Undermined Promise II

Appendix B

Youngs Creek Mine Permit: Analysis of the Characterization of the Pre-Mining Hydrologic Balance

Available at www.underminedpromise.org

To evaluate whether current practices at western surface mines provide sufficient characterization of the premining hydrologic balance, WORC took a deep dive into the permit materials of the Youngs Creek Mine, presently held by Cloud Peak Energy, Inc.

Youngs Creek Mine is a permitted Wyoming strip mine in the Decker/Sheridan coal field in the western Powder River Basin. Located approximately 12 miles north of Sheridan, WY, and adjacent to the Montana border, Youngs Creek Mine is a permit amendment of the previous Ash Creek Mine that expands the permitted area 7,107.65 acres. The permit application contemplates development of the mine beginning in 2012, although ground has yet to be broken. Technically recoverable coal resources are estimated at 327.7 million tons.

Three perennial streams flow through the permit area in a generally northwest-to-southeast direction: Youngs Creek, Little Youngs Creek, and Ash Creek. Their headwaters lie predominantly across the state border in Montana. Little Youngs Creek converges with Youngs Creek within the permit area. Both streams flow into the Tongue River, which flows north just east of the permit area. An intermittent stream, Dry Creek, also discharges into the Tongue River. There are several livestock watering ponds within the permit area, some of which are fed by the streams. Much of the permit area's surface is used as rangeland, and remains relatively undeveloped except for a network of coalbed methane wells, associated infrastructure, and two center-pivot irrigation fields.

The highest-flow groundwater aquifer is the streamlaid, alluvial sediments that comprise the streambed and underlying deposits. This alluvial aquifer is comprised of an upper layer of fine-grained silt, sand, and other clasts overlaying a lower layer of sandy gravel. Significant non-alluvial groundwater exists within the bedrock in both near-surface sandstone aquifers and coal beds, though much has been extracted in the process of coalbed methane production. A lattice of dip-slip faults runs throughout the permit area.

With reference to the whitepaper by hydrogeologist Charles Norris, "Hydrologic Protections within the Federal Surface Mine Control and Reclamation Act," published as Appendix A to this report, WORC examined the characterization of the pre-mining hydrologic balance in the Youngs Creek permit materials, as well as the assessment of Cumulative Hydrologic Impacts

(CHIA), a regulatory document produced by Wyoming Department of Environmental Quality. *(Please consult Appendix A for an explanation of the role of the CHIA in the regulatory process.)*

References below to Aqua Terra Consultants, Inc. (including "ATC" or "the consultants") of Sheridan, Wyoming, refer to the geologic consultants hired by Youngs Creek Mining Company to prepare the permit application and characterization of the pre-mining hydrologic balance.

Issues of concern identified in review of the Youngs Creek permit are listed below:

1. An intermittent stream in the permit area was misconstrued as an ephemeral stream and was not hydrologically characterized.
2. The three-dimensional characterization of groundwater flow is deficient due to the lack of requisite data.
3. The number and placement of groundwater wells is insufficient to characterize areas of bedrock groundwater exchange with alluvium.
4. Groundwater exchange between bedrock and alluvium is oversimplified in the groundwater model.
5. The analysis failed to quantify agricultural stream flow withdrawal and return during the stream flow characterization, affecting stream flow data and seepage run results.
6. The surface water quality sampling data is affected by precipitation, which throws into question the integrity of conclusions.
7. Groundwater quality data from a pre-SMCRA strip mine within the permit boundary is absent in the permit application.
8. Pre-mining groundwater pumping for coalbed methane production continues to alter baseline groundwater conditions.
9. The CHIA analysis suggests that more data is required to fully characterize the permit area's hydrologic balance and evaluate hydrologic risks related to reclamation.
10. The CHIA mischaracterizes downstream users' water rights as the appropriate standard for determining material damage to the hydrologic balance.
11. The groundwater cumulative impact area was drawn to exclude the effects of coal seam aquifer dewatering from coalbed methane production, which ignores effects on surface and groundwater.

While geologic and hydrologic data from previous mines and external studies were incorporated into the permit materials, omissions in several key areas leave much to be desired for a meaningful analysis of the permit area's pre-mining hydrologic balance. More thorough data collection would be needed to fully characterize the area's surface and groundwater quality and quantity to fulfill the promise of SMCRA.

Each of the preceding issues is discussed in detail below. Permit materials referenced in footnotes may be accessed online at bit.ly/UP2-AppB.

1. An intermittent stream in the permit area was misconstrued as an ephemeral stream and was not hydrologically characterized.

