APPENDIX A

PREVIOUS WORK

APPENDIX A1

SUMMARY OF RELEVANT GEOTECHNICAL DATA

MWH

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BUILDING A BETTER WORLD

TECHNICAL MEMORANDUM

TO: *Mr. Lance Hauer, GE*

DATE: *August 12, 2013*
(Revised September 26, 2013)

FROM: *Jason Cumbers, PE, MWH*

REFERENCE: *1012376*

CC: *Toby Leeson, MWH*

SUBJECT: *Church Rock Mill Site Repository - Summary of Relevant Geotechnical Data*

Background

NRC and DOE comments on the MWH Draft Data Gaps Report (MWH, 2012) recommended a site geotechnical investigation of the foundation materials for the new repository. MWH evaluated existing geotechnical, geological and hydraulic data for the tailings and underlying materials in the vicinity of the proposed repository. Specifically, this information was evaluated relevant to the placement of mine spoils on top of the reclaimed tailings impoundment, in order to develop a focused geotechnical investigation program to obtain information to supplement existing information on the tailings, the underlying alluvium, and the Zone 3 Sandstone.

This memorandum provides a summary of existing data from the materials described above. This summary of data is focused on the area around the conceptual repository layouts and the specific data for the tailings, in the North and Central Cells. Pertinent geotechnical, geological and hydraulic information is summarized herein, and references, where specific test results and borehole information can be found, are presented. Figure 1 shows the locations of pertinent historic borings, wells, and geologic cross sections in the vicinity of the North and Central Cells. Figure 2 shows the locations of the currently existing wells at the site, as well as the locations of aquifer tests performed within the sandstone and alluvium, and permeability tests conducted at soil boring locations. Information on the borehole permeability tests is included in this summary and the existing information from the aquifer tests is further discussed in the documents included in Appendix B.

Table 1 provides a description of the existing relevant geotechnical data by study date and material type. This data summary includes available geotechnical data pertinent to loading of the tailings with mine spoils, and generally does not include data collected in the South Cell. Information in Table 1 is compiled from reports listed in the References section of this memorandum. Table 1 is not a comprehensive summary of all available geotechnical data from the North and Central Cells.

Tailings

Geotechnical data on the tailings in the North and Central Cells are available from several sources. Additional tailings data also exist for the tailings in the South Cell. During the

preliminary geotechnical investigation for the impoundment in 1974 (SHB, 1974), a bulk sample of the cycloned tailings sands was tested for gradation, permeability, and shear strength. The 1978 geotechnical investigation (SHB, 1978a) included drilling borings through the impoundment and through the tailings within the impoundment. Tailings samples were tested for Atterberg Limits, gradations, shear strength, and relative density. In 1979, UNC conducted a stability and integrity assessment of the dam (SHB, 1979). This assessment included a series of seven borings on the interior dikes (Northern Cross Dike and Southern Cross Dike) which separate the three cells. These borings were drilled through the existing tailings and provide thickness information and standard penetration test (SPT) data on the tailings. This investigation also includes data collected in the south cell.

A series of borings (658, 659, 660, and 662) were drilled through the tailings impoundment in 1985. Borings 658, 659, and 660 were located, west to east, across the Central Cell with 660 located within Borrow Pit No. 1. Boring 662 was drilled in the South Cell. These boring logs are included as attachments to a UNC memo (UNC, 1986) and provide tailings thickness information, as well as depths and thickness of fine-grained material within the profile. Testing on the samples collected from these boreholes include specific gravity, water content, dry density, and consolidation. This data was partially summarized in the impoundment Reclamation Plan (Canonie, 1991).

In 1992, a series of shallow borings were drilled in the tailings of the Central Cell, to aid in evaluation of the radon modeling (UNC, 1993). Geotechnical samples collected from shallow depths (less than 8 feet deep) were tested for specific gravity, water content, dry density, and gradation. No boring logs for this program were available for review. Interim stabilization of the Central Cell was completed in 1991, and tailings samples were collected in November 1992. Ground surface elevations are not provided; however, the borings appear to have been drilled from the interim cover surface. This tailings data was included in Appendix B of the Central Cell Final Reclamation As-Built Report (Canonie, 1995).

Based on the data for the North and Central Cells, the average specific gravity of the tailings samples is 2.71 and in general the samples are non-plastic. Fine-grained tailings samples have about twice the percentages (average by weight) passing the No. 100 (46 percent) and No. 200 (31 percent) sieves, and 6 percent finer than 0.001 mm, as compared with the coarse-grained samples. With the exception of one sample, both the coarse and fine fractions of the tailings samples were finer than the No. 10 sieve.

The water contents of the samples tested range from 4 to 60 percent with dry densities ranging from 73 to 118 pounds per cubic foot (pcf). Average water content of the coarser samples tested is 15 percent with an average dry density of 101 pcf. The average water content of the finer samples tested is 21 percent with an average dry density of 96 pcf. The reported coefficient of consolidation (C_c) results range from 0.018 to 1.00 for the tailings samples and the friction angles (from direct shear testing) range from 30° to 39°, with some results showing cohesion.

Embankment (North and Central Cells)
A series of borings (78a-15, 17, 18, 19, 20, 21) were drilled through the tailings embankment (SHB, 1978a), presumably to provide information on the materials and construction of the embankment. Borings 15, 17 and 18 were drilled adjacent to the Central Cell. Borings 19, 20, and 21 were drilled through the embankment on the north side of the North Cell. Data from

these borings include SPT, torvane shear strength, Atterberg limits, gradations, water contents, dry density, triaxial and direct shear, and laboratory permeability.

The 33 samples from the embankment adjacent to the North and Central Cells are generally classified as low plasticity clay (CL). Atterberg limits for the embankment soils indicate the liquid limits range from 23 to 42 percent and the plasticity indices range from 8 to 22 percent. The average of the plastic Atterberg limits results is a liquid limit of 31 percent and a plasticity index of 13 percent. The percentage passing the No. 200 sieve (fines) ranges from 50 to 77 percent (by weight) and the percentage passing the No. 4 sieve (sand) ranges from 98 to 100 percent. The average of the embankment soils tested indicate 66 percent fines by weight and 100 percent sand size particles, or smaller, by weight. The water content for the embankment samples ranges from 5 to 24 percent with dry densities ranging from 107 to 126 pcf. The average water content is 13 percent and the average dry density is 114 pcf. Direct shear test results on the embankment materials include phi angles of 7°, 49°, and 38° with cohesions of 1.45 kips per square foot (ksf), 1.69 ksf and 0.31 ksf, respectively.

Alluvium
Many of the site drilling programs previously performed in the area of the North and Central Cells include information from both drilling and laboratory testing on the alluvium underlying the tailings, the embankment and the existing cover at the site. Extensive data was collected on the alluvium including field and laboratory permeabilities, Atterberg Limits, gradations, water contents, consolidation tests, Proctor compaction tests, and shear strength. The SHB investigations (SHB, 1974, 1976, 1978a, 1978b, 1979) include laboratory tests on more than 200 alluvium samples taken from the vicinity of the North and Central Cells. While portions of the alluvium were excavated for construction at the site, several of the borings appear to extend below the current depths of tailings in the area of interest and provide geotechnical data on materials still in-place below the impoundment. Borings with geotechnical data below the estimated tailings depths include SHB-74-04, SHB-76-08, 11, SHB-78a-76, 77, and SHB-78b-07.

The alluvium samples from the North and Central Cells are generally classified as low plasticity clay (CL), but also include plastic and non-plastic silts, as well as silty and clayey sands. Atterberg limits for the plastic alluvial soils indicate the liquid limits of the alluvium range from 20 to 67 percent. The plasticity indices range from 4 to 45 percent. The average of the plastic Atterberg limits results is a liquid limit of 36 percent and a plasticity index of 18 percent, which corresponds to a low plasticity clay. The percentage passing the No. 200 sieve (fines) ranges from 0 to 94 percent (by weight) and the percentage passing the No. 4 sieve (sand) ranges from 1 to 100 percent. The average of the alluvium results indicate 41 percent fines by weight and 80 percent sand size particles, or smaller, by weight. The water content for the alluvium samples ranges from 2 to 31 percent with dry densities ranging from 94 to 106 pcf.

Zone 3 Sandstone
More than 50 geotechnical borings were identified that extend into the Zone 3 Sandstone in the vicinity of the proposed repository (SHB, 1974, 1976, 1978a, 1978b, 1979 and CSI, 1980). The bulk of the sandstone data include SPT data, water contents, and the contact elevations. Geotechnical laboratory data includes gradations, water content and Atterberg limits. Field permeability tests were also performed in the sandstone. Laboratory data on samples from the Zone 3 Sandstone is limited; however, water content results range from 5 to 19 percent, and two Atterberg limits tests indicate the sandstone is non-plastic. Two gradation results indicate 27

percent and 25 percent (by weight) passing the no. 200 sieve and 68 percent and 54 percent passing the No. 4 sieve.

Proposed Borrow Areas
MWH identified nineteen borings previously drilled in/or near the proposed East and West Borrow Areas. These include ten borings (SHB78b-18,19,20,28,30,31,32,33,34 and DH-1,3) in the East Borrow (SHB, 1978b and CSI, 1980) and eight borings (SHB78a-52,53,54,55,56 and DH-6,7,8) in or near the West Borrow (SHB, 1978a and CSI, 1980). After reviewing surface elevations to account for previous borrow operations in these areas, the existing data on the remaining subsurface profile includes depth to rock, SPT, gradations, Atterberg limits, and water contents. Depth of alluvium above the sandstone or siltstone appears to vary between about 0 and 25 feet in the proposed West Borrow and between about 0 and 14 feet in the proposed East Borrow Area. The alluvium in the borrow areas is generally classified as silty clay, sandy clay, silty sand, clayey sand, or clayey silt.

Laboratory data on samples from the lower alluvium includes, water content results ranging from 4 to 9 percent, dry densities ranging from 82 to 103 pcf, and two Atterberg limits tests indicate CL or CL-ML classification (liquid limits of 29 and 25 percent, plasticity indices of 14 and 6 percent). Gradation results indicate between 37 percent and 61 percent (by weight) passing the no. 200 sieve. Strength and consolidation testing was conducted on alluvium samples from DH-1 and DH-3 (CSI, 1980), located in the proposed East Borrow. Visual classification of the alluvium and SPT data are included on the referenced boring logs.

Conclusions
Based on the available data, and the geologic mapping of impoundment Area (Appendix B), the sampling plan has been developed to collect additional stratigraphy data on the thickness of the tailings in areas, where data is limited, specifically Borrow Pit No. 1 and the center of the Central Cell. The laboratory data previously collected provides index properties for the tailings, the embankment, and the underlying alluvium. The objectives of the proposed investigation will be to confirm these index properties and collect additional data on the consolidation and strength properties of the tailings, the strength properties of the alluvium and the embankment, and hydraulic properties (conductivity and soil water characteristic curves (SWCC)) on the tailings, the alluvium, and the Zone 3 sandstone.

Attachments:
Figure 1 – Location of Historic Borings, Wells, and Geologic Cross Sections
Figure 2 – Location of Existing Wells, and Hydraulic Field Test Data
Table 1 – Church Rock Mill Site Impoundment - Summary of Relevant Existing Geotechnical Data for the North and Central Cells

References:

D'Appolonia. 1981. *State of New Mexico Environmental Improvement Division, Uranium Mill License renewal Application-Environmental Report License No. NM-UNC-ML, UNC Mining and Milling Church Rock Operations Division of United Nuclear Corporation. Vol.1, Text and Tables.* December.

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Sergent, Hauskins & Beckwith (SHB). 1976. *Geotechnical Investigation Report, Tailings Dam and Ponds, Church Rock Uranium Mill, United Nuclear Corporation.* Church Rock, New Mexico. May.

Sergent, Hauskins & Beckwith (SHB). 1978a. *Geotechnical and Design Development Investigation Report, Tailings Dam and Ponds, Church Rock Uranium Mill, United Nuclear Corporation.* Church Rock, New Mexico. July.

Sergent, Hauskins & Beckwith (SHB). 1978b. *Engineering Analysis Report – Embankment Volumes-Borrow Quantities, Tailings Disposal Systems Analysis, UNC Church Rock Mill Site*. Church Rock, New Mexico. October.

Sergent, Hauskins & Beckwith (SHB). 1979. *Geotechnical Investigation Report, Stability and Integrity Assessment, Church Rock Uranium Mill, United Nuclear Corporation.* Church Rock, New Mexico. Volume 1. July.

