ATTACHMENT II-F

GROUNDWATER HYDROLOGY

(880-X-8E-.06(1))

GROUNDWATER HYDROLOGY (880-X-8E-.06(1))

Description of Groundwater Hydrology

Groundwater availability is determined by the inherent water-bearing characteristics of aquifers which are controlled by geologic factors such as type, permeability, and structure of strata which make up the aquifers. On the Cumberland Plateau, groundwater occurs along well defined fractures, joints and bedding planes of the alternating sequences of the sandstones and shales within the Pottsville Formation. Recharge of aquifers is primarily by the infiltration of rainfall which percolates downward through openings along joints, fractures and bedding planes. As stated in "Geohydrology and Susceptibility of Major Aquifers to Surface Water Contamination in Alabama; Area 2; U.S.G.S. Circular 199F 2008", the Pottsville Formation is the predominate aquifer of north Alabama but large water supplies generally are not available from this formation. Groundwater occurs in conditions where the underlying stratum prevents downward percolation of water and forms a "perched" water table along the alternating sequences of clays, sandstones, shales and coal seams. These perched zones are susceptible to climatic conditions such as seasonal precipitation variations and frequency of rainfall which can cause an increase in aquifer storage and groundwater pressure. In general, permeability decreases with depth and as stated in "Regional Analysis of the Black Creek-Cobb Coalbed Methane Target Interval, Black Warrior Alabama, U.S.G.S. Bulletin 145" structural geology is a primary control on the hydrologic system. The production of water for water wells in the formation decreases with depth and these wells are typically developed in the weathered near-surface part of the Pottsville at an average depth of 150 feet. Due to decreasing permeability of the Pottsville, little additional water production is obtained below a depth of approximately 400 feet.

Ground water production is variable by local conditions in the Pottsville Formation and wells developed in this formation generally do not produce excessive groundwater as compared to the limestone aquifers of the Appalachian Plateaus and Interior Low Plateaus of Alabama. According to "Ground Water Atlas of the United States, U.S.G.S. Report HA 730-G", the sandstone beds of the Pottsville Formation yield small volumes of water, but the Pottsville supplies water to a large number of domestic wells because it caps thousands of square miles of upland plateaus. Water in the sandstone is obtained primarily from fractures. Recharge is primarily by the infiltration of rainfall which percolates downward through the soil and weathered rock horizon into the formation and is generally stored in and transmitted through openings along joints, fractures and bedding planes.

The overburden within the permit area is atypical of the Pottsville Formation as described with alternating layers of sandstones, shales, clays and coal seams and is capped by conglomeratic massive sandstone intervals. Information from this site shows that due to synclinal structure of Sand Mountain water is present in the strata above the coal seam and no distinct stratigraphic zones were encountered that consistently produce water were encountered during data collection. Groundwater movement near the Thunder Oaks Mine is believed to be in the direction of dip that is primarily to the south/southeast, based on the data obtained from drill holes. No springs and/or seeps were noted on the proposed permit area.

Lithologic Description of Water Bearing Zone(s)

Minimal groundwater was encountered during drilling of the Monitoring Wells/Overburden Sample points. Water was noted on several drill logs by James Mill Drilling, Inc. and several of

the lower intervals produced enough water to expel wet cuttings during the drilling of the monitoring wells. Groundwater qualities, levels and quantities are determined at the site by geology, extents of surface and underground mine works and climatic conditions. OB-1/MW-1 was drilled by James Mill Drilling Inc. on 02/18/2011 under the supervision of TASK Engineering Management Inc and a thirty (30) foot casing was installed at the time of drilling. The site of OB-1/MW-1 is located on Increment No. 5 and was drilled to a depth of 82.0 feet that penetrated the Uppercliff #1 (3" marker seam) and the Uppercliff #3 Seams. OB-2/MW-2 is located on Increment No. 1 near the boundary of Increment No. 1 and Increment No. 2 and was drilled on 02/23/2011 to a total depth of 102.00 feet. This hole was cased twenty (20) feet into massive sandstone and the drillhole penetrated the Uppercliff #1, Uppercliff #2 and Uppercliff #3 Seams. OB-3/MW-3 is located on Increment No. 2 and was drilled on 02/24/2011 to a depth of 142.50 feet. OB-3/MW-3 penetrated the Uppercliff #3 Seam and was cased twenty (20) feet into hard sandstone. a(See drawings OB-1/MW-1, OB-2/MW-2 and OB-3/MW-3 for details of these overburden/groundwater monitoring well and corresponding site data and wellhead protection appliances installed at each well.)

