



April 16, 2020

MEMORANDUM

TO: Shannon Anderson
Powder River Basin Resources Council
Sheridan, WY

FROM: Mike Wireman
Granite Ridge Groundwater
Boulder, CO

SUBJECT: Review of: Ramaco Carbon revised permit application (submitted in March 2020)
for the proposed Brook Mine, Sheridan County, WY

BACKGROUND

On September 28, 2017 the Wyoming Environmental Quality Council (EQC) issued Findings of Fact, Conclusions of Law, and Order related to Brook Mining Company, LLC's (Brook) application for a permit (submitted in October 2014) to mine coal on lands it owns and controls in Sheridan County, Wyoming. The EQC ordered that Brook's permit not be approved. The EQC decision was based primarily on the inadequate characterization of the hydrogeology, surface water hydrology and potential for subsidence within the proposed mine permit area and adjacent areas. The lack of an appropriate baseline hydrologic characterization precluded the completion of a Cumulative Hydrologic Impact Assessment (CHIA) as required pursuant to Wyoming Statute W.S. § 35-11-406(n). Without a rigorous baseline characterization assessment, including a CHIA, it is not possible to develop and implement an adequate plan to minimize disturbances to the prevailing hydrologic balance at the mine site and in associated offsite areas or to determine if the proposed mining operation has been designed to prevent material damage to the hydrologic balance outside the permit area and will not materially damage the quality and quantity of water in the surface water and groundwater systems that supply alluvial valley floors (AVF) as required pursuant to Wyoming Statutes W.S. § 35-11-406(b) and WS 35-11 406 (n).

After the September 2017 EQC decision Brook worked with the Wyoming Department of Environmental Quality (WDEQ) - Land Quality Division (LQD) to address the 14 relevant Orders related to the inadequate hydrologic characterization including the need to better characterize the : (a) hydrology in the vicinity of TR-1, (b) the hydrology of the coal seams

(including overburden and underburden), (c) the hydrology of the Tongue river alluvial aquifer, and the Slater Creek alluvium and (d) flow in the Tongue River and Goose Creek. As part of this effort, Brook collected a minimal amount of new field data in 2018. On October 19, 2018 WWC Engineering, on behalf of Ramaco Carbon (owner of Brook mine) submitted a revised permit application with some significant changes to the original mine plan:

1. there will be no mining south of the Tongue River in the TR-1 area;
2. the Masters coal seam will not be mined -only the Carney seam will be mined;
3. mining will start in the Taylor Quarry area -for first 5 years;
4. there are declared AVFs on Slater Creek and the north side of the Tongue River within the permit boundary. These were determined pursuant to State Decision Documents for permits 213-T1 and 497-T1.

The LQD reviewed and provided comments on the October 2018 revised permit application and on September 20, 2019 Brook submitted a second revised permit application. In February 2020, after further review and comment, LQD notified Ramaco Carbon that Brook Mine's permit application has been deemed technically complete under applicable Wyoming statutes. The LQD also released draft Comprehensive Hydrologic Impact Assessment (CHIA) in February 2020. On Nov. 19, 2019, Brook Mine submits application for permit to mine (WDEQ - LQD Form 1).

The revised permit application includes major revisions to Volume 5 (Hydrology). Volume 11 (Mine Plan) and Volume 12 (Reclamation). My review of the revised permit application is focused on Appendix D6 (Hydrology), Appendix D11 (Alluvial Valley Floors), Addendum MP-3 (Groundwater Model) and operational and post-closure water resource monitoring.

GENERAL COMMENTS

1. The revised mine plan excludes the TR-1 area in the vicinity of the BHC pits 1 and 2 and excludes the Masters coal seam from the planned mining. These changes will result in significantly reduced coal production and a different footprint than the original mine plan. The area where Brook proposes to mine the Carney seam includes more than 4000 acres immediately north of the Tongue River. The revised mine plan includes both highwall mining and open pit mining. Slater Creek, an intermittent stream and Hidden Water Creek, an ephemeral stream, flow from NW to SE across the permit area.
2. Surface water and groundwater use is significant in the area close to the permit area. There are 45 reservoir rights, 47 ditch diversion rights and 14 unpermitted reservoirs. The diversions are primarily (70%) used for irrigation, including irrigation of Alluvial Valley Floors. There are 480 groundwater wells within the vicinity of the mine permit area. These wells are producing from the Ft. Union Formation and used primarily for domestic and stock watering use.
3. Much of the permit application contains older (2014-2015) and superceded data and information and was written when the mine plan was substantially different (see above) and

does not accurately reflect the current mine plan. This is confusing and makes review of the document more difficult.

