The industrial facility siting permit was issued for the phosphate plant in 1982 (Chevron 1982b). Construction of the phosphate plant began in 1984 and operations commenced in 1986 (BLM 1983). Various other permits for air quality; permits to construct water supply facilities, wastewater facilities and sediment control features; and reservoir permits for the various evaporation and holding ponds were also obtained (BLM 1983).

Geology

The Site is located on the western flank of the Rock Springs Uplift in the Sweetwater Creek valley of the greater Green River Basin. Sweetwater Creek is an intermittent stream that flows generally north-northwest from the slopes of Aspen Mountain to its junction with Bitter Creek just west of Rock Springs. The topography of the Rock Springs Uplift consists of a central basin surrounded by ridges and mountains (Mason and Miller 2004). The uplift, an elongate anticline with a north-trending axis, is comprised of sedimentary rock strata with dips on the flanks between 3 and 15 degrees toward the adjacent structural lows. The highest point in the area is Aspen Mountain, at an elevation of about 8,700 feet. The Rock Springs area is characterized by cold winters and dry summers with an average annual precipitation of approximately 9 inches.

The Site is underlain by the Blair Formation which is approximately 900 feet thick and consists of thin bedded siltstones, claystones and fine-grained sandstones. The bedrock is mantled by a thin layer of alluvium comprised of windblown silts and sands (Woodward-Clyde 1982b). Groundwater flow at the Site is generally westward toward the Green River (Ardaman 1985). Recharge to groundwater aquifers occurs primarily by infiltration of precipitation in outcrop areas, infiltration of snowmelt runoff from the mountains, and leakage of stream flow (Mason and Miller 2004). Regional groundwater quality is described as relatively poor (Wyoming Water Development Commission [WWDC] 2010). Dissolved solids in groundwater are elevated due to the presence of naturally occurring soluble minerals such as trona, gypsum, and halite.

Phosphogypsum Stack System

Operation of the phosphogypsum stack system at the Site began in 1986. The entire footprint of the phosphogypsum stack system was provided with a 60-mil HDPE geomembrane bottom liner that was installed in phases as the size of the gypsum storage area increased with time. The total lined area currently covers just over 420 acres. As shown on Figure 2, groundwater flow beneath the phosphogypsum stack system is toward the west-southwest and is captured in a groundwater collection ditch that was constructed prior to beginning operation of the system. The water level in the groundwater collection ditch is maintained at an elevation that is lower than the elevation of the water table to the west-southwest, i.e., the groundwater collection ditch acts as a hydraulic barrier to seepage from the east-northeast.

The phosphogypsum stack is operated using wet stacking techniques wherein gypsum slurry is pumped at approximately 30 to 32 percent solids to sedimentation compartments (cells) located on top of the stack, where the solids can settle, and the clarified process water is decanted and pumped back to the phosphoric acid plant for reuse.

Figure 3 shows the present configuration of the Rock Springs facility. As noted, the storage area is currently divided into seven separate cells, five of which are located on the main body of the gypsum stack, while the other two are within the footprint of the most recently lined expansion area, located on the east side of the original gypsum stack footprint. Figures 4 and 5 provide topographic maps of the Rock Springs facility and phosphogypsum stack system.

The bottom elevation of the existing stack ranges from a low of about 6,580 feet (NGVD) beneath the west-southwest side of the original gypsum stacking area to a high of about 6,700 feet (NGVD) beneath the lined expansion area on the east-northeast side of the site. The elevations of the perimeter gypsum dikes on top of the gypsum stack vary from 6,790 feet (NGVD) on the west to 6,720 feet (NGVD) on the east.

Decanted process water from the stack currently flows by gravity through a perimeter ditch system to an existing lined process water surge pond and return water pump station located just south of the southwest corner of the gypsum stack. Return water is pumped from this pond back to the plant for reuse.

Site Investigation History

Several investigations had been conducted at the Site that have included characterization of hydrogeology and groundwater chemistry. The primary investigations are as follows:

Four site evaluations were performed by various consultants between 1981 and 1984 for Chevron at the proposed location of the gypsum storage facility to characterize geological, geotechnical, and hydrological subsurface conditions prior to construction of the facility (TRC 1982, Woodward-Clyde 1982 and 1982a, and Ardaman 1985). A series of deep monitoring wells, designated P-1 through P-15, were installed as part of these initial investigations. In 1985, four shallow groundwater monitoring wells (PZ-B1 through PZ-B4) were completed immediately downgradient of the groundwater collection ditch during construction of the gypsum storage impoundment (subsequently completed in 1986).

