U.S. Department of Energy
200 Grand Avenue
Grand Junction, CO 81501

January 15, 2009

Mr. Myron Fliegel
Office of Nuclear Material Safety & Safeguards
U.S. Nuclear Regulatory Commission
Mail Stop T78J
Two White Flint North
11545 Rockville Pike
Rockville, MD 20852-2747

Subject: Rock Quality Evaluation of the Minor Fraction of the Fremont Junction Rock Source for Use on the Crescent Junction Disposal Cell

Dear Mr. Fliegel:

During the U.S. Nuclear Regulatory Commission's technical review and subsequent approval of the Fremont Junction rock source, a more detailed evaluation of the deposit to further analyze the minor lithology fraction.

The enclosed report provides the results of the evaluation and indicates the basalt produced from the Fremont Junction deposit can be properly managed to assure that the appropriate volume is present in the final product.

Please contact me at 970-257-2115 if you have any questions or concerns.

Sincerely,

Donald R. Metzler
Federal Project Director

cc w/o enclosure:
J. Berwick, DOE (e)
K. Wethington, DOE (e)
B. Anderson, RAC (e)
L. Brede, RAC (e)
Project File CRJ 2.12 (C. Smith)

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SM-4224-09-1046

Rock Quality Evaluation of the Minor Fraction of the Fremont Junction Rock Source for Use on the Crescent Junction Disposal Cell

December 2008

Stoller

Work Performed by S.M. Stoller Corporation Under Purchase Order No. 3030
for Energy*Solutions*, Moab, Utah. Energy*Solutions* Performs Work for the
U.S. Department of Energy Under Task Order No. DE-AT30-07CC00014

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1.0 Introduction

The U.S. Department of Energy (DOE) previously investigated an alluvial deposit at the Fremont Junction site in Sevier County, Utah, (Figure 1) and determined that the deposit contains high quality gray basalt that is acceptable for use as aggregate and riprap for construction of the Uranium Mill Tailings Remedial Action (UMTRA) Crescent Junction disposal cell (DOE 2008). DOE estimated that the minor fraction of the deposit consists of red basalt, sandstone, and a trace amount of limestone, chert, and quartzite. The red basalt, chert, and quartzite appear to be at least as high quality as the gray basalt, but the sandstone and limestone clasts are softer and less durable.

During the U.S. Nuclear Regulatory Commission (NRC) technical review, and subsequent approval of the Fremont Junction rock source, a more detailed rock quality evaluation of the minor fraction of the deposit was requested due to concerns about the actual quantity and durability of the non-gray basalt rock types. This report presents the results of a quantitative evaluation performed to determine the actual quantity and rock quality of the minor fraction of the Fremont Junction deposit.

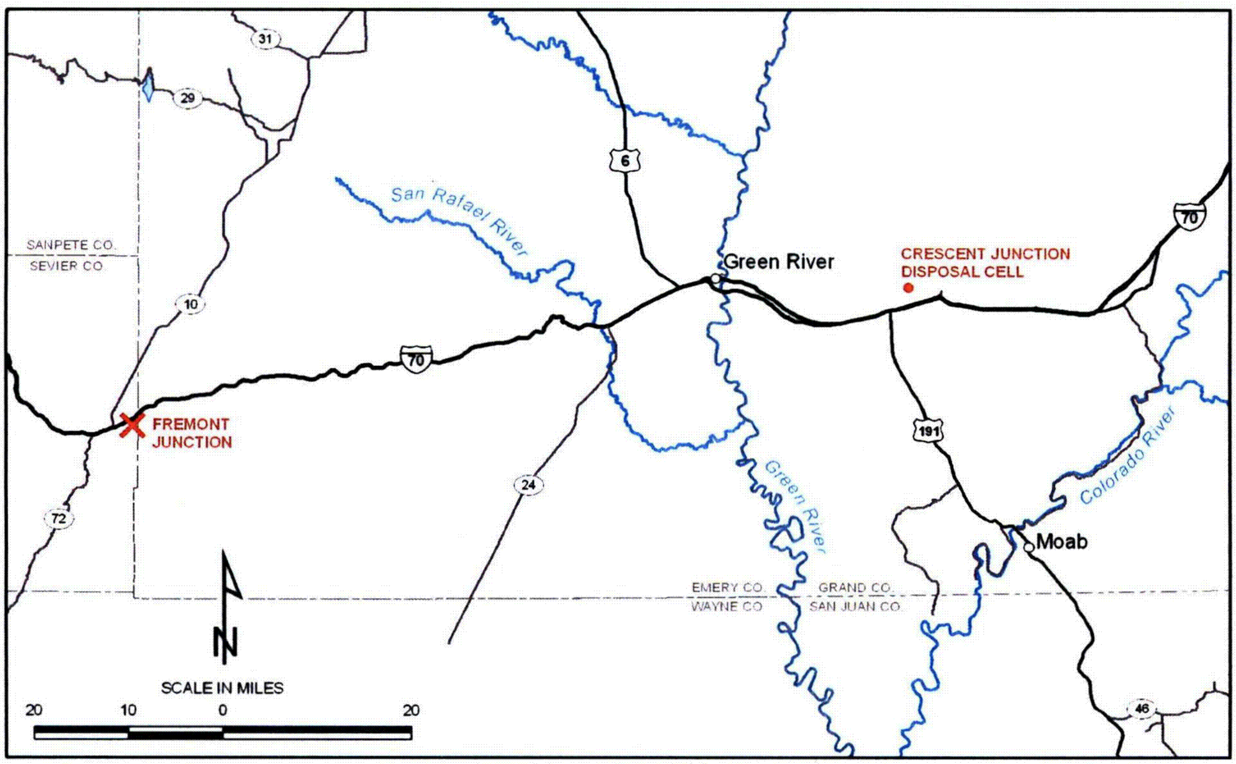

Figure 1. Location of the Fremont Junction Alluvial Deposit and the UMTRA Green River and Crescent Junction Disposal Cells

