ATTACHMENT II-F

GROUNDWATER HYDROLOGY

The following descriptions of regional groundwater and aquifer characteristics are based on information contained in the 'Hydrology Reports' for Areas 21, 22, 23, & 24 by the U.S. Geological Survey and also information contained in various hydrogeological evaluations submitted to, and approved by, the Alabama Surface Mining Commission.

Groundwater in the Warrior Basin occurs chiefly in openings along fractures and bedding planes within Pottsville Formation strata. The most productive water-bearing openings generally occur in sandstone beds within 250 to 350 ft. of the surface. Well yields in the Pottsville depend on the number and size of water-bearing openings present. The number and size of the openings normally varies from one point to another depending upon the degree of fracturing present in the rocks.

Regionally, the primary source of recharge to groundwater is rainfall which infiltrates through the overlying soils, past the root zone of plants, and into strata such as sandstone where it will sit (perch) upon an interval, such as shale, which limits the downward progress of the groundwater. Groundwater may also encounter fault and fracture zones, which will transmit the

groundwater past the bedding planes of shale, or other aquitards, to deeper aquifers. Where aquifers are overlain by less permeable strata, these aquifer may become confined due to the pressure exerted by groundwater in up-dip strata. Groundwater movement in the Warrior Basin is generally from areas of higher elevation, along bedding planes, toward stream channels. Where the static groundwater level intersects the surface, seeps or springs may occur. Where the static groundwater level intersects stream channels, groundwater discharges into the stream and contributes to surface runoff as baseflow.

Groundwater occurring above and below the Black Creek Coal Seam of the Black Creek Coal Group within the proposed Black Creek Mine exists in Pottsville Formation strata.

As mentioned in Part II-E, Groundwater Monitoring Sites GMCBCMW2 and GMCBCMW5 were drilled by personnel of Walker Drilling Service in November and December of 2011 utilizing a Gardner-Denver GD1000 air rotary drill. All monitoring wells were cased by personnel of Walker Drilling Service as shown on the attached 'Casing Specifications'. Data from these wells will be utilized to determine the characteristics of groundwater located within Pottsville Formation strata above, and below the Black Creek Coal Group at this site.

In addition, performance monitoring data will be included from several different

Groundwater Monitoring Sites at two adjacent, regulated mine sites. These include Groundwater Monitoring Sites MW-1 and MW-2 from the Sloan Mountain Mining - Sloan Mountain Mine No. 2 (ASMC permit number P-3913), and Groundwater Monitoring Sites GW-1 and GW-3 from the M.S.& R. - Merritt Rogers Mine (ASMC permit number P-3546). For groundwater monitoring site locations **see Mine Site Location Map.** Note that the attached information including casing specifications and monitoring results were copied from their respective ASMC files.

Groundwater Monitoring Site GMCBCMW2 describes the characteristics of groundwater associated with strata above the Black Creek Coal Seam, Groundwater Monitoring Site GMCBCMW5 describes the characteristics of groundwater associated with strata below the Black Creek Coal Seam, and Groundwater Monitoring Sites P3913MW-1 and P3913MW-2 describe the characteristics of groundwater associated with strata above, within, and below the Black Creek Coal Group (which mimic local domestic wells that extend into all these different aquifers). Casing details for P3546GW-1 and P3546GW-3 are not available, however, monitoring wells of that genre were surficially cased and drilled to describe the characteristics of groundwater associated with strata above, within, and below the targeted coal seams (in this case the Black Creek Coal Group). **See attached 'Casing Specifications'.**

Locally, the proposed mine site is located on an isolated ridge, with receiving streams which surround it on the southwestern, western, northern, and northeastern sides. Relief within the proposed permit boundary from the top of this ridge to the surrounding streams reaches approximately 200 feet. The recharge areas of the small sandstone and interbedded sandstone and shale aquifers which comprise this ridge, and are exposed to the surface along the ridge outslopes, are small and are limited to the outcrop areas of each interval. These small aquifers are obviously perched water table aquifers due to the fact that there is no other adjacent up-dip strata connected to them and therefore no adjacent groundwater to create a pressure head. The only strata which is hydraulically connected to this exposed strata is on the southeastern side of the proposed permit area and that is down-dip from the mine site, as shown on the Structure Contour Map in Part II-E. Water-bearing strata which does not outcrop within or adjacent to the proposed permit area, especially those intervals whose elevations underlie the bottom of the adjacent Locust Fork of the Black Warrior River, are likely to be hydraulically connected to strata whose outcrop areas extend up-dip for several thousand feet. As a result, the groundwater in these up-dip areas exert pressure on the groundwater located within the proposed permit area, causing the groundwater in wells penetrating these intervals to elevate above their respective confining layer. Obviously, the groundwater elevations of those water bearing intervals which intersect the wetted perimeter of the adjacent Locust Fork of the Black Warrior River are

influenced by its seasonal water levels.

