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.

As stated in Part II-E, this site is located in the Warrior Coal Basin. 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.

As mentioned in Part II-E, Groundwater Monitoring Sites RJRBMW-1, RJRBMW-2, RJRBMW-3, and RJRBMW-4 were drilled and cased by personnel of Walker Drilling Services, Inc. in April and May 2011. The drill used to drill the above mentioned sites was a Gardner-Denver GD1500 air rotary drill, utilizing a 4 and 3/4 and an 8 inch drill bit. Their locations are shown on the attached Mine Site Location Map. The Groundwater Monitoring Sites were drilled and cased specifically for baseline information for this proposed permit area. Groundwater Monitoring Site RJRBMW-1 monitors the aquifers both above and below the Blue Creek Seam, Groundwater Monitoring Sites RJRBMW-2 and RJRBMW-3 monitor the aquifer below the Jagger Seam, and Groundwater Monitoring Site RJRBMW-4 monitors the aquifers both above and below the Jagger Seam. See attached 'Casing Specifications'.

Within and adjacent to the proposed permit area, groundwater levels are

influenced by the presence of Turkey, Flat, and Cunningham Creeks. As such, groundwater levels observed during the sampling period are elevated. The lithology of local strata in the near subsurface as described in Part II-E of this report reveals a significant amount of sandstone and interbedded shale and sandstone. The receiving streams are most likely hydraulically connected to the strata within the proposed mine site and based on the relative elevations of the groundwater in the aquifer in question and the elevation of the adjacent stream, groundwater can probably migrate either into the stream from the proposed permit area (which is similar to most aquifer systems as described above), or away from the stream and into proposed mine site. Local groundwater levels are also affected by the presence of adjacent ridges and the aquifer systems within them. Much of the near subsurface strata which underlies the proposed permit area is laterally persistent and underlies the surrounding, adjacent ridges. If this adjacent strata is hydraulically connected to overlying intervals (by either fractures or faults, or separated from them by poorly developed aquitards) and those overlying intervals are saturated with groundwater, the groundwater in those overlying intervals will migrate downward and exert pressure on the groundwater in the underlying intervals facilitating a increase in groundwater elevations and an increase in lateral groundwater movement within the proposed permit area. Likewise, groundwater found in up-dip strata (of the intervals to be disturbed at this site) will also effect similar responses as described above. Finally, based on similar groundwater elevations of wells in close proximity

which monitor different intervals, it appears that many of the intervals to be disturbed at this site are at least partially connected hydraulically.

The interval overlying the Blue Creek Seam within and adjacent to the proposed permit area consists of sandstone, interbedded sandstone and shale, and sandy clay. Because the Blue Creek Seam does not outcrop in the immediate vicinity, this interval is laterally persistent but would be considered a local water bearing interval based on the elevations of adjacent surface topography and the orientation of this strata. As stated above, groundwater levels in this interval are influenced by both the adjacent receiving streams and groundwater in the adjacent ridges. As a result, groundwater levels averaged approximately 18 feet below the land surface in Groundwater Monitoring Site RJRBMW-1, which is approximately 11 feet above the Blue Creek Seam at this location. This interval is exposed to the surface within the local floodplain (and the proposed permit area), therefore there is no confining unit which would make this interval either a confined or artesian aquifer. This interval *may* become confined in off-site areas which underlie adjacent ridges, although no off-site investigations have confirmed this supposition. On-site recharge to this interval is either by precipitation, groundwater migration from overlying intervals (under adjacent ridges), from adjacent up-dip strata, and when the elevation of the surface water within the receiving streams are higher than the groundwater level in this interval, from the streams themselves. Due to the presence of high groundwater

levels, and the fact that the various water bearing intervals in this area are probably hydraulically connected, this interval would likely be considered a reliable source of groundwater for local domestic users based solely on quantity.

The interval between the Blue Creek and Jagger Seams in this area also consists of sandstone and interbedded shale and sandstone. This interval is also laterally persistent and would be considered a local water bearing interval. Based on the local surface topography and the orientation of the strata, the recharge area for this interval is probably limited to a few square miles. This interval does not outcrop within or adjacent to the proposed permit area therefore on-site groundwater migration into this interval is from either vertical infiltration from the overlying strata, or lateral groundwater migration from either adjacent up-dip strata or the adjacent receiving streams as discussed above. Based on elevations of groundwater in the monitoring wells, this interval might be considered a confined aquifer, however, lithologic information suggests there is no laterally persistent confining unit. As stated above, it appears that many of the intervals to be disturbed at this site are at least partially connected hydraulically. This interval would also likely be considered a reliable source of groundwater for local domestic users based solely on quantity.

Groundwater associated with the Blue Creek and Jagger Seams in the vicinity of the Bunt Mine is extremely limited in capacity due to the thinness of these

intervals and their historically moderate hydraulic conductivities. The primary source of recharge to these is interval is most likely from infiltration from the overlying intervals and is based on that strata's vertical hydraulic conductivity and the amount of groundwater in the aquifer. 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.