4. In October 23, 2014 Brook submitted Application for License to Mine (DEQ - LQD Form 3). Is this License still valid?
5. In 2016 Brook prepared an estimate of the surface damage bond for BH coal surface ownership. Estimate was approx. \$1900.00 based on potential forage loss. Bond is only for first year? Is this still in place?

MAJOR CONCERNS

1. The baseline hydrology of the Tongue River alluvium / Tongue River system is still not characterized adequately. The new water level and water quality data collected in 2018 is very limited and insufficient to adequately characterize baseline hydrologic conditions and assess potential impacts to alluvial valley floors from the proposed mining. The characterization of recharge, flow and discharge from the Tongue River member of the Ft. Union -which includes the Carney and Masters coal seams is inadequate. This is due to having too little data and the complexity of groundwater flow in the Tongue River member of the Ft. Union Fm. Brook is relying primarily on old data to characterize current baseline conditions. The revised permit includes a discussion of the “groundwater material” in the 2002 BHC permit 213. This data is very old and focused only on the area around the open pits on the BHC mine permit area – not useful for characterizing current hydrogeologic conditions in the Tongue River member including the coal seams (Carney) and interbedded lithologies (SS, Siltstone, clay).
2. The groundwater model was developed specifically to look at the radial extent of drawdown in the coal aquifers associated with mine related dewatering of the coal seams and the potential decline of water levels in nearby domestic /stock wells. The modeling effort did not assess potential impacts to the Tongue River alluvial aquifer (and AVFs) from long term changes to the groundwater flow system (recharge, flow and discharge) in the Tongue River member. The groundwater model results have high uncertainty due to the sparse data sets and inability to simulate variably saturation conditions and multiple flow systems in the Tongue River member of the Ft. Union Fm. Predictions of drawdowns at domestic well locations have very large uncertainty. Significant problems with the modeling efforts included difficulties with calibration, convergence and inability to use applicable sub-package.
3. The operational and post-mining water resource monitoring programs are poorly described in the permit application. There is no sampling and analysis plan provided for either monitoring program. There is no surface water monitoring location on the Tongue River located above the mine permit boundary nor is there a monitoring well in the Tongue River alluvium above the mine permit boundary. The proposed post-mining monitoring frequency (annually) is not appropriate for establishing post -mining water level and water quality trends. It is unclear how many and which monitoring locations are still accessible and useable. There is no information regarding the role of the WDEQ - LQD with respect to approval of the proposed monitoring program and no discussion the

criteria that will be used to reduce or eliminate post-closure monitoring and release Brook's bond.

4. WY regulations (Chapter 5, Section 3 (b) (ii)) require environmental monitoring of AVFs to help determine if the essential hydrologic functions are being maintained. The monitoring proposed by Brook is not adequate as it is based only on annual infrared photos of the Tongue River alluvial floodplain along the southern boundary of the permit application and does not include the declared AVFs downstream of the BHC mine property. It is unclear if the WDEQ AVF determination in the January 10, 2020 letter removes this requirement or does Brook need to do this?

DETAILED COMMENTS

Land Use - Appendix D1

1. The population data for Sheridan and Dayton are from 2012. Application should provide current data.
2. The economic agricultural statistics for Sheridan County are from 2007. Application should provide current data.

Climatology - Appendix D4

1. Like other baseline data the climatological data is not current -but based on data from 2000 – 2005. It is important to provide current precipitation and temperature data

Hydrology - Appendix D6

Surface water monitoring / baseline characterization

1. The permit application provides steam discharge data from two USGS stations located on the Tongue River near Monarch (USGS 06299980) and at the WY-MT state line (USGS 06306300) and two USGS stations located on Goose Creek below Sheridan (USGS 06305500) and near Acme (USGS 06305700). Data from these sites cannot be used to compare conditions upstream of the mine permit area with conditions downstream of the mine permit area. There is no monitoring station on the Tongue River above the mine permit area. The stream discharge data for these stations presented in Table D6.1-3 are not current. The most recent data from the Tongue River stations and the Goose Creek station near Acme is 2017. The most recent data for the Goose Creek station below Sheridan is 1984. The USGS monitoring station 06306300 is located at the WY-MT state line and is almost 30 miles below the mine permit area. There is no data since 1984 for the USGS station on Goose Creek below Sheridan (06305500) and the station on Goose Creek near Acme is too far upstream.
2. Discharge data is provided for Tongue River station TR03 established by the Sheridan County Conservation District. StationTR03 is located approximately 2-3 miles

downstream of the mine permit area. This is an appropriate location, but the streamflow data are very sparse, May-Aug 2013 and May-Sept 2017.

