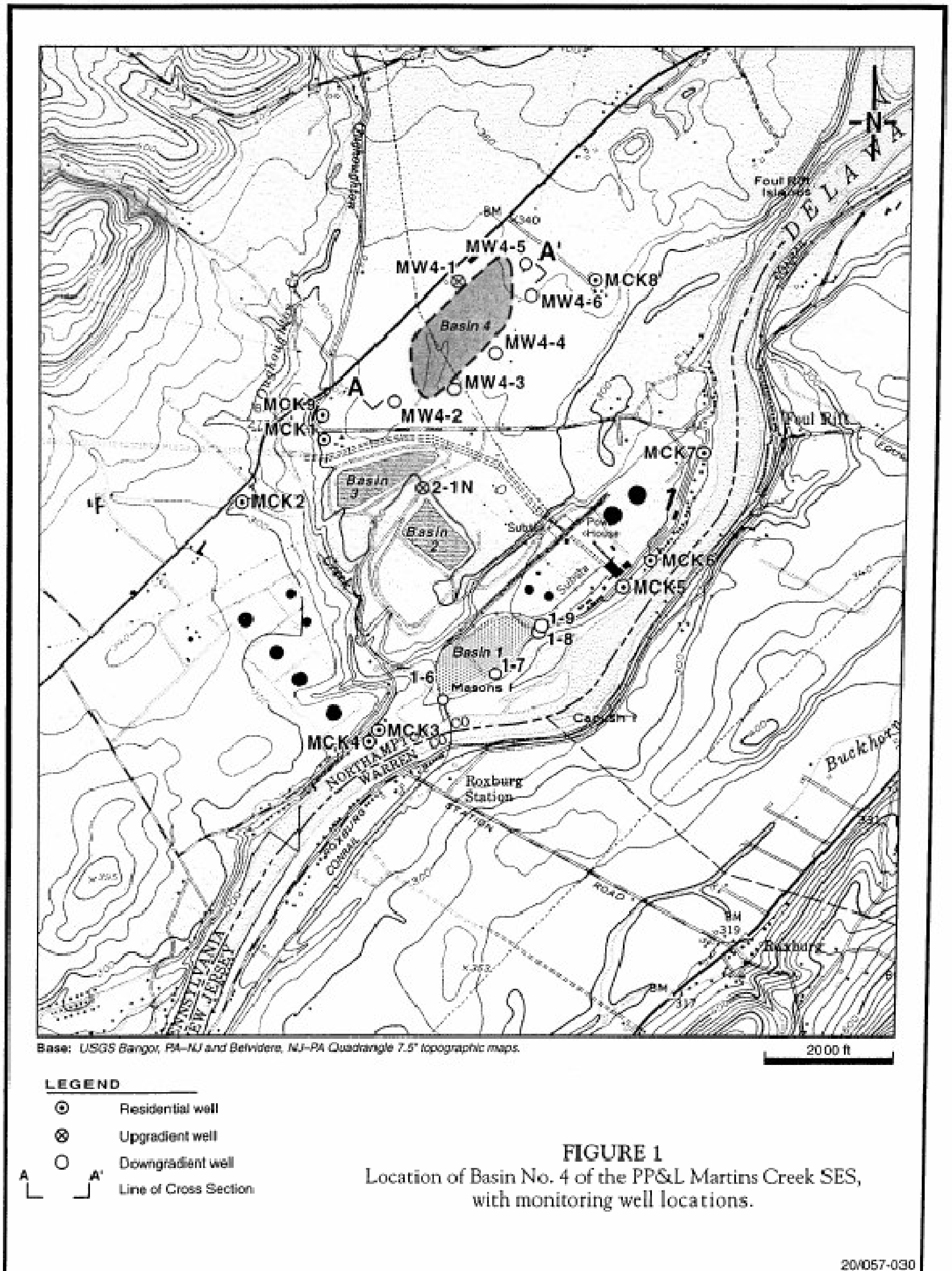

FIGURE 1
Location of Basin No. 4 of the PP&L Martins Creek SES, with monitoring well locations.

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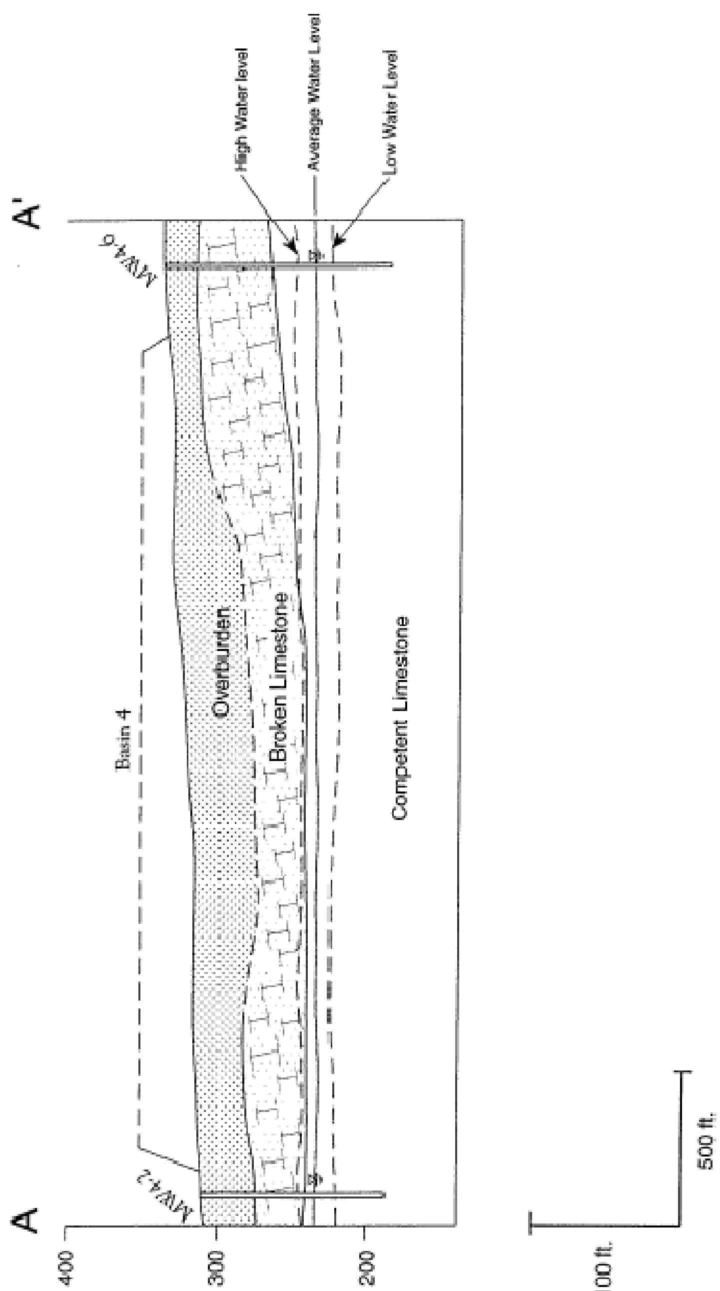

FIGURE 2
Cross Section through Basin No. 4 from West to East.

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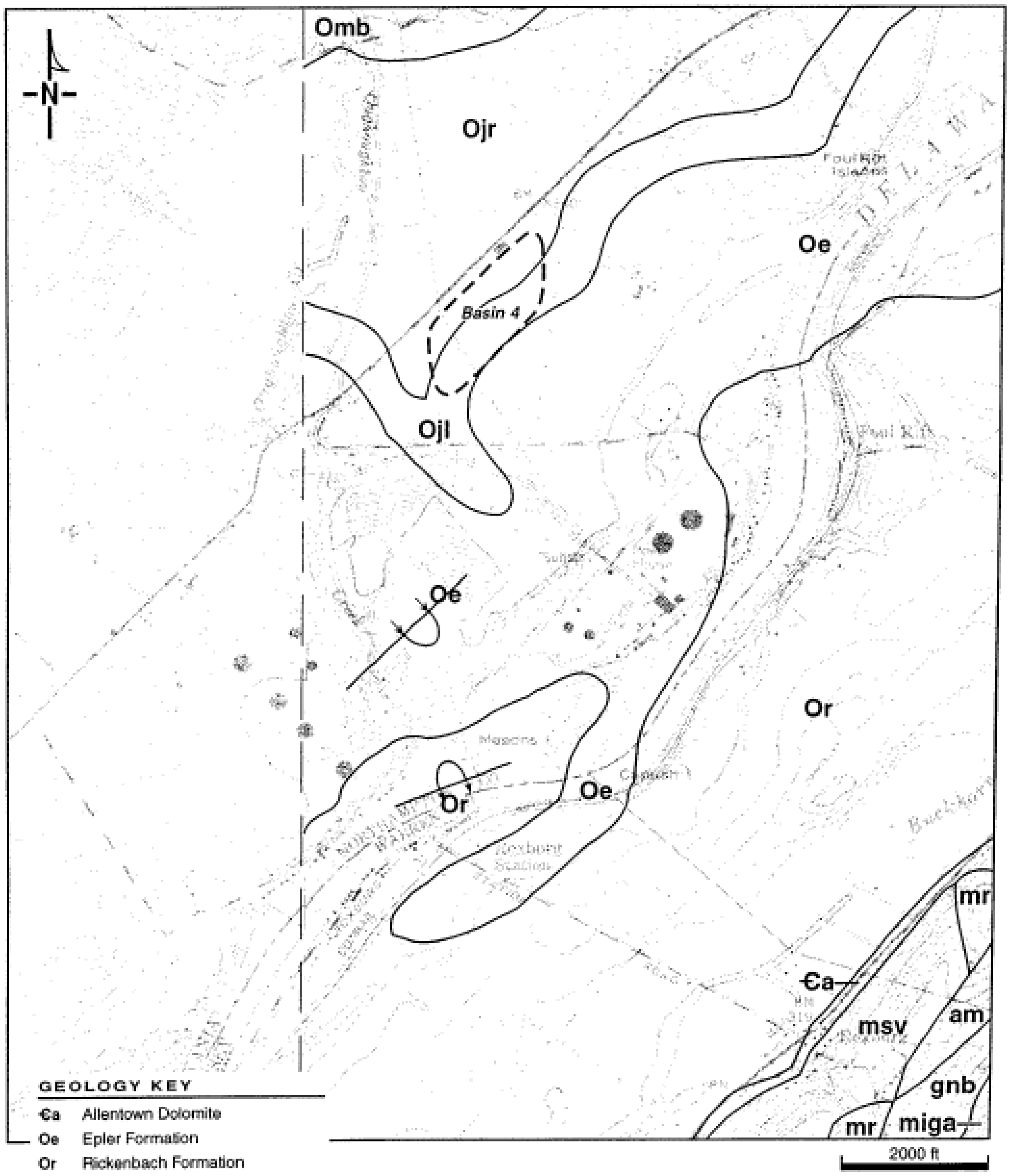

GEOLOGY KEY

€a	Allentown Dolomite
Oe	Epler Formation
Or	Rickenbach Formation
Ojl	Jacksonburg Limestone (cement limestone facies)
Ojr	Jacksonburg Limestone (cement rock facies)
Omb	Martinsburg Formation Bushkill Member
	Axial trace of overturned anticline
	Axial trace of overturned syncline

FIGURE 3
Geology of the PP&L Martins Creek SES and vicinity, Northampton County, PA,
from Geologic map and sections of parts of the Portland and Belvidere Quadrangles, NJ–PA (Drake, et. al., 1969).

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NITTANY GEOSCIENCE INC.

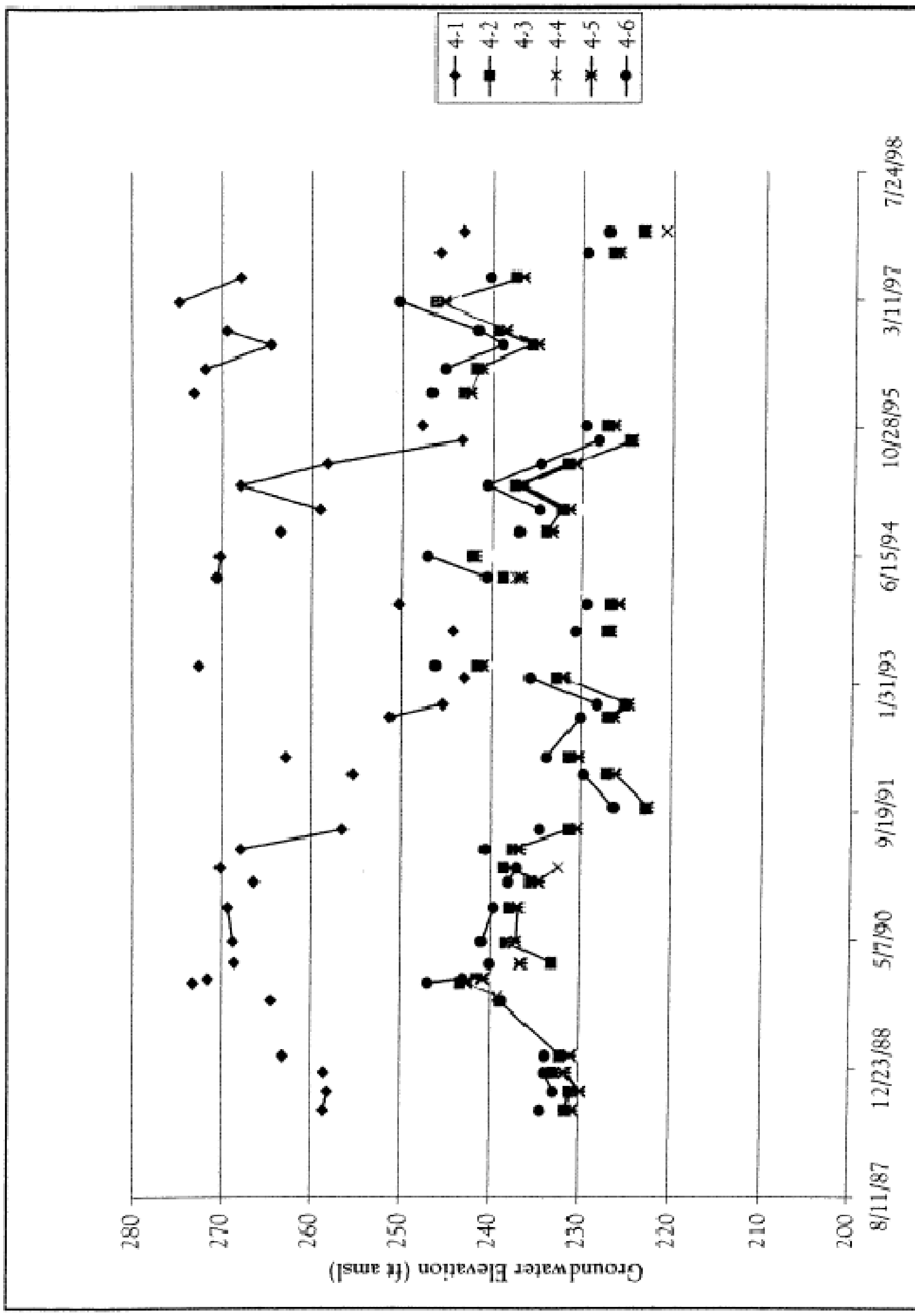

FIGURE 4
Groundwater Elevations in the Vicinity of Basin No. 4

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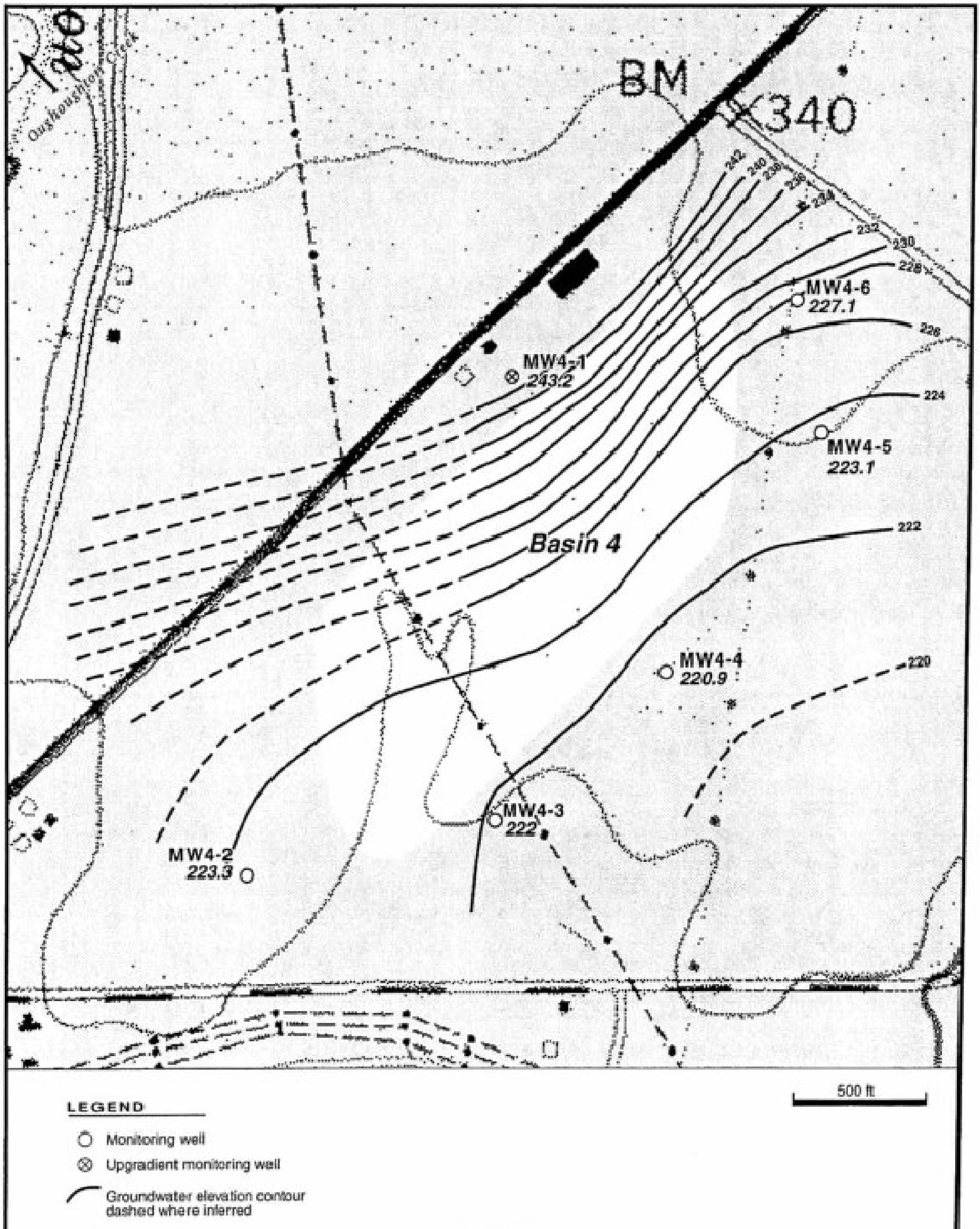

FIGURE 5
Groundwater elevation map at Basin No. 4, December 2-4, 1997.

23/057-030

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TABLES

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TABLE 1
Estimate of Pond Leachate Chemistry
Martins Creek Basin 1 Flyash

		Flyash Elemental Analysis (g/kg)	FOWL Leachate Concentration (mg/L)	ASTM-A Leachate Concentration (mg/L)
Tot. Diss. Solids	TDS	–	2104.1	–
	pH	–	5.2	–
Total Alkalinity	Tot. Alk.	–	–	–
Silver	Ag	–	–	<0.02
Aluminum	Al	*102.02*	–	13.1
Arsenic	As	*0.06434*	0.035	<0.2
Boron	B	–	–	6.73
Barium	Ba	–	0.000	0.3
Beryllium	Be	–	–	<0.01
Calcium	Ca	*15.54*	611.3	197
Cadmium	Cd	–	0.000	<0.01
Chlorine	Cl	*0.050905*	–	2
Cobalt	Co	–	–	<0.05
Carbonate	CO3	–	1.90	–
Chromium	Cr	*0.156962*	0.000	0.13
Copper	Cu	*0.045312*	0.000	<0.02
Fluoride		–	–	2.0
Iron	Fe	*67.91*	–	<0.1
Gallium	Ga	*0.029430*	–	–
Potassium	K	*9.08*	–	4.8
Lithium	Li	–	–	0.23
Magnesium	Mg	*4.27*	–	<0.1
Manganese	Mn	*0.157665*	–	<0.01
Molybdenum	Mo	*0.004915*	0.000	0.3
Sodium	Na	*2.31*	–	7.3
Nickel	Ni	*0.094648*	0.161	<0.05
Oxygen	O	*629.17*	–	–
Phosphorous	P	*1.31*	–	–
Lead	Pb	*0.057755*	–	<0.1
Sulfur	S	*5.80*	–	–
Antimony	Sb	–	–	<0.2
Selenium	Se	–	0.000	<0.2
Silicon	Si	*155.52*	–	–
Sulfate	SO4	–	1479	330
Strontium	Sr	*0.807421*	12.2	2.51
Titanium	Ti	*5.12*	–	<0.01
Thallium	Tl	–	–	<0.3
Vanadium	V	*0.19805*	–	0.21
Zinc	Zn	*0.107137*	–	<0.04
Zirconium	Zr	*0.157225*	–	–

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TABLE 2

Groundwater Sampling Parameter List

Basin 4 Annual Groundwater Sampling Parameter List	Basin 4 Quarterly Groundwater Sampling Parameter List
1,1-Dichloroethane	Aluminum-dissolved
1,1-Dichloroethene	Alkalinity-phosphate
1,2-Dichloroethane	Alkalinity-total
1-Trichloroethane	Boron-dissolved
cis-1,2-Dichloroethene	Calcium-dissolved
Cl4-ethene, ug/l	Calcium-total
trans-1,2-Dichloroethene	Chlorine-total
Trichloroethene	Chemical Oxygen Demand
Vinyl Chloride	Dissolved Oxygen
Silver-dissolved	Fluorine-total
Silver-total	Iron-dissolved
Aluminum-dissolved	Iron-total
Alkalinity-phosphate	HCO3
Alkalinity-total	Potassium-dissolved
Arsenic-dissolved	Potassium-total
Arsenic-total	Lithium-dissolved
Boron-dissolved	Magnesium-dissolved
Barium-dissolved	Manganese-dissolved
Barium-total	Manganese-total
Calcium-dissolved	Molybdenum-dissolved
Calcium-total	Sodium-dissolved
Cadmium-dissolved	Sodium-total
Cadmium-total	Ammonia, as Nitrogen
Chlorine-total	Nickel-dissolved
Chemical Oxygen Demand	Nitrate, IC
Chromium-dissolved	Nitrate, as Nitrogen
Chromium-total	Total Organic Carbon
Copper-dissolved	pH-field
Copper-total	pH-lab
Dissolved Oxygen	Redox
Fluorine-total	Sulfate
Iron-dissolved	Dissolved Solids
Iron-total	Specific Conductance, field
HCO3	Specific Conductance, lab
Mercury-dissolved	Strontium-dissolved
Mercury-total	Turbidity, lab
Potassium-dissolved	Water Temperature
Potassium-total	Depth to water
Lithium-dissolved	
Magnesium-dissolved	
Manganese-dissolved	
Manganese-total	
Molybdenum-dissolved	
Sodium-dissolved	
Sodium-total	
Ammonia, as Nitrogen	
Nickel-dissolved	
Nitrate, IC	
Nitrate, as Nitrogen	
Total Organic Carbon	
Lead-dissolved	
Lead-total	
pH-field	
pH-lab	
Selenium-dissolved	
Selenium-total	
Sulfate	
Dissolved Solids	
Specific Conductance, field	
Specific Conductance, lab	
Strontium-dissolved	
Turbidity, lab	
Water Temperature	
Zinc-dissolved	
Zinc-total	
Depth to water	

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APPENDIX A

Geologic Logs from Borings Drilled in the Vicinity of Basin No. 4

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Basin No. 4 Monitoring Well Logs

Monitoring Well Installation Data Sheet

Site: Martins Creek SES
Facility: Ash Basin No. 4
Number: 4-1
PP&L Supervisor: Craig S. Shamory

Drilling Company: Bellview Pump
(215)767-8483
Driller(s): Dave Kyper

Drilling Log

Date: 6/18/88 8"-bit, 6/22/88 6"-bit, 6/23/88 8"-bit (78' to 125')

Interval (ft)	Strata Characteristics	Comments
0 - 2	Dark brown topsoil	Damp
2 - 15	Brown gravel, cobbles, sand & clay	Damp/moist
15 - 27	Brown gravel, cobbles, sand & silt	Damp, slow drilling
27 - 42	Grey gravel, cobbles, sand & silt	Dusting
42 - 50	Grey cobbles (l.s.), gravel, & silt	Dusting
50 - 78	Cobbles, gravel, broken l.s. & silt	No cuttings
78 - 85	Same	Water @ 78'
85 - 92	Fairly competent l.s.	Water/mud returns
92 - 117	Broken l.s. w/ silt and gravel	Water/mud returns
117 - 118	Fairly competent l.s.	Water/mud returns
118 - 125	Broken l.s. w/ silt and gravel	Water/mud returns

Notes:
6/18/88 Drilled to 42' w/ 8"-bit. Chain broke on rig; shut down for repairs.
6/24/88 Water @ 62 ft., open to 67 ft. Set 6" steel casing to 100 ft.
6/27/88 Set 4" PVC screen w/ filter wrap & casing through 6" steel casing. PVC casing broke off when pulling up 6" steel casing. 8' of screen lost. Steel casing had hole drilled through side, and PVC was set through that hole.
6/28/88 Pulled 6" steel casing and opened hole w/ 10 5/8"-bit. Started setting 8" steel casing.
6/29/88 Finished setting steel casing to 82 ft. Hole open to 88 ft, and water @ 64 ft. Will set 4" PVC sreen w/ filter wrap and casing.

Monitoring Well Installation Data Sheet

Page 2

Site: Martins Creek
Facility: Ash Basin No. 4
Number: 4-1
PP&L Supervisor: Craig S. Shamory

Drilling Company: Bellview Pump
(215)767-8483
Driller(s): Dave Kyper

Completion Details

Date: 6/29/88

```
 1.5 ft. _____           ____________Stick-up Height
              |=======|------------Locking Well Cap
              | |---|<|------------Slip-on PVC Top Cap
           ___| |   | |____ <------Cement Well Pad
 0.0 ft.__/__|| |   | ||___\_______Ground Surface
             || |   | ||
             || |   | |<-----------6-Inch I.D. Protective Steel Casing
             || |   | ||           (10 feet long)
             || |   | ||
 8.0 ft.____ |__|   |__|___________Start of Cement Grout to Surface
             |  |   | <|-----------Backfill with Drill Cuttings
             |  |   |  |
             |  |   |<-|----------4-Inch I.D. PVC FJT Schedule 40 Casing
             |  |   |  |
             |  |   |  |
40.0 ft.____ |__|   |__|___________Top of Bentonite Seal ( 2  buckets)
             |==|   |==|
             |==|   |==|
             |==|   |==|
50.0 ft.____ |__|   |__|___________Top of Sand Pack ( 18 bags & natural pack)
55.0 ft.____ |__|___|__|___________Top of Screen
             |  |---|  |
             |  |---|  |
             |  |---|  |
             |  |---|  |
             |  |---|<-|-----------4-Inch I.D. 0.02" Slot Size PVC FJT
             |  |---|  |           Schedule 40 Screen
             |  |---|  |           with 35 micron filter sock
             |  |---|  |
             |  |---|  |
             |  |---|  |
             |  |---|  |
             |  |---|  |
86.0 ft.____ |  |===|<-|-----------Screw-on PVC Bottom Cap
88.0 ft.____ |         |___________Total 8-Inch Borehole Depth
             ...........
```

Monitoring Well Installation Data Sheet

Site: Martins Creek SES
Facility: Ash Basin No. 4
Number: 4-2
PP&L Supervisor: Craig S. Shamory

Drilling Company: Bellview Pump
(215)767-8483
Driller(s): Dave Kyper

Drilling Log

Date: 6/02/88 @ 1330

Interval (ft)	Strata Characteristics	Comments
0 - 1	Dark brown topsoil	Moist
1 - 2	Clayish subsoil w/ brown gravel	Moist
2 - 12	Brown clayish sand w/ gravel & cobbles	Damp
12 - 30	Brown sand w/ gravel & cobbles	Dry/dusting
30 - 43	Brown sand w/ gravel & cobbles	Dry/dusting
43 - 47	Grey l.s. layer or boulder?	Dry/dusting
47 - 55	Broken l.s. w/ clayish sand & grave	Damp
55 - 70	Broken l.s. w/ clayish sand & grave	Moist
70 - 72	Fairly competent l.s.	Moist
72 - 80	Broken l.s. w/ clayish sand & grave	Damp
80 - 90	Fairly competent l.s.	Dusting
90 - 100	Slightly broken l.s.	Water @ 92 ft.
100 - 124	Slightly broken l.s.	Flowing @ 10gpm

Notes:
6/02/88 Limestone not as fractured/broken as in first hole 4-2. Water @ 78', and open hole to 116 ft.

Monitoring Well Installation Data Sheet

Page 2

Site: Martins Creek
Facility: Ash Basin No. 4
Number: 4-2
PP&L Supervisor: Craig S. Shamory

Drilling Company: Bellview Pump
(215)767-8483
Driller(s): Dave Kyper

Completion Details

Date: 6/02/88 @ 1645

```
 1.3 ft. _____          ____________Stick-up Height
              |=======|------------Locking Well Cap
              |  |---|<|------------Slip-on PVC Top Cap
           ___|  |   | |____ <------Cement Well Pad
 0.0 ft.__/__||  |   | ||___\_______Ground Surface
             ||  |   | ||
             ||  |   | ||-----------6-Inch I.D. Protective Steel Casing
             ||  |   | ||           (10 feet long)
             ||  |   | ||
 8.0 ft.____ |__|    |__|___________Start of Cement Grout to Surface
             |  |    | <|-----------Backfill with Drill Cuttings
             |  |    |  |
             |  |    |<-|----------4-Inch I.D. PVC FJT Schedule 40 Casing
             |  |    |  |
             |  |    |  |
68.0 ft.____ |__|    |__|___________Top of Bentonite Seal ( 2 buckets)
             |==|    |==|
             |==|    |==|
             |==|    |==|
73.0 ft.____ |__|    |__|___________Top of Sand Pack ( 10 bags)
75.0 ft.____ |__|___|__|___________Top of Screen
             |  |---|  |
             |  |---|  |
             |  |---|  |
             |  |---|  |
             |  |---|<-|-----------4-Inch I.D. 0.02" Slot Size PVC FJT
             |  |---|  |           Schedule 40 Screen
             |  |---|  |
             |  |---|  |
             |  |---|  |
             |  |---|  |
             |  |---|  |
             |  |---|  |
115.0 ft.____ |  |===|<-|-----------Screw-on PVC Bottom Cap
116.0 ft.____ |         |___________Total 8-Inch Borehole Depth
              -----------
```

Monitoring Well Installation Data Sheet

Site: Martins Creek SES
Facility: Ash Basin No. 4
Number: 4-3
PP&L Supervisor: Craig S. Shamory

Drilling Company: Bellview Pump
(215)767-8483
Driller(s): Dave Kyper

Drilling Log

Date: 5/26/88 @ 1100

Interval (ft)	Strata Characteristics	Comments
0 - 1	Dark brown topsoil	Moist
1 - 5	Clayish subsoil w/ red/brown gravel	Wet
5 - 20	Brown clayish sand w/ gravel & cobbles	Moist
20 - 50	Brown sand w/ gravel & cobbles	Moist slow drilling
50 - 67	Brown sand w/ gravel & cobbles	Moist slow drilling
67 - 68	Grey l.s. layer or boulder?	Moist
68 - 74	Brown clay, silt, cobbles & gravel	Damp
74 - 80	Broken l.s.	Dry
80 - 81	Clay layer	Moist
81 - 92	More Competent l.s.	Dry
92 - 105	Fairly competent l.s.	Dusting
105 - 130	Slightly broken l.s.	No cuttings
130 - 150	Slightly broken l.s.	No cuttings

Notes:
5/26/88 Water @ 83 ft.; set PVC casing the next day.
5/27/88 Hole open to 105 ft.; water @ 79 ft.

Monitoring Well Installation Data Sheet

Page 2

Site: Martins Creek
Facility: Ash Basin No. 4
Number: 4-3
PP&L Supervisor: Craig S. Shamory

Drilling Company: Bellview Pump
(215)767-8483
Driller(s): Dave Kyper

Completion Details

Date: 5/27/88 @ 0830

```
  1.3 ft. _____          ____________Stick-up Height
               |=======|------------Locking Well Cap
               |  |---|<|------------Slip-on PVC Top Cap
            ___|  |   | |____ <------Cement Well Pad
  0.0 ft.__/__||  |   | ||___\_______Ground Surface
              ||  |   | ||
              ||  |   | ||-----------6-Inch I.D. Protective Steel Casing
              ||  |   | ||           (10 feet long)
              ||  |   | ||
  8.0 ft.____ |__|    |__|___________Start of Cement Grout to Surface
              |  |    | <|-----------Backfill with Drill Cuttings
              |  |    |  |
              |  |    |<-|-----------4-Inch I.D. PVC FJT Schedule 40 Casing
              |  |    |  |
              |  |    |  |
 64.0 ft.____ |__|    |__|___________Top of Bentonite Seal ( 3 buckets)
              |==|    |==|
              |==|    |==|
              |==|    |==|
 69.0 ft.____ |__|    |__|___________Top of Sand Pack ( 16 bags)
 73.0 ft.____ |__|___|__|___________Top of Screen
              |  |---|  |
              |  |---|  |
              |  |---|  |
              |  |---|  |
              |  |---|<-|------------4-Inch I.D. 0.02" Slot Size PVC FJT
              |  |---|  |            Schedule 40 Screen
              |  |---|  |
              |  |---|  |
              |  |---|  |
              |  |---|  |
              |  |---|  |
              |  |---|  |
103.0 ft.____ |  |===|<-|------------Screw-on PVC Bottom Cap
105.0 ft.____ |         |____________Total 8-Inch Borehole Depth
              ...........
```

Monitoring Well Installation Data Sheet

Site: Martins Creek SES
Facility: Ash Basin No. 4
Number: 4-4
PP&L Supervisor: Craig S. Shamory

Drilling Company: Bellview Pump
(215)767-8483
Driller(s): Dave Kyper

Drilling Log

Date: 6/03/88 @ 0915

Interval (ft)	Strata Characteristics	Comments
0 - 1	Dark brown topsoil	Moist
1 - 4	Orange brown clayish subsoil	Wet
4 - 18	Orange brown clay w/ sand & gravel	Moist
18 - 27	Brown clayey sand/ gravel & cobbles	Wet
27 - 32	Cobbles & Boulders (l.s. & quartzite)	Dry
32 - 38	Grey l.s. layer or boulder?	Dry/dusting
38 - 42	Void/Cave	Lost Circulation
42 - 52	Broken l.s.	No cuttings
52 - 80	Broken l.s.	No cuttings
80 - 92	Broken l.s.	No cuttings
92 - 95	Void filled with clay	No cutting
95 - 100	Broken l.s.	No cuttings
100 - 125	Slightly broken l.s.	Few cuttings
125 - 130	Fairly competent l.s.	Water returns
130 - 140	Fairly competent l.s.	Flowing @ 8 gpm

Notes:
6/03/88 Water @ 93 ft.; hole open to 109 ft. Overdrill w/ 12"-bit to set 8" steel casing to get hole open to 125 ft.
6/06/88 Finished overdrilling w/ 12"-bit and set 8" steel casing to 110 ft.
6/07/88 Drill out to 125 ft. and drove casing to 120 ft. Hole open to 124'; water at 92 ft.

Monitoring Well Installation Data Sheet

Page 2

Site: Martins Creek
Facility: Ash Basin No. 4
Number: 4-4
PP&L Supervisor: Craig S. Shamory (6/8,9)
David A. Stoner (6/10)

Drilling Company: Bellview Pump
(215)767-8483
Driller(s): Dave Kyper

Completion Details

Date: 6/08/88 @ 0800 Ran out of sand at void (90 bags used to 88 ft.)
6/09/88 Finished sandpack and bentonite seal. Backfilled to 58 ft.; ran out of cuttings. 6/10/88 Finished backfilling and completed well.

```
  1.4 ft. _____           ____________Stick-up Height
               |=======|------------Locking Well Cap
               |  |---|<|------------Slip-on PVC Top Cap
            ___|  |   |  |____  <------Cement Well Pad
  0.0 ft.__/__||  |   |  ||___\_______Ground Surface
              ||  |   |  ||
              ||  |   |  ||-----------6-Inch I.D. Protective Steel Casing
              ||  |   |  ||            (10 feet long)
              ||  |   |  ||
  8.0 ft.____ |__|    |__|___________Start of Cement Grout to Surface
              |  |    |  <|-----------Backfill with Drill Cuttings
              |  |    |   |
              |  |    |<-|-----------4-Inch I.D. PVC FJT Schedule 40 Casing
              |  |    |   |
              |  |    |   |
 82.0 ft.____ |__|    |__|___________Top of Bentonite Seal ( 3 buckets)
              |==|    |==|
              |==|    |==|
              |==|    |==|
 84.0 ft.____ |__|    |__|___________Top of Sand Pack ( 96 bags)
 86.0 ft.____ |__|___|__|___________Top of Screen
              |   |---|   |
              |   |---|   |
              |   |---|   |
              |   |---|   |
              |   |---|<-|-----------4-Inch I.D. 0.02" Slot Size PVC FJT
              |   |---|   |            Schedule 40 Screen
              |   |---|   |
              |   |---|   |
              |   |---|   |
              |   |---|   |
              |   |---|   |
              |   |---|   |
126.0 ft.____ |   |===|<-|-----------Screw-on PVC Bottom Cap
127.0 ft.____ |           |___________Total 8-Inch Borehole Depth
              ...........
```

Monitoring Well Installation Data Sheet

Site: Martins Creek SES
Facility: Ash Basin No. 4
Number: 4-5
PP&L Supervisor: Craig S. Shamory

Drilling Company: Bellview Pump
(215)767-8483
Driller(s): Dave Kyper

Drilling Log

Date: 6/08/88 @ 1340 to 77 ft.
6/09/88 @ 1300 completed drilling

Interval (ft)	Strata Characteristics	Comments
0 - 1	Dark brown topsoil	Moist
1 - 2	Orange brown clayish subsoil	Moist
2 - 17	Orange brown clay w/ sand & gravel	Damp
17 - 21	Broken l.s. w/ clay, sand & gravel	Dry & Dusting
21 - 30	Slightly broken l.s.	Dry & Dusting
31 - 65	Grey l.s. fairly competent	Dry/dusting
65 - 66	Very broken l.s. w/ clayey sand	Damp, not dusting
66 - 71	Grey l.s. fairly competent	Damp
71 - 73	Very broken l.s. w/ clayey sand	Damp
73 - 77	Grey l.s. fairly competent	Damp
77 - 83	Grey l.s. fairly competent	Damp
83 - 95	Very broken l.s. w/ clayey sand	Damp
95 - 96	Grey l.s. fairly competent	Damp
96 - 101	Very broken l.s. w/ clayey sand	Water @ 100 ft.
101 - 105	Fairly competent l.s.	No returns
105 - 120	Broken l.s.	Water returns @ 110'
120 - 126	Fairly competent l.s.	Water returns @ 110'
126 - 128	Broken l.s.	Water returns @ 110'
128 - 145	Fairly competent l.s.	No returns

Notes:
6/08/88 Quit drilling early since out of sand to complete hole.
6/06/88 by 1630 hole open to 128 ft.; water @ 99 ft. Large cobble logded in hole had to clean out again to 129 ft. by 1800.

Monitoring Well Installation Data Sheet

Page 2

Site: Martins Creek

Facility: Ash Basin No. 4

Number: 4-5

PP&L Supervisor: Craig S. Shamory (6/9)
David A. Stoner (6/10)

Drilling Company: Bellview Pump
(215)767-8483

Driller(s): Dave Kyper

Completion Details

Date: 6/09/88 @ 1930 Ran out of sand (31 bags used to 110 ft.)
6/10/88 Finished sandpack and rest of completion.

```
  1.4 ft. _____          ____________Stick-up Height
                |=======|------------Locking Well Cap
                | |---|<|------------Slip-on PVC Top Cap
             ___| |   | |____ <------Cement Well Pad
  0.0 ft.__/__|| |   | ||___\_______Ground Surface
              || |   | ||
              || |   | ||-----------6-Inch I.D. Protective Steel Casing
              || |   | ||           (10 feet long)
              || |   | ||
  8.0 ft.____ |__|   |__|___________Start of Cement Grout to Surface
              |  |   | <|-----------Backfill with Drill Cuttings
              |  |   |  |
              |  |   |<-|----------4-Inch I.D. PVC FJT Schedule 40 Casing
              |  |   |  |
              |  |   |  |
 88.0 ft.____ |__|   |__|___________Top of Bentonite Seal ( 3 buckets)
              |==|   |==|
              |==|   |==|
              |==|   |==|
 91.0 ft.____ |__|   |__|___________Top of Sand Pack ( 41 bags)
 97.0 ft.____ |__|___|__|___________Top of Screen
              |  |---|  |
              |  |---|  |
              |  |---|  |
              |  |---|  |
              |  |---|<-|-----------4-Inch I.D. 0.02" Slot Size PVC FJT
              |  |---|  |           Schedule 40 Screen
              |  |---|  |
              |  |---|  |
              |  |---|  |
              |  |---|  |
              |  |---|  |
              |  |---|  |
127.0 ft.____ |  |===|<-|-----------Screw-on PVC Bottom Cap
129.0 ft.____ |         |___________Total 8-Inch Borehole Depth
              -----------
```

Monitoring Well Installation Data Sheet

Site: Martins Creek SES
Facility: Ash Basin No. 4
Number: 4-6
PP&L Supervisor: David A. Stoner (6/10)
Craig S. Shamory (6/14)

Drilling Company: Bellview Pump
(215)767-8483
Driller(s): Dave Kyper

Drilling Log

Date: 6/08/88 @ 1520 to 77 ft.
6/09/88 @ 0825 completed drilling 71' to 145'

Interval (ft)	Strata Characteristics	Comments
0 - 2	Dark brown topsoil	Damp
2 - 4	Brown silty, clayey subsoil	Damp
4 - 15	Sand, silt, gravel & cobbles (l.s.)	Damp
15 - 17	Sand, silt, gravel & cobbles (l.s.)	Dry
17 - 20	Weathered l.s. w/ gravel & cobbles	Dry
20 - 30	Sand, gravel & cobbles (l.s.)	Damp
30 - 42	Weathered l.s. w/ sand & cobbles	Dry
42 - 48	Weathered l.s.	Dry
48 - 55	Weathered l.s. w/ sand & gravel	Dry
55 - 77	Sand, silt, gravel & cobbles (l.s.)	Damp
71 - 80	Sand, silt, gravel & cobbles (l.s.)	Damp
80 - 100	Fairly competent l.s.	Dry
100 - 126	Very broken l.s.	Water @ 106 ft.
126 - 128	Very broken l.s./ clay zone ?	No returns
128 - 145	Fairly competent l.s.	No returns

Notes:
6/10/88 Quit drilling early to not encounter water zone until after weekend.
6/06/88 Hole filled in 6 ft. over weekend. Completed drilling by 1030. Hole open to 132 ft., and water at 98 ft.

