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November 1, 2013

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Water Protection Bureau
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Permit ID: C1984003B
Revision Type: Amendment
Permitting Action: Deficiency Response - #5
Subject: Amendment App 00184; Fifth Round Technical Deficiencies

Dear Chris:

Enclosed are Western Energy's responses to the deficiency letter dated July 23, 2013.

ARM 17.24.313(1)(h): Please provide the letter from Great Northern Properties documenting their approval of the postmine land use shift as stated in your response.

Response: Please see the GNP letter dated June 30, 2013 signed by George Luther Jr. approving the postmine land use in 17.24.313 page 173..

ARM 17.24.315: The drainage control map, Exhibit D-2, was updated appropriately with flow arrows and an exhibit number; however, pond locations were removed. The approximate location of future ponds must be depicted.

Response: Enclosed is a revised Exhibit D-2 with the appropriate pond locations depicted.

ARM 17.24.321: No changes to Exhibit A-2 were made in regard to dragline walkways. In accordance with the performance standards of ARM 17.24.501, DEQ will require all spoils to be graded to the approved post mine topography within four mine passes of the active pit: no exceptions will be made for dragline walkways other than those depicted and approved in the permit.

Response: The dragline corridors have been incorporated on Exhibit A-2 to be incompliance with ARM 17.24.501.

In addition to responding to DEQ deficiencies, Western Energy added an electronic copy of Volume I to its response. The electronic Volume I includes numerous changes from the approved hardcopy. While there may be reasons for some of the changes, DEQ believes this information should be submitted under a separate revision and therefore did not include comments on the proposed new Volume 1.

Response: WECo withdraws the electronic Volume I from this amendment submittal. And will submit the electronic volumes in a separate minor revision.

ARM 17.24.314(3): The following deficiencies are associated with the PHC submitted for Areas A, B, and C. DEQ appreciates the efforts Western Energy has put into providing the updated PHC. Having an updated PHC will greatly 'assist DEQ in completing the Environmental Assessment, Cumulative Hydrologic Impact Assessment (CHIA) and Written Findings for AM 4; therefore, DEQ has identified deficiencies that must be addressed to that we can proceed with the development of these documents.

Please note: The Rosebud Mine – Comprehensive PHC is now Appendix L is labeled Appendix L in the Area B permit.

General PHC Comments:

As the PHC is only for areas A, B, and C, please do not include data or references to other mine permit areas. For example:

- *Figure 24B shows spoils water quality for AreasD and E, which are not covered by this PHC.*
- *Area F is shown on numerous figures in the PHC and the groundwater model (e.g. GM-8). Area F is a prospecting area, not a permit area. The use of water level measurements in Area F to extend the potentiometric surface maps is appropriate, but inclusion of Area F baseline water quality in the area A, B, and C PHC is not appropriate.*
- *Section 3.2.6.1, Water Quality Time Series, on pages 24 and 25 mainly discusses results from Area D.*
- *There is reference to Area F regarding alluvium & springs in the middle of RMGM-page 10. This paragraph should be left out as it does not add anything to the Area A, B, and C discussion. Also, at bottom of page re: faults.*

Response: The text has been edited to remove general references to Areas D and E data. A general clarification was added to clarify which data was used for

this PHC. In addition to Area A, B and C data, limited hydrologic data from Area D and E were used to evaluate spoils water quality characteristics and water level recovery in spoils wells. NE&W believes these data are relevant and aid in the prediction of hydrological consequences of mining in Area A, B and C.

The Area F boundary has been removed from figures in the PHC and Groundwater Model.

Area F baseline water quality data has been removed from the PHC. This resulted in changes to Tables 4, 7, 8, 9, 10, 11, 12, 13, 14 and 20 and Figures 10, 14, 15, 16, 19A, 19B, 22A-27B. Note that the numbering of these figures has changed in the revised PHC.

Section 3.2.6.1 has been edited to remove the discussion of Area D springs.

The direct references to Area F regarding alluvium and springs and also faults in the GW Model Report have been removed

The data used ip the PHC are cumulative through 2011, although 2012 water year data is available and has been reported to theDEQ. Please indicate why the PHC does not include 2012 data. As the CHIA analysis will include 2012 data, the CHIA analysis may differ from or include information not included in the PHC.

Response: The PHC does not include the 2012 data as most of the development of the report was completed before those data were available. 2012 data can be found
in the Annual Hydrologic Report.

The text in Section 1.3 (Approach) has been edited to clarify that data through Water Year (WY) 2011 were used.

The diminished alluvial aquifer recharge from reduced surface water flows was not adequately addressed in the PHC. Also, there was not enough discussion of groundwater-surface water interactions. Please include additional discussion of the interactions.

Response: Please see the response to comment p. 26, 3 Probable Hydrologic Consequences 3.1 Surface Water Quantity.

Please check all figure and table references for accuracy.

Response: Figure and table references have been checked.

Specific PHC Comments:

p. 7, 1.0 Introduction -There is no reference in the text to Figure 2.

Response: Section 1.0 has been edited to reference Figure 2.

Please include a discussion why areas A, B, and C are the only mine areas represented in this PHC based on how they are separated hydrologically from areas D and E.

Response: See responses for 17.24.314(3) General PHC Comments. The focus of this PHC is on Area A, B and C and therefore data from other areas were not included except where deemed relevant. There is no indication that Area E is hydrogeologically separated from Area B East. However, the groundwater quality and quantity in Area E may be affected by several factors not within the scope of this PHC such as: location adjacent to the town of Colstrip and several large impoundments and the occurrence of pre-1976 historical mining (Van Voast et al., 1977).