2.0 Purpose and Scope

Several rock quality investigations of the Fremont Junction deposit have been conducted in the past for the purpose of evaluating the basalt material for use in providing long-term protection of the UMTRA disposal cell near Green River, Utah, and more recently for use on the construction of the UMTRA Crescent Junction disposal cell (Figure 1). A summary of these geologic investigations is provided in the DOE Remedial Action Plan and Site Design for Stabilization of Moab Title I Uranium Mill Tailings at the Crescent Junction, Utah, Disposal Site (DOE 2008).

The rock production procedure approved by the NRC (DOE 2008) requires that the amount of any lower quality non-gray basalt rock types used in construction of the Crescent Junction disposal cell be limited to no more than 10 percent by volume. For this reason, the primary objectives of this evaluation are to (1) determine the quality of the non-gray basalt rock types based on NRC durability scoring criteria, and (2) more accurately estimate the percent by volume of the non-gray basalt rock type present in the deposit. Based on this information the lower quality non-gray basalt rock produced from the Fremont Junction deposit can be properly managed to assure that no more than 10 percent by volume is present in the final product.

3.0 Rock Quality of Minor Fraction

The alluvial deposit of gray basalt that is suitable for use in construction of the cover for the Crescent Junction disposal cell underlies an overburden that is as much as 8 feet (ft) thick in places. The underlying alluvial deposit, which ranges in thickness from 5 to 15 ft, consists of a variable amount (15 to 45 percent by volume) of subrounded cobbles and boulders of dense to vesicular basalt and other rock types such as sandstone, limestone, chert, and quartzite. The remaining volume of this deposit is matrix material smaller than 3 inches in diameter which consists of gravel, sand, and silt.

DOE estimated visually that approximately 95 percent of the cobbles and boulders in the deposit consist of gray basalt (DOE 2008). The rest of the cobbles and boulders in the deposit (approximately 5 percent) is considered the minor fraction and consists mostly of red basalt, which can be dense or vesicular and in boulders as large as 4 ft in diameter, and soft, friable sandstone that can be tan, light gray, or red and in boulders as much as 3 ft in diameter. Also represented in the minor fraction are trace amounts (less than 1 percent) of light gray to white limestone, gray chert, and white quartzite, all of which are in clasts mostly less than 1 ft in diameter. Additional basalt and sandstone samples were collected on July 30, 2008, from the 400-acre Fremont Junction site permitted by the State of Utah for purposes of ordinary sand and gravel mining (Figure 2). These samples are representative of the minor fraction of the deposit and were collected from previously excavated backhoe pits (BH-5 and BH-8) reported in DOE (2008).