Monitoring Well Installation Data Sheet

Page 2

Site: Martins Creek
Facility: Ash Basin No. 4
Number: 4-6
PP&L Supervisor: Craig S. Shamory

Drilling Company: Bellview Pump
(215)767-8483
Driller(s): Dave Kyper

Completion Details

Date: 6/14/88 @ 1045

```
  1.4 ft. _____          ___________Stick-up Height
               |=======|------------Locking Well Cap
               |  |---|<|------------Slip-on PVC Top Cap
            ___|  |   | |____  <------Cement Well Pad
  0.0 ft.__/__||  |   | ||___\_______Ground Surface
              ||  |   | ||
              ||  |   | |<-----------6-Inch I.D. Protective Steel Casing
              ||  |   | ||           (10 feet long)
              ||  |   | ||
  8.0 ft.____ |__|   |__|___________Start of Cement Grout to Surface
              |  |   | <|-----------Backfill with Drill Cuttings
              |  |   |  |
              |  |   |<-|----------4-Inch I.D. PVC FJT Schedule 40 Casing
              |  |   |  |
              |  |   |  |
 80.0 ft.____ |__|   |__|___________Top of Bentonite Seal ( 2 buckets)
              |==|   |==|
              |==|   |==|
              |==|   |==|
 85.0 ft.____ |__|   |__|___________Top of Sand Pack ( 27.5 bags)
 90.0 ft.____ |__|___|__|___________Top of Screen
              |  |---|  |
              |  |---|  |
              |  |---|  |
              |  |---|  |
              |  |---|<-|-----------4-Inch I.D. 0.02" Slot Size PVC FJT
              |  |---|  |           Schedule 40 Screen
              |  |---|  |
              |  |---|  |
              |  |---|  |
              |  |---|  |
              |  |---|  |
              |  |---|  |
130.0 ft.____ |  |===|<-|-----------Screw-on PVC Bottom Cap
132.0 ft.____ |         |___________Total 8-Inch Borehole Depth
              ...........
```

Basin No. 4 Test Boring Logs
Weston Geophysical (1987b)

BORING No. MC-1

SH 1 OF 2

FIELD BORING LOG

PROJECT PP&L SITE Ash Basin No. 4 DATE: START 7/22/86 FINISH 7/25/86

LOCATION Martins Creek GROUND ELEV. --- TOTAL DEPTH (FT.) 45.0'

CASING I.D. NW CORE SIZE ______ INCLINATION Vertical BEARING ______

CONTRACTOR Sprague and Henwood, Inc. Scranton, PA LOGGED BY B. Frothingham CHK'D BY ______

SCALE IN FEET	STRATA CHANGE	SAMPLE TYPE AND No.	SAMPLE BLOWS OR REC.	SAMPLE DEPTH RANGE (FT.)	RQD %	JOINTS	SOIL AND ROCK DESCRIPTION / COMMENTS (Unified soil class. system, Rock description, Depth to water table, Loss of drill water, etc.)
	OL	SS-1	3-4-8-22 /2"	0-2'			[OL] Organic silt, some clay, trace fine sand and gravel - medium dark brown - dry, loose - organic debris present.
	SP		5" shoe				[SP] Last 6" - coarse sand and fine gravel. Trace silt/clay.
5		SS-2	11-7-6-7 /6"	5.5'-7.5'			[SP] Gravelly coarse sand, little clay, 1 cobble ~2", medium brown, slightly olive colored, wet, loose-medium compact, poor recovery = switch to 2 1/2" spoon.
10	GP	SS-3	13-22-32-15 /6"	10.5'-12.5'			[GP] Gravel, trace clay, little fine to coarse sand, wet, poor recovery with cobbles hanging up even in 2 1/2" spoon.
15	SP	SS-4	13-24-17-8 /3"	15.5'-17.5'	water loss		No recovery with split spoon - try 5' solid spoon; 3" recovery with 5' spoon. [SP] Gravelly fine-coarse sand, trace clay, medium brown to grayish brown, moist - wet, medium compact, angular black shale fragments.
20	TOP OF ROCK	SS-5	13-9-9-8 /0"	20.5'-22.5'			No recovery - broken casing - lost hole. Move back a little and start again - drill to 20' - very hard - possible boulder or rock. Try coring. Core - NX-1 20-21', 10" rec. 50% RQD. Limestone/Dolomite, gray, mod. hard, v. slightly wx., interbedded breccia and chert.
25							

SAMPLE IDENTIFICATION

SS SPLIT SPOON SAMPLE
SHELBY
U FIXED PISTON
O OSTERBERG
D DENISON
P PITCHER
C ROCK CORE
OC ORIENTED ROCK CORE

SUMMARY

OVERBURDEN: 20.0'
ROCK 25.0'
TOTAL DEPTH 45.0'

HOLE NO. MC-1

WESTON GEOPHYSICAL
Form G-5-1

BORING No. MC-1

SH 2 OF 2

FIELD BORING LOG

PROJECT PP&L SITE Ash Basin No. 4 DATE: START 7/22/86 FINISH 7/25/86

LOCATION Martins Creek GROUND ELEV. --- TOTAL DEPTH (FT.) 45.0'

CASING I.D. NW CORE SIZE NX INCLINATION Vertical BEARING

CONTRACTOR Sprague and Henwood Scranton, PA LOGGED BY B. Frothingham CHK'D BY

SCALE IN FEET	STRATA CHANGE	SAMPLE TYPE AND No.	SAMPLE BLOWS OR REC.	SAMPLE DEPTH RANGE (FT.)	RQD %	JOINTS	SOIL AND ROCK DESCRIPTION / COMMENTS (Unified soil class. system, Rock description, Depth to water table, Loss of drill water, etc.)
20		NX-1	0.8'	20.0'-21.0'	50%	water loss	TOP OF ROCK
		NX-2	1.0'	21.0'-22.0'	0%		Limestone/Dolomite, Chert and Calc. Stringers, grey, broken, v. slight wx., fine-med. grained.
25		NX-3	1.3'	22'-26.5'	0%	irreg. frac.	Limestone/Dolomite - as above.
		NX-4	3.0'	26.5'-31.0'	44%		Limestone/Dolomite, gray fine - medium grained, slightly weathered, chert fragments [28.0'-28.4'] weathered joint, few calcite veins and vugs.
30	LS						
35		NX-5	10.3'	31.0'-41.0'	100%		Limestone/Dolomite, gray, fine to medium grained, fresh - slightly weathered joint.
40							
		NX-6	4.0'/4.0'	41.0'-45.0'	100%		Limestone/Dolomite - as above.
45							END OF BORING 45.0'

SAMPLE IDENTIFICATION

SS SPLIT SPOON SAMPLE
SHELBY
FIXED PISTON
O OSTERBERG
D DENISON
P PITCHER
C ROCK CORE
OC ORIENTED ROCK CORE

SUMMARY

OVERBURDEN: 20.0'
ROCK 25.0'
TOTAL DEPTH 45.0'
HOLE NO. MC-1

WESTON GEOPHYSICAL
Form G-5-1

BORING No. MC-2

SH 1 OF 1

FIELD BORING LOG

PROJECT PP&L SITE Ash Basin No. 4 DATE: START 7/28/86 FINISH 7/29/86

LOCATION Martins Creek GROUND ELEV. --- TOTAL DEPTH (FT.) 26.0'

CASING I.D. 4" CORE SIZE HX INCLINATION Vertical BEARING

CONTRACTOR Sprague and Henwood Scranton, PA LOGGED BY P. Turner CHK'D BY

SCALE IN FEET	STRATA CHANGE	SAMPLE TYPE AND No.	SAMPLE BLOWS OR REC.	SAMPLE DEPTH RANGE (FT.)	RQD %	JOINTS	SOIL AND ROCK DESCRIPTION / COMMENTS (Unified soil class. system, Rock description, Depth to water table, Loss of drill water, etc.)
	OL	SS-1	3-11-14-11	0-2.0'			Organic clayey silt, trace sand, gravel, dark brown. [OL]
5	CL	SS-2	15-15-18-17	5.5'-7.5'			Sandy clay, yellowish brown, moist, very stiff, mottled.[CL]
10							TOP OF ROCK
	LS	HX-1	3.7'	11.0'-15.0'	50%		Limestone/Dolomite, gray, fine - medium grained, weathered joint surfaces, black chert fragments, calcite veins.
15		HX-2	7.0'	15.0'-22.0'	63%		Limestone/Dolomite as above, several high-angle joints.
20		HX-3	2.9'	22.0'-26.0'	25%		Limestone/Dolomite as above, irregular erosional contact [22.3'], fine grained below, coarse grained above, more calcite veins, cavity fillings.
25							END OF BORING 26.0'

SAMPLE IDENTIFICATION

SS SPLIT SPOON SAMPLE	D DENISON
SHELBY	P PITCHER
FIXED PISTON	C ROCK CORE
O OSTERBERG	OC ORIENTED ROCK CORE

SUMMARY

OVERBURDEN: 11.0'
ROCK 15.0'
TOTAL DEPTH 26.0'
HOLE NO. MC-2

WESTON GEOPHYSICAL
Form G-5-1

BORING No. MC-3

SH 1 OF 3

FIELD BORING LOG

PROJECT PP&L | SITE Ash Basin No. 4 | DATE: START 7/30/86 | FINISH 8/4/86

LOCATION Martins Creek | GROUND ELEV. --- | TOTAL DEPTH (FT.) 59.0'

CASING I.D. 4" | CORE SIZE HX | INCLINATION Vertical | BEARING ---

CONTRACTOR Sprague and Henwood Scranton, PA | LOGGED BY P. Turner | CHK'D BY

SCALE IN FEET	STRATA CHANGE	SAMPLE TYPE AND No.	SAMPLE BLOWS OR REC.	SAMPLE DEPTH RANGE (FT.)	RQD %	JOINTS	SOIL AND ROCK DESCRIPTION / COMMENTS (Unified soil class. system, Rock description, Depth to water table, Loss of drill water, etc.)
	OL	SS-1	300# 4-9-14-11 0.5'	0.0'-2.0'			Organic clayey silt, dark brown, moist, trace sand, pebbles, large pebble blocked spoon [OL].
	SM	SS-1A	5-3-8-9 0.5'	2.0'-4.0'			Silty sand, light brown, moist, loose, medium to coarse grained with pebbles [SM].
5							
		SS-2	11-12-12-15 no rec.	5.5'-7.5'			No recovery.
	SW	SS-2A	19-24-24-27 0.5'	7.5'-9.5'			Gravelly sand, light grayish brown, moist, medium dense, medium to coarse grained with pebbles [SW].
10							
		SS-3	15-13-20-20 0.5'	10.5'-12.5'			Gravelly sand, greenish gray, moist, medium dense, fine to medium grained with silt, pebbles [SW].
	SW						
15							
	SP	SS-4	21-17-refusal 0.4'	15.5'-16.5'			Sand and silt, greenish gray, moist, dense, fine to medium grained silt is light brown, quartzite boulder at bottom.[SP]
	GW						Gravel, cored boulders over this interval.[GW]
20							
	CL	SS-5	12-14-21-22 2.0'	20.5'-22.5'			Silty clay, light brown, mottled, tan to dark brown, stiff to very stiff with trace sand [CL].
25							

SAMPLE IDENTIFICATION

SS SPLIT SPOON SAMPLE	D DENISON
SHELBY	P PITCHER
FIXED PISTON	C ROCK CORE
O OSTERBERG	OC ORIENTED ROCK CORE

SUMMARY

OVERBURDEN: 29.5'

ROCK 29.5'

TOTAL DEPTH 59.0'

HOLE NO. MC-3

WESTON GEOPHYSICAL
Form G-5-1

BORING No. MC-3

SH 2 OF 3

FIELD BORING LOG

PROJECT PP&L SITE Ash Basin No. 4 DATE: START 7/30/86 FINISH 8/4/86

LOCATION Martins Creek GROUND ELEV. --- TOTAL DEPTH (FT.) 59.0'

CASING I.D. 4" CORE SIZE HX INCLINATION Vertical BEARING

CONTRACTOR Sprague & Henwood Scranton, PA LOGGED BY P. Turner CHK'D BY

SCALE IN FEET	STRATA CHANGE	SAMPLE TYPE AND No.	SAMPLE BLOWS OR REC.	SAMPLE DEPTH RANGE (FT.)	RQD %	JOINTS	SOIL AND ROCK DESCRIPTION / COMMENTS (Unified soil class. system, Rock description, Depth to water table, Loss of drill water, etc.)
	CL	SS-6	16-17-20-22 no rec.	25.5'-27.5'			Silty clay, pebble blocked recovery. [CL]
		SS-6A	16-13-24-33 2.0'	27.5'-29.5'			Silty clay as above. [CL]
30	LS	HX-1	2.0'	30.0'-36.0'	0%		Limestone/Dolomite, gray, medium grained, very weathered particularly along numerous joints and fractures.
35							
		HX-2	1.3'	36.0'-42.0'	6%	Ext. Wrx. Voids	Limestone/Dolomite as above.
40							
		HX-3	0.7'	42.0'-47.0'	0%		Limestone/Dolomite as above.
45							
		HX-4	1.9'	47.0'-55.5'		Wrx. Void	Fast penetration indicates clay filled voids, weathered zone down to 54'.
50							

SAMPLE IDENTIFICATION

SS SPLIT SPOON SAMPLE
SHELBY
FIXED PISTON
O OSTERBERG
D DENISON
P PITCHER
C ROCK CORE
OC ORIENTED ROCK CORE

SUMMARY

OVERBURDEN: 29.5'
ROCK 29.5'
TOTAL DEPTH 59.0'

HOLE NO. MC-3

WESTON GEOPHYSICAL
Form G-5-1

BORING No. MC-3

SH 3 OF 3

FIELD BORING LOG

PROJECT PP&L SITE Ash Basin No. 4 DATE: START 7/30/86 FINISH 8/4/86

LOCATION Martins Creek GROUND ELEV. --- TOTAL DEPTH (FT.) 59.0'

CASING I.D. 4" CORE SIZE HX INCLINATION Vertical BEARING

CONTRACTOR Sprague & Henwood Scranton, PA LOGGED BY P. Turner CHK'D BY

SCALE IN FEET	STRATA CHANGE	SAMPLE TYPE AND No.	BLOWS OR REC.	DEPTH RANGE (FT.)	RQD %	JOINTS	SOIL AND ROCK DESCRIPTION / COMMENTS (Unified soil class. system, Rock description, Depth to water table, Loss of drill water, etc.)
	LS	HX-4	1.9'	47.0'-55.5'	16%	Wrx. Void	
55		HX-5	3.5'	55.5'-59.0'	80%		Limestone/Dolomite, dark gray, very fine to fine grained, slightly weathered to weathered, calcite veins planar dipping prominently 30° or irregular, minor black chert. END OF BORING 59.0'
60							
65							
70							
75							

SAMPLE IDENTIFICATION

SS SPLIT SPOON SAMPLE
SHELBY
U FIXED PISTON
O OSTERBERG
D DENISON
P PITCHER
C ROCK CORE
OC ORIENTED ROCK CORE

SUMMARY

OVERBURDEN: 29.5'
ROCK 29.5'
TOTAL DEPTH 59.0'
HOLE NO. MC-3

WESTON GEOPHYSICAL
Form G-5-1

BORING No. MC-4

SH 1 OF 3

FIELD BORING LOG

PROJECT PP&L SITE Ash Basin No. 4 DATE: START 8/5/86 FINISH 8/7/86

LOCATION Martins Creek GROUND ELEV. --- TOTAL DEPTH (FT.)

CASING I.D. 4" & 3" CORE SIZE NX INCLINATION Vertical BEARING

CONTRACTOR Sprague & Henwood Scranton, PA LOGGED BY P. Turner CHK'D BY

SCALE IN FEET	STRATA CHANGE	SAMPLE TYPE AND No.	SAMPLE BLOWS OR REC.	SAMPLE DEPTH RANGE (FT.)	RQD %	JOINTS	SOIL AND ROCK DESCRIPTION / COMMENTS (Unified soil class. system, Rock description, Depth to water table, Loss of drill water, etc.)
	SM	SS-1	300# 4-9-13-14 0.3'	0.0'-2.0'			Silty sand, brown, moist, loose to medium dense, pebbles.[SM]
		SS-1A	11-12-11-14 0.4'	2.0'-4.0'			Gravelly sand, brown, moist, medium dense, medium to coarse grained, pebbles, silt.[SW]
5		SS-2	10-9-9-7 0.6'	5.0'-7.0'			Gravelly sand, grayish brown, moist, loose medium to coarse grained, pebbles, silt.[SW]
	SW						
10		SS-3	14-14-31-100/5" 0.3'	10.0'-12.0'			Gravelly sand, as above.[SW]
15							Cobbles and boulders.
		SS-4	30-15-14-25 1.2'	17.5'-19.5'			Sand, grayish brown, moist, medium dense, medium grained, few pebbles, trace silt.[SP]
20	SP						Cobbles and boulders.
25							

SAMPLE IDENTIFICATION		SUMMARY
SS SPLIT SPOON SAMPLE	D DENISON	OVERBURDEN: 61.5'
SHELBY	P PITCHER	ROCK 7.5'
FIXED PISTON	C ROCK CORE	TOTAL DEPTH 69.0'
O OSTERBERG	OC ORIENTED ROCK CORE	HOLE NO. MC-4

WESTON GEOPHYSICAL
Form G-5-1

BORING No. MC-4

SH 2 OF 3

FIELD BORING LOG

PROJECT PP&L SITE Ash Basin No. 4 DATE: START 8/5/86 FINISH 8/7/86

LOCATION Martins Creek GROUND ELEV. --- TOTAL DEPTH (FT.)

CASING I.D. 4" & 3" CORE SIZE NX INCLINATION Vertical BEARING

CONTRACTOR Sprague & Henwood Scranton, PA LOGGED BY P. Turner CHK'D BY

SCALE IN FEET	STRATA CHANGE	SAMPLE TYPE AND No.	SAMPLE BLOWS OR REC.	SAMPLE DEPTH RANGE (FT.)	RQD %	JOINTS	SOIL AND ROCK DESCRIPTION / COMMENTS (Unified soil class. system, Rock description, Depth to water table, Loss of drill water, etc.)
	SP-GM	SS-5	40-17-21-20 1.2'	25.0'-27.0'			Sand and gravel, grayish brown, moist, medium dense, medium grained uniform sand with a layer [6"] pebbles, trace silt [SP-GM].
30	SP	SS-6	7-13-15-17 1.0'	30.0'-32.0'			Sand, greenish gray, moist, medium dense, fine and medium grained, few pebbles, trace silt [SP].
35	CL	SS-7	5-7-10-16 2.0'	35.0'-37.0'			Silty clay, brown, medium stiff to stiff [CL].
40	CL	SS-8	5-5-8-17 2.0'	40.0'-42.0'			Sandy clay, light brown and gray, medium stiff to stiff, pebbles, bedrock fragments [42.0'].[CL]
45		SS-9	14-13-14-17 2.0'	45.0'-47.0'			Silty clay and sandy clay, light brown, stiff, layers of exotic pebbles, appears laminated.[CL]
50							

SAMPLE IDENTIFICATION		SUMMARY
S SPLIT SPOON SAMPLE	D DENISON	OVERBURDEN: 61.5'
SHELBY	P PITCHER	ROCK 7.5'
U FIXED PISTON	C ROCK CORE	TOTAL DEPTH 69.0'
O OSTERBERG	OC ORIENTED ROCK CORE	HOLE NO. MC-4

WESTON GEOPHYSICAL
Form G-5-1

BORING No. MC-4

SH 3 OF 3

FIELD BORING LOG

PROJECT PP&L SITE Ash Basin No. 4 DATE: START 8/5/86 FINISH 8/7/86

LOCATION Martins Creek GROUND ELEV. --- TOTAL DEPTH (FT.) 69.0'

CASING I.D. 4" & 3" CORE SIZE NX INCLINATION Vertical BEARING

CONTRACTOR Sprague & Henwood Scranton, PA LOGGED BY P. Turner CHK'D BY

SCALE IN FEET	STRATA CHANGE	SAMPLE TYPE AND No.	BLOWS OR REC.	DEPTH RANGE (FT.)	RQD %		SOIL AND ROCK DESCRIPTION / COMMENTS (Unified soil class. system, Rock description, Depth to water table, Loss of drill water, etc.)
	SM	SS-10	12-22-35-45	50.0'-52.0'			Silty sand, olive brown, medium dense, very fine to medium grained, laminated, oxidized coarse lamina 1" thick [SM].
55		SS-11	13-15-18-21 2.0'	55.0'-57.0'			Silty sand, olive brown, medium dense, very fine to medium grained, laminated [SM].
60	SM	SS-12	2-10-18-7 2.0'	60.0'-62.0'			Silty sand, brown, loose to medium dense, medium grained, dark brown layer indicates almost vertical lamination. [SM]
	CL						Clay, orange brown, medium stiff bottom 2", clay fragments in sand above, sample spoon deflected off top of rock at 61.5'.
	LS	NX-1	1.5'	61.5'-63.0'	100%		Limestone/Dolomite, fresh gray medium grained, massive tight joints, slightly weathered.
65		NX-2	2.3'	63.0'-69.0'	38%		Limestone/Dolomite, gray, medium grained, massive, weathered joints.
70							END OF BORING 69.0'
75							

SAMPLE IDENTIFICATION		SUMMARY
SS SPLIT SPOON SAMPLE	D DENISON	OVERBURDEN: 61.5'
SHELBY	P PITCHER	ROCK 7.5'
U FIXED PISTON	C ROCK CORE	TOTAL DEPTH 69.0'
O OSTERBERG	OC ORIENTED ROCK CORE	HOLE NO. MC-4

WESTON GEOPHYSICAL
Form G-5-1

The following borehole logs are taken directly from: "Investigation and Geophysical Study of Five Fly Ash Disposal Areas for the Martins Creek Steam Electric Station", prepared for PP&L by Skelly and Loy Engineers-Consultants, January 1986. These logs are included here at PP&L's request because they are from the same area investigated by Weston Geophysical during this current project [sites 19 and 20]. The location of each of these borings is included on the plan map, Figure 2.

<u>1-19</u>

0.0'-15.0'	Brown sandy clay with coarse sized gravel
15.0'-20.0'	Brown clayey sand
20.0'-33.0'	Brown sandy clay with coarse sized gravel
33.0'-83.0'	Light brown clay; boulder layer encountered at approximately 43.0'-45.0'; material below boulder layer light brown clay

<u>2-19</u>

0.0'-9.0'	Brown sandy clay with layers of sandstone pebbles
‵.0'-15.0'	Brown sandy clay coarse grained gravel
15.0'-30.0'	Light brown sandy clay
30.0'-38.0'	Light brown clay with coarse sized gravel
38.0'-50.0'	Light brown sandy clay with coarse grained gravel at 39.0' layer of sandstone boulders approximately 5.0' in thickness; from 44.0' to bottom [50.0'], brown sandy clay

<u>3-19</u>

0.0'-6.0'	Dark brown sandy clay
6.0'-10.0'	Brown clayey sand
10.0'-11.5'	Brown clayey sand with coarse grained gravel
11.5'-20.0'	Light brown sandy clay
20.0'-31.0'	Light brown sandy clay with coarse grained gravel
31.0'-32.0'	Boulder zone
32.0'-50.0'	Light brown sandy clay

__-20__

0.0'-12.0'	Light brown sandy clay with coarse grained gravel
12.0'-33.0"	Dark gray coarse grained gravel
33.0'-39.0"	Light gray limestone with clay interbeds [cores]

__2-20__

0.0'-30.0'	Light brown sandy clay
30.0'-45.0"	Dark brown clayey sand
45.0'-60.0"	Light brown sandy clay

__3-20__

0.0'-9.0'	Light brown sandy clay
9.0'-15.0'	Light brown sandy clay
15.0'-25.0"	Light brown sandy clay
5.0'-31.0"	Light gray limestone [core]

__4-20__

0.0'-3.0'	Dark brown sandy clay
3.0'-6.0'	Light brown clayey sand with sandstone pebbles
6.0'-9.0'	Light brown clayey sand with limestone fragments
9.0'-15.0'	Light brown sandy clay with coarse sized gravel
15.0'-23.0"	Brown clayey sand with coarse gravel
23.5'-29.0"	Gray limestone [core]

0809J

PP&L Form 2454 (10/83)
Cat. #973401

103080

PENNSYLVANIA POWER & LIGHT COMPANY
CALCULATION SHEET

Dept. ____
Date 4-8 1986
Designed by MRA
Approved by ____

PROJECT MARTINS CREEK
ASH BASIN No. 4
SUMMARY OF STABILITY ANYLYSES

ER No. ____
Sht. No. 1 of 3

MINIMUM FACTOR OF SAFETY		SHEAR STRENGTH C (PSF)	FRICTION ANGLE - Ø - (DEGREES) 0°	5°	15°	20°	25°
SLIP-CIRCLE FAILURE		0		(0.263)	(0.806)	(1.095)	(1.403)
		100	0.139	0.528	1.196	1.535	1.895
		200	0.279	0.702	1.452	1.791	2.147
		250	0.349	0.783	1.521	1.911	2.279
WEDGE FAILURE		0		0.260	0.796	1.082	1.386
		100	0.184	0.458	1.004	1.209	1.594
		200	0.368	0.646	1.203	1.493	1.800
		250	0.460	0.740	1.297	1.592	1.899

MINIMUM Ø REQUIRED FOR F.S. ≥ 1.5 (1) SHEAR STRENGTH (PSF)	SLIP-CIRCLE	WEDGE
0	26°	27°
100	19°	24°
200	16°	20°
250	14°	19°

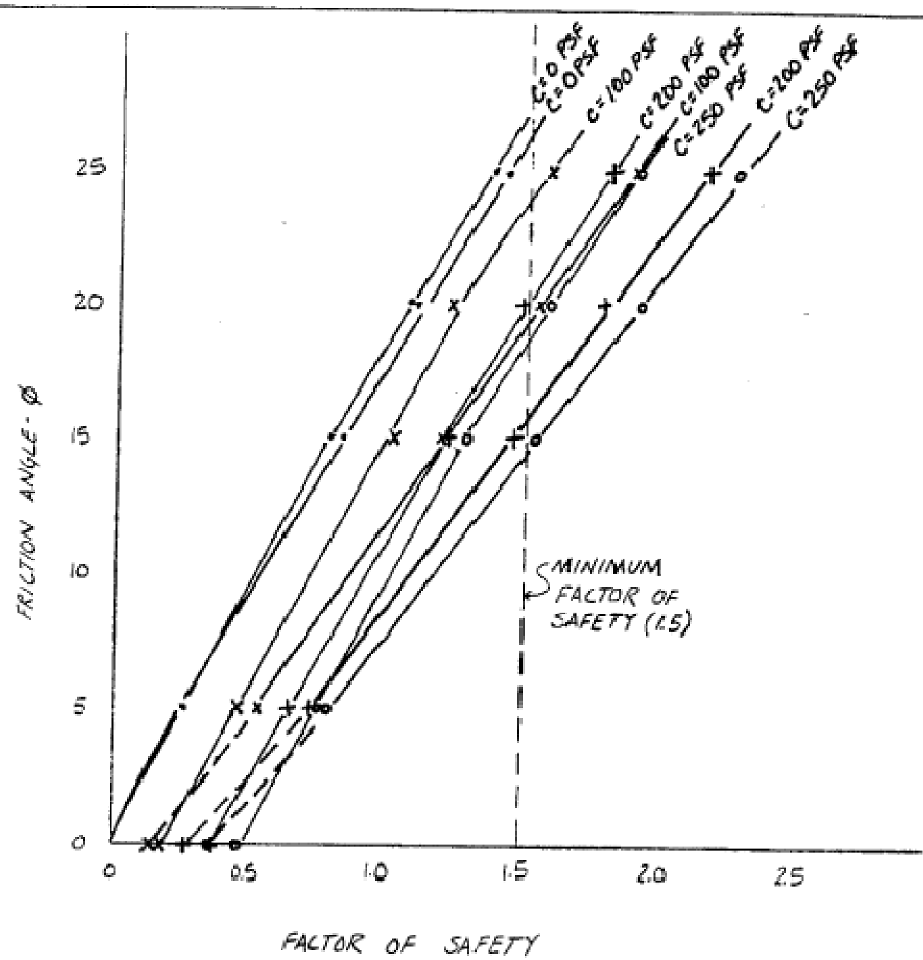
MINIMUM C REQUIRED FOR F.S. ≥ 1.5 (2) FRICTION ANGLE (DEG.)	SLIP-CIRCLE	WEDGE
15°	230	340
20	90	210
25	10	60

(1) REFER TO SHEET 2

(2) REFER TO SHEET 3

PP&L Form 2454 (10/83)
Cat. #973401

Dept. ______ Date 4-8 19 86 Designed by MRA Approved by ______	**PENNSYLVANIA POWER & LIGHT COMPANY** **CALCULATION SHEET** PROJECT MC Ash Basin No. 4 Factor of Safety vs. Ø for given C	ER No. ______ Sht. No. 2 of 3



BLUE- SLIP CIRCLE

RED - WEDGE

PP&L Form 2454 (10/83)
Cat. #973401

Dept. ____

Date 4-8 19 86

Designed by MRA

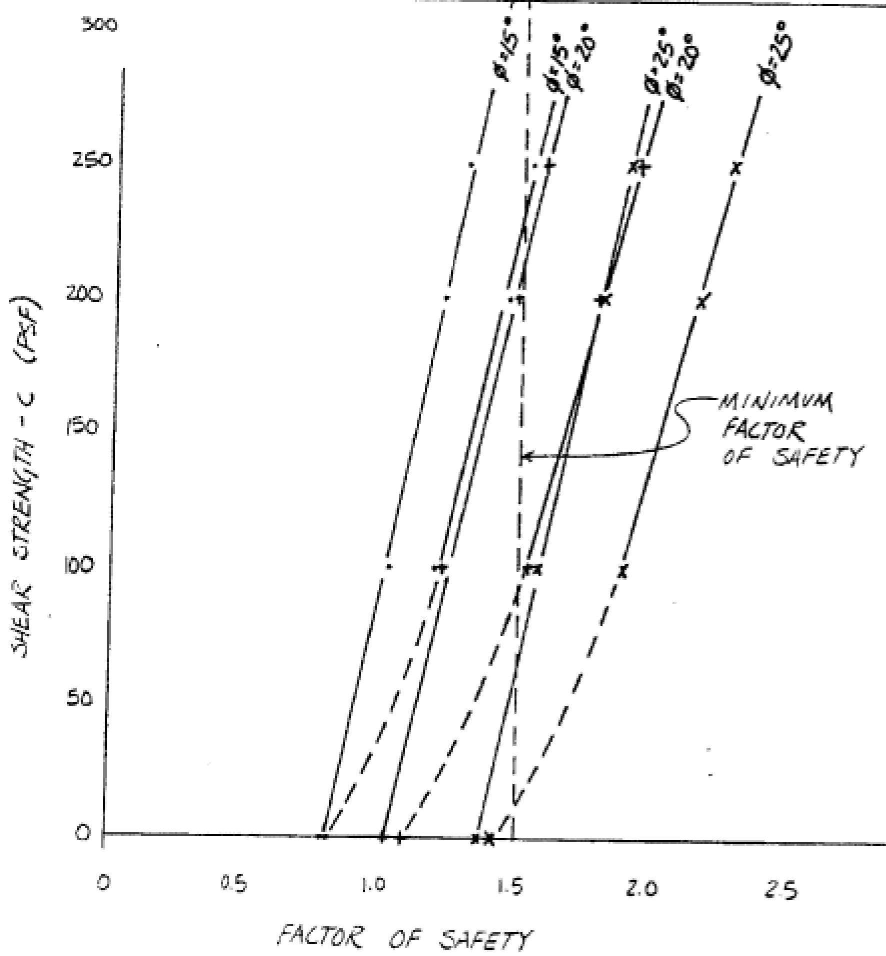
Approved by ____

PENNSYLVANIA POWER & LIGHT COMPANY
CALCULATION SHEET

PROJECT MC ASH BASIN No. 4
FACTOR OF SAFETY vs. C
FOR GIVEN ϕ

ER No. ____

Sht. No. 3 of 3



BLUE - SLIP-CIRCLE
RED - WEDGE

PP&L Form 2454 (10-83)
Cat. #973401

Dept. ______
Date 3/21 19 86
Designed by MRA
Approved by ______

PENNSYLVANIA POWER & LIGHT COMPANY
CALCULATION SHEET

PROJECT MC ASH BASIN No. 4
STABILITY ANALYSIS

ER No. 103080-914
Sht. No. 1 of ____

	ORIGINAL	G.S.
TOE (US)	0	324
	75	322
	170	320
	220	318
	265	316
	310	314
	350	312
	360	310
	390	300
	430	290

DIKE	SURFACE
0	308
165	363
180	363
236	335
320	314

$y = 324 - \frac{2}{75}(x)$ $\quad y = 308 + \frac{1}{3}(x)$

$324 - \frac{2}{75}x = 308 + \frac{1}{3}x$

$16 = \frac{27}{75}x$

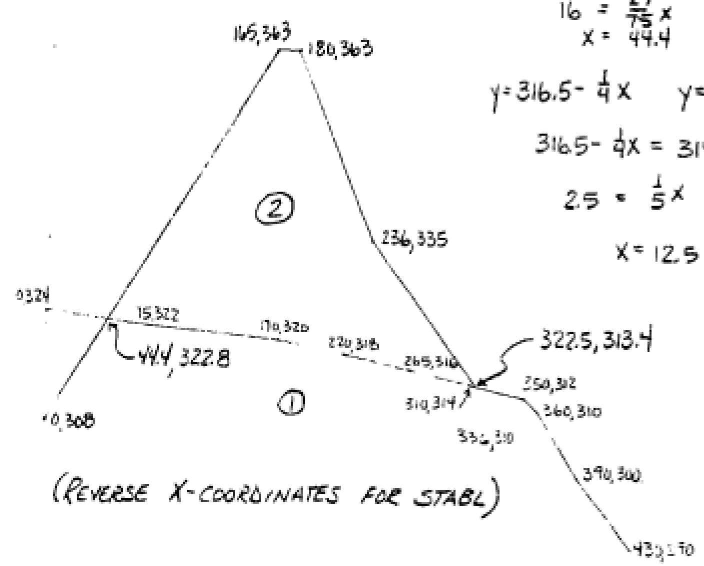
$x = 44.4 \quad y = 322.8$

$y = 316.5 - \frac{1}{4}x \quad y = 314 - \frac{2}{40}x$

$316.5 - \frac{1}{4}x = 314 - \frac{1}{20}x$

$2.5 = \frac{1}{5}x$

$x = 12.5 \quad y = 313.4$



(REVERSE X-COORDINATES FOR STABL)

PP&L Form 2454 (10/83)
Cat. #973401

Dept. ______
Date 3/21 1986
Designed by MRA
Approved by ______

PENNSYLVANIA POWER & LIGHT COMPANY
CALCULATION SHEET

PROJECT ______

ER No. ______

Sht. No. 2 of ______

SOIL SAMPLES (PROCTORS)

①	②
$\gamma_d = 121.5$ pcf	$\gamma_d = 116.5$ pcf
$\omega = 11.9\%$	$\omega = 12.7\%$
$95\%\ \gamma_d = 115.4$ PCF +	$95\%\ \gamma_d = 110.7$ PCF
$10.1\% < \omega < 14.3\%$	$9.3\% < \omega < 15.8\%$

PERMEABILITY TESTS

①	②
$\gamma_d = 115.5$ PCF	$\gamma_d = 111.4$ PCF
$\omega_i = 11.9\%$	$\omega_i = 12.1\%$
$\gamma_w = 129.2$ PCF	$\gamma_w = 124.9$ PCF
$\omega_f = 13.0\%$	$\omega_f = 21.5\%$
$\gamma_T = 130.5$ PCF	$\gamma_T = 135.4$ PCF

$$\tfrac{1}{2}\Big(\big[115.4(1+0.101)\big]+\big[110.7(1+0.093)\big]\Big) =$$

$$\tfrac{1}{2}(127.06 + 121.0) = 124.0 \text{ pcf}$$

OR

$$\tfrac{1}{2}\Big(\big[115.4(1+0.143)\big]+\big[110.7(1+0.158)\big]\Big) =$$

$$\tfrac{1}{2}(131.9 + 128.2) = 130.0 \text{ pcf}$$

127.0 – 95% PROCTOR (SOIL 2)

$$\tfrac{1}{2}\big(115.5(1+0.119) + 111.4(1+0.121)\big) = 127.0 \text{ pcf}$$

PP&L Form 2454 (10/83)
Cat. #973401

Dept.	PENNSYLVANIA POWER & LIGHT COMPANY CALCULATION SHEET	ER No.
Date 3/24 1986		
Designed by MRA	PROJECT	Sht. No. 3 of
Approved by		
	STABL DATA	

PROFIL
MARTINS CREEK ASH BASIN No. 4
15 9

0.	90.	40.	100.	1
40	100	70	110	1
70	110	80	112	1
80	112	107.5	113.4	1
107.5	113.4	194	135	2
194.	135	250	163	2
250	163	265	163	2
265	163	385.6	122.8	2
385.6	122.8	430	108	1
~~430~~	~~108~~			
107.5	113.4	120	114	1
120.	114	165	116	1
165	116	210	118	1
210	118	260	120	1
260	120	355	122	1
355	122	385.6	122.8	1

450 28 Sand
400 70 Ts/...
300 25 Core

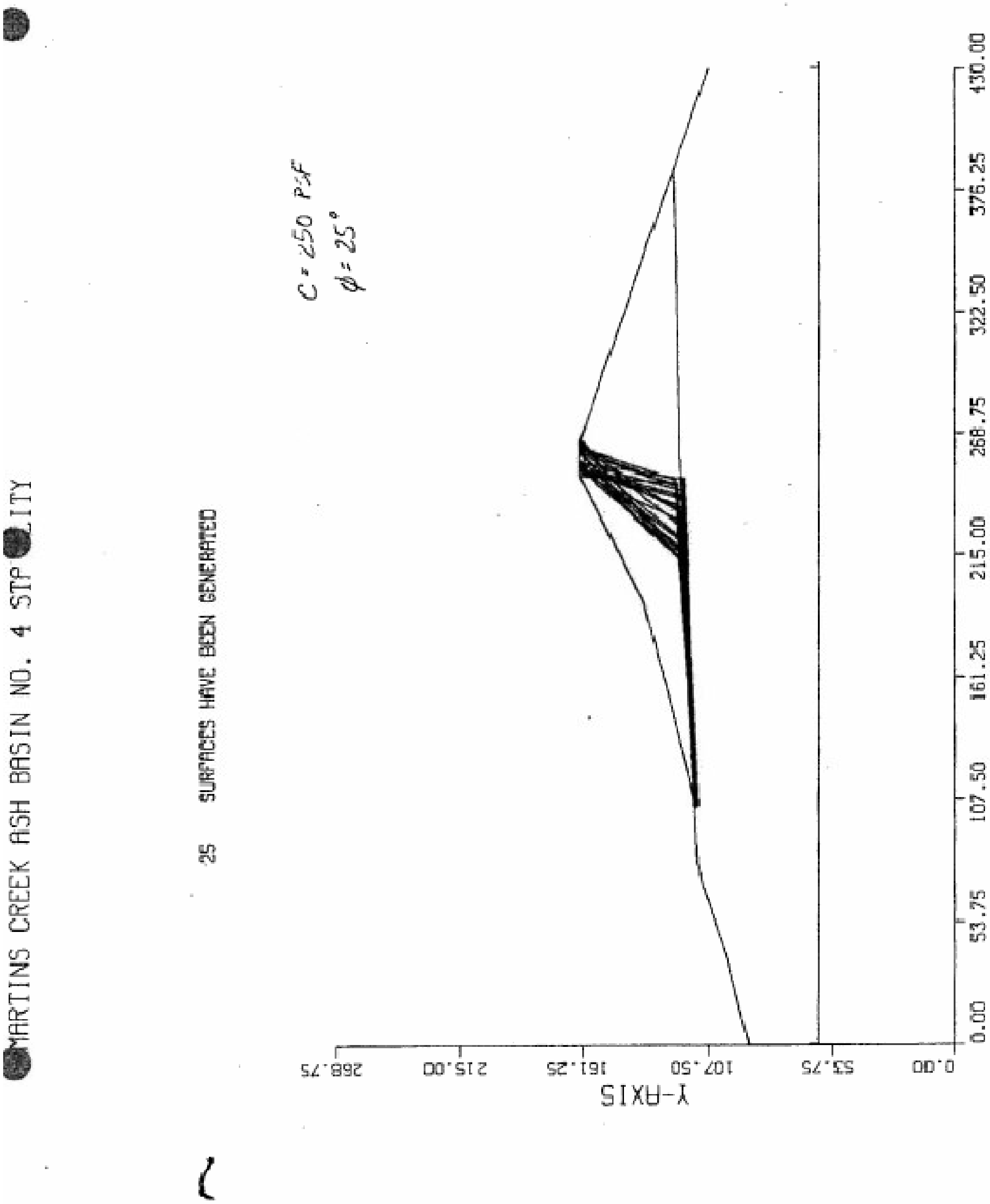
MC4C - CIRCLE

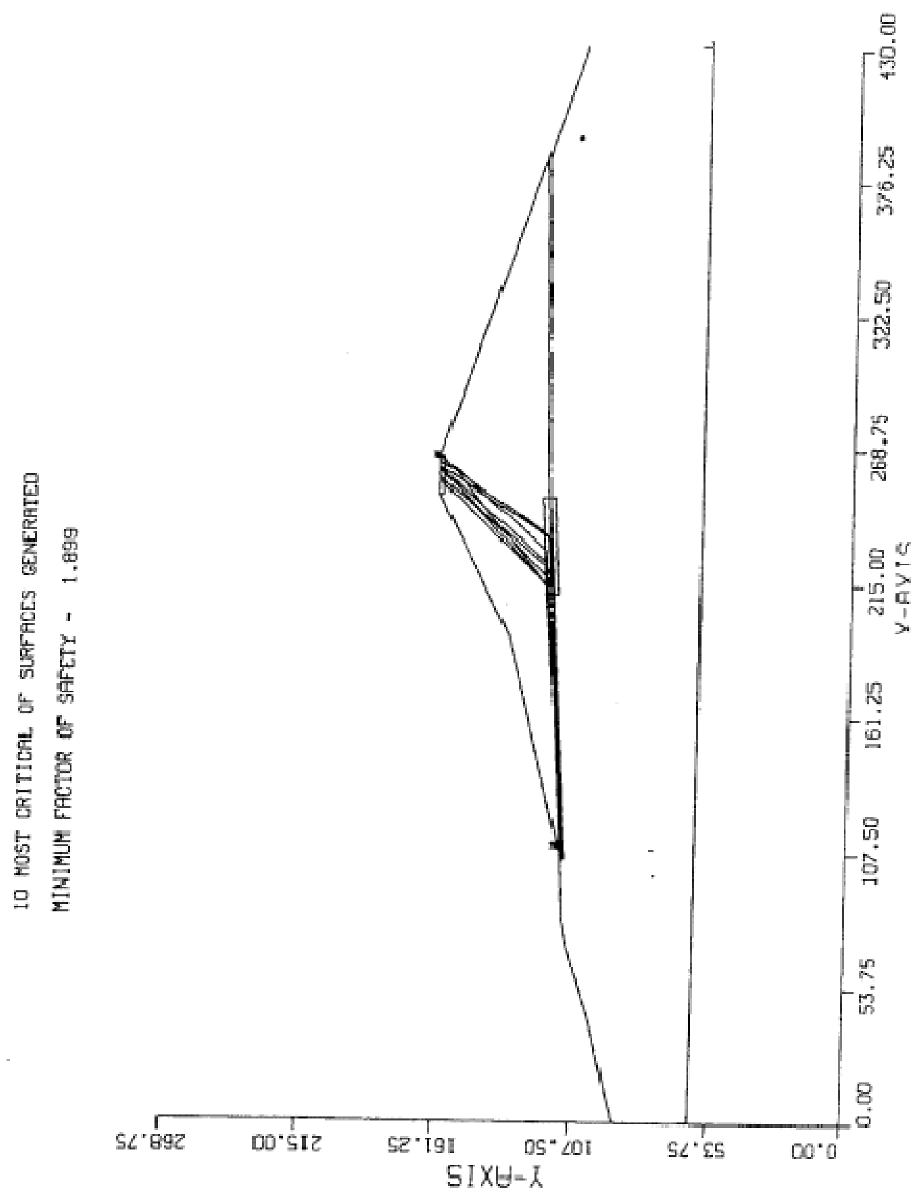
SOIL
2
120.0 130.0 250. 25. 0. 0. 1
127.0 135.0 250. 25. 0. 0. 1
LIMITS
1 1 5 0. 60. 430. 60.
CIRCL2
10 10
0. 80. 170. 250.
60. 20. 0. 0.

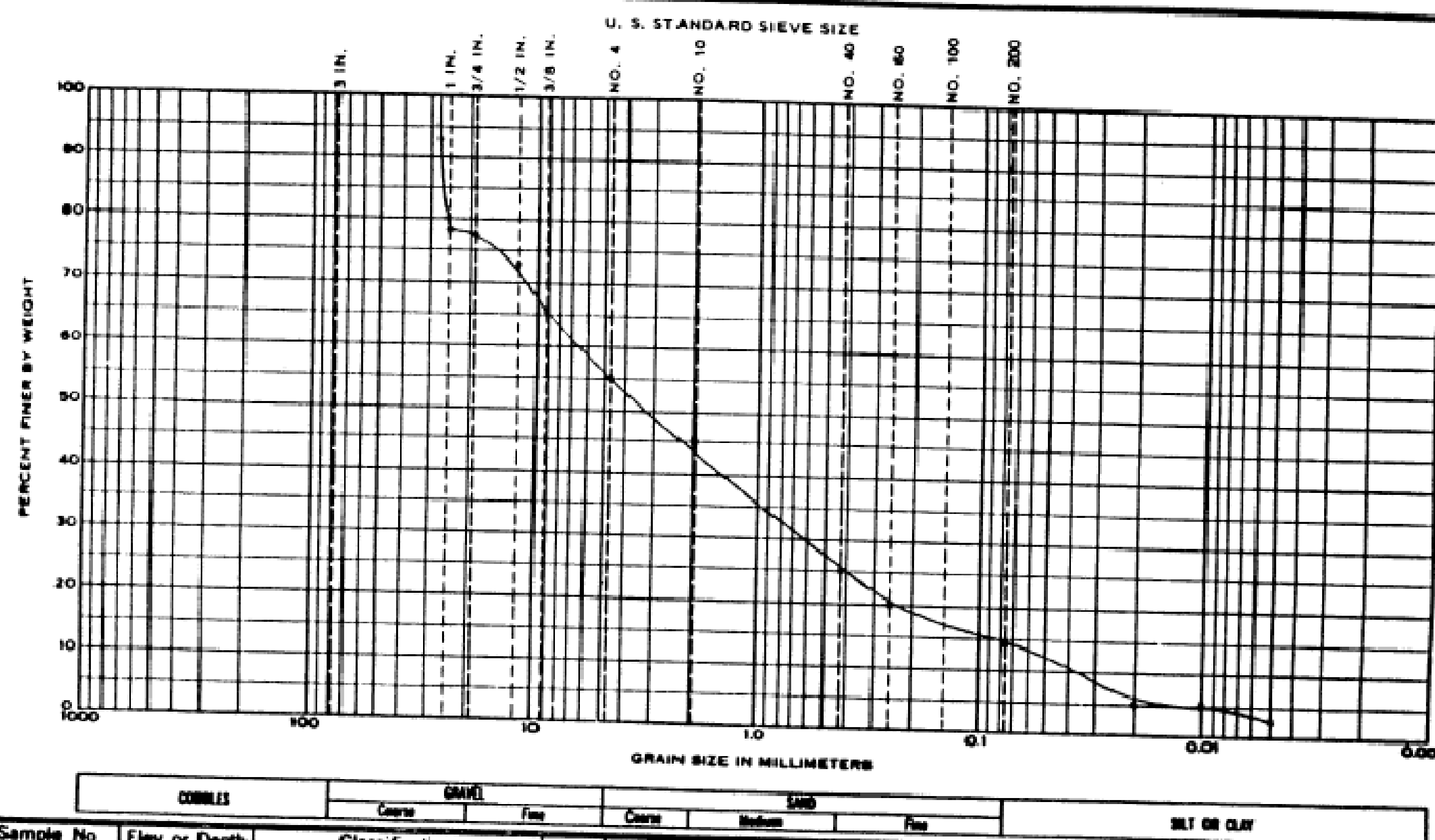
CEOCZ10

MC4C CIRCLE

MC4B WEDGE


MARTINS CREEK ASH BASIN NO. 4
25 SURFACES HAVE BEEN GENERATED
C = 250 PSF
ϕ = 25°
Y-AXIS
0.00
53.75
107.50
161.25
215.00
268.75
0.00
53.75
107.50
161.25
215.00
268.75
322.50
376.25
430.00


10 MOST CRITICAL OF SURFACES GENERATED
MINIMUM FACTOR OF SAFETY - 1.899
0.00
53.75
107.50
161.25
215.00
268.75
322.50
376.25
430.00
X-AXIS
0.00
53.75
107.50
161.25
215.00
268.75
Y-AXIS

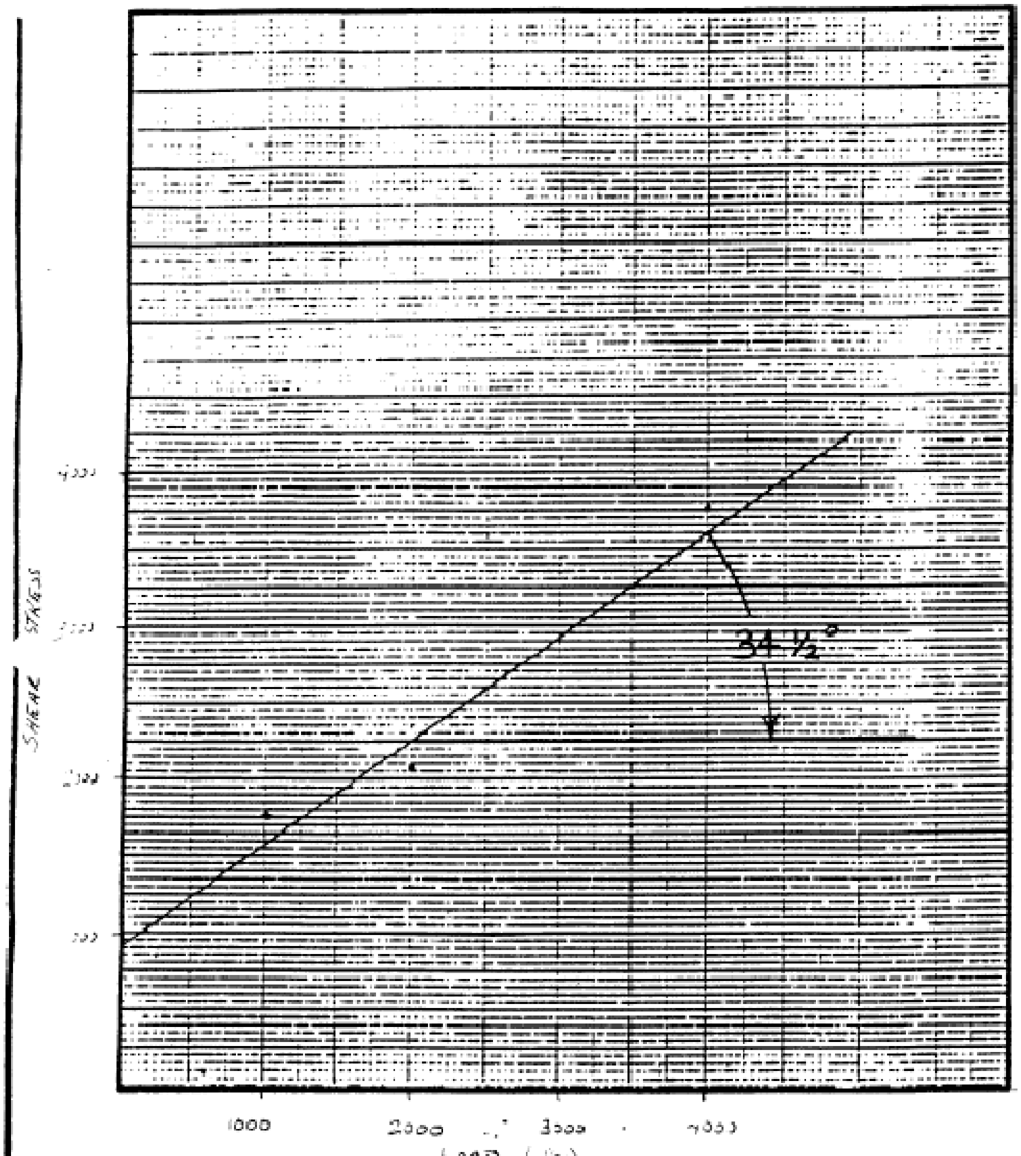


Sample No.	Elev or Depth	Classification	NatWC	LL	PL	PI	REMARKS:
B-2 S-4	8.0-10.5'	GM – Silty Gravel w/ Sand	11.29				

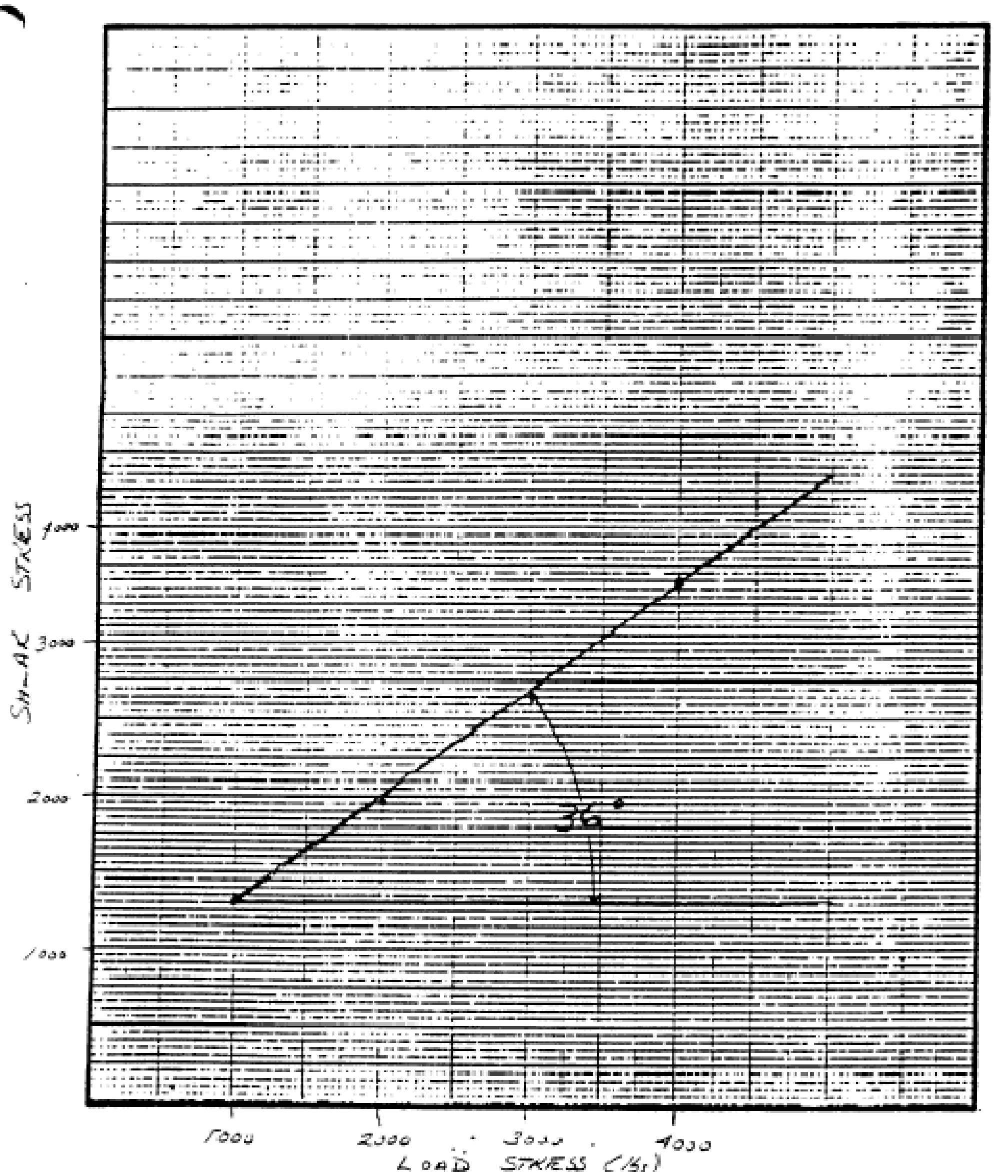
GRADATION CURVES

BORINGS, SOILS & TESTING CO.
FOUNDATION ENGINEERS
HARRISBURG, PENNSYLVANIA

Project: Martins Creek SES
Location: Ash Basin No. 4
Date 4-16-89 Made By GDE Chkd By TMR