3. Discharge data is provided for two Bighorn mine monitoring locations – TR2B80, located on the Tongue River downstream of mine permit area and HWC1-79, located on Hidden Water Creek. Again, the data are very sparse and somewhat qualitative. Data from TR2B80 are from May 2016-April 2018 and data from HWC1-79 are from 1982-1998.
4. The permit application (Section D6.1.3.1) refers to a USGS gage on Slater Creek. This station is shown on Exhibit D61-1 however, it is not included on Table D6.1-2 or Table D6.1-2.
5. Figures D6.1-3 and D6.1-4 indicate great difference in June high flow between 2016 (>500 cfs) and 2017 (>2000cfs). There is no discussion / explanation for this difference.
6. Two surface water monitoring locations were established for background characterization on Slater Creek (SM578418-SW-1 and SM578512-SW-1) and two on Hidden Water Creek (SM578415-SW-1 and SM578409-SW-1). Streamflow and water quality data from these sites is very limited. The data presented in the revised permit application are Sept-Oct 2013 and April – Sept 2014. No flow data for Slater Creek or Hidden Water Creek was obtained from Oct-March (6 months) – because the monitoring equipment was removed for winter. The baseline monitoring period was too short and is now out of date for all four baseline locations. The lack of seasonal data precludes the establishment of annual hydrograph. Current stream flow and water quality should be obtained from these locations prior to mining. The revised permit application (Page D6-9) states that site visits to these 4 locations were conducted after all 2-year 24 - hour storm events. Where is this data?
7. It has been reported that the USGS monitoring station at Monarch has been discontinued. Is this true? If so -will a new site be established? In response to this concern Brook committed to find another location. Apparently, this has not been done. Streamflow and water quality sampling stations should be established on the Tongue River upstream and downstream of permit area (within ½ mile of permit boundaries).
8. Surface water quality data presented in the revised permit application is insufficient to characterize background / ambient water quality. Very little new surface water quality data is presented. There is no current water quality data for Slater Creek or Hidden Water Creek. The sampling site on Goose Creek is located too far from the confluence of Goose Creek with the Tongue River. Data from the two new sites on the Tongue River (578420-TR-1& 578524-TR-1) can be useful for characterizing baseline conditions if sampling continues at quarterly intervals for a full year. There is no discussion /assessment of the data. The permit application (page D6-13) indicates that water quality data from the USGS station 06299980 at Monarch was reviewed, however this data is not provided. Water quality data discussed in the permit application include:

- a. data from two locations on Slater Creek collected in April 2014. These data do not represent current conditions.
 - b. data from Goose Creek – quarterly sampling from April 2015 – June 2016.
 - c. data from 13 sites (6 on the Tongue River and 7 on Tongue River tributaries) included in the 2017 SCCD report. The data are from 2016 and only include data for temperature, dissolved oxygen, pH, turbidity, conductivity and *E. coli* bacteria. These data are of limited value for evaluating potential impacts from coal mining. There are no data for ions or metals.
 - d. data from TR03 provided from Bighorn mine - June 2016 – March 2018
 - e. data from three sites from which grab samples have been collected in 2018 for water quality analyses. Two of these sampling sites (578420-TR-1& 578524-TR-1) are located adjacent to monitoring wells in the Tongue River alluvium and the Carney coal. A third sampling site 578513-IRR-DITCH-1 is an irrigation ditch located north of the Tongue River. Water quality data is presented for April, June and July,2018
 - f. data from Hidden Water Creek – 9 samples from 1979-1989
9. There is no water quality data for the Tongue River upstream of station 578525-TR-. The mine permit area extends west of this point. There should be a sampling site upstream of the western boundary of the mine permit area.
10. Page D6-11 – the revised permit application should include more specific information on the TMDLs established for the Tongue River and Goose Creek – what are the constituents of concern? What is the reach of the River / Creek? What is the TMDL limit that has been established for Goose Creek?

Groundwater monitoring / baseline characterization

11. In the original permit application, there were nine groundwater monitoring locations that were used to obtain background / baseline data. These included nine Carney wells, nine Masters wells, three alluvial wells (along Slater Creek), one underburden well and one well screened in both the Carney and Masters coal seams. The revised permit application relies primarily on these same data for characterizing baseline groundwater conditions. The hydrographs and water quality data provided for these wells only include limited data from 2013-2014.
12. In 2018, seven new groundwater monitoring wells were installed: two wells in Tongue River alluvium (578524 – AL-1 & 578420-AL-1); two wells in the Carney that are co-located with the two new alluvial wells (578524 – CRN-PUMP & 578420-CRN-PUMP); two wells in the Bighorn spoils (578415 – SPL-1 & 578415 – SPL -2); and one overburden (578513 – OVB-1). Well 578420-AL-1 is on south side of the Tongue River and apparently only sampled twice and then abandoned. Well 578524 – CRN-PUMP was only sampled once and then abandoned. In addition, it should be noted that the hydrographs for these wells are for very limited time periods -one to four months. There is no discussion of the rational for these well locations or what data will be obtained and

how / why the data is useful to address the WEQC Findings. These data are clearly inadequate for characterization of baseline groundwater and surface water hydrology. In 2019 Brook installed a third well in the Tongue River alluvial aquifer. downgradient of wells 578524 – AL-1 & 578420-AL-1. However only two water level measurements are provided for this well.