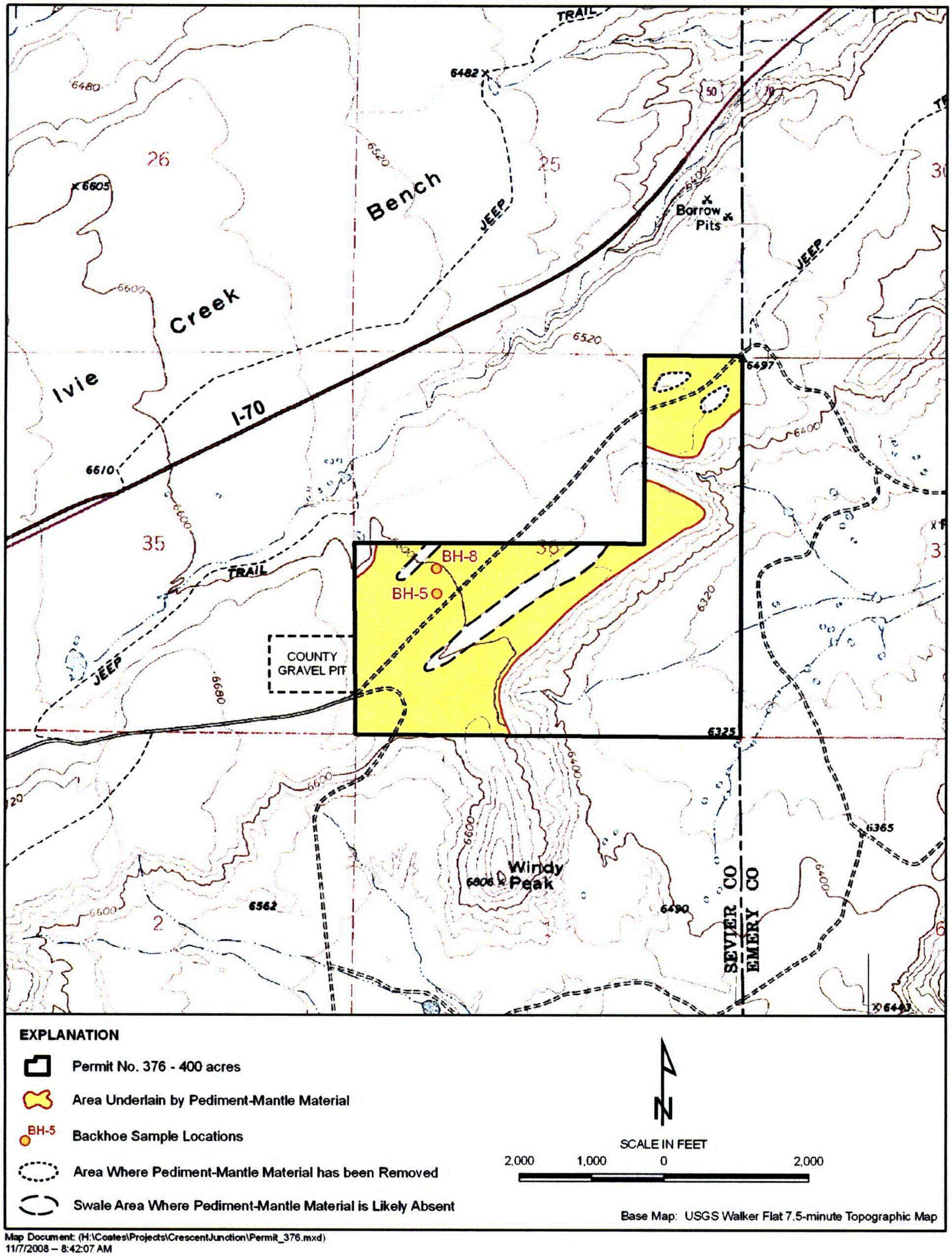

Figure 2. Minor Fraction Sample Locations at the Fremont Junction Site

A total of four samples, consisting of two basalts and two sandstones, were collected from the minor fraction of the deposit for rock durability testing. Both of the basalt samples are vesicular and of the red variety. One of the red basalt samples (BH-8A) is moderately vesicular whereas the second basalt sample is more massive and only slightly vesicular (BH-5A). Both of the sandstone samples are fine-grained and friable. One sample (BH-8B) is tan to light gray whereas the other sample (BH-8C) is light red. The basalt and sandstone samples are representative of the rock types found in the minor fraction of the deposit. Photographs of the samples are provided in Appendix A.

3.1 NRC Durability Testing

Samples were submitted for laboratory testing for the NRC rock quality criteria in accordance with NUREG-1623 (NRC 2002). Laboratory test results are presented in Appendix A and include bulk specific gravity, absorption, sodium sulfate soundness loss, and LA abrasion loss. Test results were not available (na) for rock hardness by the Schmidt rebound (hammer) method. Laboratory test results are summarized in Table 1.

Table 1. Durability Test Results for Representative Rock Samples Collected From the Minor Fraction of the Fremont Junction Deposit

Sample Location	Lab ID	Sample Description	Laboratory Test Result				
			Bulk Specific Gravity (gm/cm^3)	Absorption (%)	Sodium Sulfate Soundness Loss (%)	LA Abrasion Loss, 100 Cycles (%)	Schmidt Hammer
BH-5A	135769 141801 135771	Red basalt massive to slightly vesicular	2.588	1.4	0.0	6.1	na
BH-8A	135768 141802 135772	Red basalt moderately vesicular	2.242	1.7	0.0	7.0	na
BH-8B	135770 141799 118852	Sandstone light gray to tan, friable	2.430	2.7	1.2	13.2	na
BH-8C	135767 141800 135774	Sandstone light red, friable	2.524	1.7	1.0	13.7	na

Results of the tests presented in Table 1 were used to calculate the NRC rock quality scores using the scoring criteria presented in NUREG-1623 (NRC 2002). The calculated NRC scores are summarized in Table 2.

The NRC final rock quality score listed in Table 2 for the massive to slightly vesicular red basalt (BH-5A) is greater than 80 percent indicating that this rock type is consistent with the high quality gray basalt (DOE 2008).

The NRC final rock quality score listed in Table 2 for the moderately vesicular red basal is approximately 54 percent. Examination of the data presented in Tables 1 and 2 indicate that the relatively low final score for this sample is the result of a very low specific gravity, most likely due to the moderately vesicular nature of this rock type. Other than the low specific gravity, the other durability scores are similar to the more dense gray basalt. Because of the relative low final score for this sample, the moderately vesicular red basalt rock type is considered poor quality.

NRC final rock quality scores listed in Table 2 for the sandstone samples (BH-8B and BH-8C), are less than 50 percent, indicating that this rock type is also considered poor quality.

