Evaluation of the Sunnyside Cogeneration Associates Draft Groundwater Discharge Permit

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Introduction

This report represents my review of available documentation regarding the draft groundwater discharge permit UGW570002 by the Utah Division of Water Quality, and perhaps more importantly, geological considerations regarding this permit. The application deals with the disposal of coal ash generated from the Sunnyside Cogeneration Associates (SCA) power plant in Carbon County, Utah. In compiling this report I have highlighted deficiencies in documentation, as well as unfavorable site conditions.

The report is organized as follows. For context, a brief description of relevant local and regional geology is provided in detailing surface and subsurface hydrogeological vulnerabilities of the site. Following this, comments on the shortcomings in the documentation are provided. A copy of my resume is attached hereto.

Documents Reviewed

Draft Groundwater Discharge Permit UGW57002, July 23, 2013 version

Statement of Basis Sunnyside Cogeneration Associates Ash Landfills, Modification of Ground Water Discharge Permit UGW070002, July 23, 2013 version

Water Quality Sampling and Analysis Plan & Ash Leachate Analysis Plan: Phase I, II, III Ash Disposal Facility Permit No. UGW070002, Revised Feb. 2, 2009

Leachate Analysis, Sunnyside Cogeneration Associates, Feb. 17, 2011

Information Reviewed

- Field inspection Aug. 19, 2013
- Orthophoto imagery obtained from: http://gis.utah.gov/data/
- Stream, road, municipality shapefiles from: http://gis.utah.gov/data/
- NED data (i.e., digital topography) obtained from: http://viewer.nationalmap.gov/viewer/
- Hill slope data calculated form NED information
- Site imagery and elevation profile from Google Earth
- 100-year FEMA floodplains were obtained and digitized from: https://msc.fema.gov/webapp/wcs/stores/servlet/mapstore/homepage/MapSearch

Methodology

Geospatial information was projected and visualized using ESRI software ArcMap v. 10. This information is shown in Figures 1, 2, 4, and 5. In addition to projection and visualization, ArcMap software was used to calculate and project slopes shown in Figure 5. Google earth and its elevation profile tool were used to generate Figure 2. Insight gained from the site inspection[1] contributed greatly to the interpretation of the information in this report.

Summary

The disposal of coal ash at the SCA facilities is problematic. Of the two disposal areas, SCA-2 is too poorly located to evaluate and SCA-1 is vulnerable to disturbances and releases based on geologic conditions, including natural modification of surface water drainages, groundwater flow, and slope instability. On this basis, SCA-1 should be disqualified as a landfill for coal ash. Documentation surrounding the draft permit is incomplete and confusing. Proper review of the proposed action cannot be accomplished until the documentation is updated.

Geological Setting

Figure 1 shows the location of coal ash disposal area SCA-1. SCA-2 is not shown because it has not been constructed and its location under the township and range system is too imprecise to evaluate (see below), although it apparently is intended to lie 2 to 3 km east of SCA-1.

Current disposal in SCA-1 occurs on the south-facing slope of a large east-west oriented cliff that marks the southern margin of a large pediment surface extending westward from the base of the Book Cliffs. This surface is armored by alluvium and other debris that overlie the soft Blue Gate Member of the Mancos Shale. This armored pediment surface protects and "holds up" the underlying shale.

A very large drainage basin in the Book Cliffs feeds a stream system known as Grass Trail Creek that flows through the towns of Sunnyside and East Carbon, Utah. It is expected that periodic heavy precipitation events or rapid spring snowmelt could result in large surface water flows or perhaps even debris flows through the area. Note the proximity of Grass Trail Creek to the cliff and SCA-1 in particular (Figs 1 & 2). The implications of this proximity are discussed below.

Drainages south of the cliff can be extensive and extend eastward into the Book Cliffs. However, in the vicinity of SCA-1 they do not drain areas that approach the size of the Grass Trail Creek drainage. The reader should note that all of these stream systems are integrated with the Green River—Colorado River drainage basins.

Surface Hydrogeology

The stream network in the vicinity of SCA-1 causes me considerable concern. Figure 2 illustrates the FEMA 100-year floodplain along Grass Trail Creek just north of the landfill. At point A (Fig. 2) the floodplain is within about 70 meters of Drainage B. Figure 3 further illustrates that, within the resolution of Google Earth data, there is little by way of a topographic barrier to flood waters being diverted into Drainage B in this area (Fig. 3).

[1] See the appendix.

