**In the Matter of**

**PR Spring Tar Sands Project, Ground Water Discharge Permit-by-Rule**

**No. WQ PR-11-001**

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# PREPARED SUPPLEMENTAL TESTIMONY

**OF**

**ELLIOTT W. LIPS**

**ON BEHALF OF**

**LIVING RIVERS**

**March 16, 2012**

## I. INTRODUCTION AND QUALIFICATIONS

Q. PLEASE STATE YOUR NAME?

A. My name is Elliott W. Lips

Q. BY WHOM ARE YOU EMPLOYED AND WHAT IS YOUR POSITION?

A. I am the principal engineering geologist of Great Basin Earth Science, Inc. located at 2241 East Bendemere Circle, in Salt Lake City, Utah.

Q. FOR WHOM ARE YOU TESTIFYING IN THIS PROCEEDING?

A. I am testifying on behalf of Living Rivers.

Q. DID YOU PREVIOUSLY PREPARE TESTIMONY FOR THIS PROCEEDING?

A. Yes, it was titled: Prepared Direct Testimony of Elliott W. Lips on behalf of Living Rivers, dated January 20, 2012.

Q. IN PREPARING THIS SUPPLEMENTAL TESTIMONY, WHAT DOCUMENTS HAVE YOU REVIEWED?

A. In addition to the documents listed in my direct testimony (and the documents referenced within them), I have reviewed the following:

Prefiled Direct Testimony of Robert Herbert, February 29, 2012. (Hereafter, Herbert)

Prefiled Direct Testimony of Mark Novak on behalf of the Executive Secretary of the Utah Water Quality Board, February 29, 2012 (including references.) (Hereafter, Novak)

Letter Report for U.S. Oils Sands, In response to Elliot [sic] W. Lips and William P. Johnson Testimony dated January 20, 2012, Presence of Ground Water; prepared by Robert J. Bayer, JBR Environmental Consultants, Inc., February 29, 2012 (including references.) (Hereafter, Bayer)

Expert Report of Gerald Park (no date; hereafter, Park.)

## II. **PURPOSE AND SUMMARY OF TESTIMONY**

Q. WHAT IS THE PURPOSE OF YOUR SUPPLEMENTAL TESTIMONY?

A. My supplemental testimony will provide further evidence that the Division of Water Quality (DWQ) improperly determined on March 4, 2008, and again on February 15, 2011 that the proposed mining and bitumen extraction operation should have a *de minimis* potential effect on ground water quality and qualifies for permit-by-rule status under UAC R317-6-6.2.

Q. WOULD YOU PLEASE SUMMARIZE YOUR TESTIMONY?

A. My testimony will focus on two areas. First, DWQ incorrectly, and without basis, assumes that ground water is not present at the site above a depth of 1,500 to 2,000 feet below the ground surface. This assumption ignores information contained in published reports and the documents that U.S. Oil Sands (USOS) provided to DWQ. Furthermore, it is based on incomplete and/or missing data collection and analysis. Second, DWQ incorrectly, and without basis, assumes that the operations will not generate leachate from the tailings. DWQ ignores information contained in published reports and the documents that USOS provided to DWQ. In addition, this assumption is unsupported by any analysis and is contradicted by information known to DWQ regarding infiltration of precipitation in this area.

## III. FAILURE TO DESCRIBE EXISTING GROUND WATER

Q. WOULD YOU BRIEFLY DESCRIBE WHAT DWQ ASSUMES REGARDING THE GROUND WATER AT THE SITE?

A. DWQ assumes that there is an absence of ground water to a depth of 1,500 to 2,000 feet below the mine site (Herbert, pg. 4; Novak, pgs. 5, 13).

Q. DOES DWQ STATE WHETHER THIS ASSUMPTION WAS PART OF ITS *DE MINIMIS* DETERMINATION?

A. Yes. Herbert (pg. 4) states: "The primary premise of the permit-by-rule approval was the absence of ground water to a depth of 1,500 to 2,000 feet below the mine site." In addition, Novak (pg. 5) states: "The primary premise of this determination was the absence of ground water in the project area to a depth of 1,500 to 2,000 feet below the ground surface."

Q. DOES DWQ STATE WHAT INFORMATION IT RELIED UPON IS MAKING THIS ASSUMPTION ABOUT THE DEPTH OF GROUND WATER?

A. Yes, DWQ relied upon a published report of the regional climate and hydrogeology, regional well logs and water rights, drilling conducted by USOS, and a single site visit by DWQ staff in June, 2008. Novak, pg. 5.

Q. WHAT DOES DWQ STATE REGARDING GROUND WATER IN SHALLOW LOCALIZED PERCHED ZONES ABOVE THE 1,500 TO 2,000 FOOT DEPTH?

A. Unfortunately, this is where DWQ's evaluation completely fails because it ignores substantive evidence in the record and field evidence from agency staff. Furthermore, DWQ draws erroneous and unsupported conclusions from the drilling information, and DWQ fails to require USOS to conduct a systematic investigation for occurrence of ground water in shallow localized perched zones.

Q. WHAT DO YOU MEAN WHEN YOU SAY THAT DWQ IGNORED SUBSTATIVE EVIDENCE IN THE RECORD?

A. The "Record" to which I am referring consists of the 2008 Permit-by-Rule Demonstration (Demonstration), prepared by JBR, a consultant to USOS, the Division of Oil Gas & Mining Notice of Intention to Commence Large Mining Operation (NOI), and other documents and correspondence submitted to DWQ.

Q. WHAT EVIDENCE IS THERE IN THE RECORD FOR THE PRESENCE OF GROUND WATER IN SHALLOW LOCALIZED PERCHED ZONES?

A. The NOI states that "[n]earby springs or seeps (shown on Figure 7) **provide evidence of very localized, shallow groundwater**, likely representing isolated perched aquifers…" (pg. 30, emphasis added). The NOI also states: "[T]here are several small springs or seeps that issue in the headwater reaches of Main Canyon and support perennial flow for some distance along its main stem.…" (pg. 35) The Demonstration states that "[t]here are several nearby springs and/or seeps that **provide evidence of localized, shallow ground water**…." (pg. 2, emphasis added). Investigations by JBR (Exhibit A) in the vicinity of a seep or spring located in the affected area (1567 on Figure 7) reported "two small seepage locations" with flow. JBR further states:

"Seepage in the lower reaches of the drainage indicates that **shallow groundwater is present in the area**, and it is reasonable to assume that flow from a spring/seep may occur in the upper reaches of the basin during wetter periods of the year, or immediately following a precipitation event." (Appendix A, pg. 2, emphasis added)

Q. WERE THE SEEPS OR SPRINGS RECOGNIZED AND CONSIDERED BY DWQ IN ITS DETERMINATION?

A. No. The determination by DWQ is based on an assumption that is contrary to information presented in the Record. Specifically, DWQ bases its determination, in part, on the statement that "[t]here are no springs in the Earth Energy leased area and the nearest spring is PR Spring located slightly less than a mile east of the project site.…" (DWQ Determination dated March 4, 2008, pg. 2). However, as clearly shown on Figure 7 of the NOI (submitted with the Demonstration), there are 9 water right filings for seeps or springs and 4 seeps that were identified in the field, all within USOS's lease boundary. DWQ did not correct its faulty assumption in its subsequent determination on February 15, 2011.