Table 2. NRC Rock Quality Scores for Representative Rock Samples Collected From the Minor Fraction of the Fremont Junction Deposit

Sample Location	Lab ID	Sample Description	Weighted Test Score					Total Score	Max Score	Final Score
			Specific Gravity	Absorption	Sodium Sulfate	LA Abrasion	Schmidt Hammer			
BH-5A	135769 141801 135771	Red basalt massive to slightly vesicular	61.2	8.4	110	7.4	na	187	230	81.3%
BH-8A	135768 141802 135772	Red basalt moderately vesicular	0.0	7.2	110	6.8	na	124	230	53.9%
BH-8B	135770 141799 118852	Sandstone light gray to tan, friable	21.6	7.5	29.7	29.6	na	88.4	220	40.2%
BH-8C	135767 141800 135774	Sandstone light red, friable	33	18	30	28	na	109	220	49.5%
weighting factor igneous			9	2	11	1	3			
max score igneous			90	20	110	10			230	
weighting factor sandstone			6	5	3	8	13			
max score sandstone			60	50	30	80			220	

4.0 Percent Volume of Minor Fraction

The portion of the deposit containing mostly gray basalt quarried from the Fremont Junction site will initially be crushed to provide angularity, help remove lower quality material present in the minor fraction (crushed away), and provide appropriate sizes to meet the gradation specifications. The crushed rock will be placed in production stockpiles according to the gradation sizes required for use during construction of the Crescent Junction disposal cell. Durability test results presented above indicate that the moderately vesicular red basalt and the sandstones are characterized by poor rock quality scores and therefore should be extracted from the production stockpiles if present in amounts greater than 10 percent by volume.

A reasonable estimate of the percent by volume of the poor quality rock that can be expected to be present in the production stockpiles can be determined by examining the cover material present on the UMTRA disposal cell near Green River, Utah. This cover material was approved by the NRC for use on the Green River cell and was quarried from the same Fremont Junction deposit as planned and approved by the NRC for use on the Crescent Junction cell. Determining the amount of non-gray basalt rock types (minor fraction) present on the existing Green River cover provides a reasonable estimate of the percent by volume expected in the production stockpiles because the crushing operation would be similar.

4.1 Measurement Approach

A quantitative approach was used to measure the percent volume of the minor fraction present on the Green River cell cover. This consisted of establishing three measurement grids on the cell cover near the southeast end of the northeast facet (A), near the center of the southeast facet (B), and in the south part of the southwest facet (C). Each measurement grid is a square approximately 152 centimeters (cm) (5 ft) on each side. The locations of the three grids are shown in Figure 3 and photographs provided in Appendix B.

The Wolman pebble count method (Wolman 1954) was used to measure the length (a-axis) and the width (b-axis) of each non-gray basalt rock observed within each grid. In addition, the rock type was recorded for each non-gray basalt rock that was measured (i.e. red basalt, sandstone, chert, quartzite, etc.). The surface area of each non-gray basalt rock was calculated by multiplying the a-axis dimension by the b-axis dimension. The percent by volume for each non-gray basalt rock type is calculated by dividing the sum of the surface area of the rock type (centimeters squared [cm^2]) by the total area of the grid (23,226 cm^2) multiplied by 100 percent as shown in the equation below:

$$\text{Perent by volume} = \left(\frac{\text{area of rock type}}{\text{total area of grid}}\right) \times 100\%$$

The percent by volume of gray basalt is calculated by subtracting the percent of non-gray basalt from 100. Results of the field measurements for each grid location (A, B, and C) are presented in Appendix B and summarized in Table 3.

Table 3. Percent by Volume of Rock Types

Rock Type	Percent (%) by Volume			
	Measurement Grid			Average
	A	B	C	
Gray basalt	95.3	94.3	95.6	95.1
Non-gray basalt	4.7	5.7	4.4	4.9
red basalt	1.5	2.6	2.3	2.1
sandstone	3.1	3.1	1.7	2.6
other	0.1	0.0	0.4	0.2

Results summarized in Table 3 indicate that approximately 95 percent by volume of the rock types present on the Green River cover consist of gray basalt of high durability quality. For the remaining 5 percent (minor fraction), about half (2 to 3 percent) are red basalt, about half (2 to 3 percent) are sandstone, and a trace amount (< 1 percent) are other rock types such as chert and quartzite. Light gray to white limestone observed in-situ at the Fremont Junction deposit was not observed at any of the measurement grids on the Green River cell. Only one rock sample was observed that exhibited severe weathering effects and appeared to be altered gray-green basalt (Grid C, Appendix B). This indicates that relative poor quality rock types were removed by the crushing operation.