Groundwater samples have been collected by the facility operator since 1985, just prior to the initiation of operation of the gypsum storage facility in 1986. From 1985 through 1990, quarterly samples were obtained from the groundwater collection ditch and from monitor wells PZ-B2, PZ-B3, and PZ-B4. In 1991, five additional wells were drilled in the vicinity of the gypsum storage impoundment (PZ-B5 through PZ-B9), although PZ-B5 and PZ-B7 were abandoned shortly thereafter. Monitoring wells PZ-B6, PZ-B8 and PZ-B9 were sampled only once and were not added to the scope of quarterly sampling.

In July 2012, after the RCRA 3013 AOC was signed, groundwater monitoring was expanded to all six existing functional groundwater monitoring wells: PZ-B2, PZ-B3, PZ-B4, PZ-B6, PZ-B8, and PZ-B9. From June to September 2013, 39 new monitoring wells were installed and sampled at 15 boring locations around the facility. Locations of all functional groundwater monitoring wells and the groundwater collection ditch are shown in Figure 6.

Groundwater samples have been analyzed for pH, specific conductance, chloride, fluoride, sulfate, aluminum, antimony, arsenic, beryllium, cadmium, chromium, copper, lead, mercury, nickel, phosphorous, silver, thallium, vanadium, zinc, gross alpha, radium 226 & 228, and total dissolved solids as required by the permit to construct.

Groundwater level measurements have been collected monthly from the groundwater collection ditch and seven monitoring wells (PZ-B1, PZ-B2, PZ-B3, PZ-B4, PZ-B6, PZ-B8, and PZ-B9) and quarterly from all current monitoring wells since 2013.

Summary of Groundwater Characterization

The following groundwater characterization is a summary of the Groundwater Investigation Summary Report prepared by Formation Environmental of Boulder Colorado. The report is dated April 2016.

Stratigraphy

The Site is underlain by bedrock of the Blair Formation, which consists of approximately 900 feet of interbedded shales, siltstones, and fine-grained sandstones covered by a thin layer of alluvium. The alluvium is thickest in the Sweetwater Creek drainage and both historical and recent information indicate the alluvium supports limited unconfined groundwater flow. In many areas across the Site, there is little to no residual soil cover over the Blair Formation. The general dip of the Blair Formation mapped near the Site is approximately six to eight degrees to the west. Bedrock groundwater monitoring wells are completed in the middle Blair Formation, which appears discontinuous and of limited areal extent. The thin very fine grained sandstone layers encountered in borings during the SAWP investigation appear to be laterally discontinuous in cross section and both sandstone and shale strata contribute groundwater flow into the wells.

The alluvium of the Sweetwater Creek drainage consists mostly of silt and clay with fine-grained sand derived from weathering and transport of materials from the weathered portion of the Blair Formation. No previously completed test wells or monitoring wells have been installed exclusively in the alluvium. The residual soil encountered in the borings drilled in 2013 was typically very fine, loose, yellowish brown to brown clayey silt.

The weathered Blair Formation consists of residual strata of silts, clays, and fine grained sands closely resembling the lithology of the Blair Formation, but is less dense and with slightly higher hydraulic conductivities than competent rock below. The weathered Blair Formation was encountered in all the deeper borings completed across the Site and was generally less than 50 feet thick.

Previous investigations revealed the un-weathered Blair Formation to have very low hydraulic conductivity except where fractures and/or sandstone beds are present. The bulk properties of the Blair Formation gathered during previous investigations classify the formation as an aquitard with limited well yields of generally poor quality water. The lithology of the un-weathered Blair Formation is typical of the middle Blair Formation, with most individual strata not correlating directly from boring to boring across the Site. Some evidence of faulting was observed during drilling, specifically between wells PZ-B10 and PZ-B23, where a plastic, calcite rich clay with porous travertine was encountered while drilling the PZ-B23 boring.

Groundwater Occurrence

Based on the geologic, potentiometric and geochemical data, the groundwater encountered in the deeper portions of the Blair Formation likely originates from deep confined zones (Formation 2012b) which are recharged by infiltrating precipitation in sub-crop and outcrop areas on Aspen Mountain. Recharge for the shallow unconfined zone of the Blair Formation is from local infiltration of precipitation at the Site.

Groundwater at locations PZ-B2, PZ-B3, PZ-B4 and to an extent PZ-B6, PZ-B8, PZ-B10A and PZ-B10B is hydraulically connected to the collection ditch and responds to water levels within the collection ditch, which is periodically pumped.

Groundwater elevation measurements were collected during well development and sampling, including gauging of open boreholes in the Blair Formation. Water-bearing zones encountered during drilling were recorded, and the rate of water production was estimated. Water bearing zones were only observed in four borings (PZ-B10, PZ-B21, PZ-B22, and PZ-B23) during drilling. No groundwater was encountered in borings PZ-B1R, PZ-B12, PZ-B14, or PZ-B15 during or after drilling.