While the three perennial streams that flow through the permit area receive attention to their geologic characterization and water quality in the permit application, an intermittent stream called Dry Creek has been mischaracterized as ephemeral, and has not been hydrologically characterized except indirectly.[1]

SMCRA defines intermittent streams as:

> (a) A stream or reach of a stream that drains a watershed of at least one square mile, or
>
> (b) A stream or reach of a stream that is below the local water table for at least some part of the year, and obtains its flow from both surface runoff and ground water discharge.[2]

The consultants claim that, "Dry Creek generally has no distinct valley floor but is characterized instead as an ephemeral, parabolic channel."[3] According to Table D6-8, "Premine Drainage Basin Areas," Dry Creek has a Total Premine Area of 2.31 mi^2, which qualifies it as an intermittent stream.

In addition, the permit application does not investigate Dry Creek's relationship to groundwater in an attempt to prove it is, in fact, ephemeral. As demonstrated on Exhibit D6-1, there are no current or historic monitoring wells near the stream's main channel. The closest well is approximately 500 feet away.[4] This dearth of wells prevents an assessment of whether the stream receives groundwater at any point throughout the year, and further precludes its characterization.

As an intermittent stream, the mine boundary cannot come within 100 feet of the channel without complying with the special protections of the stream buffer rule. The Mine Plan treats Dry Creek as ephemeral, and therefore anticipates mining the stream channel throughout a significant portion of the period of operations.[5] To avoid mining within the stream buffer zone, or to incorporate any operational exceptions to the stream buffer rule allowed under SMCRA, a new Mine Plan is required.

2. The three-dimensional characterization of groundwater flow is deficient due to the lack of requisite data.

A careful characterization of the hydrologic balance of any hydrologic system must consider the vertical component of groundwater flow between surface water and various geologic strata and vertical flow among aquifers within geologic strata. Without adequate data to describe the predominant patterns and seasonal variations in such groundwater flow, one cannot confidently characterize the interconnection between surface water channels, channel deposits, and bedrock. Additionally, to create a computer model that even approximately reproduces the dynamics of the study area requires a three-dimensional characterization. Without it, calibration of crucial groundwater flows within the model is impossible. Within the context of Youngs Creek Mine, the presentation of three-dimensional groundwater flow was oversimplified due to inadequate collection of data in two major areas.

---

[1] One of the stockponds along the length of Dry Creek was sampled for water quality parameters.

[2] 30 C.F.R. §701.5 *Intermittent Stream*

[3] Appendix D5-1.1, "Landforms and Drainage Patterns" (D5-3).

[4] Interburden well IB-02-08. See Exhibit D6-2.

[5] Exhibit MP-4, "Coal Removal Sequence."

The first area of inadequate characterization of three-dimensional groundwater flow concerns the upper alluvium in Youngs and Little Youngs Creeks. Throughout most of the depth of alluvial deposits within stream valleys, a lower layer of clean, sandy gravel grades into an upper alluvial layer of fine silty sand, usually through a layer of "intermixed sand, silt, clay and rock clasts."[6] As modeled in the groundwater model, however, the alluvium is reduced from these two layers separated by the third transitional layer to a single gravel layer that is treated as "representative." ATC designate the upper layer as only marginally significant to groundwater storage and conductance, despite admitting its capacity for recharge of the lower gravel layer:

> "Although the upper alluvium allows recharge to the underlying gravel, its characterization as a separate aquifer is not essential in evaluating the valley groundwater resource that is dominated by the gravel. The upper alluvium is best characterized as a confining unit relative to the gravel that represents the groundwater resource of the valleys."[7]

Contrary to this assertion that the upper alluvium is not essential to model, this simplification removes a conceptually crucial component of alluvial groundwater storage and flow from the model that has special relevance to the protection of alluvial valley floors (AVF). First, the roots of irrigated crops draw their water from the upper alluvium, rather than the deep gravel. Second, precipitation and snow melt does not reach the lower alluvium without passing through the root zone in the upper alluvium. Third, where sub-irrigation supports crops, lower alluvial water flows upward into the shallow alluvium to replace the water lost to evapotranspiration. With respect to AVF issues, therefore, the upper alluvium is the zone of interest. Given that the Mine Plan notes "[a]dditional effects to subirrigated vegetation where shallow groundwater has been drawn down may also occur […]"[8] as a result of mining, modeling the upper alluvium as a discrete layer is all the more necessary for a realistic assessment of the effects of alluvial drawdown on the essential hydrologic functions of AVF, which must be preserved during mining.[9]

An obstacle to modeling the upper alluvium stems from a lack of data. The upper alluvium, unlike the lower gravel, was not individually characterized for hydrologic conductivity through aquifer pumping tests. Even though a handful of historic aquifer pumping tests in 1979 were undertaken in wells "probably screened across the upper alluvium, with some completion in the lower gravel," it is noted that the "[r]esults are mostly representative of the upper alluvium but biased from partial completion in the gravel."[10] This is the only indication that any aquifer pumping tests were contemplated to characterize the upper alluvium, and even then the characterization was flawed. Furthermore, determining the extent of the bias of the upper alluvium test results by the higher-conductivity lower alluvium is not possible using only information contained within the permit application, as well completion data for historic upper alluvium wells is not included.