13. The well construction logs for wells 578524 – AL-1 and 578524– CRN-PUMP (Addendum D6-7) are very inconsistent even though the two wells are co-located. The log for alluvial well (578524 – AL-1) indicates about 27 feet of alluvial gravel and an underlying sandstone while the Carney well (578524– CRN-PUMP) indicates only 15 ft of alluvium and does not indicate an underlying sandstone. These differences need to be resolved.
14. Section D6.2.1.1 states that recharge and discharge areas for the Masters and Carney aquifers are shown on Exhibits D6.2-2 and D6.2-3. These areas are not shown on these Exhibits.
15. The saturated zones maps (exhibits D6.4 thru D6.2-8) were compiled using a very limited and old data set from 2013 - 2014. These maps should be developed with current data collected over an annual hydrograph to assess seasonal variation. In the 2018 SAP Brook committed to submit the supporting info used to determine saturation zones including well names, geologic info, well depth and methodology. This information is not in the revised permit application. Why didn't Brook use saturation zone maps to locate monitoring wells? Brook says they did not and they don't need to?
16. Four of the original monitoring wells - 578417- MST, 578417- CRN, 578408 – MST and 578408 – CRN were installed in two -inch coreholes, using bentonite for isolating sampling intervals. This is a poor design for a groundwater monitoring well and is not compatible with any technical guidelines regarding construction of groundwater monitoring wells. This results in uncertainty regarding water level measurements and water quality sampling results.
17. The data and discussion regarding recharge, flow and discharge from the Tongue River member is very inadequate. The coal lithologies and sandstones within this member are the primary water-bearing units, while finer rained lithologies between the coal beds are typically minimally saturated. Lithologic logs indicate that a significant sandstone unit above the Carney seam which thickens to the east and is often saturated. Aquifer test data from BHC indicate production rates of 38 gpm from sandstones above the Carney. There needs to be a much better discussion of the estimated annual recharge to the Tongue River member including recharge via infiltration at outcrops and clinker areas as well as groundwater inflow to the Tongue River member from areas upgradient of the mine permit areas. The cross-sections indicate faulting with up to tens of feet displacement that vertically separates the permeable lithologic units in the Tongue River member. This likely results in more local groundwater flow systems that have somewhat distinct discharge locations. There is some revised discussion of recharge mechanisms to the Carney coal seam along western 2/3 of mine permit area and subsequent flow

downgradient, however the discussion of discharge from the coals and sandstone lithologies included Section D6.2.2.5 and Section 2.6.1 in Addendum MP-3-2 is very qualitative and not supported by any data. In this hydrogeologic setting – dewatering the coal seams for mining may impact groundwater flow in the saturated sandstones /siltstones and subsequently impact discharge to the Tongue River alluvium.

18. It is clear from the EQC Findings that the hydrogeology of the Tongue River alluvium was not adequately characterized in the original Brook mine permit application. This is important because the Tongue River alluvial deposits comprise the alluvial valley floors. Pursuant to WS 35-11 406 (n) (v), a coal mining operation may “*not materially damage the quantity or quality of water in surface water or underground water systems that supply these alluvial valley floors*”. In response the EQC findings, Brook extended cross-sections D-D’, E-E’, F-F’, G-G’, I-I’ and L-L’ southward past the Tongue River. However -the cross-section extensions were compiled using old, poor lithologic data from existing water wells. The SEO permit data for these types of wells is often of very poor quality. WDEQ-LQD should require Brook mine to verify the cross-sections with data from new drilling. This is necessary to substantiate the statement on page D5-8 that “*Most of the geologic cross sections demonstrate there is no hydraulic connection between targeted coals and the Tongue River*”. The permit application does not include any analysis to support this statement.
19. As stated above only two new Tongue River alluvial wells were installed in 2018. One of these wells (578420-AL-1) was abandoned after only two rounds of water level measurements and water quality sampling. The other new well (578524 – AL-1) was constructed in a more appropriate location however, the data from this well is also very limited.
20. Due to the potential for impacting AVFs on the Tongue River alluvium and the need for mining and post-mining monitoring, Brook should construct a water table map for the Tongue River alluvial aquifer. A water table map would aid in establishing baseline water level and direction / velocity of flow in the alluvial aquifer. The water level contours shown on Exhibit D6.2-3 are based on water level measurement from only two well locations and the two wells are on opposite sides of the Tongue River. It is necessary to have water level data from at least three locations on the north side of the Tongue River to prepare, even a simple water table map Because of this the water level contours presented in Exhibit D6.2-3 are not representative.
21. The revised permit application does not present a sound basis for the assumption that ground water in the Tongue River alluvium discharges to the underlying coal – The second quarter 2018 groundwater level elevation (Table D6-1-Addendum D6-9) in well 578520-CRN-PUMP was higher than the water level elevation in co-located alluvial well 578520-AL-1. Groundwater level elevations were also very similar for wells 578524-CRN-PUMP and the co-located alluvial well 578524-AL- 1. This indicates flow from the coal to the alluvium. There is no comparable water level data for areas west of well 578524-AL-1. As shown in cross section L-L’ (Addendum D5-3) the Tongue river member of the Ft. Union formation underlies the Tongue River alluvium adjacent to the