Because so few water bearing zones were observed during drilling, double and triple screened well nests were installed in many borings to intersect low-yielding groundwater in at least one screen interval. Several wells have remained dry since installation; therefore, these wells have not been developed or sampled. These wells include: PZ-B11A, PZ-B11B, PZ-12B, PZ-B13A, PZ-B13B, PZ-B17A, PZ-B19A, and PZ-B19B.

Many of the newly installed wells exhibited significant drawdown and very poor recovery while being purged dry or nearly dry during well development. However, wells PZ-B10A, PZ-B10B, PZ-B12A, PZ-B21C, PZ-B22B, PZ-B23B, and PZ-B23C exhibited little to no drawdown with moderate recoveries during development and are believed to have encountered a zone of secondary porosity such as a fault zone.

Groundwater General Chemistry

In general, groundwater encountered at the Site has high concentrations of sodium, sulfate, and TDS. The groundwater samples collected in the third quarter of 2013 had TDS concentrations ranging from approximately 1,000 mg/L to 26,000 mg/L. The high dissolved solids concentrations observed at the Site are likely associated with naturally occurring and relatively soluble minerals (e.g., trona [sodium carbonate], gypsum [calcium sulfate], and halite [sodium chloride]) found in the Blair Formation (WWDC 2010). Previous work by Mason and Miller (2004, p.62) indicated that groundwater within the Blair Formation becomes increasingly saline with distance downgradient from recharge areas. Most recharge occurs at the higher elevations associated with Aspen Mountain located south of the Site.

The major-ion compositions of groundwater samples collected during the third quarter 2013 sampling event indicate at least three distinct groundwater types, as well as groundwaters with intermediate compositions that lie between the three end-member types. Piper and ternary diagrams included in the Sampling and Analysis Report [SAR] (Formation 2014) illustrate the water-type classifications determined during the RCRA 3013 investigation, which include:

- Sodium-Sulfate to Magnesium-Sulfate Groundwater characterized by relatively low chloride and moderate TDS encountered at PZ-B9, PZ-B12A, PZ-B13C, PZ-B15A, PZ-B15B, PZ-B17B, PZ-B17C, PZ-B18A, PZ-B18B, PZ-B20A, PZ-B20B, PZ-B20C, PZ-B22B, PZ-B2, PZ-B3, PZ-B4, and the collection ditch (CD, CD Inlet)

- Bicarbonate Groundwater characterized by relatively low chloride and TDS but intermediate sodium and magnesium concentrations encountered at PZ-B6, PZ-B10A, PZ-B10B, and PZ-10C

- Sodium-Chloride Groundwater characterized by relatively high chloride and very high TDS concentrations encountered at PZ-B11C, PZ-B16A, PZ-B16B, PZ-B16C, PZ-B23A, PZ-23B and PZ-B23C

Hydrostratigraphic Units and Groundwater Potential

Hydrostratigraphic units (HSUs) were identified using the lithologic data obtained from boreholes drilled in the study area, groundwater potentiometric data collected from wells, groundwater chemistry data, and interpretation of regional geological structural information. Because hydrologic and chemical data indicate that groundwater is not laterally continuous across the Site and geologic data indicate that the local fracture systems and related faulting may control groundwater flow in separate HSUs, three main hydrostratigraphic units were identified at the Site.

The major-ion compositions of groundwater samples indicate that there are at least three distinct groundwater types present at the Site, as well as groundwater with intermediate compositions. The existence of chemically distinct groundwater types is consistent with other Site-specific evidence for multiple, separate hydrostratigraphic units (HSUs) with varying degrees of hydraulic communication. Three major HSUs were delineated during the RCRA 3013 investigation: HSU-1 (Sulfate-type Groundwater), HSU-2 (Sodium Chloride-type Groundwater) and HSU-3 (Bicarbonate-type Groundwater). Each of these HSUs is described in the following paragraphs. The extent of each of the HSUs and groundwater potential in each is shown in Figure 4.

HSU-1 comprises a sulfate-type groundwater and is the most prevalent geochemical classification of groundwater found at the Site. There is chemical variation within this water type, specifically within cation concentrations, and groundwater potentiometric data indicate that groundwater within HSU-1 is limited in vertical and lateral hydraulic connection. Groundwater potentiometric and stratigraphic/structural geologic data indicate that not all wells within this HSU are in direct hydraulic communication. Wells PZ-B12B, PZ-B13A, PZ-B13B, PZ-B17A, PZ-B19A, and PZ-B19B are dry and delineate a zone in which no groundwater was encountered.