TYPE TEST	PROJECT MARTINS CREEK SES
REMOLDED	ASH BASIN No. 4
	SAMPLE ID B-6, S-3
	6.0' - 7.5'
CLASS. GW-GM / W % 7.73	LAB NO. J-7975 / TESTED BY GDC / DATE May 6th, 1987
LL — / SP. G. —	**DIRECT SHEAR TEST REPORT**



TYPE TEST
REMOLDED

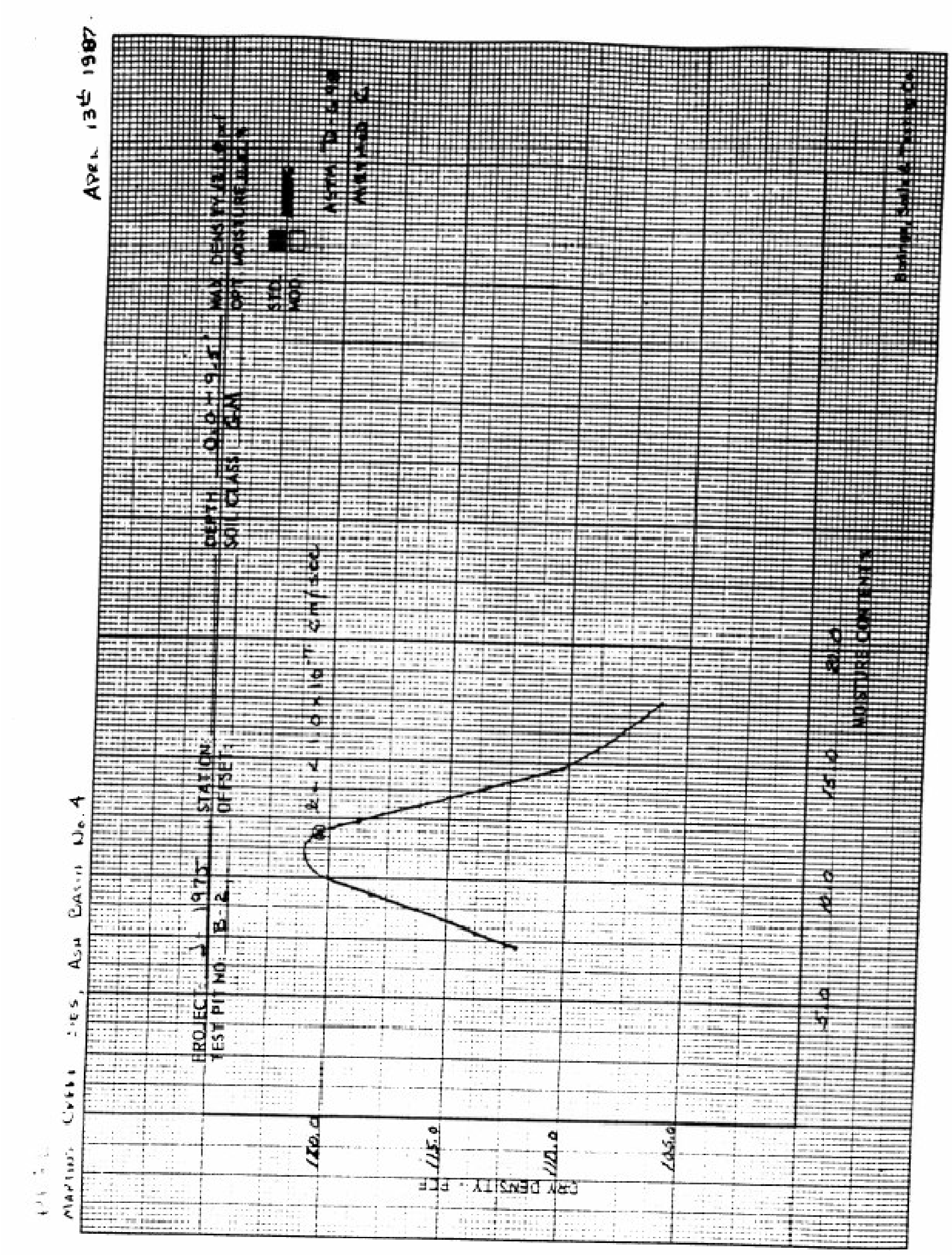
PROJECT Martins Creek
Ash Basin # 4

SAMPLE ID B-2
9.0-10.5'

CLASS. GM	W% 11.29
LL	SP. G.
PL	D_{10} 45.87

LAB NO. J-1975 TESTED BY WFB DATE 5/7/87

DIRECT SHEAR TEST REPORT



PROJECT
TEST PIT NO. B-2
STATION
OFFSET
DEPTH
SOIL CLASS
MAX DENSITY
OPT. MOISTURE
STD.
MOD.
ASTM D-698
METHOD C
DRY DENSITY - PCF
120.0
115.0
110.0
105.0
5.0
10.0
15.0
20.0
MOISTURE CONTENTS

CONSTANT HEAD PERMEABILITY TEST

PROJECT NO.: J-1975

PROJECT: MARTINS CREEK SES
ASH BASIN NO. 4

SAMPLE DESCRIPTION: B-2 ; GM SILTY GRAVEL WITH SAND

LAB NO.:

DRY DENSITY: 120.35 pcf (99.46 % Compaction)

MOISTURE CONTENT: 12.99 (BEFORE)

MOISTURE CONTENT: 14.66 (After)

TOTAL HEAD, h: 73.99 cm

AREA OF SAMPLE, A: 31.07 cm²

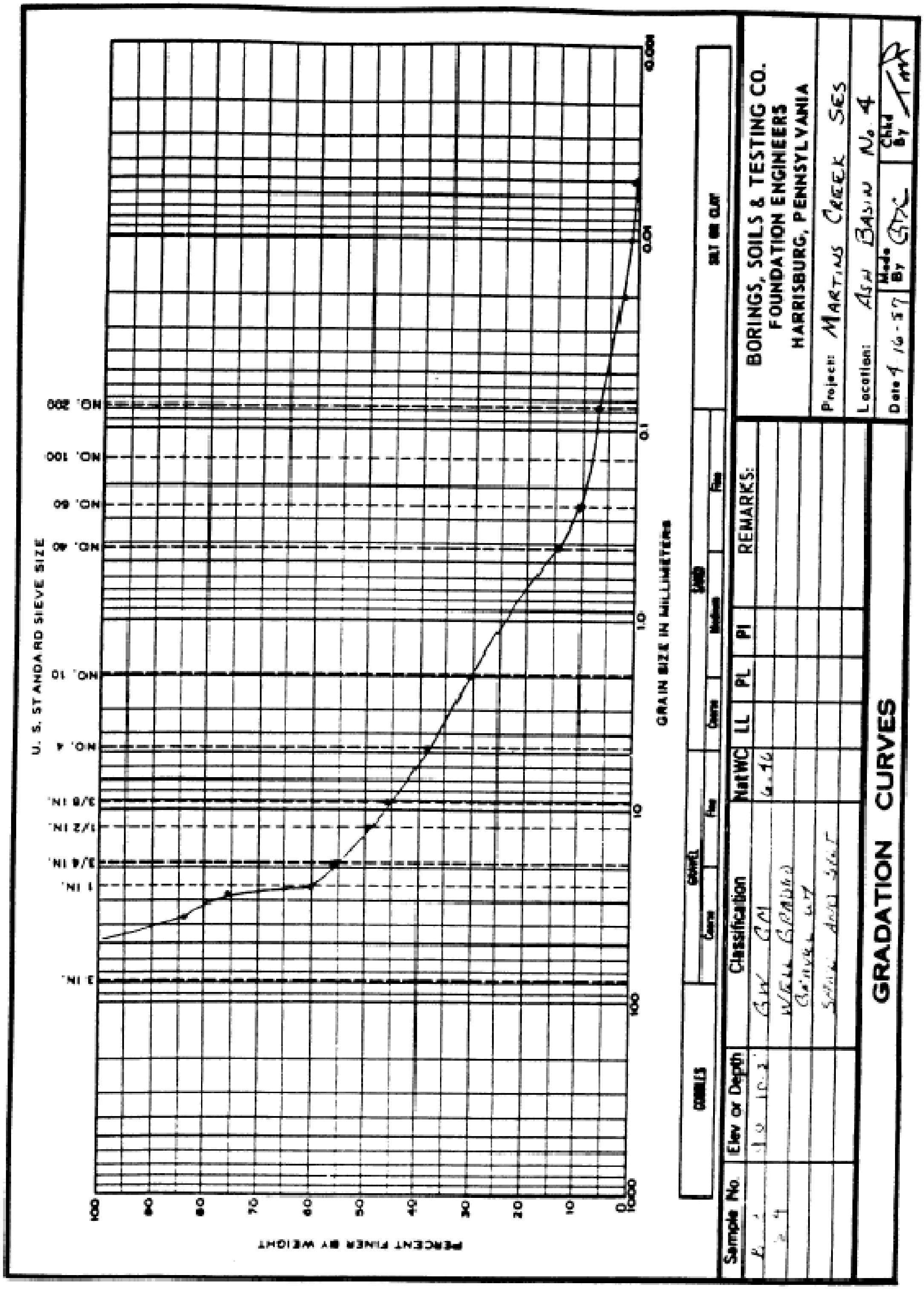
LENGTH OF SAMPLE, L: 11.64 cm

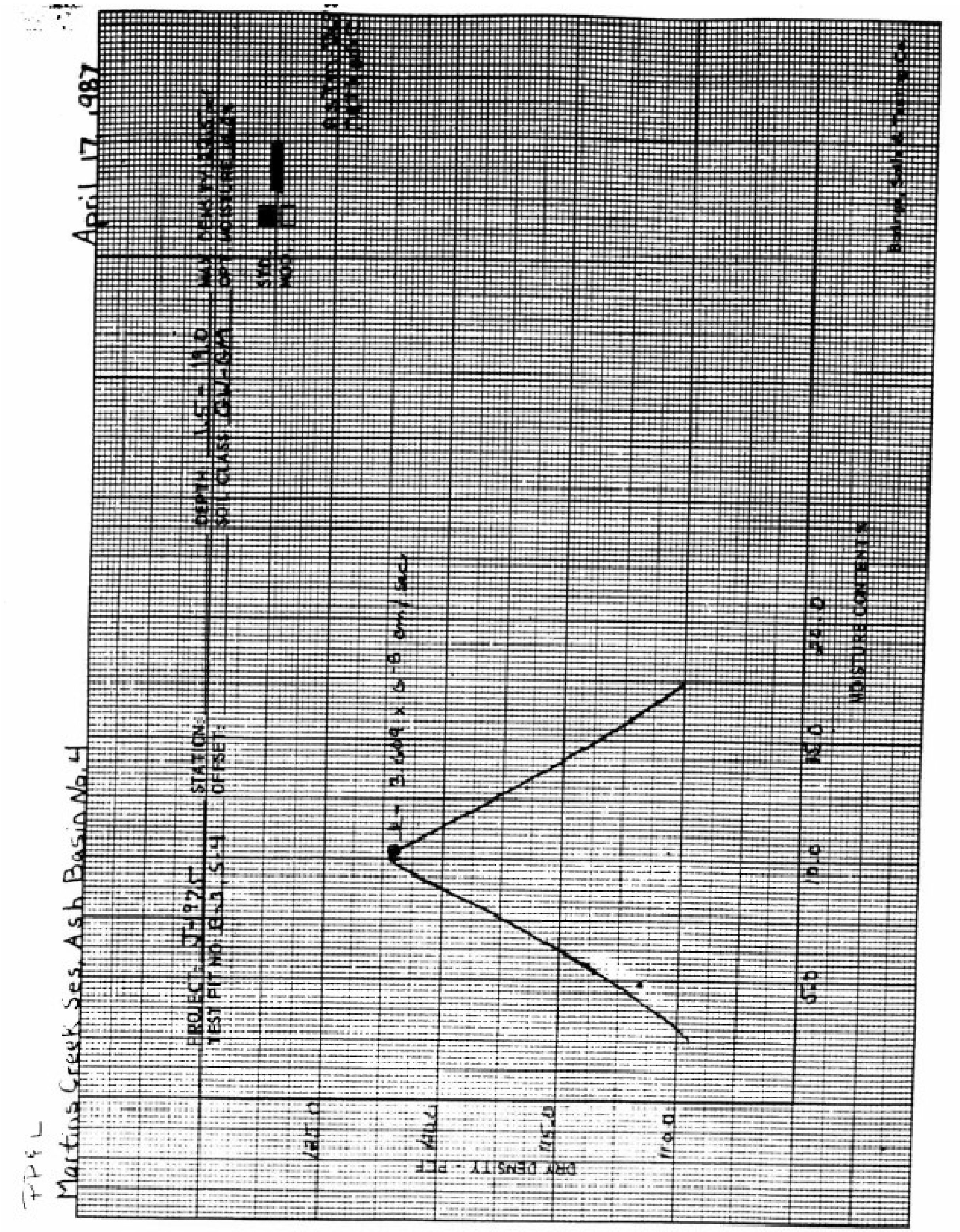
Test No.	Elapsed Time t (sec.)	Flow, Q (cc)	k (cm/sec.)
1	72000 sec	0 cc	< 1.0×10^{-7} cm/sec
2	241,200 sec	0 cc	< 1.0×10^{-7} cm/sec
3			

Average k = < 1.0×10^{-7} cm/sec.

$$k = \frac{QL}{thA}$$

BORINGS, SOILS & TESTING CO.


U. S. STANDARD SIEVE SIZE
3 IN.
1 IN.
3/4 IN.
1/2 IN.
3/8 IN.
NO. 4
NO. 10
NO. 40
NO. 60
NO. 100
NO. 200
PERCENT FINER BY WEIGHT
GRAIN SIZE IN MILLIMETERS
COBBLES
GRAVEL
SAND
SILT OR CLAY
BORINGS, SOILS & TESTING CO.
FOUNDATION ENGINEERS
HARRISBURG, PENNSYLVANIA
Project: MARTINS CREEK SES
Location: ASH BASIN No. 4
Date 4-16-57
Made By GTC
Chkd By
REMARKS:
Sample No.
Elev or Depth
Classification
Nat WC
LL
PL
PI
GW GM
WELL GRADED
GRADATION CURVES


PPL
Martins Creek Ses. Ash Basin No. 4
April 17, 1987
PROJECT:
STATION:
TEST PIT NO.
OFFSET:
DEPTH
SOIL CLASS
MAX. DENSITY
OPT. MOISTURE
STD.
MOD.
MOISTURE CONTENT
DRY DENSITY - PCF

CONSTANT HEAD PERMEABILITY TEST

PROJECT NO.: J- 1975

PROJECT: Martins Creek SES
Ash Basin No. 4

SAMPLE DESCRIPTION: B-3. GW-GM WELL GRADED GRAVEL WITH SAND AND SILT

LAB NO.:

DRY DENSITY: 124.84 (100% compaction)

MOISTURE CONTENT: 10.59% (Before Test.

MOISTURE CONTENT: 11.69% After Test)

TOTAL HEAD, h: 172.72 cm

AREA OF SAMPLE, A: 81.10 cm^2

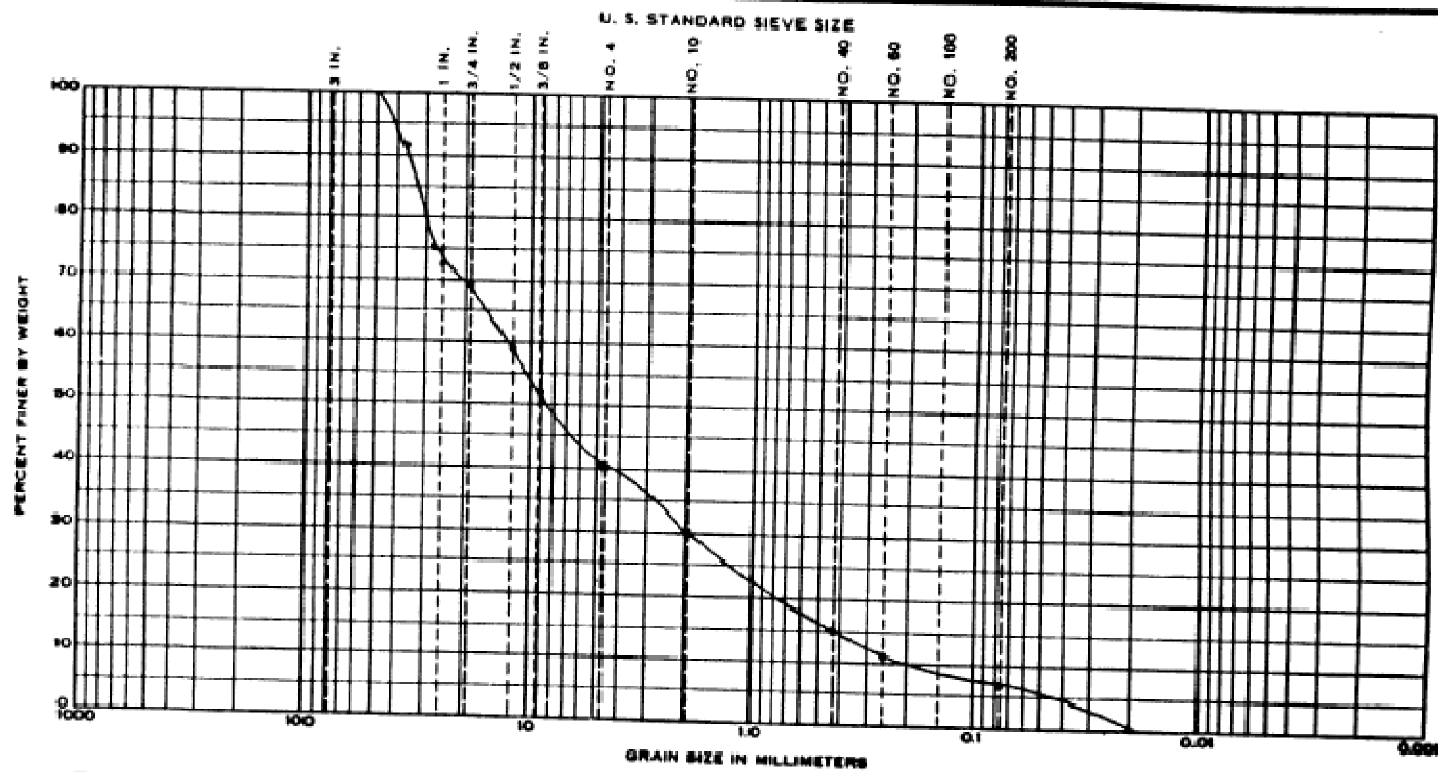
LENGTH OF SAMPLE, L: 11.64 cm

Test No.	Elapsed Time t (sec.)	Flow, Q (cc)	k (cm/sec.)
1	60,840 sec	1 ml	1.366 x 10^{-8} cm
2	85,260 sec	6 ml	5.851 x 10^{-8} cm
3			

Average k = 3.609 x 10^{-8} cm/sec.

$$k = \frac{QL}{thA}$$

BORINGS, SOILS & TESTING CO.

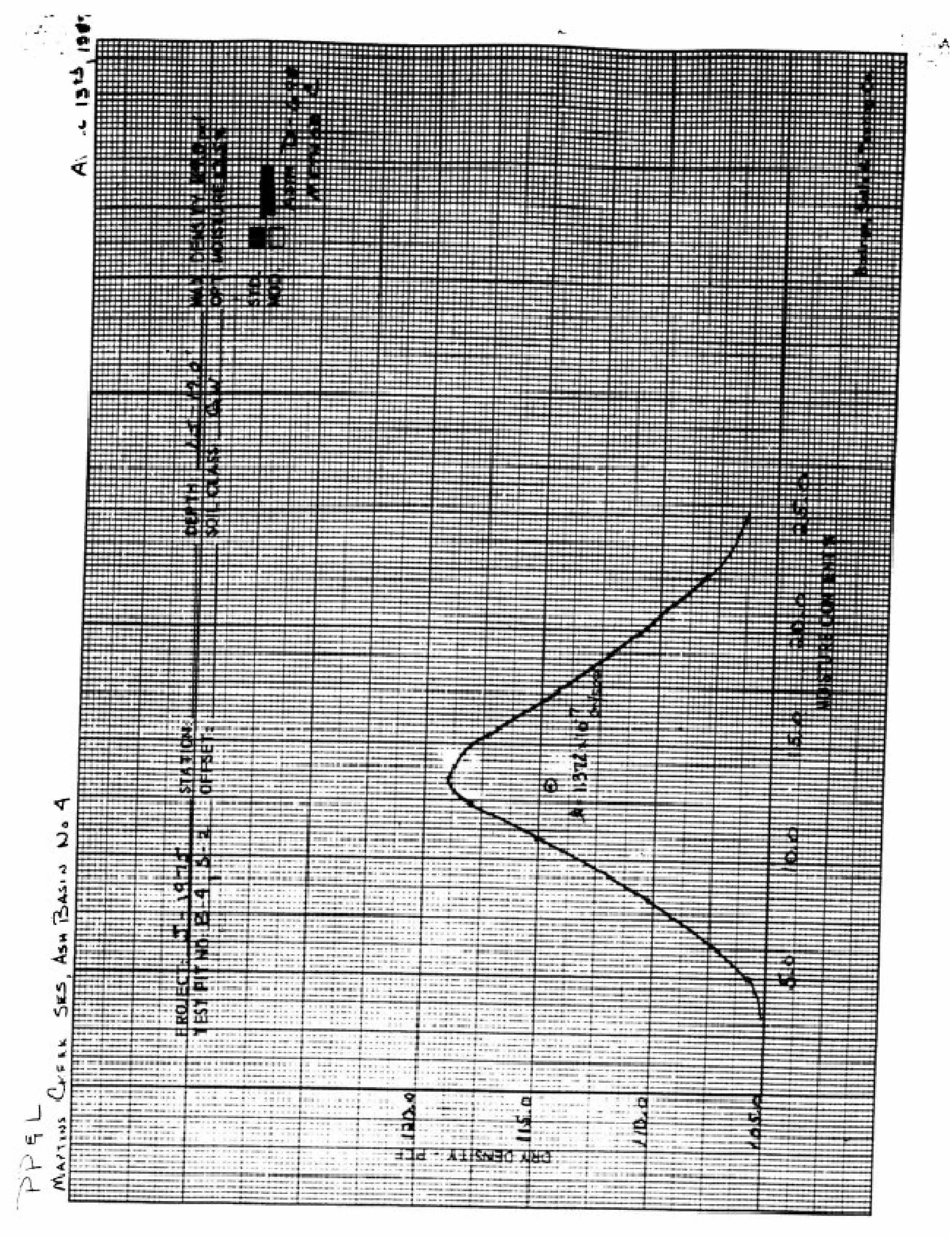


Sample No.	Elev or Depth	Classification	NatWC	LL	PL	PI	REMARKS:
B 4 S 2	35 41.5'	GW - WELL GRADED GRAVEL W/ SAND	8.23				

GRADATION CURVES

BORINGS, SOILS & TESTING CO.
FOUNDATION ENGINEERS
HARRISBURG, PENNSYLVANIA

Project: MARTINS CREEK SES
Location: ASH BASIN No. 4
Date 4-16-87 Made By GDG Chkd By


PP&L
Martins Creek SES, Ash Basin No 4
PROJECT:
TEST PIT NO
STATION:
OFFSET:
DEPTH
SOIL CLASS
MAX DENSITY
OPT MOISTURE
DRY DENSITY - PCF
120.0
115.0
110.0
105.0
5.0
10.0
15.0
20.0
25.0
MOISTURE CONTENT %

CONSTANT HEAD PERMEABILITY TEST

PROJECT NO.: J- 1375

PROJECT: Martins Creek SES
Ash Basin No 4

SAMPLE DESCRIPTION: B-4 GW - Well Graded Gravel with sand

LAB NO.:

DRY DENSITY: 114.62 pcf (96.32% compaction)

MOISTURE CONTENT: 13.10 % (Before)

MOISTURE CONTENT: 16.91 % After test

TOTAL HEAD, h: 173.99 cm

AREA OF SAMPLE, A: 31.07 cm^2

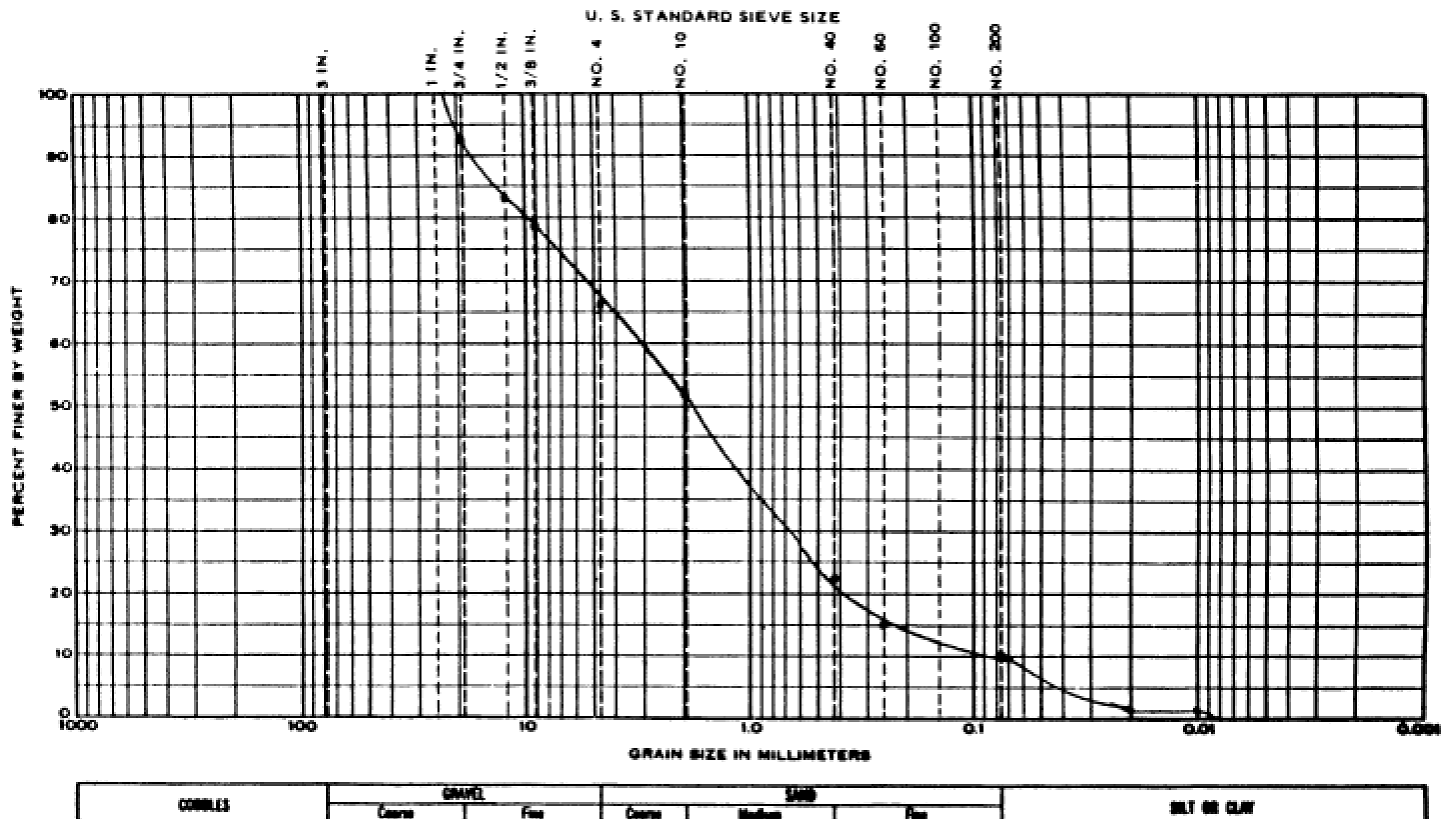
LENGTH OF SAMPLE, L: 4.584 cm

Test No.	Elapsed Time t (sec.)	Flow, Q (cc)	k (cm/sec.)
1	72,000 sec	12 cc	1.375×10^{-7} cm/sec
2	241,200 sec	40 cc	1.369×10^{-7} cm/sec.
3			

Average k = 1.372×10^{-7} cm/sec.

$$k = \frac{QL}{thA}$$

BORINGS, SOILS & TESTING CO.



Sample No.	Elev or Depth	Classification	Nat WC	LL	PL	PI	REMARKS:
B-5	9.0 10.5	GW-GM	9.06				
S 4		WELL GRADED GRAVEL					
		W/ SILT & SAND					

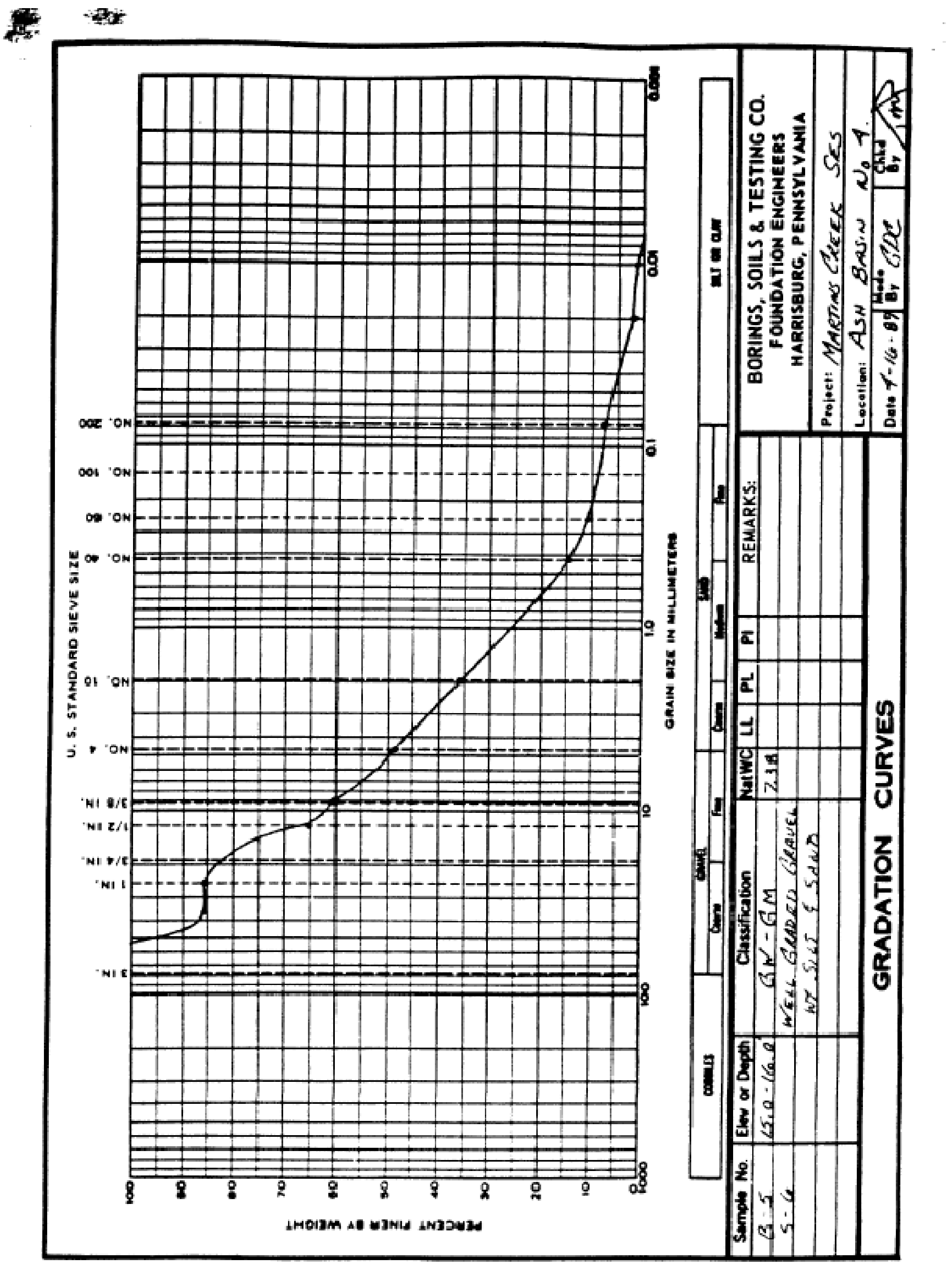
BORINGS, SOILS & TESTING CO.
FOUNDATION ENGINEERS
HARRISBURG, PENNSYLVANIA

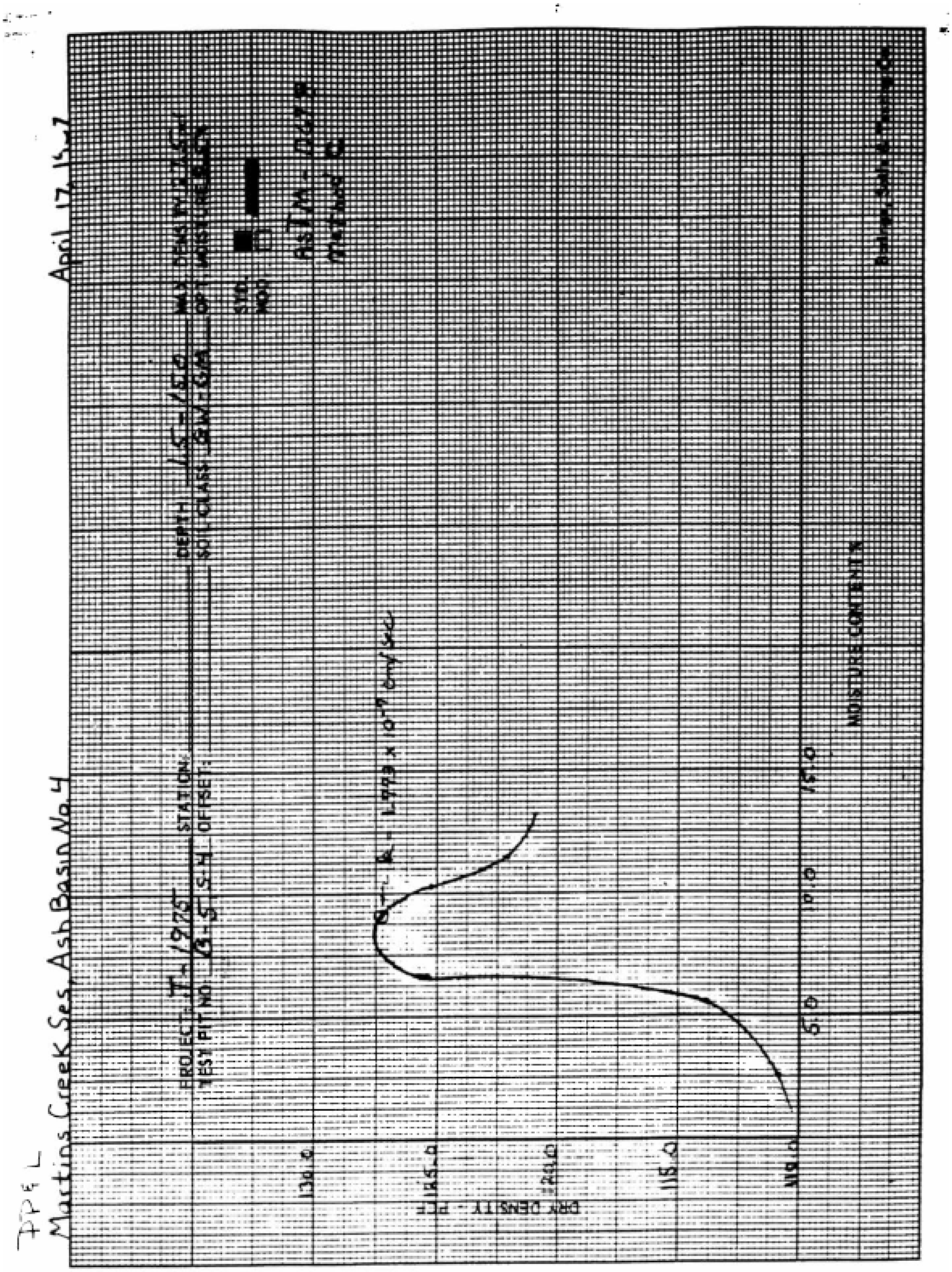
Project: MARTINS CREEK SES

Location: ASH BASIN No. 4

Date 4-16-87 Made By GDC Chkd By

GRADATION CURVES


U. S. STANDARD SIEVE SIZE
GRAIN SIZE IN MILLIMETERS
PERCENT FINER BY WEIGHT
COBBLES
GRAVEL
SAND
SILT OR CLAY
Sample No.
Elev or Depth
Classification
NatWC
LL
PL
PI
REMARKS:
B-5
S-6
15.0-16.0
GW-GM
WELL GRADED GRAVEL
W/ SILT & SAND
7.3%
GRADATION CURVES
BORINGS, SOILS & TESTING CO.
FOUNDATION ENGINEERS
HARRISBURG, PENNSYLVANIA
Project: MARTINS CREEK SES
Location: ASH BASIN No. 4
Date 4-16-89



PP&L
Martins Creek Ses, Ash Basin No. 4
April 17, 1977
PROJECT: T-1975
STATION:
TEST PIT NO. B-5 S-4
OFFSET:
DEPTH: 1.5-15.0
SOIL CLASS: GW-GM
MAX. DENSITY
OPT. MOISTURE
STD.
MOD.
ASTM-D698
Method C
k = 1.773 x 10^-7 cm/sec
130.0
125.0
120.0
115.0
110.0
DRY DENSITY - PCF
5.0
10.0
15.0
MOISTURE CONTENT %

CONSTANT HEAD PERMEABILITY TEST

PROJECT NO.: J-1975

PROJECT: MARTINS CREEK SES
ASH BASIN No 4

SAMPLE DESCRIPTION: B-5, GW-GM WELL GRADED GRAVEL WITH SILT AND SAND

LAB NO.:

DRY DENSITY: 127.88 pcf (100% COMPACTION)

MOISTURE CONTENT: 9.33% (BEFORE TEST)

MOISTURE CONTENT: 9.53% (AFTER TEST)

TOTAL HEAD, h: 152.4 cm.

AREA OF SAMPLE, A: 31.10 cm²

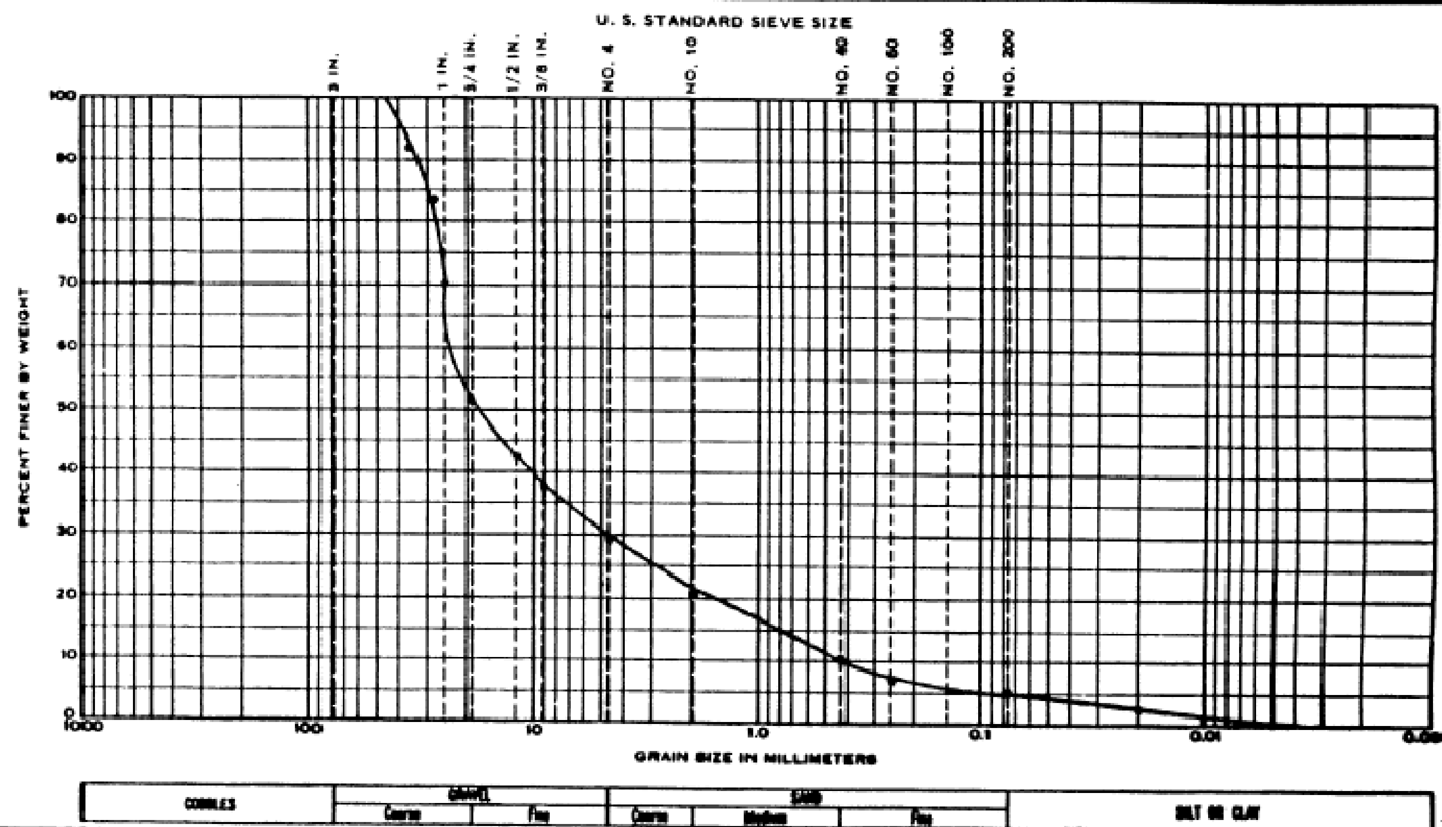
LENGTH OF SAMPLE, L: 11.64 cm

Test No.	Elapsed Time t (sec.)	Flow, Q (cc)	k (cm/sec.)
1	58,800	8.0 cc	1.231×10^{-7}
2	29,100 sec	7.0 cc	2.265×10^{-7}
3			

Average k = 1.773×10^{-7} cm/sec.

$$k = \frac{QL}{thA}$$

BORINGS, SOILS & TESTING CO.