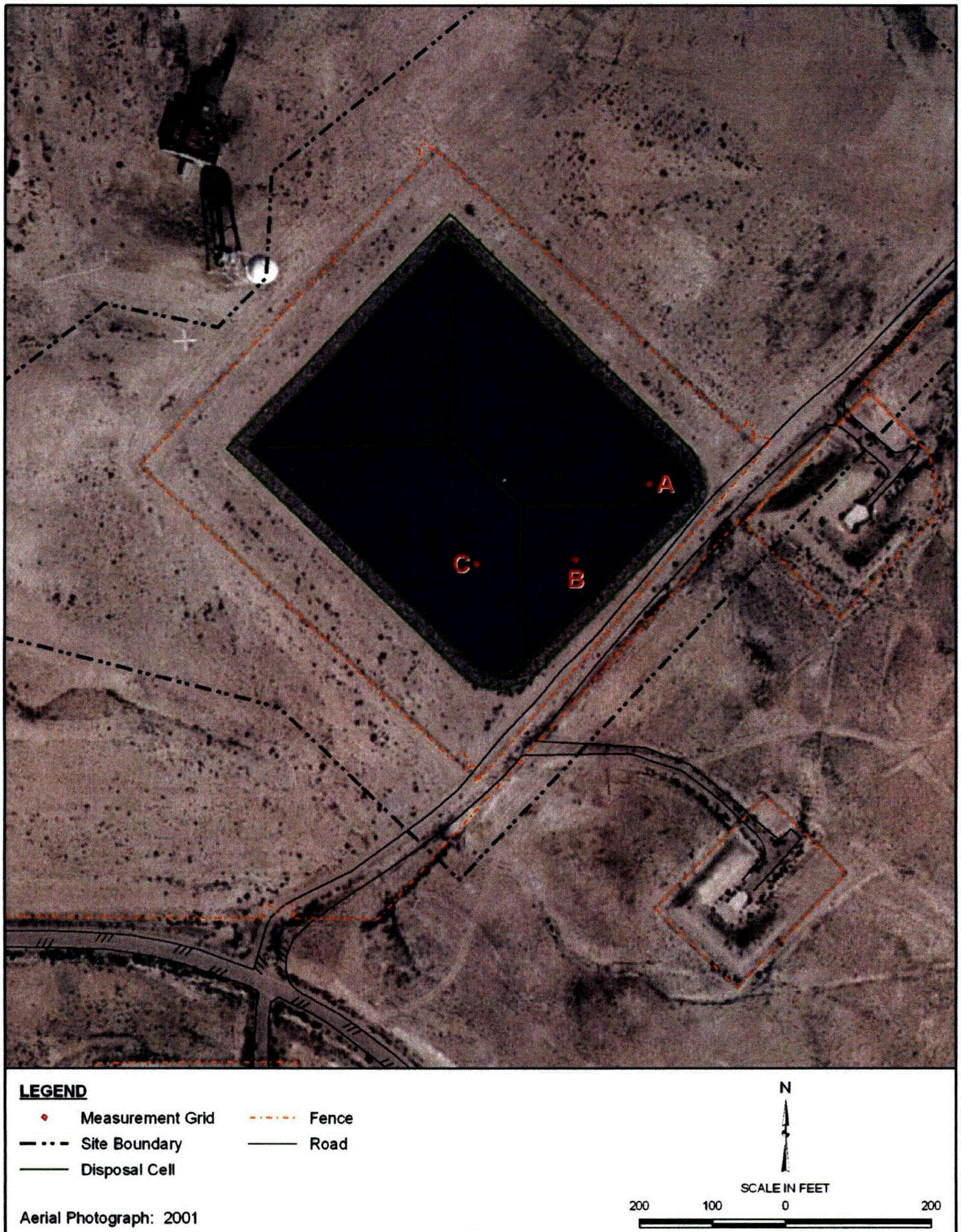

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Figure 3. Location of Measurement Grids Established at the Green River Cell Cover

5.0 Findings and Conclusions

The minor fraction of the rock material on the Green River cell cover has been determined to represent approximately 5 percent by volume and consists mostly of red basalt and sandstone. The remaining 95 percent of the rock present on the Green River cover consists of high quality gray basalt. These results provide a reasonable estimate of the percent by volume of the gray dense basalt (95 percent) and non-gray basalt rock types (5 percent) expected to occur in the Crescent Junction production stockpiles because the crushing operation would be similar and the rock source is the same as used for the Green River cover material. These quantitative results are also consistent with the visual observations of the Fremont Junction deposit presented in the DOE *Final Remedial Action Plan and Site Design for Stabilization of Moab Title I Uranium Mill Tailings at the Crescent Junction, Utah, Disposal Site* (DOE 2008).

Other findings related to the minor rock fraction are listed below:

1. Red basalt and sandstone occur in approximately equal proportions.
2. The massive to slightly vesicular red basalt is as high quality and as durable as the dense gray basalt.
3. The moderately vesicular red basalt and the sandstone are of poor quality.

Based on the findings presented above the following conclusions can be made:

1. The absence of soft, friable sandstone and limestone on the Green River cell cover suggests that the rock processing operation (vibratory and dynamic hammers) and screening planned for the Crescent Junction cover material provides assurance that the lower quality material will be removed (crushed away). Therefore, the potential is low for significant unacceptable rock to be present in the production stockpiles.
2. The amount of poor quality rock expected to occur in the production stockpiles is less than 5 percent. Therefore, it is unlikely that the lower quality material will need to be extracted to assure that no more than 10 percent by volume is present in the final product to meet the NRC requirements.

6.0 References

DOE (U.S. Department of Energy) 2008. *Final Remedial Action Plan and Site Design for Stabilization of Moab Title I Uranium Mill Tailings at the Crescent Junction, Utah, Disposal Site, Remedial Action Selection Report*, DOE-EM/GJ1547-2008, U.S. Department of Energy Office of Environmental Management, Grand Junction, Colorado, February.