Sources of groundwater in this area appear to be recharge or upward leakage of confined groundwater in the vicinity of the PZ-B18 well nest and artesian groundwater in the vicinity of the PZ-B20 and PZ-B21 well nests. Northwest of the gypsum stack, there is a downward hydraulic gradient at the PZ-B18 monitoring well nest and a lateral hydraulic gradient toward the location of the PZ-B17 well nest.

Groundwater potential decreases from northeast to southwest and there are no apparent facility influences on the hydraulic gradient or groundwater flow direction other than the groundwater collection ditch. Pre-construction site investigation indicates that groundwater was present in the area now beneath the gypsum stack. Since no current data can be obtained on groundwater conditions directly beneath the stack, it is assumed that this groundwater is still present and correlates with groundwater in HSU-1. Potentiometric contours beneath the gypsum stack are shown as estimated in Figure 2. General chemistry data indicate that there is significant variation in analyte concentrations with no apparent pattern that correlates with potential source areas at the facility. TDS concentrations measured in the HSU-1 wells are within the range detected in the monitoring wells prior to the operation of the gypsum stack. Groundwater within the Blair Formation generally has a high concentration of TDS due to naturally occurring minerals within the formation.

The constituent concentrations observed in groundwater within HSU-1 indicate that the Wyoming

Class IV(A) classification is appropriate for this unit. Total phosphorus concentrations that occur in the surface water samples collected within the collection ditch are not found within groundwater from nearby monitoring wells PZ-B2, PZ-B3, PZ-B4, and PZ-B8. Variations in total phosphorus concentrations in the collection ditch water samples suggest that phosphorus may be sourced from naturally occurring phosphorus within soils. The concentrations of phosphorus reported for the off-facility soil samples ranged from 645 mg/Kg to 1,260 mg/Kg with an average concentration of 972 mg/Kg (Formation 2014). The greatest concentration was detected in the 1.0 to 1.5 foot sample collected from upwind location OSB-03. Total phosphorus concentrations in the collection ditch water samples vary considerably due to seasonal algal growth patterns, vegetation growth and decomposition along the ditch, and pumping of water from the ditch.

HSU-2. West and southwest of the gypsum stack along the bluff capped by the Rock Springs Formation, a zone of sodium-chloride type water is encountered in seven wells: PZ-B11C, PZ-B16A, PZ-B16B, PZ-B16C, PZ-B23A, PZ-B23B, and PZ-B23C. Except for PZ-B23B, all of these wells have very high concentrations of dissolved solids. Groundwater potentiometric and stratigraphic/structural geologic data indicate that all the wells within this HSU are in hydraulic communication. Groundwater potentiometric data indicate that the source of this type of groundwater is from a deep artesian source aligned with the locations of these wells, possibly along a fracture zone.

Both the hydrologic and chemical data indicate that groundwater is not laterally continuous across the entire Site. Geologic data indicate that the local fracture systems and related faulting may control groundwater flow in separate HSUs and that the Site is generally located in an area of groundwater discharge. Groundwater potential is related to surface topography and the degree of confinement of artesian pressure developed in higher elevation recharge areas (i.e. Aspen Mountain). Results of investigations support the concept that the Blair Formation does not provide a continuous groundwater flow system: the relatively low hydraulic conductivity of the Blair Formation only allows for wells to achieve significant water yields when located in areas where secondary porosity is evident and controlled by the presence of faults. Locations and depths at which no groundwater was encountered also aid in the understanding of the continuity of each unit.

Both groundwater potential and geochemical data indicate that these wells are in hydraulic connection probably resulting from a fault or fracture zone that allows connection with deep artesian groundwater. The constituent concentrations observed in groundwater within HSU-2 indicate that the Wyoming Class IV(A) classification is appropriate for this unit.

The groundwater potential indicates that groundwater flow direction within HSU-2 is dominated by upward vertical movement (groundwater potential is higher in the deeper monitoring wells) with only a minor lateral gradient. The concentrations of COPCs in shallow groundwater in this zone (PZ-B16A and PZ-B23A) are similar to that in deeper groundwater (PZ-B11C, PZ-B16C, and PZ-B23C) and potentially due to the upward leakage of the deeper groundwater.

HSU-3. Bicarbonate is the dominant anion in the groundwater encountered in four wells located in the Sweetwater Creek drainage southeast of the gypsum stack: PZ-B6, PZ-B10A, PZ-B10B, and PZ-10C. Groundwater collected at these locations is characterized by relatively low TDS concentrations typical of the effects of local recharge (incident precipitation/runoff water). Groundwater potentiometric and stratigraphic/structural geologic data indicate that wells within this HSU are in direct hydraulic communication. The groundwater in PZ-B10C, which contains relatively high sodium and chloride with bicarbonate, indicates that the source of this type of groundwater is derived from a deep confined zone with that may align with a fracture zone.