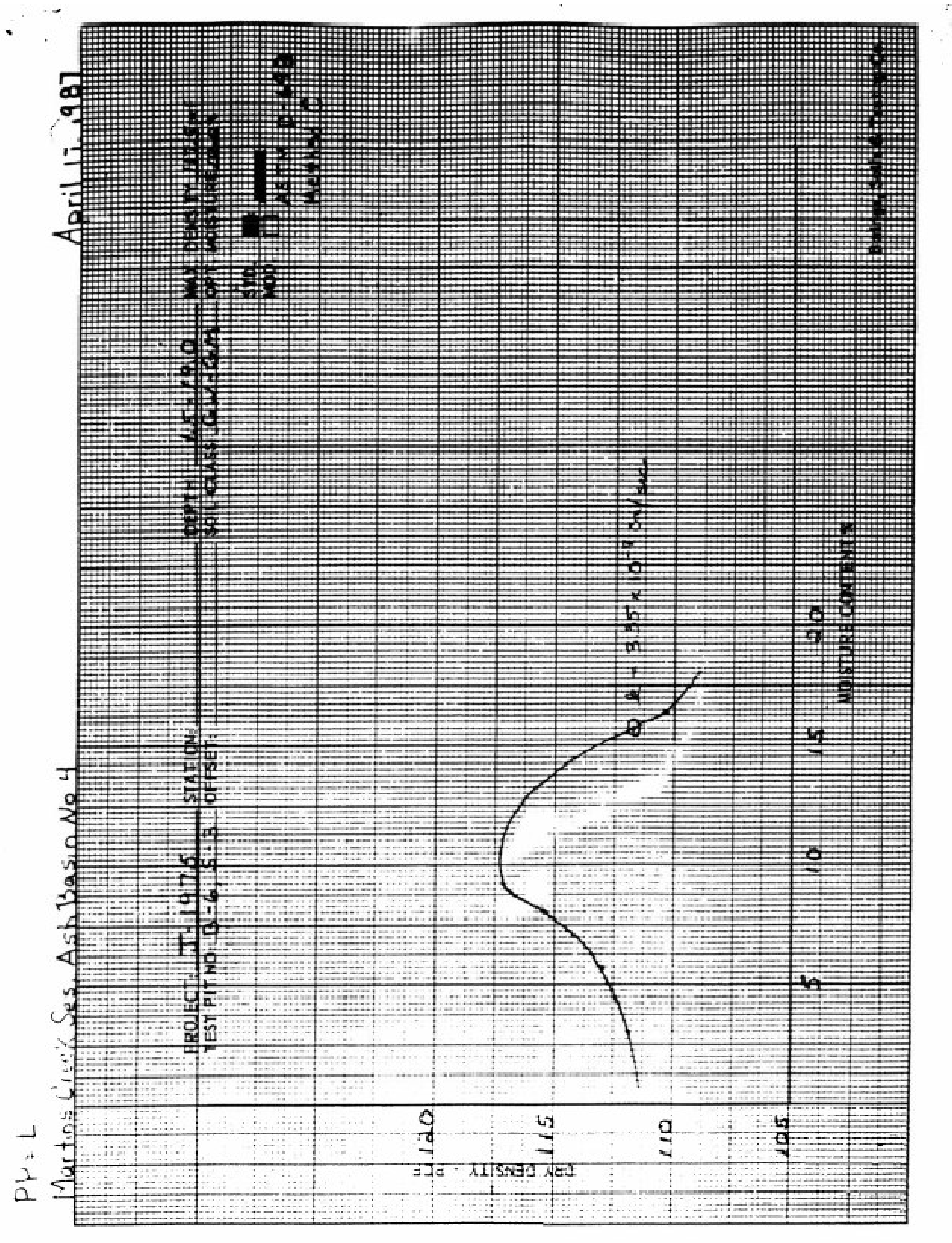


Sample No.	Elev or Depth	Classification	NatWC	LL	PL	PI	REMARKS:
B 6	6.0-7.5'	GM - GW	7.73				
S 3		Well Graded Gravel					
		w/ Silt & Sand					

GRADATION CURVES

BORINGS, SOILS & TESTING CO.
FOUNDATION ENGINEERS
HARRISBURG, PENNSYLVANIA

Project: Martins Creek SES
Location: Ash Basin No 4.
Date 4-16-87 | Made By GDC | Chkd By [illegible]



PP+L
Martins Creek Ses. Ash Basin No 4
April 17, 1987
PROJECT: J-1975
STATION:
TEST PIT NO: B-6, S-3
OFFSET:
DEPTH: 4.5-19.0
SOIL CLASS: GW-GM
MAX. DENSITY
OPT. MOISTURE
STD.
MOD.
ASTM D-698
Method C
k = 3.35 x 10^-7 cm/sec
DRY DENSITY - PCF
120
115
110
105
5
10
15
20
MOISTURE CONTENT %

CONSTANT HEAD PERMEABILITY TEST

PROJECT NO.: J-1905

PROJECT: MARTINS CREEK - SES
ASH BASIN No. 4

SAMPLE DESCRIPTION: B-6 GW-GM, WELL GRADED GRAVEL WITH SILT & SAND

LAB NO.:

DRY DENSITY: 111.37 pcf (95.21% compaction)

MOISTURE CONTENT: 5.73 % (BEFORE TEST)

MOISTURE CONTENT: 17.53 % (AFTER TEST

TOTAL HEAD, h: 152.4 cm

AREA OF SAMPLE, A: 81.10 cm²

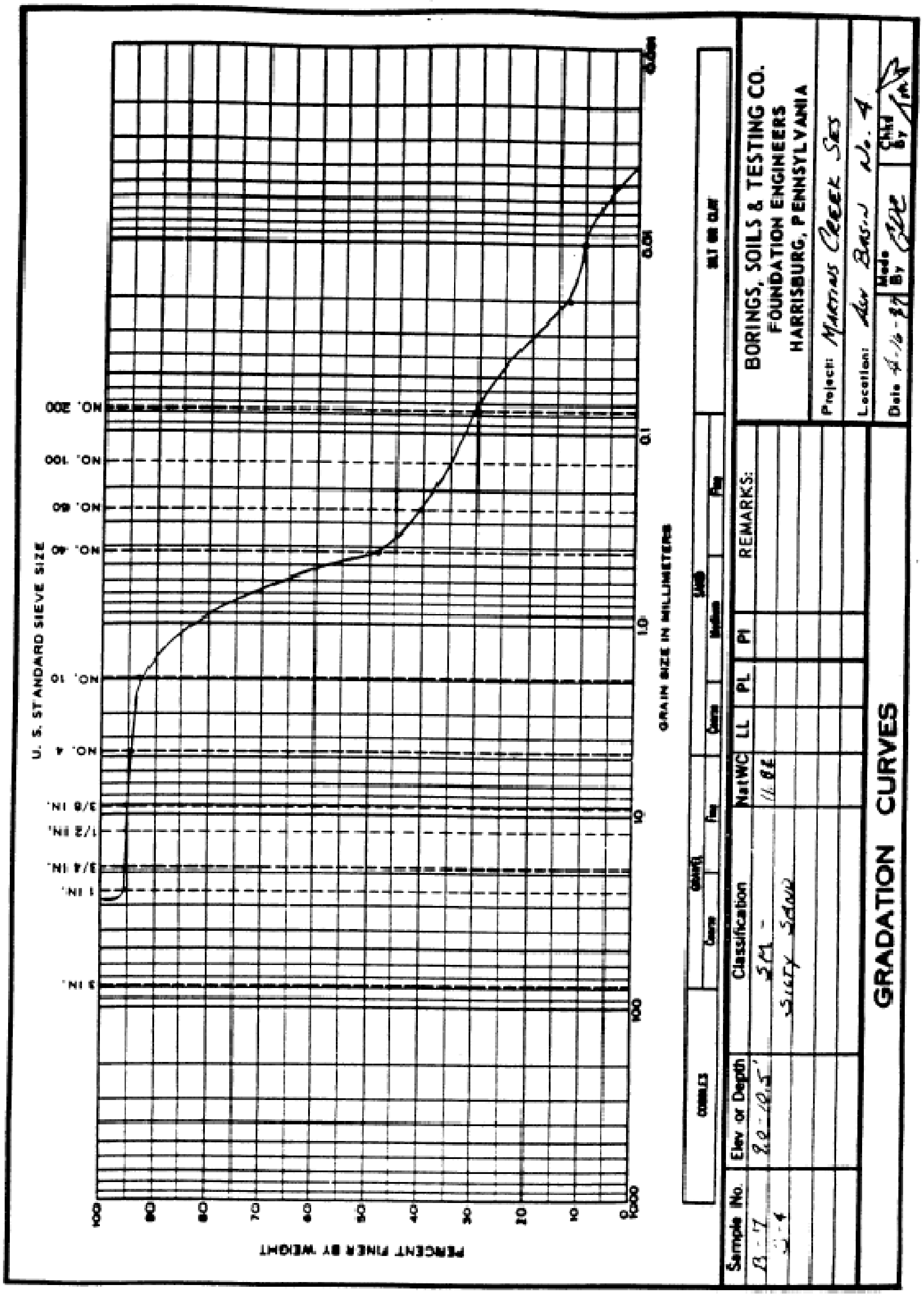
LENGTH OF SAMPLE, L: 11.64 cm

Test No.	Elapsed Time t (sec.)	Flow, Q (cc)	k (cm/sec.)
1	60,340	21.0	2.96×10^{-7}
2	15,060	6.0	3.75×10^{-7}
3			

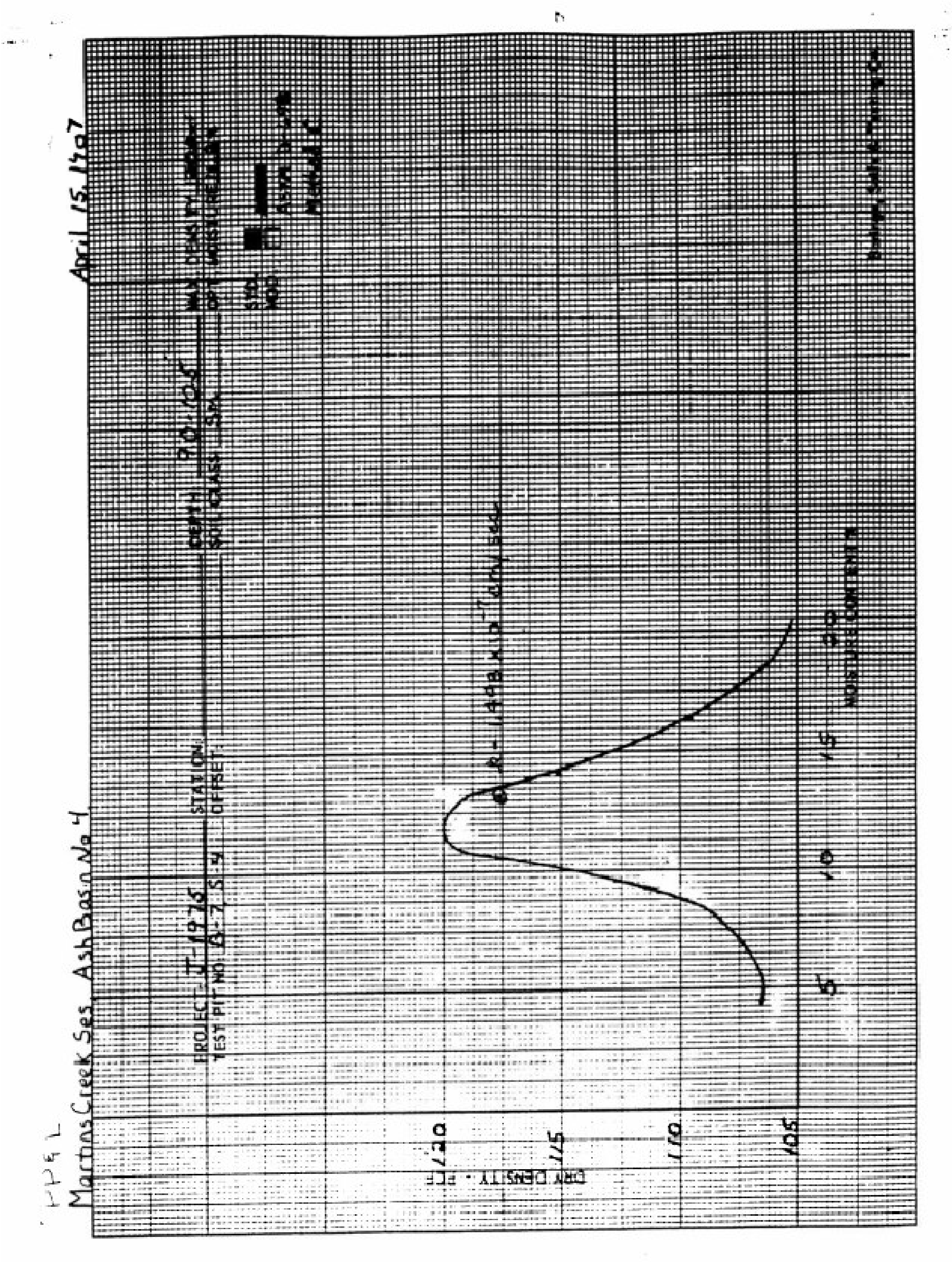
Average k = 3.35×10^{-7} cm/sec.

$$k = \frac{QL}{thA}$$

BORINGS, SOILS & TESTING CO.



BORINGS, SOILS & TESTING CO.
FOUNDATION ENGINEERS
HARRISBURG, PENNSYLVANIA
Project: Martins Creek SES
Location: Ash Basin No. 4
GRADATION CURVES
U. S. STANDARD SIEVE SIZE
3 IN. 1 IN. 3/4 IN. 1/2 IN. 3/8 IN. NO. 4 NO. 10 NO. 40 NO. 60 NO. 100 NO. 200
GRAIN SIZE IN MILLIMETERS
1000 100 10 1.0 0.1 0.01 0.001
PERCENT FINER BY WEIGHT
100 90 80 70 60 50 40 30 20 10 0
COBBLES GRAVEL Coarse Fine SAND Coarse Medium Fine SILT OR CLAY
Sample No. | Elev or Depth | Classification | NatWC | LL | PL | PI | REMARKS:
B-7 S-4 | 9.0-10.5' | SM - Silty Sand | 11.88



Martins Creek Ses, Ash Basin No 4
PROJECT
TEST PIT NO.
STATION
OFFSET
DEPTH
SOIL CLASS
MAX. DENSITY
OPT. MOISTURE
DRY DENSITY - PCF
MOISTURE CONTENT %
120
115
110
105
5
10
15
20

CONSTANT HEAD PERMEABILITY TEST

PROJECT NO.: J-1975

PROJECT: Martins Creek SES
Ash Basin No 4

SAMPLE DESCRIPTION: B-7, 0.0'-12.5', SM- Silty Sand

LAB NO.: J-1975

DRY DENSITY: 117.64 pcf (98% compaction)

MOISTURE CONTENT: 3.17% (Before Test)

MOISTURE CONTENT: [illegible] % [illegible]

TOTAL HEAD, h: 152.4 cm

AREA OF SAMPLE, A: 81.10 cm²

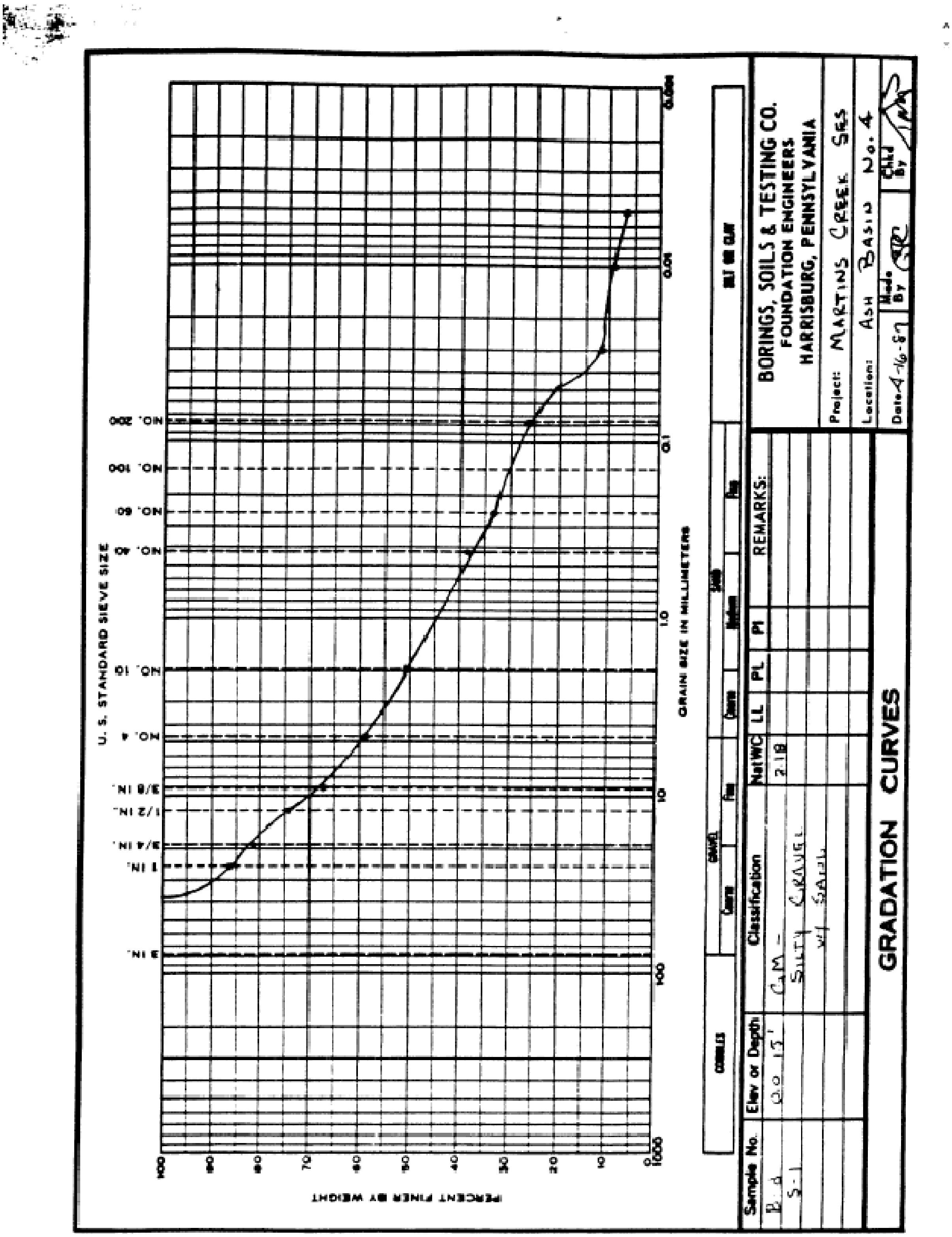
LENGTH OF SAMPLE, L: 11.64 cm

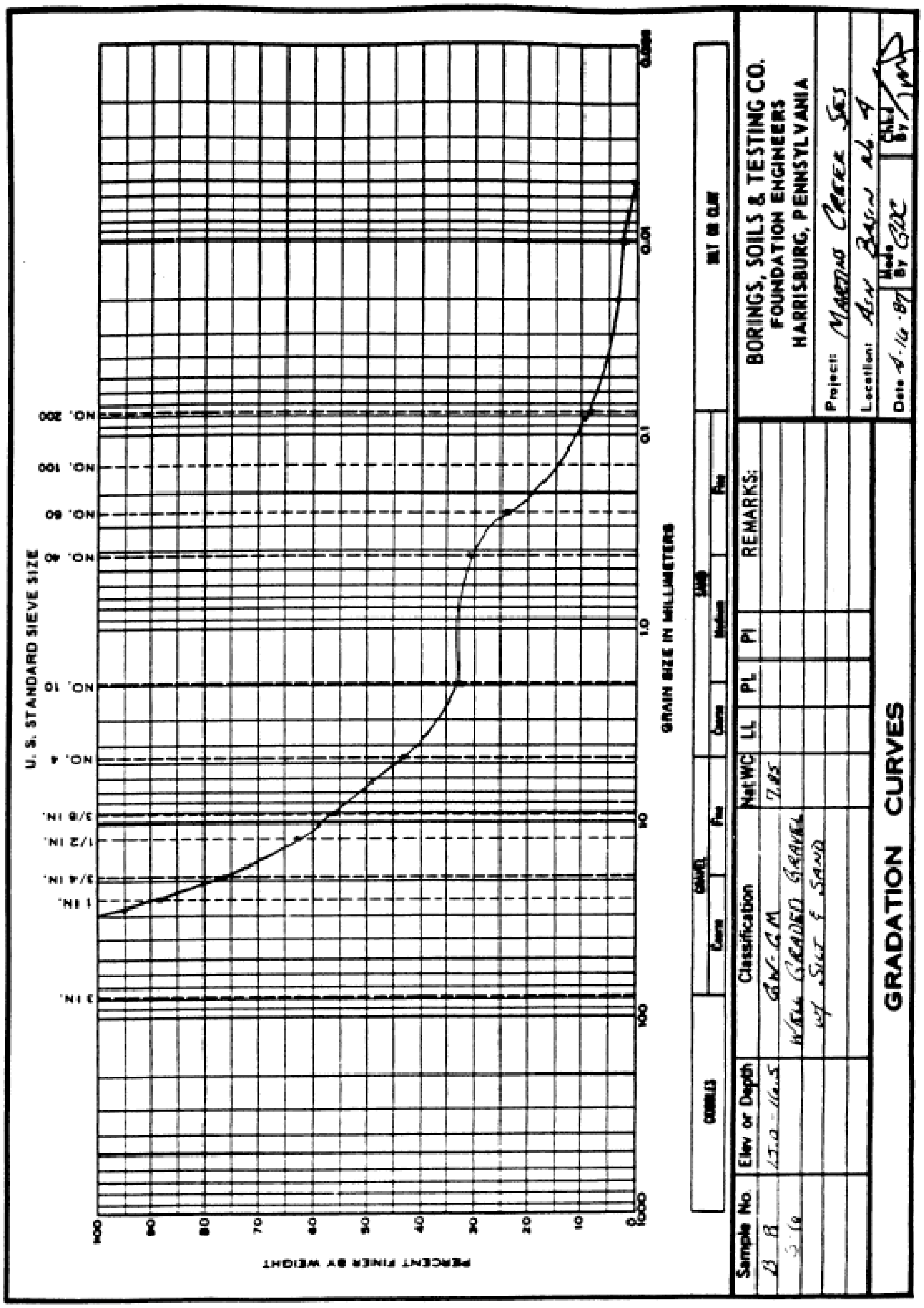
Test No.	Elapsed Time t (sec.)	Flow, Q (cc)	k (cm/sec.)
1	72,000 sec.	8 ml	1.046×10^{-7} cm/sec
2	241,200 sec	50 ml.	1.95×10^{-7} cm/sec
3			

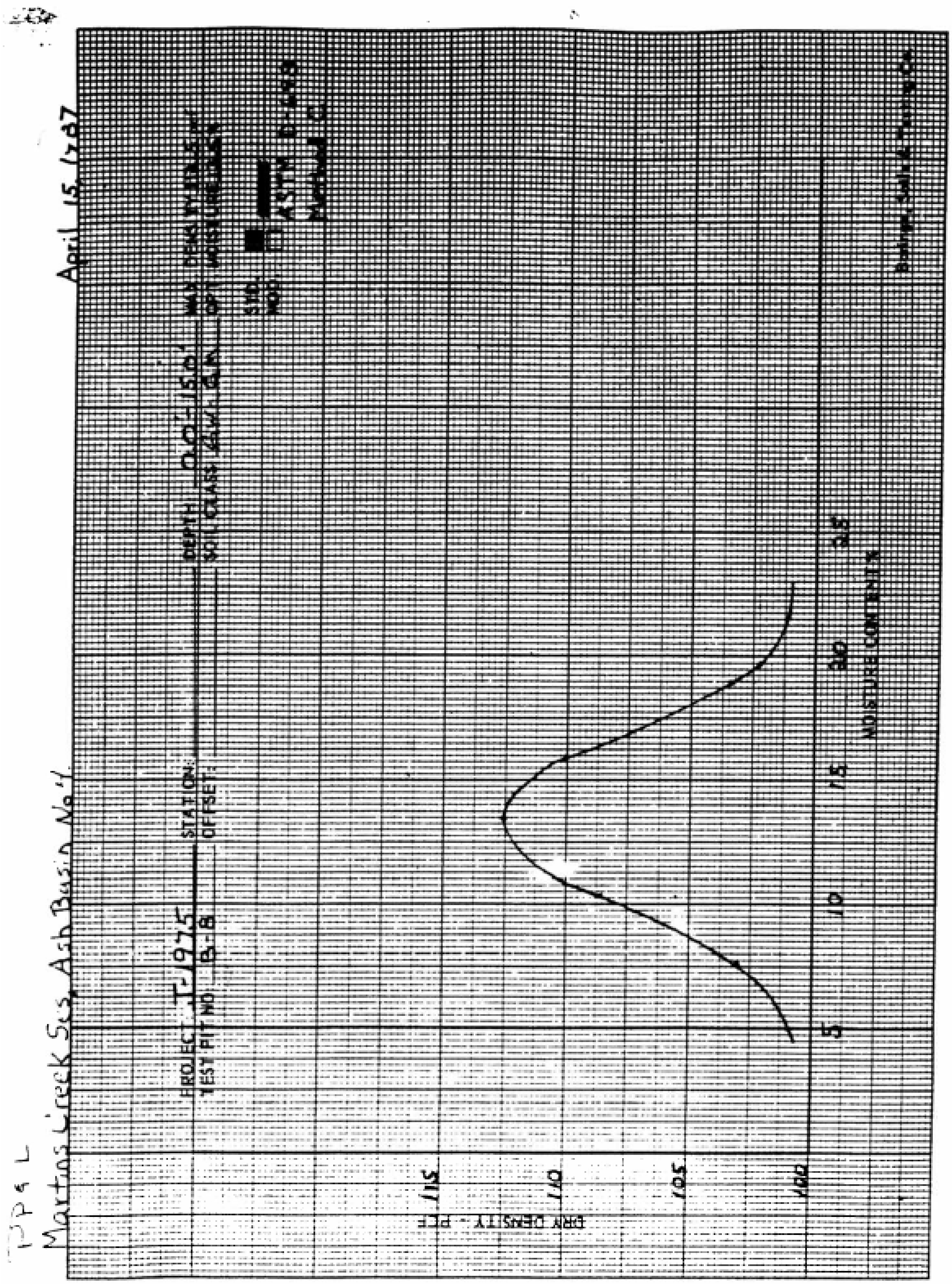
Average k = 1.498×10^{-7} cm/sec.

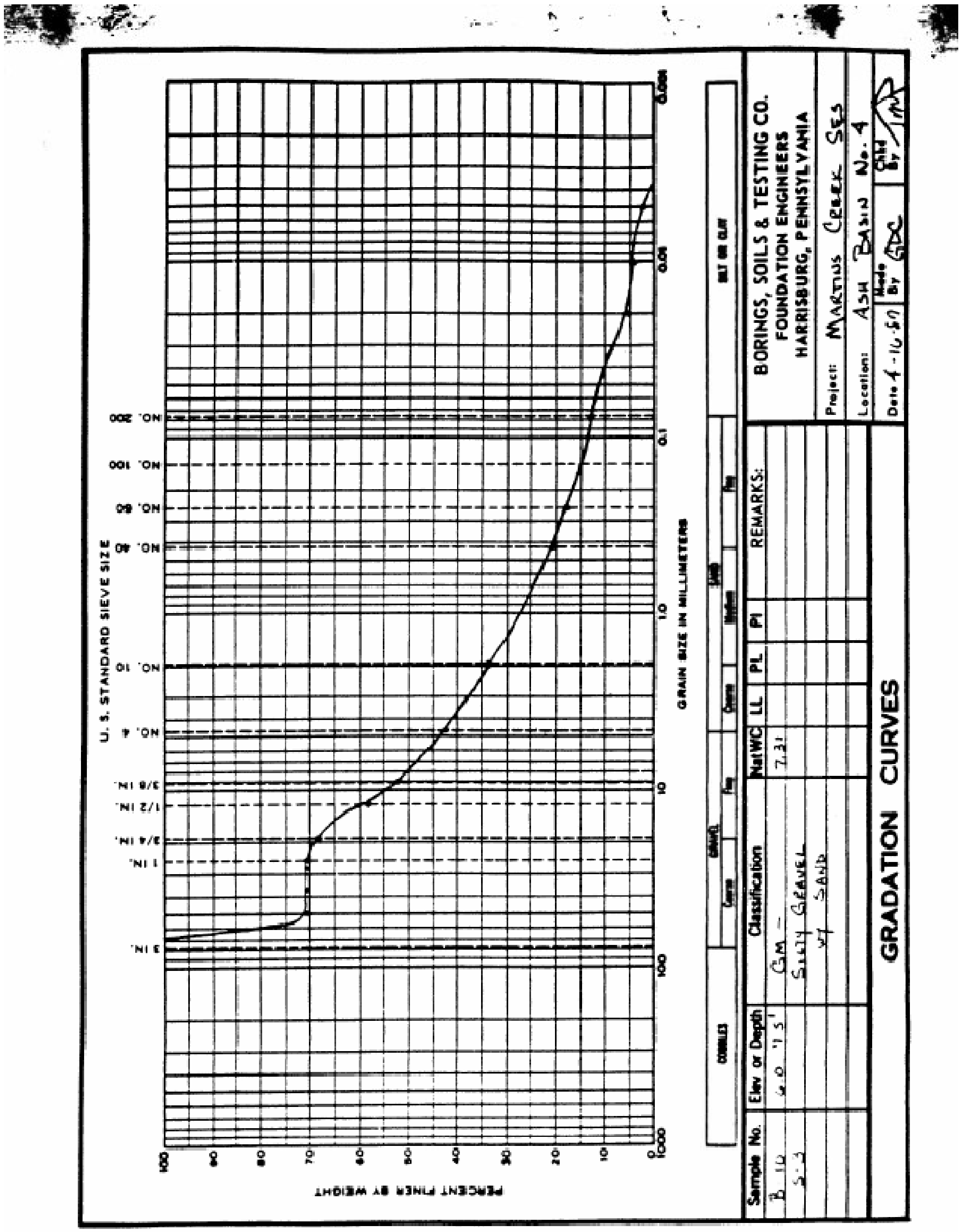
$$k = \frac{QL}{thA}$$

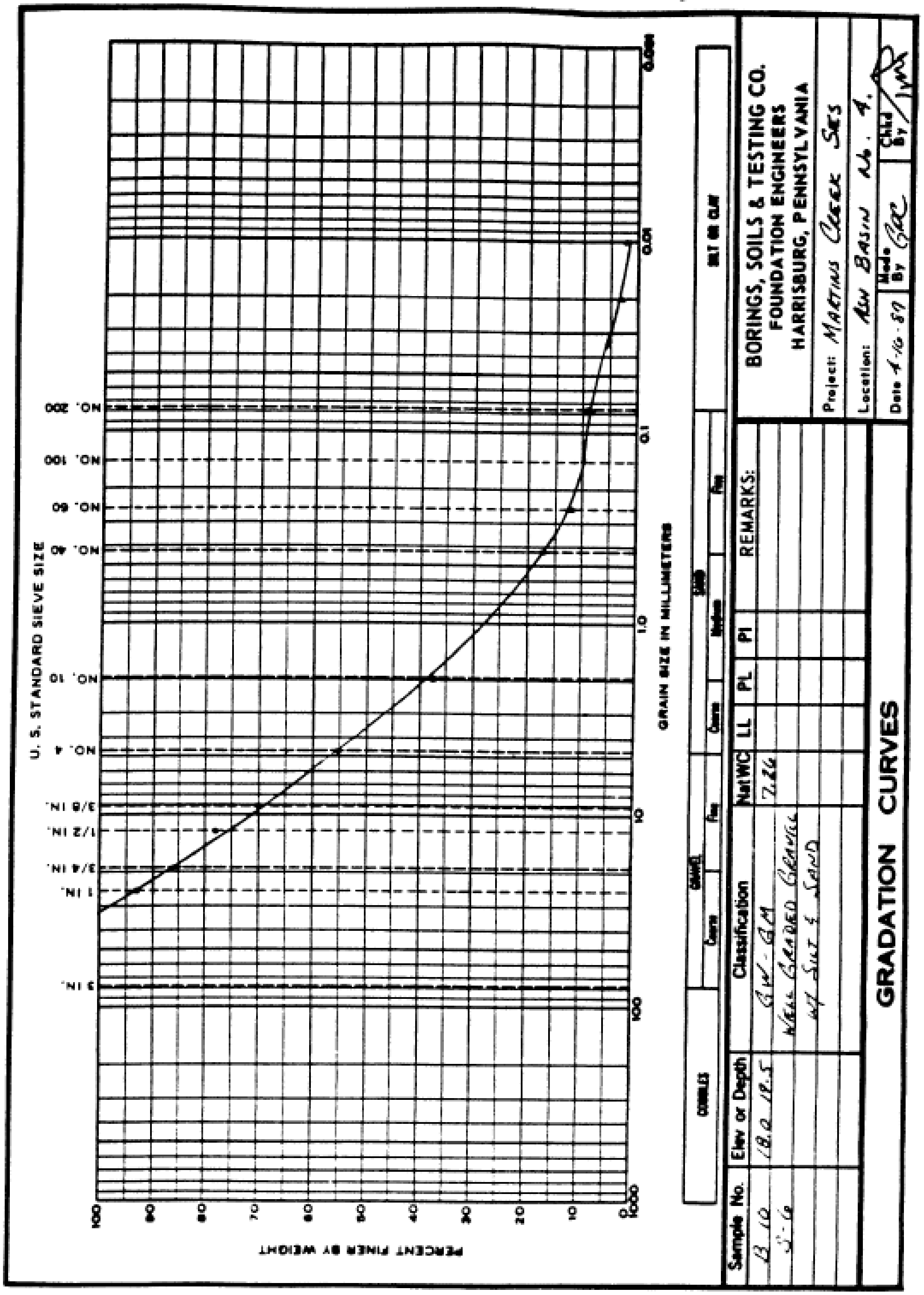
BORINGS, SOILS & TESTING CO.

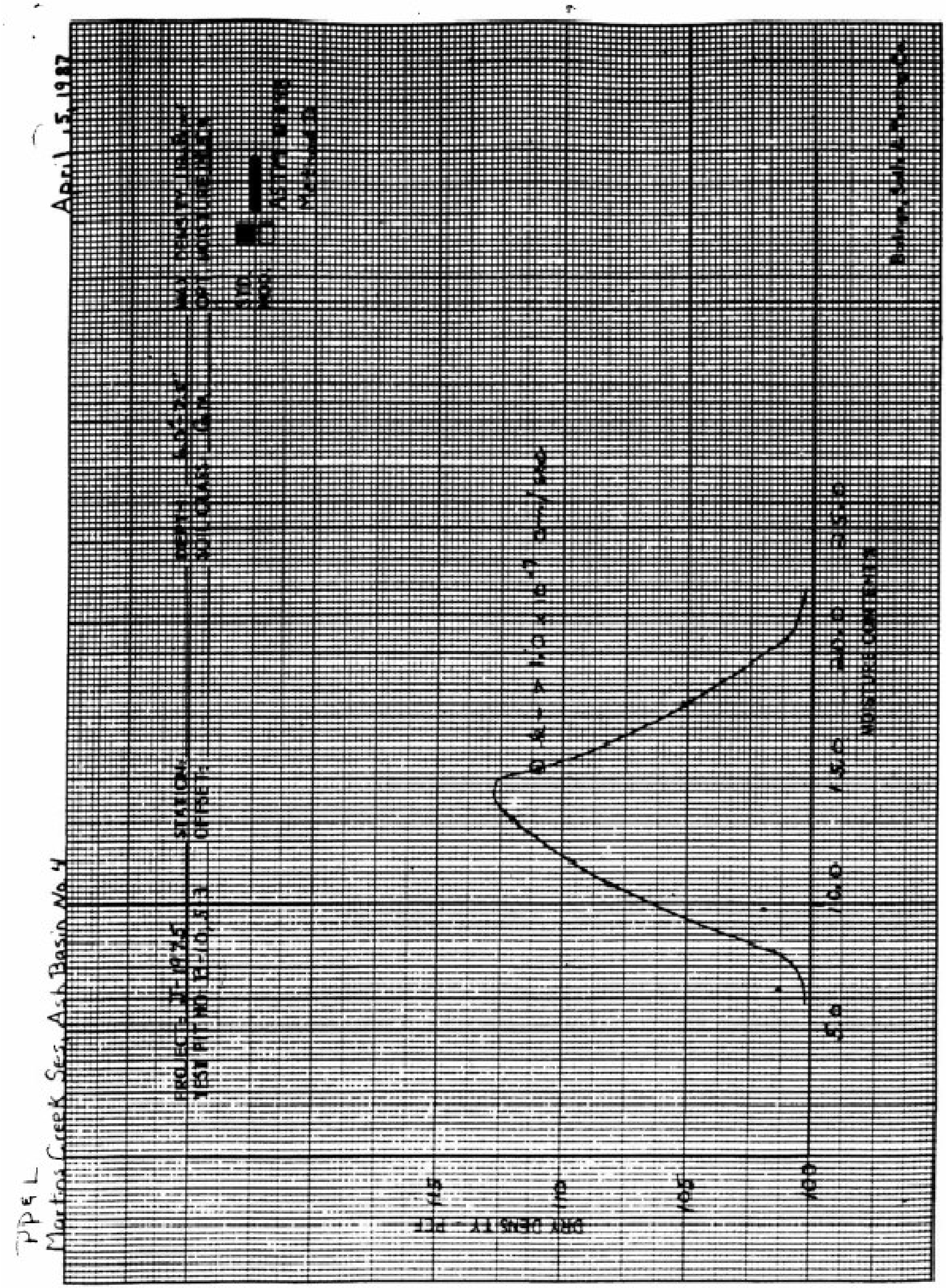

U. S. STANDARD SIEVE SIZE
3 IN.
1 IN.
3/4 IN.
1/2 IN.
3/8 IN.
NO. 4
NO. 10
NO. 40
NO. 60
NO. 100
NO. 200
PERCENT FINER BY WEIGHT
100
90
80
70
60
50
40
30
20
10
0
1000
100
10
1.0
0.1
0.01
0.001
GRAIN SIZE IN MILLIMETERS
COBBLES
GRAVEL
SAND
SILT OR CLAY
REMARKS:
Sample No.
Elev or Depth
Classification
Nat WC
LL
PL
PI
B-4
S-1
0.0-1.5'
GM -
Silty Gravel
w/ Sand
2.18
BORINGS, SOILS & TESTING CO.
FOUNDATION ENGINEERS
HARRISBURG, PENNSYLVANIA
Project: Martins Creek SES
Location: Ash Basin No. 4
Date 4-16-87
Made By
Chk'd By
GRADATION CURVES


U. S. STANDARD SIEVE SIZE
3 IN.
1 IN.
3/4 IN.
1/2 IN.
3/8 IN.
NO. 4
NO. 10
NO. 40
NO. 60
NO. 100
NO. 200
PERCENT FINER BY WEIGHT
GRAIN SIZE IN MILLIMETERS
1000
100
10
1.0
0.1
0.01
COBBLES
GRAVEL
Coarse
Fine
SAND
Coarse
Medium
Fine
SILT OR CLAY
Sample No.
Elev or Depth
Classification
Nat WC
LL
PL
PI
REMARKS:
B 8
S-10
13.0 - 16.5
GW-GM
WELL GRADED GRAVEL
W/ SILT & SAND
7.85
GRADATION CURVES
BORINGS, SOILS & TESTING CO.
FOUNDATION ENGINEERS
HARRISBURG, PENNSYLVANIA
Project: MARTINS CREEK SES
Location: ASH BASIN NO. 4
Date 4-14-87
Made By GDC
Chk'd By


PP&L
Martins Creek SES, Ash Basin No. 4
April 15, 1987
PROJECT T-975
TEST PIT NO. B-8
STATION
OFFSET
DEPTH 0.0'-15.0'
MAX. DENSITY
OPT. MOISTURE
ASTM D-698
DRY DENSITY - PCF
115
110
105
100
MOISTURE CONTENT %
5
10
15
20
25


U. S. STANDARD SIEVE SIZE
3 IN.
1 IN.
3/4 IN.
1/2 IN.
3/8 IN.
NO. 4
NO. 10
NO. 40
NO. 60
NO. 100
NO. 200
PERCENT FINER BY WEIGHT
GRAIN SIZE IN MILLIMETERS
COBBLES
GRAVEL
Coarse
Fine
SAND
Coarse
Medium
Fine
SILT OR CLAY
Sample No.
Elev or Depth
Classification
Nat WC
LL
PL
PI
REMARKS:
GM -
Silty Gravel
w/ Sand
BORINGS, SOILS & TESTING CO.
FOUNDATION ENGINEERS
HARRISBURG, PENNSYLVANIA
Project: Martins Creek SES
Location: Ash Basin No. 4
Date
Made By
Chk'd By
GRADATION CURVES


U. S. STANDARD SIEVE SIZE
3 IN.
1 IN.
3/4 IN.
1/2 IN.
3/8 IN.
NO. 4
NO. 10
NO. 40
NO. 60
NO. 100
NO. 200
PERCENT FINER BY WEIGHT
100
90
80
70
60
50
40
30
20
10
0
1000
100
10
1.0
0.1
0.01
0.001
GRAIN SIZE IN MILLIMETERS
COBBLES
GRAVEL
Coarse
Fine
SAND
Coarse
Medium
Fine
SILT OR CLAY
Sample No.
Elev or Depth
Classification
Nat WC
LL
PL
PI
REMARKS:
B 10
S-6
18.0 19.5
GW-GM
WELL GRADED GRAVEL
w/ SILT & SAND
7.26
BORINGS, SOILS & TESTING CO.
FOUNDATION ENGINEERS
HARRISBURG, PENNSYLVANIA
Project: MARTINS CREEK SES
Location: ASH BASIN No. 4
Date 4-16-89
Made By GAC
Chk'd By
GRADATION CURVES


PP&L
Martins Creek SES, Ash Basin No. 4
April 15, 1987
PROJECT:
TEST PIT NO.
STATION:
OFFSET:
DEPTH:
SOIL CLASS:
DRY DENSITY - PCF
115
110
105
100
5.0
10.0
15.0
20.0
25.0
MOISTURE CONTENT %

CONSTANT HEAD PERMEABILITY TEST

PROJECT NO.: J-1975

PROJECT: MARTINS CREEK SES
ASH BASIN NO. 4

SAMPLE DESCRIPTION: B-10, GM SILTY GRAVEL WITH SAND

LAB NO.:

DRY DENSITY: 111.05 pcf (93.45 % COMPACTION)

MOISTURE CONTENT: [illegible] 25 % (BEFORE TEST)

MOISTURE CONTENT: [illegible] (AFTER TEST)

TOTAL HEAD, h: [illegible] cm

AREA OF SAMPLE, A: [illegible] cm^2

LENGTH OF SAMPLE, L: 11.[illegible]4 cm

Test No.	Elapsed Time t (sec.)	Flow, Q (cc)	k (cm/sec.)
1	59,700 sec	1 cc	1.392×10^{-8} cm/sec
2	90,300 sec	0 cc	$> 1.0 \times 10^{-7}$ cm/sec
3			

Average k = $> 1.0 \times 10^{-7}$ cm/sec.

$$k = \frac{QL}{thA}$$

BORINGS, SOILS & TESTING CO.

CLIENT PP & L

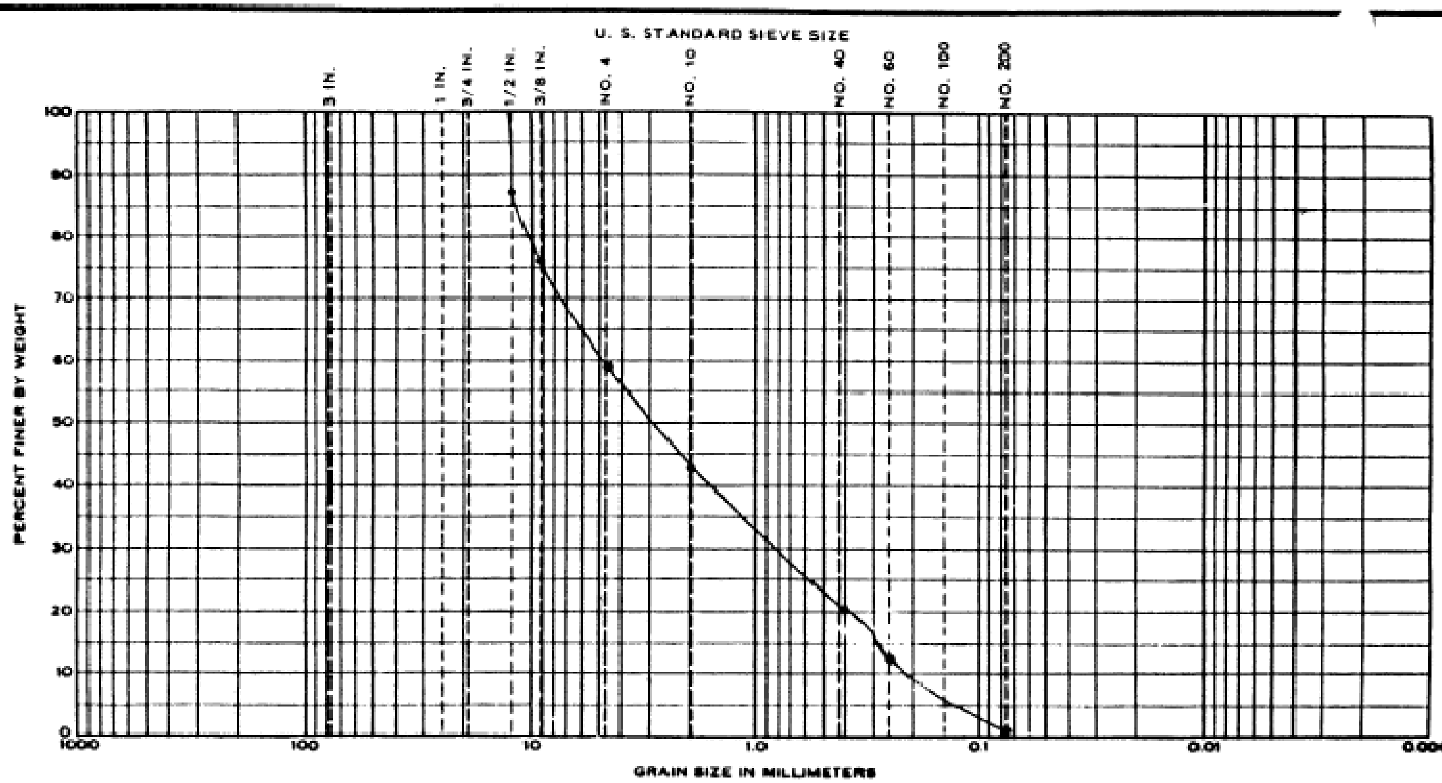
PROJECT Martins Creek SES [illegible]

	BORING NO.	SAMPLE NO.	SAMPLE DEPTH	UNIFIED CLASSIFICATION	Wn	L.L.	P.I.	% FINER 3/4 in.	% FINER # 4	% FINER # 10	% FINER # 40	% FINER # 200	% FINER 0.02 MM	% FINER 0.005 MM	COMPACT. OPT. % W	COMPACT. MAX. DENSITY	Gs	NOTES
143	mc-1	SS-4	15.5' – 17.5'	—	6.96	—		100.0	58.50	42.81	28.24	10.50					—	
143	mc-2	SS-2	[illegible] – 9.5'		[illegible]			[illegible]	99.24	[illegible]	[illegible]	62.13	42.65	20.17			—	
143	mc-3	SS-3	[illegible] – 12.5'	—	[illegible]			91.41	65.51	[illegible]	13.47	.41	—	—			—	
143	mc-4	SS-4, 5	15.5' – 15.5' [illegible]	SM	9.8	NP	NP	84.[illegible]	[illegible]	[illegible]	[illegible]	12.30	7.68	4.43	10.50	[illegible]	2.70	
143	mc-4	SS-7, 8, 1	35.0' – 37.0' 40.0' – 42.0' [illegible]	CL	17.40	26.50	7.10	95.66	84.07	79.40	70.44	[illegible]	46.13	18.17	15.50	114.[illegible]	2.78	
143	mc-4	SS-12, 14	50.0' – 57.0' 55.0' – 51.0'	ML	15.94	NP	NP	100.0	98.63	96.27	94.07	62.36	25.61	12.[illegible]	[illegible]	118.50	2.79	

[illegible]RINGS, SOILS & TESTING COMPANY

SOIL TESTING SUMMARY

SH. ____ OF ____



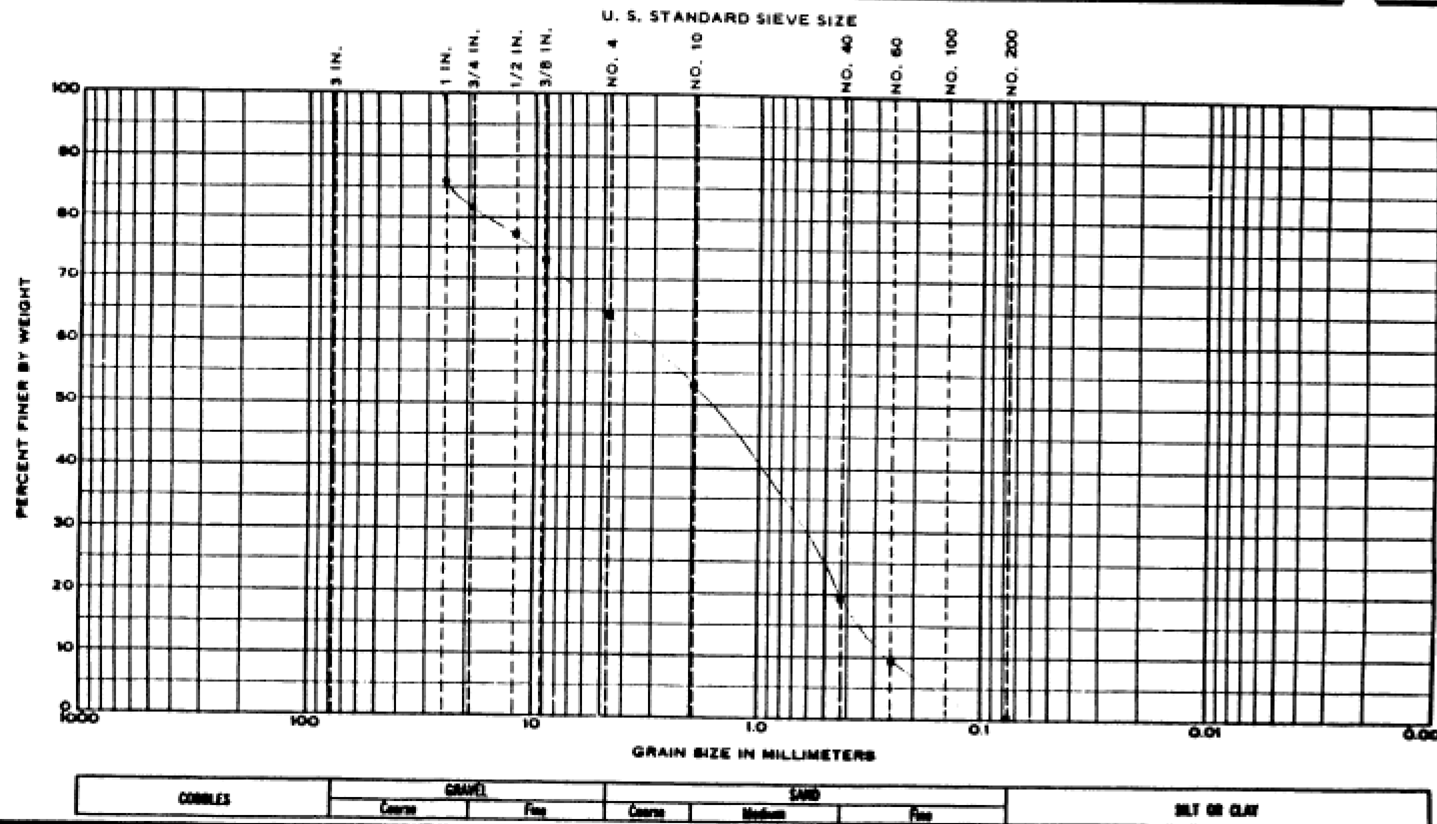
COBBLES	GRAVEL		SAND			SILT OR CLAY
	Coarse	Fine	Coarse	Medium	Fine	

Sample No.	Elev or Depth	Classification	Nat WC	LL	PL	PI	REMARKS:
MC-1, SS-4	15.5'-17.5'		6.9%				

GRADATION CURVES

BORINGS, SOILS & TESTING CO.
FOUNDATION ENGINEERS
HARRISBURG, PENNSYLVANIA

Project: Martins Creek SES, L-143
Location: Ash Basin No. 4
Date 9/25/86 Made By CH Chkd By



Sample No.	Elev or Depth	Classification	NatWC	LL	PL	PI	REMARKS:
MC-3, SS-3	16.5-12.5'		d.70				