Area D is located at a sufficient lateral distance from Area B (and Areas A and C) so that mining in Area D does not significantly influence the groundwater hydraulics in Areas A, B or C. Furthermore, the Rosebud coal in Area D tends to be unconfined or partially saturated. Hence, the degree of drawdown and the radial extent of that drawdown in association with Area D mining is limited and, as such, it is highly unlikely to affect groundwater levels in Areas A, B, C, or E.

p. 9, 1.3.1 - Existing PH C's - Please expand the discussion of groundwater/surface water interactions.

Response: The discussion in Section 1.3.1 Groundwater Quantity was expanded to include the discussion of groundwater/surface water interactions. Please see the response to comment p. 26, 3 Probable Hydrologic Consequences 3.1 Surface Water Quantity.

p. 10, 1.3.1. Surface Water - The surface water impacts section needs to be expanded to include quantitative results of modeling instead of only reassuring qualitative statements based on the assumption that the setting, including slope, aspect, drainage length and density, of the area disturbed by mining will be the same postmine as premine. One concern is the lack of postmine quantitative analysis of surface water quantity or quality. The discussion should include Western Alkaline Standards, where approved at the Rosebud Mine, for implementation after regrading is complete. Discussions with DEQ regarding an acceptable surface water analysis may help in expediting completion of the Area A, B, and C PHC.

Response: Attachment G, which provides a comparison of premine to postmine geomorphology, drainage basin characteristics and runoff modeling in

Area B was added to the report. This evaluation demonstrates that the postmine surface hydrology will be similar to premine.

p. 13, 1.4 Mining Progression - In the first paragraph "Figure B" should be "Figure 3B".

Response: The text has been edited to reference Figure 3B.

p. 16, 2.4 Precipitation - Figure 5 shows no precipitation in 1975. Missing data should be reported as such.

Response: Figure 5 has been edited to note missing data in 1975.

p. 18, 3.2 Local Surface Water Regime - The second paragraph refers to "East Rosebud Creek," but the correct name is "Rosebud Creek".

Response: The text has been edited to delete “East”.

Figure 7: The weather station referred to as "Rosebud Creek near Colstrip" (data shown in Figure 8B) is not shown on the map.

Response: The USGS gaging station Rosebud Creek near Colstrip has been added to Figure 7.

p. 19, 3.2 Local Surface Water Regime - Table 3A: Please explain why there is no data after 2006. Some stations stopped reporting (decommissioned), but two on the Yellowstone remained active.

Response: The time period is based on comparative purposes, the text has been edited to clarify this.

p. 20, 3.2.1 Local Setting- In the discussion of the East Fork Armells Creek (EFAC) groundwater sources downstream from the mine, please include Castle Rock Lake, the 2,250 acre-feet storage pond holding water piped from the Yellowstone River to supply the industrial needs of the power plant and municipal water to the town of Colstrip.

Response: The text has been edited to include Castle Rock Lake.

p. 20, 3.2.1 Local Setting - Please state evidence for baseflow in sections 8 and 15 in East Fork Armells Creek. On page 41, it is stated that the alluvium lies above the Rosebud coal between areas B and C. Please clarify which units are providing baseflow and if the Rosebud coal is contributing to flow in these reaches of EFAC.

Response: To address PHC comments WECo performed a field survey of the East Fork Armells Creek. The results are presented in a new figure and the narrative of Section 3.2.1 was updated to reflect the evaluation.

Please see the response to comment p. 26, 3 Probable Hydrologic Consequences 3.1 Surface Water Quantity.

p. 20, 3.2.2 Local Drainages - Cow Creek is not listed in the table as a drainage in Area B. However, Figure 9 shows the easternmost part of Area B in the Cow Creek drainage. Please consider where the drainage divide is drawn on Figure 9 and make the table and figure consistent regarding the Cow Creek drainage. Part of the confusion may result from pre- versus post-mine topography created by changes in Area E.

Response: The text has been edited to include the Cow Creek drainage. Figure 7 has been edited to show drainage to Cow Creek from Area B.

p. 21, 3.2.3.1 Flows - The last paragraph in this section states: "The data showed only three flow events exceeding five cfs at SW-55 and five events at SW-65 over a time period of about 28 years." So that a reader may completely understand the statement, the data should be qualified. Large time periods were not recorded due to instrumentation failures or frozen conditions which are not shown on the graphs. Please show the periods of no or suspect data on the graph or make a qualifier in the text regarding the integrity of the complete data record. The 2012 flows recorded at SW-55 and SW-65 are another reason to suspect the accuracy of data recorded on the Stevens recorders; although 2012 was a dry year, a number of days in April and May were above two cfs at SW-55. Additionally, greater detail could be shown on the graphs (figures 11 and 12) with a log scale Y-axis so that the detail of the smaller flows can be seen. It should also be noted that these data sets represent a period when a significant amount of the upstream watershed was cut off due to mining and impoundments, so that the recorded flows do not reflect the premine conditions.

Response: The text has been edited to note issues with the data set. Figures 11 and 12 (renumbered 13 and 14) have been edited to show the data on a log scale Y-axis and footnotes were added about the integrity of the complete data record.

NE&W postulates that the 2012 flows in Stocker Creek result from the significantly above normal May 2011 precipitation (~10 inches) which led to greater than normal recharge to clinker and the alluvium which in turn provided temporal base flow to Stocker Creek into 2012.

The active surface water monitoring program shown in Figure 10 and listed in Table 4 is not current. Changes made in 2011 are not reflected in the 'active' monitoring locations.

Response: Figure 10 (renumbered 12) and Table 4 were edited to reflect the active monitoring locations in Water Year 2011 to be consistent with the hydrological data used for this PHC. Note that monitoring locations in the Spring Creek and Pony Creek drainages were removed from the table and figure, since no portions of Areas A, B and C contribute to flow in these drainages.