Stream capture or stream piracy is a well-known phenomenon by which drainage networks are modified by capturing flows of one system and diverting them into another. A significant stream flow/flood event at or upstream of point A (Fig. 2) could divert flows from Grass Trail Creek, and its entire collection system, into the stream networks south of the cliff, and do so permanently. Were such an event to occur at point A, high stream flows would inevitably, and directly, impact the integrity of the pile. Were Grass Trail Creek captured at or any point up gradient from point A, high flow events might compromise the southern (and down-slope) side of the pile via widening and down cutting of the channel. Given the proximity of Drainage B and Grass Trail Creek, diversion of the latter stream south of the cliff seems likely if not inevitable in the near geologic future[2]. It appears as if a 100-year flood event may approach diversion.

Subsurface Hydrogeology

There may be a lot of uncertainty as to the regional groundwater flow system, or lack thereof, given the low permeability of the Blue Gate Member of the Mancos Shale. However, some conclusions can be drawn relative to shallow flow systems that underlie alluvial material beneath streams in the immediate vicinity of SCA-1.

Underflow (i.e., shallow groundwater flow in alluvium parallel to the overlying stream) beneath Grass Trail Creek is clearly being partially diverted at point A down the cliff face and into the drainage south of SCA-1 (Fig. 4). This is evidenced by phreatophytes (e.g., willows, marsh grasses, etc.) growing along in the cliff face, as well as mapped seeps and springs. Furthermore, this flow system is clearly impacting (bringing water into or beneath?) the eastern end of SCA-1. Phreatophytes and seeps mapped by SCA (see map in Sample Analysis Plan) indicate that there is an active flow system to receive seepage from the pile and to transport it further down gradient.

If piracy of Grass Trail Creek were to occur, all of its underflow may be diverted along and beneath the stream network to the east and south of SCA-1. In other words, the broad, verdant riparian zone along Grass Trail Creek in the town of East Carbon north of SCA-1 (Fig. 4) may be abandoned and reestablished south of the SCA-1 piles, yet becoming vulnerable to seepage from the landfill.

Slope Stability

As mentioned above, SCA-1 is largely built into a south-facing cliff, which is in places quite steep (e.g., Fig. 1). Figure 5 indicates that the slopes of the cliff in the vicinity of SCA-1 commonly exceed 20 to 25°. When coupled with surface and groundwater flow discussed above, the wisdom of building this facility into the cliff face comes into question. Loading of groundwater into the east end of SCA-1, erosion of the pile by stream piracy, or undercutting of the pile by present or diverted stream flows to the south of the pile may make this facility vulnerable to slope failure.

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[2] Geologists have a concept of time that may be foreign to the layperson. "Near geologic future" might mean anything from tomorrow to a few tens of thousands of years.

Even if none of the above phenomena were to occur, SCA-1 is emplaced into the side of an actively eroding cliff. The natural processes of headward erosion and slope retreat by rivulets actively attacking the cliff walls will ensure that coal ash will be eroded and dispersed by the stream system at some point in the future.

Draft Groundwater Discharge Permit

- SCA-2 is located far too imprecisely to evaluate its suitability. The two quarter sections given as a location equate to an uncertainty of about ½ mile in an east-west direction and ¼ mile north-south. The cited values of 110° 22' W. Long. & 39° 32' N Lat. place the landfill in the Book Cliffs. We had no opportunity to inspect the March 2013 drawing for this feature.
- MW-8 may not be an appropriate choice for background values for SCA-2. It is located near SCA-1, not SCA-2. It is also immediately south of a bare patch, raising questions as to whether it has been affected by human activity. I am concerned that this may set the bar too low for groundwater protection.
- The public has no way of knowing exactly where phase II of SCA-1 is. No map or more exact coordinates are provided and we were not able to inspect the "February 8, 1997" drawings. And, what does "additional expansion of the landfill will also incorporate referenced design specification" mean? There really should be a good map(s) in this permit that the public can use to spatially assess permit criteria.
- The public has no way of knowing exactly where phase III of SCA-1 is to be located. No map or more exact coordinates are provided and we were not able to inspect the "December 23, 2003" drawings.
- The location, and therefore suitability, of monitoring wells is not provided in the draft permit. I was able to locate a landfill expansion map in the Sampling Plan. However, this map is difficult to read. Topographic contours cannot be separated from streams. Labels for springs, seeps and wells are difficult to read. Furthermore, this map is NOT GEOREFERENCED to any common coordinate system that the public can use to locate these features. In addition, MW-7 (down gradient monitoring point) and Whitmore Spring are not identified. How can these features be designated as monitoring points if they are not geographically located anywhere in the permit?
- MW-8 is cited as a down gradient monitoring point on Drawing 5 for SCA-2. Where is Drawing 5?
- In this case, monitoring for only 10 years after final closure is inadequate. We know that leachate from these piles is chemically aggressive (pH=12.3; leachate analysis) with a very high TDS.

Sampling Plan

- As above, Whitmore Springs is not located on any map, nor is the "Fresh Water Reservoir."
- There is an inconsistency between cited existing monitoring wells and the map. MW-1, -2, -3, -4, and -7 are cited as existing wells. There is no MW-6 on the map, but there is an MW-5 and MW-8. As noted above, MW-7 is missing from the map.