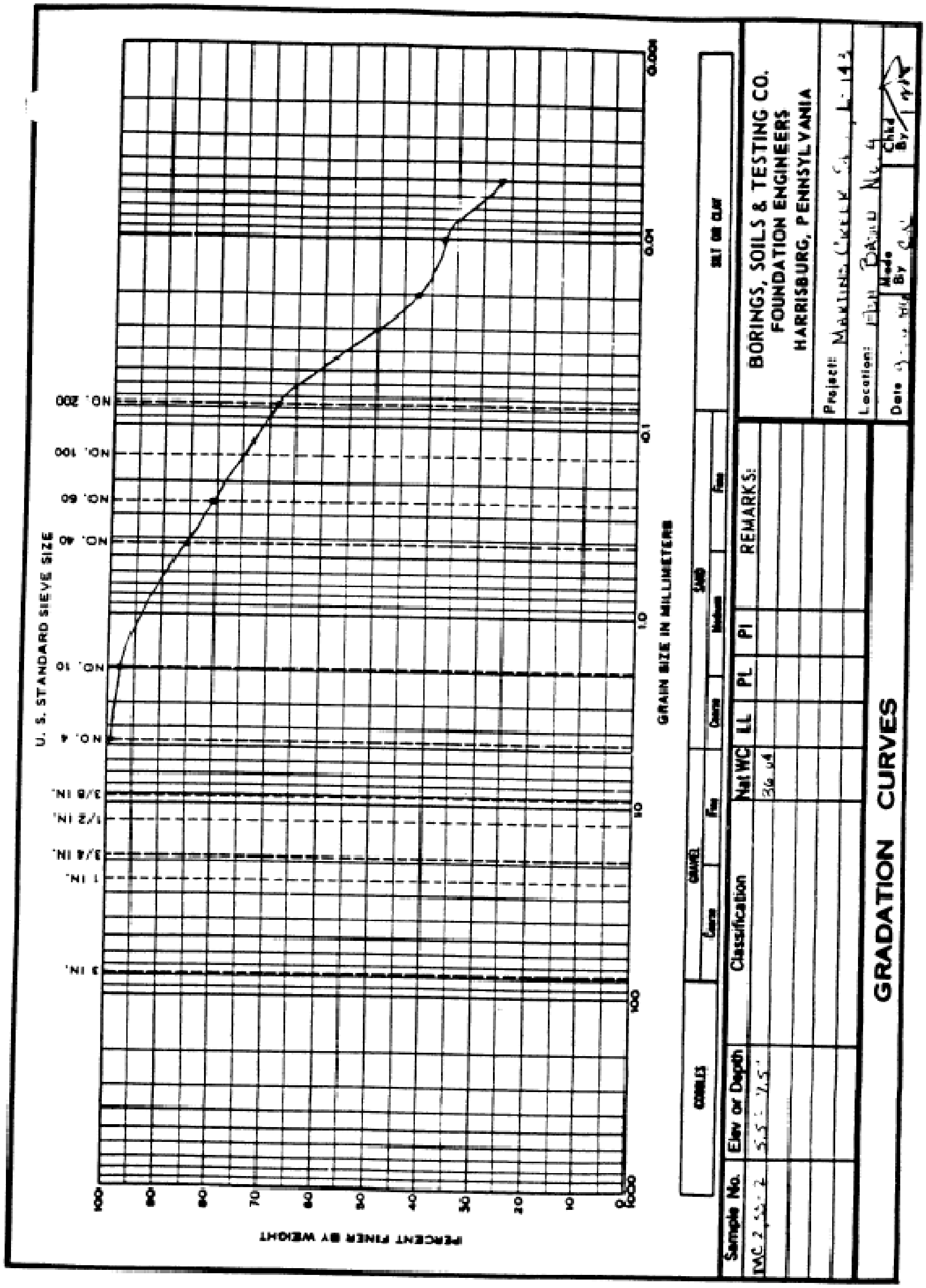
BORINGS, SOILS & TESTING CO.
FOUNDATION ENGINEERS
HARRISBURG, PENNSYLVANIA

Project: Martins Creek SES, 1-143

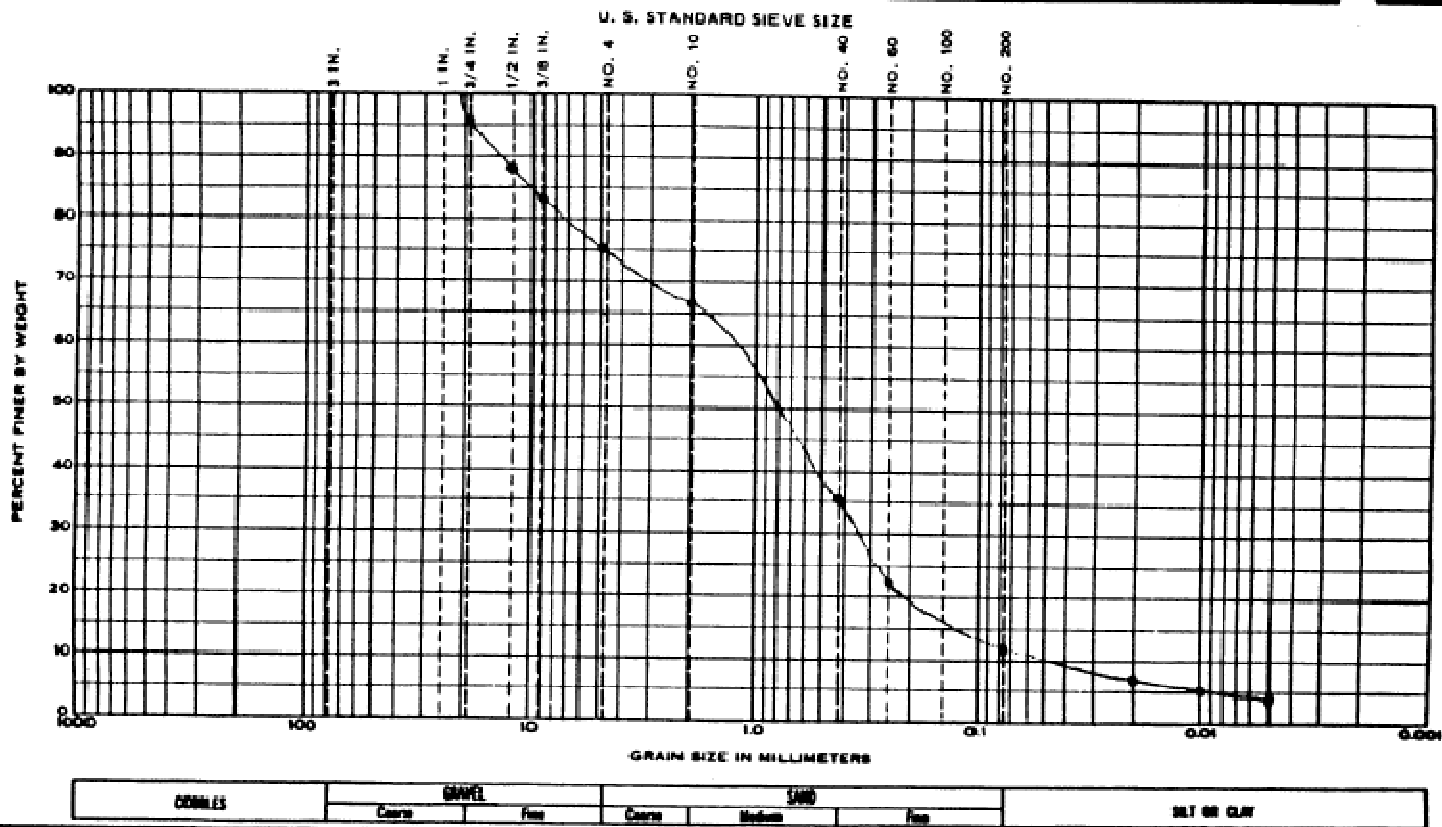
Location: Ash Basin #4

Date 9-25-86 Made By CC Chkd By [illegible]

GRADATION CURVES



U. S. STANDARD SIEVE SIZE
3 IN.
1 IN.
3/4 IN.
1/2 IN.
3/8 IN.
NO. 4
NO. 10
NO. 40
NO. 60
NO. 100
NO. 200
PERCENT FINER BY WEIGHT
100
90
80
70
60
50
40
30
20
10
0
1000
100
10
1.0
0.1
0.01
0.001
GRAIN SIZE IN MILLIMETERS
COBBLES
GRAVEL
Coarse
Fine
SAND
Coarse
Medium
Fine
SILT OR CLAY
Sample No.
Elev or Depth
Classification
Nat WC
LL
PL
PI
REMARKS:
BORINGS, SOILS & TESTING CO.
FOUNDATION ENGINEERS
HARRISBURG, PENNSYLVANIA
Project:
Location:
Date
Made By
Chkd By
GRADATION CURVES

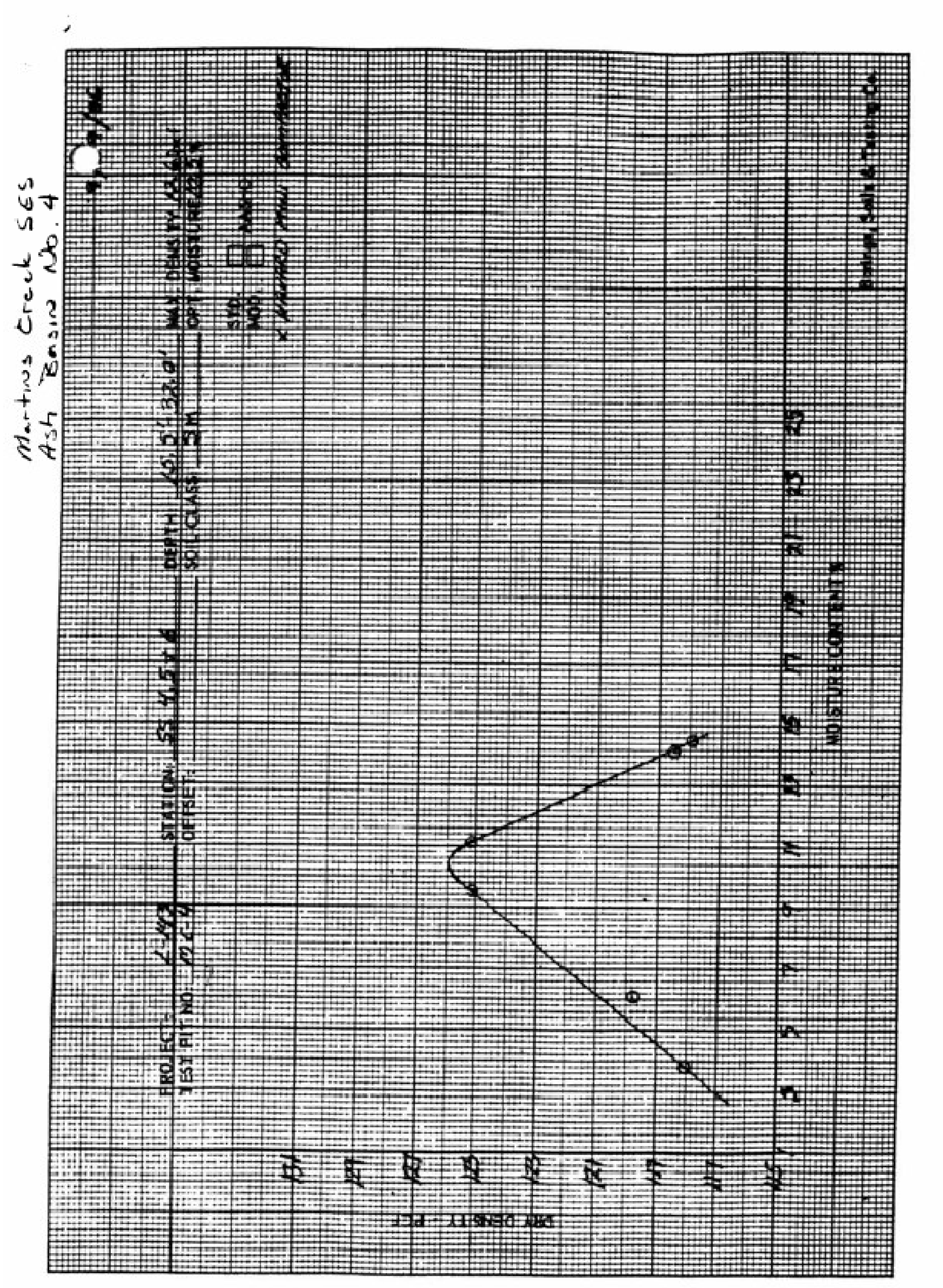


Sample No.	Elev or Depth	Classification	NatWC	LL	PL	PI	REMARKS:
MC-4, SS-4	15.5'-19.5'	SM	9.8%	-	-	-	Gs: 2.72
" , SS-5	25.0'-27.0'			NON	PLAS	TIC	
" , SS-6	30.0'-32.0'						

BORINGS, SOILS & TESTING CO.
FOUNDATION ENGINEERS
HARRISBURG, PENNSYLVANIA

Project: Martins Creek SES L-143
Location: Ash Basin No. 4
Date 9/26/86 Made By GAC Chkd By JMT

GRADATION CURVES


Martins Creek SES
Ash Basin No. 4
PROJECT:
TEST PIT NO.
STATION:
OFFSET:
DEPTH
SOIL CLASS
MAX. DENSITY
OPT. MOISTURE
STD.
MOD.
MOISTURE CONTENT %
DRY DENSITY - PCF

CONSTANT HEAD PERMEABILITY TEST

PROJECT NO.: L-143

PROJECT: MARTINS CREEK SES
ASH BASIN NO. 4

SAMPLE DESCRIPTION:

LAB NO.: MC-4, SS-4,5,6

DRY DENSITY: 133.41 pcf

MOISTURE CONTENT: 10.38 % (BEFORE TEST)

MOISTURE CONTENT: 12.99 % (AFTER TEST)

TOTAL HEAD, h: 130.86 cm

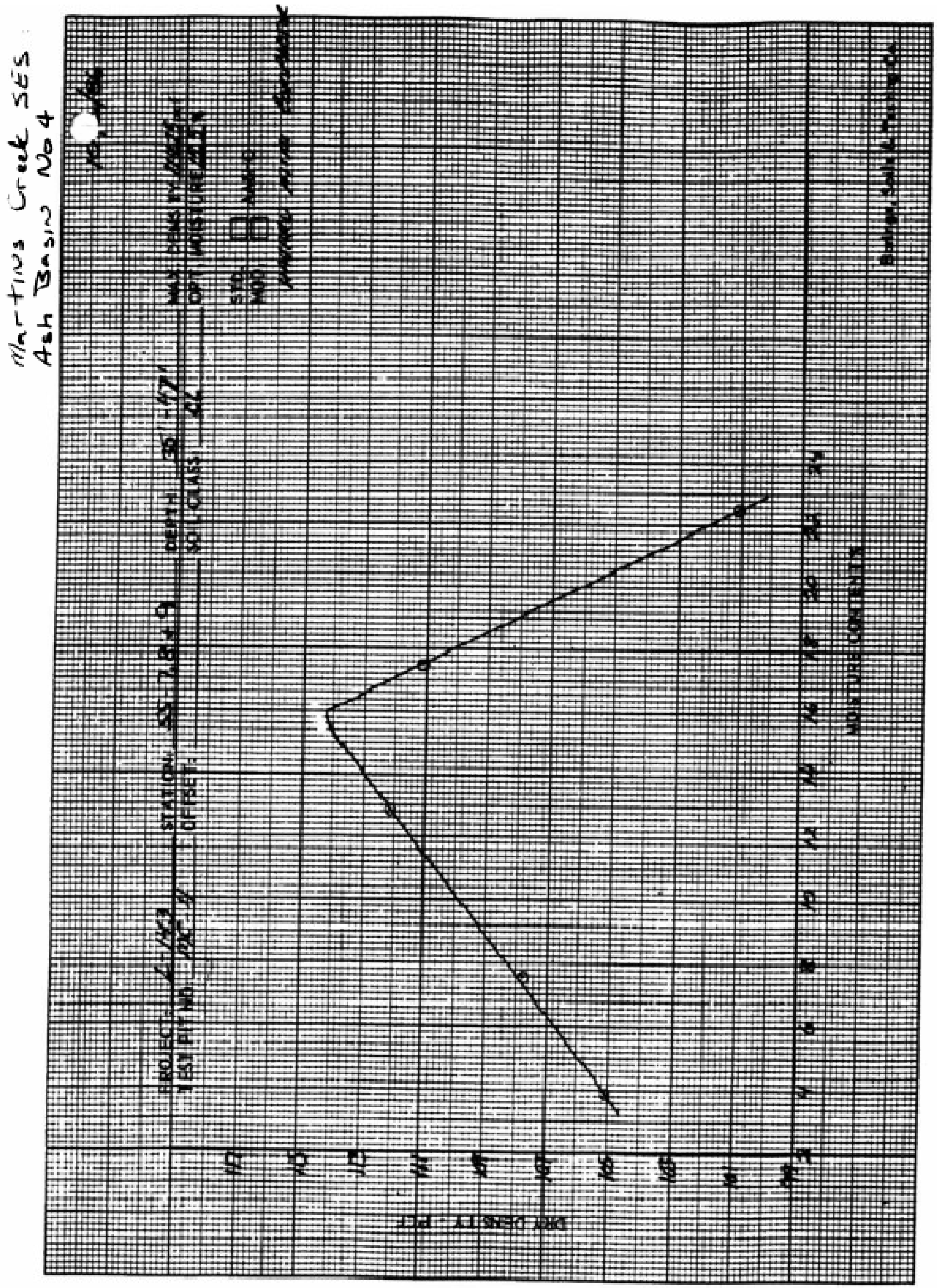
AREA OF SAMPLE, A: 41.156 cm^2

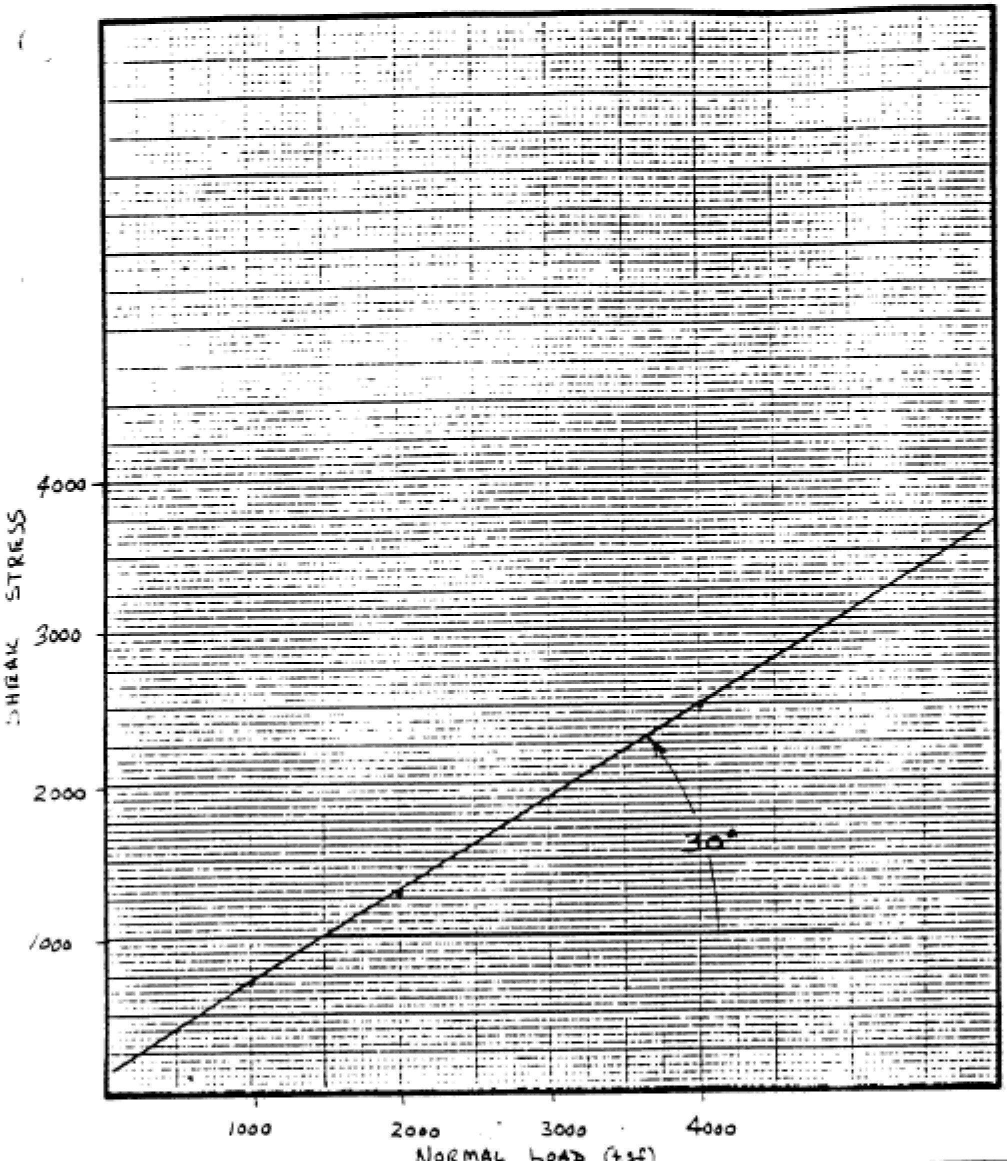
LENGTH OF SAMPLE, L: 6.299 cm

Test No.	Elapsed Time t (sec.)	Flow, Q (cc)	k (cm/sec.)
1	13,020 sec	140 cc	1.258×10^{-5} cm/sec
2	71,640 sec	985 cc	1.593×10^{-5} cm/sec
3	24,300 sec	640 cc	3.081×10^{-5} cm/sec

Average k = 1.977×10^{-5} cm/sec.

$$k = \frac{QL}{thA}$$


Martins Creek SES
Ash Basin No 4
MOISTURE CONTENT %
DRY DENSITY - PCF



TYPE TEST Molded	PROJECT Martins Creek SES
	Ash Basin No. 4
	SAMPLE ID UC-4, SS-7,8,9

CLASS. CL	W % 17.40	LAB NO. L-743	TESTED BY GC	DATE 10/2/86
LL 26.50	SP. G. 2.78			
PL 7.10	D_{10} —			

DIRECT SHEAR TEST REPORT

CONSTANT HEAD PERMEABILITY TEST

PROJECT NO.: L- 143

PROJECT: MARTINS CREEK SES
ASH BASIN No. 4

SAMPLE DESCRIPTION:

LAB NO.: MC-4, SS-7,3,3

DRY DENSITY: 115.54 pcf

MOISTURE CONTENT: 15.41 % (BEFORE TEST)

MOISTURE CONTENT: 18.36 % AFTER TEST

TOTAL HEAD, h: 113.30 cm

AREA OF SAMPLE, A: 41.156 cm^2

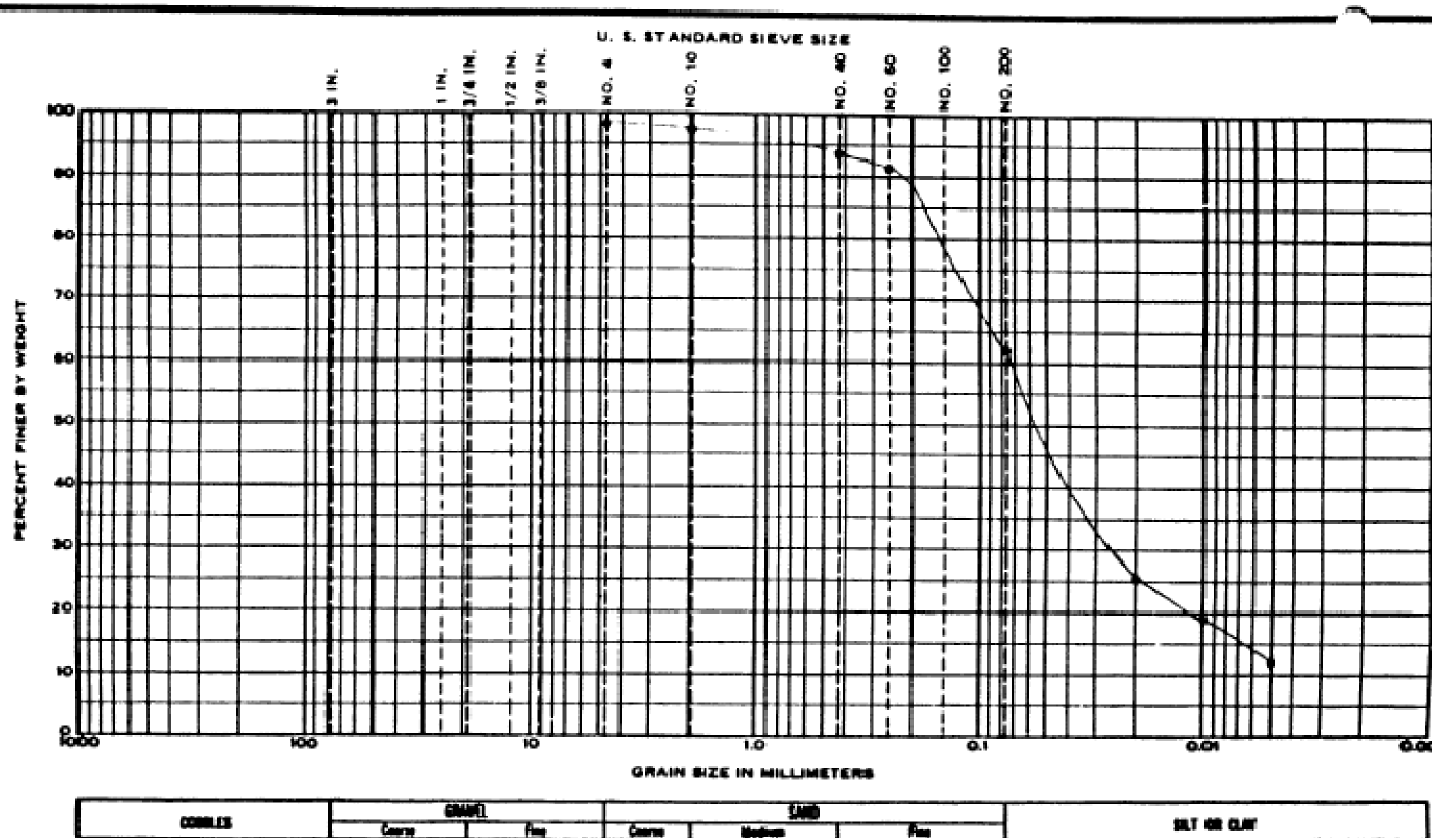
LENGTH OF SAMPLE, L: 13.80 cm

Test No.	Elapsed Time t (sec.)	Flow, Q (cc)	k (cm/sec.)
1	78,720 sec	1 cc	3.599×10^{-8} cm/sec
2	92000 sec	2 cc	6.204×10^{-8} cm/sec
3			

Average k = 4.902×10^{-8} cm/sec.

$$k = \frac{QL}{thA}$$

BORINGS, SOILS & TESTING CO.

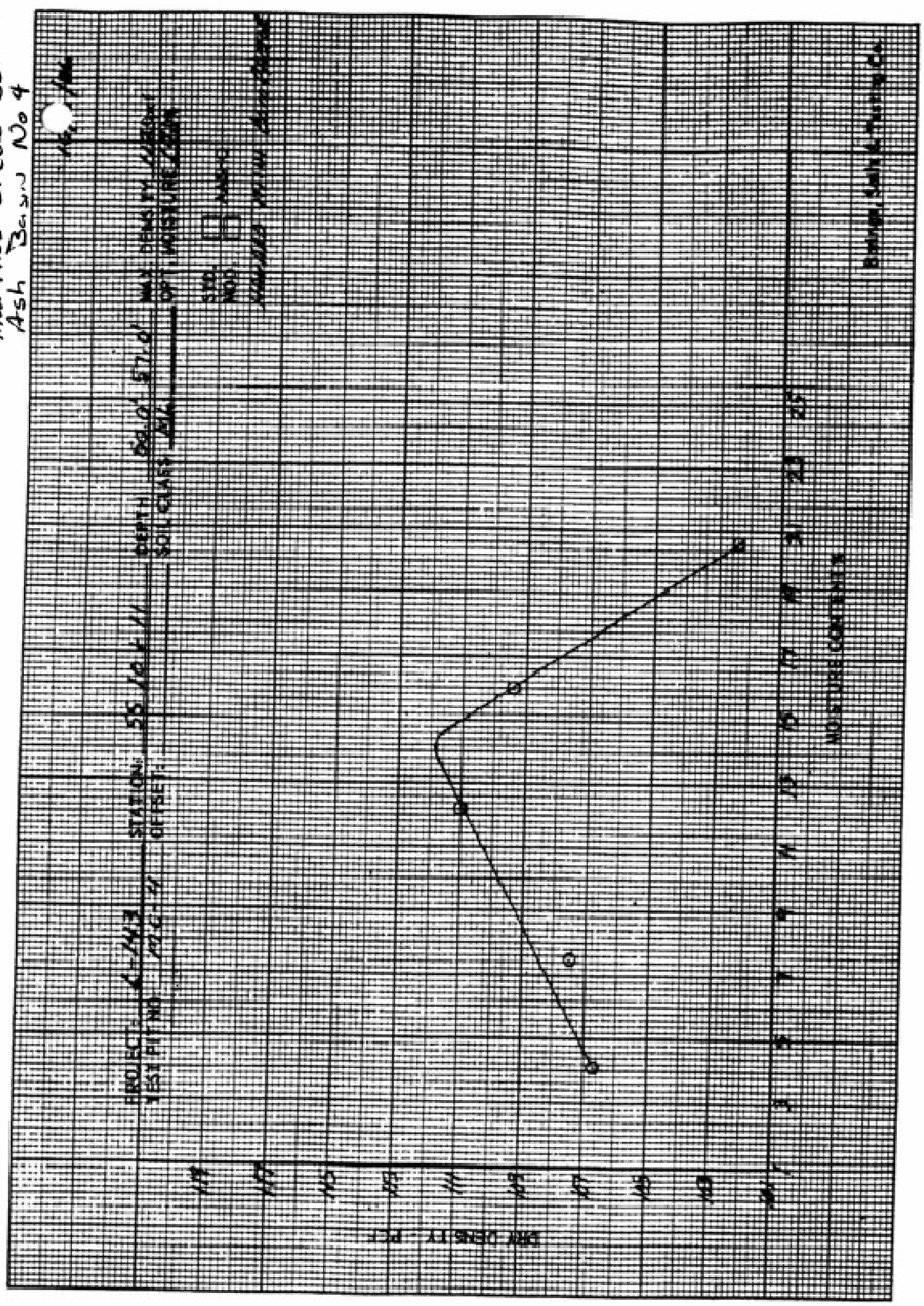


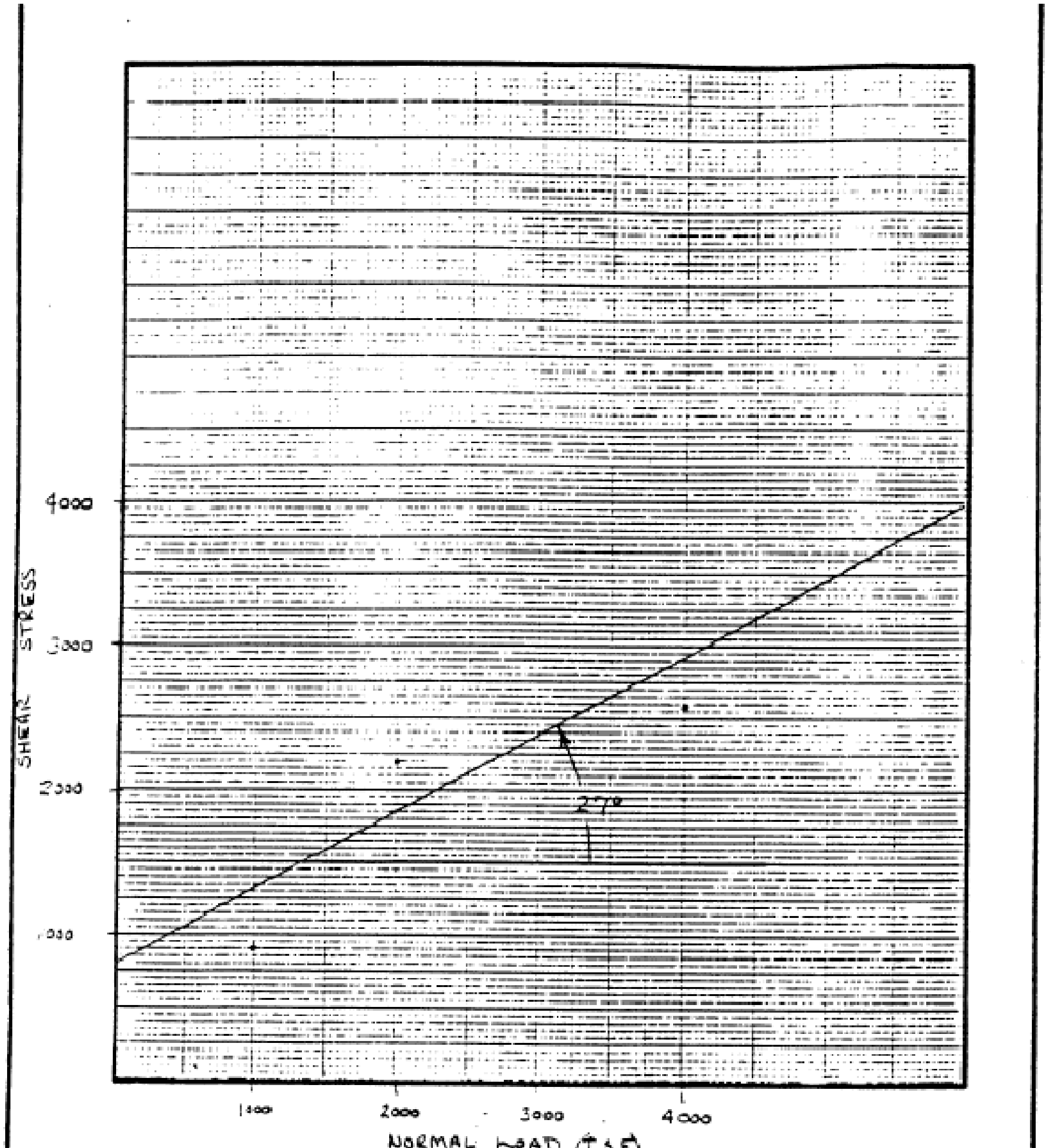
Sample No.	Elev or Depth	Classification	Nat WC	LL	PL	PI	REMARKS:
MC-4, SS-10	50.0'-52.0'	ML - Sandy Silt	19.94	-0-	-0-	-0-	Gs - 2.79
" , SS-11	55.0'-57.0'			Non	Plas	tic	

GRADATION CURVES

BORINGS, SOILS & TESTING CO.
FOUNDATION ENGINEERS
HARRISBURG, PENNSYLVANIA

Project: Martins Creek SES, L-143
Location: Ash Basin No. 4
Date 9/26/86 Made By CC Chkd By TMR


Martins Creek SES
Ash Basin No 4
PROJECT:
TEST PIT NO.
STATION:
OFFSET:
DEPTH
SOIL CLASS
MOISTURE CONTENT %
DRY DENSITY - PCF



TYPE TEST MOLDED		PROJECT MARTINS CREEK SES	
		ASH BASIN No. 4	
		SAMPLE ID MW-4, SS-9,11	
CLASS. ML	W % 19.94	LAB NO. L-43	TESTED BY GC	DATE 10/2/86
LL Ø	SP. G. 2.79	DIRECT SHEAR TEST REPORT	
PL Ø	D_{10} Ø		

CONSTANT HEAD PERMEABILITY TEST

PROJECT NO.: L - 143

PROJECT: MARTINS CREEK SES
ASH BASIN No. 4

SAMPLE DESCRIPTION:

LAB NO.: MC-4, SS-10,11

DRY DENSITY: 117.07 pcf

MOISTURE CONTENT: 17.35% (BEFORE TEST)

MOISTURE CONTENT: 16.99% (AFTER TEST)

TOTAL HEAD, h: 144.27 cm

AREA OF SAMPLE, A: 41.156 cm²

LENGTH OF SAMPLE, L: 6.353 cm

Test No.	Elapsed Time t (sec.)	Flow, Q (cc)	k (cm/sec.)
1	78,660 sec	17 cc	2.496 x 10⁻⁷ cm/sec
2	93,000 sec	1 cc	1.40 x 10⁻⁷ cm/sec
3			

Average k = 1.948×10^{-7} cm/sec.

$$k = \frac{QL}{thA}$$

BORINGS, SOILS & TESTING CO.

Basin 4

MARTINS CREEK SES
ASH BASIN NO. 4
MAJOR PERMIT MODIFICATION
FINAL VERSION - FEBRUARY 8, 1999

MISCELLANEOUS SUBMITTALS

"Summary of Martins Creek Basin No. 4 Siting Study and Hydrogeologic Data - PA DER Module 5 and 5a - Phase 1" - Submitted to DEP September 8, 1997.

"Sinkhole Contingency Plan for Basin No. 4 - PP&L's Martins Creek Steam Electric Station," June 1998 - Submitted to DEP September 8, 1997.

Summary of Martins Creek Basin No. 4
Siting Study and Hydrogeologic Data
PA DER Module 5 and 5a-Phase I

The proposed location of Martins Creek Steam Electric Station's Ash Basin No. 4 was selected based on the results of a comprehensive siting study and a detailed geophysical investigation. This discussion summarizes these studies and supplements the information provided in the attached PA DER Module 5 - Geology and Groundwater Information, and Module 5a - Phase I - Supplemental Geology and Groundwater Information.

The comprehensive siting study, performed in 1985-86, evaluated 23 potential sites for the location of the proposed Ash Basin No. 4. This study was performed by an interdisciplinary project team within PP&L and a Public Advisory Committee, consisting of residents of the Martins Creek SES area. The 23 sites were evaluated based on potential community impacts, environmental impacts, technical/engineering factors and economic considerations. Five sites were selected from the results of this evaluation for further on-site investigations. Environmental, geologic, and geophysical investigations were performed at each of the five sites. Sites No. 19 and 20, located adjacent to each other to the north of existing Basin No. 3, were selected based on the results of these investigations as the most favorable location for the proposed Basin No. 4.

Since site 19/20 is underlain by carbonate bedrock and since the area around Martins Creek SES is susceptible to sinkhole formation, a thorough geophysical study was performed to determine the most geologically acceptable location within Site 19/20 to construct the basin. A description of this study is provided in the attached report by Weston Geophysical Corporation, "Final Report, Geophysical Investigations, Ash Basin No. 4, Martins Creek Steam Electric Station." The study consisted of an extensive seismic refraction survey and a limited boring program. The study identified an area of sound bedrock, which is least susceptible to sinkhole development, in the northwestern portion of Site 19/20. PP&L subsequently selected this area as the proposed location for Basin No. 4.

After completion of the geophysical study, PP&L initiated a more extensive test boring program to determine the quantity and quality of overburden materials available for dike construction and to investigate two potentially sinkhole-prone areas. These borings confirmed the location of a weathered rock zone in the vicinity of Boring No. 9 and identified another such zone around boring No. 2, shown in Figure 3 (Dwg. No. E-209426). These areas will be grouted prior to basin construction to reduce the probability of sinkhole formation, as described in this project's Design Intent and Grouting Specification, which are attached to the permit application.

Proposed groundwater monitoring well locations, shown in Module 5a, were also selected based on the results of the geophysical survey. Well locations were selected in zones of weathered rock surrounding the proposed Basin No. 4. These weathered rock zones are most likely areas of active groundwater flow, and thus favorable monitoring well locations.

List of Attachments:

PA DER Module 5 - Geology and Groundwater Information

PA DER Module 5a, Phase I - Supplemental Geology and Groundwater Information

Figure 1: 7 1/2 Minute USGS Quadrangle Map of Basin No. 4 Area

Figure 2: Large-scale Map of Basin No. 4

Figure 3: Dwg. No. E-209426, Aerial Site Plan showing boring locations and logs

Figure 4: Soils Map of Basin No. 4 Area

D.A. Stoner
6/23/87

ER-BWQ-199.5A:REV. 3/79

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL RESOURCES
WATER QUALITY MANAGEMENT

DATE PREPARED 6/24/87

DATE REVISED

MODULE 5A - PHASE I
SUPPLEMENTARY GEOLOGY AND GROUNDWATER INFORMATION

FOR DEPARTMENT USE ONLY

To be completed when applying for waste disposal permits where the operation affects ground water as follows: 1) Spray Irrigation; 2) Impoundments constructed from earth materials, including bentonite; 3) Discharges to ground water; 4) Collection and treatment of leachate from a sanitary landfill; and 5) Construction and operation of a sanitary landfill or other solid waste disposal site.

The module is so designed that several facilities, existing or proposed, can be included in a single submission. For example, one module can cover an existing unpermitted sanitary landfill which proposes collection impoundments and spray irrigation for the leachate. It is imperative, however, that each part of the module which applies to the proposed facility be completed.

I. LOCATION

A. The name and date of the latest edition of the 7.5 minute topographic map covering the area is Belvidere NJ-PA 1975

1. Is the required copy or, if not available, a topographic map of equivalent scale attached? ☒ YES ☐ NO

2. Is the proposed and/or existing facility (impoundments, boundaries of spray irrigation fields including a 200 foot border, or boundaries of sanitary landfills) shown on the 7.5 minute topographic map? ☒ YES ☐ NO

3. Supply location of the facility, measured to the nearest 0.05 inch North and West from the southeast corner of the 7.5 minute topographic map or express location in latitude and longitude. (Degrees, minutes and seconds) 40°48'26" 75°07'00"

a. Spray irrigation and sanitary landfills: Give the location of the center of the area designated to receive waste. N/A

(1) SPRAY IRRIGATION

(a) PROPOSED North ___.___; West ___.___ Latitude ____ Longitude ____

(b) EXISTING North ___.___; West ___.___ Latitude ____ Longitude ____

(2) SANITARY LANDFILL

(a) PROPOSED North ___.___; West ___.___ Latitude ____ Longitude ____

(b) EXISTING North ___.___; West ___.___ Latitude ____ Longitude ____

b. Impoundments: Locate a point at the center of each impoundment. 40°48'26" 75°07'00"

(1) PROPOSED

North ___.___; West ___.___ Latitude ____ Longitude ____
North ___.___; West ___.___ Latitude ____ Longitude ____
North ___.___; West ___.___ Latitude ____ Longitude ____
North ___.___; West ___.___ Latitude ____ Longitude ____

(2) EXISTING

North ___.___; West ___.___ Latitude ____ Longitude ____
North ___.___; West ___.___ Latitude ____ Longitude ____
North ___.___; West ___.___ Latitude ____ Longitude ____
North ___.___; West ___.___ Latitude ____ Longitude ____

ER-BWQ-189.8A1:REV. 3/79

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL RESOURCES
WATER QUALITY MANAGEMENT

DATE PREPARED
6/24/87
DATE REVISED

MODULE 5A - PHASE I
SUPPLEMENTARY GEOLOGY AND GROUNDWATER INFORMATION

FOR DEPARTMENT USE ONLY

I. LOCATION (continued)

c. Other (describe): N/A

(a) PROPOSED North ___.___; West ___.___ Latitude ______ Longitude ______
(b) EXISTING North ___.___; West ___.___ Latitude ______ Longitude ______

B. Is the required large scale map showing the facility attached? ☒ YES ☐ NO

1. Is the large scale topographic map drawn to the following minimum scales?

a. Spray irrigation: scale 1" - 50' Contour interval 2' ☐ YES ☐ NO ☐ N/A

b. All other: scale 1" - 200' Contour interval 5' ☒ YES ☐ NO ☐ N/A

2. Is the following information plotted on the large scale map: Dwg. No. E-209426

a. Location of soils/geologic/and hydrologic test pits, wells or borings? ☒ YES ☐ NO

b. The distribution system and nozzle locations of spray irrigation systems. ☐ YES ☐ NO ☐ N/A

C. All of the following which occur within the site boundaries or within 0.25 mile of the site must be plotted on the large scale map and/or the 7.5 minute topographic map.

Check the appropriate space:

		7.5 min. topo map	large scale map	not applicable
1.	Water wells	X		
2.	Springs			X
3.	Swamps			X
4.	Streams	X	X	
5.	Public water supplies			X
6.	Other bodies of water	X	X	
7.	Sinkholes			X
8.	Underground and/or surface mines			X
9.	Mine pool discharge points			X
10.	Mining spoil piles or mine dumps			X
11.	Quarries			X
12.	Sand and gravel pits			X
13.	Gas and oil wells			X
14.	Diversion ditches			X
15.	All water quality monitoring points		X	
16.	Occupied dwellings	X	X	
17.	Roads	X	X	
18.	Power lines	X	X	
19.	Pipelines			X
20.	Public buildings			X
21.	Abandoned canal			X

ER—BWQ—188.5:REV. 3/75

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL RESOURCES
WATER QUALITY MANAGEMENT

WATER POLLUTION CONTROL

MODULE 5 – GEOLOGY AND GROUND WATER INFORMATION

DATE PREPARED 6/24/87
DATE REVISED

For Department Use Only

			IMPOUNDMENT Basin No. 4	IMPOUNDMENT	IMPOUNDMENT
			☐ EXISTING ☒ PROPOSED	☐ EXISTING ☐ PROPOSED	☐ EXISTING ☐ PROPOSED
1. LOCATION	A. TOTAL AVAILABLE ACREAGE OF SITE		56.2		
	B. TOTAL ACREAGE UTILIZED		40.4		
	C. DISTANCE (FEET) TO	(1) NEAREST OCCUPIED DWELLING(S)	1300		
		(2) NEAREST STREAM OR SPRING	2200		
		(3) NEAREST WELL(S)	1300		
	D. IS REQUIRED TOPOGRAPHIC MAP ENCLOSED SHOWING IMPOUNDMENT LOCATION, PROPERTY BOUNDARIES, AND ITEMS A THROUGH C ABOVE?		☒ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No
2. WASTE	A. INDICATE TYPE OF FACILITY AND PROCESS PRODUCING WASTE.		Martins Creek SES is a coal and oil-fired steam turbine ~~electric generating station~~ which produces fly ash and bottom ash. Basin No. 4 is a surface impoundment used for fly ash and bottom ash disposal.		
	B. EXTENT OF SITE USE	(1) HOURS/DAY	24		
		(2) DAYS/WEEK	7		
	C. VOLUME (MGD OR CU. FT./DAY)		2.3 MGD		
3. BEDROCK	A. TYPE OF LITHOLOGY (SANDSTONE, SHALE, LIMESTONE, ETC.)		Limestone, Dolomite		
	B. DEPTH (FT.)		10'-92'		
	C. DIP		Cleavage 45° Bedding 0° - 90°		
	D. FRACTURING - JOINTS OR FAULTS (DESCRIBE)		See Module 5A-PhI		
4. SOILS	A. SOIL SERIES (Soil Conservation Service Classification)		Conotton gravelly silt loam (CtA, CtB)		
	B. THICKNESS (Ft. To Bedrock)		10-90		
	C. DEPTH TO HIGHEST MOTTLING, FRAGIPAN OR HARDPAN (Ft)		N/A		
	D. DRAINAGE CHARACTERISTICS (Soil Conservation Service Classification)		Well Drained		

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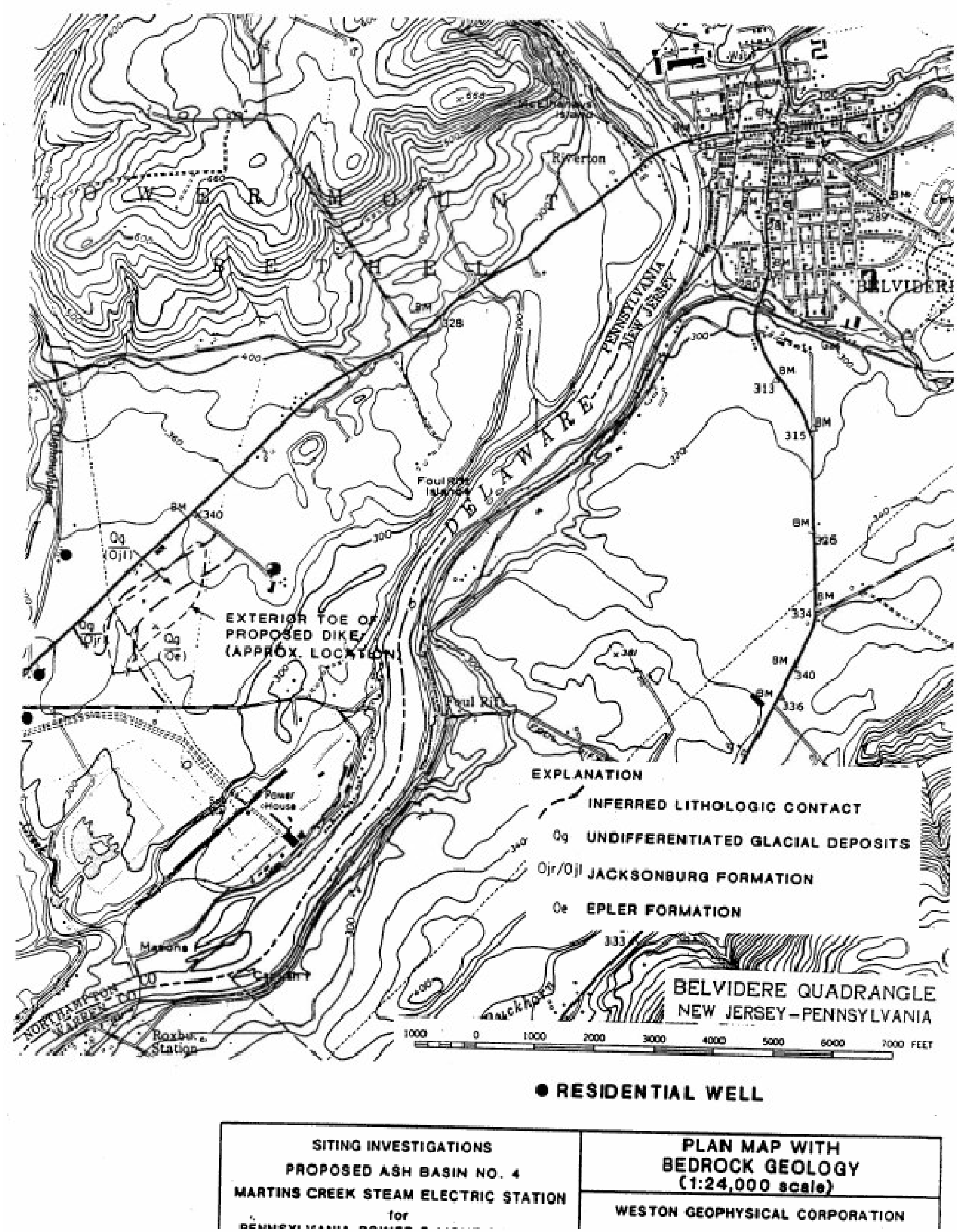
COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL RESOURCES
WATER QUALITY MANAGEMENT

WATER POLLUTION CONTROL

MODULE 5 – GEOLOGY AND GROUND WATER INFORMATION

For Department Use Only

Section	Item			
5. GROUND WATER	A. DEPTH TO HIGHEST GROUND WATER TABLE (Ft.)	70		
	B. QUALITY (1) CHEMICAL	See Module 5A		
	(2) BACTERIOLOGICAL			
	C. DIRECTION OF MOVEMENT	South/ Southeast toward Delaware River		
	D. WHAT IS THE PRESENT USE OF GROUND WATER WITHIN A ONE-HALF MILE RADIUS OF IMPOUNDMENT(S)?	Domestic Water Supply		
6. BORINGS	A. ARE LOGS OF BORINGS TO DEPTH OF 25 FEET ENCLOSED GIVING LOCATION AND DESCRIPTION OF ITEMS 3 THROUGH 5 ABOVE? (These are required of information is not otherwise available.)	[X] Yes [ ] No	[ ] Yes [ ] No	[ ] Yes [ ] No
	B. IF REQUIRED, IS MONITORING WELL INSTALLED AND LOCATION GIVEN? Proposed locations provided.	[ ] Yes [X] No	[ ] Yes [ ] No	[ ] Yes [ ] No
7. PONDS OR LAGOONS	A. HOW WILL SIDES AND BOTTOM BE CONSTRUCTED SO AS TO BE IMPERVIOUS? BRIEFLY DESCRIBE:	Inside berms and bottom will be lined with two feet of select soil, geotextile fabric, and a 30-mil Hypalon liner.		
	B. WITH WHAT WILL SIDES AND BOTTOM BE LINED?	Same as A.		
	C. WILL SURROUNDING AREAS BE GRADED TO PREVENT SURFACE WATER FROM ENTERING LAGOON?	[X] Yes [ ] No	[ ] Yes [ ] No	[ ] Yes [ ] No
	D. ARE THE IMPOUNDMENTS IN AN AREA THAT HAS BEEN DEEP MINED?	[ ] Yes [X] No	[ ] Yes [ ] No	[ ] Yes [ ] No
	E. IS THERE ACTIVE SINK HOLE DEVELOPMENT IN THE AREA? Refer to Weston Geophysical Report.	[X] Yes [ ] No	[ ] Yes [ ] No	[ ] Yes [ ] No
8. OTHER OPERATIONS	WILL THE SITE ALSO BE USED FOR SANITARY LANDFILL, IRRIGATION, OR OTHER LAND DISPOSAL OPERATION?	[ ] Yes [X] No	[ ] Yes [ ] No	[ ] Yes [ ] No
	A. IF YES, HAS THE OPERATION BEEN APPROVED BY THE PENNSYLVANIA DEPARTMENT OF ENVIRONMENTAL RESOURCES?	[ ] Yes [ ] No	[ ] Yes [ ] No	[ ] Yes [ ] No
	B. SPECIFY THE NAME OF PARTY OPERATING THE LAND FILL AND/OR DISPOSAL OPERATION.	Pennsylvania	Power & Light	Company
	C. IF PERMITTED, GIVE PERMIT NUMBER.			