Both groundwater potential and geochemical data indicate that these wells are in hydraulic connection probably resulting from a fault or fracture zone that allows connection with deep artesian groundwater. The groundwater potential and general chemistry data do not indicate that this unit is influenced by the gypsum stack. Upward flow of groundwater in this area is partially under the influence of the collection ditch and results in a shallow groundwater flow path that trends toward the northeast from PZ-B10A toward PZ-B6. The constituent concentrations observed in groundwater within HSU-3 indicate that the Wyoming Class III classification is appropriate for this unit.

The groundwater potential indicates that groundwater flow direction within HSU-3 is dominated by upward vertical movement (groundwater potential is higher in the deeper monitoring wells), with only a minor lateral gradient. The concentrations of constituents of potential concern (COPCs) in shallow groundwater in this zone (PZ-B10A and PZ-B6) are similar to that in deeper groundwater (PZ-B10C) and potentially due to the upward leakage of the deeper groundwater. The considerable difference in groundwater quality between groundwater samples collected from HSU-3 and the nearby wells completed in the HSU-2, both of which are dominated by upward flow of groundwater, illustrates the complexity of the Blair Formation groundwater flow patterns.

Summary of Groundwater Data Analyses

The following groundwater data analyses is a summary of the Groundwater Investigation Summary Report prepared by Formation Environmental of Boulder Colorado. The report is dated April 2016.

Water quality samples were collected at 23 groundwater monitoring wells and two locations within the groundwater collection ditch over the period from September 2013 to April 2015 (eight consecutive quarters) under the expanded analyte list required by the RCRA AOC. Over this period water level measurements were made approximately quarterly at all 45 monitoring well locations and the collection ditch. Prior to September 2013 water level measurements and water quality samples were only collected from the monitoring wells installed in 1985 and 1996. The recent data were evaluated using some of the same methods that are used to evaluate background conditions in the Baseline Groundwater Conditions Report [BGWCR] (Formation 2016) to characterize spatial, temporal and statistical variations in groundwater chemistry within the facility and identify chemically distinct groundwater that may be present due to chemical releases from the facility, if any. The historic monitoring data (data collected prior to July 2012) was analyzed separately prior to the RCRA order and presented in the Groundwater Data Analysis Report (Formation 2012). A summary of the results of these analyses is provided in the following paragraphs.

<u>General Considerations in the Evaluation of the Groundwater Quality Data</u>

Groundwater quality within the Blair Formation, which underlies the facility, is typically poor due to naturally occurring salts, and the concentrations of some chemical constituents that are associated with the facility, such as sulfate, are naturally elevated in groundwater from the Blair Formation. Based on the high sulfate and TDS concentrations found in groundwater samples obtained prior to facility operation, groundwater at the Site classifies as Class III (TDS from 2000 mg/L to 5000 mg/L) and Class IV(A) (TDS from 5000 mg/L to 10,000 mg/L) according the Wyoming groundwater quality standards. The high dissolved solids concentrations observed at the Site are likely associated with naturally occurring, relatively soluble minerals, such as trona (sodium carbonate), gypsum (calcium sulfate), and halite (sodium chloride), that are found in the

Blair Formation (WWDC 2010). Previous work published by Mason and Miller (2004, p.62) indicated that groundwater within the Blair Formation becomes increasingly saline with distance downgradient from recharge areas. Most recharge occurs at the higher elevations associated with Aspen Mountain located south of the Site.

Based on the data analyses provided the SAR and BGWCR, groundwater conditions in the vicinity of the facility are best described as naturally heterogeneous, variable and of generally poor quality. The potential influence of facility operations was assessed by evaluating spatial distribution of constituent concentrations in groundwater, concentration trends over time, and influence on groundwater hydrology (changes in groundwater level due to facility influence). The assessment also considered the chemistry of potential sources at the facility and the influences on groundwater sample chemistry resulting from sampling conditions.

As initially recognized in the SAR, a potential transport pathway to groundwater considered in the investigation was the infiltration and/or leaching of source materials and vertical migration to underlying shallow and possibly deeper groundwater as indicated by elevated concentrations of COPCs in subsurface soil and groundwater. This potential pathway is constrained by the arid climate, which results in limited infiltration potential, and the chemistry of the subsurface soils and bedrock materials, which are alkaline and have a high acid neutralizing potential; if any release of phosphoric acid or sulfuric acid takes place, the acid has a high potential to be neutralized before migrating downward to groundwater. Vertical migration from the main processing area is limited by the depth to saturated groundwater and the low permeability of strata above the saturated zone. Groundwater elevation and chemistry data demonstrate that operations at the facility do not affect groundwater potential or concentrations of COPCs in groundwater. As a result, the conceptual site model shows no transport of COPCs to groundwater.