Without adequate data to characterize the upper alluvium, it is unsurprising that the stratum presented a challenge to the model's integrity:

---

[6] Appendix D6-1.1.1, "Valley Alluvium" (D6-4).

[7] Appendix D11-A2-2.2, "Representative Aquifer" (D11-A2-3).

[8] Mine Plan-17.3, "Procedures to Preserve Essential Hydrologic Functions of Alluvial Valley Floors in Off-Site Areas" (MP17-2).

[9] 30 U.S.C. § 1265(B)(10)(F)

[10] Table D6-2, "Aquifer Parameters."

> "Attempts to simulate a multi-layer, alluvial aquifer system resulted in numerical instability and unrealistic parameter characterization of the upper alluvium."[11]

Models necessarily involve simplifications of observed reality, and are only useful because of such simplifications. Substantial divergence between geologic and modeled realities must be clearly addressed when interpreting model outputs, however. Such divergence is assured without collection of the requisite data, and seems to skirt the legal requirement to adequately characterize the pre-mining hydrologic balance. This is especially important when the outputs of the model are to be relied upon to predict Probable Hydrologic Consequences, which are laden with legal and regulatory ramifications.

A second poor characterization of the three-dimensionality of groundwater flow concerns an unconfirmed assumption of discharge from the alluvium to underlying bedrock (emphasis supplied):

> "Mineable sequence strata is **inferred** to be saturated everywhere beneath the alluvium because of the large volume of groundwater stored within the alluvium and because of the relatively large flux of groundwater constantly moving through it as valley underflow."[12]

This can only be inferred because no monitoring wells were screened solely in the strata beneath the alluvium. Drawings in Exhibits D11-6[13] and D11-7[14] show the alluvial transects constructed from well borings, with the screened interval of each well indicated. None of these intervals reach beyond the lower gravel layer of the alluvium, not to mention being screened solely below the gravel. Whereas some borings shown in Exhibits to Appendix D5 penetrate the alluvium, borings usually cannot provide data about groundwater presence in specific strata, as they intercept groundwater from all saturated strata.

The only well marked as having been dug through the alluvium to underlying strata was overburden well PM-OB-02. Comparing its hydrograph with those of nearby alluvial monitoring wells A1, A3, PWA-100, and PWA-102,[15] reveals that all five fluctuate in the same range between 3700 and 3710 ft MSL from 2006-2009. The head in the alluvial wells varied between 3702 and 3706 ft MSL, while the overburden well fluctuated from 3705 to 3708 ft MSL. Based on the similar groundwater head, it is likely that bedrock would exchange groundwater with the alluvium in this area, assuming an appropriately permeable interface: the lithology of PM-OB-02 is dominated by shale and clay layers, interspersed with several thin sandstone strata.

While the hypothesis that bedrock is saturated everywhere beneath the alluvium may accord with general principles, it is noted in other sections of the hydrologic characterization that much of the non-alluvial strata in contact with alluvium are impermeable, or at least restrictive of groundwater flow. That is, large impermeable clay lenses were sometimes found beneath the alluvium[16] (as with aforementioned overburden well PM-OB-02), and most alluvium was found to contact shale:

---

[11] Appendix D11-A2-2.2, "Representative Aquifer" (D11-A2-3).

[12] Appendix D6-1.1.3, "Groundwater Elevations in Alluvium and Adjacent Bedrock Units" (D6-7).

[13] "Alluvial Cross-Sections Youngs Creek / Little Youngs Creek Valleys."

[14] "Alluvial Cross-Sections Ash Creek Valley."

[15] These wells are tightly clustered across the Wyoming-Montana border in T58N R84W Section 22 (Wyoming) and T9S R39E Section 32 (Montana).

[16] Clay deposits marked on Exhibits D11-6 and D11-7, "Alluvial Cross Sections."