- Appendices are cited but not made available for inspection.

Statement of Basis

- "Because MW-1 is probably not in a location that can directly evaluate impacts from the landfill, the permittee replaced MW-1 with MW-4 in 1997 adjacent to the existing SCA # 1 Ash Landfill and MW-7 which is adjacent to sediment pond #017." This text is provided in connection with an out of compliance condition for MW-1. Taking this discussion at face value, the public still does not know the location of MW-7 or sediment pond #017.
- "In preparation for the SCA # 1 Ash Landfill Phase III, Sand Blanket drains were installed over two identified seasonal seeps to facilitate drainage and to prevent up take by the ash-fill material. One seep is under the Phase III landfill footprint; the other seep is just outside the footprint." Where are these features documented? Where are they on the land surface?
- Under the section on compliance there is discussion of exceedances for Pb and Se, discussed "per item F. above." Where is this discussion? Where is item F?

Conclusions

- SCA-1 should not, in my opinion, have been constructed in its current location. There are plenty of flat, pediment surfaces away from active drainage systems that could have accommodated this coal ash. It should never have been constructed into the cliff of an active drainage system. As it is, SCA-1 is vulnerable to flooding and permanent reorganization of the drainage network by stream capture. This could result in direct dispersal of coal ash during surface water flows similar to a 100-year event, as well as undercutting down-slope areas of the landfill before, during or after diversion. There is also likely to be increased seepage from diverted underflow from Grass Trail Creek flowing beneath the east end of the pile. These processes may combine to undermine the slope stability of the landfill. Even if none of this were to occur, because SCA-1 is perched on a cliff it will eventually be eroded and transported into the Green River—Colorado River system. Although no landfill can be considered a "permanent" feature, the permit should be disqualified on geologic considerations.
- As detailed above, there are a host of problems with documentation (or lack thereof) in the Draft Permit, the Sampling Plan, and the Statement of Basis. The public has not been provided with adequate information to judge the acceptability of the Draft Permit.

