Introduction

Figure 1 is a general location map. The only substantive difference between the current process and previous processes is that no solvent will be used other than hot water. No potential ground water contaminants will be introduced during processing or be present in the tailings. Sand tailings will be approximately 23 percent water by volume coming out of the plant. They will drain down to 5 to 7 percent water on the conveyors between the plant and where they will be deposited with the drained water collected in sumps on the conveyors and recycled back into the process.

Ultimately the tailings will include the sand tailings, solids from the water treatment plant, and fines tailings; the composition of these combined tailings will be as follows:

- Approximately 10 percent water
- Approximately 10 percent clay
- Approximately 0.5 percent bitumen
- Approximately 80 percent sand, and
- 5-10 grams of flocculent per metric ton of solids.

NaOH will be used to control pH, if needed, with a target pH of 6.5-8.0 S.U. Initially tailings will be placed in a lined repository. Once a groundwater permit or permit-by-rule has been obtained tailings and overburden will be returned to the mine, as they have been in the past.

Although the surface topography dips to the east toward Ashley Valley, subsurface strata dip to the south southwest (Blackett 1996), away from the Ashley Valley and toward Asphalt Ridge. This is confirmed by previous mining at CAR (personal communication, Jim Lekas, Site Manager, Crown Asphalt Ridge, March 26, 2012). In addition, a northwest to southeast trending fault along the eastern edge of the CAR property marks the eastern boundary of bitumen impregnation (Blackett 1996; Norwest 2012). This strongly suggests that the aquifer immediately below the CAR site is bounded by the fault on the east and flows to the south southwest away from the Ashley Valley. Please see the geology and hydrogeology sections below for additional detail.

Figure 2 shows the location of the three wells installed by Detroit Edison in 2005; the wells have not been field surveyed, however, MW-3 is at the highest surface elevation and MW-1 is at the lowest. Table 1 shows total well depth and depth to water as of the August 4, 2008, water sampling event. Table 2 provides analytical results to date as well as Utah Tier 1 standards for ground water; available lab reports are attached as Appendix A. As would be expected given the oil sands geology, detectable hydrocarbons exceeding the Tier 1 standards were in the heavier fractions (i.e., TPH-DRO, Oil & Grease). TDS ranges from 3,700 mg/L to 6,000 mg/L, as expected, given the marine origins of the geology (Blackett 1996). MW-3 has shown traces of anionic surfactant since at least 2008, but none has been found in the other wells.

Figure 2 also shows the seep that enters the mine through a steep bank. The seep gravity feeds through a series of ditches and culverts to an unlined pond at the lowest level of the mine. The water is distinctly orange in color which may be a sign of iron or other minerals.

Figure 3 is a process flow diagram for the CAR process, with an emphasis on water. Any excess water in the process system would be stored in the water treatment which has a 60-foot diameter thickener tank and a 40-foot diameter clarifier tank.

Table 1 Well Parameters During 2008 Sample Event

Well ID	Total Well Depth (feet)	Depth to Water (feet)
MW-1	20.4	flowing
MW-2	31.6	Dry
MW-3	40.6	2.2