There is no discussion of the most notable feature of figures 11 and 12, which is total lack of flows since late 1990s. One may assume this is mine influenced. Please discuss.

Response: The text has been edited to discuss the lack of flows observed in the data.

p. 21, 3.2.3.2 Water Quality -The water quality discussion of stream water is deficient. For example, there are more (including more recent) analyses of water samples from EFAC than the ones in Table 5. Also, the text refers to data in tables 5, 6 and 7, but there is no discussion of the data.

Response: Surface water quality data through water year 2011 were updated based upon additional information provided by WECo. Water quality statistics were calculated for each drainage and are presented in Tables 5A through 5D. Given the availability of these data, the original Table 5 was removed because of redundancy. The discussion of stream water quality was expanded to include a general evaluation of the water quality data presented in Tables 5A through 5D and Table 6.

Table 7 – see response below to *Table 7 identifies the MPDES discharge points.*

There should be discussion on the flow and quality impacts to EFAC from the Area A facilities, including ponds. There is a considerable stretch of the stream and underlying alluvium adjacent to Area A that is currently intermittent to perennial which may be a response to streamside ponds and the sanitary drain field. Also, water quality analyses show a systematic change in water quality, including a rise in chloride levels, that are likely associated with activities in Area A. Please include mention of these impacts to EFAC in the analysis.

Response: Please refer to the response to comment 28 for a discussion of the effects of streamside ponds on alluvial groundwater water levels.

A discussion of the changes in chloride concentration in Area A and the East Fork Armells Creek alluvium between Area A and B was added in Section

4.2.4.2. A figure showing chloride time series in these wells was added to the PHC.

Table 7 identifies the MPDES discharge points, but the water quality discussion could be enhanced by discussion of water quality measurements taken as part of discharges associated with Rosebud Mine's MPDES permit and whether or not the mine typically meets the required water quality limits.

Response: The discussion was edited to include additional information about MPDES discharges and permit limit compliance. The discussion focuses on outfall locations in use prior and up to WY 2011.

p. 22, 3.2.5 Impoundments-Water Quality- For the impoundment discussion, there should be a distinction between impoundments for the purpose of retaining sediment and mine water from entering receiving waters and impoundments for the purpose of providing for the postmine land use (e.g. livestock and wildlife water). Please indicate which impoundments are to remain as permanent ponds. Water quality in sediment ponds where cattle have no access is not pertinent to a discussion on postmine land use.

Response: The text has been edited to remove the discussion of water quality in sediment ponds. The water quality in sediment ponds is not deemed indicative of water quality after reclamation has been completed. A column was added to Table 8 to indicate which impoundments are expected to remain as permanent ponds. The discussion of water quality of livestock ponds has been retained.

Please elaborate on what the sediment pond water quality illustrates. Without information on the dates of mining, regrading, and revegetation upstream of the ponds, the changes in TDS over time have little meaning to the discussion of water quality changes through time.

Response: See the response to comment p. 22, 3.2.5 Impoundments – Water Quality.

Please be advised that Table 10, Livestock Water Quality Criteria, are not the criteria used by DEQ and the analysis may differ in the CHIA from the PHC, as submitted. The criteria used by DEQ are the Suitability of Water for Livestock by Sigler and Bauder, 2012 and Beef Briefs by Hutcheson; 2001.

Response: The Sigler and Bauder (2012) criteria used by DEQ were incorporated into the PHC (Table 10 and Attachment C). We believe that the Hutcheson guidelines are unrealistic when used as criteria. For instance, assuming them as criteria would yield a standard for sulfate of 300 mg/L, a standard for calcium of 150 mg/L and for magnesium a standard of 100 mg/L. Based on such criteria, most groundwater in the Rosebud Mine area would be

considered unsuitable for livestock watering even before any mining had commenced.

p. 23, 3.2.6.1 Spring Water Quality- springs are listed per groundwater aquifer in Table 12. Please include more detail regarding how a given aquifer was determined to be associated with each spring. More detail is also needed on the changes in spring water quality and quantity (e.g. is the change permanent or will water quality return to near baseline? Has there been a change in flow volume during or after mining?).

Response: The footnote of Table 12 was expanded to explain aquifer designations. Additional evaluation of spring water quantity and water quality data was provided. A new figure showing ponded spring water depths was added.

Several water quality tables have a "TDS Trend" column, but there is no explanation of what method is used to determine the presence or absence of a trend. Was it determined statistically or via professional judgment based on observation of data points?

Response: A footnote was added to the table to clarify how TDS trends were determined.

p. 26, 3 Probable Hydrologic Consequences 3.1 Surface Water Quantity- Statements regarding the impacts of mining to surface water are vague and unsubstantiated. There is no supporting evidence why the surface water accretions to the alluvial groundwater system should return to premine conditions. Even though streams are ephemeral, the impact of reduced or increased flow must still be discussed. Also the term "accretions" may not be understood by the average reader. .Please substitute "additions", "contributions", or "recharge" for "accretions".

Response: The text was edited to provide additional discussions and clarifications.
The existing statement was removed and replaced with:

Short Term Impacts – During Mining

Generally, surface water flow at the mine is ephemeral and it is dominated by short-term/episodic precipitation and snowmelt runoff events. In a few instances in EFAC, limited intermittent flow has been observed. However, such intermittent flows are typically associated with the presence of immediately up-gradient ponds or ponded conditions. Figure 10 shows that there are currently four dams on the EFAC. In effect, it is apparent that the intermittent flow conditions are artificially induced by the presence of the ponds that act to temporally store

surface water runoff which in turn seeps or infiltrates into the underlying alluvium. This leads to a localized increase in the water table which in turn manifests itself in some instances as the limited intermittent flow that is sometimes observed in EFAC.