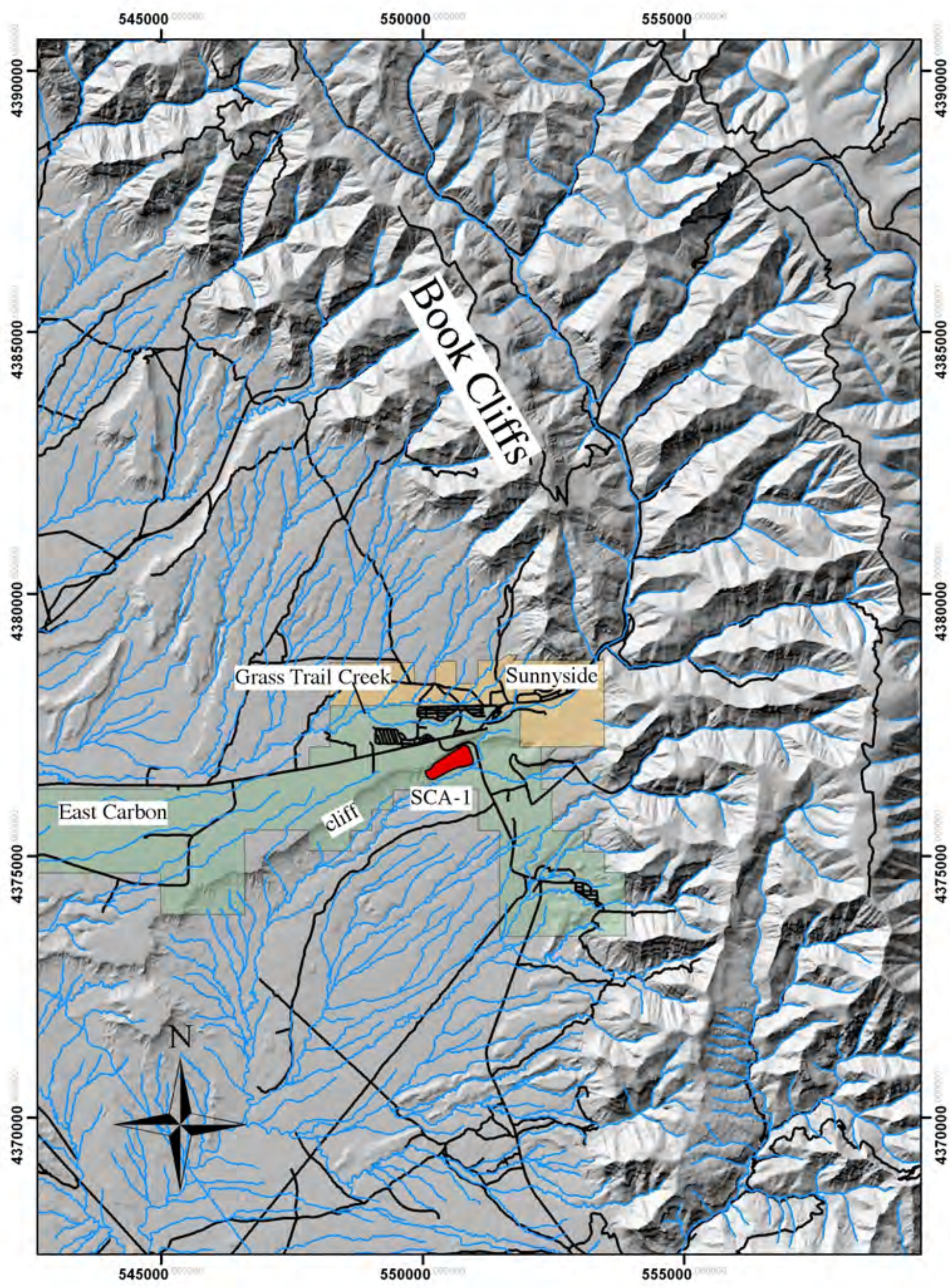

Figure 1. Index map of the Sunnyside Cogeneration geographic setting. Disposal area SCA-1 is shown in red. Black lines show roads and blue lines drainages (data from Utah Automated Geographic Reference Center, http://gis.utah.gov/data/) superimposed upon a hillshade generated from topographic data obtained from the US Geological Survey (http://viewer.nationalmap.gov/viewer/). Perimeter ticks represent positions and distances in meters (UTM projection NAD83, Zone 12S).

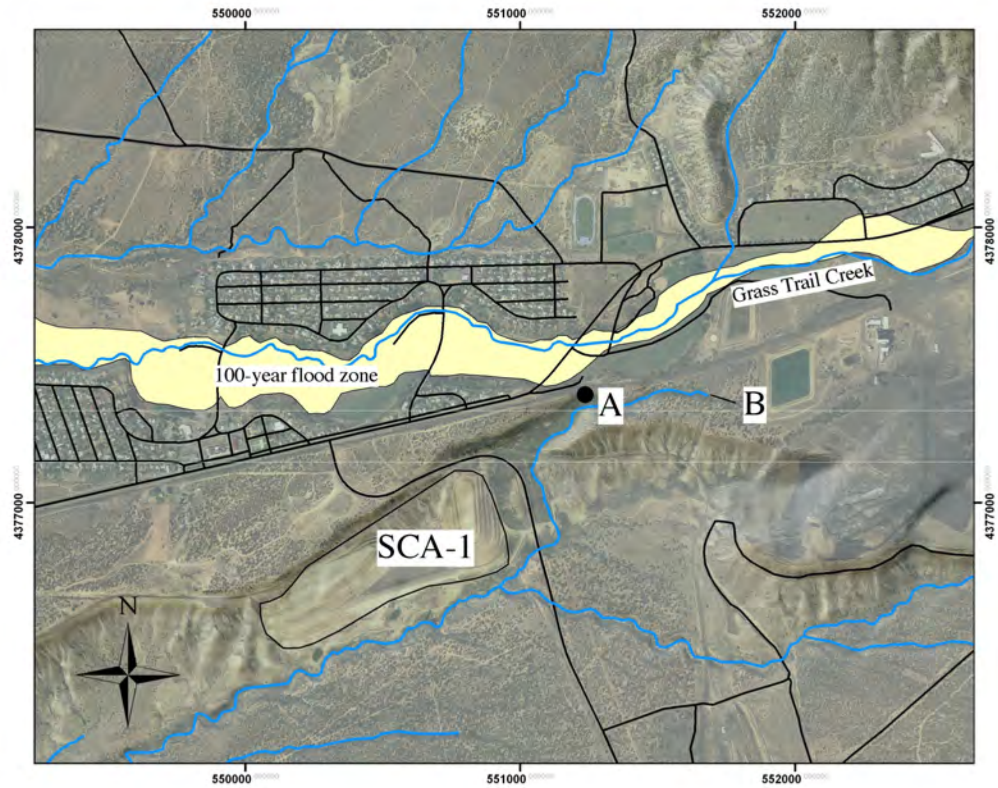

Figure 2. Map of SCA-1 relative to surface drainages and a selected FEMA 100-year flood plains (yellow) digitized from https://msc.fema.gov/webapp/wcs/stores/servlet/mapstore/homepage/MapSearch.html. Black lines show roads and blue lines drainages (data from Utah Automated Geographic Reference Center, http://gis.utah.gov/data/) with orthoimagery (http://gis.utah.gov/data/) superimposed upon a hillshade generated from NED data (http://viewer.nationalmap.gov/viewer/). Perimeter ticks represent positions and distances in meters (UTM projection NAD83, Zone 12S).