NRC (U.S. Nuclear Regulatory Commission) 2002, *Design of Erosion Protection for Long-Term Stabilization*, NUREG-1623, U.S. Nuclear Regulatory Commission, Washington, DC, September.

Wolman, M.G., 1954. *A method of sampling coarse river-bed material: Transactions of the American Geophysical Union*, v. 35, p. 951-956.

Appendix A

Photographs and Laboratory Results From Rock Samples Collected at Fremont Junction

1. Photographs of rock samples collected from the minor rock fraction of the Fremont Junction deposit.
2. Laboratory durability test results on Fremont Junction rock samples.

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Figure A–1. Photograph of Basalt Samples Collected from the Fremont Junction Deposit

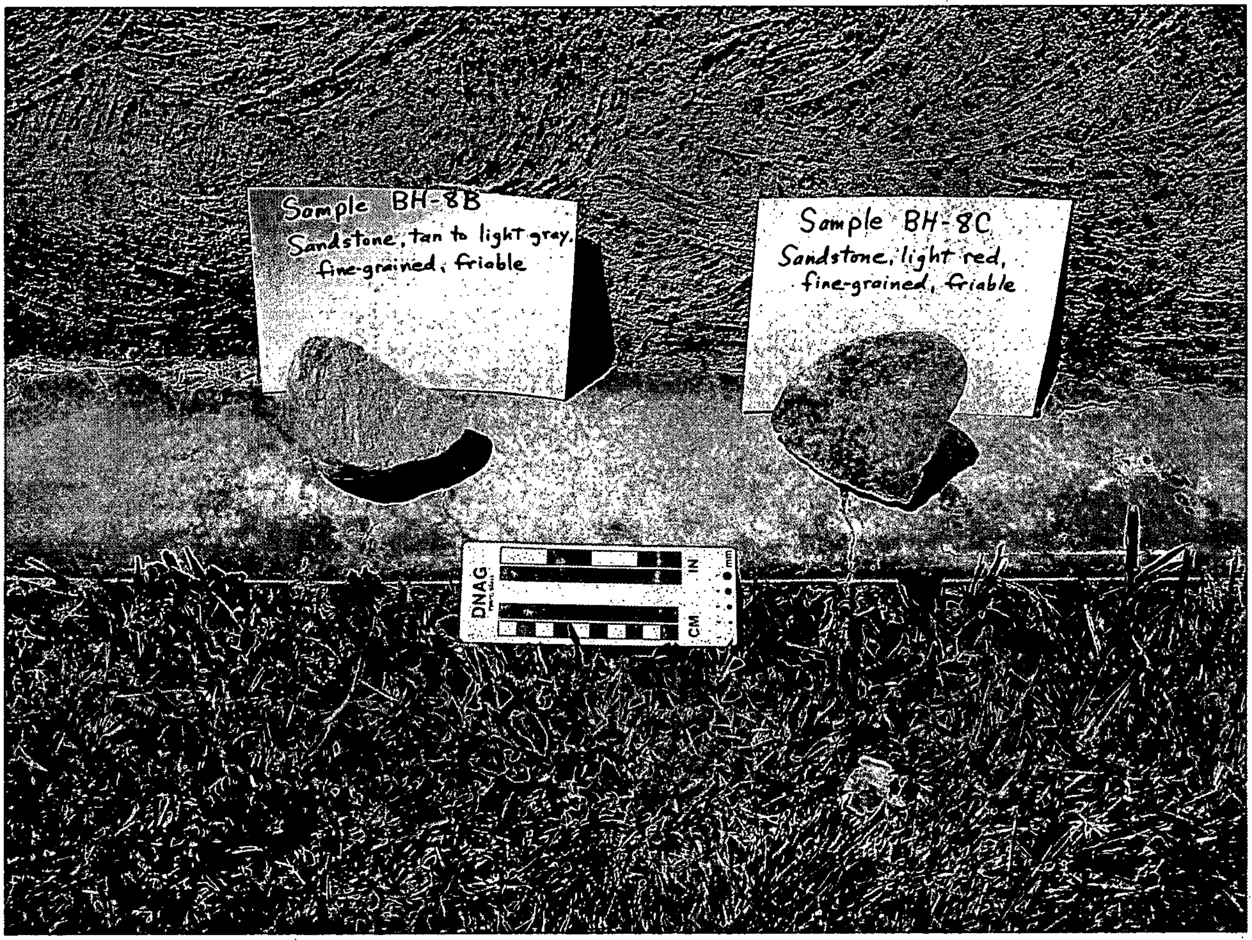

Figure A–2. Photograph of Sandstone Samples Collected from the Fremont Junction Deposit

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October 8, 2008

Neilson Construction
P.O. Box 620
Huntington, Utah 84528

Project: Energy Solutions
Project#: 3022
Material: BH-5A reddish stone
Source: ~~Blue Hills~~
Fremont

Laboratory Test	Average Test Value	Score	Weight	Score & Weight	Max Score
Mineral Type			*Igneous		
Specific Gravity	2.588	6.6	9	59.4	90
Absorption %	1.4%	4.1	2	8.2	20
Sodium Sulfate %	0.0%	10	11	110	110
LA Abrasion	6.1	7.5	1	7.5	10
Schmidt Hammer	Did not run				
Total Score					