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FORMER MILL SITE

UNC OFFICES

NORTH CELL

CENTRAL CELL

SOUTH CELL

PIPELINE ARROYO

HIGHWAY 566

BRANCH SWALE (TYP)

REPOSITORY FOOTPRINT ALTERNATIVE NO. 1

REPOSITORY FOOTPRINT ALTERNATIVE NO. 2

REPOSITORY FOOTPRINT ALTERNATIVE NO. 3

APPROX TOE OF EXISTING EMBANKMENT

RUNOFF CONTROL DITCH

BORROW PIT NO. 1

BORROW PIT NO. 2

BURIED DEBRIS AREAS (TYP)

NORTH DIVERSION DITCH

GEOLOGIC CROSS-SECTION LINE EE

LEGEND:

- 6980 EXISTING GROUND SURFACE CONTOUR ELEVATION, FT
- EXISTING DRAINAGE
- EXISTING ROADS
- PLSS SECTION LINE
- CROSS SECTION (D'APPOLONIA, 1981)
- CROSS SECTION (CANONIE, 1987)
- ZONE 3 MONITORING WELL
- ZONE 1 MONITORING WELL
- ALLUVIUM MONITORING WELL
- GEOTECHNICAL BORING
- GEOTECHNICAL BORING WITH TAILINGS INFORMATION

0 200' 400'

PROJECT LOCATION: McKINLEY COUNTY, NEW MEXICO

PROJECT: CHURCH ROCK MILL SITE PDS WORK PLAN

TITLE: LOCATION OF HISTORIC BORINGS, WELLS, AND GEOLOGIC CROSS SECTIONS

MWH

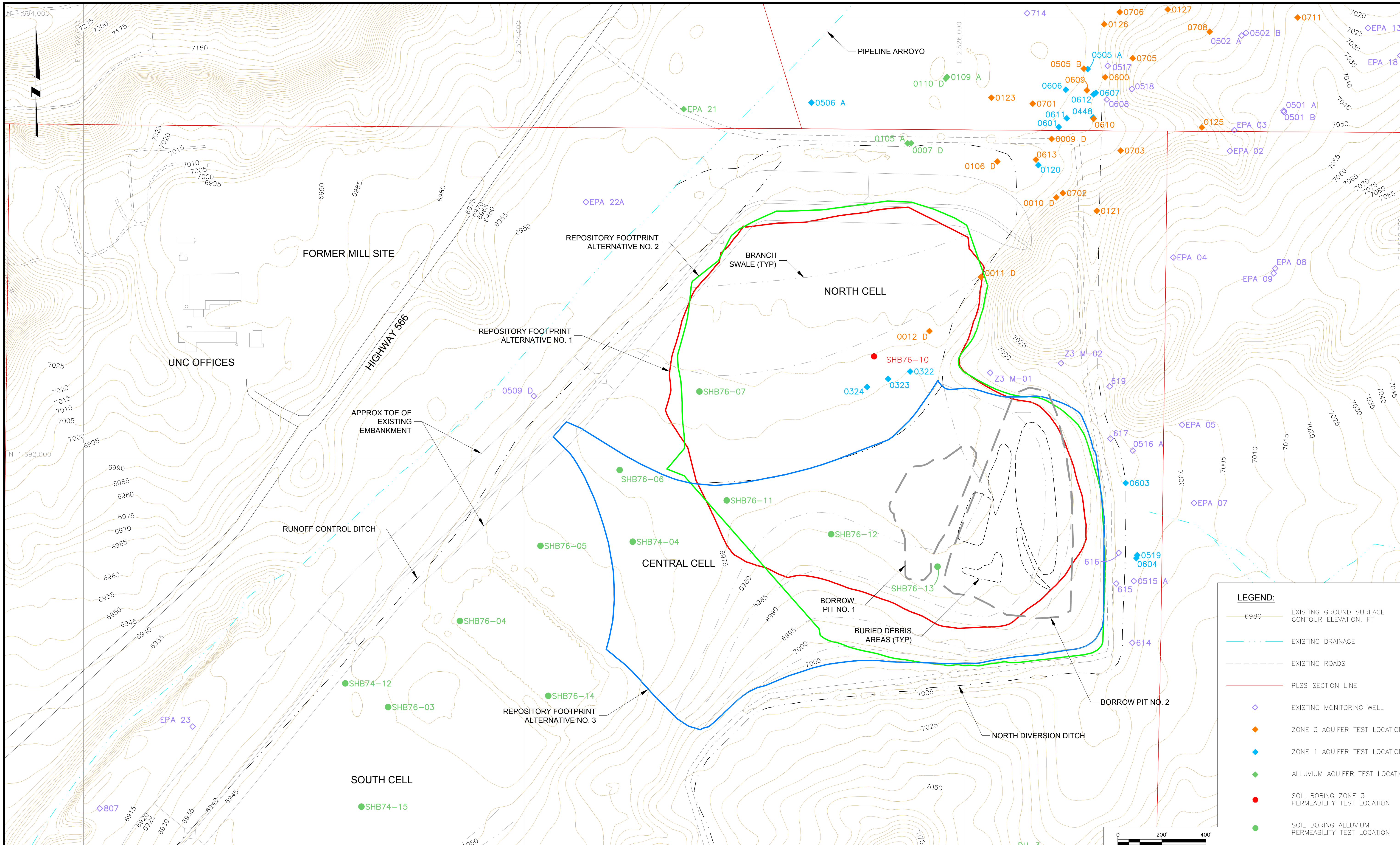
FIGURE 1

REVISION: A

FILE NAME: 1012376 GEO ALL

DATE: AUG 2013

L:\Design-Drafting\Clients-Q-Z\UNC\1012376 CHURCH ROCK\013-Sheet Set\2013-06-07 GEO SAMP PLAN\1012376 GEO ALL


PIPELINE ARROYO
FORMER MILL SITE
UNC OFFICES
HIGHWAY 566
REPOSITORY FOOTPRINT ALTERNATIVE NO. 2
BRANCH SWALE (TYP)
NORTH CELL
REPOSITORY FOOTPRINT ALTERNATIVE NO. 1
APPROX TOE OF EXISTING EMBANKMENT
RUNOFF CONTROL DITCH
CENTRAL CELL
BORROW PIT NO. 1
BURIED DEBRIS AREAS (TYP)
REPOSITORY FOOTPRINT ALTERNATIVE NO. 3
BORROW PIT NO. 2
NORTH DIVERSION DITCH
SOUTH CELL
SHB76–10
SHB76–07
SHB76–06
SHB76–11
SHB74–04
SHB76–05
SHB76–12
SHB76–13
SHB76–04
SHB74–12
SHB76–03
SHB76–14
SHB74–15
SHB76–15
SHB76–17
DH–3
EPA 21
EPA 22A
EPA 23
EPA 02
EPA 03
EPA 04
EPA 05
EPA 07
EPA 08
EPA 09
EPA 13
EPA 18
Z3 M–01
Z3 M–02
LEGEND:
EXISTING GROUND SURFACE CONTOUR ELEVATION, FT
EXISTING DRAINAGE
EXISTING ROADS
PLSS SECTION LINE
EXISTING MONITORING WELL
ZONE 3 AQUIFER TEST LOCATION
ZONE 1 AQUIFER TEST LOCATION
ALLUVIUM AQUIFER TEST LOCATION
SOIL BORING ZONE 3 PERMEABILITY TEST LOCATION
SOIL BORING ALLUVIUM PERMEABILITY TEST LOCATION
0
200'
400'

PROJECT LOCATION: McKINLEY COUNTY, NEW MEXICO

PROJECT: CHURCH ROCK MILL SITE PDS WORK PLAN

TITLE: LOCATION OF EXISTING WELLS, AND HYDRAULIC FIELD TEST DATA

MWH

FIGURE 2 | REVISION A

FILE NAME 1012376 GEO INFO | DATE AUG 2013

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Table 1 - Church Rock Mill Site Impoundment - Summary of Relevant Existing Geotechnical Data for the North and Central Cells

							Field Data			Lab Data															
Report Reference	Boring no.	Surf. Elev. (ft)	Sample Depth (ft)	Formation	Material Type	USCS	SPT (bpf)	Torvane (tsf)	Perm (ft/year)	SG	LL (%)	PI (%)	(%) p.001 mm	(%) p.200	(%) p. 100	(%) p. No.10	(%) p. No.4	w.c. (%)	Dry Density (pcf)	Consol	Std. Proctor	rel. density (pcf) min-max	Triax.	Dir. Shear (phi, c (ksf)	Perm (ft/year)(1)	Location
Hemphill 1969	6	6950	7.5-9	alluvium	Silt	SC					37	15		47				13								Central
	6	6950	40.5-41	sandstone	-	-																	UC = 296 ksf			Central
SHB 1974	SHB74-03	6954	5	alluvium	Sandy Clay	CH	18				62	45		70	87	99	100	6								Central
	SHB74-03	6954	10	alluvium	Sandy Clay	CL	46				44	27		77	93	99	100	10								Central
	SHB74-03	6954	15	alluvium	Sandy Silt	CL-ML	20				21	4		70	93			8								Central
	SHB74-03	6954	20	alluvium	Sandy Silt	CL-ML	16											4								Central
	SHB74-03	6954	25	alluvium	Sandy Silt	CL-ML	23											3								Central
	SHB74-04	6949	5	alluvium	Sandy Silt	ML	8				-	NP		55	82	99	99	5								Central
	SHB74-04	6949	10	alluvium	Clay	CL	56		4		46	29		98	99			12	104	X						Central
	SHB74-04	6949	15	alluvium	Clay	CL	45				23	4		53	82	97	100	14	104	X				42.5		Central
	SHB74-04	6949	20	alluvium	Clayey Sand	SC	11				29	11		39	79	99	100	5								Central
	SHB74-04	6949	25	alluvium	Clayey Sand	SC	15											5								Central
	SHB74-04	6949	30	alluvium	Clayey Sand	SC	15											4								Central
	SHB74-05	6946	5	alluvium	Silty Sand	SM	15				-	-		-				6	91	X				30.5		Central
	SHB74-05	6946	10	alluvium	Silty Sand	SM	24				-	-		-				10	105	X						Central
	SHB74-05	6946	15	alluvium	Sandy Silt	ML	34				23	4		53				8								Central
	SHB74-05	6946	20	sandstone	-	-	40											5								Central
	SHB74-05	6946	25	sandstone	-	-	24											10								Central
	SHB74-05	6946	30	sandstone	-	-	28											13								Central
	SHB74-06	6946	14	sandstone	-	-	-																			Central
	SHB74-39	6946	8.25	sandstone	End of Boring	SC	50/1																			North
		-	-	tailings	Cycloned Sands	-								4	9									38.5	2375	-
SHB 1976	SHB76-05		0	alluvium	Sandy Silt	ML	2											8								Central
	SHB76-05		5	alluvium	Sandy Silt	ML	3											20								Central
	SHB76-05		10	alluvium	Sandy Clay	CL	9				36	15		98	99			29								Central
	SHB76-05		9-18.5	alluvium	Clay	CH	13		0.0									22								Central
	SHB76-05		19-25	alluvium	Silty Sand	SM	9		1.7		-	NP		44	87			13								Central
	SHB76-05		25	alluvium	Silty Sand	SM	9											16								Central
	SHB76-05		30	alluvium	Silty Sand	SM	12											8								Central
	SHB76-06		0	alluvium	Silty Sand	SM	6											8								Central
	SHB76-06		5	alluvium	Sandy Clay	CL	12				32	13		81	96	100		9								Central
	SHB76-06		10	alluvium	Sandy Clay	CL	45											8								Central
	SHB76-06		9-16.5	alluvium	Sandy Silt	ML	33		5.5		39	9		87	98			11								Central
	SHB76-06		20	alluvium	Sandy SIlt	CL-ML	11											6								Central
	SHB76-06		25	alluvium	Sandy SIlt	CL-ML	6											8								Central
	SHB76-06		19-24.5	alluvium	Sandy SIlt	CL-ML	7		5.1									6								Central
	SHB76-06		35	alluvium	Sandy SIlt	CL-ML	10											8								Central
	SHB76-06		40	alluvium	Sandy SIlt	CL-ML	8											14								Central
	SHB76-06		45	alluvium	Sandy Silt	CL-ML	11											25								Central
	SHB76-06		50	alluvium	Sandy Silt	CL-ML	10											22								Central
	SHB76-06		55	alluvium	Sandy Silt	CL-ML	16											21								Central
	SHB76-06		60	alluvium	Sandy Silt	CL-ML	8											26								Central
	SHB76-06		70	alluvium	Sandy Silt	CL-ML	9											25								Central
	SHB76-07		0	alluvium	Sandy Silt	ML	2											18								North
	SHB76-07		5	alluvium	Sandy Clay	CL	4				31	12		79	95	100		25								North
	SHB76-07		10-20	alluvium	Sandy Silt	CL-ML	5		1.1		21	4		52	77			14					124.2@11			0.179	North
	SHB76-07		15	alluvium	Sandy Silt	ML	7				-	NP		57	88	100		15								North
	SHB76-07		18.5-27.5	alluvium	Sandy Silt	ML	3		1.0									26								North
	SHB76-07		25	alluvium	Sandy Silt	ML	6											20								North
	SHB76-07		30	sandstone	-	-	50/1																			North
	SHB76-07		35	sandstone	-	-	50																			North
	SHB76-08		0	alluvium	Silty Sand	SM	3											9								North