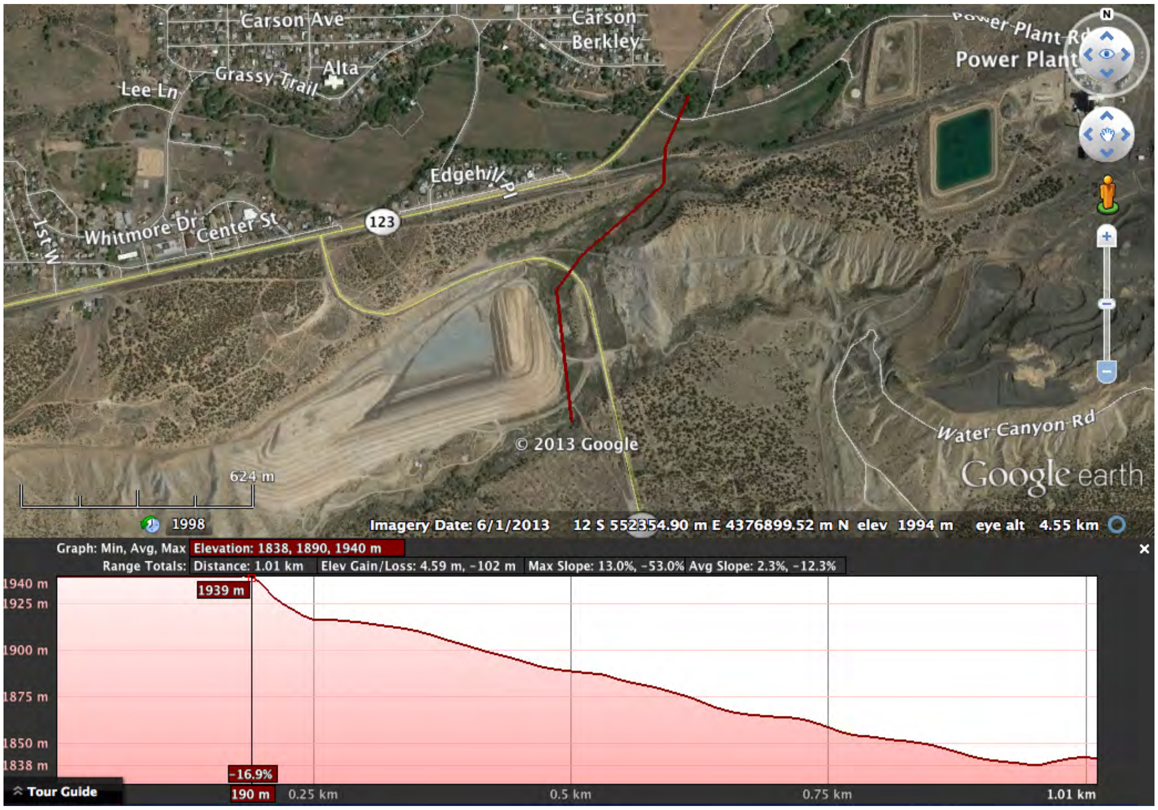

Figure 3. Google Earth aerial image and topographic profile (red) in the vicinity of SCA-1.