Q. DID DWQ DISCUSS THE EVIDENCE FOR GROUND WATER IN SHALLOW LOCALIZED PERCHED ZONES IN ITS PREFILED TESTIMONY?

A. No. Surprisingly, DWQ only relies on very general regional reports and not the site specific evidence presented by USOS. In addition, DWQ is unaware of, or failed to consider, critical evidence contained in the published reports that they cite. First, DWQ (Novak, pg. 6) states that all known springs in the Green River Formation issue from the Parachute Creek Member which is located stratigraphically above the Douglas Creek Member (citation to Price and Miller, 1975). However, this regional description should not be considered the definitive source when more detailed site specific information exists. Figures 5 and 7 of the Demonstration clearly show numerous seeps and springs in the Douglas Creek Member. Second, Price and Miller (Exhibit B) state: "[F]ield observations indicate that maps only show about half of the springs and seeps actually in the mapped area." (pg. 32)

Q. IS THE INFORMATION PROVIDED IN DWQ'S DIRECT TESTIMONY CONSISTANT WITH THE AGENCY'S PERMIT BY RULE DETERMINATION?

A. No. Surprisingly, and without justification, not only does DWQ fail to acknowledge the voluminous information in the record documenting the presence of ground water in shallow localized perched zones, its directly contradicts what the agency concluded and reported in the March 4, 2008 Permit by Rule Determination. The Determination states: "[S]hallow ground water at the site is not part of a regional aquifer but occurs in localized laterally discontinuous perched sandstone lenses of the Douglas Creek Member" and "[s]hallow ground water discharges as springs in the canyon bottoms…." (pg. 2) It is unclear how DWQ can now state with any validity that there is "[a]n absence of ground water in the project area to a depth of 1,500 to 2,000 feet below the ground surface…." (Novak, pg. 5)

Q. DID DWQ FURTHER DISCUSS THE SHALLOW LOCALIZED PERCHED ZONES IN ITS PREFILED TESTIMONY?

A. Novak (pg. 6) states that "with the regional Mesa Verde aquifer located 1,500 to 2,000 feet below the ground surface at the site, ground water contained in such a sandstone lens under saturated conditions would have unsaturated conditions below it, and so would be an isolated, localized, laterally discontinuous perched lens.…" This is correct; however, Novak (pg. 6) goes on to state that because a site visit in June 2008 reported that the alleged seeps were dried up, this information "[i]ndicated that any perched aquifers issuing from these alleged seeps did not yield usable quantities of ground water. This is not consistent with the definition of an aquifer, which does not include intermittent seeps.…" DWQ thus dismisses the shallow ground water because the agency assumes that shallow ground water cannot constitute an "aquifer." For reference, UAC R317-6-1.19 defines ground water as "subsurface water in the zone of saturation including **perched ground water**." Emphasis added. Furthermore, UAC R317-6-6.2(A)25 is not restricted to only ground water that occurs in aquifers, but applies to all ground water. Therefore, DWQ is required to protect all ground water, not just ground water that has been classified, particularly without evidence in the record, by the agency or an outside party as an aquifer.

Q. CAN YOU EXPLAIN WHAT YOU MEANT WHEN YOU SAID THAT DWQ IGNORED THE FIELD EVIDENCE FROM ITS STAFF?

A. DWQ states: "[R]esults of this field visit indicated that the seeps in the Affected Area were not flowing in sufficiently to sample…"[sic] (Novak, pg. 5), and "this indicated that any perched aquifers issuing to these alleged seeps did not yield usable quantities of ground water…" (Novak, pg. 6). From the first statement, one can conclude that the seeps were flowing, but not in sufficient quantities to sample. If there was water flowing, or any expression of ground water, no matter how little, it is prima facie evidence of ground water discharge and thus confirmation of the presence of ground water in shallow perched zones. The second statement regarding the usable quantities only relates to the definition of "aquifer" and not the definition of "ground water." (UAC R317-6-1, Novak, Exhibit A). Thus, this statement has no relevance with regard to a Permit-by-Rule determination. Similarly, Park (pgs. 3-4) documents hydrologic expressions of ground water, but dismisses them by saying that they do not indicate the presence of aquifers that provide any usable source of ground water. The issue is not whether or not the ground water constitutes an aquifer. The fact remains that the seeps are a clear demonstration of the presence of ground water. Furthermore, DWQ's observations were limited to a single site visit. It is not uncommon for seeps or springs to flow intermittently, or for the water to be consumed at or near the point of discharge Price and Miller (Exhibit B, pg. 32).

Q. CAN YOU EXPLAIN WHAT YOU MEANT WHEN YOU SAID THAT DWQ DRAWS ERRONEOUS AND UNSUPPORTED CONCLUSIONS FROM THE DRILLING INFORMATION?

A. DWQ states that the drilling and coring program conducted by USOS in 2011 confirmed the absence of shallow ground water and that ground water was not present to a depth of 1,500 to 2,000 feet (Herbert, pg. 3; Novak, pgs. 5, 7, 10). As I explained in my Direct Testimony, there was no systematic record keeping or notes in the geologic logs that provide any information on the presence or absence of ground water. As such it is not possible to draw any conclusions with regard to ground water in the area drilled. The error that DWQ commits is incorrectly interpreting a lack of an observation of ground water as meaning that there is a lack of ground water. This is an error of logic. One cannot state affirmatively that ground water is not present if there were no observations finding that it was not present. Because no observations were made regarding either the presence or absence of ground water by the driller or geologist at the time the holes were drilled, it is not possible to draw any conclusions one way or the other from the drilling data. For DWQ (or USOS) to attempt to do so, renders their statement unsupported by the actual data and therefore, these claims must be disregarded with respect to any permitting decision.

Q. WERE THE GEOLOGIST AND DRILL CREWS INSTRUCTED TO RECORD OBSERVATIONS OF GROUND WATER?

A. Bayer (pg. 2) and Park (pg. 4) state that the geologist and drill crews were instructed to record observations of ground water. First, the core logs contain no information on the drilling methods or types of fluids used in the drilling process. As such, depending on the fluid used to recirculate the drill cuttings, it is likely that small quantities of ground water (such as would exist in localized perched zones) would not be detectable. In fact, this is reflected in Park (pg. 4) where he states that the information gathered during the drilling program supports a determination that shallow ground water does not exist in any "usable quantities." This is not the same as saying that ground water does not exist, and it is not possible to confirm that small quantities of ground were not present. This is because fluid used for drilling could mask any water that is encountered during drilling.

Second, the core logs simply contain no information one way or the other on the presence **or absence** of ground water. They are silent on this matter. For reasons discussed above, one cannot support a conclusion that shallow ground water is not present with a lack of observation. In order to conclude, based on the drilling program, that ground water was not present, it would have been necessary to: 1) have a drilling method capable of confirming that no water was intercepted during the drilling process, and 2) have systematic and complete observations of the absence of ground water, along with complete records of these observations. There is no information in the record that either of these conditions is satisfied.

Third, Bayer mischaracterizes the instructions given to the drill crews. Bayer (pg.2) states: "[B]oth the geologists and drill crews were instructed to carefully observe **any evidence of ground water encountered** in any of the drill holes.…" [emphasis added]. However, in a letter from EER to Layne Christensen (a drilling contractor) dated February 18, 2011 (Exhibit C), EER gave the following instructions: "[O]wner requires the driller to record presence, depth and interval of **any artesian or obvious water bearing formations.**…" (pg. 2). [emphasis added] Thus, the drillers were not instructed to carefully observe any evidence of ground water, only ground water that was under artesian pressure, or if there was an obvious water bearing formation. It is possible that the drillers encountered ground water but did not record it because it was not artesian, or was not significant enough in their minds to constitute an obvious water bearing formation.

Fourth, regardless of what the geologists and drill crews were instructed, the logs that were prepared in the field contain no observations on the presence or absence of ground water.

Q. WAS THERE A SYSTEMATIC INVESTIGATION FOR OCCURRENCE OF GROUND WATER IN SHALLOW LOCALIZED PERCHED ZONES?

A. No.

Q. WHAT WOULD THIS TYPE OF INVESTIGATION CONSIST OF?

A. In order to document the presence of ground water in shallow localized perched zones it is generally accepted practice to conduct a systematic and thorough survey of the affected and nearby areas and document the occurrences of where ground water from these zones is discharging at the surface. These are referred to as seep and spring surveys.

Q. CAN FIELD OBSERVATIONS, SUCH AS SEEP AND SPRING SURVEYS, CONFIRM THE ABSENCE OF GROUND WATER IN SHALLOW LOCALIZED PERCHED ZONES?

A. No. They only document locations where these zones are discharging ground water at the surface. As such, there could be numerous shallow localized perched zones that are not discharging to the surface but that would still be required to be protected as ground water by DWQ.

Q. IN A GENERAL SENSE, CAN ANY OBSERVATIONS OF A LACK OF SEEPS OR SPRINGS LEAD ONE TO CONCLUDE THAT THERE IS NO GROUND WATER PRESENT IN SHALLOW LOCALIZED PERCHED ZONES?

A. No.

Q. WHAT IS THE PURPOSE OF CONDUCTING SEEP AND SPRING SURVEYS?

A. Seep and spring surveys document the location of where ground water is flowing to the surface. This information, combined with topographic and geologic data can allow one to identify the location and areal extent of zones of shallow ground water, and rates of discharge and water quality. This is critical information when evaluating potential ground water impacts of a mining operation such as the one being proposed by USOS. Quite simply, in order to evaluate the potential impacts, it is a necessary first step to document the occurrence of ground water, as expressed by seeps or springs, and to collect baseline data on ground water quality.