During mining, the alluvial groundwater levels may become depressed when mine dewatering occurs in the vicinity of alluvium. If those groundwater levels intercept the thalweg and lead to intermittent flow, then those intermittent flows could be affected or reduced accordingly. An example of water level changes in association with mine dewatering can be ascertained from Figure 21 which shows water level changes in selected East Fork Armells Creek alluvial wells. The figure shows that alluvial groundwater levels tend to decline when mining activities are closest to the alluvial wells. For example, mining closest to well WA-114, which is located between Area A and B, was conducted in 1984 and the graph shows a decline in water level between 1980 and 1985. Water levels in the two alluvial wells (WA-209 and WA-104) between Areas B and C show a more gradual decrease. Note also that some of the water level changes (e.g., prior to 1992) are most likely due to changes in climate.

When the Area B Permit was written in 1986, the East Fork Armells Creek was described to possess two short segments respectively within Sections 8 and 15 (T1N, R40E) which had continuous base flow during much of the year ranging from no flow to about 30 gpm. A recent field survey (Section 3.2.1) of EFAC showed no flow in Section 15. The previous PHC (WECo, 1986) described the source of the flow as alluvium with possible contribution of the Rosebud coal in Section 15. Given the decreased water levels in alluvial wells between Areas B and C, it is possible that the change in flow is a result of mine related dewatering. With regard to Section 8, alluvium in that vicinity is bounded by overburden and this alluvium is most likely hydraulically isolated from the Rosebud coal being mined. Hence, it is deemed as unlikely that any declination of flow in EFAC at this location is a result of mining. Rather, it is associated with presence or absence of stored surface water in the rather sizeable pond observed in Section 8 which captures water from the ephemeral runoff events.

Ephemeral flow from lateral tributaries into the EFAC will be affected by mining as flow from such tributaries is detained by sediment control ponds. Hence, some temporal flow will not reach to the EFAC alluvium. As a result, recharge in the alluvium will be reduced. However, there would be some recharge in the vicinity of the sediment control ponds. The degree that “natural” recharge would be offset by recharge from the sediment ponds cannot be quantified.

Another mining-induced factor affecting alluvial groundwater levels, which in turn may affect surface water flows, is associated with the Mine’s MPDES discharges. Mine staff report that even relatively large discharges are observed to infiltrate from the channel to the alluvium over relatively short distances and time periods.

Hence, this infiltration acts to recharge the underlying alluvial groundwater which in turn causes increased water levels.

Given that there are non-mining factors affecting the alluvial water level observations (e.g., climate and pre-existing ponds), it is sometimes difficult to differentiate mining induced observations from those associated with non-mine factors. Climatic factors such as periods of drought and high precipitation influence alluvial groundwater levels, which in turn may impact surface water flows. In general, groundwater levels decline in response to drought and then increase upon wetter climate. The groundwater levels changes in WA-118 upstream from Area B and C (Figure 21) are most likely in response to climatic factors.

Long Term Impacts – After Mining

No long term impacts on surface water flow are expected to result from mining activities. Following mining, the disturbed lands are reclaimed and tributary surface runoff is no longer detained. As the main-stem channels (e.g., EFAC) are not significantly physically disturbed (e.g., not mined out), runoff reaching the channel will infiltrate to the alluvium similar to premine conditions.

Tributary drainages will be restored during reclamation and flow patterns reestablished, including incised drainages that collect runoff and sediment from uplands and transport these to the primary drainages. Reclamation revegetation will mimic premine conditions and provide for similar surface runoff rates and volumes.

See response to comment p. 10, 1.3.1.1 Surface Water regarding the evaluation of premine to postmine surface hydrology.

Ephemeral flows, which are infrequent and occur in response to precipitation events and snowmelt are mainly influenced by climate. More specifically, the ephemeral flows reflect the nature of the snow accumulation and melt and higher intensity precipitation events. These factors are independent of mining activities and these surface water flows should be essentially the same as premine upon completion of reclamation.

Response: Following mining, it is projected that alluvial groundwater will return to pre-mine levels. This is demonstrated by referring to Figure 21 which illustrates that alluvial groundwater levels between Areas A and B are recovering as mining moves further away. In the case of well P-04, which has the longest period of record, and wells WA-101, WA-128 and WA-124, water levels have increased slightly above initial measurement levels. This may be a result of the previously described factors (e.g., MPDES discharges) that led to increasing alluvial groundwater during mining.

Given that the alluvial groundwater levels will recover, the pre-mine conditions that led to the intermittent flow reaches before mining commenced will be reestablished.

p. 26, 3.3.1 Surface Water Quantity - The text states that surface water quantity should be the same postmine as premine, but no supporting evidence is presented. Modeling results or data from reclaimed areas which support this conclusion should be the basis for these statements.

Response: See response to comment p. 10, 1.3.1.1 Surface Water.

p. 26, 3.3.2 Surface Water Quality - The text states that surface water quality will return to premine conditions, long term. Please provide supporting evidence such as model results or data from reclaimed areas to support this conclusion.

Response: See response to comment p. 10, 1.3.1.1 Surface Water.

p. 27, 3.3.3 Springs - Please include discussion of the springs that have developed in reclamation. There is one in Area C Central and one in Area C North. At a minimum, location and field water quality data is available for them. Western Energy personnel may have flow data.

Response: The text has been expanded to include more discussion of the available data for these two springs. A new figure showing the depth of ponded springs was added to the PHC.

p. 27, 3.3.4 Erosion and Sediment Yield - The text states that mine reclamation will result in similar erosion and sediment yield as premine conditions. This conclusion should be supported by modeling results or data from reclaimed areas.

