Section 2
Site Stability / Location Selection

Section 2 of this permit addresses the following regulatory sections:
R315-319-64
R315-319-101(d)

2.0 Site Stability / Location Selection

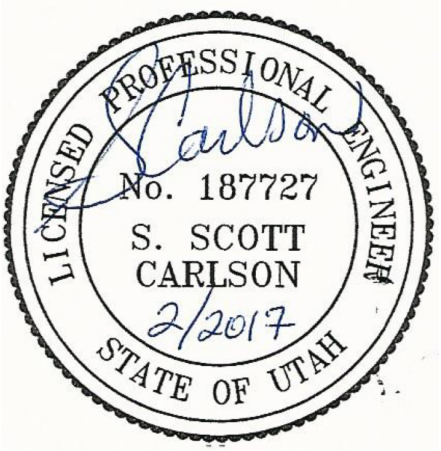
The existing SCA #2 Ash Landfill is located in unincorporated Carbon County (Portions of Sections 7 & 8, Township 14 South, Range 14 East, SLB&M) just south of the city of Sunnyside / East Carbon. (Approximately Latitude 39° 32' 24" North and Longitude 110° 22' 50" West).

This location was selected because it

- has a significant amount of existing disturbed area from a prior land owner,
- does not have regular surface water flows,
- is close to the SCA power plant and will reduce material haul distances,
- the landfill and the haul route between the power plant and the landfill are not in the near proximity to local residences,
- is a geotechnically stable area

This site has been evaluated and determined to be a stable area in accordance with the requirements of 40 CFR Section 257.64 and R315-319-64 for an existing CCR landfill.
The design incorporates recognized and generally accepted good engineering practices for this CCR unit to ensure that the integrity of the structural components of the CCR unit will not be disrupted. The evaluation and design considered all of the following factors, at a minimum, when determining that the area was stable:

- On-site or local soil conditions that may result in significant differential settling;
- On-site or local geologic or geomorphologic features; and
- On-site or local human-made features or events, both surface and subsurface.



S. Scott Carlson, PE 187727, Utah
February 2017

2.1 Geotechnical Evaluation

SCA commissioned a geotechnical evaluation of the site completed by Professional Service Industries, Inc. (PSI) in April 2012. The purpose of the geotechnical evaluation was to

- characterize the subsurface profile of the site,
- evaluate the global and local slope stability of the proposed ash landfill,
- evaluate existing groundwater conditions and
- provide geotechnical recommendations regarding erosion control and construction considerations for the proposed ash landfill.

The geotechnical evaluation report was signed by Shawn Turpin, PE, and also by Kevin C. Miller, PE #7291668. A summary of findings from the geotechnical report is included here.

2.2 Site Description

The SCA #2 Ash Landfill encompasses approximately 34 acres in a small side canyon with existing elevations ranging from approximately 6400 to 6775. The site is underlain by colluvial and alluvial deposits. The surface includes vegetated areas as well as gravel, rock and boulders with steeper areas showing significant rock outcroppings.

2.3 Field Investigation

Two borings were completed at the landfill site. B-1 was completed to approximately 50 feet near the bottom (west) of the landfill site. A permanent monitor well (MW8) was installed in the borehole to observe groundwater. B-2 was drilled to a depth of 33 ½ feet near the upper east area of the proposed site. Samples and boring characteristics were analyzed from each bore hole.

Four exploratory test pits were excavated to observe the near-surface soil conditions and depth to the bedrock.

PSI conducted Refraction Microtremor (ReMi) testing along three profile line arrays within the landfill site. This testing uses standard seismic refraction equipment. The waves measured were used to assist in differentiating between the overburden soil deposits and underlying bedrock. This assisted in determining approximate depth to bedrock at various locations across the site in between borings and test pits.

In March 2015, PSI conducted additional drilling and set two more monitor wells at 50 feet below ground surface near the bottom (west) of the landfill site. Geologic conditions were similar to the findings of the 2012 evaluation.

2.4 Laboratory Testing

Laboratory tests were completed on representative samples of the native soils and the SCA ash material to evaluate physical and engineering properties. Tests included direct shear, unconfined compressive strength, moisture-density relationship, and sieve analysis. A summary of the lab test results is shown on the following table.

Material Description	Water Content (%)	Maximum Dry Density (pcf)	Optimum Moisture Content (%)	Internal Friction Angle (Φ)	Gradation		
					Gravel (%)	Sand (%)	Silt/Clay (%)
Sandy Silt (ML)	9	-	-	-	13	32	55
Silty sand with gravel (SM)	5-7	-	-	-	26-35	32-38	33-38
Silty gravel with sand (GM) / (GP-GM)	2-5	-	-	-	40-76	15-30	9-31
Bulk combined ash sample from stockpile	-	88	24	32	2	50	48

2.4.1 Strength Tests

Given the cohesive strength developed in the compacted ash due to the pozzolanic properties of the ash, unconfined compressive strength tests were performed on three moisture conditioned cylinder samples. After drying, the samples were broken and the unconfined compressive strength of the ash material was found to be in the range of 5,760 - 6,910 psf. Effective Shear Strengths and Unit Weights of the different soils were determined as follows:

Description of Soil	Unit Weight of Soil, pcf		Effective Shear Strength	
	Moist	Saturated	C' (psf)	ϕ'
Ash	80	85	800	32
Silty gravel with sand (SM) (GM)	120	125	0	34
Gravel with silt, sand and cobbles (GP-GM)	140	145	0	38
Shale bedrock	150	155	25,000	0

2.5 Subsurface Conditions

The subsurface soil and bedrock observed generally consist of alluvial and colluvial materials (silty sands with gravel and silty gravel with sands) underlain by lean clays and sandy silt with cobbles and boulders. The soils are underlain by a relatively impervious layer of shale bedrock. The depth to the shale bedrock varied from approximately 14 to 50 feet below existing grade. Standard Penetration resistance, N-Values, ranged from approximately 32 to greater than 50 blows per foot in the overburden soils and greater than 50 blows per foot in the shale bedrock.

2.6 Groundwater

Groundwater was encountered in boring B-1 (MW-8) at a depth of approximately 20 feet below existing grades. Groundwater was not observed in boring B-2 or the exploratory excavations during the drilling/excavation operations. Groundwater is expected to remain 10 feet or more below the ground surface in the vicinity of the landfill and not anticipated to come into contact with any ash materials. Similarly, the groundwater is expected to remain perched atop the shale bedrock as it moves in a general northeast to southwest direction.

SCA conducted groundwater sampling and analysis at the monitor well MW-8 set by PSI in boring B-1 (Approximate Latitude 39^{o} 32’ 18” North and Longitude 110^{o} 23’ 04” West.) These results from 2012-2013 represent the pre-construction or baseline conditions for groundwater in the area prior to construction of the SCA#2 Ash Landfill. The analysis shows groundwater high in TDS and many of the Cations and Anions. Generally, these results are common for groundwater conditions in contact with the Mancos Shale formations. SCA also monitors the two additional down gradient wells (MW-9 and MW-10) installed by PSI in March 2015. These are generally dry. SCA installed an up-gradient monitoring well (MW-11) in October 2015 to the north east of the landfill site for the purpose of monitoring groundwater conditions prior to reaching the landfill area. However, since this site was selected due to its location at the head of the small side canyon (to reduce the potential for storm water and near surface groundwater) the up-gradient monitoring well is dry.

2.7 Stability Analysis

Ash material at the SCA #2 Ash Landfill will be placed above the existing alluvium/colluvium slopes in lifts, moisture conditioned and compacted. Based on the existing site topography,

subsurface evaluation, geophysical study (ReMi), site reconnaissance and other information from available geologic maps, cross sections were developed for use in the slope stability analyses. Various cross section options were evaluated to model long term global stability of the overall landfill design, the intermediate stability during construction and to evaluate the local shorter term stability of the ash benches that will be used throughout the construction phases of the landfill.

The PSI Geotechnical Report provides substantial detail and explanation of the modeling and calculations performed for various conditions. A summary of the results of these calculations is outlined below:

Global Long Term Stability Analyses (a minimum factor of safety of 1.2 is recommended)

Description	Geotech Cross Section	Method	Factor of Safety
Global Stability block failure mode (static)	E-E	Simplified Janbu	2.9
Global Stability block failure mode (pseudo-static)	E-E	Simplified Janbu	2.4
Global Stability circular failure mode (static)	E-E	Modified Bishop	3.0
Global Stability block circular mode (static)	E-E	Modified Bishop	2.5

Intermediate Stability Analysis (a minimum factor of safety of 1.2 is recommended)

Description	Geotech Cross Section	Method	Factor of Safety
Intermediate Stability block failure mode (static)	Intermediate Section 1	Simplified Janbu	3.5
Intermediate Stability block failure mode (pseudo-static)	Intermediate Section 1	Simplified Janbu	2.7
Intermediate Stability block failure mode (static)	Intermediate Section 2	Simplified Janbu	3.1
Intermediate Stability block failure mode (pseudo-static)	Intermediate Section 2	Simplified Janbu	2.5

Short Term Stability Analysis (Ash benches)

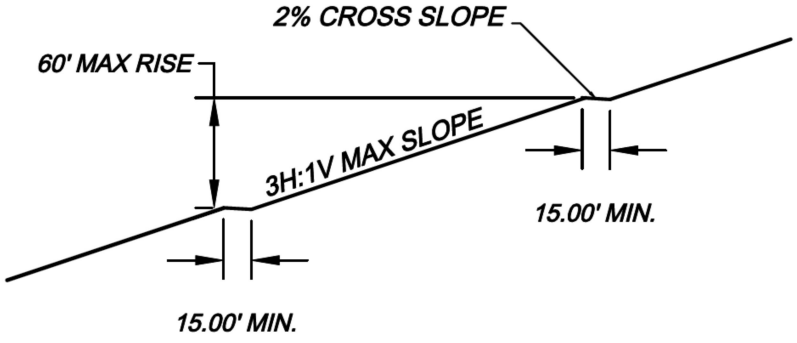
(Minimum factors of safety of 1.5 static and 1.2 pseudo-static conditions are recommended)