Table 1 - Church Rock Mill Site Impoundment - Summary of Relevant Existing Geotechnical Data for the North and Central Cells

							Field Data			Lab Data															
Report Reference	Boring no.	Surf. Elev. (ft)	Sample Depth (ft)	Formation	Material Type	USCS	SPT (bpf)	Torvane (tsf)	Perm (ft/year)	SG	LL (%)	PI (%)	(%) p.001 mm	(%) p.200	(%) p. 100	(%) p. No.10	(%) p. No.4	w.c. (%)	Dry Density (pcf)	Consol	Std. Proctor	rel. density (pcf) min-max	Triax.	Dir. Shear (phi, c (ksf)	Perm (ft/year)(1)	Location
	SHB76-08		5	alluvium	Silty Sand	SM	2											22								North
	SHB76-08		10	alluvium	Silty Sand	SM	2											23								North
	SHB76-08		15	alluvium	Clay	CL	11											26								North
	SHB76-08		20	alluvium	Clay	CL	13				46	25		97	99			22								North
	SHB76-08		25	sandstone	-	-	23											17								North
	SHB76-08		30	shale	-	-	50/5											17								North
	SHB76-08		35	sandstone	-	-	50/0																			North
	SHB76-09		0	alluvium	Silty Sand	SM	2											12								North
	SHB76-09		5	alluvium	Silty Clay	CL	7											29								North
	SHB76-09		10	alluvium	Sandy Silt	ML	5											22								North
	SHB76-09		15-25	alluvium	Clay	CL	13				38	21		78	94	100		25								North
	SHB76-09		20	alluvium	Clay	CL	21				46	25		94	98	100		21								North
	SHB76-09		25	alluvium	Clay	CL	22											22								North
	SHB76-09		30	alluvium	Sandy Clay	CL	10											31								North
	SHB76-09		35	alluvium	Clay	CH	14											26								North
	SHB76-09		40	alluvium	Sandy Silt	ML	1																			North
	SHB76-09		45	alluvium	Clay	CH	11											30								North
	SHB76-09		50	alluvium	Clay	CH	5											31								North
	SHB76-09		55	alluvium	Silty Sand	SM	36											23								North
	SHB76-09		60	alluvium	Silty Sand	SM	13											24								North
	SHB76-09		65	alluvium	Silty Sand	SM	10											21								North
	SHB76-09		70	alluvium	Sandy Clay	SC	13											20								North
	SHB76-09		75	alluvium	Sandy Clay	SC	45											18								North
	SHB76-10		1.5-7.5	sandstone 3	-	-	50/3		15.3									9								North
	SHB76-10		5	sandstone 3	-	-	50/5											8								North
	SHB76-11	6957	0	alluvium	Sandy Silt	ML	6											9								Central
	SHB76-11	6957	5	alluvium	Sandy Silt	ML	10											6								Central
	SHB76-11	6957	10	alluvium	Sandy Clay	CL	26				27	10		67	90	100		10								Central
	SHB76-11	6957	9-18	alluvium	Sandy Clay	CL	25		1.1		26	10		78	94	100		16								Central
	SHB76-11	6957	18.5-27.5	alluvium	Sandy Silt	ML	12		1.0									5								Central
	SHB76-11	6957	25	alluvium	Sandy Clay	CL	14											22								Central
	SHB76-11	6957	30	alluvium	Sandy Silt	ML	11											10								Central
	SHB76-11	6957	35	alluvium	Sandy Silt	ML	9					NP		55	94	100		10								Central
	SHB76-11	6957	40	alluvium	Sandy Silt	ML	9											11								Central
	SHB76-11	6957	45	alluvium	Sandy Silt	CL-ML	12											18								Central
	SHB76-11	6957	50	alluvium	Sandy Silt	CL-ML	15											9								Central
	SHB76-11	6957	55	alluvium	Sandy Silt	CL-ML	21											10								Central
	SHB76-11	6957	60	alluvium	Sandy Silt	CL-ML	10											24								Central
	SHB76-11	6957	65	alluvium	Sandy Silt	CL-ML	7											21								Central
	SHB76-11	6957	70	alluvium	Sandy Silt	CL-ML	2											22								Central
	SHB76-11	6957	75	sandstone	-	-	38											13								Central
	SHB76-12		0	alluvium	Silty Sand	SM	16											12								Central
	SHB76-12		5	alluvium	Sandy Clay		21											6								Central
	SHB76-12		9-16	alluvium	Sandy Clay		27		12.0									10								Central
	SHB76-12		15	alluvium	Sandy Clay		6											6								Central
	SHB76-12		18.5-25	alluvium	Sandy Clay		16		14.5		-	NP		61	91	100		8								Central
	SHB76-12		25	alluvium	Sandy Clay		13											6								Central
	SHB76-12		30	alluvium	Sandy SIlt	ML	21											5								Central
	SHB76-12		35	alluvium	Sandy Clay	CL	54											12								Central
	SHB76-12		40	alluvium	Sandy SIlt	CL-ML	34											8								Central
	SHB76-12		45	alluvium	Sandy Silt	CL-ML	23											4								Central
	SHB76-12		50	alluvium	Sandy Silt	CL-ML	18											5								Central

Table 1 - Church Rock Mill Site Impoundment - Summary of Relevant Existing Geotechnical Data for the North and Central Cells

							Field Data			Lab Data															
Report Reference	Boring no.	Surf. Elev. (ft)	Sample Depth (ft)	Formation	Material Type	USCS	SPT (bpf)	Torvane (tsf)	Perm (ft/year)	SG	LL (%)	PI (%)	(%) p.001 mm	(%) p.200	(%) p. 100	(%) p. No.10	(%) p. No.4	w.c. (%)	Dry Density (pcf)	Consol	Std. Proctor	rel. density (pcf) min-max	Triax.	Dir. Shear (phi, c (ksf)	Perm (ft/year)(1)	Location
	SHB76-12		55	alluvium	Sandy Silt	CL-ML	40											7								Central
	SHB76-12		60	sandstone	-	-	50/1											9								Central
	SHB76-13		0	alluvium	Sandy Clay	CL	13											9								Central
	SHB76-13		9-17.5	alluvium	Sandy Clay	CL	31		8.0		35	17		82	97			8								Central
	SHB76-13		10	alluvium	Sandy Silt	ML	40											4								Central
	SHB76-13		15	alluvium	Sandy Clay	CL	59											9								Central
	SHB76-13		18.5-25	alluvium	Sandy Silt	CL-ML	24		1.3									10								Central
	SHB76-13		25	alluvium	Sandy Silt	CL-ML	22											4								Central
	SHB76-13		30	alluvium	Sandy Silt	CL-ML	22											8								Central
	SHB76-13		35	alluvium	Sandy Silt	CL-ML	28											6								Central
	SHB76-13		40	alluvium	Sandy Silt	CL-ML	26											8								Central
	SHB76-13		45	alluvium	Sandy Silt	CL-ML	29											8								Central
	SHB76-13		50	alluvium	Sandy Silt	CL-ML	24											5								Central
	SHB76-13		55	alluvium	Sandy Silt	CL-ML	30											7								Central
	SHB76-13		60	sandstone	-	-	50/4											16								Central
SHB 1978a	SHB-78a-15	6964	0-2	dam	Sandy Clay	-	9											11								Central
	SHB-78a-15	6964	4.5-6	dam	Sandy Clay	-	21											16								Central
	SHB-78a-15	6964	9.5-10.5	dam	Sandy Clay	CL	35	0.89			32	10		75	93	100		14	114			1 pt (15 deg.), c=1600 psf				Central
	SHB-78a-15	6964	14.5-16	dam	Sandy Clay	CL	58	0.99										13								Central
	SHB-78a-15	6964	18.5-21	dam	Sandy Clay	CL	75											13								Central
	SHB-78a-15	6964	24.5-25	dam	Sandy Clay	CL	44	0.95			42	22		75	90	99	100	16	116							Central
	SHB-78a-15	6964	28.5-31	dam	Sandy Clay	CL	25	0.60										16								Central
	SHB-78a-15	6964	34.5-36	dam	Sandy Clay	CL	12											21								Central
	SHB-78a-15	6964	39.5-40.5	dam	Sandy Clay	CL	22	0.99										18	110					7, 1.45		Central
	SHB-78a-15	6964	44.5-45.5	dam	Sandy Clay	CL	26	0.67										23								Central
	SHB-78a-17	6962	0-1	dam	Sandy Clay	CL	14	0.42										10	110							North
	SHB-78a-17	6962	4.5-6	dam	Sandy Clay	CL	27											15								North
	SHB-78a-17	6962	9.5-11	dam	Sandy Clay	CL	38	0.79										12								North
	SHB-78a-17	6962	14.5-16	dam	Sandy Clay	CL	41											11								North
	SHB-78a-17	6962	19.5-20.5	dam	Sandy Clay	CL	85	0.92			30	12		63	88	99	100	11	124				1 pt			North
	SHB-78a-17	6962	24.5-26	dam	Sandy Clay	CL	20	0.6										12								North
	SHB-78a-17	6962	29.5-31	dam	Sandy Clay	CL	12											24								North
	SHB-78a-17	6962	34.5-36	dam	Sandy Clay	CL	18	0.52										20	107							North
	SHB-78a-17	6962	39.5-41	alluvium	Silty Sand	SM	19	0.2										19								North
	SHB-78a-17	6962	44.5-46	alluvium	Clay	CL	15											24								North
	SHB-78a-18	6959	0-1.5	dam	Clay	CL-SC	10											12								North
	SHB-78a-18	6959	4.5-6	dam	Clay	CL-SC	52											12								North
	SHB-78a-18	6959	9.5-11	dam	Clay	CL-SC	30											12	115							North
	SHB-78a-18	6959	14.5-16	alluvium	Sandy Clay	CL	4											30								North
	SHB-78a-18	6959	19.5-20.5	alluvium	Silty Sand	SM	3											27								North
	SHB-78a-19	6965	0-2	dam	Sandy Clay	CL												12								North
	SHB-78a-19	6965	2-3.5	dam	Sandy Clay	CL	125	0.99			29	13		61	86	100		10	126					49, 1.69		North
	SHB-78a-19	6965	3.5-4.5	dam	Sandy Clay	CL	50	0.83										10								North
	SHB-78a-19	6965	4.5-7	dam	Sandy Clay	CL	43											12								North
	SHB-78a-19	6965	7-9.5	dam	Sandy Clay	CL												10								North
	SHB-78a-19	6965	9.5-11	dam	Sandy Clay	CL	82	0.69			23	8		50	72	97	98	10	114					38, 0.31		North
	SHB-78a-19	6965	11-13.5	dam	Sandy Clay	CL	30											8								North
	SHB-78a-19	6965	13.5-16	alluvium	Silty Sand	CL	-											18								North
	SHB-78a-19	6965	17.5-21	alluvium	Silty Sand	SM	3											21								North
	SHB-78a-19	6965	20-21.5	alluvium	Silty Sand	SM	10											27	94	X						North
	SHB-78a-19	6965	24-25.5	alluvium	Silty Sand	CL	32											28								North
	SHB-78a-19	6965	25.5-28	alluvium	Clay	CL	22											26								North