Q. IS THERE INFORMATION AS TO WHY USOS DID NOT CONDUCT A SEEP AND SPRING SURVEY?

A. Yes. Bayer (pg. 3) explains that seep and springs surveys are not required by regulation and that professional judgment must also be considered in determining how much baseline data to collect. In Bayer's opinion, a seep and spring inventory was not necessary or important for this project (pg. 3).

Q. IS THERE ANYTHING UNIQUE TO THIS PROJECT THAT WOULD INDICATE THAT A SEEP AND SPRING SURVEY IS NOT NECESSARY OR IMPORTANT?

A. No. This is a large-scale open-pit mining operation that will disturb 213 acres (NOI, pg. 22) and that has the potential to affect ground water in hundreds to thousands of acres adjacent to the actual disturbed area. It is common practice to conduct seep and spring surveys for these types of operations. I have personally been involved in conducting several seep and spring surveys for similar open-pit and underground mining operations. Professional judgment requires one to perform the same level of work as those practicing in their field. Seep and spring surveys are the standard of practice for documenting the occurrence of areas of ground water discharge, determining flow rates, and for collecting data on baseline ground water quality.

Q. DOES BAYER EXPLAIN WHY THERE WAS NO SEEP AND SPRING SURVEY CONDUCTED FOR THIS PROJECT?

A. Bayer (pgs. 3-4) offers four reasons: 1) inspection of USGS topographic maps, 2) a lack of evidence for a seep or spring at the location of water right 49-1567, 3) the geologic information obtained from the drill logs, and 4) climate data.

First, Bayer states that there is no topographically upgradient terrain adjacent to the project site, resulting in a limited recharge area. However, this observation is contradicted by the numerous seeps and springs shown on Figure 7 in similar topographic settings, and the observation by Price and Miller (Exhibit B, pg. 31) that most of the seeps and springs in the southern Uinta Basin are above the 7,000 feet in altitude and are concentrated in the headwater areas of Avintaquin, Willow, and Bitter Creeks. The PR Spring project is located at about 8,000 feet above sea level in the headwater area of Main Canyon, a tributary of Willow Creek.

Second, Bayer reports that there was no evidence of a seep or spring at the location of water right 49-1567. However, this is contradicted by a JBR investigation of this area (Exhibit A) which reported: "Seepage in the lower reaches of the drainage indicates that shallow groundwater is present in the area, and it is reasonable to assume that flow from a spring/seep may occur in the upper reaches of the basin during wetter periods of the year, or immediately following a precipitation event."

Third, Bayer states that the relatively impermeable rocks would restrict recharge and development of saturated conditions within the sandstone lenses. However, this observation is contradicted by the numerous seeps and springs that do exist in the area (see Figure 7 of the Demonstration), so no matter how much the movement of water is restricted by the surrounding low permeable strata, ground water can and does migrate in the subsurface.

Fourth, Bayer cites high evapotranspiration and low annual precipitation in the area. However, again, regardless of these climatological factors, ground water does infiltrate into the subsurface as evidenced by the numerous seeps and springs in the area (see Figure 7), and as discussed in Price and Miller (Exhibit B, pg. 28) and Holmes and Kimball (Exhibit D, pg. 34).

Q. IN YOUR PROFESSIONAL OPINION, SHOULD THERE HAVE BEEN A SEEP AND SPRING SURVEY FOR THE PROJECT AREA?

A. Absolutely. First, there is abundant evidence that ground water exists in shallow localized perched zones in the project area. Second, it is standard practice in this area to conduct seep and spring surveys in order to collect data on ground water occurrence and ground water quality. Third, the justifications provided by Bayer for not conducting a seep and spring survey are contradicted by information in the record.

Q. ARE THERE ANY DATA OR MEASUREMENTS ON EXISTING GROUND WATER QUALITY IN OR NEAR THE PROPOSED MINE SITE?

A. No. The Documents contain absolutely no data or measurements of existing ground water quality in or near the proposed mine site. In fact the Demonstration states that "[t]he baseline water quality of ground water underlying the project area is not known…." (pg. 4).

Q. WHY IS BASELINE WATER QUALITY INFORMATION IMPORTANT?

A. Because without baseline information on the existing water quality, it is impossible to evaluate any impacts associated with the proposed mining operation. Furthermore, in its Permit-by Rule Determination (March 8, 2008) DWQ states: "[C]onsidering the factors described above, the proposed mining and bitumen extraction operation should have a *de minimis* potential effect on ground water quality and qualifies for permit-by-rule status under UAC R317-6-6.2.A(25)

…." DWQ cannot conclude that there will be a *de minimis* potential effect on ground water quality without first establishing existing water quality.

Q. IN YOUR DIRECT TESTIMONY, YOU DISCUSSED THE DOUGLAS CREEK AQUIFER. WOULD YOU SUMMARIZE THAT TESTIMONY?

A. The purpose of my discussion of the Douglas Creek aquifer in my direct testimony was twofold. First, I provided references to the Douglas Creek aquifer in order to support the interpretation that ground water can and does exist in shallow localized perched aquifers in the Douglas Creek Member of the Green River Formation (the unit to be mined at the proposed operation.) Second, I discussed ground water in the Douglas Creek Member in order to provide support for the fact that precipitation in this area exceeds evapotranspiration and that recharge to shallow ground water is from direct precipitation on outcrops of the Douglas Creek.

Q. WHAT WAS THE RESPONSE FROM USOS TO YOUR DISCUSSION OF THE DOUGLAS CREEK AQUIFER?

A. Bayer (pg. 4) stated that he believes I mischaracterized the language in the Demonstration.

Q. WOULD YOU PLEASE CLARIFY WHY YOU BELIEVE GROUND WATER IN THE DOUGLAS CREEK MEMBER IS IMPORTANT?

A. Under the permit, mining will occur down to and including the "C" tar sand bed which is located in the Douglas Creek Member of the Green River Formation. Holmes and Kimball report that the Douglas Creek aquifer underlies almost the entire southeastern Uinta Basin and crops out in the southern part of their study area (the hydrologic basin) at high altitudes (Exhibit D, pg. 33). This agrees with Figure 5 of the Demonstration which shows the Douglas Creek as the bedrock unit at the surface throughout much of the project area. Holmes and Kimball state that recharge to the Douglas Creek aquifer in the southeastern Uinta Basin originates from precipitation on the outcrop area and from infiltration from streams (Exhibit D, pg. 34). Holmes and Kimball describe general movement of water in the Douglas Creek aquifer from the recharge areas at high altitudes in the southeastern part of the basin north and northwest towards discharge areas along the Green and White Rivers, but also report that in the southern part of the basin where the aquifer is incised by deep, narrow canyons, some ground water probably moves toward discharge points at numerous springs in the canyon bottoms (Exhibit D. pg. 34). Holmes and Kimball further state that ground water in the Douglas Creek aquifer is discharged by springs in the outcrop area of the aquifer (Exhibit D, pg. 34). These statements regarding discharge are in agreement with the occurrence of numerous seeps and springs in the Douglas Creek shown in the Demonstration (Figures 5 and 7). In sum, the information in the published literature is in complete agreement with what I stated in my direct testimony, and adds further support to the presence of shallow ground water at the site. While the Douglas Creek aquifer may not be a continuous, regional aquifer as it is in the central or northern parts of the basin, the Douglas Creek Member none the less out crops in the project area and is a layer that receives recharge from precipitation, transmits ground water, and discharges to numerous springs in the southern part of the basin

## IV. FAILURE TO EVALUATE SEEPAGE OF WATER THROUGH THE TAILINGS

Q. DID USOS COMMENT ON YOUR TESTIMONY REGARDING THE WATER CONTENT OF THE TAILINGS?

A. Yes, Bayer correctly pointed out that I failed to mention that the belt filtration and disk filtration processes rely on vacuum or pressure differential to remove water from the tailings.

Q. IS THIS IN ANY WAY RELEVANT TO SEEPAGE OF WATER THROUGH THE TAILINGS?

A. Absolutely not. First, prior to the change of operations to use belt filtration and disk filtration, USOS reported the moisture content of the tailings as being between 10 and 20 percent (and that approximately 85 percent of the water would be removed.) DWQ states that the dewatered tailings will have a moisture content of 15% and will be stored in a tailings handling area (Novak, pg. 12). In other words, DWQ does not report a significant difference in the moisture content of the tailings as a result of the use of the belt or disk filters. Second, this minor (if any) difference in the initial moisture content is irrelevant to the question of seepage of water through the tailings.