<u>Groundwater Potential</u>

Groundwater potential at the Site is related to surface topography when unconfined and the degree of confinement and artesian pressure developed in higher elevation recharge areas. Most recharge occurs at the higher elevations associated with Aspen Mountain located south of the Site. Groundwater potential decreases from northeast to southwest, as shown in Figure 2. There are no apparent facility influences on the hydraulic gradient or groundwater flow direction other than the groundwater collection ditch. The collection ditch intercepts the groundwater table and since it is pumped down periodically, the ditch generates a low in the potentiometric surface.

Geologic data indicate that the local fracture systems and related faulting may control groundwater flow in HSUs and that the Site is generally located in an area of groundwater discharge.

The RCRA 3013 investigation supports the concept that the Blair Formation does not provide a continuous groundwater flow system and the relatively low hydraulic conductivity of the Blair Formation only allows for wells to achieve significant water yields when located in areas where secondary porosity is evident and controlled by the presence of faults. Previously observed aquifer transmissivities were very low (Ardaman 1985) except in areas where fractures and/or sandstone beds were present (Woodward-Clyde 1982b). Observed drawdown and recoveries during the RCRA 3013 investigation indicate that the Blair Formation acts as an aquitard except in localized areas where secondary porosity is present.

As described in the BGWCR, no spatial pattern of chemical concentrations in groundwater is evident at the Site, except for elevated concentrations of nitrate+nitrate and selenium between wells PZ-B12A, PZ-B22B and PZ-B4 (upgradient to downgradient, respectively). An apparent groundwater pathway exists in this area as evidenced by observed nitrate+nitrate and selenium concentrations measured at these wells and the possible presence of a fracture zone. As described in the BGWCR, the groundwater travel time between PZ-12A and PZ-22B is estimated to be about 13 years (assuming an effective porosity of 1%).

Hydrographs showing trends in groundwater elevation are included in Appendix A. The water level within the groundwater collection ditch is managed to achieve groundwater capture by maintaining a lower level than that of the shallow unconfined groundwater down gradient of the ditch. Groundwater elevations in wells near the groundwater collection ditch (PZ-B2, B3, B4, B6, B8, B10A, and B10B) are hydraulically connected and fluctuate corresponding to the water level in the groundwater collection ditch, which is periodically pumped down as a source of plant makeup water. Steadily increasing groundwater elevations have been observed for several years at well PZ-B9. Well PZ-B9 is situated in an arroyo that was dammed as a result of the construction of the Gypsum Stack. This causes storm water runoff to pool and infiltrate in the vicinity of the well. Increasing trends in groundwater elevation have also been observed in a number of other monitoring wells including PZ-B11C, PZ-B12A, PZ-B12C, PZ-B14, PZ-B15A, PZ-B15B, PZ-B16A, PZ-B16B, PZ-B16C, PZ-B17C, PZ-B18B, PZ-B18C and PZ-B20C. These groundwater level trends are the result of very slow groundwater yield from the very low hydraulic conductivity Blair Formation, in which almost all the monitoring wells are installed. All the recently completed monitoring wells were installed in a nested arrangement within a single boring and most of these borings were dry upon the completion of drilling. Groundwater at initially dry locations has taken many months to years to equilibrate to static conditions resulting in a trend of significant groundwater level increase.

Groundwater Quality

The groundwater data analysis presented in the BGWCR generally confirms the investigation findings documented in the SAR. Time series charts showing concentration trends for each analyte are included in Appendix B. Post plots showing concentrations in groundwater samples are included in Appendix C. The high concentrations of major ions (calcium, magnesium, sodium, sulfate and chloride) are typical of the groundwater of HSU-1 and HSU-2. Most metals are detected at very low concentrations or are not detected above analytical method limits. The major ions and most metals do not show any spatial correlation with potential sources within the facility or groundwater flow paths from those sources. The exceptions are nitrate, selenium and phosphorus.

Concentrations of nitrate and selenium are elevated in samples from wells PZ-B4, PZ-B22B, and PZ-B12A. Nitrate is typically not detected in groundwater samples and selenium is typically present in concentrations of less than 0.005 mg/L. Selenium is also elevated in samples from the groundwater collection ditch. Selenium is not detectable in ore processed at the facility. While sources of these constituents are unknown, the distribution and concentration of nitrate and selenium was recognized and described in the SAR and BGWCR and suggest transport along a groundwater flow path that connects these wells and terminates at the groundwater collection ditch.