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Report Reference	Boring no.	Surf. Elev. (ft)	Sample Depth (ft)	Formation	Material Type	USCS	SPT (bpf)	Torvane (tsf)	Perm (ft/year)	SG	LL (%)	PI (%)	(%) p.001 mm	(%) p.200	(%) p. 100	(%) p. No.10	(%) p. No.4	w.c. (%)	Dry Density (pcf)	Consol	Std. Proctor	rel. density (pcf) min-max	Triax.	Dir. Shear (phi, c (ksf)	Perm (ft/year)(1)	Location
	SHB-78a-19	6965	28-29.5	alluvium	Clay	CL	28																			North
	SHB-78a-19	6965	29.5-32	alluvium	Clay	CL	20											26								North
	SHB-78a-19	6965	32-33.5	alluvium	Silty Sand	SM	13	0.16				NP		46	88	100		20	111							North
	SHB-78a-19	6965	33.5-36	alluvium	Silty Sand	SM	16											25								North
	SHB-78a-19	6965	36-37.5	alluvium	Silty Sand	CL	51				41	22		74	94	100		23	100							North
	SHB-78a-19	6965	37.5-40	alluvium	Clay	CH	43											24								North
	SHB-78a-19	6965	40-41.5	alluvium	Clay	CH	34	0.83			61	38		73	80	100		25	99				1 pt			North
	SHB-78a-19	6965	41.5-44	alluvium	Clay	CH	22											28								North
	SHB-78a-19	6965	44-45	alluvium	Clay	CH	22	0.13			67	41		78	87	100		27	96							North
	SHB-78a-20	6964	0-1.5	dam	Clay	CL	7											15								North
	SHB-78a-20	6964	4.5-6	dam	Clay	CL	49	0.79										11								North
	SHB-78a-20	6964	9.5-10.5	dam	Clay	CL	40	0.67			28	13		63	86	99	100	10	111							North
	SHB-78a-20	6964	14.5-16	alluvium	Silty Sand	SM	19											10								North
	SHB-78a-20	6964	19.5-20.5	alluvium	Silty Sand	SM	5					NP		16	35			23	96						5.5	North
	SHB-78a-20	6964	24.5-25.5	alluvium	Silty Sand	CH	15	0.33										29	93							North
	SHB-78a-20	6964	29.5-31	alluvium	Clay	CH	12																			North
	SHB-78a-20	6964	34.5-35.5	alluvium	Clay	CH	12	0.84										26								North
	SHB-78a-20	6964	39.5-40.5	alluvium	Clay	CH	13	0.93			57	31		93	96	97	98	26	97				1 pt			North
	SHB-78a-20	6964	44.5-46	alluvium	Clay	CH	17											27								North
	SHB-78a-21	6964	0-1.5	dam	Sandy Clay	CL	16											14								North
	SHB-78a-21	6964	4.5-6	dam	Sandy Clay	CL	55				34	16		77	90			13								North
	SHB-78a-21	6964	9.5-10.5	dam	Sandy Clay	CL	51	0.55										5	107							North
	SHB-78a-21	6964	14.5-15.5	alluvium	Sandy Clay	CL	13	0.67										12								North
	SHB-78a-21	6964	19.5-21	alluvium	Sandy Clay	CL	4				39	21		72	88			29								North
	SHB-78a-21	6964	24.5-25.5	alluvium	Sandy Clay	CL	18	0.96										22	105					25.5, 0.05		North
	SHB-78a-21	6964	29.5-30.5	alluvium	Clay	CH	19	0.73										24								North
	SHB-78a-21	6964	34.5-36	alluvium	Clay	CH	17											23								North
	SHB-78a-21	6964	39.5-40.5	alluvium	Clay	CH	27	0.72			50	32		84	94			22	102				1 pt			North
	SHB-78a-21	6964	44.5-45.5	alluvium	Clay	CH	19	0.87										19								North
	SHB-78a-22	6956	0-1.0	alluvium	Silty Sand	SM	4											6	93							North
	SHB-78a-22	6956	1.0-3.0	alluvium	Silty Sand	SM	9											9								North
	SHB-78a-22	6956	3.0-5.0	alluvium	Silty Sand	SM	11											11	100							North
	SHB-78a-22	6956	5.0-7.0	alluvium	Sandy Clay	CL	3											12								North
	SHB-78a-22	6956	7.0-9.0	alluvium	Sandy Clay	CL	10				26	10		55	78	100		21	103				1 pt			North
	SHB-78a-22	6956	9.0-11.0	alluvium	Sandy Clay	CL	3				27	10		56	69			31								North
	SHB-78a-22	6956	11-13.0	alluvium	Sandy Clay	CL	10											34	105							North
	SHB-78a-22	6956	13-15.0	alluvium	Sandy Clay	CL	3																			North
	SHB-78a-24	6955	0-1.5	tailings	Silty Sand	SM												9	84							Central
	SHB-78a-24	6955	1.5-3.5	tailings	Silty Sand	SM	4																			Central
	SHB-78a-24	6955	3.5-5.5	tailings	Silty Sand	SM	2/30											23								Central
	SHB-78a-24	6955	5.5-8	tailings	Silty Sand	SM						NP		13	25	100		19								Central
	SHB-78a-24	6955	8-10.0	tailings	Silty Sand	SM	3/18											36								Central
	SHB-78a-24	6955	10.0-12	alluvium	Silty Sand	SM	7											27								Central
	SHB-78a-24	6955	12-14.5	alluvium	Sandy Clay	CL												24								Central
	SHB-78a-24	6955	14.5-16.5	alluvium	Sandy Clay	CL	14	0.43			42	23		83	93			24	99				1 pt			Central
	SHB-78a-24	6955	16.5-18.5	alluvium	Sandy Clay	CL	2											29								Central
	SHB-78a-24	6955	18.5-21	alluvium	Sandy Clay	CL												22	81							Central
	SHB-78a-24	6955	21-23.0	alluvium	Clay	CL	39	0.69			42	21		87	97	98	100	21	106				1 pt			Central
	SHB-78a-24	6955	23.0-25	alluvium	Clay	CL	15											19								Central
	SHB-78a-24	6955	25-27.5	alluvium	Clay	CL												23	83							Central
	SHB-78a-24	6955	27.5-30	alluvium	Silty Sand	SM	9											24								Central
	SHB-78a-25	6958	6-8.5	tailings	Silty Sand	SM	20	0.06				NP		14	25	98	100	9								Central

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	SHB-78a-25	6958	17-18.0	tailings	Silty Sand	SM	7					NP		14	25	99	100	20								Central
	SHB-78a-25	6958	19.5-22	alluvium	Sandy Clay-Clayey Sand	CL-SC	2											27								Central
	SHB-78a-25	6958	22.0-24	alluvium	Sandy Clay-Clayey Sand	CL-SC	5				35	17		59	81			27								Central
	SHB-78a-25	6958	24.0-26	alluvium	Sandy Clay-Clayey Sand	CL-SC	8	0.1										29	93							Central
	SHB-78a-25	6958	26-28.5	alluvium	Sandy Clay-Clayey Sand	CL-SC		0.32										21	64							Central
	SHB-78a-25	6958	28.5-30.5	alluvium	Sandy Clay-Clayey Sand	CL-SC	4				28	12		42	79			21								Central
	SHB-78a-25	6958	30.5-32.5	alluvium	Sandy Clay-Clayey Sand	CL-SC	16											21								Central
	SHB-78a-25	6958	32.5-33.5	alluvium	Sandy Clay-Clayey Sand	CL-SC		0.8										19	108					30, 0		Central
	SHB-78a-26	6962	6.5-9	tailings	Silty Sand	SM	8					NP		22	43			10	96					30, 0		Central
	SHB-78a-26	6962	8.0-10.5	tailings	Silty Sand	SM												19								Central
	SHB-78a-26	6962	10.5-12.5	tailings	Silty Sand	SM	2											21						33, 0		Central
	SHB-78a-26	6962	12.5-14.5	tailings	Silty Sand	SM	9											12	99							Central
	SHB-78a-26	6962	15.5-18	tailings	Silty Sand	SM	3					NP		14	23	100		17								Central
	SHB-78a-26	6962	19.5-22	tailings	Silty Sand	SM	2/18"					NP		20	33			18								Central
	SHB-78a-26	6962	21-23	tailings	Silty Sand	SM												24								Central
	SHB-78a-26	6962	23-25.5	alluvium	Sandy Clay	CL	10											27								Central
	SHB-78a-26	6962	25.5-27.5	alluvium	Sandy Clay	CL	10											27								Central
	SHB-78a-26	6962	27.5-30	alluvium	Sandy Clay	CL												23	83							Central
	SHB-78a-26	6962	31-32.5	alluvium	Sandy Clay	CL	7				39	22		78	91	100		26								Central
	SHB-78a-26	6962	32-34	alluvium	Sandy Clay	CL	7	0.55										22								Central
	SHB-78a-26	6962	34-36.5	alluvium	Sandy Clay	CL		0.92										20	110							Central
	SHB-78a-26	6962	36.5-37.5	alluvium	Sandy Clay	CL	14											22								Central
	SHB-78a-27	6957	3.5-5	alluvium	Silty Clay	CL	10											20								Central
	SHB-78a-27	6957	5-10.5	alluvium	Silty Clay	CL	13											17	95							Central
	SHB-78a-27	6957	9.5-11	alluvium	Silty Clay	CL	3				37	15		86	95			29								Central
	SHB-78a-27	6957	14.5-15.5	alluvium	Silty Clay	CL	16				42	21		66	78	92	94	24	94							Central
	SHB-78a-27	6957	19.5-21	alluvium	Silty Clay	CL	2				31	11		89	98			31								Central
	SHB-78a-27	6957	25-30.5	alluvium	Silty Clay	CL	7											27	94							Central
	SHB-78a-27	6957	30.5-35	alluvium	Silty Clay	CL	8											25								Central
	SHB-78a-27	6957	35-40.5	alluvium	Silty Clay	CL	20											22	100							Central
	SHB-78a-27	6957	40.5-45	alluvium	Silty Clay	CL	7											22								Central
	SHB-78a-27	6957	44.5-45.5	alluvium	Silty Clay	CL	9				40	20		80	93			21								Central
	SHB-78a-27	6957	50.5-51	alluvium	Silty Sand	SM	3											24								Central
	SHB-78a-28	6955	4.5-6	alluvium	Silty Clay	CL	15				41	21		92	98			21	101							Central
	SHB-78a-28	6955	5.5-10	alluvium	Silty Clay	CL	19											17								Central
	SHB-78a-28	6955	10-15.5	alluvium	Silty Clay	CL	7											18	102							Central
	SHB-78a-28	6955	15.5-20	alluvium	Silty Sand	SM	15											15								Central
	SHB-78a-28	6955	20-25.5	alluvium	Silty Sand	SM	4											31	85							Central
	SHB-78a-28	6955	25.5-30	alluvium	Silty Clay	CL	3											30								Central
	SHB-78a-28	6955	30-35.5	alluvium	Silty Clay	CL	10											26	97							Central
	SHB-78a-28	6955	34.5-36	alluvium	Silty Clay	CL	3				36	16		90	98			23								Central
	SHB-78a-28	6955	40.5-45.5	alluvium	Silty Clay	CL	8											24	95							Central
	SHB-78a-28	6955	45.5-49.5	alluvium	Silty Sand	SM	19											25								Central
	SHB-78a-28	6955	49.5-49.6	sandstone	-	-	50/1"																			Central
			bulk	tailings		SM-SP						NP		5	11			18	98			90.5 / 107.8		34.5, 0.13		Central
			bulk	tailings														18	100					37, 0.22		Central
			bulk	tailings														18	102					39, 0.15		Central
	SHB-78a-52	6988	5.0-10	alluvium	Clayey Sand	SC					27	11		43	73	95	98	7								W. Borrow
	SHB-78a-52	6988	20	alluvium	Silty Clay	CL																				W. Borrow
	SHB-78a-52	6988	25	alluvium	Silty Clay	CL																				W. Borrow
	SHB-78a-52	6988	30	alluvium	Silty Sand	SM																				W. Borrow
	SHB-78a-52	6988	35	alluvium	Silty Clay	CL																				W. Borrow

Table 1 - Church Rock Mill Site Impoundment - Summary of Relevant Existing Geotechnical Data for the North and Central Cells