western part of the mine permit area. As shown in the cross-section the Carney and Masters coals seams occur within a few to tens of feet below the bottom of the alluvium. If the vertical gradient is upward -ground water will flow from the Tongue River member into the alluvial aquifer. In addition the cross section shown in Addendum MP-3 -Figure 2.3-3 depicts discharge of groundwater from the Carney coal to the Tongue River alluvial aquifer.

22. The aquifer property data obtained from BHC pump tests / slug tests in the spoils is not suitable for characterizing aquifer properties for the Tongue River alluvial aquifer. The spoils are essentially anthropogenic fill and groundwater flow in these spoils is likely quite different than groundwater flow through the coarse sand and gravels which comprise the Tongue River alluvial aquifer.

Aquifer tests

23. The revised permit application includes the same 2013-2014 baseline data / information regarding aquifer testing that was included in the original permit application and limited aquifer test data from 2018. The 2013-2014 tests were conducted primarily to assess hydraulic properties of coals to be mined. The wells chosen for the aquifer testing are located in the far east end of the permit area and, given the variability in saturated conditions and water quality in the coal seams, it is unknown if the results from these wells are representative of hydraulic properties of the coal seams to the west. The Slater Creek alluvial monitoring wells were not monitored during the aquifer tests. This was a serious omission. As determined by WDEQ there are AVF lands within the Slater Creek valley which might be impacted. To evaluate potential impacts to the Slater Creek AVF an aquifer test (pumping the coal aquifer and monitoring the saturated alluvium) should be conducted near the saturated Slater Creek alluvium.
24. In June 2018 two aquifer tests were completed at locations 578524 and 578520. These tests were conducted to evaluate effects of pumping the Carney coal on water levels in the overlying Tongue River alluvium. For the test at location 578524, the Carney well was pumped at 4 gallons per minute (gpm) for 24 hours. There was no reported effect on the water level in the co-located alluvial well 578524-AL-1. It is likely that the Carney well was not pumped at a high enough yield and was not pumped long enough to stress the alluvial aquifer. This significantly constrains the usefulness of this data. The June 2018 aquifer test at location 578520 was aborted and no useful data were collected. The limited water level, water quality and pump test data from the two new Tongue River alluvial wells is not sufficient to adequately characterize the hydrogeology of the Tongue River alluvium and the nature of the hydraulic relationship between groundwater in the alluvial aquifer and groundwater in the coal seams north of the Tongue River or surface water in the Tongue River. Sampling and monitoring need to continue for at least a full year and water level and water quality data need to be obtained from locations west of 578524.
25. The revised permit application includes hydraulic property data from aquifer tests at 33 locations conducted by BHC in 1979-1981. Hydraulic data are presented for the Tongue

River alluvial aquifer, the Dietz and Monarch coal seams and spoils BHC mine. The permit application provides a comparison of hydraulic conductivity data from BHC aquifer testing and Brook aquifer testing. This comparison has limited usefulness. The BHC tests were conducted in different hydrogeologic units than the Brook tests. Hydraulic conductivity values vary significantly. The 33 BHC locations are east of the Brook mine permit area and have limited value for establishing baseline conditions in the Tongue River alluvium to the west. Brook has not conducted any aquifer testing in the Tongue River alluvial aquifer and no aquifer property data are presented for this aquifer west of the BHC properties.

26. Table D6.2-2 includes data for 18 slug tests performed in March, April and June 2018. (Six Carney wells, five Masters wells and five alluvial wells. There is no discussion of the data from these tests in Section D6.2.2.2 or Addendum D6-8.
27. There is no data regarding the vertical hydraulic conductivity in the Tongue River member or the Tongue River alluvium. This data is important for helping evaluate the hydraulic relationship between the coals seams and overlying alluvial deposits along Slater Creek and the Tongue River. Brook committed to providing this but has not provided.