Figure 1 Location Map

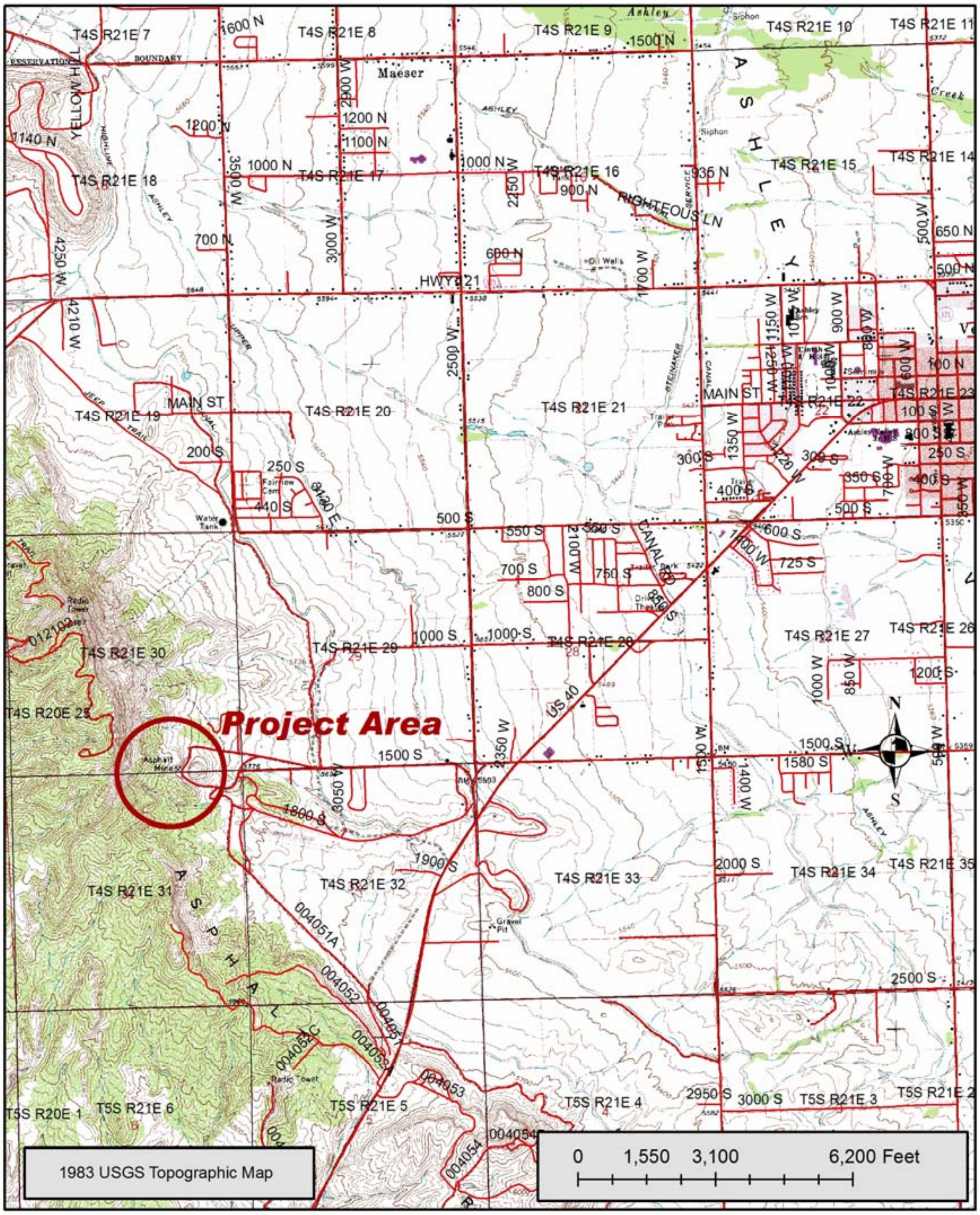


Table 2 Analytical Results from Monitoring Wells 2005-2012

	Benzene	Toluene	E-Benzene	Xylenes	Naphthalene	TPH-GRO	TPH-DRO	Oil & Grease	RCRA Lead	TDS	TRPH	Semi-vols	Volatiles	Field pH	Lab pH	Hexane
Utah Tier 1 (2008) (mg/L)	0.30	3	4	10	0.7	10	10	10	0.015		10					
	All Parameters Except pH Reported in mg/L															
MW-1																
5/1/2005	Not Sampled															
8/4/2008	<0.0010	<0.0020	<0.0020	<0.0020	<0.0020	<10	**21**	**19**		**6,000**	**5.1**	<0.010	ND'''	4.13	3.24	<0.002
9/15/2009	<0.002	<0.002	<0.002	<0.002	<0.010	<0.020	**7.5**	**3.8**		**5,200**	<3.0	ND''	ND*		3.8	<0.002
2/29/2012	<0.002	<0.002	<0.002	<0.002	<0.002	<0.020	**27.0**	**15.1**		**3,960**	**7.56**	<0.010	ND***		3.89	<0.002
MW-2																
5/1/2005	ND**	ND**	ND**	ND**	ND**	ND**	ND**	**5.7**	**0.17**							
8/4/2008	Well Dry															
9/15/2009	Well Dry															
2/29/2012	Well Dry															
MW-3																
5/1/2005	**0.003**	**0.008**	**0.006**	**0.055**	**0.048**	**0.6**	**4.5**	**32**	ND							
8/4/2008	<0.0010	<0.0020	<0.0020	<0.0020	<0.0020		**5.3**	**12**		**4,300**	<3.0	<0.010	ND'''	6.39	6.59	<0.002
9/15/2009	<0.020	<0.020	<0.020	<0.020	<0.040'	<0.20	**4.5**	**16**		**3,700**	<3.0	ND'	ND****		6.71	<0.02'''
2/29/2012	<0.020	<0.020	<0.020	<0.020	<0.020	<0.20	**3.39**	**5.89**		**3,700**	**4.39**	<0.010	ND****		6.49	<0.02'''
	* Method detection limit (MDL) varies by parameter between 0.002 mg/L and 0.010 mg/L															
	** Lab report not available															
	*** All parameters below MDL EXCEPT Cyclohexane, which was 0.00427 mg/L															
	**** MDL varies by parameter between 0.020 mg/L and 0.10 mg/L; higher MDLs were due to sample dilution factor of 10															
	' MDL varies by parameter between 0.040 mg/L and 0.081 mg/L; higher MDLs were due to sample dilution factor of 4															
	'' MDL varies by parameter between 0.010 mg/L and 0.020 mg/L; concentrations for all parameters were less than the MDL															
	''' MDL varies by parameter between 0.020 mg/L and 0.20 mg/L; higher MDLs were due to sample dilution factor of 20															