Q. WOULD YOU PLEASE EXPLAIN FIELD CAPACITY AND WHY IS IT IMPORTANT TO THE ABILITY OF WATER TO PERCOLATE THROUGH THE TAILINGS?

A. As I explained in my direct testimony, the tailings will be at or near field capacity. Field capacity is the moisture or water content of a material that remains after excess water has drained away under gravitational forces. It is the water content of the soil that remains in the pore space bound to the soil particles. The importance is that when a material, such as the tailings, is at field capacity, any additional water that is added to it will drain under gravity. This is a necessary result because adding water to a soil at field capacity raises the water content above the field capacity and this additional water will drain until the water content once again reaches the field capacity. Even with the use of disk or belt filtration, the tailings will be near field capacity. In addition, Bayer reports that after the filtration process, the tailings will be placed in piles and that any water that drains from them will be collected and recycled (pg. 5). Even assuming that the tailings are slightly below their field capacity when they are placed in the storage piles (no data exists in the record to support this assumption) any water added by USOS for dust control, or from precipitation will increase the moisture content. Furthermore, even assuming that the tailings are still slightly below their field capacity when they are moved from the storage piles to their ultimate disposal in the pits or dumps (again no data exists in the record to support this assumption), the only effect of the slightly lower initial moisture content would be in the increased time it would take for infiltrating precipitation to raise the moisture content to field capacity, at which time leachate would drain from the tailings. Seepage of water through the tailings in the dumps and pits will occur; it is just a matter of time.

Q. WHAT IS THE IMPORTANCE OR RELEVANCE OF THE NUMERICAL VALUES OF WATER CONTENT THAT USOS REPORTS FOR THE TAILINGS?

A. The actual moisture content of the tailings that are placed into the pits and dumps is only relevant with regard to how soon additional water from precipitation will percolate through the tailings. As I explained in my direct testimony, "water will infiltrate through the tailings regardless of the moisture content when they are placed in the pits or dumps. The only effect moisture content has on this process is how long it will take for water to reach the bottom of the pits or dumps. If the initial moisture content of the tailings is slightly below the field capacity, it will take longer for precipitation to percolate through them; conversely, if the initial moisture content of the tailings is at or above the field capacity, precipitation will percolate sooner."

Q. DID USOS COMMENT ON THE TAILINGS BEING "FREE DRAINING"

A. Bayer (pg. 6) states that water will not drain from the tailings. Bayer, however, confuses free draining (a soil property) with water draining from the tailings (a condition dependent on available water.) As I stated in my direct testimony, "free draining" is a property of the soil, and describes the capacity for water to drain through the soil easily. A soil can be free draining and not have water draining through it. Water will drain through a "free draining" soil if there is enough available water. Thus, regardless of the water content of the tailings while they are in the storage pile, or after they are placed in the dumps and pits, the tailings will have the capacity to drain and they are properly described as free draining. In fact, DWQ states that any water draining from the tailings while they are in the storage pile will be captured for recycling (Novak, pg. 12). This provides evidence that the tailings will have the capacity for water to drain easily, even after they pass through the belt and disk filters.

Q. WHAT IS THE RELEVANCE OF THE TAILINGS BEING FREE DRAINING?

A. It is significant for two reasons. First, it is critical to understanding how water will migrate through the tailings once they are placed in the dumps and pits, and ultimately for the evaluation of the impacts of the seepage water on ground water. Second, in its March 4, 2008 Determination, DWQ listed four factors relevant for determining whether the proposed operation will have a *de minimis* effect on ground water quality. The third factor stated that "processed tailings will not be free-draining…." This statement is in error and DWQ could only have reached this conclusion by ignoring all the available evidence presented in the Record that the tailings will drain easily, or because DWQ does not understand the difference between a free-draining material (one that has the capacity to drain freely), and one where all the water has drained to the point of being at or near field capacity. Just because the tailings will have been drained to close to their field capacity does not mean that they are not free draining. Furthermore, as I discussed above, any additional water will easily drain from them because they have the capacity for this to occur.

Q. WHAT DOES THE DEMONSTRATION STATE WITH REGARD TO THE POTENTIAL FOR SEEPAGE OF WATER THROUGH THE PITS AND DUMPS?

A. The Demonstration states that "[b]ecause of the low rainfall in the area, breakthrough of infiltrating precipitation to the base of the pit waste deposits is not anticipated to occur." (pg. 12)

Q. IN YOUR OPINION, IS THIS CORRECT?

A. Absolutely not. In my direct testimony, I explained in detail the reasons why this assumption by USOS is not supported by any data or analyses, and that it also directly conflicts with information in published reports and other information in the Record.

Q. DID USOS PROVIDE COMMENTS ON YOUR OPINION THAT SEEPAGE OF WATER THROUGH THE TAILINGS WILL OCCUR?

A. Bayer (pg. 6) claims that in my direct testimony I: 1) overlooked or disregarded the combined volume of tailings and overburden and their capacity to absorb excess water, and 2) ignored the effect of revegetation and resultant evapotranspiration in excess of precipitation. Bayer's claims are without basis. First, the volume of the tailings and overburden and their capacity to absorb excess water simply affects how long it will take for water to infiltrate through the tailings – a point I made clear in my direct testimony. Second, as I explained in my direct testimony (and supported by references to published literature and field evidence), excess precipitation is sufficient under current conditions to infiltrate into the subsurface and recharge ground water and thus is sufficient to seep through the tailings and backfill material.

Q. YOU STATED EARLIER IN YOUR TESTIMONY THAT DWQ'S ASSUMPTION THAT OPERATIONS WILL NOT GENERATE LEACHATE FROM THE TAILINGS IS UNSUPPORTED BY ANY ANALYSIS. WOULD YOU PLEASE EXPLAIN THIS?

A. USOS failed to conduct, and DWQ failed to require, an analysis of the seepage of water through the tailings in the dumps or pits. Without analysis, there is no basis for the assumption that the operations will not generate leachate from the tailings.

Q. ARE THERE ACCEPTED METHODS FOR CONDUCTING SUCH ANALYSES?

A. There are computer programs designed specifically to evaluate seepage of precipitation through material placed in landfills and dumps. One such program is the Hydrologic Evaluation of Landfill Performance (HELP) developed by the U.S. Army Corps of Engineers. HELP is a hydrologic model for conducting water balance analysis of landfills, cover systems, and other solid waste containment facilities. The model accepts weather, soil and design data, and uses solution techniques that account for the effects of surface storage, snowmelt, runoff, infiltration, evapotranspiration, vegetative growth, soil moisture storage, and leakage through soil.

Q. WHAT INFORMATION WOULD THE HELP PROGRAM PROVIDE?

A. The program would conduct water balance calculations through various layers and can be tailored to input material properties and thicknesses in order to be specific to varying designs. As such, HELP could be used to evaluate the seepage of water through various layers of material in the dumps and backfilled pits. Ultimately, the model provides a valuable result – the amount of water that seeps from the base of a dump or pit. As I described in my direct testimony, this is the seepage water that will come into contact with the underlying soils and/or bedrock. In fact, HELP could evaluate the seepage of water into these materials (inputs to the program) and, in the case of the dumps, determine whether the seepage water will infiltrate into the underlying geologic materials or will flow from the toe of the dumps and discharge to surface water.

Q. ARE YOU AWARE OF ANY RECENT GROUND WATER PERMIT APPLICATIONS SUBMITTED TO DWQ THAT EVALUATED SEEPAGE OF PRECIPITATION WITH THE HELP PROGRAM?

A. Yes, the Ground Water Permit Application submitted to DWQ by Red Leaf Resources on December 20, 2011 for its Southwest #1 Project contained an analysis of the infiltration and seepage of precipitation using the HELP program.

Q. WHERE IS THE RED LEAF SOUTHWEST #1 PROJECT?

A. It is an oil shale project located in the southern Uinta Basin approximately 15 miles north of the PR Spring project site.

Q. WOULD YOU SUMMARIZE THE RESULTS OF THE SEEPAGE ANALYSIS CONDUCTED FOR THE RED LEAF PROJECT USING THE HELP PROGRAM?

A. The results of the analysis indicated that excess precipitation would infiltrate through a 1-foot thick vegetated topsoil layer, a 2-foot thick overburden layer, and a 3-foot thick layer of a layer of bentonite amended soil with a permeability of $1x10^{-7}$ cm/sec.