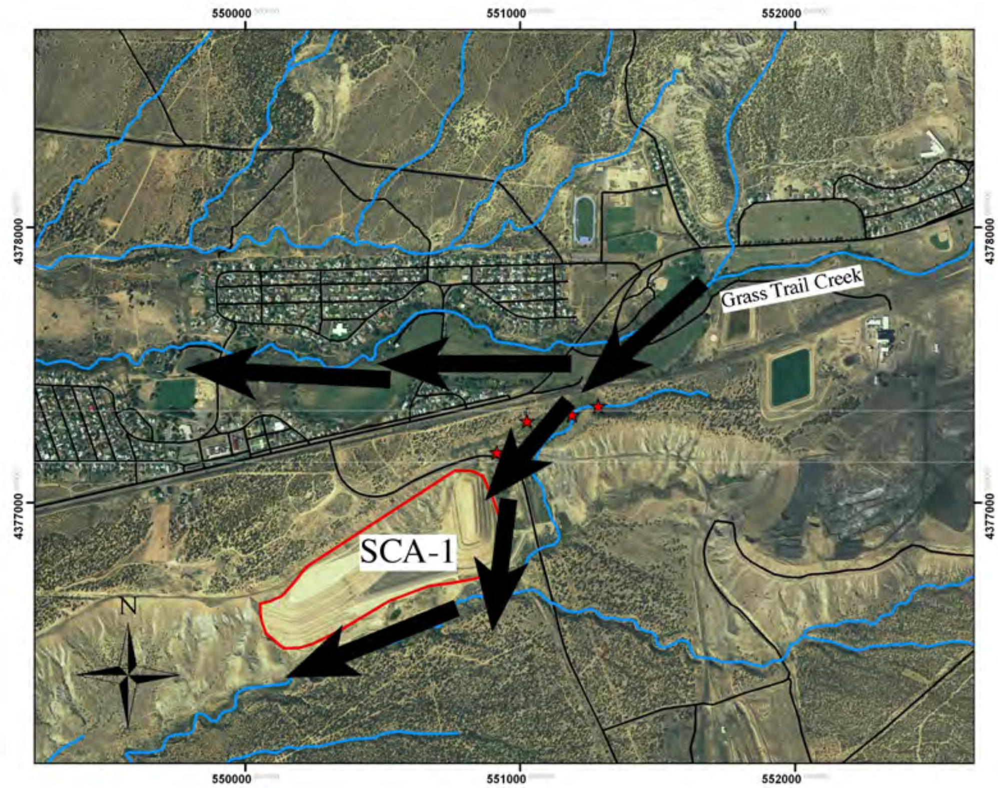

Figure 4. Map illustrating selected features of shallow groundwater flow systems in the vicinity of SCA-1. Bold, black arrows show the diversion of underflow from Grass Trail Creek along the east edge of SCA-1 and into the stream south of the landfill. Black lines show roads, blue lines drainages, and red stars seeps and springs (data from Utah Automated Geographic Reference Center, http://gis.utah.gov/data/) with orthoimagery (http://gis.utah.gov/data/) draped over the hillshade image. Perimeter ticks represent positions and distances in meters (UTM projection NAD83, Zone 12S)

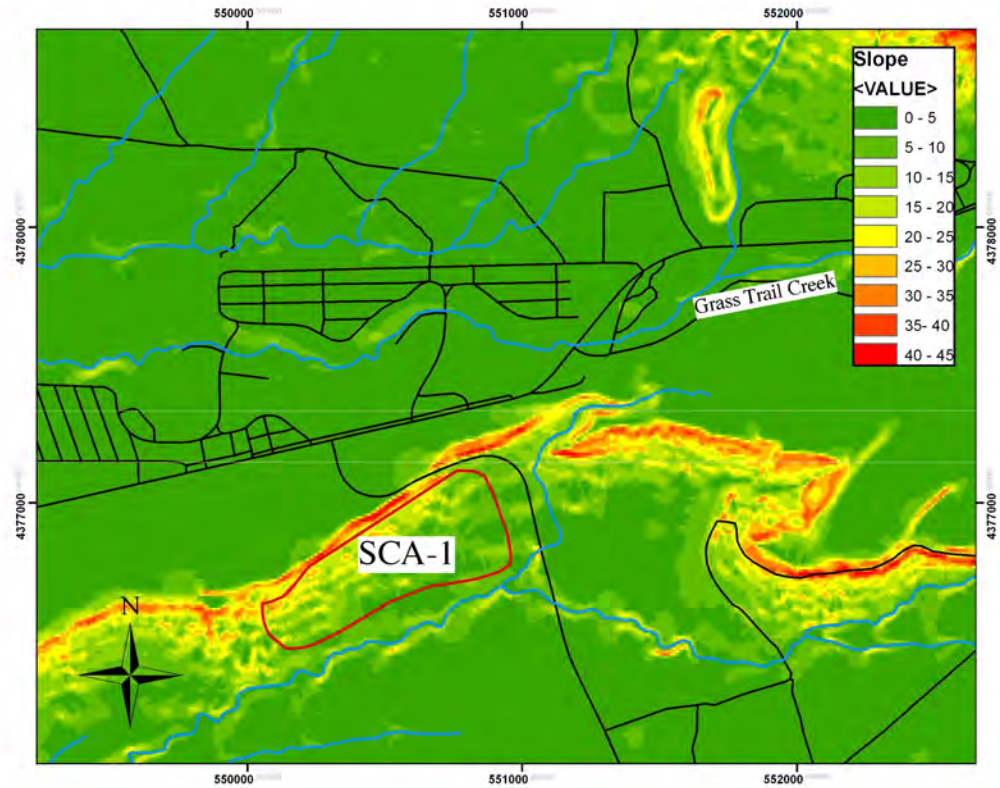

Figure 5. Slope map of the cliff into which SCA-1 is constructed. Topographic data obtained from the US Geological Survey (http://viewer.nationalmap.gov/viewer/) were used to generate slope values (in degrees; see key) using ArcMap (ESRI, v. 10). Black lines show roads and blue lines drainages (data from Utah Automated Geographic Reference Center,(http://gis.utah.gov/data/; UTM projection NAD83, Zone 12S).