Legend

Monitoring Wells

N

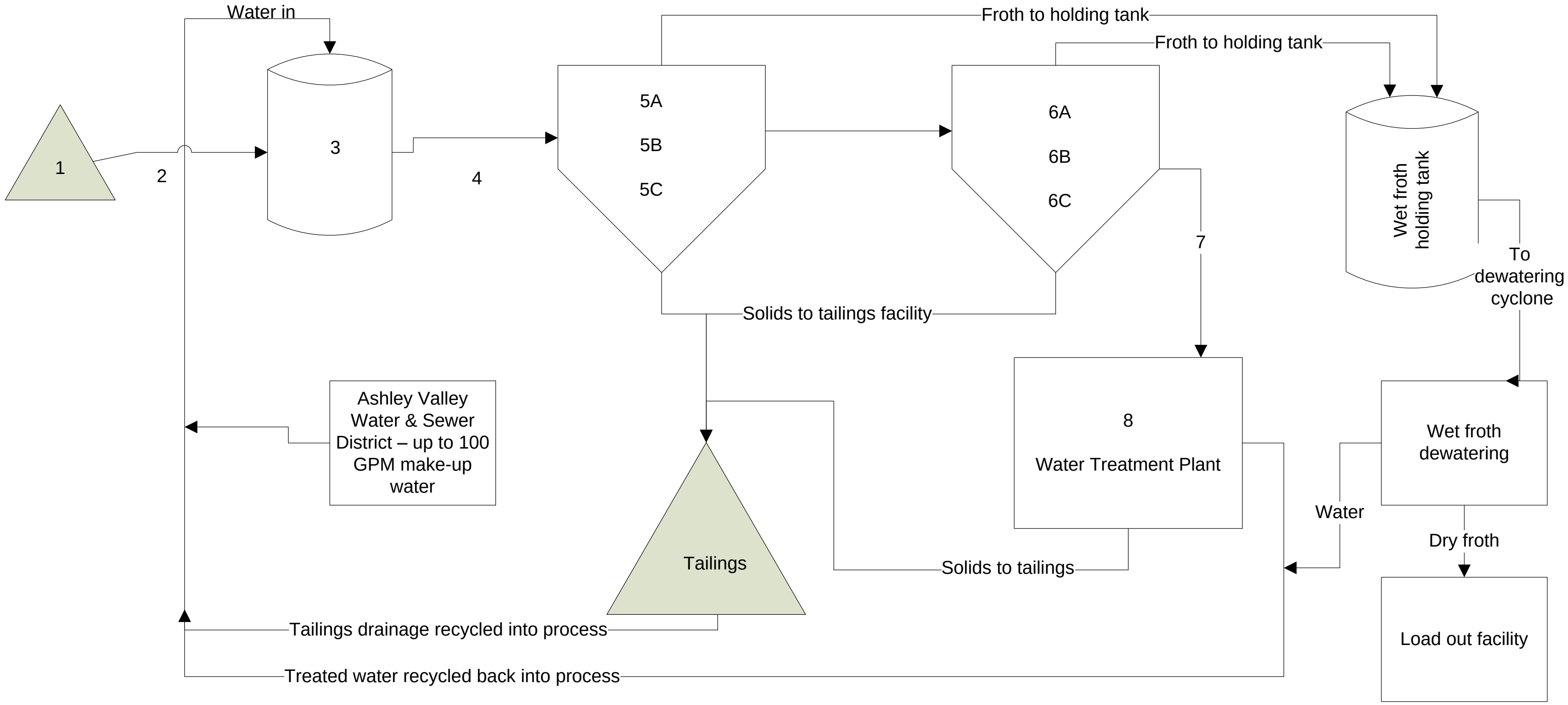
0 187.5 375 750 Feet

CROWN ASPHALT RIDGE

Figure 2
Ground Water Seepage Collection Area

JBR

DRAWN BY	DATE DRAWN
JS	03/27/2012
SCALE	1:3,500



1. Ore stockpile
2. Crushers – conveyor to conditioning tank
3. Conditioning tank – hot water added and sands further broken down
4. Slurry to Primary Separation Tank
5. Primary Separation Tank
    - 5A. Wet froth – 60% bitumen, 15%clay, 25% water
    - 5B. Middlings – to Secondary Separation Tank
    - 5C. Sand – to tailings facility
6. Secondary Separation Tank
    - 6A. Wet froth – to wet froth holding tank
    - 6B. Middlings – dirty water to water treatment plant
    - 6C. Sand and fines – to tailings facility
7. Middlings to water treatment plant
8. Water treatment plant – flocculent and NaOH added
    - Clarified water recycled back into process
    - Solids to tailings facility

Sand tailings are ~23% water on the conveyor out. They dewater to ~15% water, the excess collected and recycled to the process. Tailings further dewater in the mine to ~5-7% water, the excess again collected and recycled to the process.

Ultimate composition of tailings, including solids from the Secondary Separation Tank and the water treatment plant, is ~10% water; ~10% clay; ~0.5% bitumen; ~80% sand; and 5-10 grams of flocculent per metric ton of solids. Target pH is 6.5-8.0.

Wet froth is dewatered in a centrifuge or settling tank to dry froth and water. Water is recycled back into the process and dry froth is sent to a holding tank for load out.

Figure 3
Crown Asphalt Ridge
Process Flow Diagram

Attachments to the CAR Ground Water Discharge Permit Application

Part A, Item 7

The process is described in the Introduction. The product is a dry froth consisting of bitumen and fines which is used as an amendment to asphalt. The raw material is oil sands.

Part A, Item 9

See Figure 4, Water wells within one mile. This shows all water wells in the Utah state database that are within one mile of CAR Tract A (DWR 2012), including the in-mine monitoring wells. There are no oil or gas wells within the one-mile buffer area. Table 3 shows the water right number, well status, priority date, beneficial uses, flow rate and annual volume (usage) for the wells. Table 4 shows the wells for which well logs are available from the state database (DWR 2012); included is well depth, static water level, and other pertinent information. The well logs are in Appendix B.

Figure 4 shows the USGS topographic map over an aerial photograph. Topography includes the northwest to southeast trending Asphalt Ridge, and the landscape sloping down on both sides of the ridge. The aerial photo shows all man-made structures.

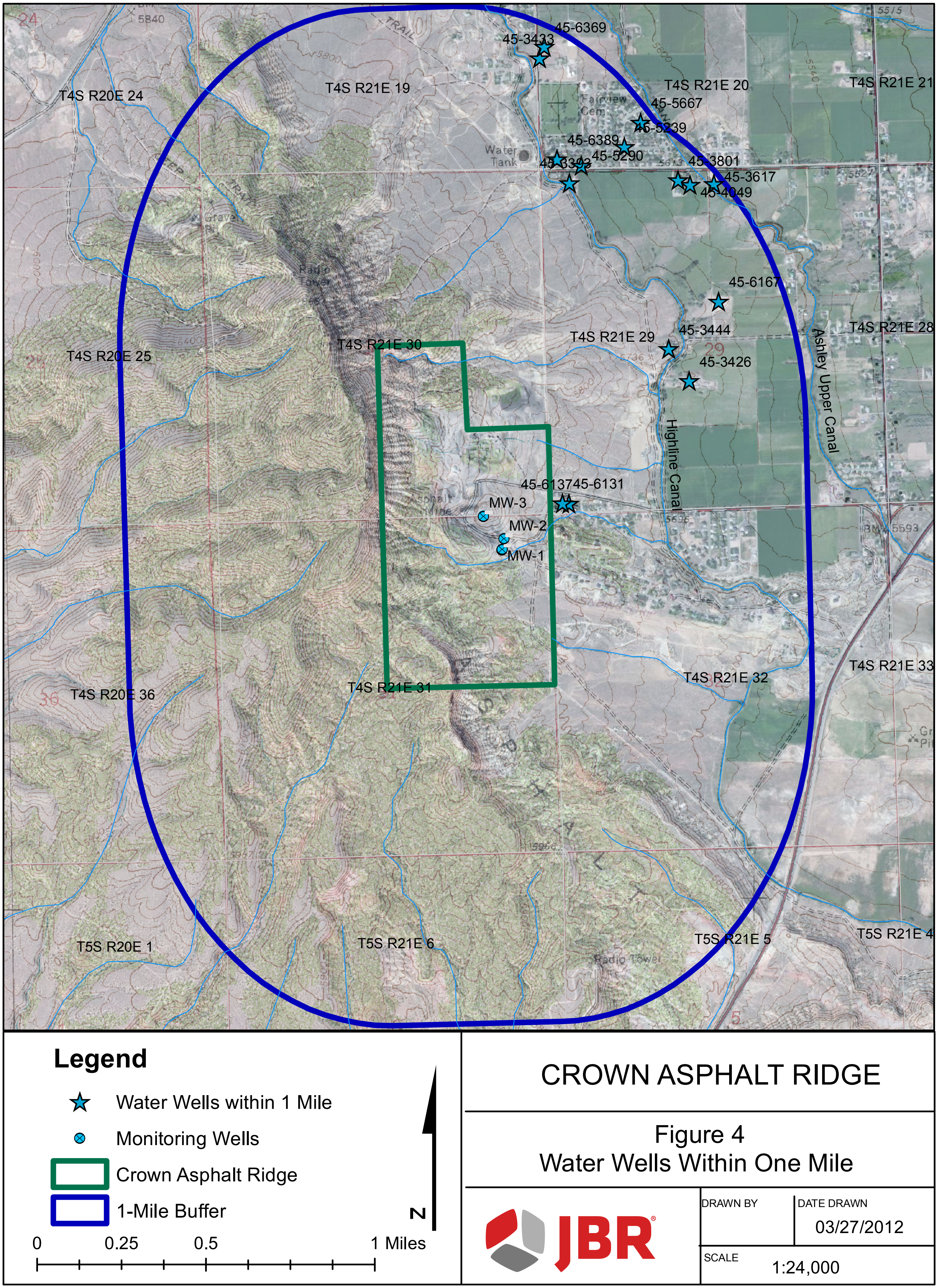
Table 3 Water Wells Within One Mile of CAR Tract A