*** Based on previous materials received in lab**
Rating = Unable to calculate without Schmidt hammer results

TEST RESULTS

Specific Gravity and Absorption ASTM C-127
Lab # 135769

Relative Density (oven Dry) = 2.588
Relative Density (SSD) = 2.625
Relative Density (apparent) = 2.688
Absorption (%) = 1.4 %

BH-5A

Los Angeles Abrasion ASTM C-131
Lab # 141801

100 Revolutions		Grading A	
12 Spheres			
	% Wear	=	6.1 %

Sodium Soundness ASTM C-88
Lab # 135771

% Loss = 0.0 %

Schmitt Hammer

Rebound Number Did not run

Average=

Sincerely,

Susan Arnold

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Geotechnical, Environmental, & Materials Engineering/Testing/Research

October 8, 2008

Neilson Construction
P.O. Box 620
Huntington, Utah 84528

Project: Energy Solutions
Project#: 3022
Material: BH-8A highly porous reddish stone
Source: ~~Blue Hills~~
Fremont

Laboratory Test	Average Test Value	Score	Weight	Score & Weight	Max Score
Mineral Type			*Igneous		
Specific Gravity	2.242	0	9	0	90
Absorption %	1.7%	3.5	2	7	20
Sodium Sulfate %	0.0%	10	11	110	110
LA Abrasion	7.0	6.7	1	6.7	10
Schmidt Hammer	Did not run				
Total Score					

*** Based on previous materials received in lab**
Rating = Unable to calculate without Schmidt hammer results

TEST RESULTS

Specific Gravity and Absorption ASTM C-127
Lab # 135768

Relative Density (oven Dry) = 2.242
Relative Density (SSD) = 2.279
Relative Density (apparent) = 2.329
Absorption (%) = 1.7 %

BH-8A

Los Angeles Abrasion ASTM C-131
Lab # 141802

100 Revolutions — Grading A
12 Spheres
% Wear = 7.0 %

Sodium Soundness ASTM C-88
Lab # 135772

% Loss = 0.0 %

Schmitt Hammer

Rebound Number — Did not run

Average=

Sincerely,

Susan Arnold

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Geotechnical, Environmental, & Materials Engineering/Testing/Research

October 8, 2008

Neilson Construction
P.O. Box 620
Huntington, Utah 84528

Project: Energy Solutions
Project#: 3022
Material: BH-8B Tan Sandstone
Source: ~~Blue Hills~~ Fremont

Laboratory Test	Average Test Value	Score	Weight	Score & Weight	Max Score
Mineral Type			Sandstone		
Specific Gravity	2.430	3.5	6	39	60
Absorption %	2.7%	1.5	5	45	50
Sodium Sulfate %	1.2%	9.8	3	30	30
LA Abrasion	13.2	3.7	8	57.6	80
Schmidt Hammer	Did not run				
Total Score					

Rating = Unable to calculate without Schmidt hammer results

TEST RESULTS

Specific Gravity and Absorption ASTM C-127
Lab # 135770

Relative Density (oven Dry) = 2.430
Relative Density (SSD) = 2.496
Relative Density (apparent) = 2.603
Absorption (%) = 2.7 %

BH-8B

Los Angeles Abrasion ASTM C-131
Lab # 141799

100 Revolutions   Grading A
12 Spheres
% Wear = 13.2 %

Sodium Soundness ASTM C-88
Lab # 118852

% Loss = 1.2 %

Schmitt Hammer

Rebound Number   Did not run

Average=

Sincerely,

Susan Arnold

Susan Arnold

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October 8, 2008

Neilson Construction
P.O. Box 620
Huntington, Utah 84528

Project: Energy Solutions
Project#: 3022
Material: BH-8C orange sandstone
Source: ~~Blue Hills~~
Fremont

Laboratory Test	Average Test Value	Score	Weight	Score & Weight	Max Score
Mineral Type			Sandstone		
Specific Gravity	2.524	5.3	9	47.7	90
Absorption %	1.7%	3.8	2	7.6	20
Sodium Sulfate %	1.0%	10	11	110	110
LA Abrasion	13.7	3.2	1	3.2	10
Schmidt Hammer	Did not run				
Total Score					

Rating = Unable to calculate without Schmidt hammer results

TEST RESULTS

Specific Gravity and Absorption ASTM C-127
Lab # 135767

Relative Density (oven Dry) = 2.524
Relative Density (SSD) = 2.568
Relative Density (apparent) = 2.640
Absorption (%) = 1.7 %

BH-8C

Los Angeles Abrasion ASTM C-131
Lab # 141800

100 Revolutions		Grading A	
12 Spheres			
	% Wear	=	13.7 %

Sodium Soundness ASTM C-88
Lab # 135774

% Loss = 1.0 %

Schmitt Hammer

Rebound Number Did not run

Average=

Sincerely,

Susan Arnold

Susan Arnold

Appendix B

Photographs and Field Measurement Results of Minor Rock Fraction on UMTRA Green River Cell Cover

1. Photographs of Field Grids A, B, and C on the UMTRA Green River cell rock cover.
2. Field measurement results for Grids A, B, and C on the UMTRA Green River cell rock cover.