Phosphorus is detected in groundwater samples in concentrations of less than 1.0 mg/L and frequently in concentrations of less than 0.1 mg/L. The sample collected from the collection ditch in April 2015 had a concentration of 39.3 mg/L. The concentration at a seepage face referred to as the CD Inlet was 2.82 mg/L. The elevated concentrations of phosphorus were described in the SAR (Formation 2014) and the source of phosphorus in the collection ditch is attributed to phosphorus that is available within native materials then concentrated by bioaccumulation.

As part of the analyses conducted in the BGWCR, trend tests were performed for each analyte at each monitoring well - this resulted in a total of 792 tests. The Mann-Kendall test, which is non-parametric and independent of the data distribution, indicated that, of the analyte concentration trends with a detection rate of 70% or greater, a total of 189 had a decreasing (D) or probably decreasing (PD) trend; 54 had an increasing (I) or probably increasing (PI) trend; and the remaining 310 had either a stable trend (S) or no trend (NT). Most of the increasing trends were observed in samples obtained from the monitoring wells that were installed in 1985 or 1997 in which dedicated sampling equipment had been installed. Most of the decreasing trends were observed in the monitoring wells that were installed in 2013. As described in the BGWCR, some of the decreasing trends may be due to the turbidity of the samples obtained.

Poor yielding monitoring wells installed during the RCRA 3013 investigation initially yielded groundwater samples with high turbidity. After several rounds of purging and sampling, turbidity decreased indicating that well development had been enhanced. In addition, sampling methodologies were refined based on the difficult conditions encountered during the investigation (i.e. utilizing the no-purge bailer method versus volumetric purging). Samples obtained from wells became less turbid due to lower degree of disturbance to the water column. Even though some upper outliers were removed based on high turbidity, the decreasing trends in the recently installed monitoring wells may be attributed to the slow recovery of the monitoring wells from the disturbed conditions resulting from installation in strata that yield very low groundwater flow to the well. Due to the very slow groundwater movement, trend tests over a two year period may be insufficient to capture true natural variability in the older established wells and are not sufficient to delineate trends in the recently installed wells where water quality is likely influenced by the disturbance caused by the installation of the monitoring well. Some analytes, such as nitrate which is not present in the native media, should be independent of the well installation/sampling effect and trend analysis could therefore be valid.

In summary, the available monitoring data are sufficient to identify specific chemical constituents that can serve as indicator parameters for facility releases. The data also indicate that groundwater chemistry is consistent with that expected for the Blair Formation based on regional investigations and there is no spatial pattern indicative of substantial facility releases. The data also indicate that initial groundwater samples in newly installed monitoring wells have high constituent concentrations related to the disturbed conditions resulting from drilling. As a result, statistical analyses of the available data must consider these potential influences on the data set.

Alternative Liner Demonstration

The liner system beneath the original phosphogypsum stack and all the lateral expansion liners constructed since 1985 consist of a 60-mil HDPE geomembrane liner underlain by a 16-oz. geotextile. The geotextile was installed to minimize stress concentrations in the liner resulting from near surface weathered rock fragments that may be present in the liner subgrade. Almost the entire lined area is covered with up to 200 or more feet of sedimented gypsum. The only uncovered liner is in the return water ditch that runs along the northeast and southeast sides of the phosphogypsum stack. The top of the phosphogypsum stack is kept ponded for sedimentation of the fine silt-sized phosphogypsum crystals and for evaporative cooling.

As described in the previous sections of this report, no evidence of liner leakage has been measured in groundwater samples obtained from the groundwater collection ditch or in monitor wells constructed around the lined phosphogypsum stack system. Either there are no defects in the geomembrane liner or the sedimented gypsum above the geomembrane is acting as the non-synthetic component of a composite liner.

This is not unexpected. The hydraulic conductivity of sedimented phosphogypsum is relatively low even at initial sedimented densities and decreases substantially as the thickness of the gypsum above the liner increases. For example, sedimented Rock Springs phosphogypsum has a vertical hydraulic conductivity of less than $4x10^{-4}$ cm/sec at a depth of 1 foot and a vertical hydraulic conductivity of less than $7x10^{-5}$ cm/sec at a depth of 100 feet. Furthermore, the diameter of the gypsum crystals (less than 0.06 mm) is much smaller than the diameter of a typical defect (2 to 3.56 mm) in the geomembrane and would fill the defect during initial sedimentation. This was demonstrated by the tests performed by Garlanger et al (1994) during development of the Florida Phosphogypsum Management Rule (17-763 FAC).