Water Right No.	Status[1]	Priority Date	Uses[2]	Flow (cfs)	Volume (ac-ft)	Location	Well Log
45-6137	T	20051021	I	0.000	1.333	N170 E310 SW 29 4S 21E SL	√
45-6131	T	20050819	I	0.000	1.332	N180 E210 SW 29 4S 21E SL	
45-3426	T	19720313	DIS	0.015	0.000	N2000 W450 S4 29 4S 21E SL	√
45-3444	P	19720725	IS	0.015	0.000	N2500 W770 S4 29 4S 21E SL	√
45-6167	T	20061113	I	0.000	4.000	S2070 E160 N4 29 4S 21E SL	
45-4049	T	19770609	IS	0.015	0.000	S248 W285 N4 29 4S 21E SL	
45-3617	P	1934	IS	0.100	0.000	S235 E90 N4 29 4S 21E SL	
45-3393	T	19690623	DIS	0.015	0.000	S200 E475 NW 29 4S 21E SL	
45-3801	P	19770411	IS	0.015	0.000	S175 W470 N4 29 4S 21E SL	√
45-5290	T	19870722	DI	0.015	0.000	N70 E665 SW 20 4S 21E SL	
45-6389	A	20090604	I	0.000	1.000	N170 E285 SW 20 4S 21E SL	
45-5239	T	19860415	I	0.015	0.000	N365 E1335 SW 20 4S 21E SL	
45-5667	T	19960307	I	0.000	4.000	N730 W1060 S4 20 4S 21E SL	√
45-3433	T	19720424	IS	0.500	0.000	S950 E50 W4 20 4S 21E SL	
45-6369	A	20080828	I	0.000	3.000	S770 E125 W4 20 4S 21E SL	√

[1] A=approved; T=terminated; P=perfected

[2] I=irrigation; D=domestic; S=stock

Source: DWR Database



CROWN ASPHALT RIDGE

Figure 4
Water Wells Within One Mile

JBR

DRAWN BY	DATE DRAWN
	03/27/2012
SCALE	1:24,000

Table 4 Well Logs within or near One Mile of CAR Tract A

Water Right Number	T-R-S	Quarter Section	Direction Relative to Mine	Year Drilled	Depth of Well (ft BGS)	Static Water Level (ft BGS)
45-5022	4-21-29	NE	NE	1982	30	10
	4-21-29	SE	NE	1988	42	14
	4-21-29	NE	NE	1994	34	8
45-3860	4-21-29	NW	NE	1977	40	9
45-3801	4-21-29	NE	NE	1977	90	22
45-5305	4-21-29	SE	NE	1988	42	14
45-3676	4-21-29	NE	NE	1976	50	15
45-3426	4-21-29	SE	NE	1972	140	dry
45-3444	4-21-29	SE	NE	1973	70	dry
45-3444	4-21-29	SE	NE	1977	113	40
45-5667	4-21-20	SW	NE	1996	32	17
45-6369	4-21-20	SW	NE	2012	400	dry
45-5656	4-21-29	NE	NE	1994	34	8
45-6137	4-21-29	SW	NE	2007	192	dry

Source: DWR Well Log Databases

The two wells closest to the CAR site on Figure 3 are for water rights 45-6131 and 45-6137; the later of these (45-6137) was drilled to 192 feet and abandoned as dry. There is no well log for the earlier well (45-6131), but judging by the fact that the water right was terminated, and the second well is located only 100 feet away, it can be inferred that this well was also unsuccessful.

The nearest mapped spring or seep is 3.6 miles north northwest of the northwest corner of Tract A (USGS 2012). There are no Drinking Water Protection Zones or well-head protection areas in the state database for Uinta County (Utah DDW 2012). The nearest perennial stream is a section of Ashley Creek, 3.9 miles north northeast of the northeast corner of Tract A; the Green River is 10 miles south of the southern boundary of Tract A (USGS 2012).

Part B Item 3

Berms have prevented run-on into the pit since the area was first disturbed. This ground water seep shown on Figure 2 meets the requirements of R317-6-6.2-A6 for permit-by-rule: ”natural ground water seeping or flowing into conventional mine workings which re-enters the ground by natural gravity flow prior to pumping or transporting out of the mine and without being used in any mining or metallurgical process". The sump area will be bermed to ensure that no storm water or water from other sources (i.e., process water) will comingle with the intercepted ground water. The water will either evaporate or infiltrate via gravity flow; none of the water will be pumped or transported out of the mine.

Discharge from the seep is too small to measure and is expected to yield 1 gpm or less over time. One gpm is 1,440 gallons per day of 1.6 acre-feet.

Part B Item 4

The only potential discharges to groundwater would be draindown from tailings or leachate from precipitation through tailings. Composition of the tailings is given in the Introduction. No contaminants of solvents other than water will be used in processing the oil sand. CAR will recover draindown to the extent possible to recycle back into the process, as described in the Introduction.

No water quality analyses have been performed on tailings from this process, which has not been tried. CAR intends to run analyses of tailings samples once the process has been reasonably optimized. Results of these analyses will be provided to DWQ.