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Figure B–1. Photograph of Field Grid A

Figure B–2. Photograph of Field Grid B

Figure B–3. Photograph of Field Grid C

Table B–1. Field Measurement Results for Grid A

Grid A (23,226 cm^2)				
Clast No.	a-axis (cm)	b-axis (cm)	area (cm^2)	Rock Type
1	7	3	21	chert
2	4	3	12	red basalt
3	3	2	6	red basalt
4	11	7	77	red basalt
5	5	4	20	red basalt
6	4	3	12	red basalt
7	4	3	12	red basalt
8	13	7	91	red basalt
9	14	7	98	red basalt
10	5	5	25	red basalt
11	13	6	78	sandstone
12	4	3	12	sandstone
13	5	4	20	sandstone
14	4	4	16	sandstone
15	3	2	6	sandstone
16	7	5	35	sandstone
17	9	5	45	sandstone
18	3	3	9	sandstone
19	10	2	20	sandstone
20	10	4	40	sandstone
21	3	2	6	sandstone
22	8	6	48	sandstone
23	12	8	96	sandstone
24	7	2	14	sandstone
25	10	5	50	sandstone
26	6	6	36	sandstone
27	11	9	99	sandstone
28	8	2	16	sandstone
29	14	4	56	sandstone
30	4	4	16	sandstone

Summary Statistics (percent by volume)

gray basalt	95.3
non gray basalt	4.7
chert	0.1
red basalt	1.5
sandstone	3.1

Table B–2. Field Measurement Results for Grid B

Grid B (23,226 cm²)				
Clast No.	**a-axis (cm)**	**b-axis (cm)**	**area (cm²)**	**Rock Type**
1	4.0	2.0	8.0	red basalt
2	8.0	5.0	40.0	red basalt
3	10.0	6.0	60.0	red basalt
4	12.0	7.0	84.0	red basalt
5	7.0	3.0	21.0	red basalt
6	12.0	8.0	96.0	red basalt
7	6.0	3.0	18.0	red basalt
8	5.0	5.0	25.0	red basalt
9	7.0	2.0	14.0	red basalt
10	5.0	4.0	20.0	red basalt
11	5.0	2.0	10.0	red basalt
12	3.0	2.0	6.0	red basalt
13	4.0	3.0	12.0	red basalt
14	4.0	4.0	16.0	red basalt
15	7.0	6.0	42.0	red basalt
16	9.0	8.0	72.0	red basalt
17	4.0	3.0	12.0	red basalt
18	8.0	5.0	40.0	red basalt
19	4.0	2.0	8.0	red basalt
20	10.0	6.0	60.0	sandstone
21	6.0	6.0	36.0	sandstone
22	2.0	2.0	4.0	sandstone
23	5.0	4.0	20.0	sandstone
24	6.0	3.0	18.0	sandstone
25	6.0	3.0	18.0	sandstone
26	8.0	5.0	40.0	sandstone
27	8.0	6.0	48.0	sandstone
28	6.0	5.0	30.0	sandstone
29	4.0	3.0	12.0	sandstone
30	10.0	5.0	50.0	sandstone
31	4.0	2.0	8.0	sandstone
32	8.0	5.0	40.0	sandstone
33	5.0	3.0	15.0	sandstone
34	9.0	7.0	63.0	sandstone
35	4.0	4.0	16.0	sandstone
36	7.0	5.0	35.0	sandstone
37	4.0	2.0	8.0	sandstone
38	6.0	4.0	24.0	sandstone
39	3.0	2.0	6.0	sandstone
40	5.0	4.0	20.0	sandstone
41	5.0	2.0	10.0	sandstone
42	6.0	6.0	36.0	sandstone
43	3.0	3.0	9.0	sandstone
44	5.0	5.0	25.0	sandstone
45	11.0	7.0	77.0	sandstone

Table B–2. Field Measurement Results for Grid B (continued)

Summary Statistics (percent by volume)

gray basalt	94.3
non gray basalt	5.7
red basalt	2.6
sandstone	3.1

Table B–3. Field Measurement Results for Grid C

Grid C (23,226 cm^2)				
Clast No.	**a-axis (cm)**	**b-axis (cm)**	**area (cm^2)**	**Rock Type**
1	8	8	64	quartzite
2	9	3	27	rubblized altered gray-green basalt
3	11	7	77	red basalt
4	4	3	12	red basalt
5	5	4	20	red basalt
6	5	4	20	red basalt
7	16	7	112	red basalt
8	11	8	88	red basalt
9	8	7	56	red basalt
10	9	5	45	red basalt
11	8	4	32	red basalt
12	4	2	8	red basalt
13	10	5	50	red basalt
14	5	3	15	red basalt
15	15	6	90	sandstone
16	3	2	6	sandstone
17	6	5	30	sandstone
18	6	3	18	sandstone
19	5	2	10	sandstone
20	6	3	18	sandstone
21	8	6	48	sandstone
22	5	4	20	sandstone
23	9	3	27	sandstone
24	8	7	56	sandstone
25	6	4	24	sandstone
26	8	5	40	sandstone

Summary Statistics (percent by volume)

gray basalt	95.6
non gray basalt	4.4
rubblized basalt	0.1
quartzite	0.3
sandstone	1.7
red basalt	2.3

End of Current Text