Response: See response to comment p. 10, 1.3.1.1 Surface Water.

p. 28, 4.1.1 Regional geologic units should be listed in stratigraphic order (top to bottom).

Response: The text has been edited to address this comment.

p. 28, 4.2.1 Please describe the significance of differences in the upper and lower portions of Figure 18 in terms of groundwater flow between aquifers.

Response: See the response to comment p. 20, 3.2.1 Local Setting and the response to comment p. 26, 3 Probable Hydrologic Consequences 3.1 Surface Water Quantity.

p. 29, 4.2.2.1 Alluvium - Please consistently refer to East Fork Armells Creek as such, rather than changing the name to E. Armells Creek.

Response: The text has been edited per the comment.

Please substantiate/verify statements made about the impacts to alluvium. Does data indicate that ponds have helped alleviate reduced flow to Armells Creek due to mining through headwaters?

Response: Please see the response to comment p. 26, 3 Probable Hydrologic Consequences 3.1 Surface Water Quantity.

p. 31, 4.2.3 Hydraulic Properties - Figure 20A and 20B: It is understandable why premine water levels may need to be simulated, but why are current groundwater levels simulated and not reflective of current measurements? Simulated data are not as relevant as measured data in this part of the PHC.

Response: Figures 20B (re-numbered Figure 23B) was replaced with a figure showing potentiometric surfaces in Rosebud coal/spoils and McKay coal based on 2011 water level measurements.

p. 32, 4.2.3 Hydraulic Properties - Figure 28 seems out of place as it is referred in the text between Figures 20 and 21.

Response: Figure 28 has been renumbered to follow the figures with potentiometric maps and relabeled accordingly.

p. 32. - 2.4.1 What aquifer is represented by Table 15 - baseline from Area 49?

Response: No "aquifer" delineations were given in the Area 49 report. A footnote was added to Table 15 to clarify this.

p. 32 and p. 101, 4.2.4.1 General Water Quality Evaluation, Table 16A- Why are there no premining data on overburden, interburden and sub-McKay? It is not clear that upgradient water is not changed or that changes in bedrock aquifer water qulaity is associated with spoil or another reason.

Response: Only available water quality data from the Rosebud Mine Water Monitoring Database were used. If mining started within 0.5 miles of a well before that well was monitored, it was not considered baseline. Using this

criteria, there were no wells in Area A overburden, interburden and sub-McKay that were deemed as baseline, as mining in Area A started in 1975. The text was edited to provide additional clarification.

NE&W was advised by DEQ to ignore the statement "It is not clear that upgradient water is not changed or that changes in bedrock aquifer water quality is associated with spoil or another reason", as its meaning is not clear.

p. 33, 4.2.4.2 Detailed Groundwater Quality Evaluation - Statistical Analysis - The PHC evaluates changes (or the lack of change) to aquifer water quality two ways: statistically (two-tailed t-test) and well by well. The DEQ has numerous questions regarding the statistical analysis:

- *Does the t-test assume a bell shaped normal distribution and does the data support this assumption? Does the data support the use of a t-test?*
- *Multiple factors influence water quality in wells, and each well may be influenced by different factors. Is it valid to use at-test in this case?*
- *Elaborate on how baseline and postmine water quality samples were selected. Are postmine samples all from the same year or are they averages of values over many years? Are all postmine samples downgradient of mining or are some upgradient of mining?*
- *It is not clear which wells are used in the t-test. The variability in some wells over time leads one to question the use of a statistical method to determine whether or not a given aquifer is impacted by mining. With some wells there is uncertainty if mining could have caused the changes observed in a given well or if climate or local geology is responsible for the change (or lack of change) observed in a well.*
- *Please indicate why the two-tailed t-test was not performed on the alluvium. The statement that "alluvial groundwater quality is to be analyzed in the same manner" is vague and confusing.*
- *At what point was postmine chosen-after reclamation? Does drawdown correlate with change in water quality? What wells were chosen? Were all wells chosen? Are there enough wells through time to make assumptions?*

Response: T-tests were originally used as a screening tool to identify which strata had most likely been impacted by mining.

Although NE&W believes that this approach is valid, the Rosebud Mine Water Monitoring Database has become fully operational since the first draft of the PHC was written. The database allows for a quick review of water quality time series for all wells in Areas A, B and C including those completed in the overburden, McKay coal and sub-McKay strata. Hence, the statistical evaluation and the t-test analysis were removed from the updated PHC.

Additional evaluation of overburden, McKay coal and sub-McKay coal TDS data was performed using the database. The results are included in the updated PHC.

p. 34, 4.2.4.2, Detailed Groundwater Quality Evaluation - Time Series Evaluation - DEQ questions the use of wells (and hydrographs) that have a few samples and no current data. It is hard to discuss these wells as meaningful in the present as there is no current data to substantiate a response. (The same question is applicable top. 31, 4.2.3 Hydraulic Properties).

Response: TDS time series graphs were presented for all wells for which more than two data points were available. Although not all this information is useful for an analysis of long term trends, it provides information on the range and variability of TDS concentrations in each area of the Rosebud Mine. All water quality data for the strata most likely to be impacted are shown for purposes of completeness.

p. 33, 4.2.4.2 Detailed Groundwater Quality Evaluation - Statistical Analysis - The text states: "Table 18 summarizes the results of the t-tests on the major constituent concentrations for which livestock criteria are available. (Note: calcium, magnesium, sodium and bicarbonate are not in the table)." However, all of the omitted ions have established cattle criteria.

Response: The statistical analysis including Table 18 was removed from the PHC (see also the response for comment p. 33, 4.2.4.2 Detailed Groundwater Quality Evaluation – Statistical Analysis).

p. 45, 4.2.4.3 Water Quality Exceedances - The text states that "... cadmium concentrations in the groundwater from Colstrip area of 0.01 mg/L or lower. … "Should this be "0.0 1 mg/L or higher" rather than lower?