							Field Data			Lab Data															
Report Reference	Boring no.	Surf. Elev. (ft)	Sample Depth (ft)	Formation	Material Type	USCS	SPT (bpf)	Torvane (tsf)	Perm (ft/year)	SG	LL (%)	PI (%)	(%) p.001 mm	(%) p.200	(%) p. 100	(%) p. No.10	(%) p. No.4	w.c. (%)	Dry Density (pcf)	Consol	Std. Proctor	rel. density (pcf) min-max	Triax.	Dir. Shear (phi, c (ksf)	Perm (ft/year)(1)	Location
	SHB-78a-52	6988	39.5	total depth	Silty Clay	CL	-																			W. Borrow
	SHB-78a-53	6985	0	alluvium	Silty Clay	CL	5											8								
	SHB-78a-53	6985	5	alluvium	Silty Sand	SM	3											6								W. Borrow
	SHB-78a-53	6985	10	alluvium	Silty Sand	SM	7											7								W. Borrow
	SHB-78a-53	6985	15	alluvium	Silty Sand & Gravel	SM	14											6								W. Borrow
	SHB-78a-53	6985	20	alluvium	Silty Sand & Gravel	SM	14											4								W. Borrow
	SHB-78a-53	6985	25	alluvium	Silty Sand	SM	19											6								W. Borrow
	SHB-78a-53	6985	30	alluvium	Silty Sand	SM	22											9								W. Borrow
	SHB-78a-53	6985	35	alluvium	Silty Sand	SM	20											7								W. Borrow
	SHB-78a-53	6985	40	alluvium	Silty Sand & Gravel	SM	24											6								W. Borrow
	SHB-78a-53	6985	41	total depth	Silty Sand & Gravel	SM	-																			W. Borrow
	SHB-78a-54	6985	4.5-8.5	sandstone	-	-	-																			W. Borrow
	SHB-78a-55	6995	0	alluvium	Silty Sand	SM	5																			W. Borrow
	SHB-78a-55	6995	5	alluvium	Silty Sand	SM	9																			W. Borrow
	SHB-78a-55	6995	10	alluvium	Silty Sand	SM	17																			W. Borrow
	SHB-78a-55	6995	15	alluvium	Silty Sand	SM	25																			W. Borrow
	SHB-78a-55	6995	20	alluvium	Clayey Sand	SC	30																			W. Borrow
	SHB-78a-55	6995	24.5-26	alluvium	Clayey Sand	SC	41				29	14		49	72	95	98	8								W. Borrow
	SHB-78a-55	6995	30	alluvium	Silty Sand	SM	39																			W. Borrow
	SHB-78a-55	6995	35	alluvium	Silty Sand	SM	42																			W. Borrow
	SHB-78a-55	6995	40	alluvium	Silty Clay	CL	38																			W. Borrow
	SHB-78a-55	6995	45	alluvium	Silty Clay	CL	47																			W. Borrow
	SHB-78a-55	6995	50-51	alluvium	Silty Sand	SM	30																			W. Borrow
	SHB-78a-56	6993	0-4.5	sandstone	-	-																				W. Borrow
	SHB-78a-64	6973	.5-2	alluvium	Silty Sand & Gravel	SC-SM	81				23	7		46	64	87	94	7								North
	SHB-78a-64	6973	2-4.5	sandstone	-	SM						NP		27	54	64	68	7								North
	SHB-78a-64	6973	4.5-6	sandstone	-	GM	50/.5"				20	NP		25	28	46	54	5								North
	SHB-78a-68	6989	1-5.5	alluvium	Silty Sand	SM	20												5							Central
	SHB-78a-68	6989	4.5-6	alluvium	Silty Sand	SM	18				20	NP		31	48	67	74		4							Central
	SHB-78a-68	6989	9.5-11	alluvium	Silty Sand	SM	17				21	NP		40	60	70	80		6							Central
	SHB-78a-68	6989	14.5-16	alluvium	Clayey Silt	CL	88				32	12		93	95	100			9							Central
	SHB-78a-68	6989	19.5-22	Sandstone	-	-	50/3"												8							Central
	SHB-78a-68	6989	22.5-24.5	Sandstone	-	-	50/3"												9							Central
	SHB-78a-74	6963	0-10	alluvium	Silty Clay	CL					31	31		72	86	100		9								Central
	SHB-78a-76	6965	0-5	alluvium	Silty Clay	CL					33	16		71	77	100		7								Central
	SHB-78a-76	6965	5-10	alluvium	Silty Clay	CL					42	21		79	92			10								Central
	SHB-78a-76	6965	16-19.5	alluvium	Sandy Silt	ML					23	NP		52	84	100		6								Central
	SHB-78a-78	6980	6-10	alluvium	Silty Sand	SM					23	NP		48	81	98	100	7								Central
	SHB-78a-78	6980	17-20	alluvium	Clayey Sand	SC					26	9		49	67	83	87	10								Central
	SHB-78a-78	6980	22-25	alluvium	Clayey Silt	CL					33	15		75	90	99	100	15								Central
	SHB78a-81	6975	0.5-2	alluvium	Silty Clay	CL	15											7								Central
	SHB78a-81	6975	4.5-6	alluvium	Silty Clay	CL	30											9								Central
	SHB78a-81	6975	9.5-11	alluvium	Silty Sand	SM	21											4								Central
	SHB78a-81	6975	14.5-16	alluvium	Silty Sand	SM	9											7								Central
	SHB78a-81	6975	19.5-21	alluvium	Silty Clay	CL	28											10								Central
	SHB78a-81	6975	24.5-26	alluvium	Silty Sand	SM	23											5								Central
	SHB-78a-83	6985	0.5-2	alluvium	Silty Sand	SM	10											4								Central
	SHB-78a-83	6985	4.5-6	alluvium	Silty Sand	SM	20				-	NP		26	51	87	94	2								Central
	SHB-78a-83	6985	9.5-11	alluvium	Silty Sand	SM	14				-	NP		24	49	94	97	4								Central
	SHB-78a-83	6985	12-14.5	sandstone	-	-	50/1"																			Central
	SHB-78a-85	6983	0.5-2	alluvium	Silty Sand	SM	9											3								Central
	SHB-78a-85	6983	4.5-6	alluvium	Silty Clay	CL	17				33	15		60	77	100		6								Central

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							Field Data			Lab Data															
Report Reference	Boring no.	Surf. Elev. (ft)	Sample Depth (ft)	Formation	Material Type	USCS	SPT (bpf)	Torvane (tsf)	Perm (ft/year)	SG	LL (%)	PI (%)	(%) p.001 mm	(%) p.200	(%) p. 100	(%) p. No.10	(%) p. No.4	w.c. (%)	Dry Density (pcf)	Consol	Std. Proctor	rel. density (pcf) min-max	Triax.	Dir. Shear (phi, c (ksf)	Perm (ft/year)(1)	Location
	SHB-78a-85	6983	9.5-11	alluvium	Silty Sand	SM	17					NP		34	62	94	97	3								Central
	SHB-78a-85	6983	14.5-16	alluvium	Silty Clay	CL	26				35	16		80	93	100		8								Central
	SHB-78a-85	6983	19.5-21	alluvium	Silty Clay	CL	16				34	15		74	87	98	99	8								Central
	SHB-78a-85	6983	24.5-26	alluvium	Silty Sand	SM	23											4								Central
	SHB-78a-85	6983	29.5-31	alluvium	Silty Clay	CL	21											7								Central
SHB, 1978b	SHB78b-1	6996	0	alluvium	Sandy Silt	ML	32																			Central
	SHB78b-1	6996	5	alluvium	Sandy Silt	ML	14				26	NP		54	85	98	100	6								Central
	SHB78b-1	6996	10	alluvium	Sandy Silt	ML	24																			Central
	SHB78b-1	6996	15	sandstone	-	-	50/0.5"																			Central
	SHB78b-1	6996	20	sandstone	-	-	50/1"																			Central
	SHB78b-1	6996	25	Shale	-	-	50/2"																			Central
	SHB78b-2	6990	0	alluvium	Sandy Clay	CL	7																			Central
	SHB78b-2	6990	5	alluvium	Sandy Clay	CL	36																			Central
	SHB78b-2	6990	10	alluvium	Sandy Clay	CL	37				25	10		53	72	90	95	7								Central
	SHB78b-2	6990	15	alluvium	Silty Sand	SM	17																			Central
	SHB78b-2	6990	20	alluvium	Silty Sand	SM-SC	15																			Central
	SHB78b-2	6990	25	alluvium	Clayey Sand	SC	10																			Central
	SHB78b-2	6990	30	alluvium	Clayey Sand	SC	18																			Central
	SHB78b-3	6991	0	alluvium	Sandy Clay	CL	8																			Central
	SHB78b-3	6991	5	alluvium	Sandy Clay	CL	32																			Central
	SHB78b-3	6991	10	alluvium	Sandy Clay	CL	24																			Central
	SHB78b-3	6991	15	alluvium	Silty Sand	SM	15				-	NP		48	91	100		5								Central
	SHB78b-3	6991	20	alluvium	Silty Sand	SM	18																			Central
	SHB78b-3	6991	25	alluvium	Sandy Clay	CL	20																			Central
	SHB78b-3	6991	30	alluvium	Silty Sand	SM	27																			Central
	SHB78b-4	6994	0	alluvium	Sandy Clay	CL	10																			Central
	SHB78b-4	6994	5	alluvium	Sandy Clay	CL	40				34	16		79	95	100		8								Central
	SHB78b-4	6994	10	alluvium	Silty Sand	SM	11																			Central
	SHB78b-4	6994	15	alluvium	Silty Sand	SM	12																			Central
	SHB78b-4	6994	25	alluvium	Silty Sand	SM-SC	21																			Central
	SHB78b-4	6994	30	alluvium	Clayey Sand	SC	33																			Central
	SHB78b-5	6998	0	alluvium	Clayey Sand	SC	7																			Central
	SHB78b-5	6998	5	alluvium	Sandy Clay	CL	39				32	15		76	91	100		7								Central
	SHB78b-5	6998	10	alluvium	Sandy Clay	CL	21																			Central
	SHB78b-5	6998	15	alluvium	Sandy Clay	CL	16				30	13		62	80	100		8								Central
	SHB78b-5	6998	20	alluvium	Sandy Clay	CL	19																			Central
	SHB78b-5	6998	25	alluvium	Sandy Clay	CL	29																			Central
	SHB78b-5	6998	30	alluvium	Silty Sand	SM-SC	24																			Central
	SHB78b-6	7002	0	alluvium	Sandy Clay	CL-ML	10																			Central
	SHB78b-6	7002	5	alluvium	Sandy Clay	CL-ML	12				24	5		61	84	98	100	5								Central
	SHB78b-6	7002	10	alluvium	Silty Sand	SM	38																			Central
	SHB78b-6	7002	15	alluvium	Clayey Sand	SC	15																			Central
	SHB78b-6	7002	20	alluvium	Clayey Sand	SC	55																			Central
	SHB78b-6	7002	25	alluvium	Silty Sand	SM-SC	31																			Central
	SHB78b-6	7002	30	alluvium	Silty Sand	SM-SC	19																			Central
	SHB78b-7	6987	0	alluvium	Sandy Clay	CL	23																			Central
	SHB78b-7	6987	5	alluvium	Sandy Clay	CL	44																			Central
	SHB78b-7	6987	10	alluvium	Silty Sand	SM	18				23	NP		44	85	99		5								Central
	SHB78b-7	6987	15	alluvium	Silty Sand	SM	26																			Central
	SHB78b-7	6987	20	alluvium	Sandy Clay	CL	56																			Central
	SHB78b-7	6987	25	alluvium	Silty Sand	SM	23																			Central
	SHB78b-7	6987	30	alluvium	Clayey Sand	SM	53																			Central