LOWER MOUNT BETHEL
McElhaneys Island
Riverton
BELVIDERE
PENNSYLVANIA
NEW JERSEY
DELAWARE
Foul Rift Islands
Foul Rift
EXTERIOR TOE OF PROPOSED DIKE (APPROX. LOCATION)
Power House
Martins Creek
Masons
Roxburg Station
NORTHAMPTON CO
WARREN CO
Qg
Ojl
Ojr
Oe
EXPLANATION
INFERRED LITHOLOGIC CONTACT
Qg UNDIFFERENTIATED GLACIAL DEPOSITS
Ojr/Ojl JACKSONBURG FORMATION
Oe EPLER FORMATION
BELVIDERE QUADRANGLE
NEW JERSEY – PENNSYLVANIA
1000 0 1000 2000 3000 4000 5000 6000 7000 FEET
RESIDENTIAL WELL
SITING INVESTIGATIONS
PROPOSED ASH BASIN NO. 4
MARTINS CREEK STEAM ELECTRIC STATION
for
PLAN MAP WITH
BEDROCK GEOLOGY
(1:24,000 scale)
WESTON GEOPHYSICAL CORPORATION

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MODULE 5A - PHASE II SUPPLEMENTARY GEOLOGY AND GROUNDWATER INFORMATION

FOR DEPARTMENT USE ONLY

II. SOILS

A. List each of the soil series and phases present on the site.

Soil Series – Phase

1. Conotton gravelly silt loam (CtA, CtB)
2. ___
3. ___
4. ___
5. ___

B. Is the required copy of the U.S.D.A. Soil Conservation Service soils map for the area showing site boundaries attached? ☒ YES ☐ NO

C. Have borings or test pits been made to describe soils and determine their depth? ☒ YES ☐ NO

1. Are their locations shown on both the large scale map and the soils map? ☒ YES ☐ NO

2. The minimum thickness of soil to horizon(s) containing 60% or more coarse fragments is 24 inches.

   a. How was soil thickness determined? Test borings

3. Are the required pit or boring descriptions (by horizon) attached? ☒ YES ☐ NO

D. The percolation rates for the soils are: (Complete where applicable. For example: spray irrigation, tile fields, seepage beds, etc.)

		Soil Series
1. N/A	inches/hour	
2.	inches/hour	
3.	inches/hour	
4.	inches/hour	
5.	inches/hour	

E. How were the percolation rates determined? N/A

1. If percolation tests were run, are all percolation test holes shown on the soils map? ☐ YES ☐ NO

F. What are the drainage characteristics of the soil? Well drained

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MODULE 5A - PHASE I
SUPPLEMENTARY GEOLOGY AND GROUNDWATER INFORMATION

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II. SOILS (continued)

G. What is the maximum slope at the proposed site? 5 percent.

H. What is the shallowest depth from the surface to mottling? N/A inches.

1. How was the above determined? Test borings

I. Is there a fragipan present? ☐ YES ☒ NO

1. What is the shallowest depth to the fragipan? ______ inches.

a. How was the above determined? Test borings

Name and address of the soil scientist supplying the above data:

Name David A. Stoner, Pennsylvania Power & Light Company

Street Two North Ninth Street

City and State Allentown, Pennsylvania Zip 18101-1179

Phone number (include area code) (215) 767-9171

Sources of Data:

USDA Soil Survey of Northampton County, PA July 1974

Test Boring Data (attached)

III. GEOLOGY

A. All of the following which occur within the site boundary or within 0.25 mile of the site are to be plotted on the large scale map and the 7.5 minute topographic map.

1. Location(s) of maximum and minimum thickness of glacial deposits
2. Lithologies
3. Areas where bedrock outcrops
4. Faults
5. Lineaments
6. Fracture traces
7. Directions of ground water flow

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MODULE 5A - PHASE I
SUPPLEMENTARY GEOLOGY AND GROUNDWATER INFORMATION

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III. GEOLOGY (continued)

B. Sediments

1. Is the site within the glaciated area of Pennsylvania? ☐ YES ☐ N
2. Are there a. glacial deposits present under the proposed site? ☒ YES ☐ N
   b. colluvial deposits ☐ YES ☒ N
   c. alluvial deposits ☒ YES ☐ N
   d. lacustrine deposits ☐ YES ☒ N
3. Describe the type and texture of the unconsolidated materials.

   Recent alluvial clay, silt, sand, and gravel overlie lag gravel and coarse sands and gravels. Reworked material includes glacial till and weathered bedrock and local clay saprolite.

4. What is their maximum thickness? 92 feet.
5. What is their minimum thickness? 10 feet.
6. How were the thicknesses determined? Seismic refraction correlated with limited boring data. (see attached Weston Geophysical Report)
7. Are the location(s) of maximum and minimum thicknesses shown on the large scale map? ☒ YES ☐ N
8. Discuss the effects of these materials on discharges from the proposed facility.

   Material will have variable vertical permeabilities in gravel, sand, silt, and clay layers, however these will be isolated from the basin by impermeable basin liner.

C. Bedrock

1. Formation name Epler, Jacksonburg formations.
2. Lithologies (plot on large scale map if more than one lithology)

   Epler interbedded limestone and dolomite; Jacksonburg shaley limestone, limestone.

3. Is the location of all places where the bedrock is less than 5 feet plotted on the large scale map? ☐ YES ☒ N
4. How were the locations determined? Surficial materials 10' thick or greater. (see attached Weston Geophysical Report) N/A
5. Does bedrock crop out within the boundaries or within 200 feet of the proposed facility? ☐ YES ☒ N
6. Are all outcrops shown on the large scale map? No outcrops. ☐ YES ☐ N

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MODULE 5A - PHASE II
SUPPLEMENTARY GEOLOGY AND
GROUNDWATER INFORMATION

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III. GEOLOGY (continued)

D. Weathering

1. Characterize the degree of weathering Moderate to fresh.

2. Has a saprolite developed on the bedrock? ☐ YES ☒ NO

   a. What is the shallowest depth from the surface to bedrock. 10' feet.

   b. Describe the texture Fine-grained to crypto-granular, fine to coarse grained, crystalline.

3. If bedrock is a carbonate rock:

   a. Are there any undrained surface depressions or sinkholes at the site? ☒ YES ☐ NO

   b. Are all sinkholes within 0.25 mile of the site shown on the 7.5 minute topographic map and/or on the large scale map? ☒ YES ☐ NO

E. Structure

1. Are all lineaments and fracture traces on the site and within 0.25 miles of the site located on the 7.5 minute topographic map and/or the large scale map? ☒ YES ☐ NO

2. Briefly characterize these fractures, joints, etc. and discuss their control on the movement of infiltrating water and ground water. Steeply dipping joints spaced one to several feet apart locally exhibit weathering and solutioning.

3. Describe the regional structure of bedrock in the area of the site? Site is on SE margin of Valley and Ridge province comprised of folded Paleozoic sandstone, shale, limestone, and dolomite deformed in several Paleozoic orogenies.

4. Give a detailed description of the local structure The actual basin site is obscured by surficial deposits, however, in the vicinity, local well-developed axial cleavage occurs, dipping approximately 45° SE. Bedding dips vary between 0° and 90° depending on position on the limbs of folds in the area.

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III. GEOLOGY (continued)

5. Describe folding as it applies to the site A series of northeast-trending overturned antiforms and synforms are interpreted to traverse the site.
   a. Strike and plunge of fold axis are:
      Strike N40E Plunge 45°SE
   b. Location of site in relation to local structure On northwest limb of interpreted overturned synform.
6. Attitude of bedding Unknown.
   a. Strike ____ and dip ____ of ____ formation.
   b. Strike ____ and dip ____ of ____ formation.
   c. Strike ____ and dip ____ of ____ formation.
7. Attitude of jointing Unknown.
   a. Strike ____ and dip ____ of joints.
   b. Strike ____ and dip ____ of joints.
   c. Strike ____ and dip ____ of joints.
8. What is the respective spacing of these joints?
   a. Joints are generally spaced 1' to several feet in region.
   b. ____
   c. ____
9. Are joints open? (explain) ☐ YES ☐ NO
   a. Joints are tight to open and solutioned.
   b. ____
   c. ____
10. Cleavage
   a. Strike ~N40E and dip ~45° of cleavage.
   b. Strike ____ and dip ____ of cleavage.
   c. Strike ____ and dip ____ of cleavage.
11. Faults No faults mapped.
   a. Strike ____ and dip ____ of faults.
   b. Strike ____ and dip ____ of faults.
   c. Strike ____ and dip ____ of faults.
12. Are the locations of all faults that occur within 0.25 mile of the site's boundaries shown on the large scale map and 7.5 minute topographic map? ☒ YES ☐ NO

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III. GEOLOGY (continued)

F. Land Use

1. Are there any active or inactive surface mines at the site or within 0.25 mile of the site? ☐ YES ☒ NO

2. Are there any active or inactive deep mines at the site or within 0.25 mile of the site boundaries? ☐ YES ☒ NO

   a. What is the minimum depth to mined-out area? ________ feet

   b. What is the areal extent of the mined-out area ________

   c. What mineral resource was extracted? ________

      (1) If coal, name the seam(s) that were mined. ________

Sources of Data:

Martins Creek Site Geology Compilation, Weston Geophysical, November, 1983

Test Boring Data

Aerial Photography and Field Inspection

Comments: (Attach additional sheets if necessary)

See Weston Geophysical's "Final Report, Geophysical Investigations, Proposed Ash Basin No. 4, Martins Creek Steam Electric Station" for additional geologic information.

Name and address of geologist supplying the above data:

Name: Preston Turner, Geologist

Street: Weston Geophysical Corporation, P.O. Box 550

City & State: Westboro, MA Zip: 01581

Phone Number (include area code): (617) 366-9191

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MODULE 5A - PHASE I
SUPPLEMENTARY GEOLOGY AND
GROUNDWATER INFORMATION

FOR DEPARTMENT USE ONLY

IV. HYDROLOGY

A. Have test pits ____, borings X, or wells ____ (check one or more) been made for the hydrologic investigation? ☒ YES ☐ N

1. Is the required complete geologic description (log) of all earth materials penetrated included? ☒ YES ☐ N

2. If a well, what was the method of drilling? N/A

B. Depth to ground water table

1. The maximum depth to the water table within the site is 74.5 feet.

a. Date of measurement 3/24/87.

b. The location is shown on the 7.5 minute ____ or large scale X map (check one). Boring No. 2

c. If measurement is from a well or pit, give date of completion for same ____

2. The minimum depth to the water table within the site is 70 feet.

a. Date of measurement 3/26/87.

b. Is the location shown on the 7.5 minute ____ or large scale X map (check one). Boring No. 1

c. If measurement is from a well or pit, give date of completion for same ____

3. Describe seasonal water table fluctuations at the above locations.
The water table will fluctuate 10-13 feet in response to seasonal changes, as observed in Basin No. 2 and No. 3 monitoring wells.

4. Describe all perched or special water table conditions.
The water table is unconfined and generally occurs within the bedrock.

5. Does ground water drain to deep mines? ☐ YES ☒ N

C. Have you shown the direction(s) of ground water movement from the site on the X large scale or ____ 7.5 minute map (check one)? ☒ YES ☐ N

a. Describe how the above was determined:
Ground water flows to the south/southeast in the area, based on water table maps drawn from water levels observed in Basin No. 2 and No. 3 monitoring wells and the test borings identified above.

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MODULE 5A - PHASE I
SUPPLEMENTARY GEOLOGY AND GROUNDWATER INFORMATION

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IV. HYDROLOGY (continued)

b. The location of the ground water discharge point(s) affected by this facility is N/A Water will be discharged to the Delaware River.

c. Discuss the rate of ground water flow at this site as it applies to the operation of this facility: Ground water flow rates at this site will not change due to operation of this facility, since the basin will be lined with an impermeable liner.

D. Describe below the proposed ground water quality monitoring points for approval. (For sanitary landfills, monitoring point proposals are subject to final approval of the Engineering Design Plans. No wells are to be drilled until final approval of the Engineering Design Plans.) Use numbers only and number all monitoring points consecutively.

1. Wells, (check one) For multiple wells indicate with monitoring point number (a) for existing and (b) for proposed.

(a) ________ For existing wells complete the table below.

(b) X For proposed new well construction, complete the table from your specifications.

MONITORING POINT NUMBER	DRILLING METHOD	DEPTH	DIAMETER	CASING SIZE & DEPTH	CASING ZONES*1 PERFORATED	LOCATION*2 INCHES NORTH	LOCATION*2 INCHES WEST	Estimated SURFACE ELEVATION
4-1	Air Rotary	100'	8"	4",100'	60-100'	10.5	1.0	327
4-2	Air Rotary	100'	8"	4",100'	60-100'	9.6	0.8	310
4-3	Air Rotary	100'	8"	4",100'	60-100'	9.75	1.15	313
4-4	Air Rotary	100'	8"	4",100'	60-100'	10.0	1.4	326
4-5	Air Rotary	100'	8"	4",100'	60-100'	10.2	1.65	333
4-6	Air Rotary	100'	8"	4",100'	60-100'	10.5	1.7	332

2. Springs N/A

MONITORING POINT NUMBER	ELEVATION	RATE OF FLOW (gpm)	DATE OF MEASUREMENT	LOCATION* INCHES NORTH	LOCATION* INCHES WEST

*Measured from the southeast corner of the 7.5 minute topographic map

NOTE: Phase II must be completed within 60 days after the monitoring points are approved and the permit is issued.

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SUPPLEMENTARY GEOLOGY AND GROUNDWATER INFORMATION

FOR DEPARTMENT USE ONLY

IV. HYDROLOGY (continued)

E. Do all springs listed have a continuous year-round flow? N/A YES NO

1. If not, explain ____________________

F. Other describe and locate.

____

FOR DEPARTMENT USE ONLY:

Proposed monitoring point locations and construction approved:

Name: ____________________ Date ____________________

Comments: ____________________

NOTE:	Phase II must be completed within 60 days after the monitoring points are approved and the permit is issued.

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MODULE 5A - PHASE I SUPPLEMENTARY GEOLOGY AND GROUNDWATER INFORMATION

FOR DEPARTMENT USE ONLY

IV. HYDROLOGY (continued)

Name and address of geologist or hydrogeologist supplying the above data:

Name: David A. Stoner, Pennsylvania Power & Light Company

Street: Two North Ninth Street

City & State: Allentown, Pennsylvania Zip 18101-1179

Phone Number (include area code) (215) 770-4423

Sources of Data:

Basin No. 2 and No. 3 Monitoring Well Data

Aerial Photo and Field Observations

Test Borings (attached)

PA Geological Survey published reports

Comments: (attach additional sheets if necessary)

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MODULE 5A - PHASE I SUPPLEMENTARY GEOLOGY AND GROUNDWATER INFORMATION

FOR DEPARTMENT USE ONLY

V. CLIMATOLOGY AND FLOODING

A. Will this be an all-season operation? ☒ YES ☐ NO

1. If seasonal, include operating dates: ________ to ________

B. Precipitation data: For a sanitary landfill requiring collection and treatment of leachate complete 1, 2, 3, 5 & 6.
For spray irrigation complete 3, 4, 5 & 6.
x For impoundments complete 2, 5 & 6.

1. Maximum precipitation inches/yr. ________
2. Average precipitation inches/yr. 43.89
3. Maximum monthly precipitation Month ________ in. ________
4. Minimum monthly precipitation Month ________ in. ________
5. Station of record Allentown, PA (ABE Airport)
6. Length of historical record 1944-1983.

C. Flooding Frequency

1. Will all or part of the site be inundated? (check one)

a. ____ once in 5 years or more
b. ____ once in 10 years
c. ____ once in 25 years
d. ____ once in 50 years
e. ____ once in 100 years
f. X never

D. Source of flooding information U.S.G.S. 7.5 Minute Flood Plain Maps

VI. IMPOUNDMENTS

Answer the following questions for impoundments only:

A. How will the sides and bottom of the impoundment be made impervious? ☒ YES ☐ NO

Briefly describe or explain The inside slopes and bottom of the impoundment will be lined with two feet of select soil, a geotextile fabric, and a 30-mil thick Hypalon liner.

B. Will the surrounding area be graded or diked to prevent surface water from entering the impoundment? ☒ YES ☐ NO

Briefly describe or explain The crest of the dike (355') is 12-45' above the surrounding topography. Outside slopes of the dikes will be 2H:IV and 4H:IV at the bottom with a drainage culvert to prevent ponding of water near the toe of the dike.

C. Will the sides be constructed to maintain a two (2) foot free-board, and be protected against wave action? ☒ YES ☐ NO

D. How will the impoundment be protected from acts of third parties? Access control will consist of routine patrols by plant security personnel.

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MODULE 5A - PHASE I SUPPLEMENTARY GEOLOGY AND GROUNDWATER INFORMATION

FOR DEPARTMENT USE ONLY

VII. DISCHARGE TO GROUND WATER

A. If there is a discharge or a potential discharge to ground water, background water quality must be determined.

1. How was background water quality determined?

Describe Although no discharges to ground water will occur due to facility operation, background water quality, observed in nearby Basin No. 3 monitoring wells MW 3-1, 3-2, 3-3 are provided below.

2. What is the background water quality?

			MW 3-1	MW 3-2	MW 3-3
a.	Temperature	degrees C	10.4	10.3	10.2
b.	pH		7.25	7.3	7.5
c.	Alkalinity		148.0	156.0	130.0
d.	Total solids				
e.	Suspended solids				
f.	Settleable solids				
g.	MBAS				
h.	BOD 5 day				
i.	COD.25 w $K_2Cr_2O_7$				
j.	Specific conductance	Micromhos	475.0	465.0	405.0
k.	~~Total~~ iron Dissolved	mg/l	< 0.05	< 0.05	< 0.05
l.	Manganese "	mg/l	< 0.02	< 0.02	< 0.02
m.	Aluminum "	mg/l	< 0.20	< 0.20	< 0.20
n.	Copper "	mg/l	< 0.02	< 0.02	< 0.02
o.	Zinc "	mg/l	0.01	0.01	0.02
p.	Nickel "	mg/l	< 0.05	< 0.05	< 0.05
q.	Chromium "	mg/l	< 0.05	< 0.05	< 0.05
r.	Sulfate		36.9	37.3	36.3
s.	Chloride		12.1	12.1	12.1
t.	Fluoride				
u.	Kjeldahl -- Nitrogen				
v.	Ammonia -- Nitrogen				
w.	Nitrate -- Nitrogen		11.4	11.83	8.63
x.	Phosphorus				
	Date Collected		1/9/87	1/8/87	1/6/87

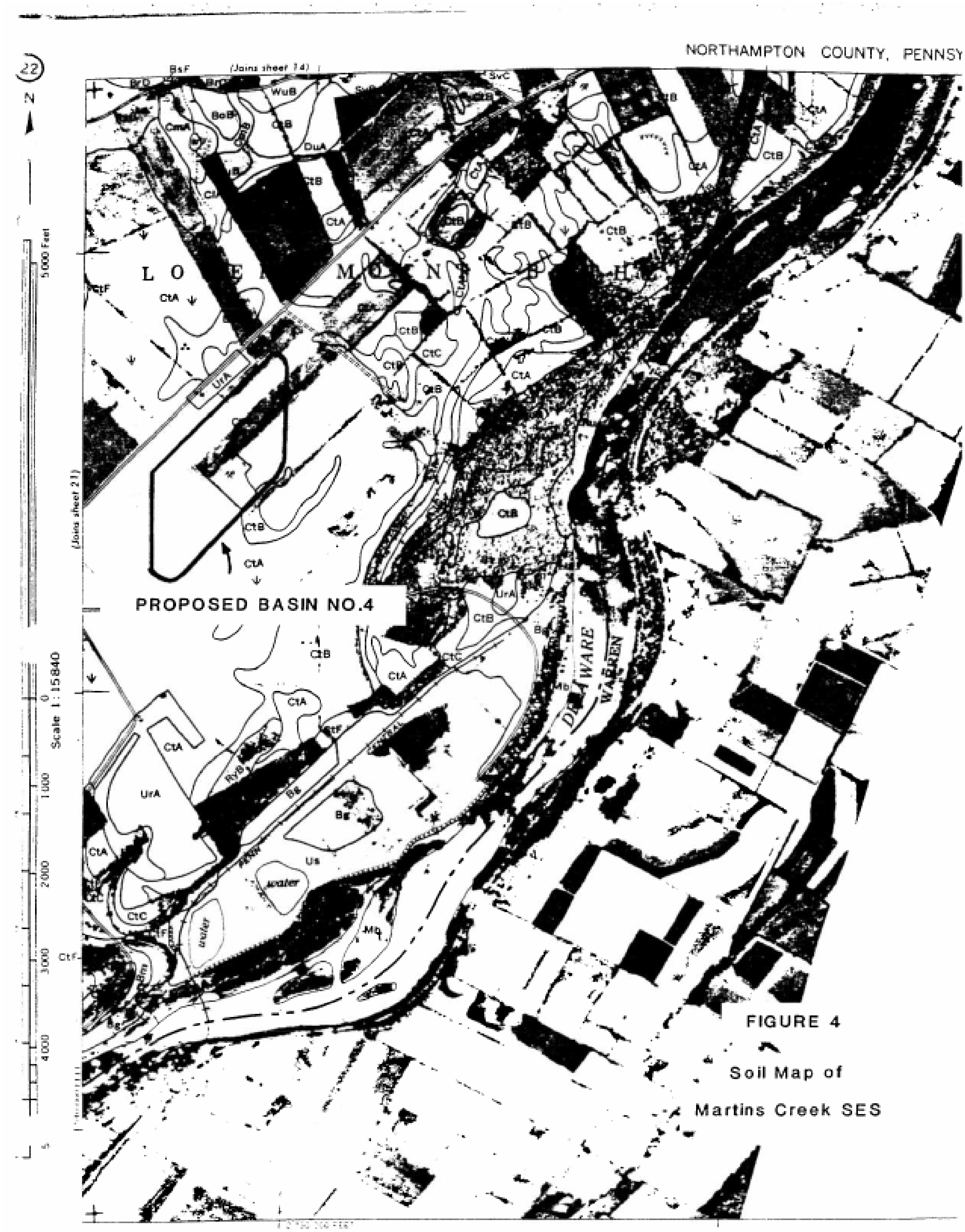


FIGURE 4

Soil Map of

Martins Creek SES

DAM INSPECTION REPORT

Dam No.: D48-149

Dam Name: Martins Creek Ash Basin No. 4

Inspector: Christopher R. Kulick, E.I.T.
(accompanied by Mike Sames)

Date of Inspection: January 15, 2009

LOCATION

Stream: Tributary to Oughoughton Creek

Municipality: Lower Mount Bethel Township

County: Northampton

Latitude: 40°48’30” Longitude: 75°07’00” GPS Verified: Yes

OWNER: Pennsylvania Power & Light Co.

PERTINENT DATA

Type: Earthen

Height: 43 Feet

Storage: 325 Acre Feet

D.A.: 0.06 Square Miles

Class: B-2

PRESENT CONDITIONS

Crest: The crest of the dam has a circular, horizontal alignment with a level appearance. The crest is covered with snow. The crest is in good condition.

Upstream Face: The majority of the upstream face consists of a PVC liner which extends throughout the entire basin area. The liner is covered with snow and not visible. The face is in good condition.

Downstream Face: The downstream face consists of an approximate 2H:1V slope with a moderate, dense vegetative cover consisting mostly of crown vetch. The dense cover hindered a close inspection of the face. The face is in fair condition.

Primary Spillway (Approach, crest, outlet, abutments, etc.): The primary spillway consists of the stop log structure which provides drawdown capabilities. See drawdown facilities for more details.

Emergency Spillway: This dam is not equipped with an emergency spillway.

Drawdown Facilities: The drawdown facilities consist of a stop log structure housed within a concrete structure within the reservoir. There are three closure structures associated with the facilities. The stop log structure itself and two valve structures. The control structures were rehabilitated and are in good condition. No flow was discharging from the spillway. The valve was completely closed. The flow exiting the outlet pipe, which is located several thousand feet downstream, originates at the IWTB. Flow discharges the CMP outlet to a grouted riprap channel. The outlet structure and channel are in good condition.

Downstream Toe and Areas Beyond (Seepage, toe, drain, vegetation, etc.): The downstream toe has a moderate, dense cover of crown vetch. The dense growth hindered a close inspection of this area.

Comments: The dam is in good condition. The owner should consider establishment of a maintenance program which includes the routine cutting of vegetation on the downstream face and along the toe. The goal should be the establishment of a controlled grass cover in these areas.

There is no low flow release required at this dam.

During the inspection, I met with Steve Holler, PE, PLS, PPL. According to Mr. Holler, PPL is no longer pumping to the reservoir and the reservoir was 25 feet below the normal pool elevation. Steve indicated that PPL is closing the basin and dewatering the reservoir by pumping to the IWTB. Furthermore, the coal fire units were shut down September 14, 2007. Therefore, no more sluiced ash will be pumped to the reservoir. According to the Division of Dam Safety, Rich Reisinger, and PPL, plans are being developed for the closure of the basin.

Submitted by:

Christopher R. Kulick, E.I.T.
Engineering Field Representative
Dam Safety and Technical Services Section
Watershed Management Program
Northeast Regional Office

Attachment

cc: Division of Dam Safety

WP: D48-149-01-15-09-2.doc

D48-149 Crest – Left Side 01/15/2009

D48-149 Crest/Upstream Face 01/15/2009

D48-149 Upstream Face – Left Side 01/15/2009

D48-149 Upstream Face – Right Side 01/15/2009

D48-149 Downstream Face – Dam Center – Looking Right 01/15/2009

D48-149 Downstream Face – Dam Center – Looking Left 01/15/2009

D48-149 Downstream Face/Toe Area – Left Side 01/15/2009

D48-149 Downstream Face/Toe Area – Left Side 01/15/2009

D48-149 Downstream Face/Toe Area – Right Side 01/15/2009

D48-149 Downstream Face/Toe Area – Right Side 01/15/2009

D48-149 Riser Structure 01/15/2009

D48-149 Slide Gate Panels 01/15/2009

D48-149 Stoplog Structure 01/15/2009

D48-149 Gate Valve 01/15/2009

D48-149 Gate Valve Control Structure 01/15/2009

D48-149 Outlet from Riser & IWTB 01/15/2009

D48-149 Discharge Channel 01/15/2009

CRK:sp
H&T(D)P: 1/21/09
R(F)P: 1/26/09

DAM INSPECTION REPORT

Dam No.:	D48-149
Dam Name:	Martins Creek Ash Basin No. 4
Inspector:	Christopher R. Kulick, E.I.T.
Date of Inspection:	March 13, 2008

LOCATION

Stream:	Tributary to Oughoughton Creek
Municipality:	Lower Mount Bethel Township
County:	Northampton

Latitude: 40° 48' 30" Longitude: 75° 07' 00" GPS Verified: Yes

OWNER: Pennsylvania Power & Light Co.

PERTINENT DATA

Type:	Earthen
Height:	43 feet
Storage:	325 acre feet
D.A.:	0.06 square miles
Class:	B-2

PRESENT CONDITIONS

Crest: The crest of the dam has a circular, horizontal alignment with a level appearance. The crest consists of a gravel maintenance road which encircles the entire dam. The crest is in good condition.

Upstream Face: The majority of the upstream face consists of a PVC liner which extends throughout the entire basin area. The liner is in good condition. Above the liner, the face consists of a gravel cover. The face is in good condition.

Downstream Face: The downstream face consists of an approximate 2H:1V slope with a dense vegetative cover consisting mostly of crown vetch. The dense cover hindered a close inspection of the face. The face is in fair condition. Several animal holes, all approximately 8-inches in diameter, were observed on the right-half of the face. These were pointed out to PPL employees.

Primary Spillway (Approach, crest, outlet, abutments, etc.): The primary spillway consists of the stop log structure which provides drawdown capabilities. See drawdown facilities for more details.

Emergency Spillway: This dam is not equipped with an emergency spillway.

Drawdown Facilities: The drawdown facilities consist of a stop log structure housed within a concrete structure within the reservoir. There are three closure structures associated with the facilities. The stop log structure itself and two valve structures. The control structures were rehabilitated and are in good condition. The outlet is several thousand feet downstream. A 10-inch flow depth was discharging from the CMP outlet to a grouted riprap discharge channel. The outlet structure and channel are in good condition.

Downstream Toe and Areas Beyond (Seepage, toe, drain, vegetation, etc.): The downstream toe has a dense cover of crown vetch and other perennial vegetative growth. The dense growth hindered a close inspection of this area.

Comments: The dam is in good condition. The animal holes on the downstream face should be excavated, backfilled and stabilized. The owner should consider establishment of a maintenance program which includes the routine cutting of vegetation on the downstream face and along the toe. The goal should be the establishment of a controlled grass cover in these areas.

There is no low flow release required at this dam. During the inspection, I met with Steve Holler. According to Mr. Holler, as of January 10, 2008, PPL is no longer pumping to the reservoir. Furthermore, the coal fire unites were shut down September 14, 2007. Therefore, no more sluiced ash will be pumped to the reservoir. PPL plans to retire the reservoir by breaching and/or filling the reservoir. There engineer is in the early design stage.

Submitted by:

Christopher R. Kulick, E.I.T.
Engineering Field Representative
Dam Safety and Technical Services Section

Northeast Regional Office

Attachment

cc: Division of Dam Safety

WP: D48-149-03-13-08-2.doc

D48-149 Crest- Left Side 3/13/08

D48-149 Crest/ Upstream Face- Right Side 3/13/08

D48-149 Crest/ Upstream Face- Left Side 3/13/08

D48-149 Downstream Face/ Toe Area- Right Side 3/13/08

D48-149 Downstream Face/ Toe Area- Right Side 3/13/08

D48-149 Downstream Face/ Toe Area- Left Side 3/13/08

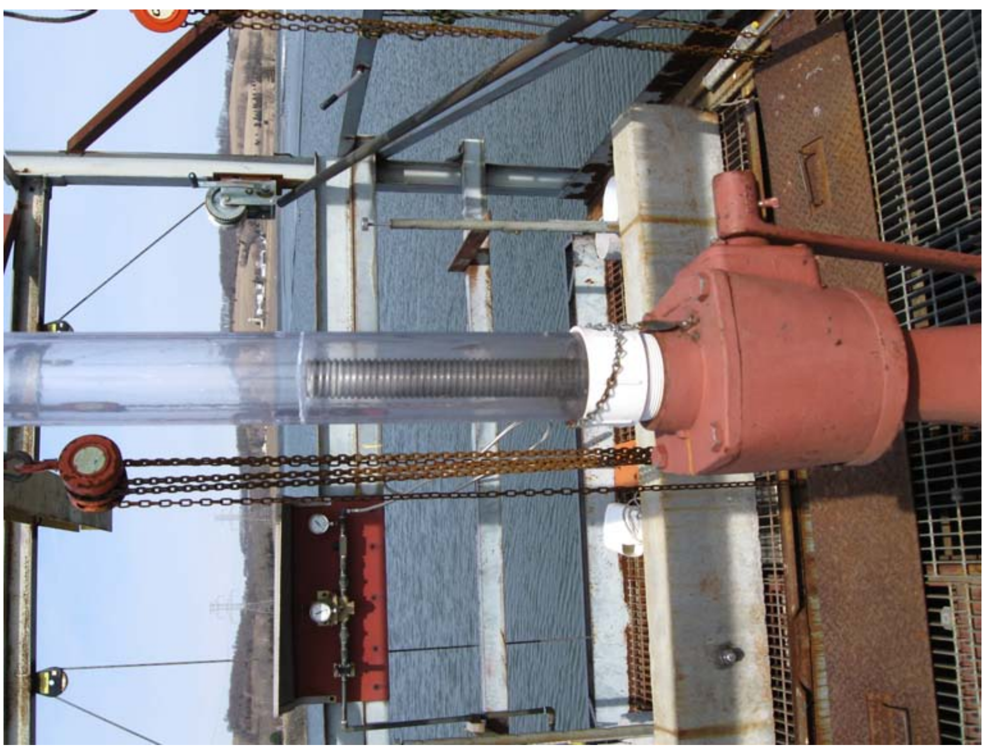
D48-149 Downstream Face/ Toe Area- Left Side 3/13/08

D48-149 Primary Spillway- Pedestrian Bridge Leading to Stoplog Structure & Valve Structure 3/13/08

D48-149 Stoplog Structure 3/13/08

D48-149 Primary Spillway- Outlet 3/13/08

D48-149 Primary Spillway- Discharge Channel 3/13/08



D48-149 Drawdown Facility- Upstream Closure 3/13/08

CRK:sml
D48-149-03-13-08-2.doc
H: 03/17/08
T(D): 3/28/08
R(F): 5/28/08

DAM INSPECTION REPORT

Dam No.:	D48-149
Dam Name:	Martins Creek Ash Basin No. 4
Inspector:	Michael A. Sames
Date of Inspection:	August 29, 2006

LOCATION

Stream:	Tributary to Oughoughton Creek
Municipality:	Lower Mount Bethel Township
County:	Northampton

Latitude: 40° 48' 30" Longitude: 75° 07' 00" GPS Verified: Yes

OWNER: Pennsylvania Power & Light Co.

PERTINENT DATA

Type:	Earthen
Height:	43 feet
Storage:	325 acre feet
D.A.:	0.06 square miles
Class:	B-2

PRESENT CONDITIONS

Crest: The crest of the dam has a circular, horizontal alignment with a level appearance. The crest consists of a gravel maintenance road which encircles the entire dam. The crest is in good condition.

Upstream Face: The majority of the upstream face consists of a PVC liner which extends throughout the entire basin area. The liner is in good condition. Above the liner, the face consists of a gravel cover. Overall, the face is in good condition. The face has an approximate 2H:1V slope.

Downstream Face: The downstream face consists of an approximate 2H:1V slope with a dense vegetative cover consisting mostly of crown vetch and golden rod. There are a couple of small areas on the face which were recently seeded with a low grass cover establishing. Adjacent to these two areas, near the crest, the face has two small bare areas which appear from recent construction. The dense cover hindered a close inspection of the face. Over the face is in fair condition.

Primary Spillway (Approach, crest, outlet, abutments, etc.): The primary spillway consists of the stop log structure which provides drawdown capabilities. See drawdown facilities for more details.

Emergency Spillway: This dam is not equipped with an emergency spillway.

Drawdown Facilities: The drawdown facilities consist of a stop log structure housed within a concrete structure within the reservoir. There are three closure structures associated with the facilities. The stop log structure itself and two downstream valve structures. The control structures were rehabilitated last year and are in good condition. The outlet is several thousand feet downstream. A 6-inch flow was discharging from the CMP outlet to a grouted riprap discharge channel. The outlet structure and channel are in good condition.

Downstream Toe and Areas Beyond (Seepage, toe, drain, vegetation, etc.): The downstream toe has a dense cover of crown vetch, golden rod and other perennial vegetative growth. The dense growth hindered a close inspection of this area.

Comments: Overall, the dam is in good condition. The owner should consider establishment of a maintenance program which includes the routine cutting of vegetation on the downstream face and along the toe. The ultimate goal should be the establishment of a controlled grass cover in these areas. The two small bare areas on the downstream face should be seeded and mulched. There is no low flow release required at this dam. This facility is a storage facility for fly ash.

Submitted by:

Michael A. Sames
Engineering Field Representative
Permitting and Technical Services Section
Northeast Regional Office

Attachment

cc: Division of Dam Safety

WP: D48-149-08-29-06-1.doc

D48-149 Crest/Upstream Face 8/29/06

D48-149 Crest/Upstream Face 8/29/06

D48-149 Crest/Upstream Face 8/29/06

D48-149 Crest/Upstream Face 8/29/06

D48-149 Crest/Upstream Face 8/29/06

D48-149 Crest/Upstream Face 8/29/06

D48-149 Downstream Face 8/29/06

D48-149 Downstream Face 8/29/06

D48-149 Downstream Face 8/29/06

D48-149 Downstream Face 8/29/06

D48-149 Downstream Face 8/29/06

D48-149 Downstream Face 8/29/06

D48-149 Footbridge to the Stop Log Structure 8/29/06

D48-149 Stop Log Structure 8/29/06

D48-149 Upstream Valve Closure 8/29/06

D48-149 Downstream Valve Closure 8/29/06

D48-149 Spillway/Drawdown Outlet Structure 8/29/06

D48-149 Spillway/Drawdown Outlet Channel 8/29/06

MAS:lms
D48-149-08-29-06-1.doc
H: 8/31/06
T(D): 9/12/06
T(F): 9/26/06

DAM INSPECTION REPORT

Dam No.: D48-149

Dam Name: Martins Creek Ash Basin No. 4

Inspector: Christopher R. Kulick, E.I.T.

Date of Inspection: September 13, 2007

LOCATION

Stream: Tributary to Oughoughton Creek

Municipality: Lower Mount Bethel Township

County: Northampton

Latitude: 40° 48' 30" Longitude: 75° 07' 00" GPS Verified: Yes

OWNER: Pennsylvania Power & Light Co.

PERTINENT DATA

Type: Earthen

Height: 43 feet

Storage: 325 acre feet

D.A.: 0.06 square miles

Class: B-2

PRESENT CONDITIONS

Crest: The crest of the dam has a circular, horizontal alignment with a level appearance. The crest consists of a gravel maintenance road which encircles the entire dam. The crest is in good condition.

Upstream Face: The majority of the upstream face consists of a PVC liner which extends throughout the entire basin area. The liner is in good condition. Above the liner, the face consists of a gravel cover. The face is in good condition.

Downstream Face: The downstream face consists of an approximate 2H:1V slope with a dense vegetative cover consisting mostly of crown vetch. The dense cover hindered a close inspection of the face. The face is in fair condition.

Primary Spillway (Approach, crest, outlet, abutments, etc.): The primary spillway consists of the stop log structure which provides drawdown capabilities. See drawdown facilities for more details.

Emergency Spillway: This dam is not equipped with an emergency spillway.

Drawdown Facilities: The drawdown facilities consist of a stop log structure housed within a concrete structure within the reservoir. There are three closure structures associated with the facilities. The stop log structure itself and two downstream valve structures. The control structures were rehabilitated and are in good condition. The outlet is several thousand feet downstream. A 4-inch flow was discharging from the CMP outlet to a grouted riprap discharge channel. The outlet structure and channel are in good condition.

Downstream Toe and Areas Beyond (Seepage, toe, drain, vegetation, etc.): The downstream toe has a dense cover of crown vetch and other perennial vegetative growth. The dense growth hindered a close inspection of this area.

Comments: The dam is in good condition. The owner should consider establishment of a maintenance program which includes the routine cutting of vegetation on the downstream face and along the toe. The goal should be the establishment of a controlled grass cover in these areas. There is no low flow release required at this dam.

Submitted by:

Christopher R. Kulick, E.I.T.
Engineering Field Representative
Permitting and Technical Services Section
Northeast Regional Office

Attachment

cc: Division of Dam Safety

WP: D48-149-09-13-07-2.doc

D48-149 Crest 09/13/2007

D48-149 Upstream Face 09/13/2007

D48-149 Downstream Face 09/13/2007

D48-149 Primary Spillway 09/13/2007

CRK:cmz
D48-149-09-13-07-2.doc
H: 09/20/07
T(D): 10/23/07
R(F): 12/5/07

DAM INSPECTION REPORT

Dam No.: D48-149

Dam Name: Martins Creek SES Ash Basin No. 4

Inspector: Christopher R. Kulick

Date of Inspection: March 4, 2004

LOCATION

Stream: Tributary to Oughoughton Creek

Municipality: Lower Mount Bethel Township

County: Northampton

Latitude: 40° 48' 10" Longitude: 75° 07' 05" GPS Verified: Y

OWNER: PPL Martins Creek, LLC

PERTINENT DATA

Type: Earthen

Height: 43 feet

Storage: 325 acre feet

D.A.: 0.06 square miles

Class: B-2

PRESENT CONDITIONS

Crest: The crest of the dam has a parallelogram-shaped horizontal alignment and has a level appearance. At two locations, the crest is higher due to ash discharge pipes extending into the reservoir from the power plant station. The two locations are approximately 2 feet higher than the remainder of the crest. The crest consists of a one-lane gravel access roadway that extends along the perimeter of the reservoir.

Upstream Face: The slope of the upstream face of the dam was estimated at 2H:1V that consists of a rubberized liner that overlays the earthen fill. The liner extends from below the normal pool to approximately 2 feet below the crest. Above this, the face consists of the gravel road surface. One vegetated fill area extends from the crest into the reservoir and is located approximately 300 feet to the right of the concrete riser structure. Several repair patches were noted throughout the liner.

Downstream Face: The slope of the downstream face of the dam was estimated at 2H:1V. The face mostly consists of a moderate crown vetch cover. Two access roads extend from the toe area to the crest, one on each side of the riser structure. Both access roads consist of a gravel surface. The two ash discharge pipes on the left side of the face are exposed. Some sporadic sapling and brush growth was noted throughout the face.

Primary Spillway (Approach, crest, outlet, abutments, etc.): The approach to the primary spillway, which is located within the reservoir, is clear and unobstructed. The spillway consists of a concrete riser structure near the center of the dam. Access to the riser structure is by a steel pedestrian bridge.

The riser structure could only be inspected from the embankment because the pedestrian bridge was caution-taped off for unknown reasons. Because of this, the wooden stop logs within the riser structure were not observed and the depth of flow could not be determined. No outlet was located.

Drawdown Facilities: The drawdown control for the reservoir is located within the concrete riser structure and consists of the wooden stop log structure within the primary spillway intake structure. No outlet was found.

Downstream Toe and Areas Beyond (Seepage, toe, drain, vegetation, etc.): The downstream toe areas and beyond consist of a roadside swale at the toe leading to a one-lane gravel access road that traverses the perimeter of the toe. The two ash discharge pipes from the power station cross the access road to the left of the primary spillway.

The left toe area consisted of standing water, which appeared as a result of poor drainage. The remainder of the roadside swales had standing water with minor flow. A liquid carbon dioxide storage tank within a barbed wire fenced-in area is located just to the left of the access road.

Comments: Overall, the dam is in good condition. The overgrowth on the downstream face should be cut on a routine basis. The roadside swales along the toe of the dam should be graded to alleviate standing water so any potential seepage could be observed.

No low flow release is required for this dam.

Submitted by:

Christopher R. Kulick, E.I.T.
Engineering Field Representative
Soils and Waterways Section
Northeast Regional Office

Attachment

cc: Division of Dam Safety

WP: D48-149-03-04-04-2.doc

D48-149 Crest/Upstream Face – Left Side 03/04/04

D48-149 Crest/Upstream Face – Right Side 03/04/04

D48-149 Downstream Face/Toe Area – Left Side 03/04/04

D48-149 Downstream Face/Toe Area –Right Side 03/04/04

D48-149 Downstream Face/Toe Area Near the Dam Center 03/04/04

D48-149 Primary Spillway Intake Structure 03/04/04

D48-149	Steel Pedestrian Access Bridge to Primary Spillway Intake Structure	03/04/04

CK:smd
D48-149-03-04-04-2
H: 3/8/04, T(D): 3/25/04, R(F): 4/5/04, R(F): 4/13/04

DAM INSPECTION REPORT

Dam No.: D48-149

Dam Name: Martins Creek SES Ash Basin No. 4

Inspector: Christopher R. Kulick

Date of Inspection: March 23, 2005

LOCATION

Stream: Tributary to Oughoughton Creek

Municipality: Lower Mount Bethel Township

County: Northampton

Latitude: 40° 48' 10" Longitude: 75° 07' 05" GPS Verified: Y

OWNER: PPL Martins Creek, LLC

PERTINENT DATA

Type: Earthen

Height: 43 feet

Storage: 325 acre feet

D.A.: 0.06 square miles

Class: B-2

PRESENT CONDITIONS

Crest: The crest of the dam consists of a parallelogram-shaped embankment surrounding the reservoir. The crest has a level appearance except at two locations where ash discharge pipes cross the crest and extend into the reservoir from the power station. Fill on top of these pipes allow vehicular access to pass over. These two areas are on the left side of the crest and are approximately 4 ft. above the remainder of the crest. The entire crest consists of a one-lane gravel roadway with some minor rutting. No other deficiencies were noted.

Upstream Face: The upstream face of the dam exists on a uniform slope that was estimated at 3H:1V. The face consists of a rubberized liner on top of the earthen fill. The liner extends from below the normal pool elevation to approximately 2 ft. below the crest. Above the liner, the face consists of a gravel surface. A vegetated fill area extends from the crest into the reservoir. This is a ash unloading area that is located approximately 300 ft. to the right of the concrete riser structure. Within this area, a concrete pad and headwall structure was constructed to limit the disturbance of the service vehicles. Several areas of the liner are patched and the remainder of the liner is in good condition with no holes or tearing observed. A sporadic moderate brush growth was noted along the top portion of the face.

Downstream Face: The downstream face is on a uniform slope estimated at 2H:1V. The face consists of a matted-down crown vetch cover. Two access roads exist on the face. One is for access to the crest and the other is for exiting the crest. The entrance ramp extends from the downstream toe to the crest to the left of the concrete intake structure. The exit ramp is located to the right of the concrete intake structure and extends to the downstream toe. Both access roads consist of a one-lane gravel road surface. The two ash discharge pipes on the left side of the face are exposed on the downstream face. Sporadic sapling and brush growth was noted throughout the face.

Primary Spillway (Approach, crest, outlet, abutments, etc.): The approach to the primary spillway is clear and unobstructed. The spillway consists of a concrete riser structure located in the reservoir near the center of the dam approximately 80 ft. from the crest. Access to the riser structure is by a steel pedestrian bridge. The bridge is in good condition.

The pool elevation is controlled by wooden stop logs within the riser structure. The stoplog structure could only be inspected from the pedestrian bridge. The top log was barely visible due to the estimated 2-inch flow depth to the concrete box structure. Several inches of flow was noted over the stop logs. The outlet could not be located.

Drawdown Facilities: The drawdown control for the reservoir is provided by wooden stop logs within the primary spillway intake structure. The outlet could not be located.

Downstream Toe and Areas Beyond (Seepage, toe, drain, vegetation, etc.): The downstream toe area of the dam consists of a roadside swales leading to a one-lane gravel access roadway that traverses the perimeter of the toe area. The ash discharge pipe from the power station exists on the left toe area.. The left toe area also had standing water. This standing water appears to be from poor drainage. The roadside swales had standing water with minor flow noted. A Liquid Carbon Dioxide storage tank within a barbed wire fenced-in area is at the toe just to the left of the access road to the dam.

Comments: The dam is in good condition. The overgrowth on the embankment and along the downstream toe should be cut on a regular basis. The roadside swales along the toe should be graded to promote flow and prevent standing water so that any seepage could be observed.

There is no low flow release required for this dam.