Groundwater levels

28. The revised permit application includes pre-mining potentiometric surface maps (Exhibits D6.2-2 and D6.2-3) for the Masters and Carney seams. These maps were constructed based on computed average water levels using water level data from 2013-2014. The potentiometric surface contours presented on the two maps are very similar as are flow directions which indicate groundwater flow towards the Tongue River and /or the Tongue River alluvium. The maps also indicate a steep gradient. Based on the use of “*computed average water levels*” and the fact that the data is 5-6 years old, there is significant uncertainty as to how representative these maps are of the current potentiometric surface. The revised permit application does not include any update of these maps.
29. The 2018 potentiometric surface elevation data from 578524– CRN-PUMP and 578520 – CRN-PUMP is not at all useful. There is only one measurement from well 578524 – CRN-PUMP and two from 578520 -CRN-PUMP. Table D6-1 (Addendum D6-9) indicates that well 578524– CRN-PUMP was plugged and abandoned after only one measurement. Why was this well abandoned? This severely limits the availability to obtain trend data in the future.
30. The information contained in the revised permit application regarding the impact of the development of coal bed natural gas (CBNG) on the potentiometric surface elevations in the Carney and Masters coal aquifers within the proposed permit area is confusing and incomplete. On page D6-31 the revised permit application states that “*it is unlikely that the CBNG dewatering efforts have significantly affected water levels in the wells utilized for the aquifer tests*”. On page D6-35 the revised permit application states that “*CBNG production has affected the potentiometric surface prior to baseline monitoring on the*

eastern edge of the permit area". In Addendum MP-3 (page MP-3-20) it states that *"withdrawals from the aquifer system for coal bed methane (CBM) production are believed to have impacted water levels in the coal seams"* and *"the volume of recharge entering the model laterally from adjacent aquifers is minimal because CBM development has significantly decreased water levels in the coal aquifers"*. Since the groundwater modeling was focused on declines in the potentiometric surface of the coal seams due to dewatering – it is obvious that this refers to the western part of the mine permit area. The information in the revised permit area is incomplete and inadequate for assessing the affect of CBNG dewatering on the current and future of water levels in the coal seams to be mined. This needs to be considered when conducting a CHIA. Recent water

31. The discussion regarding saturation zones (D6.2.2.7) is incomplete. Most of the Carney coreholes listed in Tables D6.2-24 (Carney), D6.2-25 (underburden) and D6.2-26 (Slater Creek alluvium) indicate partial or fully saturated conditions. There is no discussion of when the measurements were taken or if they represent a full hydrograph or just a single measurement.

Groundwater quality

32. The revised permit application does not include an adequate analysis /discussion of the groundwater quality data. There was no sound rationale for the selected sampling locations in the Tongue River alluvial aquifer and the Carney coal aquifer. As shown by the piper diagram in Figure D6.2-2 there is a lot of variability in the ground water quality between geologic /aquifer units. The explanation for these differences presented on in Section D6.2.3 is very qualitative and general and not adequate for establishing baseline.
33. The piper diagram presented in Figure D6-2-3 indicates that the ion chemistry of the groundwater from the Carney wells is similar to the ion chemistry of groundwater from the two Tongue Rive alluvial aquifer wells. This may indicate mixing of groundwater from the Carney with groundwater in the alluvial aquifer.
34. The revised permit application provides 2013-2014 ground water quality data from four Carney wells, four Masters wells, three Slater Creek alluvial wells and one underburden well. These data are very limited and outdated.
35. Ground water quality data are presented for six of the seven new wells installed in 2018. Well 578524 – AL-1 was sampled four times; wells 578420-AL-1, 578420-CRN-PUMP and 578415 - SPL -2 were sampled two times; wells 578524 – CRN-PUMP and 578415 – SPL-1 were sampled one time.
36. Six samples were collected from only two locations for the Tongue River alluvium and collected over a very short time period and not over a full annual hydrograph. These data are not adequate for characterizing spatial and seasonal differences in water quality. These two wells are located south of the eastern part of the mine permit area and may not be representative of the alluvial aquifer upstream to the west.

37. Water quality in the Carney (578420-CRN-PUMP; 578524 – CRN-PUMP) from 2018 samples is much different / better (based on TDS, sulfate, bicarbonate) than 2013-14 data. There is no discussion or explanation for this difference.
38. As stated previously wells 578524 – CRN-PUMP and 578420-AL-1 have been plugged and abandoned so there can be no future sampling. Why were these wells abandoned?
39. The conclusions regarding the hydraulic connection between Slater Creek alluvium and underlying Carney coal are based on one ground water quality sample and based entirely on the interpretation that the two water bearing units have slightly different water types. This is poor interpretation of very limited data.