Groundwater elevations recorded at Groundwater Monitoring Site GMCBCMW2 indicate this well intersects intervals that exist under confined aquifer conditions. Depth to groundwater in this well averages 41.75 feet from the surface as recorded during the monitoring period (in a well which is approximately 215 feet deep), and as stated above this monitoring site monitors the characteristics of groundwater associated with strata above the Black Creek Coal Seam. Based on the location of this well and its surrounding topography, it highly unlikely that the resultant average groundwater level in this well is from the contributions of several perched water table aquifers and more likely from a hydraulic connection to up-dip groundwater. Aquifers intersected by this well which underlie the Locust Fork of the Black Warrior River have a recharge area of several hundred to several thousand acres along their respect outcrop areas. Based on the recharge areas of the intervals below the receiving streams and the resultant water levels observed, a well penetrating these aquifers would be considered a reliable source of domestic groundwater based solely on quantity.

Groundwater levels recorded at Groundwater Monitoring Site GMCBCMW5 are surprising. The depth averages 89.96 feet from the surface as recorded during the monitoring period (in a well which is approximately 115 feet deep), and as stated above this monitoring site monitors the characteristics of groundwater

associated with strata below the Black Creek Coal Seam. Given the location of this monitoring site (adjacent to Crooked Creek and Locust Fork), its relatively low elevation, and the fact that this well penetrates strata which underlies the Locust Fork of the Black Warrior River (and has an outcrop area of several square miles), one would assume that this well's groundwater level would be influenced by either up-dip groundwater or the surface water contained in the Locust Fork of the Black Warrior River. The observed data indicates that groundwater levels in GMCBCMW5 are much lower than expected. This observed information indicates that the sandstone penetrated by, and not cased out of, the well (sandstone strata underlying the Black Creek Coal Seam) has either very small grain size which would result in low porosity, a cementing agent which restricts or interrupts groundwater flow, or the sandstone intervals contain a significant amount of shale interbedding such that groundwater flow is restricted. In any event, based on groundwater levels, this interval transmits only a small amount of groundwater and as such would not be considered a very reliable source of domestic groundwater based solely on quantity. It also indicates that if groundwater quality is affected by mining, this interval would restrict its movement into other underlying intervals.

Recharge to the small sandstone and interbedded sandstone and shale aquifers which outcrop above the Locust Fork of the Black Warrior River, and are exposed to the surface along that ridge's outslopes, consists exclusively of

precipitation. Infiltration into these intervals are controlled primarily by the slope of the outcrop area, and the hydraulic conductivity of the soil present at the surface. Obviously, soils with a greater sand content will allow a higher percentage of infiltration during any given precipitation event and soils with a greater shale content will have a higher percentage of runoff.

Intervals both above and below the target coal seams which are at, or below, the elevation of the Locust Fork of the Black Warrior River receive recharge from precipitation, direct infiltration from the river along its' wetted perimeter, and recharge from strata outcropping in up-dip areas. Infiltration in these aquifers are also controlled primarily by the hydraulic conductivity of the respective interval. As stated above, some intervals above the Black Creek Seam which also underlie the Locust Fork of the Black Warrior River receive a greater amount of groundwater from up-dip areas whereas the interval below the Black Creek Seam receives much less, as indicated by the observed data.

Groundwater associated with the Lick Creek, Upper and Lower Jefferson, and Black Creek Seams are extremely limited in capacity due to the thinness of these intervals, their relatively low hydraulic conductivities, and the local topography. The outcrop area of these intervals are also limited due (again) to their thinness and to the local topography. The primary source of recharge to these intervals are most likely direct infiltration from rainfall along their outcrop

area. Infiltration from their respective overlying intervals are based on that strata's vertical hydraulic conductivity and the amount of groundwater in that interval which, as stated above, is also very limited. The target coal seams would not be considered reliable sources of domestic groundwater based on quantity and the elimination of these intervals during mining would not measurably affect the quantity of local groundwater resources.

Qualified personnel from the PERC Engineering Laboratory have collected 7 samples from Groundwater Monitoring Sites GMCBCMW2 and GMCBCMW5 between the dates 01-30-2012 and 09-10-2012. In addition, qualified personnel from the PERC Engineering Laboratory have collected 34 samples from Groundwater Monitoring Site P3546GW-1 and 35 samples from Groundwater Monitoring Site P3546GW-3 between the dates 05-22-2003 and 03-16-2012. Samples collected by the PERC Engineering Laboratory were taken with either a hand bailer or a submersible pump after development. Water level is measured prior to development. Practices employed by the PERC Engineering Laboratory concerning the volume of groundwater extracted at groundwater monitoring sites prior to sampling is outlined as follows: Where recharge of groundwater is sufficient, three well volumes of groundwater (measured from the static depth) are pumped prior to sampling so the sample obtained is from recharge. Where recharge is slow, and three well volumes cannot be obtained within the monitoring cycle (usually monthly), only one well