Description	Cross Section Slope (Ash Bench)	Bench Height (ft)	Method	Factor of Safety
Short term stability circular failure mode (static)	2H:1V	60	Modified Bishop	2.1
Short term stability circular failure mode (pseudo-static)	2H:1V	60	Modified Bishop	1.8

2.8 Design Parameters

After reviewing the recommendations from the PSI Geotechnical Engineering Report, SCA determined the following design parameters for the SCA #2 Ash Landfill:

- 3H:1V slope on the face of the landfill
- Benches/Terraces 15 feet wide at a maximum vertical spacing of 60 feet
- Drainage Collection ditches on each bench/terrace with the ditch profile slope generally in the range of 1-2%. Drainage is directed to perimeter collection ditches, through erosion control BMP's and sediment traps and then into a clay-lined sediment pond.



TYPICAL FILL SECTION

In an effort to be more conservative and provide for a greater factor of safety in the design, SCA is using a design slope of 3H:1V on the face of the landfill instead of the steeper 2H:1V slope that the geotechnical engineer has determined to be allowable. SCA recognizes the variability that may occur in construction and has chosen this gentler slope to provide flexibility and a level of tolerance in the construction conditions. A construction tolerance will allow segments with

slopes up to 2.5H:1V without re-grading, but all areas that inadvertently end up steeper than 2H:1V will be re-graded.

SCA also expects that this gentler design slope will give the project a greater stability, reduced risk of erosive conditions and improved conditions for reclamation.

2.9 Settlement Analysis

The placement of ash on the alluvium is likely to cause settlement of the alluvium. The geotechnical analysis of the site indicates that, given the granular nature of the overburden and ash materials, consolidation settlement and secondary compression have been determined to be negligible. Immediate settlement is calculated with the soil behaving as a linear elastic material. Settlement is estimated to be on the order of 6 to 8 inches. Settlement of the material should occur relatively quickly after initial placement. Thus the majority of expected settlement should occur during construction as the ash materials are placed.

The magnitude of expected settlement (even if it was double the estimated amount) is tolerable during construction and operation of the SCA #2 Ash Landfill.

2.10 Summary of Geotechnical Conclusions

The conclusions of the PSI geotechnical evaluation are summarized in the following paragraphs.

Water: While ground water was not observed in MW-9, MW-10, MW-11, Boring B-2 (upper east slope) or in any of the test pits, ground water was observed in Boring B-1 (MW-8) at the lower west end of the site. No surface waters are present at the site or within the near proximity of the site. The granular surface soils (ranging from approximately 14 to 50 feet thick) on top of the relatively impervious shale bedrock will provide an adequately porous layer to convey any ground water that does migrate under the proposed ash landfill. Any migrating ground water is expected to move in a general northeast to southwest direction atop the shale bedrock and at least 10 feet below the ground surface in the vicinity of the landfill and not come into contact with the ash materials.

Leachate Evaluation: PSI recommended placement of a 6-inch thick low permeability soil cap on top of the completed landfill with a native soil cover above that for re-vegetation. Surface water should be controlled to reduce the potential for erosion or ponding and observed erosion conditions should be repaired. Providing these recommendations are followed, PSI anticipates that the risk of water percolating through the ash material and into the groundwater is minimal.

SCA is following R315-319-102 and is installing an 18-inch thick infiltration layer with a permeability no greater than 1 x 10-5 cm/sec. This will minimize the potential for water to migrate into the fill and will thereby minimize saturation and increase stability of the fill.

Structural Stability: PSI conducted several structural stability analyses for the landfill in various possible configurations ranging from bench heights of 30 ft. and cross slope section of 1.5H:1V up to a bench height of 60 feet and cross slope section of 2H:1V. All of the configurations modeled indicated short term and long term safety factors greater than the minimums recommended per ASTM E 2277-03 "Standard Guide for Design and Construction of Coal Ash Structural Fills" and also in accordance with the guidelines presented in USACE Manual EM 1110-2-1902 "Slope Stability".

Settlement: PSI recommends that ash materials be placed in maximum 12-inch lifts and with proper compaction; the expected settlement occurring in this landfill will have minimal impact.

Site Suitability: Based on the results and recommendations of their study, PSI is of the opinion that the site of the SCA#2 ash landfill is suitable from a geotechnical engineering perspective.

2.11 Unstable Closure Requirements

Subsection R315-319-101(d) requires the owner of an existing CCR landfill to close within 6 months of determining that the existing CCR landfill has not demonstrated compliance with the location restriction for unstable areas specified in Subsection R315-319-64(a). The conclusions reached by PSI have determined that the area is stable. In the event that conditions change and future conditions demonstrate an unstable area, SCA will comply with the requirements of Subsection R315-319-101(d) at that time.

APPENDIX 2-A

GEOTECHNICAL ENGINEERING REPORT
PSI – APRIL 2012