Groundwater Model

40. While the MODFLOW model is an excellent model, the results have a high uncertainty because the model simulations and predictions were derived based on limited site-specific data and broad assumptions:
 - a. The 2013-2014 hydraulic properties data provided by Brook mine were obtained from only one location in the far east part of the mine permit area and for some parameters, average values or literature derived values were used for all nodes.
 - b. The slug test data obtained in 2018 are useful but eleven of the 16 slug tests were conducted using coal wells and only one slug test was conducted using a Tongue river alluvial well.
 - c. Limited hydraulic property data was obtained from a pump test conducted at location 578524. The pump test attempted at location 578520 was aborted.
 - d. Aquifer parameters for the under and interburden zones were not measured through pumping tests for the Brook Mine Project.
 - e. The model applies a single storage coefficient to each layer and used no site-specific porosity data -but an assumed 10%
 - f. Annual and seasonal recharge was not considered quantitatively but assigned a single regional value and adjusted in calibration.
 - g. The top layer for the model combined the alluvial deposits, the spoils at the BHC facility and the overburden (Tongue River member lithologies above the Carney seam). These three types of deposit have significantly different hydraulic properties and combining them is inappropriate.
 - h. It is clear from the hydraulic data presented in Addendum MP-3 that the alluvial aquifer and the coal aquifers vary significantly within each aquifer. This implies significant heterogeneity – which the model design and assumptions do not accommodate.
 - i. The model assumed that groundwater flow was “Darcy flow” – through homogenous geologic conditions. However there is significant heterogeneity and groundwater flow in the coals most likely occurs under fracture flow conditions.

41. Modeling the current CBM affected coal seam water levels as static is far too simplistic. If the drawdowns from CBM production have caused the coals to be partially saturated what will happen if the water levels recover in areas where coal has been removed? The modeling indicates groundwater level recovery of 90% after 10 years for the Carney and 20 years for the Masters. This does not account for water level fluctuations due to CBM production.

Alluvial Valley Floors - Appendix D11

1. As with much of the text in this permit application the text in Section D11.1 is outdated. Brook mine concludes that there are no AVFs in the Slater Creek drainage and therefore did provide information to satisfy the requirement pursuant to WS 35-11 406 9 (n) (v) that mining *not materially damage the quantity or quality of water in surface or underground water systems that supply these alluvial valley floors* above requirement. However, WDEQ has made a determination that there are about 13 acres of AVF in Slater Creek. This determination is described in a January 7, 2016 LQD staff memorandum and confirmed in a January 10, 2020 letter from the Acting WDEQ Administrator to Randall Atkins, WWC.
2. The WDEQ, in the CHIA, only recognizes declared AVFs on the Tongue River downstream of BHC mining property. However, both Brook and WDEQ agree that the alluvial sediments underlying the flood plain along the north side of the of the Tongue River are potential AVFs. Exhibit D11.1-1 clearly indicates potentially sub-irrigated lands occur along the north side of the Tongue river adjacent to the mine permit boundary. On page D11-1 the permit application states that *“Based on data presented herein, the Tongue River valley in the areas studied by RAMACO, appears to be an AVF. Portions of these areas are within the Permit area; however, no surface disturbance or mining is proposed there. As such, no material damage is anticipated to this AVF”*.
3. When lands classified as alluvial valley floors will be affected by mining, LQD is required to evaluate whether any anticipated interruption or disturbance will be significant to a farm's agricultural production. Chapter 3, Section 2(f) of the Land Quality-Coal Rules outlines the approved test for measuring significance to farming. In the January 10, 2020 letter the WDEQ Administrator informs Brook that pursuant to WS 35-11 406 9 (n) (v) (A) *LQD does not identify any potential for mining to interrupt, discontinue, or preclude agricultural activities on lands identified as AVFs* Because no lands classified as AVFs will be affected, the test for significance to farming is unnecessary. This finding is based on Brooks conclusion that no AVFs will be affected because there will be no surface disturbance on AVFs and that there is little or no farming on the AVFs. This conclusion relies on incomplete information regarding current and future farming activities. In addition, there is not adequate discussion of potential impact that could occur from trench / highwall mining to the north of the Tongue River, which could reduce / alter discharge from the Tongue River Member of the Ft. Union Fm., (including the sandstones and coal seams) to the Tongue River or Tongue River alluvium. This is directly related to one of the three

“essential hydrologic functions” established by the WDEQ – “*ability to transmit groundwaters of suitable quality and quantity, to support sub-irrigation of certain areas*”. Brook mine concludes that there is no discharge from the coals and sandstones in the Tongue River member to the Tongue River or Slater Creek alluvium. However, neither the permit application nor the CHIA have presented any quantitative data that supports this conclusion. The cross-sections included in Appendix 5 indicate that the Carney and Masters coals occur only a few feet beneath the Tongue river alluvium. The cross-sections are based on very limited data and do not provide much detail on the lithologies and preferential flow paths that would allow upward flow of water from the coals to the alluvium. The cross section shown in Addendum MP-3 -Figure 2.3-3 depicts discharge of groundwater from the Carney coal to the Tongue River alluvial aquifer.