> "Although there are exceptions, the alluvial deposits typically overlie and abut against shale, which is normally considered an aquitard. This suggests that there is relatively little flux of groundwater either into or out of the alluvium from adjacent and underlying mineable sequence deposits."[17]

While it may be assumed that over geologic time the low-transmissivity shale facilitates adequate infiltration of alluvial groundwater into the mineable sequence strata, this is merely an assumption without verification from properly-screened wells. Conversely, without appropriate data, there is no demonstration that upward flow from the bedrock to the alluvium does not occur, or at least did not occur before coalbed methane development.

Public confidence that a baseline characterization of the hydrologic balance is appropriately nuanced can only be assured by the presentation of adequate geologic and hydrogeologic data, which were not collected in these cases.

3. The number and placement of groundwater wells is insufficient to characterize areas of bedrock groundwater exchange with alluvium.

Groundwater discharge between bedrock and stream alluvium is a central element to an area's hydrologic balance. Although it was concluded that bedrock discharge is only present to a "limited extent" due to the presence of alluvial contact with impermeable shales, as noted above, some effort was made to identify where such discharge may occur within the Youngs Creek Mine permit area.[18]

Exhibit D6-2 identifies seven regions of "inferred groundwater flow," denoted by arrows indicating the inferred direction of flow. Three areas of bedrock discharge to alluvium and four areas of alluvial discharge to bedrock are indicated. Six of these areas are described and discussed in-text.[19] The characterization of these flows was hindered by a lack of wells and borings that would have allowed estimation or quantification based on observed groundwater levels. Furthermore, despite having no empirical data on flow rate, the three bedrock discharges to alluvium were incorporated into the permit area's groundwater computer model with arbitrarily assigned flow rates.

Most areas were identified because borings for geologic cross-sections revealed permeable strata (sand or sandstone) in contact with saturated alluvium, suggesting flow to or from the alluvium. Further evidence of flow between alluvium and bedrock for each identified area was compiled from a combination of sources, including:

- the groundwater elevation measurements made during the drilling of coal borings (which mostly recorded the depth of first encounter with groundwater, if any, rather than a true static water level, which would be required to determine vertical gradients);[20]

---

[17] Appendix D6-1.1.1, "Valley Alluvium" (D6-5).

[18] Appendix D6-1.1.1, "Valley Alluvium" (D6-5).

[19] Appendix D6-1.2.2 "Bedrock Strata" (D6-8).

[20] Some ambiguity exists as to how quickly measurements followed drilling, as some holes were reportedly left overnight before groundwater measurement: "The geologic descriptions from many of these holes identify the depth(s) at which groundwater, if any, was encountered. Where there was clear evidence of groundwater while drilling, the exploration holes were often allowed to remain open overnight or longer before backfilling to permit a groundwater depth measurement, where possible. The groundwater depth data were subsequently equated to

- the spatial distribution of dry and wet borings;[21]
- visual observation of groundwater discharge to a stream, in one case;[22]
- voluminous groundwater presence during the drilling of a cluster of fault assessment wells;[23]
- inferences from the geologic fundamentals of groundwater flow;[24] and
- outputs of the groundwater computer model.[25]

While helpful in identifying bedrock-alluvium discharges, these sources of data do not allow for quantification of the flow rate of identified discharges (not to mention characterization of seasonal variation and response to precipitation), which is crucial for a robust characterization of the hydrologic balance. To do so would require an analysis of groundwater measurements from wells bored in the path of the flow to track groundwater heads and gradients. Additionally, the extensive distribution of bedrock borings is only partially useful, as borings are not as suitable for measuring groundwater head as are properly-constructed wells, as they fill to a static level from all intercepted aquifers, whereas wells only measure groundwater head in the strata in which they are screened. Furthermore, even while a well that records a history of groundwater heads is necessary, a single well is not sufficient. Clustering two or more groundwater head measurement wells that allow for the determination of groundwater gradient and thus estimation of flow would have provided much more reliable, higher-resolution data that would allow far greater confidence in the conclusions drawn about bedrock groundwater discharge to and from alluvium.[26]

4. Groundwater exchange between bedrock and alluvium is oversimplified in the groundwater model.

Overall, a network of groundwater wells that could have provided reliable, high-resolution data on groundwater discharge between alluvium and bedrock within the Youngs Creek Mine permit area was not installed. This did not obviate the need to account for these flows in the computer groundwater model of the permit area, however. Correspondingly, the model encapsulates three of the seven areas of bedrock-alluvium flux. However, these three flows are all discharge from bedrock to alluvium. The four areas of suspected groundwater discharge from alluvium to bedrock were ignored.

