

APPENDIX C

SUMMARY OF GROUNDWATER MODEL MODIFICATIONS

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The original regional PRB groundwater model as prepared for the PRB Oil and Gas EIS (BLM 2003a) and developed for the BLM by AHA (2002) was modified as part of the Task 1B effort for water resources to produce a groundwater model more suited to modeling the combined impacts of CBNG development and coal mine dewatering in the eastern PRB. These modifications primarily were made to the regional PRB model, as this model had to be calibrated before it was telescoped down to produce a model focused on the overlap zone of coal mine dewatering and CBNG development using the TMR module of Groundwater Vistas. The modifications to the original regional PRB groundwater model and modifications to the telescoped Coal Mine Groundwater Model (CMGM) are summarized below:

Modifications to the Original Regional PRB Groundwater Model:

1. Hydrogeologic data on the PRB were not sufficient to model 17 individual layers; therefore, the original 17 layers were combined into 6 HSUs to facilitate running of the model.
2. Cells not used in the original regional PRB model (i.e., “dead space”) were removed to reduce storage requirements for the model and decrease run times.
3. The original regional PRB model was converted from Visual MODFLOW files to Groundwater Vistas file format. The model was then run using MODFLOW 2000.
4. CBNG wells were converted from the MODFLOW Drain Package used in the original regional PRB model to the MODFLOW Well Package.
5. Constant heads used for perennial rivers in the original regional PRB model were converted to the MODFLOW River Package. The Powder River and its tributaries were left as constant heads.
6. Streams that are perennial over only part of their reach, such as the Belle Fourche and Antelope Creek, were converted from the MODFLOW River Package to the MODFLOW Drain Package. All ephemeral streams were modeled as the MODFLOW Drain Package in the original regional PRB model, and this was maintained in the modified regional PRB model.
7. Recharge from precipitation was changed in the modified regional PRB model to 5 percent of precipitation for regional precipitation recharge and to 10 percent of precipitation for recharge along the clinker zones east of the coal mines.
8. The solver used in the original regional PRB model was changed to the PCG2 solver in the modified model.
9. Grid spacing in the original PRB model was a uniform 0.5 x 0.5 mile. In the modified model, a grid spacing of 0.25 x 0.25 mile was used in the area of the coal mines and the CBNG well fields.
10. Calibration targets from GAGMO (2001, 2003) reports were incorporated into the modified regional PRB model (approximately 350 monitoring wells). In addition,

approximately 70 monitoring wells in the Wasatch Formation were obtained from WDEQ/LQD files and incorporated into the modified regional PRB model. BLM and USGS wells also were added.

11. The Wasatch Formation (HSU-3) in the modified regional model was extended to the east based on geologic data provided by the BLM. In addition, the location of the clinker outcrop areas was revised based on geologic mapping provided by the BLM.
12. A low-permeability layer was placed between the Wasatch and the Fort Union formations (between HSU-3 and HSU-5) to represent the thick clay and claystone units that separate the Wasatch and the upper coals of the Fort Union. This layer was assigned as HSU-4.

Additions to the CMGM:

1. The CMGM was telescoped down from the modified regional PRB model using the TMR capability of Groundwater Vistas to focus on the overlap zone of coal mine dewatering and CBNG development. The CMGM preserved many of the boundary conditions and features of the modified regional PRB model.
2. The model domain boundaries of the CMGM on the west, north, and south were set as MODFLOW Constant Head Boundaries with time varying heads to match changes in water levels in the modified regional model just beyond the domain boundaries. The eastern boundary was set as a no-flow boundary along the outcrop of the Wasatch for HSU's 1-3 and along the outcrop of the Fort Union for HSU's 4-6. The time varying heads in the west, north, and south boundaries were set according to water level changes in the regional model near these boundaries.
3. The coal mine pits were changed to the MODFLOW Drain Package, and the 3-D configuration of the mine pits over time was obtained from the BLM (Braz 2005) for past mining conditions and from the mine operators (Task 2 report) for expected future mining conditions. Drain elevations were placed 5 meters above the pit floor bottoms, and the drain conductances were set during calibration.
4. HSU-5 was set as the Upper Fort Union and includes all the coal units of the eastern PRB and represents the Wyodak-Anderson coal. HSU-6 was set as the Lower Fort Union and represents the Lebo and Tullock members of the Fort Union.
5. Outside of the coal mine boundaries, the stratigraphy of the original regional PRB model obtained from Goolsby, Finley, and Associates (2001) was preserved. Within the coal mine boundaries, the coal stratigraphy provided by the BLM (Braz 2005) was used. These two stratigraphic packages were merged to the west of the coal mine boundaries. The merged data set was then contoured to form a new data set with consistent elevations for the coal layers.
6. Modifications made to the original regional PRB model discussed above were preserved and used in the telescoped CMGM model.