Q. BASED ON THESE RESULTS, DO YOU HAVE AN OPINION ON THE SEEPAGE OF EXCESS PRECIPITATION AT THE PR SPRING PROJECT SITE?

A. The results indicate that in this area, there is enough excess precipitation to infiltrate through a layer of material that will have much less permeability than the tailings at the PR Spring project, and therefore, I conclude that there is sufficient excess precipitation to infiltrate through the tailings and into ground water.

Q. IN YOUR OPINION, SHOULD USOS HAVE EVALUATED THE SEEPAGE OF WATER THROUGH THE TAILINGS USING THE HELP PROGRAM?

A. Yes. This program is designed specifically to analyze this very question, and it has been used by engineers for this purpose in support of a ground water permit application submitted to DWQ. It is unclear why DWQ did not require the use of a generally accepted and commonly used methodology to evaluate seepage of water through the tailings at PR Spring. Furthermore, DWQ is aware that the results of the seepage analyses for a nearby project indicate that there is sufficient excess precipitation in this area for seepage to occur (acknowledging differences in the details of the two projects). I would expect DWQ to apply this knowledge and question USOS's assumption that seepage will not occur through the tailings at the PR Spring project and require USOS to conduct seepage analyses.

Q. DOES THIS CONCLUDE YOUR TESTIMONY FOR NOW?

A. Yes.

____________________________________

Elliott W. Lips
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# EXHIBIT A

# JBR MEMORANDUM DATED
JUNE 27, 2007

jbr environmental consultants, inc.
8160 South Highland Drive • Sandy, Utah 84093 [P] 801.943.4144 [F] 801.942.1852

# Memorandum

**To:** Barclay Cuthbert, Earth Energy Resources

**From:** Linda Matthews; authored by Ryan Clerico, JBR

**Date:** June 27, 2007

**Subject:** Water Right 49-1567 on Earth Energy Lease – Spring Investigation

JBR biologists Ryan Clerico and Marit Sawyer reviewed the area described in Karla Knoop's memorandum dated 24 April 2007 regarding water right 49-1567, for the purposes of documenting the presence, flow rate, and wetland area surrounding a potential spring and/or seep.

The area surrounding Earth Energy's test site, located in the southeast ¼ of Section 35, Township 15 South, Range 23 East (Salt Lake Base and Meridian) was thoroughly inspected for the presence of springs and/or seeps. Water right 49-1567 is located approximately 700 feet north and 2,200 west of the southeast corner of Section 35 (KK memo). At the time of inspection, on 16 May 2007, no spring and/or seep was observed in the area; however, geology and slopes (less than 10%) in the general vicinity of the spring appeared consistent with the potential for the development of groundwater expression. Slopes in the upper reaches of the basin were less then 8% (as determined from the USGS *PR Spring* 7.5-minute map and generally confirmed in the field). Vegetation within the upper basin consisted of serviceberry (*Amelanchier spp.*), oak (*Quercus spp.*), and mountain big sagebrush (*Artemisia tridentata)* shrubs, and a relatively substantial community of grasses and herbaceous growth. Soils were generally dry throughout the area, although the quantity and diversity of grasses and herbs suggest that either relatively shallow groundwater or slow infiltration rates make water available for vegetative growth. A number of elk tracks and droppings were observed throughout the area.

A drainage with a defined bed-and-bank section was observed descending the slope from the upper reaches of the basin immediately behind the Earth Energy test site. Sand and small cobbles were observed in the bed, and high water mark in the form of bank nicks suggests that this drainage experiences intermittent and/or ephemeral flow, primarily in the form of surface runoff. This drainage was followed downslope to a slightly steeper section (approximately 10%), and then into a significantly steeper section (greater than 20%). Within the steeper sections, the channel lost bed-and-bank definition due to rapid runoff rates. Two small seepage locations were observed at the base of rock outcrops within the drainage, although flow was immeasurably small and did not persist for more than a few feet. The approximate location of these seeps is 4369542 North/645193 East (UTM Zone 12 North, NAD 1983 Meters). The drainage was followed approximately two-thirds of the way "downstream" towards the confluence with Main Canyon, and no other seepages were observed.

It is possible that the spring/seep has dried up since the last field observation. Winter precipitation within the state of Utah has been substantially lower than that of years past, and the most recent precipitation recorded at the nearby Upper PR Canyon meteorological station was less than 0.10 inch on May 7, 2007 (University of Utah Department of Meteorology). At the time of inspection, a total of 13.6 inches of accumulated precipitation had been recorded for Water Year 2007 at the East Willow Creek SNOTEL station (NRCS). Seepage at the lower reaches of the drainage indicates that shallow groundwater is present in the area, and it is reasonable to assume that flow from a spring/seep may occur in the upper reaches of the basin during wetter periods of the year, or immediately following a precipitation event. However, there was no indication that flow, seepage, and/or ground saturation has occurred in the upper reach recently.

In regards to jurisdiction under the Section 404 of the Clean Water Act, it is unlikely that this spring/seep (and any wetlands surrounding it) would be considered jurisdictional. In accordance with guidance provided in the United States Environmental Protection Agency (EPA) and U.S. Army Corps of Engineers (USACE) joint memorandum *Clean Water Act Jurisdiction Following the U.S. Supreme Court's Decision in Rapanos v. United States & Carabell v. United States* dated 5 June 2007, the spring/seep, and any wetlands associated with it, would not likely be considered jurisdictional for two reasons. First, based on the guidance, the agencies will generally not assert jurisdiction over erosional features, such as small washes characterized by low volume, infrequent, or short duration flow. Second, the upper reach of the channel that was observed (a non-navigable tributary of Main Canyon that is not relatively permanent) lacks a significant nexus to navigable waters of the United States and/or a tie to interstate commerce. While a portion of the upper reach of the drainage contains a short defined bed-and-bank section, that definition is lost in the steeper, downstream section before reaching Main Canyon. Since the spring/seep could not be located, characteristics of vegetation, soils, and hydrology could not be fully evaluated; however, due the apparent ephemeral nature of the spring/seep, wetland characteristics may only be present during the wetter times of the year, or perhaps even only in wetter years. No wetlands were observed within or adjacent to any portions of the drainage.

According to the water right 49-1567 application, up to 4.5 gpm were requested for usage. There was no evidence, based on ground saturation, drainage channel morphology, and vegetative communities, that flow at or near 4.5 gpm is present at the project site, either perennially or ephemerally.

EXHIBIT B

PRICE AND MILLER, 1975

(TITLE PAGE AND EXCERPTS ONLY,
FULL REPORT IS IN BAYER, REFERENCE NO. 3)

STATE OF UTAH
DEPARTMENT OF NATURAL RESOURCES

Technical Publication No. 49

# HYDROLOGIC RECONNAISSANCE OF THE SOUTHERN UINTA BASIN, UTAH AND COLORADO

by

Don Price and Louise L. Miller
U.S. Geological Survey

Prepared by
the United State Geological Survey
in cooperation with
the Utah Department of Natural Resources
Division of Water Rights

1975

According to the hydrograph, water levels fluctuated seasonally during the period 1935-70, reflecting seasonal changes in ground-water storage with little overall change from year to year. During 1971, however, the water level in the well declined about 5 feet (1.5 m). Because there was no known significant increase in ground-water withdrawals in the area during that period, the decline must be attributed to a change in ground-water recharge. There probably has been a decrease in natural recharge owing to recent below normal precipitation in the area (fig. 4), and there may have been a decrease in recharge from irrigation. The unconsolidated deposits in this area apparently receive some recharge by seepage from canals and irrigated land. Probable changes in irrigation diversions and practices in the area may have caused a reduction of recharge from irrigation and resulting water-level decline in the well.

Local year-to-year declines of water levels in consolidated rocks in the northern Uinta Basin have been attributed to continued or increased ground-water withdrawals (Price and Arnow, 1974, p. C16). In the northern Uinta Basin availability of water for recharge is much greater than it is in the southern Uinta Basin. It seems reasonable, therefore, to conclude that any local large-scale withdrawals of ground water from consolidated rocks in the southern Uinta Basin would result in a depletion of storage and a decline of water levels.