Appendix: Report of Site Visit Aug. 19, 2013

On Monday, Aug. 19, 2013 I visited the towns of Sunnyside and East Carbon, Utah to inspect and photograph the SCA power plant and SCA-1 landfill in support of this report. As expected, entry to the power plant and landfill are controlled, so all inspections were made from public roads, which nonetheless afforded excellent views. Photo panoramas were taken with representative images shown and discussed below. The path of my inspection is detailed in Figure A1.

A photo panorama shows the spatial scale of the SCA-1 landfill as well as its development near and into the cliff (Fig. A2). A grader working the landfill is indicated for scale, as well as the wetland that manifests diverted groundwater flow from beneath Grass Trail Creek. This wetland could also mark the path of diverted stream flow if/when stream piracy occurs. It is already occupied by an ephemeral drainage.

Figure A3 shows a number of important details. The power plant is shown in its relationship to SCA-1 in the foreground (power plant at intermediate distance) and the Book Cliffs in the background. At its east end, the capped portion of SCA-1 is offset somewhat from the natural slope of the cliff. However, toward the west, new areas of excavation are directly on the cliff (Fig. A4). The Blue Gate Shale Member of the Mancos Formation is seen in the slopes, overlain by capping alluvium "holding up" the soft shale. Especially prominent are the diverted underflow and intermittent drainage. Here, the diverted underflow is readily apparent in the vegetation, whereas the path for the potential diversion of Grass Creek Trail is also obvious.

After inspecting the power plant and SCA-1 area, I traveled into the Book Cliffs via Whitmore Canyon, then driving up the Water Canyon Road to Bruin Point. Figure A5 is a view from the crest at an elevation of >10,000' back toward Sunnyside. With the San Rafael Swell and Sunnyside in the distance, the large system of canyons at high elevation is apparent. The high elevations provide an orographic trap for both summer monsoon moisture and winter cyclonic precipitation. Combined with the large drainage system of canyon networks that feed Grass Trail Creek, the potential for episodic flash floods is readily apparent. This provides important perspective to the SCA-1 site given the potential for stream piracy to divert flows beneath and across the landfill. Also worth noting is the potential for debris flows, which could be enhanced if wildfires were to affect this drainage system.

Fig. A1. Black arrows show the path of my inspection of SCA landfill and power plant area. The image was obtained from Google earth.

Figure A2. Photo panorama taken from Highway 124 northward toward SCA-1. A grader is indicated for scale.