Submitted by:

Christopher R. Kulick, E.I.T.
Engineering Field Representative
Permitting and Technical Services Section
Northeast Regional Office

Attachment

cc: Division of Dam Safety

WP: D48-149-03-23-05-2.doc

D48-149 Crest/Upstream Face – Left Side 03/23/05

D48-149 Crest/Upstream Face – Left Side 03/23/05

D48-149 Crest/Upstream Face – Right Side 03/23/05

D48-149 Crest/Upstream Face – Right Side 03/23/05

D48-149 New Concrete Pad & Headwall Structure – Ash Unloading Area on Right Side of Upstream Face 03/23/05

D48-149 Downstream Face/Toe Area – Right Side 03/23/05

D48-149 Downstream Face/Toe Area – Right Side 03/23/05

D48-149 Downstream Face/Toe Area – Left Side 03/23/05

D48-149 Downstream Face/Toe Area – Left Side 03/23/05

D48-149 Primary Spillway & Drawdown Facility 03/23/05

D48-149 Primary Spillway & Wooden Stop Log Structure 03/23/05

CK:kab
D48-149-03-23-05-2.doc
H & T(D)P: 9/1/2005
R(F)P: 9/1/2005

DAM INSPECTION REPORT

Dam No.:	D48-149
Dam Name:	Martins Creek SES Ash Basin No. 4
Inspector:	Christopher R. Kulick
Date of Inspection:	April 2, 2002

LOCATION

Stream:	Tributary to Oughoughton Creek
Municipality:	Lower Mount Bethel Township
County:	Northampton

Latitude: 40°48’10” Longitude: 75°07’05” GPS Verified Y

OWNER: PPL Martins Creek, LLC

PERTINENT DATA

Type:	Earthen Fill
Height:	43 feet
Storage:	325 acre-feet
D.A.:	0.06 square miles
Class:	B-2

PRESENT CONDITIONS

Crest: The crest of the dam consists of an oval-shaped embankment. The crest appears level except at two locations where ash discharge pipes cross the crest and extend into the reservoir from the power station. These two areas are on the left side of the crest and are approximately 2 ft. above the remainder of the crest. A one-lane gravel roadway traverses the entire perimeter of the reservoir along the center of the crest. The gravel roadway has a few minor depressions. No other deficiencies were noted.

Upstream Face: The upstream face is on even slope and consists of a rubberized liner that overlays the earthen fill from below the normal pool to approximately 2 ft. below the crest. From the liner to the crest, the upstream face consists of a gravel surface. A vegetated fill area extends from the crest into the reservoir. This fill area is located approximately 300 ft. to the right of the concrete riser structure. A few areas of liner are patched and the remainder of the liner appears in good condition with no holes or tearing noted. A minor amount of knee to waist-high brush growth was noted along the top portion of the face.

Downstream Face: The downstream face is on an even slope and consists of a knee-high crown vetch cover. The face also consists of two access roads, one for access to the dam and the other for exiting the dam. The entrance ramp extends from the downstream toe to the crest to the left of the concrete intake structure. The exit ramp is located to the right of the concrete intake structure to the downstream toe. Both access roads are one-lane and have a gravel road surface. The two ash discharge pipes on the left side of the face are exposed on the downstream face. Some sporadic sapling and brush growth was noted.

Primary Spillway (Approach, crest, outlet, abutments, etc.): The approach to the primary spillway is clear and unobstructed. The primary spillway consists of a concrete riser structure located in the reservoir near the center of the dam approximately 80 ft. from the upstream face. Access to the riser structure is by a steel pedestrian bridge, which appears in good condition.

The pool elevation is controlled by wooden stop logs within the riser structure. Several inches of flow was noted over the stop logs. The outlet could not be located. The intake structure appears sin good condition.

Drawdown Facilities: The drawdown control for the reservoir is provided by wooden stop logs within the primary spillway concrete intake structure. The outlet could not be located. Two wooden stop logs were stored on the pedestrian access bridge.

Downstream Toe and Areas Beyond (Seepage, toe, drain, vegetation, etc.): The downstream toe of the dam consists of a roadside swale and a one-lane gravel access roadway that traverses the perimeter of the toe area. The toe area to the left of the primary spillway consists of the ash discharge pipe from the power station. The left toe area had standing water. This appeared to be from poor drainage of this area. The roadside swales had standing water with minor flow noted. A section of the roadway has eroded due to run-off of a farm field. The erosion does not prevent access around the toe. This area is on the right toe area. A Liquid Carbon Dioxide storage tank within a barbed wire fenced-in area is at the toe just to the left of the entrance access road to the dam.

Comments: Overall, the dam appears in good condition. The overgrowth on the embankment and along the downstream toe should be cut on a regular basis. The roadside swales along the toe should be graded to promote flow and prevent standing water so that any seepage could be noted.

There is no low flow release required for this dam.

Submitted by:

Engineering Field Representative
Soils and Waterways Section
Northeast Regional Office

Attachment

cc: Division of Dam Safety

WP: D48-149-04-02-03-2.doc

D48-149 Crest/Upstream Face – Left Side 04/02/03

D48-149 Crest/Upstream Face – Left Side 04/02/03

D48-149 Crest/Upstream Face – Right Side 04/02/03

D48-14- Vegetated Area on Right Side of Upstream Face 04/02/03

D48-149 Gravel Access Road on Downstream Face to the Right of the Spillway 04/02/03

D48-149 Gravel Access Road on Downstream Face to the Left of the Spillway 04/02/03

D48-149 Downstream Face & Toe Area – Left Side 04/02/03

D48-149 Downstream Face & Toe Area – Left Side 04/02/03

D48-149 Downstream Face & Toe Area – Right Side 04/02/03

D48-149 Primary Spillway 04/02/03

CRK:jar
H: 4/4/03
T(D): 4/17/03
R(F): 4/23/03

3140-FM-WE0001 Rev. 3/2008

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL PROTECTION
BUREAU OF WATERWAYS ENGINEERING
DIVISION OF DAM SAFETY

DEP Data Records	Inspection Record #: 1825336
Complaint Record #	Enforcement Record #

DAM SAFETY INSPECTION NOTICE

DEP Office	Dam Safety Central Office Phone 717 787 8568	Dam Permit or ID. #	D 48-149
Address	400 Market Street, Harrisburg, PA 17110	Dam or Project Name	Martins Creek Basin No. 4
		County	Northampton
Owner or Permittee	PPL Martins Creek, LLC	Municipality	Lower Mt. Bethel Twp.
Complete Mailing Address	Attn: Steve Holler, P.E. 6605 Foul Rift Road Bangor, PA 18013	Take GPS readings at the center of the crest of the dam.	
		Latitude:	40 ° 48 ' 13 " N
		Longitude:	75 ° 07 ' 04 " W

Type of Inspection:
☐ ADMIN - Administrative / File Review
☐ CEI - Compliance Evaluation
☐ COMPL - Complaint Inspection
☐ CONST - Construction Progress
☐ DAM12 - Category 1 or 2 dam
☐ DAM3 - Category 3 dam
☒ FUI - Follow-up Inspection
☐ INCDT - Incident response
☐ OTHER ______

Fold Line

Location / Appurtenance	Insp.	Condition OK	Condition Concern	Comment / Explain Concern	Violation? Check if yes	Cite 25 Pa. Code
Crest	☒	☒	☐		☐	
Upstream Face	☒	☒	☐		☐	
Downstream Face	☒	☐	☒	Vegetation on the downstream/outslope	☐	
Outlet Structure	☒	☒	☐		☐	
Outlet Conduit	☐	☐	☐	face is thick & about waist high	☐	
Primary Spillway	☐	☐	☐		☐	
Emergency Spillway	☐	☐	☐	which prevents a close visual	☐	
Spillway Channels	☐	☐	☐		☐	
Downstream Toe Area	☒	☐	☒	Inspection. This is similiar along	☐	
Encroachments	☐	☐	☐		☐	
Site Restoration	☐	☐	☐	the toe. The vegetation should be	☐	
E & S Plan on Site	☐	☐	☐		☐	
E & S Controls	☐	☐	☐	cut or sprayed more routinely.	☐	
	☐	☐	☐		☐	
	☐	☐	☐		☐	
	☐	☐	☐		☐	

Inspection Results Code:
☐ DVN (De Minimus Violation)
☒ NOVIO (No significant violations noted)
☐ OUTST (Outstanding violations, notice req'd)
☐ RECUR (Recurring violations)
☐ REPAR (Repairs or upgrade required)
☐ VIOIC (Viols noted and immediately corrected)
☐ VIOLS (Violation(s) noted)
☐ VOV (New and outstanding violations Noted)
☐ VRV (New and recurring violations noted)

Violations Noted? ☐ Yes ☒ No **Field Notice of Violation?** ☐ Yes ☒ No **Compliance Order?** ☐ Yes ☒ No

Remarks: *This report is a summary of the undersigned DEP representative's visual inspection only on this date, not an in-depth investigation of the dam's present condition or compliance history. The inspector's full report is available by contacting the DEP office noted above.*

A Dam Permit Application for Modifications/closure of the basin has been submitted & is currently under review by the Division.

DEP Inspector was accompanied by		DEP Rep:	
☒ Owner	☒ Engineer for Owner or Permittee	(signature) [signature]	Date: 9/2/09
☐ Permittee	☒ Other: EPA Rep.	(print name) Richard Reisinger Phone: 717 772 5957	Time: 2:00 p.m.

☒ White – Owner, Permittee, or Representative ☒ Yellow – Division of Dam Safety, Central Office ☒ Pink – DEP Regional File NERO

3140-FM-WE0001 Rev. 3/2008

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL PROTECTION
BUREAU OF WATERWAYS ENGINEERING
DIVISION OF DAM SAFETY

DEP Data Records	Inspection Record # 1825697
Complaint Record #	Enforcement Record #

DAM SAFETY INSPECTION NOTICE

DEP Office: Dam Safety Central office Phone: 717 787 8568
Address: 400 Market Street, Harrisburg, PA 17110
Owner or Permittee: PPL Martins Creek, LLC
Complete Mailing Address: Attn: Steve Holler, P.E., 6605 Foul Rift Road, Bangor, PA 18013

Dam Permit or ID. #: D48-165
Dam or Project Name: Martins Creek Basin No 1
County: Northampton
Municipality: Lower Mt Bethel Twp.
Take GPS readings at the center of the crest of the dam.
Latitude: 40 ° 47 ' 34 " N
Longitude: 75 ° 06 ' 47 " W

Type of Inspection:
☐ ADMIN - Administrative / File Review
☐ CEI - Compliance Evaluation
☐ COMPL - Complaint Inspection
☐ CONST - Construction Progress
☐ DAM12 - Category 1 or 2 dam
☐ DAM3 - Category 3 dam
☒ FUI - Follow-up Inspection
☐ INCDT - Incident response
☐ OTHER ______

Fold Line

Location / Appurtenance	Insp.	Condition OK	Condition Concern	Comment / Explain Concern	Violation? Check if yes	Cite 25 Pa. Code
Crest	☒	☐	☐	Basin is mostly covered with	☐	
Upstream Face	☒	☐	☐	vegetation, trees, & Brush & does	☐	
Downstream Face	☒	☐	☐		☐	
Outlet Structure	☒	☐	☐	not appear to impound water on	☐	
Outlet Conduit	☐	☐	☐	a routine Basis.	☐	
Primary Spillway	☐	☐	☐		☐	
Emergency Spillway	☐	☐	☐		☐	
Spillway Channels	☐	☐	☐		☐	
Downstream Toe Area	☒	☐	☐		☐	
Encroachments	☐	☐	☐		☐	
Site Restoration	☐	☐	☐		☐	
E & S Plan on Site	☐	☐	☐		☐	
E & S Controls	☐	☐	☐		☐	
	☐	☐	☐		☐	
	☐	☐	☐		☐	
	☐	☐	☐		☐	

Inspection Results Code:
☐ DVN (De Minimus Violation)
☒ NOVIO (No significant violations noted)
☐ OUTST (Outstanding violations, notice req'd)
☐ RECUR (Recurring violations)
☐ REPAR (Repairs or upgrade required)
☐ VIOIC (Viols noted and immediately corrected)
☐ VIOLS (Violation(s) noted)
☐ VOV (New and outstanding violations Noted)
☐ VRV (New and recurring violations noted)

Violations Noted? ☐ Yes ☒ No **Field Notice of Violation?** ☐ Yes ☒ No **Compliance Order?** ☐ Yes ☒ No

Remarks: *This report is a summary of the undersigned DEP representative's visual inspection only on this date, not an in-depth investigation of the dam's present condition or compliance history. The inspector's full report is available by contacting the DEP office noted above.*

Dam Permit Application for Closure of the Basin has been submitted & is currently under review by the Division.

DEP Inspector was accompanied by
☒ Owner ☒ Engineer for Owner or Permittee
☐ Permittee ☒ Other: EPA Rep.

DEP Rep:
(signature) [signature]
(print name) Richard Reisinger Phone: 717 772 5957
Date: 9/2/09 Time: 11:00-12:30

☒ White – Owner, Permittee, or Representative ☒ Yellow – Division of Dam Safety, Central Office ☒ Pink – DEP Regional File NERO

Cooling Towers, Martins Creek Power Plant, Bangor, PA, 09.01.09.

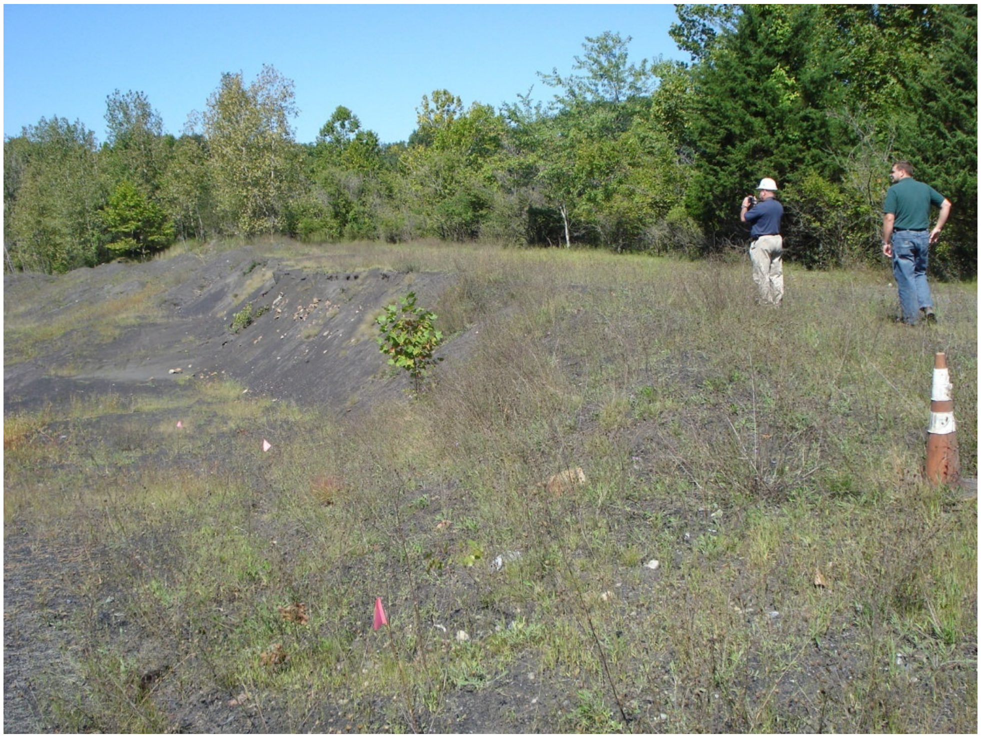
Discharge Pipeline, Martins Creek Power Plant, Bangor, PA, 09.01.09.

(Basin 1) S End, Martins Creek Power Plant, Bangor, PA, 09.01.09.

(Basin 1) N End, Martins Creek Power Plant, Bangor, PA, 09.01.09.

(Basin 1) Inlet Pipe (where would sluice in) Martins Creek Power Plant, Bangor, PA, 09.01.09.

(Basin 1) Inlet Basin Area, Martins Creek Power Plant, Bangor, PA, 09.01.09.



(Basin 1) Berm Nearest Plant, Martins Creek Power Plant, Bangor, PA, 09.01.09.

(Basin 1) Berms to be Flattened Before Closure (black gravel=bottom ash; white objects are buckets), Martins Creek Power Plant, Bangor, PA, 09.01.09.

(Basin 1) Outlet Pipe (discharge), Martins Creek Power Plant, Bangor, PA, 09.01.09.

(Basin 1) Inlet to Outlet Pipe, Martins Creek Power Plant, Bangor, PA, 09.01.09.

(Basin 1) S Dike Area, Martins Creek Power Plant, Bangor, PA, 09.01.09.

(Basin 1) Outfall Structure from Lower End (concrete riser, most likely concrete pipe), Martins Creek Power Plant, Bangor, PA, 09.01.09.

(Basin 1) Toe and Outfall at Bottom of Steep Embankment, Martins Creek Power Plant, Bangor, PA, 09.01.09.

(Basin 1) Railroad Tracks, Martins Creek Power Plant, Bangor, PA, 09.01.09.

(Basin 1) Toe at Bottom of Steep Embankment, Martins Creek Power Plant, Bangor, PA, 09.01.09.

(Basin 2) Discharge Structure, Martins Creek Power Plant, Bangor, PA, 09.01.09.

(Basin 3) Earthen Cap (view from Basin 4 E berm), Martins Creek Power Plant, Bangor, PA, 09.01.09.

(Basin 4) At Elev. 355' at Top of Dike, Martins Creek Power Plant, Bangor, PA, 09.01.09

(Basin 4) Outfall Structure, Martins Creek Power Plant, Bangor, PA, 09.01.09.

(Basin 4) Colling Towers, Martins Creek Power Plant, Bangor, PA, 09.01.09.

(Basin 4) Watermark on Liner (view from outfall structure), Martins Creek Power Plant, Bangor, PA, 09.01.09.

(Basin 4) Looking Down Outfall Structure, Martins Creek Power Plant, Bangor, PA, 09.01.09.

(Basin 4) Ash from Outfall, Martins Creek Power Plant, Bangor, PA, 09.01.09.

(Basin 4) 10' Deep of Rip Rap from Outfall, Martins Creek Power Plant, Bangor, PA, 09.01.09.

(Basin 4) Two Lines Coming into the Basin, Martins Creek Power Plant, Bangor, PA, 09.01.09.

(Basin 4) Machine Pushing Material Around, Martins Creek Power Plant, Bangor, PA, 09.01.09.

(Basin 4) Machine Pushing Material Around (zoomed in view), Martins Creek Power Plant, Bangor, PA, 09.01.09.

(Basin 4) Machine Pushing Material Around (zoomed in view), Martins Creek Power Plant, Bangor, PA, 09.01.09.

(Basin 4) Looking Back Toward Outfall Structure (from E berm on northern end), Martins Creek Power Plant, Bangor, PA, 09.01.09.

(Basin 4) Markings from Previous Inspections Where Liner Needs Maintenance, Martins Creek Power Plant, Bangor, PA, 09.01.09.

(Basin 4) Ash from Inside Basin, Martins Creek Power Plant, Bangor, PA, 09.01.09.

(Basin 4) From NW Berm, Martins Creek Power Plant, Bangor, PA, 09.01.09.

(Basin 4) Inlet to Previously Used to Sluice Material from ITWB & Cooler Blowdown (as of Sept. 09, Cooler Blowdown goes to IWTB), Martins Creek Power Plant, Bangor, PA, 09.01.09.

(Basin 4) Grass On Top of Coal Ash (nothing holding ash together, so subject to sloughing), Martins Creek Power Plant, Bangor, PA, 09.01.09.

(Basin 4) Power Washing Fly Ash Off Liner, Martins Creek Power Plant, Bangor, PA, 09.01.09.

(Basin 4) SE Outer Embankment, Martins Creek Power Plant, Bangor, PA, 09.01.09.

(Basin 4) Cooling Towers (from outer E berm), Martins Creek Power Plant, Bangor, PA, 09.01.09.

(IWTB) Carbon Dioxide System, Martins Creek Power Plant, Bangor, PA, 09.01.09.

(IWTB) Ducks Indicating Presence of Fish in Basin, (from discharge structure), Martins Creek Power Plant, Bangor, PA, 09.01.09.

(IWTB) Inlets to Basin (far side is from cooling tower blowdown), Martins Creek Power Plant, Bangor, PA, 09.01.09.

(IWTB) Oil Water Seperator, Martins Creek Power Plant, Bangor, PA, 09.01.09.

(IWTB) Oil Water Separator (with IWTB in background),Martins Creek Power Plant, Bangor, PA, 09.01.09.

(Combined Structure) 1 of 4, Martins Creek Power Plant, Bangor, PA, 09.01.09.

(Combined Structure) 2 of 4, Martins Creek Power Plant, Bangor, PA, 09.01.09.

(Combined Structure) 3 of 4, Martins Creek Power Plant, Bangor, PA, 09.01.09.

(Combined Structure) 4 of 4, Martins Creek Power Plant, Bangor, PA, 09.01.09.

Coal Combustion Dam Inspection Checklist Form

US Environmental Protection Agency

Site Name: PPL MARTINS CREEK Date: 2 SEPTEMBER 2009

Unit Name: ASH BASIN NO. 1 (RETIRED) Operator's Name: PPL GENERATION

Unit I.D.: Hazard Potential Classification: High Significant **Low**

Inspector's Name: FREDERIC C. TUCKER, PE / LAUREN OHOTSKE

Check the appropriate box below. Provide comments when appropriate. If not applicable or not available, record "N/A". Any unusual conditions or construction practices that should be noted in the comments section. For large diked embankments, separate checklists may be used for different embankment areas. If separate forms are used, identify approximate area that the form applies to in comments.

	Yes	No		Yes	No
1. Frequency of Company's Dam Inspections?	MNTLY		18. Sloughing or bulging on slopes?		✓
2. Pool elevation (operator records)?	NO POOL		19. Major erosion or slope deterioration?		✓
3. ~~Decant inlet~~ RISER TOP elevation (operator records)?	241.44		20. ~~Decant~~ OUTLET Pipes:		
4. Open channel spillway elevation (operator records)?	N/A		Is water entering inlet, but not exiting outlet?	N/A	
5. Lowest dam crest elevation (operator records)?	245 & 263		Is water exiting outlet, but not entering inlet?	N/A	
6. If instrumentation is present, are readings recorded (operator records)?	N/A		Is water exiting outlet flowing clear?	N/A	
7. Is the embankment currently under construction?		✓	21. Seepage (specify location, if seepage carries fines, and approximate seepage rate below):		
8. Foundation preparation (remove vegetation, stumps, topsoil in area where embankment fill will be placed)?	N/A		From underdrain?	N/A	
9. Trees growing on embankment? (If so, indicate largest diameter below)	✓		At isolated points on embankment slopes?		✓
10. Cracks or scarps on crest?		✓	At natural hillside in the embankment area?		✓
11. Is there significant settlement along the crest?		✓	Over widespread areas?		✓
12. ~~Are decant trashracks~~ IS RISER SCREEN clear and in place?	✓		From downstream foundation area?		✓
13. Depressions or sinkholes in tailings surface or whirlpool in the pool area?	N/A		"Boils" beneath stream or ponded water?		✓
14. Clogged spillways, groin or diversion ditches?	N/A		Around the outside of the decant pipe?	N/A	
15. Are spillway or ditch linings deteriorated?	N/A		22. Surface movements in valley bottom or on hillside?		✓
16. Are outlets of ~~decant~~ RISER or underdrains blocked?	N/A		23. Water against downstream toe?		✓
17. Cracks or scarps on slopes?		✓	24. Were Photos taken during the dam inspection?	✓	

Major adverse changes in these items could cause instability and should be reported for further evaluation. Adverse conditions noted in these items should normally be described (extent, location, volume, etc.) in the space below and on the back of this sheet.

Inspection Issue # / COMMENT (KEYED TO ITEM NOS. ABOVE) Comments

1. MONTHLY DRIVE AROUND BY OPERATING PERSONNEL.

2. THERE IS NO OPERATING POOL. BASIN IS RETIRED AND A PROPOSED CLOSURE PLAN HAS BEEN SUBMITTED TO DEP FOR APPROVAL.

3. OUTLET STRUCTURE (RISER) IS STILL OPEN, BUT WATER FROM STORM RUNOFF REPORTEDLY NEVER BUILDS UP ENOUGH TO OVERFLOW INTO THE RISER OUTLET, BECAUSE THE DEPOSITED ASH MATERIALS AND FOUNDATION SOILS (GRANULAR ALLUVIUM) ARE HIGHLY PERMEABLE. V-NOTCH WEIR INVERT 1.75' BELOW TOP OF RISER OR APPROX. EL 239.7, BASED ON TOP OF RISER ELEV. 241.44' NOTED ON DWG. AS OF 5/10/64.

EPA FORM -XXXX

— CONTINUED NEXT PAGE —

1/3

PPL MARTINS CREEK ASH BASIN NO. 1

- CONTINUED FROM PREVIOUS PAGE -

4. THERE ARE NO OPEN CHANNEL SPILLWAYS
5. DAM CREST ELEV. IS 263± AROUND NORTHERN PART OF BASIN, INCLUDING CREST OF CROSS DIKE BUILT OVER ASH; PERIMETER EMBANKMENT AROUND NORTHERN PART OF BASIN RAISED MULTIPLE TIMES TO ULTIMATE ELEV. 263±; EACH EMBANKMENT RAISE WAS SUPPORTED ON ASH ON INTERIOR SIDE.
6. THERE IS NO INSTRUMENTATION FOR MONITORING OF STRUCTURAL PERFORMANCE OR PHREATIC LINE IN THE EMBANKMENTS. MONITORING WELLS AND PIEZOMETERS WERE INSTALLED AND MONITORED IN LATE 2005 FOR ASSESSMENT OF GROUNDWATER QUALITY AND GRADIENTS.
8. NO INFORMATION IS AVAILABLE CONCERNING FOUNDATION PREP.
9. THE BASIN IS GENERALLY OVERGROWN WITH THICK VEGETATION INCLUDING TREES GROWING ON THE CROSS DIKES AND IN THE ASH. SOME TREES WERE OBSERVED TO BE MORE THAN 12" IN DIA. THE OUTER SLOPES WERE OBSERVED TO BE GENERALLY FREE OF TREE GROWTH BUT OVERGROWN WITH LARGE BUSHES AND TALL WEEDS AND GRASS. THE THICK VEGETATION HAMPERED VISUAL INSPECTION FOR SLUMPS, SLIDES, TENSION CRACKS, AND OTHER SIGNS OF EMBANKMENT DISTRESS.
13. BASIN TOO OVERGROWN TO NOTICE DEPRESSIONS OR SINKHOLES.
14. THERE ARE NO SPILLWAYS, DRAIN OR DIVERSION DITCHES.
15. THERE ARE NO SPILLWAY OR DITCH LININGS.
16. THE OUTLET FOR THE BASIN IS A 4-FT DIA. RCP EXTRA STRONG RISER PIPE WITH BOTTOM DISCHARGE THROUGH 3-FT DIA. RCP EXTRA STRONG OUTLET PIPE WITH INLET INVERT OF 217.5 FT. RISER APPEARED UNOBSTRUCTED, BUT THERE WAS NO POOL AND NO WATER 2/3

PPL MARTINS CREEK ASH BASIN NO. 1

– CONTINUED FROM PREVIOUS PAGE –

FLOWING INTO RISER TO OBSERVE WHETHER OR NOT IT WAS FREE FLOWING WITHOUT OBSTRUCTIONS. THE OUTLET END OF DISCHARGE PIPE WAS NOT ACCESSIBLE FOR VIEWING

20. FUNCTION OF OUTLET PIPE COULD NOT BE OBSERVED SINCE NO WATER WAS FLOWING IN AND THE DISCHARGE END COULD NOT BE OBSERVED.

21. THERE ARE NO UNDERDRAINS. NO SEEPAGE WAS OBSERVED, BUT NO WATER WAS CONTAINED IN THE BASIN.

3/3

U. S. Environmental Protection Agency

Coal Combustion Waste (CCW)
Impoundment Inspection

Impoundment NPDES Permit # ____________ INSPECTOR FREDERICK C. TUCKER, PE, LAUREN OHOTZKE

Date ____________

Impoundment Name ASH BASIN NO. 1 PPL MARTINS CREEK

Impoundment Company PPL

EPA Region III

State Agency (Field Office) Addresss PA DEP WASTE MANAGEMENT

Name of Impoundment ASH BASIN NO. 1

(Report each impoundment on a separate form under the same Impoundment NPDES Permit number)

New ________ Update ________

	Yes	No
Is impoundment currently under construction?		✓
Is water or ccw currently being pumped into the impoundment?		✓

IMPOUNDMENT FUNCTION: BASIN IS CURRENTLY RETIRED. FORMERLY WAS USED FOR DISPOSAL OF MAINLY FLY ASH AND BOTTOM ASH FOR 40 YEARS.

Nearest Downstream Town : Name HUTCHINSON, N.J. (ACROSS DELAWARE R.)

Distance from the impoundment APPROX. 14 mi

Impoundment

Location: Longitude 75 Degrees 06 Minutes 47 Seconds

Latitude 40 Degrees 47 Minutes 34 Seconds

State PA County HAMPTON

Does a state agency regulate this impoundment? YES ✓ NO ______

If So Which State Agency? PA DEPT. OF ENVIRONMENTAL PROTECTION (DEP)
- BUREAU OF WASTE MANAGEMENT
- DIVISION OF DAM SAFETY

EPA Form XXXX-XXX, Jan 09 1

HAZARD POTENTIAL (In the event the impoundment should fail, the following would occur):

______ **LESS THAN LOW HAZARD POTENTIAL:** Failure or misoperation of the dam results in no probable loss of human life or economic or environmental losses.

__✓__ **LOW HAZARD POTENTIAL:** Dams assigned the low hazard potential classification are those where failure or misoperation results in no probable loss of human life and low economic and/or environmental losses. Losses are principally limited to the owner's property.

______ **SIGNIFICANT HAZARD POTENTIAL:** Dams assigned the significant hazard potential classification are those dams where failure or misoperation results in no probable loss of human life but can cause economic loss, environmental damage, disruption of lifeline facilities, or can impact other concerns. Significant hazard potential classification dams are often located in predominantly rural or agricultural areas but could be located in areas with population and significant infrastructure.

______ **HIGH HAZARD POTENTIAL:** Dams assigned the high hazard potential classification are those where failure or misoperation will probably cause loss of human life.

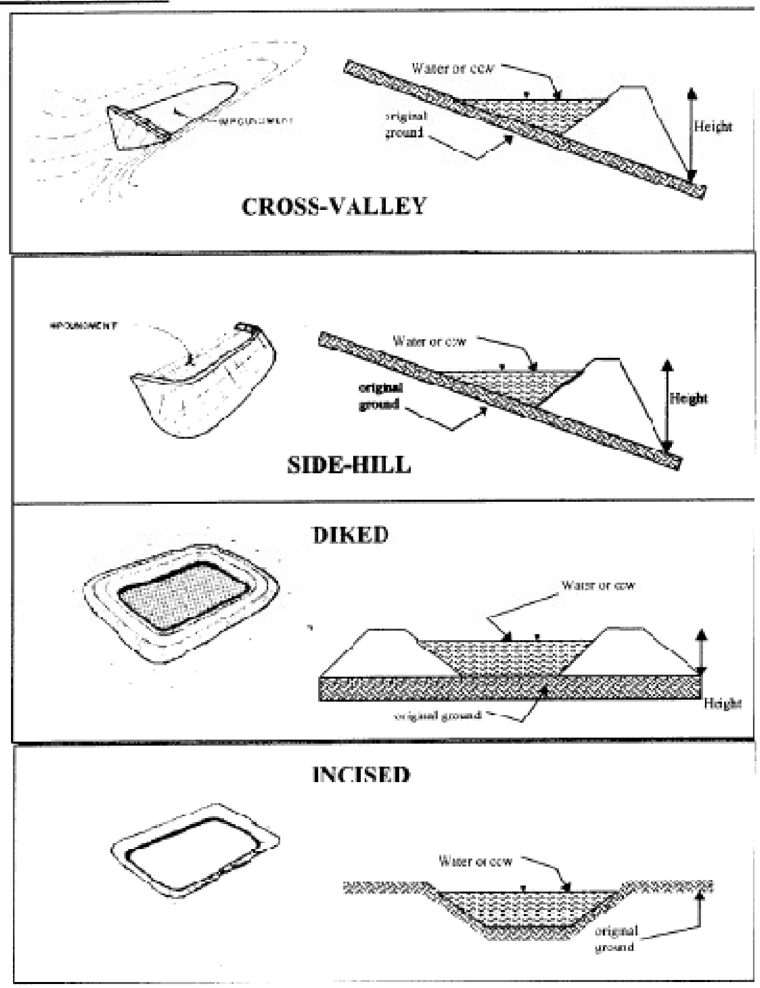
DESCRIBE REASONING FOR HAZARD RATING CHOSEN:

RETIRED BASIN LOCATED IN RURAL AREA WITH NO HABITABLE STRUCTURES DOWNSTREAM BETWEEN IT AND DELAWARE RIVER.

DETERMINATION MADE BY PA DEP DIV OF DAM SAFETY.

EPA Form XXXX-XXX, Jan 09

CONFIGURATION:



_____ Cross-Valley
_____ Side-Hill
_____ Diked
_____ Incised (form completion optional)
✓ Combination Incised/Diked

*Embankment Height 35 feet		Embankment Material	EARTH
Pool Area NO WATER IMPOUNDED acres		Liner	NONE
** Current Freeboard NO WATER feet		Liner Permeability	BOTTOM HIGHLY PERMEABLE

* MAX. HEIGHT ABOVE OUTSIDE TOE NORTHERN PORTION

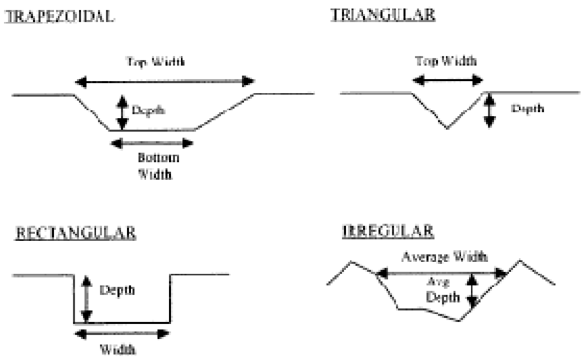
** THE SURFACE ELEV. OF ASH AND DREDGE SOIL MATERIALS INSIDE THE BASIN IS IRREGULAR, RANGING FROM AT OR NEAR CREST ELEV. TO APPROXIMATELY 20' BELOW CREST ELEV. IN BOTH THE SOUTH AND NORTH PORTIONS OF THE BASIN. SURFACE OF WASTE MATERIALS APPEARED DRY & STABLE.

EPA Form XXXX-XXX, Jan 09

TYPE OF OUTLET (Mark all that apply)

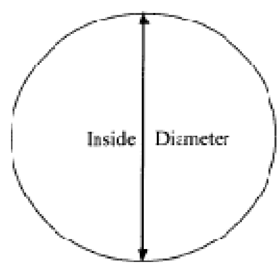
_____ **Open Channel Spillway**
_____ Trapezoidal
_____ Triangular
_____ Rectangular
_____ Irregular

_____ depth
_____ bottom (or average) width
_____ top width



__✓__ **Outlet**

__36"__ inside diameter



Material
_____ corrugated metal
_____ welded steel
__✓__ concrete EXTRA STRONG RCP
_____ plastic (hdpe, pvc, etc.)
_____ other (specify) ____________________

Is water flowing through the outlet? YES _______ NO __✓__

_____ **No Outlet**

_____ **Other Type of Outlet** (specify) ________________________________

The Impoundment was Designed By ____PPL____________________________
____

Has there ever been a failure at this site? YES __________ NO ____✓______

If So When? ____________________________

If So Please Describe : ____

Has there ever been significant seepages at this site? YES _______ NO ✓

If So When? ____________________________

IF So Please Describe: ____

EPA Form XXXX-XXX, Jan 09 6

Has there ever been any measures undertaken to monitor/lower Phreatic water table levels based on past seepages or breaches at this site? YES ________ NO ✓

If so, which method (e.g., piezometers, gw pumping,...)? ____________________

If so Please Describe : ____

EPA Form XXXX-XXX, Jan 09 7

Coal Combustion Dam Inspection Checklist Form

US Environmental Protection Agency

Site Name:	PPL MARTINS CREEK	Date:	2 SEPTEMBER 2009
Unit Name:	ASH BASIN NO. 4	Operator's Name:	PPL GENERATION
Unit I.D.:		Hazard Potential Classification:	**High** Significant Low
Inspector's Name:	FREDERIC C. TUCKER, PE / LAUREN CHOTZKE		

Check the appropriate box below. Provide comments when appropriate. If not applicable or not available, record "N/A". Any unusual conditions or construction practices that should be noted in the comments section. For large diked embankments, separate checklists may be used for different embankment areas. If separate forms are used, identify approximate area that the form applies to in comments.

	Yes	No		Yes	No
1. Frequency of Company's Dam Inspections?	QTLY		18. Sloughing or bulging on slopes?		✓
2. Pool elevation (operator records)?	327		19. Major erosion or slope deterioration?		✓
3. Decant inlet elevation (operator records)?	311		20. Decant Pipes:		
4. Open channel spillway elevation (operator records)?	N/A		Is water entering inlet, but not exiting outlet?	N/A	
5. Lowest dam crest elevation (operator records)?	355		Is water exiting outlet, but not entering inlet?	N/A	
6. If instrumentation is present, are readings recorded (operator records)?	N/A		Is water exiting outlet flowing clear?	N/A	
7. Is the embankment currently under construction?		✓	21. Seepage (specify location, if seepage carries fines, and approximate seepage rate below):		
8. Foundation preparation (remove vegetation,stumps, topsoil in area where embankment fill will be placed)?	✓		From underdrain?	N/A	
9. Trees growing on embankment? (If so, indicate largest diameter below)		✓	At isolated points on embankment slopes?		✓
10. Cracks or scarps on crest?		✓	At natural hillside in the embankment area?	N/A	
11. Is there significant settlement along the crest?		✓	Over widespread areas?		✓
12. Are decant trashracks clear and in place?	N/A		From downstream foundation area?		✓
13. Depressions or sinkholes in tailings surface or whirlpool in the pool area?		✓	"Boils" beneath stream or ponded water?		✓
14. Clogged spillways, groin or diversion ditches?	N/A		Around the outside of the decant pipe?	N/A	
15. Are spillway or ditch linings deteriorated?	N/A		22. Surface movements in valley bottom or on hillside?		✓
16. Are outlets of decant or underdrains blocked?	N/A		23. Water against downstream toe?		✓
17. Cracks or scarps on slopes?		✓	24. Were Photos taken during the dam inspection?	✓	

Major adverse changes in these items could cause instability and should be reported for further evaluation. Adverse conditions noted in these items should normally be described (extent, location, volume, etc.) in the space below and on the back of this sheet.

Inspection Issue # / COMMENT (KEYED TO ITEM NOS. ABOVE) Comments

1. INSPECTIONS PERFORMED QUARTERLY BY PPL PE, DAILY BY OPERATING PERSONNEL, AND ANNUALLY BY OUTSIDE CONSULTANTS; ANNUALLY BY DEP DAM SAFETY.

2. THERE ESSENTIALLY IS NO POOL IN BASIN; STORM WATER IS PUMPED TO INDUSTRIAL WASTE TREATMENT BASIN (IWTB).

4. THERE IS NO OPEN CHANNEL SPILLWAY AT THIS DIKED BASIN.

6. THERE IS NO INSTRUMENTATION.

8. BASIN IS LOCATED OVER CARBONATE ROCK GEOLOGY. PPL REPORTED THAT EXTENSIVE PROGRAM OF FOUNDATION GROUTING WAS DONE. IN ADDITION BASIN WAS LINED WITH GEOMEMBRANE (HYPALON) AS ADDITIONAL SAFEGUARD.

EPA FORM -XXXX

— CONTINUED NEXT PAGE —

1/2

PPL MARTINS CREEK ASH BASIN NO. 4

— CONTINUED FROM PREVIOUS PAGE —

12. THERE ARE NO TRASHRACKS ON DECANT TOWER. HOWEVER, SKIMMER PLATE WAS USED TO PREVENT SYNOSPHERES (FLOATING ASH "BEADS") FROM DISCHARGING INTO DECANT TOWER.

14. THERE ARE NO SPILLWAYS OTHER THAN DECANT TOWER, WHICH IS NO LONGER USED. STORM WATER THAT COLLECTS IN BASIN IS PUMPED TO IWTB. NO ASH HAS BEEN SLUICED INTO BASIN SINCE THE COAL-FIRED UNITS WERE TAKEN OUT OF SERVICE AND RAZED IN 2007. THERE ARE NO GROINS OR DIVERSION DITCHES.

15. THERE ARE NO SPILLWAY OR DITCH LININGS.

16. THE OUTLET FOR THE DECANT TOWER IS NO LONGER USED. THERE ARE NO UNDERDRAINS.

20. THE OUTLET FOR THE DECANT TOWER IS A 33" DIAMETER PIPE THAT PASSES UNDER THE CONTAINMENT DIKE TO A NEW MANHOLE LOCATED JUST BEYOND OUTSIDE TOE OF DIKE. OUTLET PIPE IS BURIED AND NOT VISIBLE. IT IS NO LONGER USED. AFTER A RELEASE INCIDENT IN 2005, THE OUTLET PIPE WAS SLIPLINED AND BOTH THE INLET AND OUTLET ENDS OF THE PIPE WERE FITTED WITH GATE VALVES. NOW THAT THE BASIN IS NO LONGER USED FOR ASH DISPOSAL, BOTH VALVES REMAIN IN A CLOSED POSITION SO THAT WATER CANNOT PASS THROUGH TO A PIPELINE THAT DISCHARGES TO THE DELAWARE RIVER.

2/2

U. S. Environmental Protection Agency

Coal Combustion Waste (CCW)
Impoundment Inspection

Impoundment NPDES Permit # ____________ INSPECTOR FREDERIC C. TUCKER, PE, LAUREN OHOTZKE

Date ____________

Impoundment Name ASH BASIN No. 4 PPL MARTINS CREEK

Impoundment Company PPL

EPA Region III

State Agency (Field Office) Addresss PA DEP WASTE MANAGEMENT

Name of Impoundment ASH BASIN NO. 4

(Report each impoundment on a separate form under the same Impoundment NPDES Permit number)

New ________ Update ________

	Yes	No
Is impoundment currently under construction?		✓
Is water or ccw currently being pumped into the impoundment?		✓

IMPOUNDMENT FUNCTION: BASIN IS CURRENTLY RETIRED. FORMERLY WAS USED FOR DISPOSAL OF PREDOMINANTLY FLY ASH.

Nearest Downstream Town : Name HUTCHINSON, NJ. (ACROSS DELAWARE R.)

Distance from the impoundment APPROX. 2 mi.

Impoundment

Location: Longitude 75 Degrees 07 Minutes 00 Seconds

Latitude 40 Degrees 48 Minutes 30 Seconds

State PA County NORTHAMPTON

Does a state agency regulate this impoundment? YES ✓ NO ______

If So Which State Agency? PA DEPT. OF ENVIRONMENTAL PROTECTION (DEP)

- BUREAU OF WASTE MANAGEMENT &
- DIVISION OF DAM SAFETY

EPA Form XXXX-XXX, Jan 09 1

HAZARD POTENTIAL (In the event the impoundment should fail, the following would occur):

______ **LESS THAN LOW HAZARD POTENTIAL:** Failure or misoperation of the dam results in no probable loss of human life or economic or environmental losses.

______ **LOW HAZARD POTENTIAL:** Dams assigned the low hazard potential classification are those where failure or misoperation results in no probable loss of human life and low economic and/or environmental losses. Losses are principally limited to the owner's property.

______ **SIGNIFICANT HAZARD POTENTIAL:** Dams assigned the significant hazard potential classification are those dams where failure or misoperation results in no probable loss of human life but can cause economic loss, environmental damage, disruption of lifeline facilities, or can impact other concerns. Significant hazard potential classification dams are often located in predominantly rural or agricultural areas but could be located in areas with population and significant infrastructure.

✓ **HIGH HAZARD POTENTIAL:** Dams assigned the high hazard potential classification are those where failure or misoperation will probably cause loss of human life.

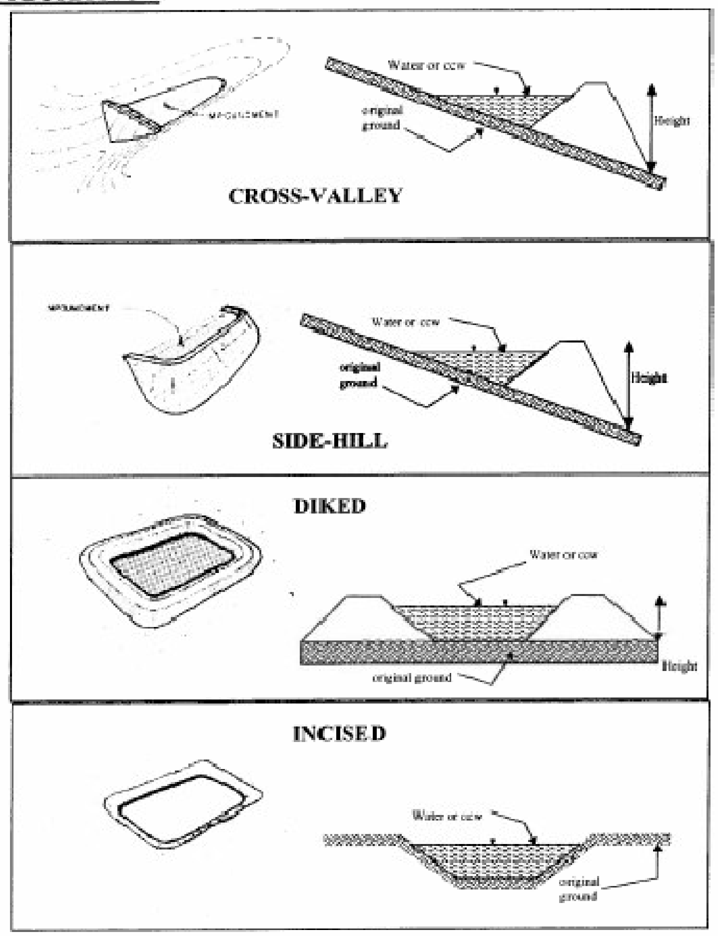
DESCRIBE REASONING FOR HAZARD RATING CHOSEN:

IMPOUNDMENT LOCATED IN RURAL SETTING WITH 14 HABITABLE STRUCTURES & 30 RESIDENTS DOWNSTREAM.

DETERMINATION MADE BY PA DEP DIV OF DAM SAFETY

EPA Form XXXX-XXX, Jan 09 2

CONFIGURATION:



_____ Cross-Valley
_____ Side-Hill
_____ Diked
_____ Incised (form completion optional)
__✓__ Combination Incised/Diked

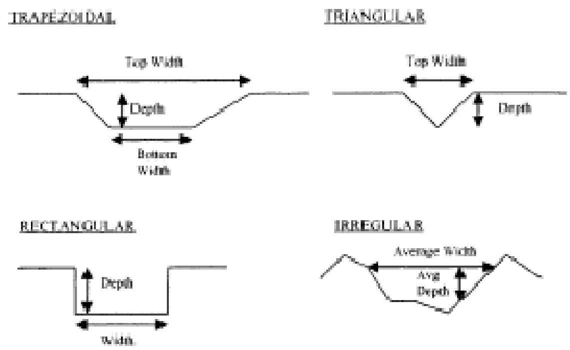
Embankment Height ___45___ feet Embankment Material ___EARTH___
Pool Area ___37___ acres Liner ___36 MIL HYPALON___
Current Freeboard ___28___ feet Liner Permeability ___UNKNOWN - PRESUMED VERY LOW___

EPA Form XXXX-XXX, Jan 09 3

TYPE OF OUTLET (Mark all that apply)

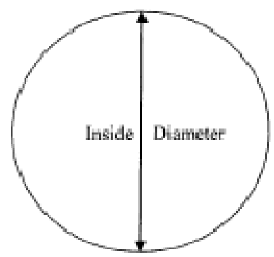
____ **Open Channel Spillway**
____ Trapezoidal
____ Triangular
____ Rectangular
____ Irregular

____ depth
____ bottom (or average) width
____ top width



__✓__ **Outlet**

__32"__ inside diameter



Material
____ corrugated metal
____ welded steel
__✓__ concrete
____ plastic (hdpe, pvc, etc.)
____ other (specify) ____________

Is water flowing through the outlet? YES ______ NO __✓__

____ **No Outlet**

____ **Other Type of Outlet** (specify) ________________

The Impoundment was Designed By ___PPL___________________

If So Please Describe : WOODEN STOP LOG IN DECANT TOWER (DISCHARGE STRUCTURE) FAILED, CAUSING RELEASE OF 100 MILLION GALLONS OF WATER AND FLY ASH, WHICH FLOWED THROUGH DISCHARGE PIPELINE TO DELAWARE RIVER AND OUT MANHOLE AND ONTO ABOUT 10 ACRES OF SURROUNDING FIELDS AND INTO Oughoughton CREEK TO DELAWARE RIVER. THE RELEASE WAS STOPPED ON 27 AUGUST 2005 AND CLEAN UP OPERATIONS BEGAN IMMEDIATELY AFTERWARD. THE EMERGENCY RESPONSE ACTIONS WERE COMPLETED IN MARCH 2006 AND FOLLOW-UP RIVER ASSESSMENT WORK CONTINUED THROUGH JUNE 2007.

Has there ever been significant seepages at this site? YES _______ NO ___✓___

If So When? ____________________________

IF So Please Describe: ____

EPA Form XXXX-XXX, Jan 09 6

Has there ever been any measures undertaken to monitor/lower Phreatic water table levels based on past seepages or breaches at this site? YES ________ NO ✓

If so, which method (e.g., piezometers, gw pumping,...)? ____________________

If so Please Describe : ____________________

Coal Combustion Dam Inspection Checklist Form

US Environmental Protection Agency

Site Name: PPL MARTINS CREEK   Date: 2 SEPTEMBER 2009

Unit Name: INDUSTRIAL WASTE TREATMENT BASIN   Operator's Name: PPL GENERATION

Unit I.D.: (IWTB)   Hazard Potential Classification: High Significant Low

Inspector's Name: FREDERIC C. TUCKER, PE / LAUREN OHOTZKE

Check the appropriate box below. Provide comments when appropriate. If not applicable or not available, record "N/A". Any unusual conditions or construction practices that should be noted in the comments section. For large diked embankments, separate checklists may be used for different embankment areas. If separate forms are used, identify approximate area that the form applies to in comments.