On June 20, 2011, the first groundwater samples were taken by TASK Engineering Management Inc. after giving all monitoring wells time to stabilize. On this date the monitoring wells showed the following depths:

Monitoring Well ID	**Depth to Water**	**Water Elevation (MSL)**
MW-1	28.00'	1297.68
MW-2	22.00'	1291.98
MW-3	34.40'	1268.91

Note that the Sand Mountain Syncline structure and the capping action of the Upper Conglomerate have determined the relative groundwater elevations on this site. The areas of intrusion of the Underwood Sandstone Interval produced substantial amounts of groundwater during the drilling of the exploratory drill holes within and/or near the boundaries of these intrusions. (See Hydro-Geo Map). At total of fifteen (15) groundwater samples were collected from June 20, 2011 through August 23, 2012 and showed little variation other than seasonal lows and highs. For a more detailed description of the lithology of the Pottsville water bearing zones and the intrusion areas of the Underwood Sandstone Interval see the attached Lithologic fence diagrams (cross-sections) in Part II-E, shown as drawings Geologic Section A-A' and Geologic Section B-B'.

Aquifer Test(s):

Aquifer test(s) have not been required at this time.

Well Inventory:

A well inventory has been conducted by TASK Engineering Management Inc. utilizing interviews and samples, (where landowner permission was given) on all occupied dwellings within one-half mile of the proposed permit boundary. The inventory revealed that there are two hundred (200) residences located within one-half (1/2) mile of the mine site. Of these residences forty-one (41) have wells. More specifically resident IDs 1, 2, 8, 13, 14, 15, 21, 23, 24, 28, 31, 32, 33, 38, 48, 49, 55, 60, 63, 64, 66, 67, 70, 71, 72, 80, 83, 84, 107, 108, 161, 167, 169, 174, 175, 186, 198, 198B, 199, 201 and 202 have wells. Of these nine residences do not have public water, resident IDs 10, 80, 84, 172, 173, 174, 198, 198B and 199. Residence 167 (Billy G. Turner) has public water but uses his well for household water. All of the ten (10) residences using wells for

household water have been sampled and analyzed. No resident had a usable spring and all other wells that were usable were used for garden irrigation and/or livestock. Six (6) wells were capped with the pumps in place and were not accessible and one (1) well had been filled in and was not accessible as well. Six (6) residences refused sampling, nine (9) residences were vacant with five (5) of these vacant residences uninhabitable, two (2) residences had burned and have not been rebuilt and two (2) residences were destroyed by the tornado of April 27, 2011 and have not been rebuilt. The residents' primary water source, along with all other residences within the half-mile radius is obtained from the Northeast Alabama Water District Authority.

See Well Inventory and Hydro-Geo Map.

Groundwater Baseline Quality:

See attached Groundwater Baseline Analysis.

Geologic Structures that Impact Groundwater Movement

The Sand Mountain Syncline directly impacts the movement of groundwater at the Thunder Oaks Mine. As stated previously in the geologic section of this permit, the bedding planes of the strata dip to the south, southeast to conform to the host rock of the structure. These strata of the syncline along with local faulting may affect the movement of groundwater but at this time, no relationship can be determined. Previous mining and old open highwalls and cuts have accumulated water and the local folding and faulting influences the movement of groundwater within the permit and adjacent areas due to unconsolidated and fractured zones created by existing spoil materials that allow easier flow of groundwater. For maps and cross-sections to support the geology/lithology of this site, see the attached Structural Contour Map (Hydro-Geo

Map) and fence diagrams shown as, Geologic Section A-A' and Geologic Section B-B' (cross-sections) in Part II-E.

Groundwater Description Support Data:

All maps Fence Diagrams (cross-sections) are certified under Attachment II-H, Certification Statement.