Groundwater below the Jagger Seam is found primarily in a sandstone or sandstone and shale interval located between 0 and 35 ft. below the Jagger Seam as shown by lithologic information submitted for Groundwater Monitoring Sites RJRBMW-2 and RJRBMW-3 and is at least 35 feet thick as shown in the casing specs for Groundwater Monitoring Site RJRBMW-3. This interval also does not outcrop within or immediately adjacent to the proposed permit area. This sandstone interval may constitute the perimeter or a fringe area of the Lick Creek Sandstone Member (Culbertson, 1964), known locally as the 'Jagger Bedrock'. The average groundwater elevation measured in Groundwater Monitoring Site RJRBMW-2 averaged 21.83 ft. below the surface, or approximately 42 ft. above the top of the Jagger Coal Seam. At Groundwater Monitoring Site RJRBMW-3, the average groundwater elevation was measured at only 6.85 ft. below the land surface, or approximately 54 ft. above the top of the Jagger Coal Seam. The groundwater in these wells may be classified as

confined due to the presence of a substantial confining unit shown in the lithology for RJRBMW-2 (at 85-100 feet), however there is no such developed unit in RJRBMW-3 and stated above it is just as likely that the various intervals discussed above are hydraulically connected. Recharge for this interval is from overlying interval and from precipitation from along this intervals outcrop area. If this sandstone interval constitutes a part of the Jagger Bedrock, the extent of the aquifer would be regional instead of local. This aquifer is likely to be capable of suppling several residences with domestic water in this area and would be considered a reliable source of groundwater for local domestic users based solely on quantity.

Personnel from the PERC Engineering Laboratory have sampled Groundwater Monitoring Sites RJRBMW-1, RJRBMW-2, RJRBMW-3, and RJRBMW-4 on three occasions between the dates 05-10-11 and 07-12-11. Samples were taken with either a hand bailer or a submersible pump after development. Water level is measured prior to development. Practices employed by PERC Engineering 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 samples were taken to the PERC Engineering Laboratory where they are analyzed according to ASTM specifications. Parameters tested include pH, iron, manganese, conductivity, sulfates, acidity, and alkalinity. See attached analysis. Averages for selected parameters from groundwater samples taken within and/or adjacent to the proposed permit area are shown below:

Monitoring Site and Interval Measured:	pH* (S.U.):	FeT (mg/l):	SpC (umhos):	SO4 (mg/l):
RJRBMW-1 (above and below Blue Creek)	6.92	3.39	500	81.33
RJRBMW-2 (below Jagger)	7.54	0.31	527	0.50

Monitoring Site and Interval Measured:	pH* (S.U.):	FeT (mg/l):	SpC (umhos):	SO4 (mg/l):
RJRBMW-3 (below Jagger)	8.52	1.16	1956	0.50
RJRBMW-4 (above and below Jagger)	8.57	3.35	771	5.78

* 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 comparison between averages shown for groundwater at the Bunt Mine vs. Pottsville Formation averages show that the local groundwater is of either lower or higher pH, lower or higher mineralization, lower or higher specific conductivity, and either lower or higher sulfate concentrations than the Pottsville averages shown above. This indicates that local groundwater is of either lower or higher quality than the Pottsville averages and as such could be reliable as a domestic source from a quality standpoint. Sulfate concentrations

exhibited above ranged from a low average of 0.50 mg/l to a high average of 81.33 mg/l in spite of the fact that there is no significant coal related disturbance in close proximity to the monitoring wells sampled. Elevated sulfate concentrations may be a result of coal seams or horizons encounters during drilling. The disparity in quality between the monitoring wells are most likely a function of differences in location, total depth, strata encountered, and casing specifications.

A well inventory initiated by PERC Engineering Co., Inc. in July of 2011 revealed that there are 132 residences within a ½ mile radius of the proposed Bunt Mine. See attached Well Inventory Maps. Pertinent information of the well inventory is also attached. The well inventory will be updated and estimates of impact assessed during the technical review.

As stated above, Groundwater Monitoring Sites RJRBMW-2, RJRBMW-3, and RJRBMW-4 penetrate the strata below the Jagger Coal Seam and receive groundwater from this interval. In addition it was stated that all of the intervals above and below the target coal seams at this site are most likely hydraulically connected. The static depth of the groundwater in each of the above mentioned Groundwater Monitoring Sites was determined by qualified personnel of the PERC Engineering Laboratory on July 12th, 2011. The elevation of the groundwater in each well was utilized to determine the gradient of the

groundwater in the aquifer below the Jagger Coal Seam at this location. The static depths of the groundwater and their respective corresponding elevations are as follows:

Monitoring Site:	Surface Elevation*:	Depth** to Groundwater:	Groundwater Elevation*:
RJRBMW-2	381.0	22.65	358.35
RJRBMW-3	364.5	7.05	357.45
RJRBMW-4	384.0	47.8	336.20

* - ft. MSL
** - feet

The above information (along with the locations of the above referenced Groundwater Monitoring Sites) reveals a local flow direction of North 74 degrees West and a groundwater gradient whose magnitude is 0.0087 ft./ft..

Groundwater movement for all aquifers in the vicinity of the Bunt Mine should be influenced by the dip direction of the strata, adjacent stream locations, and local surface topography.