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	SHB78b-7	6987	35	alluvium	Silty Sand	SM-SC	35																			Central
	SHB78b-7	6987	40	alluvium	Silty Sand	SM-SC	72																			Central
	SHB78b-7	6987	45	alluvium	Silty Sand	SM-SC	26																			Central
	SHB78b-7	6987	50	alluvium	Silty Sand	SM-SC	40																			Central
	SHB78b-7	6987	55	alluvium	Silty Sand	SM-SC	21																			Central
	SHB78b-7	6987	60	alluvium	Silty Sand	SM-SC	37																			Central
	SHB78b-8	6985	0	alluvium	Sandy Clay	CL	10																			Central
	SHB78b-8	6985	5	alluvium	Silty Sand	SM	14																			Central
	SHB78b-8	6985	10	alluvium	Silty Sand	SM	16																			Central
	SHB78b-8	6985	15	alluvium	Silty Sand	SM	14																			Central
	SHB78b-8	6985	20	alluvium	Silty Clay	CL	18																			Central
	SHB78b-8	6985	25	alluvium	Silty Clay	CL	21				33	14		94	99			13								Central
	SHB78b-8	6985	30	alluvium	Silty Sand	SM	42																			Central
	SHB78b-9	7007	0	alluvium	Silty Sand	SM-SC	27																			Central
	SHB78b-9	7007	5	alluvium	Clay	CH	48																			Central
	SHB78b-9	7007	10	alluvium	Silty Sand	CL	50				42	18		93	94	98	100	11								Central
	SHB78b-9	7007	15	shale	Silty Sand	CL	27																			Central
	SHB78b-10	7000	0	alluvium	Silty Sand	SM	9																			Central
	SHB78b-10	7000	5	alluvium	Silty Sand	SM	2																			Central
	SHB78b-10	7000	10	alluvium	Silty Sand	SM	18				-	NP		22	43	69	87	4								Central
	SHB78b-10	7000	15	alluvium	Silty Sand	SM	12																			Central
	SHB78b-10	7000	20	sandstone	-	-	100/1"																			Central
	SHB78b-18	7018	0	alluvium	Silty Sand	SM	8																			E. Borrow
	SHB78b-18	7018	4.5	alluvium	Sandy Clay	CL	14				26	11		52	79	95	99	4								E. Borrow
	SHB78b-18	7018	12	alluvium	Clay	CH	41																			E. Borrow
	SHB78b-18	7018	14.5	shale	-	-	100/6				32	11		92	98	100		38								E. Borrow
	SHB78b-18	7018	20	shale	-	-	100/8"																			E. Borrow
	SHB78b-18	7018	25	shale	-	-	100/5"																			E. Borrow
	SHB78b-19	7032	0	alluvium	Silty Sand	SM	7																			E. Borrow
	SHB78b-19	7032	4.5	alluvium	Silty Sand	SM	24				22	NP		41	64	88	94	5								E. Borrow
	SHB78b-19	7032	9	sandstone	-	-	100/0"																			E. Borrow
	SHB78b-20	7053	3	sandstone	Silty Sand	SM-SC	9																			E. Borrow
	SHB78b-28	7052	0	alluvium	Silty Sand	SM	27																			E. Borrow
	SHB78b-28	7052	7	sandstone	-	-	100/8"																			E. Borrow
	SHB78b-30	7045	0	alluvium	Sandy Clay	CL	15																			E. Borrow
	SHB78b-30	7045	4.5	alluvium	Sandy Clay	CL	39				27	11		55	73	86	92	8								E. Borrow
	SHB78b-30	7045	7	sandstone	-	-	100/0"																			E. Borrow
	SHB78b-30	7045	15	sandstone	-	-	100/0"																			E. Borrow
	SHB78b-31	7016	0	alluvium	Silty Sand	SM-SC	6																			E. Borrow
	SHB78b-31	7016	5	alluvium	Silty Sand	SM	16																			E. Borrow
	SHB78b-31	7016	9.5	alluvium	Sandy Clay	CL	42				26	11		52	83	99	100	5								E. Borrow
	SHB78b-31	7016	15	alluvium	Sandy Clay	CL	26																			E. Borrow
	SHB78b-31	7016	20	alluvium	Silty Sand	SM	35																			E. Borrow
	SHB78b-31	7016	25	alluvium	Silty Sand	SM	35																			E. Borrow
	SHB78b-31	7016	30	alluvium	Silty Clay	CL	43																			E. Borrow
	SHB78b-32	7023	0	alluvium	Silty Sand	SM-SC	7																			E. Borrow
	SHB78b-32	7023	4.5	alluvium	Silty Sand	SM	13				-	NP		29	70	100										E. Borrow
	SHB78b-32	7023	10	alluvium	Sandy Clay	CL-ML	23																			E. Borrow
	SHB78b-32	7023	15	alluvium	Sandy Clay	CL-ML	26																			E. Borrow
	SHB78b-32	7023	20	alluvium	Sandy Clay	CL-ML	26																			E. Borrow
	SHB78b-32	7023	24.5	alluvium	Sandy Clay	CL-ML	50				25	6		61	92	100		6								E. Borrow

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	SHB78b-32	7023	30	alluvium	Sandy Clay	CL-ML	50																			E. Borrow
	SHB78b-33	7025	0	alluvium	Silty Sand	SM-SC	7																			E. Borrow
	SHB78b-33	7025	4.5	alluvium	Sandy Clay	CL	19				27	9		51	77	100		7								E. Borrow
	SHB78b-33	7025	10	alluvium	Silty Sand	SM	19																			E. Borrow
	SHB78b-33	7025	14.5	alluvium	Silty Sand	SM	32				21	NP		47	86	100		5								E. Borrow
	SHB78b-33	7025	20	alluvium	Clayey Silt	ML	16																			E. Borrow
	SHB78b-33	7025	25	alluvium	Clayey Silt	ML	50																			E. Borrow
	SHB78b-34	7037	0	alluvium	Silty Sand	SM	10																			E. Borrow
	SHB78b-34	7037	5	alluvium	Clayey Silt	ML	15																			E. Borrow
	SHB78b-34	7037	10	alluvium	Silty Sand	SM-SC	39																			E. Borrow
	SHB78b-34	7037	14.5	alluvium	Silty Sand	SM-SC	12				18	NP		40	69	98	98	5								E. Borrow
	SHB78b-34	7037	20	alluvium	Silty Sand	SM-SC	40																			E. Borrow
	SHB78b-34	7037	25	alluvium	Silty Sand	SM	23																			E. Borrow
	SHB78b-34	7037	30	alluvium	Clayey Silt	ML-CL	20																			E. Borrow
SHB, 1979	SHB-79-9	6967	0	alluvium	Sandy Clay	CL	11											19								North
	SHB-79-9	6967	5	alluvium	Clayey Sand	SC	59											12								North
	SHB-79-9	6967	10	alluvium	Clayey Sand	SC	85																			North
	SHB-79-9	6967	15	alluvium	Silty Sand	SM	27											11								North
	SHB-79-9	6967	20	alluvium	Silty Sand	SM	11											5								North
	SHB-79-9	6967	25	alluvium	Clay	CH	11											21								North
	SHB-79-9	6967	30	alluvium	Clay	CH	31																			North
	SHB-79-9	6967	35	alluvium	Clay	CH	13											26								North
	SHB-79-9	6967	40	alluvium	Clay	CH	6											31								North
	SHB-79-9	6967	45	alluvium	Clayey Sand	SC	12											21								North
	SHB-79-9	6967	50	sandstone	-	-	17											19								North
	SHB-79-9	6967	55	sandstone	-	-	50/0"																			North
	SHB-79-10	6967	0	alluvium	Sandy Clay	CL	33											12								North
	SHB-79-10	6967	5	alluvium	Silty Sand	SC-SM	42											14								North
	SHB-79-10	6967	10	alluvium	Silty Sand	SC	54																			North
	SHB-79-10	6967	15	alluvium	Clayey Sand	SC	29											14								North
	SHB-79-10	6967	20	alluvium	Clayey Sand	SC	26																			North
	SHB-79-10	6967	25	sandstone	-	-	50/0"																			North
	SHB-79-11	6967	30	sandstone	-	-																				North
	SHB-79-12	6968	0	alluvium	Clayey Sand	SC	46																			Central
	SHB-79-12	6968	5	tailings	Sand	SP	11																			Central
	SHB-79-12	6968	10	tailings	Sand	SP	5																			Central
	SHB-79-12	6968	15	tailings	Sand	SP	2																			Central
	SHB-79-12	6968	20	tailings	Sand	SP	1																			Central
	SHB-79-12	6968	25	tailings	Sand	SP	12																			Central
	SHB-79-12	6968	30	tailings	Sand	SP	9																			Central
	SHB-79-12	6968	35	tailings	Sand	SP	13																			Central
	SHB-79-12	6968	40	alluvium	Clay	CH	16																			Central
	SHB-79-12	6968	45	alluvium	Sand	SP	5																			Central
	SHB-79-12	6968	50	alluvium	Silty Sand	SM-SC	8																			Central
	SHB-79-12	6968	55	alluvium	Sandy Clay	CL	6																			Central
	SHB-79-13	6968	0	alluvium	Clayey Sand	SC	35																			Central
	SHB-79-13	6968	5	alluvium	Clayey Sand	SC	7																			Central
	SHB-79-13	6968	10	Tailings	Sand	SP-SC	4																			Central
	SHB-79-13	6968	15	Tailings	Sand	SP-SC	1																			Central
	SHB-79-13	6968	20	Tailings	Sand	SP-SC	1																			Central
	SHB-79-13	6968	25	Tailings	Sand	SP-SC	1																			Central
	SHB-79-13	6968	30	Tailings	Sand	SP-SC	10																			Central

Table 1 - Church Rock Mill Site Impoundment - Summary of Relevant Existing Geotechnical Data for the North and Central Cells

							Field Data			Lab Data															
Report Reference	Boring no.	Surf. Elev. (ft)	Sample Depth (ft)	Formation	Material Type	USCS	SPT (bpf)	Torvane (tsf)	Perm (ft/year)	SG	LL (%)	PI (%)	(%) p.001 mm	(%) p.200	(%) p. 100	(%) p. No.10	(%) p. No.4	w.c. (%)	Dry Density (pcf)	Consol	Std. Proctor	rel. density (pcf) min-max	Triax.	Dir. Shear (phi, c (ksf)	Perm (ft/year)(1)	Location
	SHB-79-13	6968	35	Tailings	Sand	SP-SC	19																			Central
	SHB-79-13	6968	40	alluvium	Clay	CH	8																			Central
	SHB-79-13	6968	45	alluvium	Silty Sand	SM	9																			Central
	SHB-79-14	6968	0	alluvium	Clay	CH	15											17								North
	SHB-79-14	6968	5	tailings	Sand	SP-SC	4											15								North
	SHB-79-14	6968	10	tailings	Sand	SP-SC	2											22								North
	SHB-79-14	6968	15	tailings	Sand	SP-SC	8											41								North
	SHB-79-14	6968	20	tailings	Sand	SP-SC	10											34								North
	SHB-79-14	6968	25	alluvium	Sandy Clay	CL	5											36								North
	SHB-79-14	6968	30	alluvium	Clayey Sand	SC	5											24								North
	SHB-79-14	6968	35	alluvium	Clayey Sand	SC	7											26								North
	SHB-79-14	6968	40	alluvium	Clay	CH	8											9								North
	SHB-79-14	6968	45	alluvium	Clay	CH	23											32								North
	SHB-79-15	6966	0	alluvium	Clayey Sand	SC	26											12								North
	SHB-79-15	6966	5	tailings	Sand	SP-SC	6											12								North
	SHB-79-15	6966	10	tailings	Sand	SP-SC	1																			North
	SHB-79-15	6966	15	tailings	Sand	SP-SC	2											45								North
	SHB-79-15	6966	20	alluvium	Sand	SP-SC	6											36								North
	SHB-79-15	6966	25	alluvium	Sand	SP-SC	6											28								North
	SHB-79-15	6966	30	alluvium	Sand	SP-SC	2											21								North
	SHB-79-15	6966	35	alluvium	Sand	SP-SC	4											22								North
	SHB-79-15	6966	40	alluvium	Sand	SP-SC	8											23								North
	SHB-79-15	6966	45	alluvium	Clay	CH	11											29								North
	SHB-79-16	6968	0	alluvium	Clayey Sand	SC	50/.5"											8								North
	SHB-79-16	6968	5	sandstone	-	-	50/2"											6								North
	SHB-79-17	6967	0	alluvium	Silty Sand	SM-SC	24																			Central
	SHB-79-17	6967	5	alluvium	Silty Sand	SM-SC	17																			Central
	SHB-79-17	6967	10	tailings	Sand	SP-SC	50/5"																			Central
	SHB-79-18	6967	0	alluvium	Silty Sand	SM-SC	57																			Central
	SHB-79-18	6967	5	alluvium	Silty Sand	SM-SC	8																			Central
	SHB-79-18	6967	10	tailings	Sand	SP-SC	4																			Central
	SHB-79-18	6967	15	tailings	Sand	SP-SC	19																			Central
	SHB-79-18	6967	20	tailings	Sand	SP-SC	11																			Central
	SHB-79-18	6967	25	tailings	Sand	SP-SC	27																			Central
	SHB-79-18	6967	30	tailings	Sand	SP-SC	9																			Central
	SHB-79-18	6967	35	tailings	Sand	SP-SC	10																			Central
	SHB-79-18	6967	40	tailings	Sand	SP-SC	19																			Central
	SHB-79-18	6967	45	tailings	Sand	CH	75																			Central
CSI, 1980	DH-1	7016	4	alluvium	Sandy Clayey Silt to Clayey Silty Sand	SM-SL	14																			E. Borrow
	DH-1	7016	6	alluvium		SM-SL	18																			E. Borrow
	DH-1	7016	8	alluvium		SM-SL	13																			E. Borrow
	DH-1	7016	12	alluvium	Sandy Clayey Silt	ML	13											6.1	91	X						E. Borrow
	DH-1	7016	15	alluvium	Sandy Clayey Silt	ML	18											5.2	82							E. Borrow
	DH-1	7016	19	alluvium	Sandy Clayey Silt	ML				2.65								5.5	88	C						E. Borrow
	DH-1	7016	20	alluvium	Sandy Clayey Silt	ML	18											5.5	85				CU			E. Borrow
	DH-1	7016	21	alluvium	Sandy Clayey Silt	ML												5.2	84							E. Borrow
	DH-1	7016	24	alluvium	Sandy Clayey Silt	ML	17																			E. Borrow
	DH-1	7016	29	alluvium	Sandy Clayey Silt	ML	19																			E. Borrow
	DH-1	7016	34	alluvium	Sandy Clayey Silt	ML																				E. Borrow
	DH-1	7016	39	alluvium	Sandy Clayey Silt	ML	22																			E. Borrow
	DH-1	7016	70	alluvium	Sandy Clayey Silt	ML	27																			E. Borrow
	DH-2	7082	2	alluvium	Sandy Silt	ML												18.4	101							S. Central