---

groundwater elevations after the exploration holes were professionally surveyed." See Appendix D6-1.1.3, "Groundwater Elevations in Alluvium and Adjacent Bedrock Units" (D6-7). Further text adds to the ambiguity surrounding which specific borings were left overnight, stating that "most of the exploration borings in this particular area recorded the depth at which groundwater was first encountered during drilling rather than a true static water level measured some time after drilling" (Appendix D6-1.2.2, "Bedrock Strata," D6-9).

[21] See Exhibit D6-2, "Groundwater Flow in Alluvium and Non-Alluvial Strata."

[22] "Similarly, groundwater effluent to Little Youngs Creek is visibly apparent […] along the north valley wall of the stream." Appendix D6-1.1.3, "Groundwater Elevations in Alluvium and Adjacent Bedrock Units" (D6-7).

[23] Appendix D6-1.2.2, "Bedrock Strata" (D6-11).

[24] "Groundwater conditions in some areas of Exhibit D6-2 are inferred by reference to the geologic cross sections of Appendix D5 and the findings of the alluvial groundwater model housed in Appendix D11." Appendix D6-1.1.3, "Groundwater Elevations in Alluvium and Adjacent Bedrock Units" (D6-7).

[25] *Ibid.*

[26] Two groundwater wells completed in the overburden were presumably used to identify the presence of alluvium-to-bedrock discharge from the seventh area of "inferred" discharge, which received no description or discussion in-text, alluded to above. The wells are located near stream valley alluvium, are parallel to the direction of stream flow, and both hydrographs suggest a hydraulic gradient away from the stream alluvium. See Section 24, T58N, R84W, and Section 19, T58N, R23W.

Moreover, the rates of flow for these three bedrock discharges to alluvium were arbitrarily estimated "based on comparing model outputs to what would reasonably be expected for groundwater fluxes between the two aquifer types."[27] These figures are displayed on Exhibit D11-A2-5. Without empirical evidence of flow rates, calibration of the groundwater model relies on speculation for some inputs, delivering figures as wide-ranging as 1.0 acre-feet per year, 38 acre-feet per year, and 152 acre-feet per year.

Additionally, these three areas of bedrock-alluvium exchange were modeled as one-way flows, as shown on Exhibit D11-A2-3. While "general head" ("head-dependent flux") boundaries were used, in each case they were bordered on one side by no-flow area. This was presumably to make them one-directional to coincide with the consultants' simplifying assumptions that these three areas of bedrock-to-alluvium groundwater flow were only significant as sources of water to the hydrologic system.

These three factors (three of seven identified areas modeled; fluxes derived from speculation; exchanges modeled only as one-way flows) pose a serious obstacle to comfortably accepting the model's output, the stated purpose of which is to predict probable hydrologic consequences of mining.[28]

5. The analysis failed to quantify agricultural stream flow withdrawal and return during the stream flow characterization, affecting stream flow data and seepage run results.

Continuous gauging stations were installed at several points along the three perennial streams within the permit area to collect data on stream stage between April 2007 and October 2009. Exhibit D11-2 identifies seven irrigation ditches that divert water from Youngs Creek and Little Youngs Creek in both Montana and Wyoming. Neither diversions from these ditches or returning runoff flow or groundwater seepage of the withdrawn water are separately accounted for in the hydrologic baseline data:

> "Stream flow volumes, and potentially peak flow rates as well, recorded at all of the stream flow gauging stations installed by the Permittee are affected to some degree by diversion of flow for agricultural flood irrigation activities. These diversions are found upstream of the Permittee's uppermost gauging stations, and they are also found between the Permittee's gauging stations […]. In addition to the effects of the diversions themselves, return flows from irrigated lands that occur as direct overland runoff and seepage from mounded water tables probably also affect the stream flow monitoring records."[29]

Furthermore, variable agricultural schedules meant irrigation was inconsistent between years:

> "As a further complication, it appeared during the course of the baseline investigation that some irrigation practices were not followed consistently from one irrigation season to the next, but that instead some lands irrigated one year were not irrigated the next, and vice versa."[30]

Thus, dynamic agricultural stream flow withdrawals and returns (as runoff and seepage) were not accounted for by the baseline stream flow sampling regime. Due to these unknown variables, the stream

---

[27] Appendix D11-A2-5.1, "Calibration Methods" (D11-A2-12).

[28] Appendix D11-A2-1, "Introduction" (D11-A2-1).

[29] Appendix D6-2.1.4, "Stream Flow Rates and Flow Volumes from Gauging Stations" (D6-30).

[30] *Ibid.*

flow data presented in the permit application may not be representative of the prevailing hydrologic balance.