Paragraph VI (4) of Attachment C (Phosphogypsum Stack System Construction and Operational Requirements of the proposed Consent Decree between the United States, the State of Wyoming, and the J.R. Simplot Company specifies that the non-synthetic component of the composite Liner shall consist of either of the following:

b.iii. a A layer of compacted soil at least eighteen (18) inches thick, placed below the Geomembrane, with a maximum hydraulic conductivity of 1×10^{-7} centimeters per second, constructed in six-inch lifts; or

b.iii. b A layer of mechanically compacted Phosphogypsum at least twenty-four (24) inches thick, placed above the Geomembrane, with a maximum hydraulic conductivity of 1×10^{-4} centimeters per second.

b.iii. c Slurry discharged into the expansion area allowing the phosphogypsum to sediment in to reach a maximum hydraulic conductivity of $1 x 10^{-4}$ centimeters per second.

It also states that the non-synthetic component of a Phosphogypsum Stack composite Liner will not be required for vertical expansions under the following conditions:

b.iv. a. where it has been demonstrated to and approved by the STATE or EPA that a synthetic Liner alone or in contact with sedimented gypsum placed in slurry form will be equivalent or superior to a composite Liner designed and installed in accordance with the requirements of this Section VI (Phosphogypsum Stack System Construction Requirements); or

b.iv. b. where it has been demonstrated to and approved by the STATE or EPA that a synthetic Liner in contact with sedimented gypsum placed in slurry form is equivalent or superior to a composite Liner with twenty-four (24) inches of compacted Phosphogypsum placed above the Geomembrane;

In addition, the proposed language in the current draft of Attachment C states that

b. v where it has been demonstrated and certified by a third-party engineer and approved by the STATE or EPA that a synthetic Liner in contact with sedimented gypsum placed in slurry form, and with consideration of the physical and hydrogeological setting of the specific lateral expansion, provides an equivalent or superior degree of protection for human health and the environment.

Simplot proposes to use both compacted phosphogypsum and sedimented phosphogypsum as the non-synthetic components of the composite liner. The compacted phosphogypsum will be used over permanently exposed areas, e.g., slopes of the earthen perimeter dike, and within the initial 44-acre sedimentation area. The sedimented gypsum will be used in the remaining 120 acres.

Because of the topography of the proposed expansion area, gypsum slurry will be introduced along the northeast side of area and flow to the low area along the southwest side of the area. Process water will accumulate in this low area until the overflow elevation of the outfall structure is reached, and process water is discharged to the return water ditch. This will take approximately one month. Gypsum slurry will continue to discharge into the low area for approximately three additional months at which time, there will be no process water ponded above the uncovered geomembrane.

Gypsum will continue to be introduced from the northeast and be deposited on a phosphogypsum beach moving away from the overflow weir. Any defect in the geomembrane will be filled with sedimented gypsum as soon as the moving beach reaches the defect.

The leakage through the composite liner system, q, as the thickness of phosphogypsum increases with time can be computed for sedimented phosphogypsum and compacted gypsum using the following equations from Garlanger et al (1994):

$$q = \frac{4\sqrt{k_h k_v} h_w r_d}{1+\frac{4\sqrt{k_h k_v} t}{\pi r_d k_v}}, \quad (1)$$

$$q = 4\sqrt{k_h k_v} h_w r_d, \quad (2)$$

where k_h and k_v are the horizontal and vertical hydraulic conductivities of the sedimented gypsum, h_w is the height of gypsum/water above the liner, r_d is the radius of the defect in the geomembrane, and t = 1.5 mm is the thickness of the liner. The computed seepage rates through the proposed liner system for increasing thicknesses of gypsum above the liner using an anisotropy ratio of 2, two 3.56-mm diameter defects per acre for the sedimented gypsum and four 3.56-mm diameter defects per acre for the compacted gypsum is provided in Figure 7. Also shown for comparison is the predicted leakage when the non-synthetic component over the entire area is compacted phosphogypsum with a saturated hydraulic conductivity of $1x10^{-4}$ cm/sec. The hydraulic conductivity of the Rock Springs sedimented gypsum was computed from the following equation:

$$k_v = 1.16 \times 10^{-4} \mathrm{e}^{2.455},$$

where the void ratio, e, was computed from the expected dry density corresponding to the thickness of Rock Springs gypsum above the liner.

As can be seen by the results presented in Figure 7, the proposed liner system is superior to a composite Liner with twenty-four (24) inches of compacted Phosphogypsum placed above the Geomembrane.

Because the groundwater monitoring data, including the water quality data associated with samples obtained from the groundwater collection ditch over the past 33 years, shows no evidence of groundwater impacts from the existing phosphogypsum stack system, which has only sedimented phosphogypsum above the geomembrane, and because the results presented in Figure 7 indicate that the proposed liner system is superior to the composite liner specified in Attachment C, the proposed liner system should be approved by the US EPA and the State of

Wyoming.

If there are any questions, please contact the undersigned.

Very truly yours,
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