For the pilot runs CAR will process approximately 70 tons of oil sands per hour, 24 hours per day for 30 days to debug and optimize the wet froth process, and 133 tons per hour, 24 hours per day for 30 days to debug and optimize the dry froth process. Production thereafter would process 133 tons per hour. Mining at CAR is restricted by its Uintah County Conditional Use Permit to a 16-hour work day to minimize impacts to the residential neighborhood to the southeast.

Tailings are expected to have a bulk density of 125 pounds/ft^3 with 25 percent pore space. Since the clean, dry tailings will be mixed with overburden when returned to the mine pit, their combined bulk density may be slightly different. However, in mixing the tailings (at approximately field capacity of 10 percent moisture) with dry overburden, the overall percentage of water returned to the mine will be reduced substantially. Since the average annual rainfall in Vernal is 8.3 inches and average annual pan evaporation is 39.75 inches, it is unlikely that substantial quantities of precipitation will leach through the combined tailings and overburden and into groundwater (WRCC 2012).

Part B Item 5

See previous response.

Part B Item 7

Based on the expected composition of the tailings, as given in the Introduction, the only addition to the oil sands ore will be 5-10 grams of flocculent per metric ton of solids, which would likely be undetectable in the tailings. If the residual bitumen were considered a waste product, the bitumen remaining in the tailings following hot water treatment would be the least mobile components of bitumen, having already been subjected to full saturation of hot water, with agitation. These components would most likely be in the oil and grease mobility range or the total petroleum hydrocarbon diesel range (TPH-DRO). To pursue this, we include an analysis from an oil sands project that used an organic solvent in its process. While the end result for processed tailings cannot be considered characteristic of a non-organic solvent process residual, and holding times for the samples were outside the method requirement, it nevertheless is informative about the organic components of unprocessed oil sands and what components are least mobile in the ore.

In 2007, oil sands samples were obtained from Asphalt Ridge. One of the tar sands samples was analyzed in its raw state, and one was processed at Earth Energy's pilot-scale plant in Grande Prairie, Alberta prior to analysis; the produced sands and fines were analyzed separately because they were generated as two separate waste streams. Results of analyses are provided in Table 5 and the discussion that follows.

Table 5 Asphalt Ridge Tar Sands Analytical Summary

ANALYTICAL PARAMETER (UNITS)	UNPROCESSED TAR SAND	PROCESSED SAND	PROCESSED FINES
Total Petroleum Hydrocarbon – Diesel Range Organics			
TPH-DRO (mg/kg)	12,000	930	3,400
SPLP Semi-volatiles[1]			
3&4-Methyphenol (mg/L)	<0.025	<0.025	<0.025
2-Methylphenol (mg/L)	<0.025	<0.025	<0.025
2,4-Dinitrotoluene (mg/L)	<0.025	<0.025	<0.025
Hexachlorobenzene (mg/L)	<0.025	<0.025	<0.025
Hexachlorobutadiene (mg/L)	<0.025	<0.025	<0.025
Hexachloroethane (mg/L)	<0.025	<0.025	<0.025
Nitrobenzene (mg/L)	<0.025	<0.025	<0.025
Pentachlorophenol (mg/L)	<0.025	<0.025	<0.025
Pyridine (mg/L)	<0.025	<0.025	<0.025
2,4,5-Trichlorophenol (mg/L)	<0.025	<0.025	<0.025
2,4,6-Trichlorophenol (mg/L)	<0.025	<0.025	<0.025
SPLP Volatiles[1]			
Benzene (mg/L)	<0.040	<0.040	<0.040
Carbon tetrachloride (mg/L)	<0.040	<0.040	<0.040
Chlorobenzene (mg/L)	<0.040	<0.040	<0.040
Chloroform (mg/L)	<0.040	<0.040	<0.040
1,4-Dichlorobenzene (mg/L)	<0.040	<0.040	<0.040
1,2-Dichloroethane (mg/L)	<0.040	<0.040	<0.040
1,1-Dichloroethane (mg/L)	<0.040	<0.040	<0.040
2-Butanone (mg/L)	<0.020	<0.020	<0.020
Tetrachloroethene (mg/L)	<0.040	<0.040	<0.040
Trichloroethene (mg/L)	<0.040	<0.040	<0.040
Vinyl chloride (mg/L)	<0.020	<0.020	<0.020
TCLP Metals			
Calcium (mg/L)	2.1	0.71	3.1
Magnesium (mg/L)	<0.50	<0.50	0.77
Potassium (mg/L)	<0.50	<0.50	1.2

Analytical Parameter (units)	Unprocessed tar Sand	Processed Sand	Processed Fines
Sodium (mg/L)	3.8	9.9	29
Inorganic Analysis			
Alkalinity (as $CaCO_3$) (mg/kg)	<20	63	75
Bicarbonate (as $CaCO_3$) (mg/kg)	<20	63	66
Carbonate (as $CaCO_3$) (mg/kg)	<10	<14	<12
Chloride (mg/kg)	<5.0	19	21
Sulfate (mg/kg)	<5.0	60	61
Total Dissolved Solids (mg/kg)	24	300	6,100
Other Hydrocarbons			
Oil & Grease (mg/kg)	140,000	3,000	30,000
TRPH (mg/kg)	64,000	1,100	9,500

Analyses by American West Analytical Laboratories
[1] Holding times were exceeded
Source: Earth Energy Resources 2008

Volatile and Semi-Volatile Organics

All sample results – before and after processing – show that both volatile and semi-volatile organics were below detection in the leachate, confirming that the organics present were among the least mobile. Note that these analyses were for liquid media while those for inorganics and other hydrocarbons were for solid (soil) medium. It may be relevant to note that the analyses for these parameters were compromised to an unknown extent in that the samples were not analyzed by the lab within the allowable holding times. In addition to these lab errors, reporting limits for volatiles and semi-volatiles were generally above the applicable ground water standard for these analytes. Thus, it is possible that greater concentrations than those measured by the lab were actually present in the samples. Oil sands are comprised of bitumen, which is the non-volatile end member of the petroleum maturation process. By definition, then, bitumen contains little or no volatile or semi-volatile constituents. Therefore, it is believed that the results still indicate a *de minimis* effect on ground water from volatile or semi-volatile components, particularly given the hydrogeologic setting as described below in Part C.