Variable agricultural stream flow withdrawal also has implications for seepage run results. Seepage runs were performed along Youngs Creek and Little Youngs Creek twice, on 11/02/07 and 08/14/08, to determine which reaches of the streams were gaining or losing flow. Results were reported in-text for four reaches of Youngs Creek and three reaches of Little Youngs Creek.[31] Irrigation ditches divert from five individual seepage run reaches, and two ditches divert upstream of the first stream flow monitoring station on each stream, potentially affecting measurements on all reaches.

Data for stream flow diversions into irrigation ditches was only collected for three of the five ditches that divert from seepage run reaches. This data is helpful, but is incomplete; the inclusion of such data for the other four ditches would assist interpretation of the agricultural impact on the gaining and losing conditions of the streams, and thus the permit area's prevailing hydrologic balance.

The case of the Peoples & Lord ditch provides a clear example of why measuring stream flow into all ditches during seepage runs would have been useful. The reach from which the Peoples & Lord ditch diverts gained flow during the November 2007 run, but lost flow during the August 2008 run. The permit application ascribes this late-summer loss to "consumptive evapotranspirational uses that were probably negligible in November compared to August," noting that "a large area of subirrigation exist[s] within this reach."[32] However, diversions from the Peoples & Lord ditch were not measured, despite their potential significance during the end of the growing season. That is, water was more likely to have been diverted for crop irrigation during the August seepage run rather than the one in November. The reach's losing condition could be more confidently attributed to riparian evapotranspiration if ditch diversion were known to be negligible. This is impossible without measurement.

Without quantifying the impact of agricultural stream flow withdrawal and return, characterizations of stream reach gaining and losing conditions and, by extension, the permit area's hydrologic balance, cannot be confidently interpreted. This is compounded by the inter-seasonal and inter-annual variability of agricultural diversions from streams, which cannot be captured by two seepage runs during different times of different years.

6. The surface water quality sampling data is affected by precipitation, which throws into question the integrity of conclusions.

Surface water quality sampling was completed quarterly for two years at seven sites on the three perennial streams flowing within the permit area. Such infrequent stream sampling increases the need for care taken in collecting the data. Because higher stream flow from recent precipitation can both dilute concentrations of contaminants but also carry more sediment, sampling too soon – before two to three days have elapsed – following precipitation events can skew test results. Though it should have been clarified in-text that surface water quality samples were only collected after stream flow had renormalized following precipitation events, it was not.

---

[31] Based on the number and placement of stream monitoring stations at which flow rates were taken. See Table D6-6, "Instantaneous Stream Flow Measurements."

[32] Appendix D6-2.1.3.2, "Youngs Creek" (D6-29).

In fact, a section of the report discusses the visibility of certain precipitation events in the record of surface water quality monitoring data, which presents as diluted levels of Total Dissolved Solids from a water quality sample taken following a precipitation event in April 2009.[33] That is, the contractors describe collection of water quality samples during precisely the wrong time to derive a reliable measurement. This creates ambiguity about what conclusions may be drawn from the rest of the samples.

7. Groundwater quality data from a pre-SMCRA strip mine within the permit boundary is absent in the permit application.

The present permit area includes the meager extent of a former strip mine, referred to as Public Service of Oklahoma (PSO) No. 1, and later Ash Creek Mine. Following backfilling, grading, and seeding procedures that ended in 1996,[34] a single well (referred to as BF-1) was drilled into the backfilled and graded area. The summary of groundwater well sampling history[35] lists the well as having water quality samples and groundwater head measurements taken quarterly since May 1996, its date of installation. Whereas the groundwater head data is presented on Exhibit D6-4, no water quality data collected from BF-1 is presented on either the water sampling summary table (Table D6-4) or in the comprehensive listing of groundwater sample results (Addendum D6-A4). The absence of these records is an obstacle to verifying the Probable Hydrologic Consequences before mining begins, and interpreting the prevailing post-mining hydrologic conditions.

It is assumed that backfill groundwater quality samples were obtained, however, as a table in the CHIA displays a summary of backfill water quality information, including median concentrations of major ions and total dissolved solids.[36] Even so, there is a discrepancy in the number of samples represented in the table and the number claimed in the permit application. The number of samples for each ion is listed as 11 (except HCO_3, which is marked "N/A"). If water quality samples were taken from the backfill well quarterly since May 1996 (second quarter 1996), 11 samples would only cover through the fourth quarter of 1998. The ambiguity about what backfill water quality data was taken is unfortunate, since solid data would offer insight into the potential future groundwater quality of the reclaimed Youngs Creek Mine.