Response: The text is correct, no changes are needed.

p. 47, 4.2.5 Groundwater Use. Impacts to wells is based upon a 3-mile radius of mining. This must be based on wells within the mine impact area as determined by the anticipated/predicted drawdown extent and the anticipated extent of water quality changes, Please identify specific wells likely to be impacted based on information available from public sources (e.g. GWIC) about the supply and well completion.

Response: Available public well data were used to update Figure 29 (renumbered 34) showing private users. Additional evaluation was provided to determine which wells have the potential to be impacted. A table was added listing private wells within the five-foot simulated drawdown contour.

p. 46, 4.3 Probable Hydrologic Consequences. Is there substantiated, quantified support (well logs, geophysical logs, pump tests or other scientific observations) for the theory of a rubble layer at the base of the spoil?

Response: A reference discussing the existence of a rubble layer was provided in the updated PHC (Van Voast et al., 1988).

p. 48, 4.3.2 Re-Establishment of Groundwater Levels and 4.3.3 Groundwater Quality - There needs to be more expanded discussion of recovery to date based on recharge to spoil. Recovery discussions/projections should be made for all of areas A, B, C.

Response: A table was added with a summary of water level recovery in spoils wells to date. The text was expanded to discuss the results.

The text suggests that the variability of TDS in Rosebud wells in Area B is attributable to alluvial groundwater, rather than spoils. Please discuss this possibility at greater length.

Response: Section 4.3.3 was edited to include a summary of the findings of the detailed groundwater quality analysis regarding Rosebud coal / alluvium interaction.

p. 50, 5.0 Summary - The list of impacts should include: "6) Changes in surface water quality due to discharge of spoils influenced groundwater." Discussion should note potential surface water quality effects.

Response: Text addressing this comment was included in Section 5.

The following comments address the Groundwater Model provided within the PHC for Areas A, B and C:

Figures and Tables

The pages of Figure 27 are not listed in the List of Figures. Please correct this omission.
The Era/Period Labels are misplaced on left geologic column in Figure GM-2. Please correct this figure.

Response: The list of figures has been revised per comment. Pages are now listed on Figure 27. Geologic column labels on GM-2 have been corrected.

In Figure GM-23, page 2, Zone G is colored light gray on a white background and its boundaries cannot be seen. Please use a more contrasting color to show this zone.

Response: The color representing Zone G has been changed per this comment.

Figures GM-25 through GM-31 are incorrectly referenced in the text. Please correct the text references to these figures.

Response: The references have been corrected.

In Figure GM-27, page 4, the graph for well WM-109 does not match the others (same graph as on figure GM-27, page 2). Please include the correct WM-109 graph in Figure 27, page 4.

Response: The plots for WM-109 have been corrected.

The references to several tables are incorrect: Section 3.1.1 refers to Table GM-3 and TM-3 where it should be GM-4, Section 3.1.3 refers to Table GM-5 where it should be GM-3, and Section 4.1.3 refers to Table I-5 where it should be GM-5. Please ensure all table references are correct.

Response: The references have been corrected.

For easier use, please sort Tables GM-1 and GM-2 by model layer.

Response: The tables have been resorted per the comment.

Model Development

The specific versions of software used for model simulations and pre- and post-processing are not listed in the report. For example, the report cites the reference for MODFLOW88, but it is unlikely this version was used as significant improvements have been made to the program since that time. The report also discusses ARCView, which was replaced by ARCGIS several years ago. Please include the correct names and version numbers for all referenced software in the report.

Response: MODFLOW88/96 was used in the modeling effort owing to its simplicity and convenience in assigning storativity values. Later versions of MODFLOW could be used but would produce the same results.

ARCView and ARCGIS are one and the same. The text was revised to ARCGIS.

The discussion of the model framework and construction in Section 2. l.4 is not complete. Please add more detail to this section including: Figures illustrating

horizontal discretization; active extent of all layers, cross-section of model layer thickness, and the location of the pumping well; a discussion of how model grid spacing transitions from the 250 ft grid to the 2,500 ft grid, and how this conforms to standard practice; a table showing the row and column widths for all rows arid columns; and a description or illustration of the boundary condition parameters for all drain reaches.

Response: Figures have been updated and the discussion enhanced as relevant for each of the areas described above. Note that model layer thicknesses were provided in the text. The model layer thicknesses were added to the text. A conceptual cross-section of the model layers had been provided in Figure GM-25 of the report. Note that the for the modeling approach used, the only purpose of assigning the model layer thickness is to develop model transmissivities.

Please explain why no alluvium is modeled between Area C and Area B Extension, or include the alluvium at this location in the model.

Response: The alluvium in this reach was represented by the drain package. Moving westward the alluvium tends to become bounded by overburden deposits and is more hydraulically isolated in this area. Additional model simulations were conducted testing the significance the addition of zonation representing alluvium. Based upon these tests the model calibration results were very similar. Hence, it is deemed that application simulations would be similar as well.

There are several permanent surface water features near the town of Colstrip (in particular Castle Rock Lake) which are not included in the model. Please include these features in the model or explain why they are not simulated.

Response: Additional discussion was added, including information discussed below, to explain why the features in the town of Colstrip were not included in the model. It is noted that this issue was discussed in the initial model scoping meeting held with DEQ in 7/13/2010. At that meeting, the DEQ was advised that the modeling effort would not attempt to simulate the influences of outside factors, including the Castle Rock Lake (reservoir) or issues associated with PPL.