Non-volatile Hydrocarbons

As expected, all sample results show that TRPH, TPH-DRO, and oil and grease were very high in the unprocessed ore and significantly reduced by processing. In spite of these reductions, some levels remain high, particularly in the processed fines. In fact, the lab analytical reports note that the results for oil and grease are outside the method limits for the unprocessed ore and the processed fines, as well as for TRPH for the processed fines. Note that both of these analyses used EPA Method 1664a, which uses n-Hexane as the solvent; while this may be useful in characterizing the processed oil sand material, it does not characterize the likely leachate from precipitation. The absence of volatile or semi-volatile constituents in the processed material indicates that the organic compounds in the residual material are likely to be no more mobile than the undisturbed, *in situ* oil sands themselves.

One way of considering the environmental effects of the residual material is to compare it with the Utah's Department of Environmental Quality, Division of Environmental Response and Remediation's clean-up standards for petroleum-contaminated soils at underground storage tank sites. The initial screening and Tier 1 risk-based screening levels for oil and grease or TRPH in soil are 1,000 mg/kg and 10,000 mg/kg, respectively. Of the total petroleum analyses preformed on the Asphalt Ridge samples, only the oil and grease analysis for the processed fines sample exceeded the Tier 1 screening level. However, if the processed fines were mixed with the processed sands in their produced ratio of 1:4, the combined result would be 8,400 mg/kg, which complies with the applicable Tier 1 screening level. Table 6 shows the effect of recombining the processed sands and fines for the three types of total petroleum analyses performed on the Asphalt Ridge samples. It is worthy of reminder that these analyses were of oil sands processed using an organic solvent, unlike the CAR process.

Table 6 Comparison of Total Petroleum Analyses with Tier 1 Screening Levels

Analysis	Processed Sand	Processed Fines	80% Processed Sand + 20% Processed Fines	Tier 1 Screening Criteria
TPH-DRO	930	3,400	1,424	5,000
Oil & Grease	3,000	30,000	8,400	10,000
TRPH	1,100	9,500	2,780	10,000
All analyses are in mg/kg				

<u>Metals and Other Inorganics</u>

At DWQ's request, the 2007 samples were analyzed for TCLP calcium, magnesium, potassium, and sodium as a means of determining the potential of the leachate to cause salinity in any ground water it might enter. The results were detectable, but levels of the constituents were unremarkable. It is believed that the results indicate a *de minimis* effect on ground water from the analyzed metals, particularly given the hydrogeologic setting as described below.

Otherwise, we believe that no hazardous substances would be found in the tailings.

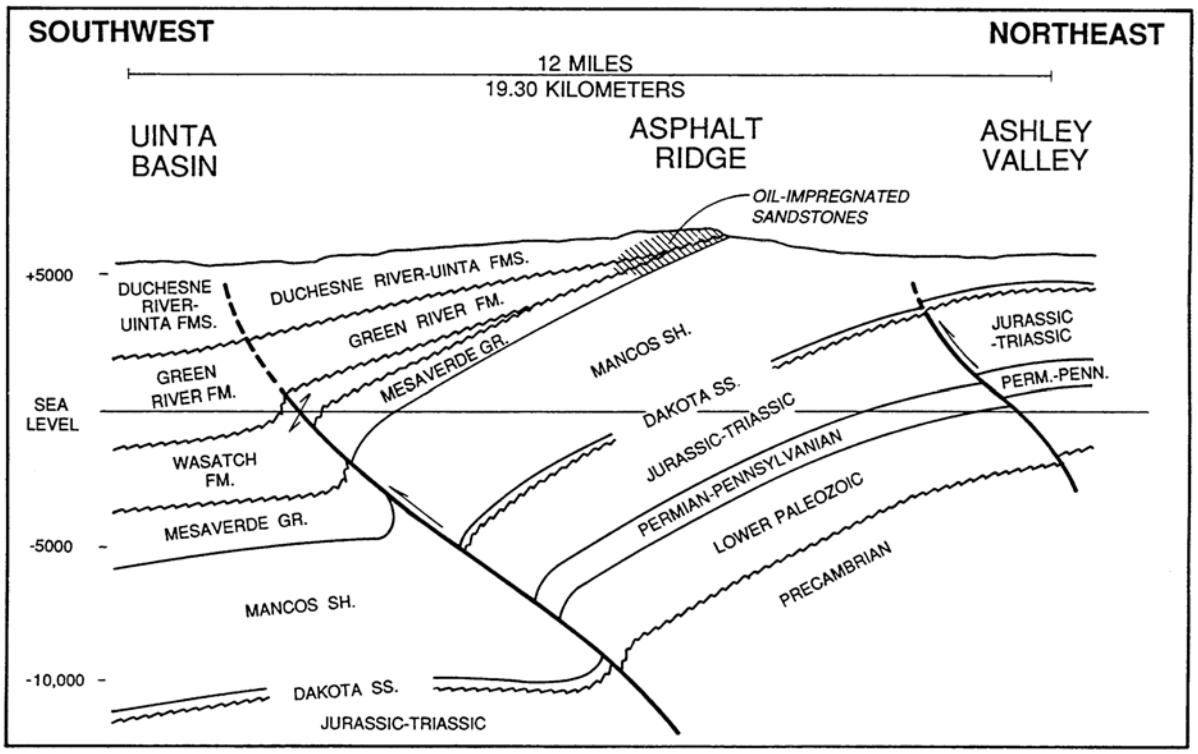
<u>Part C Item 8</u>

<u>Geology</u>

Figure 5 shows a geologic cross section of Asphalt Ridge as described by Campbell and Ritzma (1979) in the Utah Geological Society publication, *Tar-Sand Resources of the Uinta Basin, Utah* (Blackett, 1996). Asphalt Ridge is located between the Ashley Valley to the northeast and the Uinta Basin to the southwest. The figure shows how the strata dip to the south southwest. The geologic setting is described in the same publication as follows:

Exposed strata consist of the Asphalt Ridge Sandstone and the overlying Rim Rock Sandstone, both of the Mesaverde Group (Cretaceous), and the Duchesne River Formation (Eocene-Oligocene). The Asphalt Ridge Sandstone and the Rim Rock Sandstone are separated by a thin tongue of Mancos Shale. All Cretaceous units are of marine origin. At Asphalt Ridge the Duchesne River Formation, containing interbedded fluvial sandstones with associated shales and conglomerates, lies unconformably atop the Rim rock Sandstone (Campbell and Ritzma 1979). The Rim Rock Sandstone (Mesaverde) ranges from about 100 feet (30m) to more than 300 feet (90m) in thickness, due to erosion of the unit prior to deposition to the overlying Duchesne River Formation (Kayser 1966).