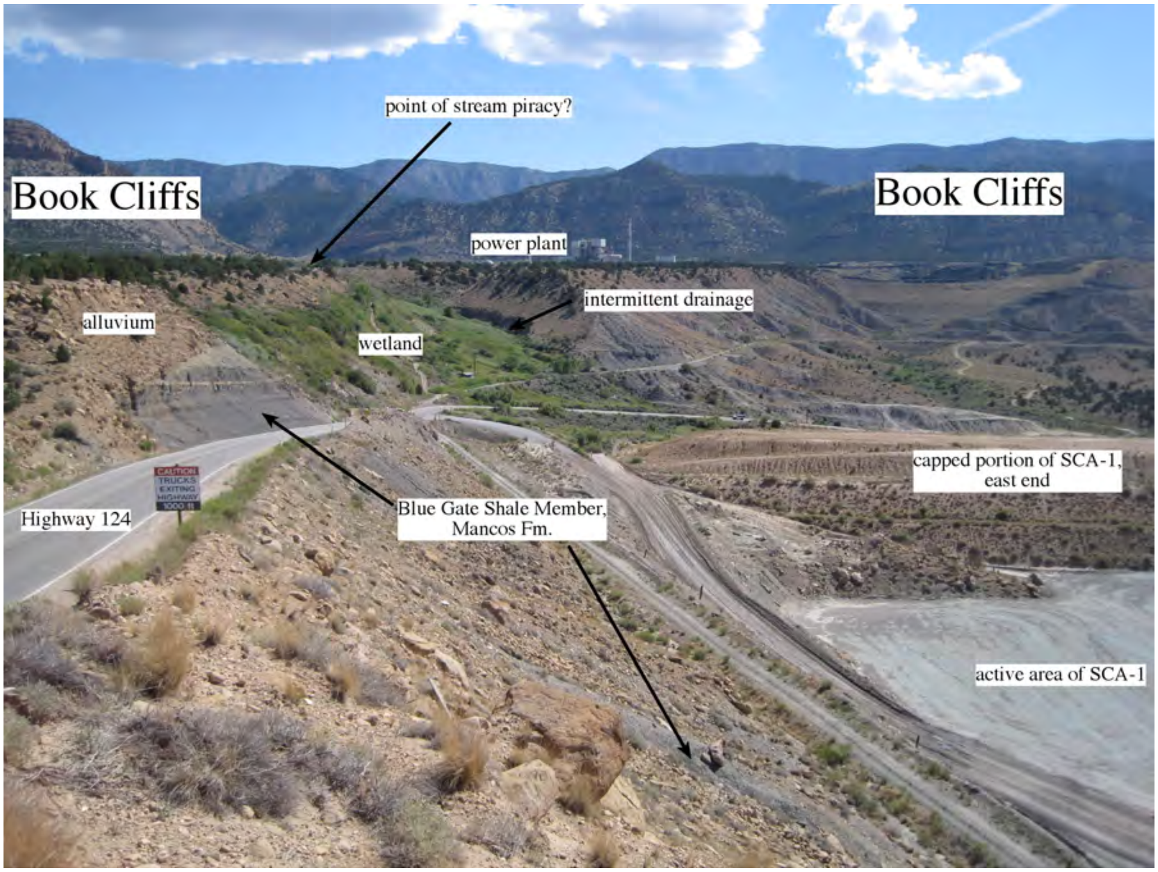

Figure A3. Annotated photograph of the east end of the SCA-1 landfill and SCA power plant. View is to the east.

Figure A4. West end of SCA-1.

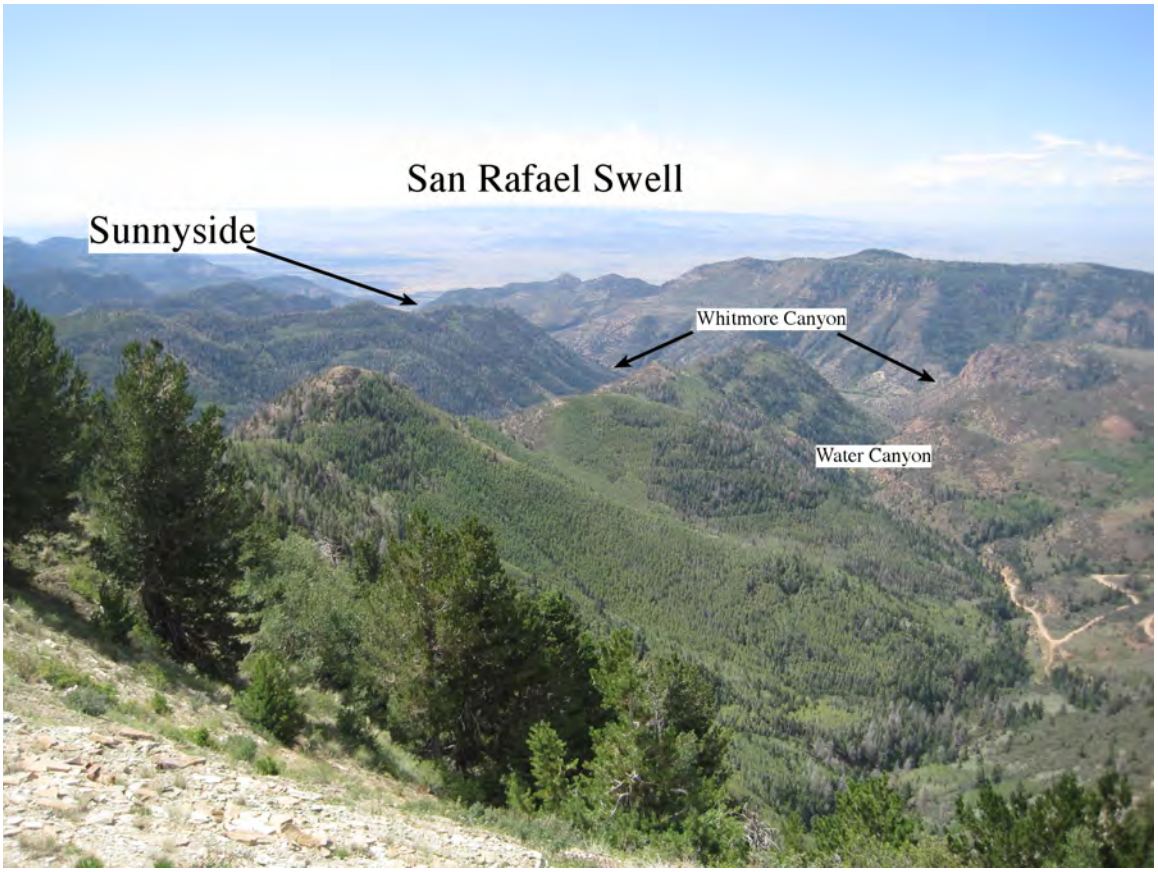

Figure A5. View to the southwest from near Bruin Point on the crest of the Book Cliffs back toward Sunnyside, Utah.