While it is true that Castle Rock is a significant influence, its effects are likely relatively steady over time. In essence, the primary objective of the existing model is to evaluate transient effects of mining. Given that there is no transient influence as a result of reservoir presence (unless there are dramatic/systematic changes in stage over time), it could be either included in the modeling effort or excluded from the modeling effort without altering the transient effects of mining for Areas A, B, and C. This is simply due to the principle of superposition.

The Rosebud coal outcrops near the perimeter of Area A whereas the Castle Rock reservoir lies in the underburden. In effect, the coal tends to be unsaturated or nearly so near its outcrop. Hence, any mining in the vicinity of this outcrop will not lead to any substantive drawdown in areas to north and east of the mine or in the direction of Castle Rock reservoir.

In summary, the reservoir is a significant hydrologic feature. However, because it is situated outside and stratigraphically beneath the Rosebud Coal outcrop, it is unlikely to have any influence on evaluating the transient effects of mining in the vicinity of the mine. Therefore, it is not necessary to incorporate it into the model.

Calibration Targets and Model Calibration

The report does not adequately describe the target selection process. How were "representative" wells selected from closely spaced wells, i.e. was a quantitative method or professional judgment used? What are the dates of the observed water levels for the targets (include dates in Table GM-1), and if water levels were measured after start of mining what is the justification for use of these measurements as premine conditions? If the measurements at targets occurred at different times, is there climatic bias in the target values? Could additional targets be included in areas of the model domain without coverage, such as Area A, Areas B and C in the Underburden, and outside the mine area (are there MBMG/GWIC wells which could be used)? Why are Interburden wells in Area E included, but no other targets from Areas D and E? Please include a more detailed discussion of the target selection process which addresses the above questions.

Response: A supplement to the modeling effort was added to the Rosebud Mine Groundwater Model report to discuss the rationale behind the model targets. This supplement also includes an evaluation of the targets employed in the present model report and also includes additional historical data recently provided by WECo for consideration in the overall modeling effort.

1) For the closely spaced alluvial wells, a representative well was selected. Generally, water levels in these closely spaced wells were very similar. In other words, any of the wells could have been selected with virtually no change in statistics. In effect, professional judgment was employed.

2) In many cases, the first observation water level value was selected (dates are included in the updated table). Note that observation wells were installed over time. In some instances, if the first value or first few observations were highly anomalous, a later value was selected. In other instances, trends in water levels were observed. Such trends were either "climatic induced" trends or mining induced (declining) trends. The mine pass history was checked in instances where declining trends were observed to determine if such trends were more

likely related to mining or to climate. In some instances, mining induced trends were observed. Generally, drawdown responses were not observed in any of the simulated strata unless mining was within a one or two mile radius of a given observation point. The alluvium near mining, the Rosebud coal, interburden and the McKay coal tended to be more responsive to mining.

3) Most of the climate induced variations are evident in some alluvial wells and in some overburden wells. Any climatic effects for deeper strata are not as significant, although they were observed in some areas, particularly in portions of the East Fork Armells Creek drainage upgradient of Areas B and C. It is possible that there is some limited climatic bias related to alluvial wells and overburden wells. However, it is highly unlikely that systematically selecting slightly lower or slightly higher water levels for the select climate responsive wells would lead to a substantive difference in the overall model calibration results.

4) Given the lack of response of underburden wells to mining to date, it is our opinion that much effort focusing on the underburden is not warranted. In effect, it is not anticipated that any meaningful improvement and/or insights would be attained by added wells that are unresponsive to mining.

5) Area E was initially considered by NE&W as a pre-permit mine area. However, more recently, WECo did provide more information about the mine pass history for WECo mining conducted in Area E. That information does affect our conclusion about which targets are appropriate in the vicinity of Area E. However, given that fact that relatively few targets were employed in Area E, the effect of removing these wells from the calibration effort is unlikely to noticeably alter the model calibration results.

Area D was not included as it located outside the radius of influence of mining associated with Areas A, B, and C. It is also located northeast of the PPL facility and the confounding factors associated with that same facility. It is also noted that a separate modeling effort was completed previously for Area D.

Please note that target values for WO-186 and WR-168 were corrected.

Please include observed water level contours on Figure GM19 for comparison with simulated results.

Response: Water level contour maps using observation data are incorporated into
Attachment GM-B for the Rosebud coal and the McKay coal.

Please provide scaled statistics for each model layer.

Response: Scaled statistics for each model layer had been provided in Figure GM-21 of Attachment D (pages 1 and 2). To assist the reviewer, these layer by layer statistics were moved to a new Table GM-3.

Section 3.1.1 discusses how the model matches observed vertical gradients. On closer examination, the model appears to generally (under predict) gradients above coal seams (Overburden-Rosebud & Interburden-McKay) and (over predict) gradients below coal seams (Rosebud-Interburden & McKay-Underburden). Could adjustments to leakance fix this issue? Please include more detail in the discussion of vertical gradients.

Some adjustments in leakance are possible. However, the leakance values were assigned statistically using automatic calibration procedures (i.e., PEST application).

Additional evaluation was conducted on an expanded set of well pairs as shown in GM-5. Focus was placed on computing differences from the overburden through McKay coals. WD (sub-McKay) wells were not used in the updated evaluation that was performed as the sub-McKay has tended to be nonresponsive to coal mining. However, the WD wells were left in Table GM-5 for illustrative purposes. Based upon the evaluation, the average residual on a unit by unit basis for the wells used for vertical gradient simulation is as follows:

Overburden – average underprediction was 1.95 feet.
Rosebud coal – average overprediction of 2.41 feet.
Interburden – average underprediction of 3.83 feet.
McKay coal – average overprediction of 2.33 feet.

The observed net head difference in compared vertical wells is 254.07 feet (compares only from Overburden through McKay coal). The maximum head of compared wells is 3535.27 at WO-185. The minimum head was 3281.20 at WM-106.