	Yes	No		Yes	No
1. Frequency of Company's Dam Inspections?	QTLY		18. Sloughing or bulging on slopes?		✓
2. Pool elevation (operator records)?	295+		19. Major erosion or slope deterioration?		✓
3. ~~Decant Inlet~~ outlet elevation (operator records)?	299		20. ~~Decant~~ OUTLET Pipes:		
4. Open channel spillway elevation (operator records)?	N/A		Is water entering inlet, but not exiting outlet?		✓
5. Lowest dam crest elevation (operator records)?	310		Is water exiting outlet, but not entering inlet?		✓
6. If instrumentation is present, are readings recorded (operator records)?	N/A		Is water exiting outlet flowing clear?	✓	
7. Is the embankment currently under construction?		✓	21. Seepage (specify location, if seepage carries fines, and approximate seepage rate below):		
8. Foundation preparation (remove vegetation, stumps, topsoil in area where embankment fill will be placed)?	✓		From underdrain?	N/A	
9. Trees growing on embankment? (If so, indicate largest diameter below)		✓	At isolated points on embankment slopes?		✓
10. Cracks or scarps on crest?		✓	At natural hillside in the embankment area?	N/A	
11. Is there significant settlement along the crest?		✓	Over widespread areas?		✓
12. Are decant trashracks clear and in place?	N/A		From downstream foundation area?		✓
13. Depressions or sinkholes in tailings surface or whirlpool in the pool area?		✓	"Boils" beneath stream or ponded water?		✓
14. Clogged spillways, groin or diversion ditches?	N/A		Around the outside of the decant pipe?	N/A	
15. Are spillway or ditch linings deteriorated?	N/A		22. Surface movements in valley bottom or on hillside?		✓
16. Are outlets of ~~decant~~ basin or underdrains blocked?		✓	23. Water against downstream toe?		✓
17. Cracks or scarps on slopes?		✓	24. Were Photos taken during the dam inspection?	✓	

Major adverse changes in these items could cause instability and should be reported for further evaluation. Adverse conditions noted in these items should normally be described (extent, location, volume, etc.) in the space below and on the back of this sheet.

Inspection Issue # | Comments — COMMENT (KEYED TO ITEM NOS. ABOVE)

1. INSPECTIONS PERFORMED QUARTERLY BY PPL PE, DAILY BY OPERATING PERSONNEL.

2. POOL ELEVATION WAS JUST ABOVE INLET INVERT OF OUTLET PIPE.

4. THERE IS NO OPEN CHANNEL SPILLWAY AT THIS DIKED BASIN.

6. THERE IS NO INSTRUMENTATION.

8. BASIN HAS A SYNTHETIC LINER PLACED ON PREPARED FOUNDATION, DUE TO CARBONATE GEOLOGY. ORIGINAL HYPALON LINER WAS RECENTLY REPLACED WITH OIL-RESISTANT SYNTHETIC LINER.

— CONTINUED NEXT PAGE —

EPA FORM -XXXX

1/2

PPL MARTINS CREEK IWTB

— CONTINUED FROM PREVIOUS PAGE —

9. NO TREES BUT ONE VERY LARGE BUSH AND TALL WEEDS OBSERVED ON OUTER SLOPE.

12. THERE ARE NO TRASH RACKS AT INLET END OF OUTLET PIPE.

14. THERE ARE NO OVERFLOW SPILLWAYS, GROINS OR DIVERSION DITCHES.

15. THERE ARE NO SPILLWAY OR DITCH LININGS, EXCEPT AT THE OUTFALL OF THE DISCHARGE PIPELINE TO THE RIVER, WHERE THERE IS A GROUTED RIPRAP CHANNEL IN GOOD CONDITION.

16. A REINFORCED CONCRETE INLET STRUCTURE LEADS TO A 42" DIA. CMP OUTLET WHICH IS FITTED WITH A GATE VALVE. THE OUTLET PIPE LEADS TO A COMBINING STRUCTURE, WHERE FLOWS FROM THE IWTB AND ASH BASIN NO. 4 FORMERLY WERE COMBINED AND DISCHARGED THROUGH A CMP THAT OUTFALLS INTO THE GROUTED RIPRAP CHANNEL TO THE DELAWARE RIVER. THE OUTFALL PIPE DISCHARGES THROUGH A REINF. CONC. END WALL AND HAS A STEEL BAR TRASH GUARD THAT WAS OBSERVED TO BE RUSTY BUT SOUND AND FREE OF DEBRIS. THERE ARE NO UNDERDRAINS.

20. WATER DISCHARGING AT OUTFALL WAS CLEAR.

2/2

U. S. Environmental Protection Agency

Coal Combustion Waste (CCW)
Impoundment Inspection

Impoundment NPDES Permit # PA-0012823 INSPECTOR FREDERIC C. TUCKER, PE/ LAUREN OHOTZKE

EFFECTIVE Date 1 DECEMBER 2006 ; EXPIRES 30 NOVEMBER 2011

Impoundment Name INDUSTRIAL WASTE TREATMENT BASIN PPL MARTINS CREEK
Impoundment Company PPL
EPA Region III
State Agency (Field Office) Addresss PA DEP ~~WASTE MANAGEMENT~~ WATER QUALITY

Name of Impoundment INDUSTRIAL WASTE TREATMENT BASIN (IWTB)
(Report each impoundment on a separate form under the same Impoundment NPDES Permit number) NOTE: THE IWTB DOES NOT RECEIVE COAL COMBUSTION WASTE RESIDUES (ASH), ALTHOUGH WATER FROM ASH BASIN NO. 4 IS PUMPED INTO THE IWTB. HOWEVER, THE WATER IS FILTERED THROUGH A 10' THICK CRUSHED STONE LAYER BEFORE BEING PUMPED TO THE IWTB.

New ________ Update ________

	Yes	No
Is impoundment currently under construction?		✓
Is water or ccw currently being pumped into the impoundment?	✓ WATER ONLY	

IMPOUNDMENT FUNCTION: TREATMENT — EQUALIZATION

Nearest Downstream Town : Name HUTCHINSON, N.J. (ACROSS DELAWARE R.)
Distance from the impoundment APPROX. 1.6 mi.
Impoundment
Location: Longitude 75 Degrees 07 Minutes 02 Seconds
Latitude 40 Degrees 47 Minutes 52 Seconds
State PA County HAMPTON

Does a state agency regulate this impoundment? YES ✓ NO ______

If So Which State Agency? PA DEPT. OF ENVIRONMENTAL PROTECTION (DEP) — BUREAU OF ~~WASTE MANAGEMENT~~ WATER QUALITY
(DIVISION OF DAM SAFETY IS REVIEWING WHETHER DIKE SHOULD BE REGULATED UNDER DAM SAFETY REGULATIONS)

EPA Form XXXX-XXX, Jan 09 1

HAZARD POTENTIAL (In the event the impoundment should fail, the following would occur):

______ **LESS THAN LOW HAZARD POTENTIAL:** Failure or misoperation of the dam results in no probable loss of human life or economic or environmental losses.

__✓__ **LOW HAZARD POTENTIAL:** Dams assigned the low hazard potential classification are those where failure or misoperation results in no probable loss of human life and low economic and/or environmental losses. Losses are principally limited to the owner's property.

______ **SIGNIFICANT HAZARD POTENTIAL:** Dams assigned the significant hazard potential classification are those dams where failure or misoperation results in no probable loss of human life but can cause economic loss, environmental damage, disruption of lifeline facilities, or can impact other concerns. Significant hazard potential classification dams are often located in predominantly rural or agricultural areas but could be located in areas with population and significant infrastructure.

______ **HIGH HAZARD POTENTIAL:** Dams assigned the high hazard potential classification are those where failure or misoperation will probably cause loss of human life.

DESCRIBE REASONING FOR HAZARD RATING CHOSEN:

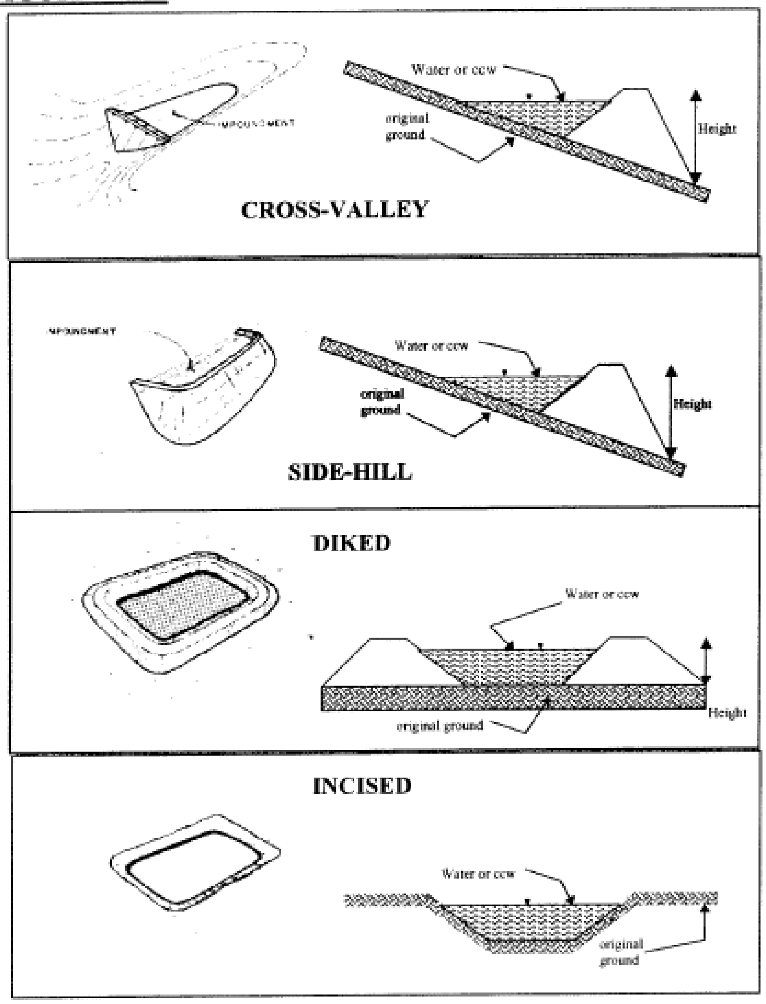
THIS IMPOUNDMENT CURRENTLY IS NOT REGULATED BY THE PA DIVISION OF DAM SAFETY AND HAS NOT BEEN CLASSIFIED BY THEM. THE DIVISION OF DAM SAFETY IS REVIEWING WHETHER THE IWTB SHOULD BE REGULATED. THE IWTB APPEARS TO MEET CRITERIA FOR REGULATION.

THE BASIN IS PARTLY INCISED WITH MUCH OF THE WATER STORAGE BELOW THE TOE ELEVATION OUTSIDE THE BASIN. AT THE TIME OF THE SITE VISIT THE WATER LEVEL IN THE BASIN APPEARED TO BE ONLY A FEW FEET ABOVE THE OUTSIDE TOE ELEVATION OF THE LOW (NORTHWEST) SIDE OF THE BASIN. HOWEVER, AT MAXIMUM POTENTIAL STORAGE (TO TOP OF DAM ELEV.) THERE WOULD BE WELL OVER 100 ACRE-FT STORED ABOVE THE OUTSIDE TOE ELEVATION ON NW SIDE.

LOW HAZARD POTENTIAL RATING GIVEN SINCE NO HABITABLE STRUCTURES OR PUBLIC ACCESS ROADS ARE EXPECTED TO BE IMPACTED SHOULD THIS DAM FAIL, AND ECONOMIC AND ENVIRONMENTAL LOSSES ARE EXPECTED TO BE LOW.

EPA Form XXXX-XXX, Jan 09

CONFIGURATION:



_____ Cross-Valley
_____ Side-Hill
_____ Diked
_____ Incised (form completion optional)
✓ Combination Incised/Diked

*Embankment Height	15	feet	Embankment Material	EARTH
Pool Area	15	acres	Liner	NEW O/L RESISTANT GEOMEMBRANE
Current Freeboard	10±	feet	Liner Permeability	UNKNOWN - PRESUMED VERY LOW

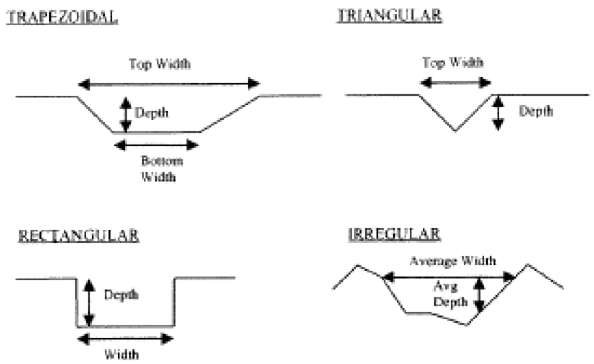
* MAX. ABOVE LOW POINT OF OUTSIDE TOE

EPA Form XXXX-XXX, Jan 09 3

TYPE OF OUTLET (Mark all that apply)

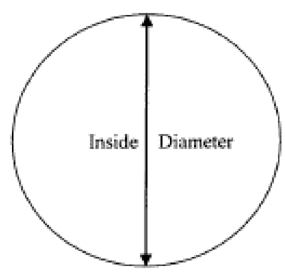
_____ **Open Channel Spillway**
_____ Trapezoidal
_____ Triangular
_____ Rectangular
_____ Irregular

_____ depth
_____ bottom (or average) width
_____ top width



__✓__ **Outlet**

__42"__ inside diameter



Material
__✓__ corrugated metal
_____ welded steel
_____ concrete
_____ plastic (hdpe, pvc, etc.)
_____ other (specify) ____________________

Is water flowing through the outlet? YES __✓__ NO _______

_____ **No Outlet**

_____ **Other Type of Outlet** (specify) ________________________________

The Impoundment was Designed By ____PPL____________________________

EPA Form XXXX-XXX, Jan 09 4

Has there ever been a failure at this site? YES __________ NO ____✓_____

If So When? ____________________________

If So Please Describe : ____

EPA Form XXXX-XXX, Jan 09 5

Has there ever been significant seepages at this site? YES _______ NO ___✓___

If So When? ___________________________

IF So Please Describe: ____

Has there ever been any measures undertaken to monitor/lower Phreatic water table levels based on past seepages or breaches at this site? YES ________ NO ✓

If so, which method (e.g., piezometers, gw pumping,...)? ____________________

If so Please Describe : ____________________

Martins Creek Attendance List

September 2, 2009

Name	Company
Steve Holler	PPL- Martins Creek
Andy Spear	PPL Generation- Allentown
Craig Shamory	PPL Services- EMD
Chris Reitman	Advanced Geo Services
Jim Berger	DEP
Lisa Hannigan	DEP
Fred Tucker	Dewberry
Lauren Ohotzke	Dewberry
Dane Devanney	PPL- Peaking Power
Martin Matlin	EPA
Chris Kulick	PA DEP Northeast Regional Office
Rich Reisinger	PA DEP Dam Safety
Jim Aiella	PA DEP Dam Safety

Martins Creek Power Plant Site Visit Notes

September 2, 2009

Martins Creek Power Plant Basins

- **Basin 1; (not active/not yet closed)**
  - Has permitting for closure
  - Originally contained both fly ash and bottom ash (now ONLY bottom ash w/ minimal fly ash present especially mixed with the bottom ash in the bottom layer)
  - Not lined
  - Ringed Dike
    - No outside drainage area
    - Only drains its own contents
  - Has river gravel in bottom
    - Very permeable
    - Water goes right out
  - Not used since end of 3rd quarter 2005
  - Shut down September 2007 (along with Basin 2)
- **Basin 2; (CLOSED)**
  - Unlined
  - "in the woods"
  - Approximately 30' depth or less
  - Shut down September 2007 (along with Basin 1)
    - Capped with soil for closure purposes
- **Basin 3; (CLOSED)**
  - Lined
    - Synthetic polypropylene(?)
    - Has bottom ash below liner
  - Approximately 30' depth or less
  - Put in service with closure of Basin 2
  - Closed in late 1980s
    - Capped with soil for closure purposes
    - New discharge structure to creek built upon closure
- **Basin 4; (not active/not yet closed)**
  - Lined
    - Synthetic polypropylene(?)
    - Has bottom ash below liner
  - Primarily fly ash
  - Geomembrane Liner

- Ringed Dike
    - No outside drainage area
    - Only drains its own contents
- Water Level
    - Approximately 348' when in use
    - Approximately 327' at time of site visit (9/2/09)
- "Significant" hazard

- **Industrial Waste Treatment Basin (IWTB); (ACTIVE)**
    - "low volume waste basin"
    - Built in 1976
    - Re-lined "2007-ish" with an oil resistant liner
    - Liner on primarily native grounds and bottom ash
    - In the past, had received from Basin 4
    - Currently receives:
        - Storm water
        - Cooling tower blowdown from:
            - Martins Creek
            - Lower Bethel plant
    - "much cleaner"
        - pH control
        - CO_2 system at outfall

Misc. Notes

- Coal fire station
  - Demolished/no longer at site
- Combined Structure
  - Structure with weir in it that measures:
    - Flow
    - pH
  - All basins come together here for measurement?
- Cooling towers use water from DE River
- Permits address geology
- Sinkhole formation by river not of concern
  - Prior to building Basin (#?), lots of testing and grouting done along NE side to help avoid sinkholes.
  - Built in area less likely to be sinkhole prone.
- Grouted up everything down to bedrock after construction
- RELEASE was August "23rd-ish", 2005

Items Requested

- Numbers for IWTB to check if regulation is needed by Dam Safety **(Andy is looking into this and will get back to us)**
  - Water below natural grade not regulated by Dam Safety
  - Structure greater than 15' in height and 50(?) acre-ft or more are in need of regulation
- Information on stability in permit information (original documents from DEP)
- Documentation for "cut-off wall"
  - Only drawings are available
  - No as-builts available
- Copy of permit application **(possibly received from Andy while on site)**
  - Technical information
  - Stability information
  - Sinkhole issues
- Typical sections
- Copy of cover and TOC for QAQC **(received on site)**
- Regional map including schools, hospitals, etc. **(Fred will check in documentation received on site)**
- Copy of intakes **(Fred will check in documentation received on site)**
- Monitoring information, piezometers, observations wells in embankments **(N/A)**
- Monitoring well data of impoundments **(included in documentation from Craig Shamory)**
- NPDES permit **(received from Steve Holler while on site)**
- Spreadsheet from Lisa **(Lauren will e-mail Jim Berger (because Lisa's e-mail not available), and ask for Lisa's contact info.)**

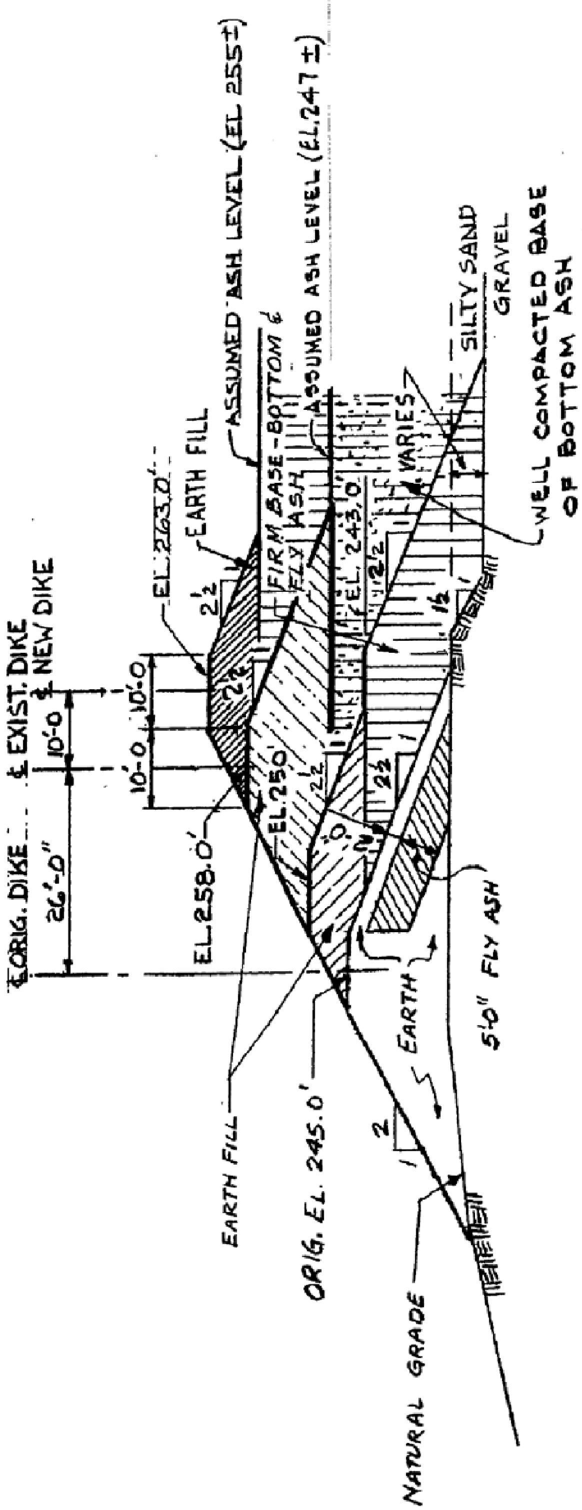


EXHIBIT 1:

ASH BASIN NO. 1 – REPRESENTATIVE SECTION OF EMBANKMENT DAM

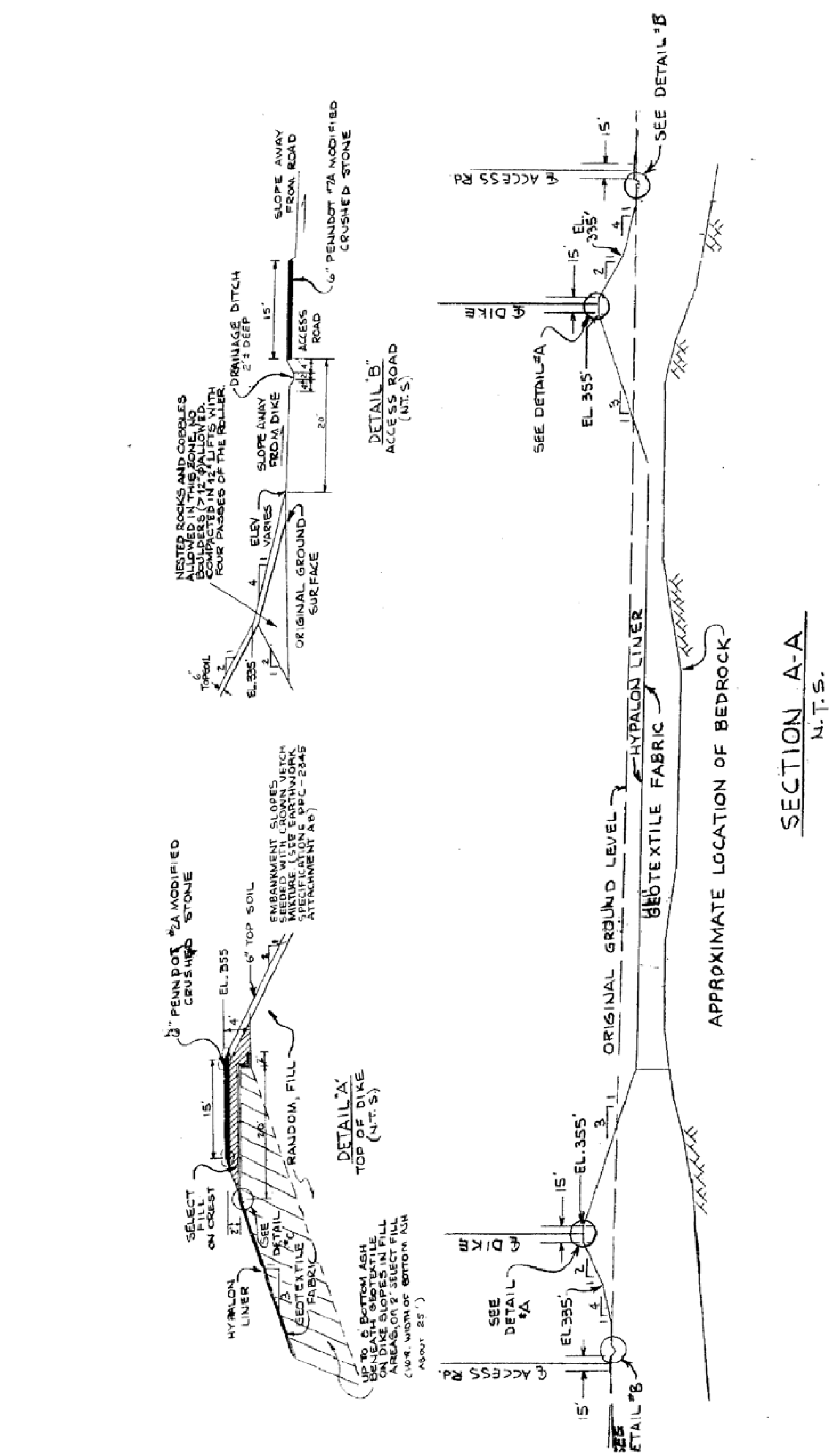


EXHIBIT 2:

ASH BASIN NO. 4 – REPRESENTATIVE SECTION AND DETAILS OF EMBANKMENT DAM AND BASIN

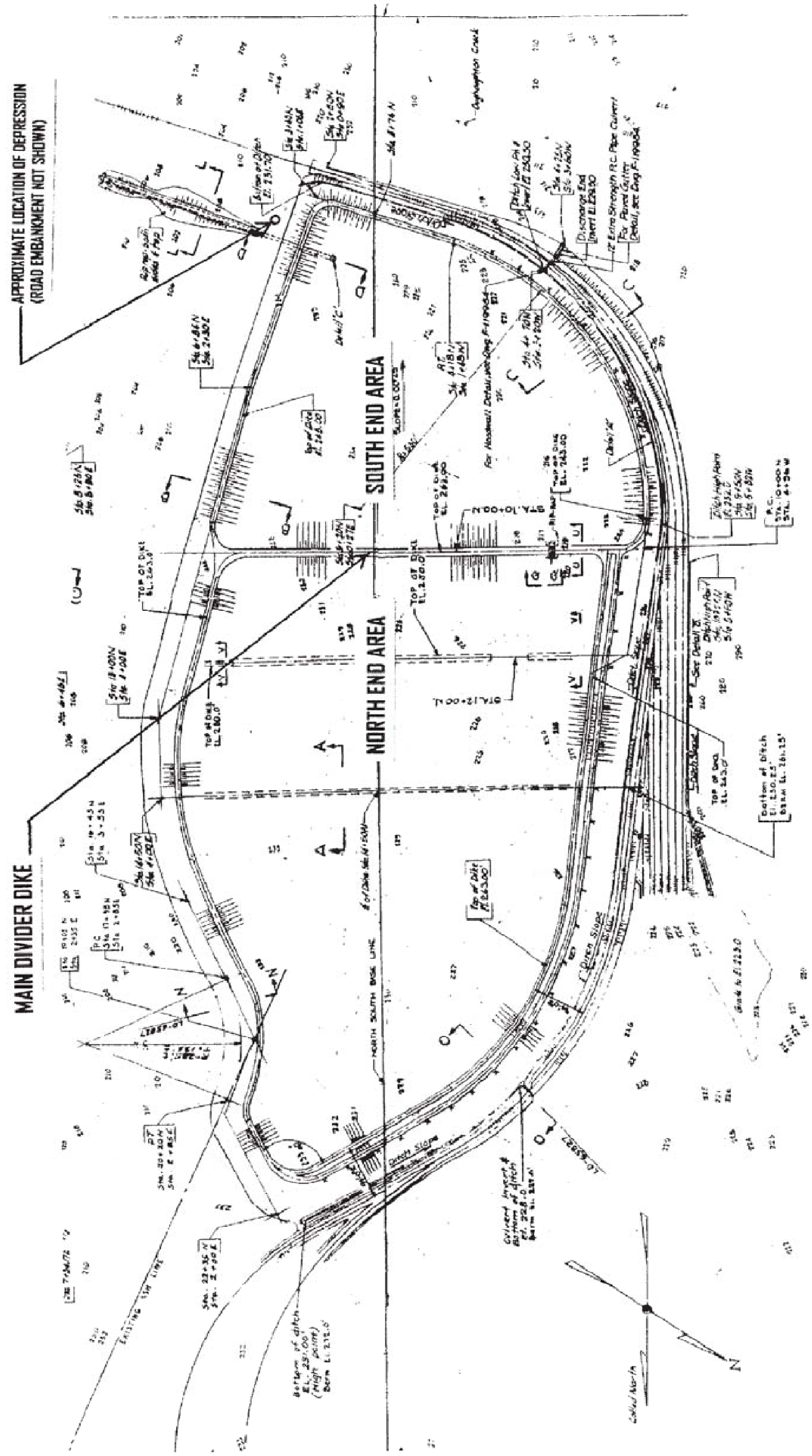


EXHIBIT 3:

ASH BASIN NO. 1 – PLAN VIEW SHOWING BASIN LAYOUT AND LOCATION OF OUTLET STRUCTURE

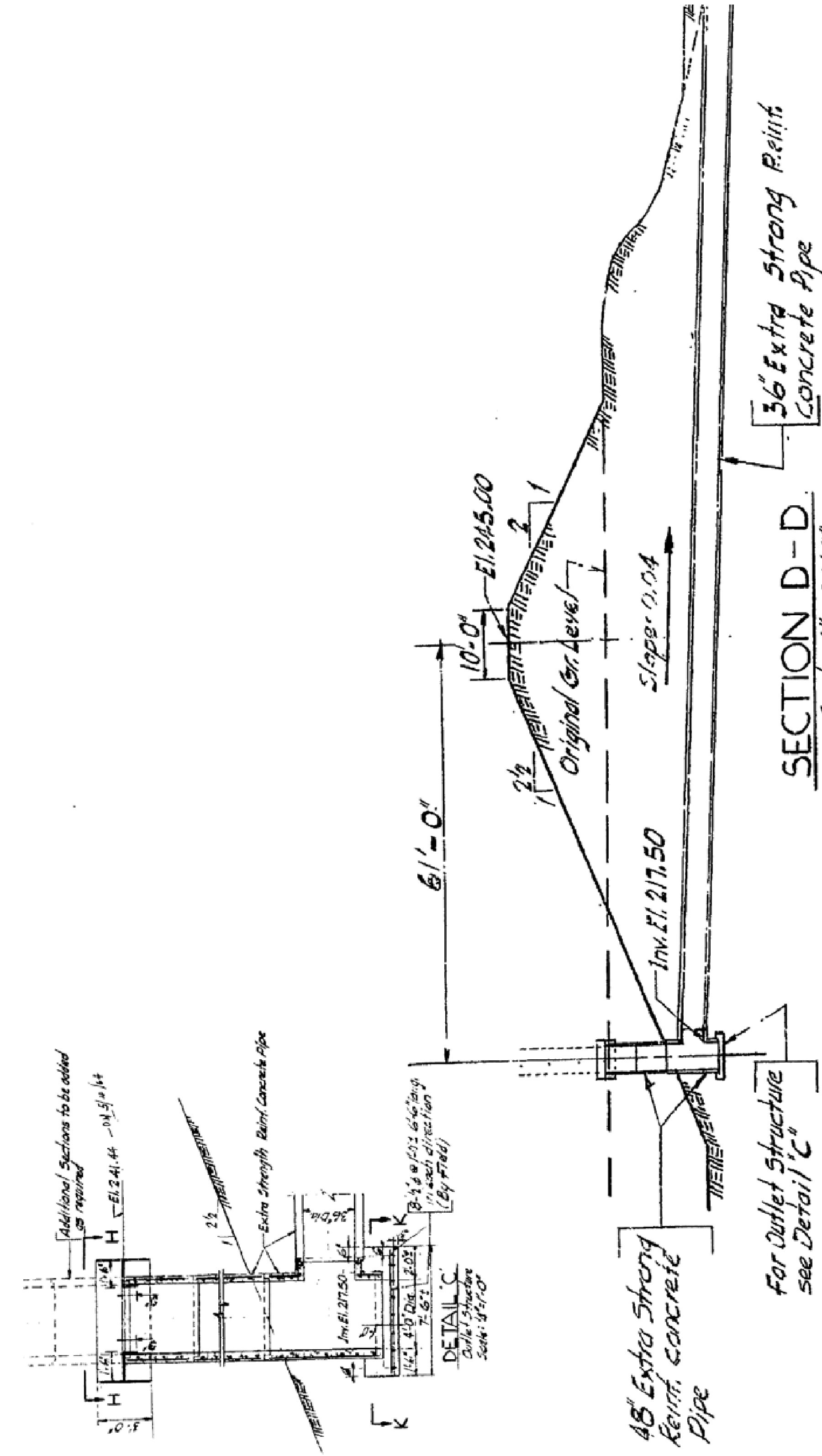


EXHIBIT 4:

ASH BASIN NO. 1 – SECTION AND DETAIL OF BASIN OUTLET STANDPIPE AND BOTTOM DISCHARGE PIPE

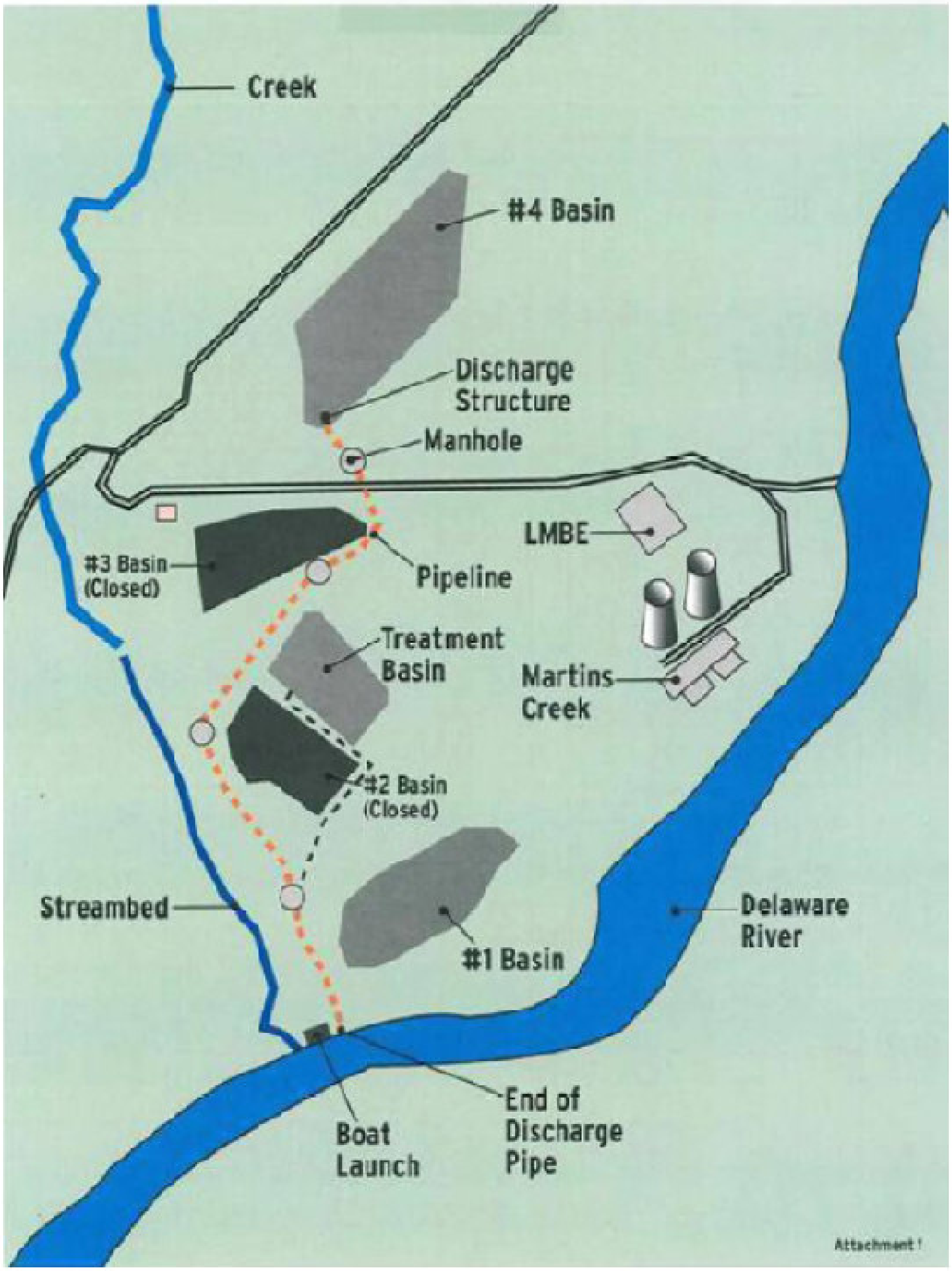


EXHIBIT 5:

SCHEMATIC PLAN VIEW OF MARTINS CREEK SES SHOWING LAYOUT OF BASINS AND DISCHARGE PIPING

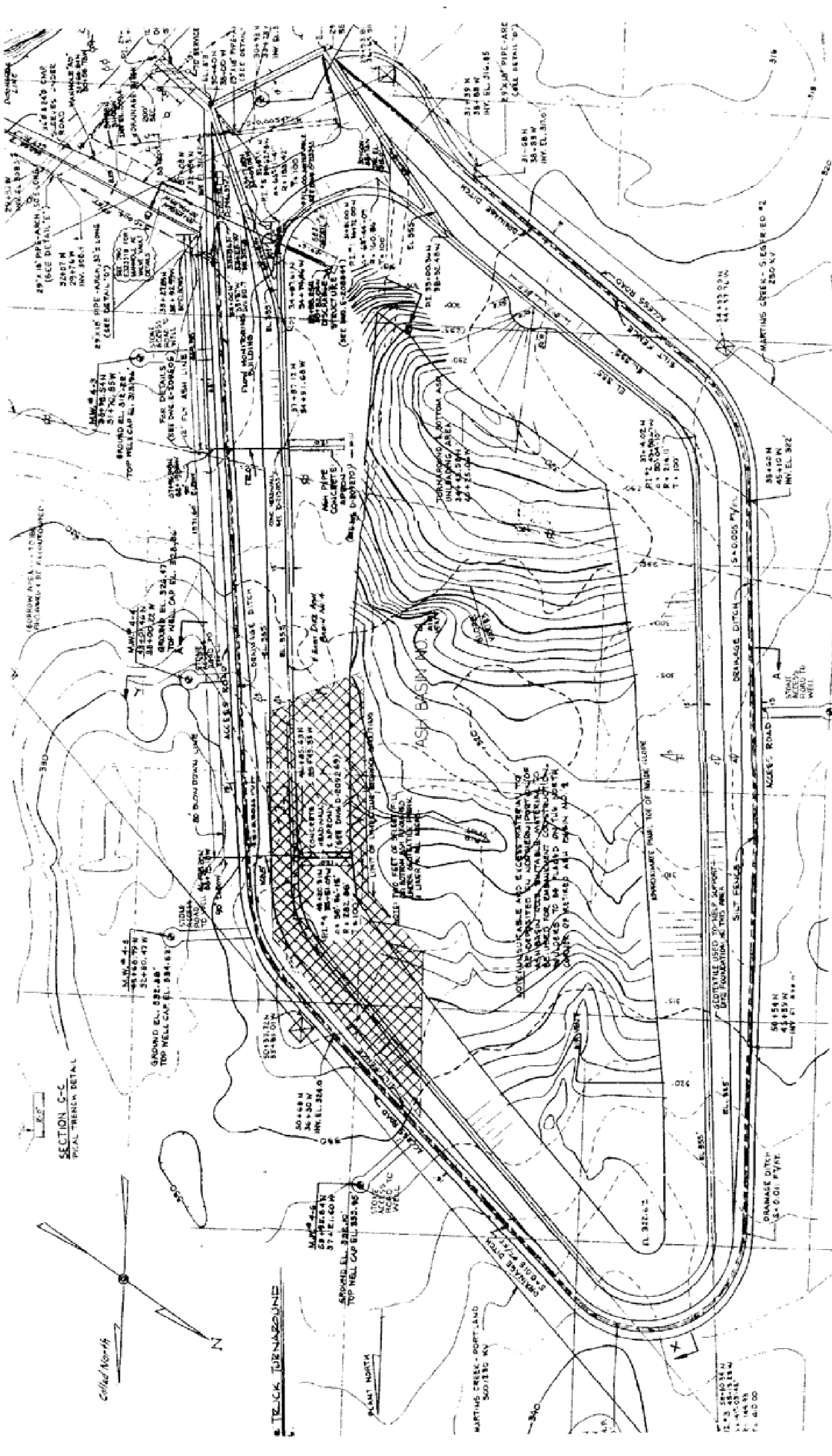


EXHIBIT 6:

ASH BASIN NO. 4 – PLAN VIEW SHOWING BASIN LAYOUT AND LOCATION OF OUTLET STRUCTURE

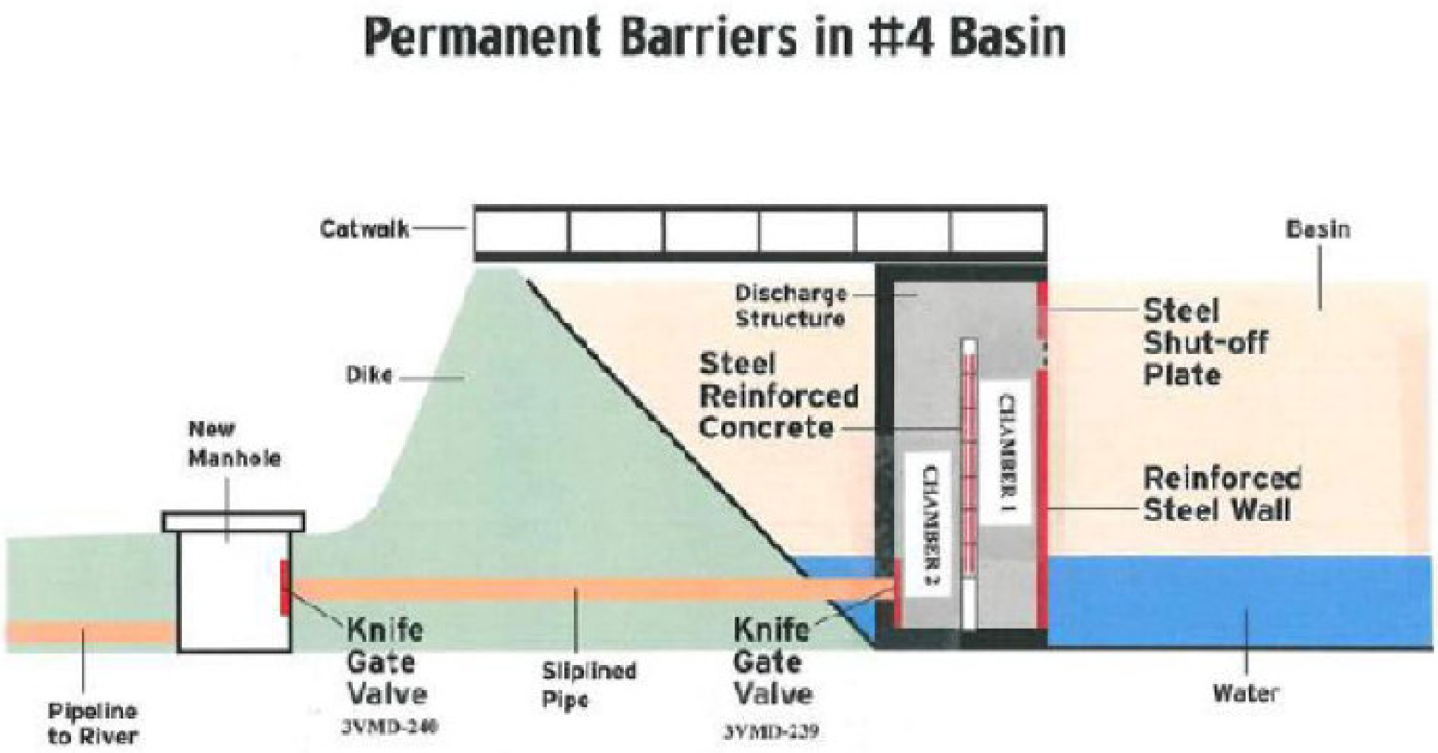
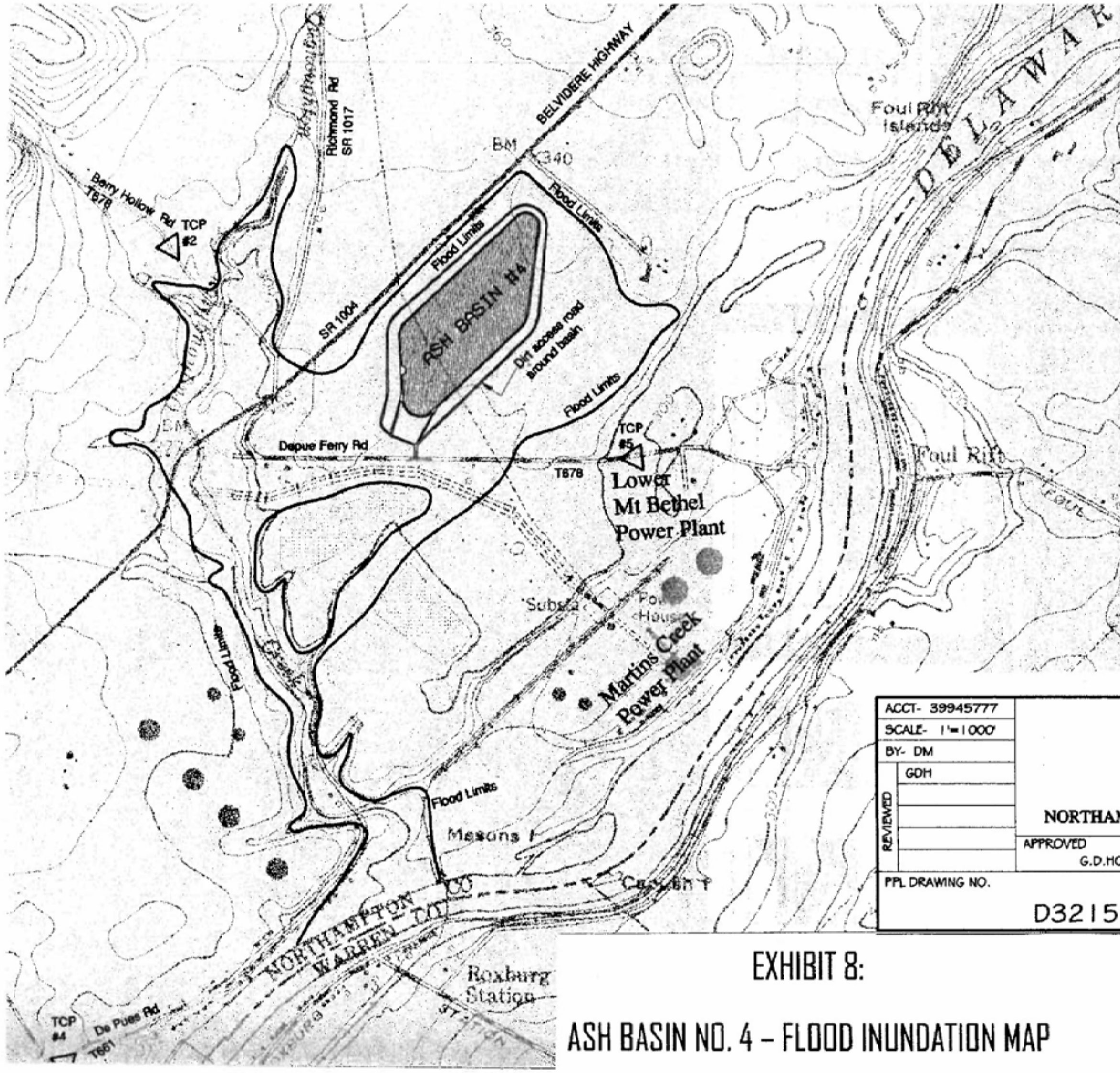


EXHIBIT 7:

ASH BASIN NO. 4- SCHEMATIC SECTION OF OUTLET STRUCTURE SHOWING PRINCIPAL MODIFICATIONS MADE AFTER RELEASE INCIDENT IN 2005



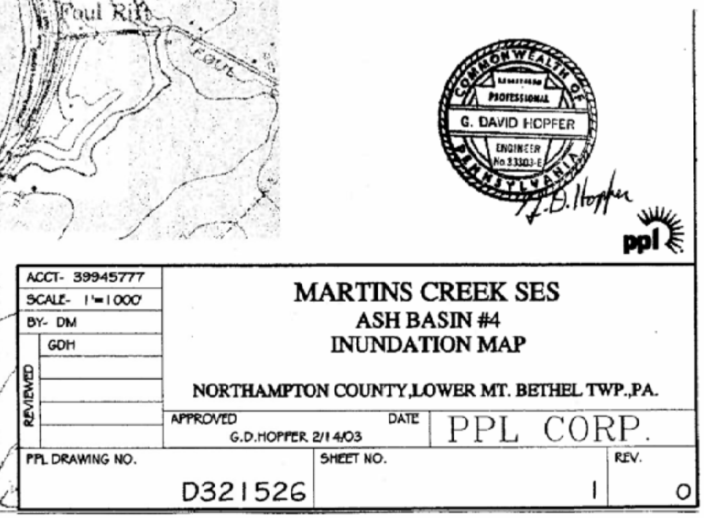


EXHIBIT 8:

ASH BASIN NO. 4 – FLOOD INUNDATION MAP