Figure 5 Geologic cross-section of the Asphalt Ridge tar-sand area (after Campbell and Ritzma 1979)



Source: Blackett 1996

Figure 6 is a general geologic map of the Asphalt Ridge tar-sand area including Vernal and the area of the CAR mine and processing plant in the southwestern corner of Township 4 South, Range 21 East (Sections 31 and 32) after Hintze (1980) from Blackett (1996). Blackett describes the geologic origin of tar-sands as follows (Blackett 1996):

> Lacustrine rocks are the most important petroleum source beds in continental sedimentary sequences. Organic matter on lake bottoms is normally derived from fresh-water algae and bacteria that tend to be oil-prone and waxy. ... As a lacustrine basin evolves by sediment accumulation and subsidence, oil

generation occurs and migration tends to move oil upward within a homogenous carrier bed. Bitumen moves out of the fine-grained lacustrine source rocks, through the more permeable carrier beds, and finally into porous traps.

Tar-sand deposits are a product of biodegradation and water-washing (dissolution of oil by meteoric water) of crude oils after migrating from sources and accumulating in traps. ... The bacteria consume the light-hydrocarbons in the crude oil, resulting in density and viscosity increases in the residual oil. Water-washing removes the water-soluble hydrocarbons, whereas, biodegradation removes paraffins and isoprenoids.

The remaining bitumen has both high viscosity and low water solubility.

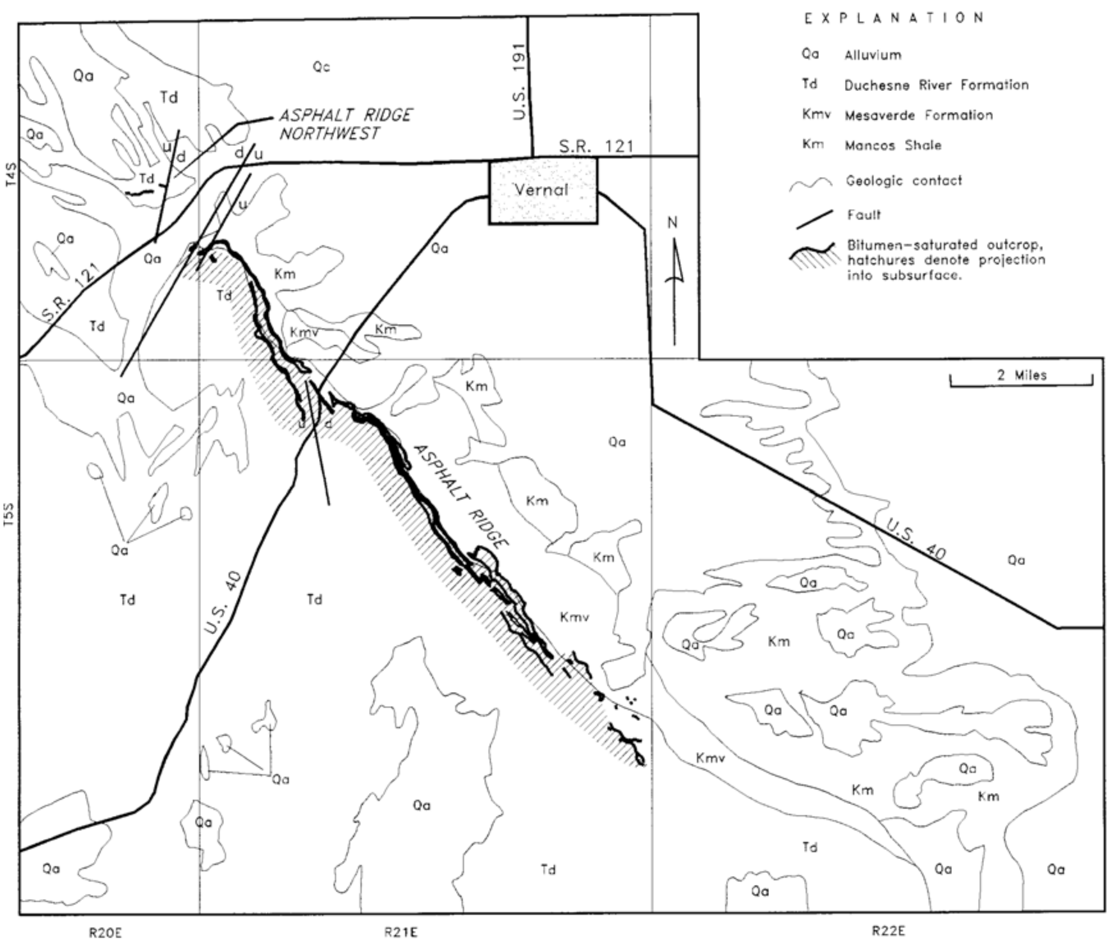


Figure 6 General geology of the Asphalt Ridge tar-sand area (after Hintze, 1980; tar-sand outcrops from unpublished UGS file data)

Source: Blackett 1996

Figure 6 also shows the abrupt eastern edge of the oil sands deposit, which coincides with a fault through the eastern part of the CAR property.

> Minor faults within the deposit are confined to rocks of the Mesa Verde Group and do not pass upward into the Tertiary units. A prominent fault, exposed at an asphalt pit in sections 30 and 31, T4S, R21E, strikes N24°W. The fault surface is vertical and the displacement is 150 feet down on the west side. (Blackett 1996)

Blackett (1996) makes the following additional observations:

- Attitudes measured on outcrops of the Rim Rock Sandstone indicate dips ranging from 8 to 30 degrees south-southwest
- Asphalt Ridge is a northwest-southeast trending cuesta, where Cretaceous and Tertiary formations dip to the southwest.
- Most of area comprising the tar-sand outcrops is administered by the Bureau of Land Management. Sands making up the "down-dip" (southwest) portion of the deposit are primarily Utah State lands managed by SITLA.

Topography is shown on Figure 3. Stratigraphy is shown on Figure 5 and described above.

Hydrology

Hydrology is described in the response to Part A Item 9.