## Discharge

Ground water is discharged from the southern Uinta Basin by seeps and springs, evapotranspiration, diffuse seepage to the Green, White, Duchesne, and Strawberry Rivers, and by wells. Some ground water may move to the northern Uinta Basin in deep, confined aquifers which dip northward into the northern Uinta Basin. Also, ground water might possibly move along fault and gilsonite-dike zones that cross into the northern Uinta Basin. However, no direct data exist to confirm such movement to the northern Uinta Basin. It is most probable, therefore, that ground water moving northward through the area (at least in the upper 100 feet or 30.5 m of saturated rock) discharges by diffuse seepage to the Strawberry, Duchesne, and White Rivers or their alluvial deposits.

*Seeps and springs*.--Discharge of ground water through individual seeps and springs in the southern Uinta Basin is estimated to be on the order of 4,500 acre-feet (5.6 $hm^3$) per year. Most of the springs and seeps are above the 7,000-foot (2,134 m) altitude and are concentrated mostly in the headwater areas of Avintaquin, Willow, and Bitter Creeks (pl. 1). However, a number of springs, including those with the largest yields, are at lower altitudes.

All springs known to have estimated or reported yields of more than 100 gal/min (6 l/s) and a representative sampling of springs with smaller yields are listed in table 12. Assuming that the recorded yields of the four large springs in table 12 approximate the annual average yield of those springs, then they would have a total annual discharge of about 1,300 gal/min (82 l/s) or about 2,100 acre-feet (2.6 $hm^3$) per year.

At least 270 springs are shown on the U.S. Geological Survey 7½' and 15' topographic quadrangle maps of the southern Uinta Basin. Field observations indicate that the maps show only about half of the springs and seeps actually in the mapped area. Therefore, it is estimated that there are at least 500 individual springs and seeps in the area. Of these 500 springs and seeps, several have reported yields of as much as 60 gal/min (3.8 l/s) (table 12), but most of the springs observed by the writers had yields of 0.5 to 5 gal/min (0.03 to 0.32 l/s). It is concluded from these observations that the average yield per spring is about 3 gal/min (0.19 l/s), and that total annual discharge from them averages about 1,500 gal/min (95 l/s) or about 2,400 acre-feet (3.0 $hm^3$) per year. This, plus the 2,100 acre-feet (3.0 $hm^3$) per year from the four large-yield springs, gives a total discharge from springs and seeps of about 4,500 acre-feet (5.6 $hm^3$) per year.

Some of the water from Stinking Springs, Camel Rocks Springs, and several springs observed by Thomas (1952, p. 23) in Desolation Canyon reaches the Strawberry and Green Rivers and leaves the area as streamflow. Essentially all the water discharged by the other seeps and springs in the southern Uinta Basin is consumed at or near the point of discharge.

*Evapotranspiration*.--A large volume of ground water is consumed annually by evapotranspiration in the southern Uinta Basin. Most of this water is consumed by greasewood, saltcedar, and saltgrass along the lower reaches of the perennial and larger intermittent streams. The plants are all phreatophytes (water-loving plants that thrive on ground water) that have a high salt tolerance. Under ideal growing conditions and 100 percent plant density, greasewood may consume 2 feet (0.6 m) or more of water annually, and saltcedar may consume as much as 9 feet (2.7 m) (Mower and Nace, 1957, p. 21, and Robinson, 1958, p. 75). The figure for greasewood probably is representative for the southern Uinta Basin, but the figure for saltcedar is somewhat high as it was obtained in a warmer climatic zone with a longer growing season.

As noted earlier, these plants are the dominant vegetation along the alluvial plains of the Green, White, and the lower Duchesne Rivers and the larger streams that head in the southern Uinta Basin. Estimated consumptive use of water in the southern Uinta Basin by these phreatophytes ranges from about 1.5 to 3.5 feet (0.5 to 1.1 m) and totals about 204,000 acre-feet (252 $hm^3$) per year (table 8). Although essentially all the water consumed by phreatophytes along the flood plains of the perennial streams (the first three groups in table 8) is ground water, much of this water is derived from streamflow induced into the adjacent alluvial aquifers by the pumping effect of the phreatophytes as shown in figure 9 and discussed on pages 24-25. Because this water simply passes through the aquifer to the plant roots at a relatively rapid rate, it has not been regarded as a source of ground-water recharge in this report, nor is it counted as ground-water discharge by evapotranspiration. However, some of the water consumed by phreatophytes is derived directly from the ground-water system (from alluvium that would be saturated even if the phreatophytes did not exist).

# EXHIBIT C

## EER LETTER TO LAYNE CHRISTENSEN
FEBRUARY 18, 2011

February 18, 2011

**Layne Christensen**
17800 E. 22nd Avenue.
Aurora, CO 80011

Attention: Brian Dellett, Account Manager

By e-mail to: BWDellett@laynechristensen.com

**Re: Spring/Summer 2011 Core Drilling Program - Request for Quotation**

Dear Mr. Dellett:

**Earth Energy Resources Inc. (EER)** is planning a spring/summer oil sand core drilling program on its PR Spring leases located on the East Tavaputs Plateau, approximately 70 miles south of Vernal Utah. Your company has been contacted and pre-qualified to carry out this work by our consultant geologist, Mr. Gerald (Jerry) Park, from Salt Lake City. If your company is interested in performing this work, please submit to the undersigned (via e-mailed pdf copies of your standard bid form) by the requested date and time, a comprehensive list of requested rates and prices on a footage contract basis for the work described below. EER will contact the company(s) with the most attractive proposal and and arrange a pre-award meeting where terms and conditions will be finalized, any outstanding questions answered and mobilization details tentatively arranged.

At this point in time, drill rig mobilization is planned for early May 2011 or shortly thereafter if roads and terrain have not dried sufficiently following the spring thaw. Drill pads and access trails will be prepared by a local oilfield construction contractor.

Scope of Work: (refer to attached 2001 Coring Program Map)

- Program: 145 HQ, air-drilled core holes in the Green River Formation (Douglas Creek Member)
    - 57 hole 400 ft. spaced program (over ~160 acre initial mine plan area)
    - 88 hole 40 acre spaced program (over ~4,000 acres)
- Depth: 220 - 300 ft.
- Core: 2.5 in. dia. recovered in standard 10 ft. core barrel

Geology:

- The Douglas Creek Member of the Green River Formation is comprised of sedimentary rocks including sandstone, siltstone, shale, mudstone, and limestone. The sandstone is cemented with bitumen and calcite; the rock is generally not hard, but tough, drills well, and is competent.
- Ground water if present is perched, or possibly connate; there are no aquifers present within the depth range we are working.
- Due to the oxidized nature of the bitumen, associated gas is not expected to be encountered.

Logistics:

- Location from Vernal, Utah: travel westerly on Highway 40, 13 mi. to junction State Highway 88; go south 18 mi. to Ouray; continue south on County road 2810 55 mi. to PR Spring/Earth Energy Resources Project area. The project area is also accessible from Interstate 70, 3.5 mi. west of the Utah-Colorado state line, or northeast of Harley Dome through Hay and San Arroyo canyons. This route is the shortest, however the climb for heavy equipment is rigorous and not feasible in wet or snowy weather. (Refer to attached Location Map)
- Closest hospital and helicopter service is Grand Junction, CO; Vernal, UT is a close second.
- Operations are centered around a room and board camp provided by EER. Accommodation for rig crews will be based on double occupancy rooms with shared washroom facilities.
- Work schedule: two rigs operating 24/7 with crew rotation on 10/4 work/rest cycle (other scheduling can be considered).
- Working distances from camp range from 1/8 mi. to 3.5 mi.
- Rig water provided in 400 bbl tanks at site by Owner. Air compressors available for rent in Vernal.
- Owner will provide site for Contractor's fuel dump, supplies and equipment.
- Drill sites, and access roads, level, rough-cut, preferably left with some roots and rock for ease of reclamation, provided by Owner.
- Utilities in the area are limited to a buried gas gathering pipeline and a number of producing gas wells. No drilling will take place close to the pipeline route or existing producing gas well sites.

Drilling Operations:

- Owner requires 90+% core recovery from initial core point to T.D. of hole at contact with formation underlying deepest oil sand bed. Owner's geologist will establish initial core point depth for all holes. Overburden depth ranges from zero(outcrop) to approximately 60 ft.
- Owner requires driller to record presence, depth and interval of any artesian or obvious water bearing formations.
- Gas is not expected to be encountered therefore a BoP or gas diverter/blooey line is not required as part of the rig equipment however a functioning gas detector must be in place at an appropriate location near the drill stem.
- Air, mist, and foam are preferred drilling fluids. Owner would like to minimize use of water for drilling as the haul distance from nearest surface source is prohibitive. However, high core recovery is paramount, and good fluid flow (air, mist or foam) is necessary. These alternative coring fluids have not been tested at this site. Recent air coring in somewhat similar rocks at another location significantly improved coring rates. Rock conditions should direct the fluid used and Contractor shall be prepared to drill with any of the above combinations, up to and including conventional water-based drilling mud if necessary.
- EER personnel will run an electric log with drill on hole and then driller will plug hole after logging is completed. This routine may be modified for practical reasons.
- Cuttings to be returned to hole, or buried and/or if water is present. Slurry to be captured in small, parallel backhoe pits provided (and closed) by Owner.