volume will be pumped. The well will then be allowed to recharge and a sample will be obtained after a volume equal to the volume of the pump line has been discharged. In infrequent instances where recharge is very limited, and the volume of water in the well is too small to be pumped to the surface, a 'bottom sampler' is employed to bail as much water as possible from the well. The well will then be allowed to recharge and the bottom sampler will again be used to obtain a sample when ample groundwater is present to be collected. Depth to water, and pH, are measured in the field, and the sample is split into two separate containers: a 473 ml plastic bottle is acidified and utilized for metals analysis, and a one quart plastic bottle is utilized for all other analysis. Both are stored in an ice chest for transport to the PERC Engineering Laboratory. All groundwater samples taken to the PERC Engineering Laboratory are analyzed according to ASTM specifications. Parameters tested include pH, iron, manganese, conductivity, sulfates, acidity, and alkalinity. Not all parameters were analyzed on all occasions. Groundwater Monitoring Sites P3913MW-1 and P3913MW-2 were monitored on 9 occasions by personnel of McGeeHee Engineering Corp. between the dates 12-30-2009 and 12-09-2011. Due to the fact that the collection and analysis of these samples were conducted by personnel of McGeeHee Engineering Corp., sample collection, groundwater level determination, storage procedures, holding times, and analysis methods are not known, but are assumed to be valid. **See attached results of monitoring well analysis.** Averages for selected parameters from groundwater samples taken

at monitoring wells measuring chemical quality in groundwater associated with strata above, within, and below the Black Creek Coal Group are shown below:

Monitoring Site:	pH* (S.U.):	FeT (mg/l):	SpC (umhos):	SO4 (mg/l):
	(Above Black Creek Seam)			
GMCBCMW2	6.50	6.29	83.4	0.60
	(Below Black Creek Seam)			
GMCBCMW5	8.15	3.27	961	1.00
	(Above, Within, and Below Black Creek Seam)			
P3913MW-1	7.03	6.72	281	59.13
P3913MW-2	6.15	1.71	143	68.63
P3546GW-1	6.81	4.03	424	-n/a-
P3546GW-3	6.60	1.74	241	-n/a-

* median

Groundwater quality in the Pottsville Formation was described by Thomas J. Hill in "Hydrologic Assessment, Eastern Coal Province Area 23, Alabama" on page 59. The following is an excerpt from his findings:

Parameter:	Max:	Min:	Ave:
Fet (mg/l)	7.40	0.10	0.89
pH (s.u.)	9.40	6.40	8.40*
SpC (umhos)	1760	37	504
SO4 (mg/l)	37.0	0.20	11.0

*median

A typical comparison of groundwater from the above groundwater monitoring sites is not feasible based on which interval the monitoring site evaluates. The monitoring sites at P-3913 ans P-3546 are both down dip of significant current or previous coal related disturbance. As stated above, all of these sites monitor groundwater associated with strata above, within, and below the Black Creek Coal Group. The groundwater in all of these sites, as compared to the Pottsville averages shown above are lower in pH, higher in mineralization, and where measured, higher in sulfates. A comparison between averages shown for groundwater above the Black Creek Coal Group at the Black Creek Mine (GMCBCMW2) vs. Pottsville Formation averages show that the local groundwater in this interval is of lower pH, higher mineralization, lower specific conductivity, and lower sulfate concentrations than the Pottsville averages shown above. This says that, on average, local groundwater in this interval is of slightly lower quality than the Pottsville averages and as such is probably not very reliable as a domestic source from a quality standpoint unless this groundwater is treated to remove mineralization. The monitoring sites drilled for this proposed mine site are located down dip from a small amount of pre-law disturbance. A comparison between averages shown for groundwater below the Black Creek Coal Group at the Black Creek Mine (GMCBCMW5) vs. Pottsville Formation averages show that the local groundwater in this interval is of lower pH, higher mineralization, higher specific conductivity, and lower sulfate concentrations than the Pottsville averages shown above. This says

that, on average, local groundwater in this interval is of lower quality than the Pottsville averages and as such is probably not very reliable as a domestic source from a quality standpoint. Most if not all of the groundwater in this area has been affected by previous disturbance.

A well inventory initiated by PERC Engineering Co., Inc. in August of 2012 revealed that there are 219 residences within a ½ mile radius of the Black Creek Mine. The locations of all inventoried residences within a ½ mile radius of the proposed facility are shown on the attached Well Inventory Map. Pertinent information of the well inventory is attached (**See Well Inventory Summary and Well Inventory Maps**). The well inventory is on-going and will be completed and estimates of impact to local groundwater resources and well owners as a result of this operation will assessed during the technical review.

Groundwater movement for groundwater both above and below the Black Creek Seam in the vicinity of the Black Creek Mine should be down dip, as shown on the Structure-Contour Map in Part II-E. Groundwater movement in this area is also influenced by local surface topography, local fault or fracture systems (if they exist), adjacent and on-site surface mines, and the orientation of the receiving streams.