Table 1 - Church Rock Mill Site Impoundment - Summary of Relevant Existing Geotechnical Data for the North and Central Cells

							Field Data			Lab Data															
Report Reference	Boring no.	Surf. Elev. (ft)	Sample Depth (ft)	Formation	Material Type	USCS	SPT (bpf)	Torvane (tsf)	Perm (ft/year)	SG	LL (%)	PI (%)	(%) p.001 mm	(%) p.200	(%) p. 100	(%) p. No.10	(%) p. No.4	w.c. (%)	Dry Density (pcf)	Consol	Std. Proctor	rel. density (pcf) min-max	Triax.	Dir. Shear (phi, c (ksf)	Perm (ft/year)(1)	Location
	DH-2	7082	5	alluvium	Sandy Silt	ML	6											5.3	78							S. Central
	DH-2	7082	6	alluvium	Sandy Silt	ML												4.5	93				UU			S. Central
	DH-2	7082	8	alluvium	Sandy Silt	ML	8											4.6	88							S. Central
	DH-2	7082	11	alluvium	Sandy Silt	ML	17											4.9	105							S. Central
	DH-2	7082	15	alluvium	Sandy Silt	ML	17											7.8	88							S. Central
	DH-2	7082	22	sandstone	Silty Sand	-	50/1"																			S. Central
	DH-2	7082	25	sandstone	-	-	50/1"																			S. Central
	DH-2	7082	30	sandstone	-	-	50/1"																			S. Central
	DH-3	7043	2	alluvium	Sandy Clayey Silt to Clayey Silty Sand	SM-ML								37	76		100	11.7	105	C						E. Borrow
	DH-3	7043	5	alluvium		SM-ML	12			2.66								6.5	97	S						E. Borrow
	DH-3	7043	6	alluvium		SM-ML	12																			E. Borrow
	DH-3	7043	8	alluvium		SM-ML	13																			E. Borrow
	DH-3	7043	12	alluvium	Sandy Clayey Silt	ML	9						24	87	96		99	9.4	90							E. Borrow
	DH-3	7043	13	alluvium	Sandy Clayey Silt	ML												7.1	83	C						E. Borrow
	DH-3	7043	16	alluvium	Sandy Clayey Silt	ML	10											5.8	94							E. Borrow
	DH-3	7043	20	alluvium	Sandy Clayey Silt	ML	11							37	66		90	5.5	103				CU		416	E. Borrow
	DH-3	7043	25	alluvium	Sandy Clayey Silt	ML	14											6.1	87							E. Borrow
	DH-3	7043	26	alluvium	Sandy Clayey Silt	ML												5.4	88				UU			E. Borrow
	DH-3	7043	29	alluvium	Sandy Clayey Silt	ML							14	55	91		100									E. Borrow
	DH-3	7043	31	alluvium	Sandy Clayey Silt	ML	12											6.5	90							E. Borrow
	DH-3	7043	35	alluvium	Sandy Clayey Silt	ML	16																			E. Borrow
	DH-3	7043	46	total depth	Sandy Silt to Silty Sand	SM-ML	46																			E. Borrow
	DH-4	7019	4	alluvium	Silty Sand to Sandy Silt	SM-ML	50																			S. Central
	DH-4	7019	6	siltstone	-	-	50																			S. Central
	DH-4	7019	8	siltstone	-	-	50																			S. Central
	DH-4	7019	10	siltstone	-	-	100																			S. Central
	DH-4	7019	15	siltstone	-	-	50																			S. Central
	DH-4	7019	20	siltstone	-	-	50																			S. Central
	DH-4	7019	25	siltstone	-	-	50																			S. Central
	DH-4	7019	29	sandstone	-	-	100																			S. Central
	DH-4	7019	40	total depth	-	-	100																			S. Central
	DH-6	7012	4	alluvium	Sandy Clayey Silt	ML	17																			W. Borrow
	DH-6	7012	6	alluvium	Sandy Clayey Silt	ML	50																			W. Borrow
	DH-6	7012	8	alluvium	Sandy Clayey Silt	ML	50																			W. Borrow
	DH-6	7012	10	alluvium	Sandy Clayey Silt	ML	50																			W. Borrow
	DH-6	7012	15	siltstone	-	-	50																			W. Borrow
	DH-6	7012	20	siltstone	-	-	50																			W. Borrow
	DH-6	7012	25	siltstone	-	-	100																			W. Borrow
	DH-6	7012	30	siltstone	-	-	100																			W. Borrow
	DH-6	7012	40	total depth	-	-	100																			W. Borrow
	DH-7	7022	4	alluvium	Clayey Silt to Sandy Clayey Silt	ML	50																			W. Borrow
	DH-7	7022	6	siltstone	-	-	50																			W. Borrow
	DH-7	7022	9	siltstone	-	-	50																			W. Borrow
	DH-7	7022	11	siltstone	-	-	50																			W. Borrow
	DH-7	7022	15	siltstone	-	-	50																			W. Borrow
	DH-7	7022	20	sandstone	-	-	50																			W. Borrow
	DH-7	7022	25	siltstone	-	-	50																			W. Borrow
	DH-7	7022	30	siltstone	-	-	50																			W. Borrow
	DH-7	7022	40	siltstone	-	-	50																			W. Borrow
	DH-7	7022	50	total depth	-	-	50																			W. Borrow
	DH-8	6998	4	alluvium	Clayey Silt	ML-CL	50																			W. Borrow

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							Field Data			Lab Data															
Report Reference	Boring no.	Surf. Elev. (ft)	Sample Depth (ft)	Formation	Material Type	USCS	SPT (bpf)	Torvane (tsf)	Perm (ft/year)	SG	LL (%)	PI (%)	(%) p.001 mm	(%) p.200	(%) p. 100	(%) p. No.10	(%) p. No.4	w.c. (%)	Dry Density (pcf)	Consol	Std. Proctor	rel. density (pcf) min-max	Triax.	Dir. Shear (phi, c (ksf)	Perm (ft/year)(1)	Location
	DH-8	6998	6	alluvium	Clayey Silt	ML-CL	50																			W. Borrow
	DH-8	6998	8	siltstone	-		50																			W. Borrow
	DH-8	6998	11	siltstone	-		50																			W. Borrow
	DH-8	6998	15	siltstone	-		50																			W. Borrow
	DH-8	6998	20	shale	-		X																			W. Borrow
	DH-8	6998	25	siltstone	-		100																			W. Borrow
	DH-8	6998	30	siltstone	-		50																			W. Borrow
	DH-8	6998	40	siltstone	-		50																			W. Borrow
	DH-8	6998	50	total depth	-		50																			W. Borrow
Canonie, 1986	658	6976	7.5-10	tailings	Fine					2.81								17.4	88							Central
&1991	658		12.5-15	tailings														21.5	105	0.018						Central
	658		17.5-20	tailings	Fine/Coarse mixed					2.83								23.5	104							Central
	658		27.5-30	tailings	Coarse					2.81								23.4	98							Central
	658		30-32.5	tailings	Coarse					-								43.6	97	0.055						Central
	658		37.5-40	tailings	Coarse					2.89								31.2	92							Central
	659	6990	7.5-10	tailings	Coarse					2.84								6.1	95							Central
	659		17.5-20	tailings	Coarse					2.83								10.5	94							Central
	659		27.5-30	tailings	Coarse					2.74								13.1	97							Central
	659		30-32.5	tailings	Coarse					-								32	106	0.022						Central
	659		35-37.5	tailings	Fine/Coarse mixed					2.72								29.6	78							Central
	660	6975	8	tailings	Fine					2.81								44.2	74							Central
	660		12.5-15	tailings	Fine					2.84								60	94							Central
	660		25-27.5	tailings	Fine					2.75								32.2	89	sample disturbed						Central
	660		35-37.5	tailings	Fine					2.84								41.4	79							Central
	660		38	tailings	Fine													44.5	73	Cc=1.0						Central
	662	6957	17.5-20	tailings	Sandy, coarse													34.1	97	Cc=0.043						South
	662		25	tailings	Coarse					2.78								25.1	96							South
	662		30	tailings	Coarse					2.79								29.6	94							South
	662		32.5	tailings	Coarse					-								34.1	97							South
	662		37.5-40	tailings	Fine					2.72								36.4	84	0.068						South
	662		40-42.5	tailings	Fine/Coarse mixed					-								43.8	89	0.082						South
Canonie, 1993	5M		5-5.8	tailings	Coarse					2.63			5	20	28	100		8.5	90							Central
	5M		6.8-7.5	tailings	Coarse					2.65			2	11	22	100		6.4	103							Central
	9M		3.3-4	tailings	Coarse					2.68			3	9	15	100		6.9	105							Central
	9M		5-5.5	tailings	Coarse					2.68			4	15	17	100		7.1	-							Central
	9M		6.2-7	tailings	Coarse					2.65			2	10	17	100		7.1	112							Central
	9G		3.3-4	tailings	Coarse					2.68			4	18	29	100		9.8	113							Central
	9G		4-5	tailings	Coarse					2.64			2	10	20	100		7.5	-							Central
	9G		5.8-6.5	tailings	Coarse with slime					2.65			6	22	32	100		27.3	78							Central
	11M		2.5-5	tailings	Coarse					2.68			3	16	22	100		4.9	101							Central
	11M		4-5	tailings	Coarse					2.64			2	9	15	100		5	-							Central
	11M		6.4-7.5	tailings	Coarse					2.69			3	11	17	100		4.7	102							Central
	13K		3.3-4	tailings	Sand					2.67			2	8	16	100		5.2	109							Central
	13K		4-5	tailings	Sand					2.65			2	10	17	100		7.2	-							Central
	13K		5.8-6.5	tailings	Sand Trace Slime					2.64			3	10	14	100		7.8	102							Central
	17A		1.8-2.4	tailings	Coarse with clay					2.69			6	26	38	100		11.1	117							Central
	17A		3.2-4	tailings	Coarse with clay					2.63			3	21	29	100		13.4	113							Central
	17A		4-5	tailings	Coarse with slime					2.69			5	25	37	100		14.1	-							Central
	17A		5.8-6.5	tailings	Coarse with slime					2.66			6	25	36	100		13.7	115							Central
	11K		3.3-4	tailings	Coarse					2.68			3	12	18	100		10.7	101							Central
	11K		4-4.7	tailings	Fine with clay					2.66			2	12	15	100		7.0	96							Central
	11K		6.3-7	tailings	Fine with clay					2.67			5	22	29	100		9.3	95							Central

Table 1 - Church Rock Mill Site Impoundment - Summary of Relevant Existing Geotechnical Data for the North and Central Cells