Comparing the net underprediction/overprediction as a percentage of the overall head difference of 254.07 feet (on a layer by layer basis) yields the following:

Overburden:	0.8 percent (under)
Rosebud coal:	0.9 percent (over)
Interburden:	1.5 percent (under)
McKay coal:	0.9 percent (over)

In view of the above, we believe that any change in vertical leakances would not lead to a substantive improvement in the model calibration statistics.

Parameter Zonation

The discussion of parameter zonation in Section 3 .1.2 lacks detail. Please include a discussion of the rationale for including transmissivity/leakance Zone B in Layer 1, and how its shape was determined; why transmissivity/leakance Zones H and K in Layers 4 and 5 are the same shape as transmissivity/leakance Zone B; the rationale for transmissivity/leakance Zone J in Layer 5; and the rationale for recharge Zones I and J.

Response: A subsection was added to provide more detail on the rationale for zonation. Note the following:

1) The rationale behind the zonation for Zone B are the following:

a. The outline indicated is an approximate boundary where the overburden is thicker, generally exceeding a thickness of 200 feet. It is deemed that the relative saturated section of the overburden is likely greater where the thickness is greater. Thus, transmissivity is assumed to be greater as well. The PEST simulation was used to estimate the magnitude of the parameters.

b. Given that there are likely to be more low permeability layers present over the larger overburden thickness, it is likely that the net leakance should be substantially lower. Again, PEST was used to estimate the magnitude of the parameters.

2) The reasons that a lower transmissivity was assigned to Zone H in layer 4 were discussed in part in Section 3.1.1 of the report. The same shape was maintained under the assumption that greater overburden pressure may lead to lower transmissivity in model layer 4. A similar argument for the zonation is applied to layer 5. However, using the results of the PEST estimation procedure, it is reasonable to combine Zone K and I as one zone and it would not substantially alter the calibration results.

3) Zone J equates to the Lebo shale which is known to be a unit of low permeability and of low water-bearing capacity. It was assigned a relatively low transmissivity.

4) The rationale for assigning relatively higher recharge rates to Zones I and J is provided in Section 3.1.2. Applying slightly higher rates for Zone J led to a better steady-state calibration for wells in the vicinity of the proposed Area F permit.

Sensitivity Analysis

The zone designations used in the sensitivity analysis for Transmissivity, Leakance, and Recharge do not match those on Figures 23 and 24. Also, the

drain reaches are not identified anywhere in the report. The sensitivity analysis cannot be evaluated without knowing which zones are where. Please use the same zone designations throughout the report.

Response: Cross references for labels have been added to Attachment GM-C. A crossreference is also included to identify model drains and those drains employed in sensitivity analysis.

Transient Model

Section 4.0 of the report does not describe how time is discretized. Please include the lengths of each transient stress period in a table.

Response: Section 2.1.3 defines the length of stress periods as being one year. This is now emphasized to a greater degree throughout the report.

The transient model evaluation is entirely qualitative. Please include transient calibration targets in the model, perform a transient model calibration, and include transient model calibration statistics in the model report. Please also include spoil wells as targets in the transient model to demonstrate how well the model simulates the recovery after mining.

Response: The transient model evaluation is not “entirely qualitative” given that comparisons are made between observed and simulated drawdowns.

It is not practical to conduct a true transient calibration effort owing to the sequential series of models that must developed and run. Note that several thousand iterations were required to complete the steady-state calibration. That model was then used to construct a sequential transient model series to represent the impacts of mining and then recovery over time. Hence, it would be impractical to alter the various aquifer parameters iteratively for this sequential series to define a “best-fit.” A more practical way is to compare observed responses to simulated responses to determine if the model provides a reasonable representation of the system behavior.

Table GM-6 was added to provide statistical summaries of the graphical results shown on Figures GM27 (page 1 through page 4).

Section 4.1.2 discusses the potential of a combined coal/sandstone aquifer present in some locations. If this is the case, transmissivity would likely be higher in those locations as well as storativity. Can this area with sandstone over coal be delineated from geologic logs and included in model?

Response: Note that many of the sandstones are well cemented and any flow is fracture related. Hence, it is not necessarily true that the presence of sandstone equates directly to higher transmissivities. In fact, based upon our review of exploration logs, yields of sandstones in the Tongue River member are commonly a few gallons per minute and there is no systematic pattern for such sandstone yields. Finally, our preliminary judgment is that such a delineation would be difficult to reliably perform.

The transient model fit to observed drawdown curves is poor for several Area C-Central/East wells. WM-153, WM-186, WM-168, WR-168, and WR-126 show less drawdown than predicted by the model. Water levels in WR-126 and WM-186 have actually increased. Would increased recharge in the clinker north of this area improve the model calibration? Please include additional analysis/discussion of the anomalous results in this area.

Response: The relatively poorer fit in the northern portions of Area C is associated with a localized over-prediction of Rosebud coal potentiometric head in this area of the model. This over-prediction could be reduced but it would be at the expense of other portions of the model domain. Given that the model tends to be conservative (or over-predicts drawdown) in this area of the Rosebud Mine, we do not propose making other adjustments to the model at this stage.

If you have any questions or comments please feel free to contact me as soon as possible so WECo can answer them in a timely fashion. (406) 748-5124

Sincerely,

Dicki Peterson

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Enclosures 17.24.313 and 17.24.315
Appendix L – Rosebud Mine A, B, C Comphrensive PHC
Exhibit A-2 Area B-East Approximate Mine Plan
Exhibit D-2 Area B-East Approximate Hydrologic Control Plan

Cc: Daniel Munoz, Rusty Batie, Wade Steere