8. Pre-mining groundwater pumping for coalbed methane production continues to alter baseline groundwater conditions.

The groundwater of coal seams within the permit area has been pumped for coalbed methane (CBM) production since around 1999. Table D6-3 indicates that approximately 3,059 acre-feet have been extracted between 1999 and 2009. This has led to the nearly total dewatering of some areas of the coal bed, evidenced by many dry coal seam borings. Groundwater head elsewhere in the permit area has recovered in recent years, as recorded in well hydrographs shown in Exhibit D6-4. The permit application

---

[33] Appendix D6-2.3.4, "Trends in Surface Water Quality" (D6-39).

[34] "The initial mine pit and facilities were developed between 1976 and 1978, but because the mine owners were unable to develop a coal transportation system or market for the coal, mining was suspended from 1980 through 1993 and the mine had been backfilled, graded, and permanently reseeded by 1996." See Appendix D6-0.0 "Executive Summary" (D6-1).

[35] Table D6-1, "Groundwater Monitoring Summary."

[36] Major ions include Cl, HCO_3, SO_4, Na, K, Ca, and Mg. See Table 8. "Median Concentration and Number of Samples for Major Ions and Total Dissolved Solids from the Alluvial Aquifer, Anderson-Dietz Coal Aquifer, and Backfill Aquifer in the Groundwater CIA," section 3.2.2 "Groundwater Quantity and Quality," Wyoming DEQ CHIA 28, p. 30. June 2011. Available from Wyoming DEQ/LQD offices in Sheridan and Cheyenne.

speculates this to be due to the plugging and abandonment of some CBM wells in the area during the period of groundwater monitoring.

The operation of CBM wells within the permit area raises concerns for the characterization of the pre-mining hydrologic balance, as it has already been disrupted by extensive groundwater pumping. This pumping will likely continue until the beginning of mine construction and operation, at which time wells will be plugged and abandoned to make room for the mine. As mine development is already years behind schedule, however, groundwater extraction by CBM wells has already continued longer than anticipated, and may yet continue for some time. This means that the baseline groundwater data collected from 2006 to 2009 no longer accurately characterizes the non-alluvial groundwater. By lowering groundwater head in the coal seams, CBM-related pumping changes groundwater gradients, which is of concern for all areas of contact between alluvium and bedrock. Areas of previous discharge from alluvium into bedrock are likely to become more severe. Areas without discharge to or recharge from bedrock may develop discharge to bedrock. Areas with recharge from bedrock to alluvium may see anything from reduced flow to alluvium to a reversal of flow, creating alluvial discharge to bedrock. The effect is one-way however; in all cases alluvial flow is reduced in all reaches.

As CBM production has continued beyond the anticipated opening of the mine, the characterization of groundwater quantity in non-alluvial aquifers and hydrologically connected units is out of date. This means that the approved permit does not accurately reflect the pre-mining hydrologic balance.

9. The CHIA analysis suggests that more data is required to fully characterize the permit area's hydrologic balance and evaluate hydrologic risks related to reclamation.

Two sections in the CHIA imply that additional baseline hydrologic data was needed for a more confident understanding of the hydrologic balance as well as a more precise analysis of cumulative hydrologic impacts of mining.

First, the discussion of baseline hydrologic conditions in Ash Creek concludes with a somber statement on the adequacy of the collected baseline data:

> "The interacting influence of prior drought and irrigation withdrawals make [it] somewhat difficult to define the baseline hydrology of Ash Creek from the short period of monitoring records."[37]

Defining the baseline hydrology of all components of the permit area's hydrologic balance with confidence is a prerequisite to a nuanced analysis of the potential for material damage from mining.

Secondly, the analysis of the backfill aquifer's physical characteristics notes that while "the backfill aquifer will need to be sufficiently permeable to allow water to pass through it and recharge the remaining Anderson-Dietz coal aquifer and to yield water for the post-mining land use,"

---

[37] Section 3.1.2 "Ash Creek," Wyoming DEQ CHIA 28, p. 16.

> "No aquifer test has been completed in the small area of saturated backfill created by the reclamation of the historic PSO #1/Ash Creek Mine, so no site specific data is available to evaluate the aquifer's physical characteristics."[38]

As it is the responsibility of the regulatory authority to ensure that the hydrologic balance outside the permit area is protected throughout the process of mining and reclamation, both sets of missing data could have been required before the a finding of no material damage was made.

10. The CHIA mischaracterizes downstream users' water rights as the appropriate standard for determining material damage to the hydrologic balance.