Groundwater Sampling and Analytical Methods:

Groundwater samples were taken by TASK Engineering Management Inc. from the installed monitoring wells at the proposed mine site by the following methods:

1) Prior to starting the groundwater sampling sequence, the groundwater level was measured using the top of the casing as a reference point. This level and/or depth to the water surface was then measured using a "Solinst Water Level Meter 101" which will electronically read the existing water level and measure to an accuracy of 1/100' and to a depth of 300'. Ground surface elevations are determined by aerial photographs and digital terrain models and final water elevations are determined by correction (subtraction) of the stickup interval value measured for each individual well to adjust to actual surface elevation (MSL) and final determination of the water elevation (MSL).

2) Once water elevation is determined, the monitoring well is bailed using a three (3) inch diameter, three (3) foot length PVC well bailer to purge at least ten (10) bailer volumes (where the water quantities are available in the well). The well will then be allowed to recover for a minimum of one (1) hour.

3) After purging and recovery, the monitoring well is sampled using a "Solinst Stainless Steel Point Source Bailer-Model 429" which allows samples of groundwater from specific depths using a system of top and bottom ball valves. Samples are taken approximately ten (10) feet above the coal seam as determined from drill logs and developed geologic columns.

Note: Samples are taken approximately ten (10) feet above the coal seam because most coal seams within the Pottsville Formation are generally fairly good aquifers due to the cleat systems found in coal and representative samples can be taken by this method.

4) Monitoring well samples are decanted from the bailer into new, clean plastic sample bottles immediately after removing the bailer from the well. Depth to water surface, pH and Conductivity are measured in the field. After all field measurements are completed, the time, date, mine identification and monitoring well identification are recorded on the sample bottle and on a chain of custody form to maintain documentation and sample integrity. Samples are then deposited

in a field cooler with ice to refrigerate to near 4°C for delivery to the TASK Engineering Management Inc. offices for further chemical testing.

5) The bailer is washed with distilled water and dried after each sample sequence to avoid contamination.

All groundwater samples were taken by the hand-dip (grab) method as defined by the 17th Edition of Standard Methods for the Examination of Water and Wastewater. See following for description and documentation of methodology of analyses:

1) Analysis of pH was a direct reading and performed in accordance with the standard operating procedures of the Hach Company's sensION1 Portable pH meter.

2) Analysis of Conductivity, SpC, was a direct reading and performed in accordance with the standard operating procedures of the Hach Company's DR3 Spectrophotometer which is equipped with a conductivity meter.

3) Analysis of Total Iron, Fe, was utilizing a Hach DR/890 Colorimeter and performed in accordance with the Hach DR/820-DR/850-DR/890 Datalogging Colorimeter Handbook, "FerroVer Method", pp.227 through 233 (USEPA approved).

4) Analysis of Total Manganese, Mn, was performed in accordance with the Hach DR/820-DR/850-DR/890 Datalogging Colorimeter Handbook, "Periodate Oxidation Method", pp.253 through 261 (USEPA approved).

5) Analysis of Sulfate, SO_4, was performed in accordance with the Hach DR/820-DR/850-DR/890 Datalogging Colorimeter Handbook, "SulfaVer 4 Method", pp.539 through 545 (USEPA approved).

6) Analysis of Acidity was performed by digital titration in accordance with the Hach Water Analysis Handbook , "Methyl Orange Method" pp.2-3 through 2-5.

7) Analysis of Alkalinity was performed by digital titration in accordance with the Hach Water Analysis Handbook, "Titration Method" pp.2-9 through 2-12.

NOTE: Any chemical analyses parameters outside the ability of TASK Engineering Management Inc. will be sent to ESC Lab Sciences for processing. Samples not analyzed by TASK Engineering Management Inc. will be so noted by correspondence to the Regulatory Authority.

Results of Groundwater Sampling and Analytical Data for Each Sample See attached Groundwater Water Baseline Tables. All groundwater samples were analyzed for pH, Total Iron, Total Manganese, Conductivity, Sulfates, Acidity, Alkalinity, Water Depth and Water Elevation.

GROUNDWATER BASELINE ANALYSIS

SAMPLE I.D.: MW-1
MONITORING SOURCE: WELL
SURFACE ELEVATION: 1323.01 FT.
CASING STICKUP: 2.67 FT. (32")
MONITORING ELEVATION: 1325.68 FT.