Table 4 shows the location and depth to groundwater of the wells within one mile of the project area for which there are well logs in the Utah water rights database. The table shows that wells drilled in the Quaternary alluvium northeast of Asphalt Ridge are generally shallow and have static water levels ranging from 8-40 feet. At the same time, wells drilled in the Duchesne and Mesaverde formations, or the Mancos Shale, were all dry. The CAR mine is located outside the alluvial deposits in the oil-sand bearing formations. The tailings disposal site is located in mined out portions of the CAR mine.

Detroit Edison, a subsidiary of DTE Energy, drilled monitoring wells in the mine as part of a due diligence effort related to purchase of the property in 2005. See Figure 2 and Table 2. The data collected were submitted to DWQ as a courtesy; the information had not been ordered or requested. In his letter of June 27, 2005, to DTE Energy, Mark Novak of DWQ wrote the following:

> To evaluate possible ground water pollution, five borings were done on site, in locations most likely to have been affected by previous activities. Three borings were completed as monitor wells. Soil samples, and ground water samples taken from two of the three monitor wells, showed hydrocarbons at non-detectable or low concentrations, which would be consistent with naturally-occurring hydrocarbons in soils and ground water associated with the tar sands deposit.
>
> Information presented in the current report does not suggest to DWQ that this site poses a significant risk of pollution, or to require additional investigation. (Personal communication, Mark Novak, Ground Water Protection Section, Utah Department of Environmental Quality, Division of Water Quality, June 27, 2005)

Part C Item 9

No ground water discharge control plan has been developed because we believe that the project qualifies for permit-by-rule under R317-6-6.2-A.

Part C Item 10

CAR will continue to monitor ground water periodically so long as the monitoring wells are not overtaken by mining.

Summary and Conclusions

We believe that the CAR project should have PBR under the 2008 and/or 1996 PBRs, since it is essentially the same process and processing equipment as planned for the 2008 pilot without the use of an organic solvent; the solvent would have had the most potential to migrate to groundwater of the tailings residual components. As demonstrated in both previous requests for PBR, and approved by DWQ, we believe that process tailings will pose *de minimis* risks and impacts to groundwater based on the three criteria for PBR (DWQ 2006).

> The control technology selected for any given setting should be based on several factors including:
>
> • Hydrogeologic Setting – depth to ground water, vadose zone lithology, background ground water quality, and aquifer type (unconfined water table, confined, bedrock fracture flow, karstic limestone, volcanic lava flows).
>
> • Nature of Potential Discharge – contaminant mobility and toxicity or concentration of contaminants in the discharge to ground water as compared to protection levels that will be contained in the ground water discharge permit.
>
> • Methods for monitoring performance of the control technology.

1. Hydrogeologic Setting.

- While the depth to groundwater from the bottom of the open mine pit is not great, the artesian nature of MW-1 and 38-foot water column in MW-3 (which is drilled from a higher elevation) indicate that the aquifer is confined and protected by the confining aquitard from potential contamination.
- The groundwater quality shown in Table 2 demonstrates that the water beneath the mine is of limited use, given the high total dissolved solids (TDS) and high oil and grease concentration. This water quality reflects the geologic setting, beneath an oil sands deposit for thousands, if not hundreds of thousands, of years.
- Geologic faulting and subsurface strata dip to the south southwest and appear to protect the Ashley Valley, which is a high ground water use area. Assuming ground water gradient follows the stratigraphy, ground water under the mine pit would flow to the south southwest which is an area of very limited use due to the topography.
- Direct observations indicate that the aquifer beneath the mine pit has low hydraulic conductivity.

2. Nature of the Potential Discharge. No organic solvents will be used in the process, only heated water. The only residual in the tailings would be an estimated 0.5 percent asphaltine components that did not separate out during the extraction process. These would likely be the least mobile hydrocarbons in the matrix, which already have low mobility. Five to ten grams of flocculent per metric ton of solids would be the only additive to the tailings. NaOH will be used to maintain pH, if necessary. CAR will be draining tailings and recycling water to the extent possible, having constructed a water treatment plant and extensive facilities to capture steam and water throughout the processing plant.

3. Method of Monitoring Performance. Tailings will be sampled for residual hydrocarbons. Monitoring wells can be sampled for the same suite of parameters as were sampled in 2008, 2009, and 2012.

For these reasons we believe that the CAR processing plant and tailings pose *de minimis* risks to groundwater.

Please let me know if you have any questions or need any additional information. I look forward to discussing this with you.

Thank you,

<Jon Schulman> sent via email

Jon Schulman

JBR Environmental Consultants

References

Blackett, Robert E. 1996. Tar-Sand Resources of the Uinta Basin, Utah, A Catalog of Deposits. Open-File Report 335, Utah Geological Survey. May 1996.

Campbell, J.A., and Ritzma, H.R. 1979. Geology and petroleum resources of the major oil-impregnated sandstone deposits of Utah, Utah Geological and Mineral Survey, Special Studies 50.

Earth Energy Resources. 2008. Earth Energy Resources, Inc. PR Spring Operation, Uintah and Grand Counties, Utah, Ground Water Discharge Permit-by-Rule Demonstration.

Hintze, L.F., compiler. 1980. Geologic map of Utah, Utah Geological and Mineral Survey Map A-1, scale 1:500,000.

Kayser, R.B., 1966. Bituminous sandstone deposits, Asphalt Ridge, Uintah County, Utah, Utah Geological and Mineral Survey, Special Studies 19.

Norwest Corporation. 2012. Asphalt Ridge Oil Sands Property Evaluation. February 2, 2011.

USGS. 2012. National Hydrography dataset GIS file StreamsNHDHighRes(SGID93 Water) and SpringsNHDHighRes (SGIS93), accessed on line at the Utah Automated Geographic Reference Center (AGRC) at http://gis.utah.gov/agrc

Utah Division of Water Quality Ground Water Protection Section (DWQ). 2006. Ground Water Quality Protection Permitting Information Document. December 2006.

Utah Division of Drinking Water (DDW). 2012. Drinking Water Source Protection Program accessed on line at http://www.drinkingwater.utah.gov/source_protection_intro.htm March 29, 2012.

Utah Division of Water Rights (DWR). 2011. Water rights database for Utah, accessed online September 17, 2011 at http://www.waterrights.utah.gov/wellinfo/default.asp

Western Regional Climate Center (WRCC). 2012. Accessed online at http://wrcc.dri.edu/