#950, 633 – 6th Avenue SW, Calgary, AB, T2P 2Y5 CANADA Office 403-233-9366 Fax 403-290-0045

Drilling Equipment & Material Costs:

- Contractor shall supply two fully equipped purpose-built coring rigs, crewed as specified (incl. crew truck), all drill pipe, casing, bits, collars, core barrel assemblies, and all other required tooling, all as part of the quoted "per foot drilled" cost.
- Contractor shall provide and quote hourly or day rates for single axle water trucks to support each drilling rig as required.
- Contractor shall supply and quote prices for consumable items including but limited to: mud, foam, LCM's, bentonite pellets, cardboard core boxes, etc.
- Quoted prices shall also include hourly rates for rig moves (when not drilling), stand-by rates for weather or Owner-caused delays, crew travel time, and lump sums for mobilization to and de-mobilization from the work site.

Safety and Insurance:

- Contractor shall state his Lost Time Accident and Recordable Injury frequency rates in his proposal for the current year and previous 3 years.
- Contactor shall include copy of his Safety Policy Statement with proposal submission. Copy of full safety program to be provided by successful bidder at time of contract award.
- Contractor to have all insurance coverages in place that are required by Owner. Contactor shall list insurance coverages currently in force or coverage that is proposed to be in force during period work is performed.

Due date/time for receipt of proposals is:  Noon, March 7, 2011.

Should you require further clarification or have any questions concerning this work, please do not hesitate to contact the undersigned in Calgary at O: 403-233-9366 X2, C: 403-473-8995 or by e-mail at: tim.wall@earthenergyresources.com .  You may also contact Mr. Jerry Park in Salt Lake City  at O: 801-733-7079, C: 801-699-8332 or by e-mail at:  parkgeol@sisna.com.  Thank you for your proposal.

Yours very truly,
Earth Energy Resources Inc.

T.J.(Tim) Wall
Vice President, Engineering

/attach.

# EXHIBIT D

## HOLMES AND KIMBALL, 1987

(TITLE PAGE AND EXCERPTS ONLY,
FULL REPORT IS IN BAYER, REFERENCE NO. 8)

# Ground Water in the Southeastern Uinta Basin, Utah and Colorado

*By* Walter F. Holmes *and* Briant A. Kimball

U.S. GEOLOGICAL SURVEY WATER-SUPPLY PAPER 2248

DEPARTMENT OF THE INTERIOR
DONALD PAUL HODEL, Secretary

U.S. GEOLOGICAL SURVEY
Dallas L. Peck, Director

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GB1027.U38H64 1985 553.7'9'09792 86-600366

**Table 9.** Summary of mass-transfer model of the bird's-nest aquifer
[Mean concentrations, in millimoles per liter unless noted; meq/L = milliequivalents per liter; log atm = log atmospheres]

| Constituent | Northeast (20 samples) | White River, 09306500 (365 samples) | Mixed solution Ratio 0.46-0.54 (White River: bird's-nest aquifer) | Southwest | |
|---|---|---|---|---|---|
| | | | | Analyzed (13 samples) | Calculated |
| Calcium | 3.960 | 1.764 | 2.774 | 0.207 | 0.204 |
| Magnesium | 7.499 | 1.065 | 4.025 | .584 | .558 |
| Sodium | 41.473 | 2.841 | 20.612 | 21.175 | 20.173 |
| Chloride | 1.961 | 1.080 | 1.485 | 1.495 | 1.495 |
| Alkalinity (meq/L) | 9.549 | 3.770 | 6.428 | 13.508 | 13.216 |
| Sulfur (total) | 26.914 | 1.861 | 13.385 | 3.935 | 3.785 |
| pH (log units) | [1]7.67 | [1]8.16 | [1]8.17 | [1]8.74 | [1]8.74 |
| PE (log units)[2] | 7.593 | 8.357 | 8.357 | 5.77 | — |
| Calcite saturation[3] | .492 | .592 | .819 | .688 | — |
| Dolomite saturation[3] | 1.274 | .867 | 1.742 | 1.819 | — |
| Carbon dioxide (log atm.) | −2.0617 | −2.902 | −2.702 | −2.932 | — |
| | | | | | Mass transfer[4] |
| Sodium-magnesium ion exchange | | | | | + .045 |
| Calcite | | | | | + .851 |
| Dolomite | | | | | −3.421 |
| Carbon dioxide | | | | | −5.221 |
| Hematite | | | | | +2.400 |
| Pyrite | | | | | −4.800 |

[1]Geometric mean.
[2]PE equals negative logarithm of the "electron" activity. See Stumm and Morgan (1981, Chapter 7).
[3]Represented as logarithm of the ion activity product divided by the equilibrium constant for each particular mineral. The ion activity products were calculated by PHREEQE (Parkhurst, Thorstenson, and Plummer, 1980).
[4]Mass transfer is the millimoles of each mineral dissolved (positive value) or precipitated (negative value).

from the carbonate minerals of the Green River Formation as described by Desborough and Pitman(1974) also could have been the source. Because no large increase in dissolved iron was observed in the water, pyrite ($FeS_2$) was assumed to be a sink for the iron and the reduced sulfur.

This combination of reactions brought about an increase in pH and alkalinity. The change can be seen in the plot of alkalinity versus sulfate in figure 18. The calculated reaction path is indicated, and it generally agrees with the observed data. The change in pH also can be compared with a decrease in chloride in figure 19. Part of the pH change is due to the mixing of river water with the aquifer water, but apparently a carbonate-clay buffer increases the pH, as in the alluvial aquifer.

The depletion of calcium and magnesium results from precipitation of calcite and dolomite and the exchange with sodium from the clay minerals. It is not clear if dolomite is actually being precipitated in the aquifer or if magnesium is merely controlled by precipitation of a high magnesium calcite or by sorption to clays. These reactions decrease the non-carbonate hardness (table 5). Because silica does not show a large variation, it was assumed that it is controlled in solution by sorption reactions on active surfaces of clays and quartz.

Because of the number of components and phases in this model, the solution composition is determined by fixing only one of the parameters, the partial pressure of carbon dioxide. Thus, in a sence, a solution to the mass transfer is forced on the model, and the results represent only one of several possible solutions. The validity of the model is determined in part by the geochemical intuition used in selecting the reactions.

## Douglas Creek Aquifer

The Douglas Creek aquifer was identified in six test holes drilled during 1975–78 (Holmes, 1980). The aquifer underlies almost the entire southeastern Uinta Basin and may extend beyond the boundaries of the study area to the north and west. The aquifer crops out in the southern part of the study area at high altitudes, along the eastern border of the study area near the Utah-Colorado State line, along the western border of the study area in Desolation Canyon, and in the bottoms of deeply incised canyons in the central part of the study area.

The Douglas Creek aquifer consists of beds of sandstone and limestone of the Douglas Creek Member of the Green River Formation and some intertonguing sandstone of the Renegade Tongue of the Wasatch Formation. The top of the

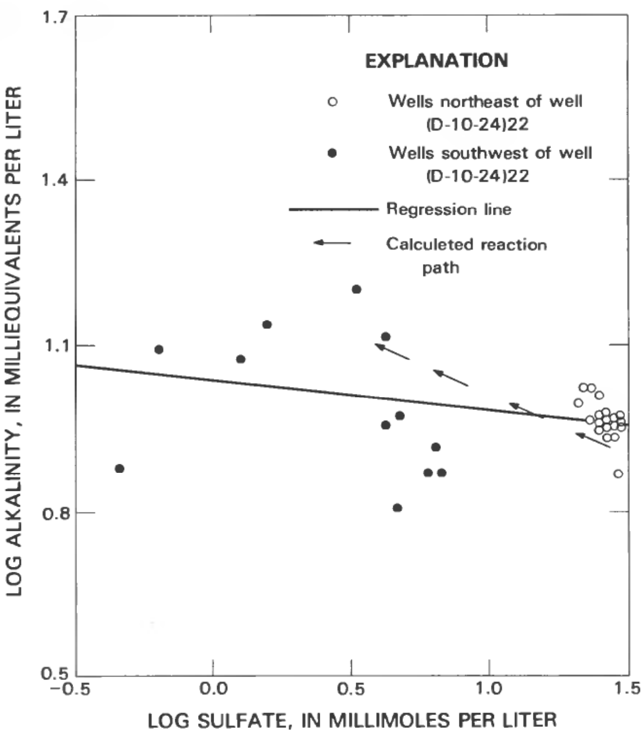


**Figure 18.** Plot of alkalinity versus sulfate in water from the bird's-nest aquifer showing the reaction path calculated by the mass-transfer model.