The CHIA presents two conflicting sets of criteria to define material damage to the hydrologic balance. In general, Wyoming DEQ has defined material damage to the hydrologic balance as:

> "[A] significant long-term or permanent adverse change to the hydrologic regime."[39]

Presumably to include groundwater in this definition, they further specify that a "significant long-term or permanent adverse change" includes "changes to the surface or groundwater hydrology that are inalterable conditions contrary to the Wyoming State Constitution, or of statutes administered by the WSEO [Wyoming State Engineer's Office], or water quality standards administered by the WDEQ/WQD [Wyoming DEQ Water Quality Division]."[40]

Although the concept of "inalterability" requires some further clarity, this general definition of material damage appears to cover impacts to the entire hydrologic system, regardless of whether or not an individual water user's rights are harmed. However, this broad definition appears to be supplanted by another set of narrower standards for surface water and AVF, which explicitly evaluate material damage only with respect to water users. The definition of material damage criteria for surface water quantity begins and concludes thus:

> "Surface water quantity is evaluated to predict if coal mining will cause material damage to downstream surface water rights. [...] Material damage to surface water quantity is predicted to occur if the analysis indicates that coal mining will cause a decrease in surface water quantity such that downstream surface water rights will be materially affected."[41]

For alluvial valley floors, material damage findings are only required for AVF that are determined to be significant to agriculture.[42] For AVF that are deemed not significant to agriculture, the only requirements are that "the essential hydrologic functions must be maintained and/or restored if the AVF is approved to be mined."[43] Thus, preventing material damage only applies to AVF that support agricultural operations, rather than to the broader hydrologic system of which the AVF is a part.

---

[38] Section 6.2.2 "Backfill Aquifer Physical Characteristics," Wyoming DEQ CHIA 28, p. 58.
[39] Wyoming DEQ CHIA 28, p. 46.
[40] *Ibid.*
[41] Section 5.1.1 "Water Quantity," Wyoming DEQ CHIA 28, p. 47.
[42] Wyoming Statues § 35-11-406(n)(v)
[43] Section 5.3 "Alluvial Valley Floors," Wyoming DEQ CHIA 28, p. 49.

SMCRA regulations make clear that protecting the hydrologic balance and protecting water users' rights are separate mandates of the law; one may not substitute for the other.[44]

11. The groundwater cumulative impact area was drawn to exclude the effects of coal seam aquifer dewatering from coalbed methane production, which ignores effects on surface and groundwater.

To determine if material damage would be caused by the Youngs Creek Mine outside its permit area, Wyoming DEQ determined a boundary for cumulative hydrologic impacts on both surface and groundwater.[45] The groundwater cumulative impact area (CIA) was drawn to determine drawdown in the coal seam aquifer, but it excluded the effects of groundwater extraction by coalbed methane production, as specified in an addendum to the CHIA prepared by a hydrology consultant (emphasis supplied):

> "The purpose of this memo is to summarize work completed to date to define potential groundwater drawdown *as a direct result of mining activities* and to develop the working groundwater CIA for the YCM Amendment Area cumulative hydrologic impact assessment (CHIA) based on available information for the site *that ignores the potential impact of CBM activities*."[46]

This is justified in the CHIA on the basis of the difficulty to separate the effects of ongoing CBM activities and mining:

> "[I]n general, the large groundwater level declines resulting from CBM activities make it difficult to accurately predict potential impacts to groundwater levels that may result from mining activities."[47]

Coalbed methane-related pumping changes groundwater gradients throughout the permit area. This creates a complicated hydrogeologic setting, which requires detailed characterization to support a nuanced picture of the permit area's prevailing pre-mining hydrologic balance. As discussed above, CBM-related groundwater drawdowns are also concerning for all areas of contact between alluvium and bedrock, because the alluvium is hydrologically connected to surface water. Ignoring CBM-related drawdown of the coal seam aquifers ignores any cumulating effects of groundwater withdrawal on surface stream flow. The choice to disregard the effects of ongoing CBM production directly contradicts the CHIA's statement that, "[c]onceptually, the groundwater CIA is defined as: […] (2) the extent of any measurable impacts the groundwater drawdown may have on the surface water system […]." By discounting the effect of CBM withdrawals, the CHIA ignores a major factor affecting both surface water flow and groundwater flow.

---

[44] 30 C.F.R. §780.21(h)

[45] Wyoming DEQ CHIA 28, p. 4.

[46] Addendum B: Memorandum on Groundwater Cumulative Impact Area (CIA) for the Youngs Creek Mine Amendment CHIA. Wyoming DEQ CHIA 28, p. 88.

[47] Wyoming DEQ CHIA 28, p. 10.