DATE	H2O DEPTH FT.	H2O ELEV. FT.	pH s.u.	SpC u-mhos/cm	Fe Mg/l	Mn Mg/l	SO4 Mg/l	ACID Mg/l	ALKA Mg/l
06/20/11	28.00	1297.68	5.60	110	0.11	0.62	3	5	15
07/20/11	29.50	1296.18	5.65	122	0.12	0.85	4	6	15
08/23/11	29.50	1296.18	5.62	115	0.11	0.77	3	4	12
09/13/11	29.50	1296.18	5.61	113	0.12	0.82	3	7	20
10/17/11	30.80	1294.88	5.60	112	0.10	0.75	4	5	17
11/18/11	29.75	1295.93	5.62	113	0.11	0.84	3	5	16
12/09/11	29.25	1296.43	5.64	120	0.14	0.91	4	4	15
01/16/12	29.33	1296.35	5.63	118	0.12	0.88	3	6	14
02/09/12	29.00	1296.68	5.62	116	0.11	0.76	3	8	23
03/30/12	27.85	1297.83	5.61	196	0.19	1.30	1	6	17
04/19/12	27.25	1298.43	5.63	125	0.16	0.95	3	6	19
05/16/12	27.66	1298.02	5.64	138	0.14	0.83	4	7	21
06/12/12	28.00	1297.68	5.62	130	0.15	0.72	4	7	20
07/26/12	29.50	1296.18	5.61	132	0.12	0.94	3	5	23
08/23/12	28.60	1297.08	5.54	129	0.03	0.15	1	6	20

GROUNDWATER BASELINE ANALYSIS

SAMPLE I.D.: MW-2
MONITORING SOURCE: WELL
SURFACE ELEVATION: 1311.31 FT.
CASING STICKUP: 2.67 FT. (32")
MONITORING ELEVATION: 1313.98 FT.

DATE	H2O DEPTH FT.	H2O ELEV. FT.	pH s.u.	SpC u-mhos/cm	Fe Mg/l	Mn Mg/l	SO4 Mg/l	ACID Mg/l	ALKA Mg/l
06/20/11	22.00	1291.98	5.40	45	0.10	0.25	2	11	26
07/20/11	22.50	1291.48	5.43	58	0.11	0.18	1	10	25
08/23/11	22.55	1291.43	5.42	110	0.14	0.22	2	7	21
09/13/11	22.75	1291.23	5.41	75	0.12	0.36	2	7	23
10/17/11	23.10	1290.88	5.40	83	0.11	0.22	1	8	19
11/18/11	22.66	1291.32	5.43	48	0.12	0.31	2	12	33
12/09/11	22.50	1291.48	5.40	90	0.10	0.25	1	11	25
01/16/12	22.25	1291.73	5.35	60	0.09	0.26	1	9	23
02/09/12	22.85	1291.13	5.30	49	0.08	0.24	2	13	35
03/30/12	21.08	1292.90	5.15	61	0.09	0.12	1	10	28
04/19/12	21.00	1292.98	5.25	55	0.10	0.12	1	6	24
05/16/12	21.25	1292.73	5.32	105	0.11	0.25	2	8	27
06/12/12	21.08	1292.90	5.35	88	0.10	0.32	2	5	19
07/26/12	22.33	1291.65	5.37	51	0.11	0.26	1	7	22
08/23/12	24.58	1289.40	5.26	67	0.36	0.45	1	8	26

GROUNDWATER BASELINE ANALYSIS

SAMPLE I.D.: MW-3
MONITORING SOURCE: WELL
SURFACE ELEVATION: 1300.61 FT.
CASING STICKUP: 2.7 FT. (32.4")
MONITORING ELEVATION: 1303.31 FT.