Operational and Post-Mining Water Resource Monitoring

1. A sampling and analysis plan should be provided for the operational water resource monitoring program.
2. It is very unclear if all the proposed monitoring locations, for both the operational and post-mining water resource monitoring programs, are currently accessible and usable. Most of monitoring wells and surface water stations were established 15 years ago and may have been degraded or modified.
3. Table MP.7-1 lists 19 operational surface water monitoring locations that will be sampled for water quality on a quarterly basis. Has Brook committed to this? Will the data be available to the public?
4. Table MP. 7-3 includes a number of proposed operational monitoring locations for the Masters coal seam and former BHC monitoring locations. With the new mine plan, will these locations remain in the monitoring program?
5. On page MP-58 the revised mine plan states that, during mine operation, surface water quantity data in the form of peak daily flow rate will be measured continuously at 4 locations between April and October. Has Brook committed to this? How will this be verified?
6. The nine alluvial wells listed in Table MP.7-4 include only one existing well in the Tongue river alluvium (578524-AL-1). Monitoring well 578520 -AL has been abandoned and monitoring well 578415 – AL is proposed but has not been installed. One monitoring well in the Tongue River alluvial aquifer is not adequate.
7. On page MP-61 the text states that “*In the event that a groundwater monitoring well is discontinued or damaged during the mining process, it will be replaced with another monitoring well so that the total number of working groundwater monitoring wells remains the same*”. The application should identify the monitoring wells that may be destroyed by mining. How will this be verified? Will WDEQ be advised?
8. The post-mining monitoring program that is discussed in Section RP.8.4 of the Reclamation Plan is inadequate.
 - j. Section RP.8.4.1 states that groundwater monitoring will consist of annual water level monitoring and water quality sampling until a “*definite trend is established*” Establishing a trend with only annual monitoring could take many years. There is a real concern that Brook mine will not monitor long enough to establish trends.

- k. No information is provided regarding the criteria that will be used by WDEQ to determine if water quality and water levels are suitable for release of Brook’s bond. What constitutes compliance?
- l. On page RP-41 the text states that *certain water quality parameters will be eliminated as data indicate*. There should be an explanation of what criteria will be used to decide to eliminate a water quality parameter.
- m. Section RP.8.4 indicates that the pump tests will be conducted in the backfilled spoil to determine transmissivity and storage coefficient. There is no discussion of acceptable values for these parameters and what mitigation would be required if these values are not obtained. There is also a concern that water levels in the monitoring wells will not recover for many years – so conducting the pump tests may not be possible.
- n. There is no discussion or plan provided for “post-mining inspections”

SELECTED REFERENCES

September 28, 2017 – Wyoming Environmental Quality Council - *Findings of Fact, Conclusions of Law and Order, Re: Brook Mine Application TFN 6 2-05, Docket 17-4802*

December 2017, *2016 Tongue River watershed Monitoring Project Final Report, Sheridan County Conservation District*

January 18, 2018 – Letter from BJ Kristiansen, WDEQ to Jeff Baron, WWC Engineering (Brook), Re: *Brook Mine Hydrologic Monitoring and Testing Proposal Related to Addressing Environmental Quality Council (EQC) Findings and Order for TFN 6 2/025*

February 2108 - *2018 Hydrology and Subsidence Sampling and Analysis Plan to Address Environmental Quality Council Findings and Order*, prepared by WWC Engineering for Ramaco

February 26, 2018 – WDEQ Memorandum from Muthu Kuchanur and Matt Kunze to BJ Kristiansen, Re: *First Round Comments on February 2018 Hydrology and Subsidence Sampling and Analysis Plan to Address Environmental Quality Council Findings and Order (TFN 6 2/025)*

July 20, 2018 –Letter from Jeff Barron, WWC Engineering (on behalf of Ramaco) to BJ Kristiansen, WDEQ Re: *Round 1 Comment Responses for 2018 Hydrology and Subsidence Sampling and Analysis Plan (SAP) TFN 6 2/025*

July 30, 2018 – WDEQ Memorandum from Muthu Kuchanuv and Matt Kunze to BJ Kristiansen Re: *Second Round Comments on February 2018 Hydrology and Subsidence Sampling and Analysis Plan to Address Environmental Quality Council Findings and Order (TFN 6 2/025)*

October 19, 2018 – Revised Permit to Mine Application TFN 6 2/025, Ramaco Wyoming Coal, LLC