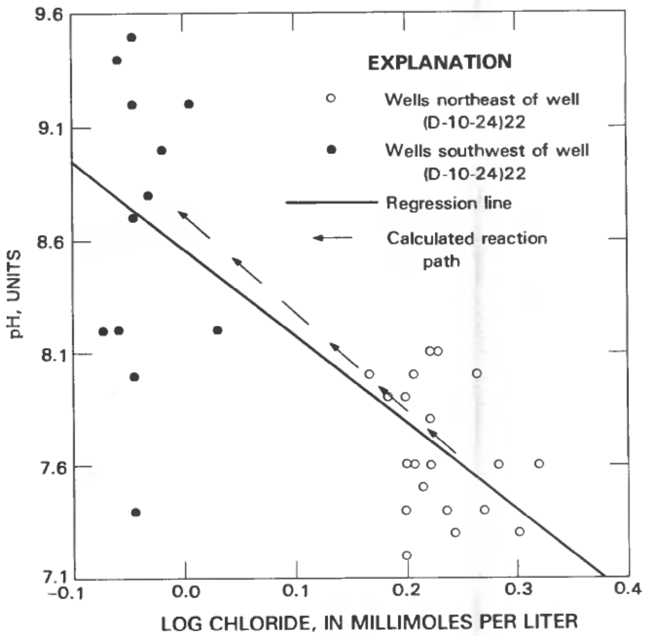


**Figure 19.** Plot of pH versus chloride in the bird's-nest aquifer showing the reaction path calculated by the mass-transfer model.

aquifer normally is just below the lowest sequence of the fine-grained beds in the upper part of the Douglas Creek Member or the lower part of the Parachute Creek Member of the Green River Formation. The aquifer generally is about 500 feet thick, but it may be thicker than 1,000 feet in the center of the basin. Water levels in the aquifer vary from a few feet below land surface in the bottom of deeply incised canyons in the southern part of the study area, to more than 100 feet above land surface in the central and northern parts of the study area.

The results of aquifer tests of the Douglas Creek aquifer show a range in transmissivity from 16 to 170 feet squared per day and an estimated range in the storage coefficient from about $7X10^{-4}$ to $2.5X10^{-4}$ (Holmes, 1980, p. 1). Permeability is primarily intergranular; although locally, fracturing may increase the permeability and enhance transmissivity. The aquifer is under water-table conditions where it crops out in the southern part of the study area and under artesian conditions in the central and northern parts. Maximum yields to individual wells completed in the Douglas Creek aquifer are estimated to be less than 500 gallons per minute.

Recharge to the Douglas Creek aquifer in the southeastern Uinta Basin originates from precipitation on the outcrop area and from infiltration from streams through alluvial deposits crossing the outcrop area. Leakage from underlying rocks of the Wasatch Formation or from the overlying Parachute Creek Member of the Green River Formation probably is insignificant.

Discharge from the Douglas Creek aquifer is primarily from springs in the outcrop area of the aquifer and discharge to the White and Green Rivers and their major tributaries and associated alluvial aquifers. Some wells discharge small quantities of water from the aquifer in the central part of the study area.

A summary of the ground-water budget for the Douglas Creek aquifer is presented in table 10.

## Recharge

Recharge to the Douglas Creek aquifer is from precipitation and infiltration from streams.

### Precipitation

Recharge from precipitation on the outcrop of the Douglas Creek aquifer is estimated to average 18,500 acre-feet per year. The recharge occurs at high altitudes in the southern part of the study area where the Douglas Creek aquifer crops out or is near the surface. Precipitation in the outcrop area ranges from 14 to 20 inches per year (Waltemeyer, 1982, pl. 1).

Estimates of recharge from precipitation are based on base flow during December through February as measured at continuous-record gaging stations, partial-record sites, or miscellaneous-measurement sites (fig. 2) located downstream from the outcrop of the aquifer. Measurement of base flow at these sites during December through February represent average discharge from the aquifer during a long time. If it is assumed that all the recharge is discharged by springs in the canyon bottoms and that the aquifer is in steady-state conditions, then the measured discharge in the canyon bottoms must equal the recharge.

**Table 10.** Summary of ground-water budget for the Douglas Creek aquifer

| Component | Long-term average (acre-feet per year) |
|---|---|
| Recharge: | |
| Precipitation | 18,500 |
| Infiltration from streams | 920 |
| Total | 19,420 |
| Discharge: | |
| Springs in the outcrop area of the aquifer | 18,500 |
| White and Green Rivers and major tributaries and associated alluvial aquifers | 920 |
| Wells | 250 |
| Total | 19,670 |

#### Infiltration from streams

Recharge to the Douglas Creek aquifer from stream infiltration was estimated from a digital-computer model to be 920 acre-feet per year. The recharge occurs along major tributaries of the White and Green Rivers in the central and southern parts of the study area where the aquifer is at or near the surface. Streamflow infiltrates the Douglas Creek aquifer after passing through thick alluvial deposits. In the central and northern parts of the study area, the aquifer is overlain by the relatively impermeable marlstone, siltstone, and oil-shale beds of the Parachute Creek Member, which prevent recharge.

### Movement

Water in the Douglas Creek aquifer generally moves from recharge areas at high altitudes in the southeastern part of the study area north or northwest toward discharge areas along the Green and White Rivers and perhaps to other more distant discharge areas. In the southern part of the study area where the aquifer is incised by deep, narrow canyons, some ground water probably moves toward discharge points at numerous springs in the canyon bottoms.

### Storage

The amount of recoverable water stored in the Douglas Creek aquifer is estimated to be 16 million acre-feet. The estimate is based upon an areal extent of 2,500 square miles, an average thickness of 500 feet, and an average specific yield of 0.02.

Water-level measurements from the six test holes indicate that water-level fluctuations are less than 10 feet per year. The fluctuations probably are due to seasonal variations in the balance between recharge and discharge.

### Discharge

Ground water in the Douglas Creek aquifer is discharged by springs in the outcrop area of the aquifer, seepage to the White and Green Rivers and major tributaries, and wells.

#### Springs in the Outcrop Area of the Aquifer

Discharge from the Douglas Creek aquifer through springs in the southern part of the study area is estimated to be 18,500 acre-feet per year.

#### Seepage to the White and Green Rivers and Major Tributaries

Discharge from the Douglas Creek aquifer to the White and Green Rivers and to major tributaries is estimated from a digital-computer model to be 920 acre-feet per year. The discharge occurs in the central, northern, and western parts of the study area where the potentiometric surface of the aquifer is above the bottoms of the canyons.

#### Wells

Discharge from the Douglas Creek aquifer through wells is estimated to be 250 acre-feet per year. Most discharge is from producing or abandoned gas wells in the central part of the study area where artesian pressure causes water to flow at the land surface. Discharge from these wells range from about 1 to 35 gallons per minute. Well (D–14–22) 2aaa–1 (pl. 1), provides water for domestic use at the Geokinetics Inc. operation (fig. 1).

### Digital-Computer Model of the Flow System

#### Design

A simulation of an artesian aquifer with leaky streambeds was used to model part of the flow system in the Douglas Creek aquifer. The aquifer boundaries, grid size, and leakage nodes used in the model are shown in figure 20.

The aquifer is under water-table conditions south of the area modeled, but that part of the aquifer was not included in the model because of insufficient data. The southern extent of the model is at the approximate outcrop of the aquifer in the bottoms of the major drainages. The effects on the simulated results on setting the boundary at these locations should be minimal.

CERTIFICATE OF SERVICE

The undersigned hereby certifies that on this 16thth day of March, 2012, a true and correct copy of the foregoing Pre-Filed Supplemental Testimony of Mr. Lips and Dr.Johnson was served via e-mail, as follows:

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