(2)(g) Sealing or Managing Mine Openings, Exploration Holes, Other Boreholes or Wells

The mine portals will be sealed in accordance with Map 28, Portal Entry Seals and Map 30 Portal Entry Water Tight Seals. Vent shafts will be sealed in accordance with Map 29 Shaft Seals. The exploration and monitoring holes will be sealed in accordance with the requirements of Rule 4.07.

Two types of seals were considered for installation at the Bowie #2 Mine. If mine water in-flows are experienced in the mine, a water-tight seal as shown on Map 30 may need to be installed to plug the portals and contain potentially degrading mine water from flowing from the abandoned portals.

It is highly unlikely mine water will build up behind the portal seals since the dip of the mine workings is 2 to 5 degrees to the northeast. Additionally, the mine has been idle since February 29, 2016, and there is no indication water has reached the portals. The Operator intends to seal the portals as shown on Map 28.

The dip of the mine workings will prevent acid or other toxic drainage for entering surface waters and will minimize disturbance to the prevailing hydrologic balance.

Although water-tight seals are not required, the design will be maintained in the permit. The design of the concrete water-tight seal was taken from Bureau of Mines Information authored by Cheken, Garrett, and Pitt. They developed an equation used for design after work done in Africa on seals which where able to withstand hydrostatic pressure in excess of 6,000 psi. The equation is as follows;

$L = (p*a*b)/((a+b)*fc)$
where;
L = Length of plug, ft.
a = width of entry, ft.
b = Height of entry, ft.
p = Hydrostatic pressure, psi.
fc= Allowable compressive strength of rock or concrete, whichever is the lesser, psi.

The height and width, a and b, of the portal entries is 8-feet and 20-feet, respectfully. The roof, ribs and floor will be cleaned to competent material but will not be recessed into solid rock or coal. The maximum calculated hydrostatic pressure, p, for the seal will be 60-feet of water or 26 psi (measured from the seal elevation to the piezometric surface of the upper perched water bearing zone). Coal will have the lowest compressive strength, and triaxial tests preformed on the coal typically average 1000 psi. Garrett Campbell and Pitt recommend the use of a factor of safety of 4 to 5. The allowable compressive strength will be (1/5)*(1000)= 200 psi. Using this data, the length of the plug required would be 0.75'. The applicant would like additional

certainty added to the plug length and will propose that a minimum plug length should be 3-feet, or 4 times that calculated. A sketch of the water tight seal is shown on Map-30 of Volume II.

(2)(g) Drill holes, not completed to aquifers will be sealed by replacing cuttings or other suitable media in the hole and placing a suitable plug 10 feet below the ground to support a cement plug or other media approved by the Division to within 3 feet of the ground surface.

Sealing of the drill holes will prevent acid or other toxic drainage for entering ground waters, minimize disturbance to the prevailing hydrologic balance and ensure the safety of people, livestock, fish and wildlife, and machinery in the permit and adjacent areas.

Drill holes completed in non artisan aquifers will be sealed using cement or other suitable sealant by placing the sealant to extend 20 feet above and below the water bearing zone. A surface plug will then be placed in accordance with the above paragraph. The hole will be marked.

Gob Vent Boreholes (GVBs) present unconventional circumstances for abandonment procedure to assure methane does not leak to the surface. The Mine is using a pressurized ventilation system to Apush@ methane up through the GBV's to cause exhausting of methane gas to the surface.

GVB's are constructed by drilling a hole to within 30 ft. above the seam then placing a string of 5.5 or 6.5 inch casing in the hole with the open bottom of casing suspended approximately 230 feet above the seam leaving 200 ft. of open hole. The bottom 200 ft. of casing is perforated, at the top of the perforations a cement basket is placed and cement is pumped into the annulus above the basket completely grouting the casing in-place. This provides at least 200 ft. of fully grouted casing, in the worst case scenario (GVB-4-D-A), where the total depth of he hole is 500 ft. and the amount of perforated casing was adjusted to 100 ft. Typically hole depths are in excess of 1000 feet which results in the grouted interval (fully cemented to the formation) in excess of 600 ft.

GVB's will be sealed as follows:

1. The condition of borehole will be verified by sounding the total depth of the borehole.
2. A bridge plug will be placed at the lowest point possible in the blank casing. The bridge plug will always be placed above the perforated casing.

2.05.4(2)(e)

3. The placement of the bridge plug will be verified.
4. The cessation of methane gas flow will be confirmed. Placement of a hole plug or other suitable media may be required to stop methane flow.
5. The theoretical well volume will be calculated.
6. The borehole will be filled with cement to within three feet of the ground surface or a minimum height of 50 feet above the bridge plug or both. Cement will be placed utilizing a tremmie. The top of the cement plug will be sounded.
7. The actual volume of cement used will be compared to the theoretical well volume to assure the cement did not bridge.
8. The remainder of the borehole will be filled to the surface with soil.
9. The borehole location will be marked.
10. A well abandonment report will be submitted to the DMG that includes all of the items required in Rule 4.07.3. The report should include the theoretical and actual volume of cement used.