DATE	H2O DEPTH FT.	H2O ELEV. FT.	pH s.u.	SpC u-mhos/cm	Fe Mg/l	Mn Mg/l	SO4 Mg/l	ACID Mg/l	ALKA Mg/l
06/20/11	34.40	1268.91	6.12	68	1.01	2.05	1	12	23
07/20/11	34.25	1269.06	6.17	74	1.08	1.10	2	7	19
08/23/11	34.66	1268.65	5.90	70	1.05	2.44	1	13	26
09/13/11	34.83	1268.48	6.08	72	1.07	2.14	1	9	20
10/17/11	35.33	1267.98	6.05	69	1.04	1.84	1	10	19
11/18/11	35.10	1268.21	5.57	66	1.01	2.68	2	8	25
12/09/11	34.75	1268.56	6.06	70	1.07	2.55	2	8	27
01/16/12	34.00	1269.31	6.08	71	1.15	2.21	1	11	26
02/09/12	33.66	1269.65	6.03	70	1.25	1.82	2	7	25
03/30/12	34.63	1268.68	5.99	72	1.65	1.12	1	10	30
04/19/12	34.50	1268.81	6.01	70	1.26	1.78	2	10	24
05/16/12	34.33	1268.98	5.35	69	1.23	1.36	2	8	26
06/12/12	34.00	1269.31	6.01	68	1.31	1.11	1	11	32
07/26/12	34.75	1268.56	6.06	73	1.45	1.53	2	9	27
08/23/12	35.45	1267.86	5.99	66	1.70	1.80	7	9	30

SEASONAL GROUNDWATER DATA

SAMPLE I.D.: MW-1
SURFACE ELEVATION: 1323.01 FT.
CASING STICKUP: 2.67 FT. (32")
MONITORING ELEVATION: 1325.68 FT.

SEASON	H20 DEPTH	H2O EL.	pH s.u.	SpC u-mhos/cm	Fe Mg/l	Mn Mg/l	SO4 Mg/l	ACID Mg/l	ALKA Mg/l
SUMMER	29.32	1296.36	5.63	122.20	0.10	0.71	2.80	5.60	18.00
FALL	29.93	1295.75	5.61	115.00	0.12	0.83	3.67	4.67	16.00
WINTER	28.73	1296.95	5.61	143.33	.014	0.98	2.33	6.67	18.00
SPRING	27.73	1297.95	5.63	125.75	0.14	0.78	3.50	6.25	18.75
AVERAGE	28.93	1296.75	5.62	126.57	0.12	0.82	3.08	5.80	17.69

SEASONAL GROUNDWATER DATA

SAMPLE I.D.: MW-2
SURFACE ELEVATION: 1311.31 FT.
CASING STICKUP: 2.67 FT. (32")
MONITORING ELEVATION: 1313.98 FT.

SEASON	H20 DEPTH	H2O EL.	pH s.u.	SpC u-mhos/cm	Fe Mg/l	Mn Mg/l	SO4 Mg/l	ACID Mg/l	ALKA Mg/l
SUMMER	22.94	1291.04	5.23	72.20	0.17	0.29	1.40	7.80	23.40
FALL	22.75	1291.23	5.37	73.67	0.11	0.26	1.33	10.33	25.67
WINTER	22.06	1291.92	5.41	56.67	0.09	0.21	1.33	10.67	28.67
SPRING	21.33	1292.65	5.35	73.25	0.10	0.24	1.75	7.50	24.00
AVERAGE	22.27	1291.71	5.34	68.95	0.12	0.25	1.45	9.08	25.43

SEASONAL GROUNDWATER DATA

SAMPLE I.D.: MW-3
SURFACE ELEVATION: 1300.61 FT.
CASING STICKUP: 2.7 FT. (32.4")
MONITORING ELEVATION: 1303.31 FT.

SEASON	H20 DEPTH	H2O EL.	pH s.u.	SpC u-mhos/cm	Fe Mg/l	Mn Mg/l	SO4 Mg/l	ACID Mg/l	ALKA Mg/l
SUMMER	34.79	1268.52	5.67	71.00	1.27	1.80	2.60	9.40	24.40
FALL	35.06	1268.25	6.03	68.33	1.04	2.36	1.67	8.67	23.67
WINTER	34.10	1269.21	5.83	71.00	1.35	1.72	1.33	9.33	27.00
SPRING	34.31	1269.00	6.06	68.75	1.20	1.58	1.50	10.25	26.25
AVERAGE	34.56	1268.75	5.87	69.77	1.22	1.86	1.78	9.41	25.33