							Field Data			Lab Data															
Report Reference	Boring no.	Surf. Elev. (ft)	Sample Depth (ft)	Formation	Material Type	USCS	SPT (bpf)	Torvane (tsf)	Perm (ft/year)	SG	LL (%)	PI (%)	(%) p.001 mm	(%) p.200	(%) p. 100	(%) p. No.10	(%) p. No.4	w.c. (%)	Dry Density (pcf)	Consol	Std. Proctor	rel. density (pcf) min-max	Triax.	Dir. Shear (phi, c (ksf)	Perm (ft/year)(1)	Location
	13G		1-1.5	tailings	Fine with slime					2.69			26	76	92	100		12.0	117							Central
	13G		3.3-4	tailings	Fine with slime					2.66			4	17	25	100		12.8	100							Central
	13G		4-4.9	tailings	Fine					2.67			3	12	41	100		8.0	101							Central
	13G		5.8-6.5	tailings	Fine					2.65			6	17	52	100		5.9	95							Central
	15C		2.9-3.6	tailings	Fine with slime					2.67			3	24	34	100		14.4	110							Central
	15C		4.1-4.8	tailings	Fine with slime					2.68			4	23	38	100		14.0	112							Central
	15C		6.3-7.0	tailings	Fine with slime					2.67			4	23	38	100		19.0	98							Central
	17I		3.0-4.1	tailings	Fine with slime					2.67			3	45	59	100		11.5	112							Central
	17I		4.1-4.8	tailings	Fine with slime					2.67			4	31	47	100		17.1	110							Central
	17I		6.1-6.8	tailings	Fine with slime					2.69			3	39	52	100		13.3	94							Central
																					Notes: (1) remolded to 95% of ASTM D698,				
																					c=cohesion, UC=unconfined compression, CU=consolidated undrained				
																					UU=unconsolidated undrained, C=collapse, S=swell, NP=non-plastic				

APPENDIX A2

BORROW CHARACTERIZATION

MWH

MWH

BUILDING A BETTER WORLD

TECHNICAL MEMORANDUM

TO: *Mr. Lance Hauer, GE* DATE: *February 17, 2012*

FROM: *Eileen Dornfest, Clint Strachan, MWH, Inc.*
Stephen Dwyer, Dwyer Engineering, LLC REFERENCE: *1012151*

SUBJECT: *Potential Borrow Areas and Borrow Characterization Plan, Northeast Church Rock Millsite*

Cover Construction Materials

As requested by GE, available cover materials from select potential borrow areas on the NECR site were evaluated for geotechnical characteristics and estimated volume. Five potential areas containing borrow source material have been identified within the United Nuclear Corporation property at the Northeast Church Rock Millsite. These potential borrow sources are Borrow Areas 1, 2, D-N, D-S, and Dilco Hill. Limited investigations have been conducted within Borrow Areas 1 and 2. The remaining borrow areas have not yet been sampled or characterized. The potential borrow areas are shown on Figure BA-1. A stockpile of topsoil material available for cover construction is also shown on Figure BA-1.

Estimated quantities of soil material required for cover construction range from approximately 160,000 cubic yards (cy) to over 350,000 cy, depending on the capacity and configuration of the mine waste repository. In addition, the Engineering Evaluation/Cost Analysis (EPA, 2009) indicates that approximately 200,000 cy of borrow material may be required to restore the mine site.

Borrow Areas 1 and 2

Borrow Areas 1 and 2 were sampled in 2008 with an excavator. Thirteen test pits were excavated within Borrow Area 1, with depths ranging from 8.0 feet to greater than 12.0 feet. The depths of the test pits excavated in Borrow Area 1 were generally limited by the reach of the excavator. Twelve test pits were excavated within Borrow Area 2, with depths ranging from 3.9 to 12.0 feet. The test pit identification numbers, GPS coordinates, and depths are provided in Tables 1 and 2 for Borrow Areas 1 and 2, respectively. The approximate locations of the test pits in Borrow Areas 1 and 2 are shown in Figure BA-2.

Table 1. Borrow Area 1 Test Pit Depths and Locations

Test Pit ID	GPS Location (latitude/longitude)	Depth
NTP-01	N 35º 38.734´/ W 108º 29.668´	9.5 ft Rock[1]
NTP-02	N 35º 38.733´/ W 108º 29.692´	>12.0 ft
NTP-03	N 35º 38.734´/ W 108º 29.720´	>12.0 ft
NTP-04	N 35º 38.709´/ W 108º 29.662´	>12.0 ft
NTP-05	N 35º 38.702´/ W 108º 29.692´	>12.0 ft
NTP-06	N 35º 38.700´/ W 108º 29.726´	8.0 ft Rock[1]
NTP-07	N 35º 38.673´/ W 108º 29.662´	>12.0 ft
NTP-08	N 35º 38.674´/ W 108º 29.692´	>12.0 ft
NTP-09	N 35º 38.678´/ W 108º 29.725´	8.5ft Shale[1]
NTP-10	N 35º 38.643´/ W 108º 29.664´	>12.0 ft
NTP-11	N 35º 38.644´/ W 108º 29.693´	>12.0 ft
NTP-12	N 35º 38.647´/ W 108º 29.732´	>12.0 ft
NTP-13	N 35º 38.?´/ W 108º 29.?´	>12.0 ft

Notes: 1. The test pits were terminated shallower than 12 ft due to refusal as a result of rock or shale.

Table 2. Borrow Area 2 Test Pit Depths and Locations

Test Pit ID	GPS Location (latitude/longitude)	Depth
STP-01	N 35º 38.439´/ W 108º 30.262´	3.9 ft
STP-02	N 35º 38.460´/ W 108º 30.264´	4.0 ft
STP-03	N 35º 38.456´/ W 108º 30.267´	9.9 ft
STP-04	N 35º 38.444´/ W 108º 30.279´	9.5 ft
STP-05	N 35º 38.434´/ W 108º 30.286´	3.1 ft
STP-06	N 35º 38.478´/ W 108º 30.300´	8.6 ft
STP-07	N 35º 38.471´/ W 108º 30.311´	8.5 ft
STP-08	N 35º 38.458´/ W 108º 30.329´	11.8 ft
STP-09	N 35º 38.456´/ W 108º 30.333´	4.9 ft
STP-10	N 35º 38.505´/ W 108º 30.336´	10.3 ft
STP-11	N 35º 38.498´/ W 108º 30.345´	12.0 ft
STP-12	N 35º 38.487´/ W 108º 30.360´	11.1 ft

Estimates of available borrow material volume from Borrow Areas 1 and 2 are provided below. Estimates are based on the depth of borrow material encountered in test pits, as well as assumptions about geometry of the borrow pit excavations.

- Borrow Area 1 – 204,000 cy (assumes an average excavation depth of 12 ft, and 5:1 (horizontal:vertical) slopes along the excavation perimeter).
- Borrow Area 2 – 143,000 cy (assumes an average excavation depth of 8 ft, with 5:1 slopes along the excavation perimeter).

AMEC collected samples from both Borrow Areas 1 and 2 and tested them for limited geotechnical properties in 2008. The results of the laboratory testing and the material types are provided in Table 3 below (Dwyer, 2012).

Table 3. Laboratory Test Results for Borrow Areas 1 and 2

Sample	Ksat (cm/sec)	% Sand	% Silt	% Clay	USDA Classification
Borrow Area 1	1.41E-04	35.8	31.9	33.6	Clay Loam
Borrow Area 2	4.19E-04	46.2	24.1	29.6	Sandy Clay Loam

Dilco Hill Borrow Area

The area designated as Dilco Hill is shown on Figure BA-1. No exploration or characterization of this potential borrow source has been conducted, but the material is assumed to be composed predominately of shale with siltstone and sandstone. Estimates of the volume of material available from the Dilco Hill Borrow Area are based on an assumed depth and lateral extent of excavation, as shown on Figure BA-3. The estimated volume of material available from Dilco Hill is approximately 337,000 CY.

Borrow Areas D-N and D-S

The areas designated as potential Borrow Areas D-N and D-S are located in drainages north of the Church Rock tailings facility, as shown in Figure BA-1. No exploration or characterization of these potential borrow sources has been conducted, and no estimates of available borrow material have been developed. If these borrow sources are determined to be necessary for cover construction, these borrow areas will be sampled and characterized as a portion of the pre-design data collection activities.

Topsoil Stockpile

A topsoil stockpile containing approximately 34,000 CY of material exists on UNC property north of Highway 566 and west of the UNC offices. The location of the topsoil stockpile is shown on Figure BA-1. AMEC tested one sample from the topsoil stockpile for limited geotechnical properties in 2008. The results of the laboratory testing are provided in Table 4 below (Dwyer, 2012).

Table 4. Laboratory Test Results for Topsoil Stockpile Material

Sample	Ksat (cm/sec)	% Sand	% Silt	% Clay	USDA Classification
Topsoil Stockpile	1.27E-04	34.5	31.9	33.6	Clay Loam

Further characterization of these borrow materials will be necessary to determine suitability of the proposed material for soil cover construction, as well as to develop geotechnical parameters for final design. The proposed borrow soil investigation is discussed below.

Erosion Protection Materials

Erosion protection materials (basalt rock) are also currently stockpiled on site (personal communication with UNC personnel). These rock sizes and stockpile volumes are provided in Table 5 below. These erosion protection materials are surplus materials from previous construction at the site and have already been tested and characterized. Therefore, they should not require any additional geotechnical sampling or testing.

Table 5. Volume of Materials Stockpiled on Site

D_{50} Diameter (in)	Volume Stockpiled on Site (cubic yards)
0.02 (crusher fines)	822
0.35 (base coarse)	325
1.5	4,469
3.0	600
6.0	143
10.0	314

Future Borrow Soil investigation

The borrow sources described above will require sampling and laboratory testing to measure applicable geotechnical and hydraulic properties. The sample frequency and laboratory testing program will be specified as part of the pre-design data collection task. The laboratory test results will be used to help determine the applicability of the different soils for use in a final cover system. An adequate number of trenches and/or borings will need to be excavated and sampled to adequately characterize the full extent of the borrow sources. If the borrow soil investigation results indicate the material volumes or properties are inadequate for cover construction, investigation of additional borrow sources may be warranted.

A preliminary summary of the laboratory testing to be performed on samples from the borrow areas is provided in Table 6. The tests will be performed as specified during the pre-design data collection task.

Table 6. Soil Tests and Methods for Additional Borrow Material Characterization

Test	Test Method
Saturated hydraulic conductivity	(Rigid Wall - ASTM D2434M) or flexible wall depending on soil texture flexible wall
Dry bulk density	ASTM D7263
Moisture Content	ASTM D7263
Calculated total porosity	ASTM D7263
Moisture Characteristics (5-7pts. min): other test methods such as centrifuge is to be approved prior to their use	
Hanging Column Method	ASTM D6836
Pressure Plate Method	ASTM D6836
Water Potential (Dewpoint Potentiometer)	ASTM D6836
Relative Humidity (Box)	Karathanasis & Hajek. 1982. Quantitative Evaluation of Water Adsorption on Soil Clays. SSA Journal 46:1321-1325; Campbell, G. and G. Gee. 1986. Water Potential: Miscellaneous Methods. Chp. 25, pp. 631-632, in A. Klute (ed.), Methods of Soil Analysis, American Society of Agronomy, Madison, WI
Moisture Retention Characteristics & Calculated Unsaturated Hydraulic Conductivity:	ASTM D6836; van Genuchten, M.T. 1980. A closed-form equation for predicting the hydraulic conductivity of unsaturated soils. SSSAJ 44:892-898; van Genuchten, M.T., F.J. Leij, and S.R. Yates. 1991. The RETC code for quantifying the hydraulic functions of unsaturated soils. Robert S. Kerr Environmental Research Laboratory, Office of Research and Development, U.S. Environmental Protection Agency, Ada, Oklahoma. EPA/600/2091/065. December 1991
Specific Gravity Fine	ASTM D854
Specific Gravity Coarse	ASTM C127
Particle size analysis (Wet) Standard Sieves with Wash & Hydrometer	ASTM D422
USDA Classification	ASTM D422, USDA Soil Textural Triangle
Atterberg Limits:	ASTM D4318
Standard Proctor Compaction	ASTM D698

References

US Environmental Protection Agency Region 9. 2009. *Engineering Evaluation /Cost Analysis Northeast Church Rock (NECR) Mine Site, Gallup New Mexico.* May 30.

Dwyer, Steve. 2012. *Memo: Summary of NECR Geotechnical Data Available to Date.* January 3.

cc: Randall McAlister, GE
Toby Leeson, MWH

Attachments:

Figure BA-1: Potential Borrow Area Locations
Figure BA-2: Test Pit Locations in Borrow Area 1
Figure BA-3: Dilco Hill Borrow Area

FIGURES

P.O. BOX 3077
Gallup, New Mexico 87305-3077

PROJECT LOCATION	McKINLEY COUNTY, NEW MEXICO
PROJECT	NECR REMOVAL ACTION
TITLE	POTENTIAL BORROW AREA LOCATIONS
FIGURE	BA-1
DATE	FEB 2012
FILE NAME	1012217D008

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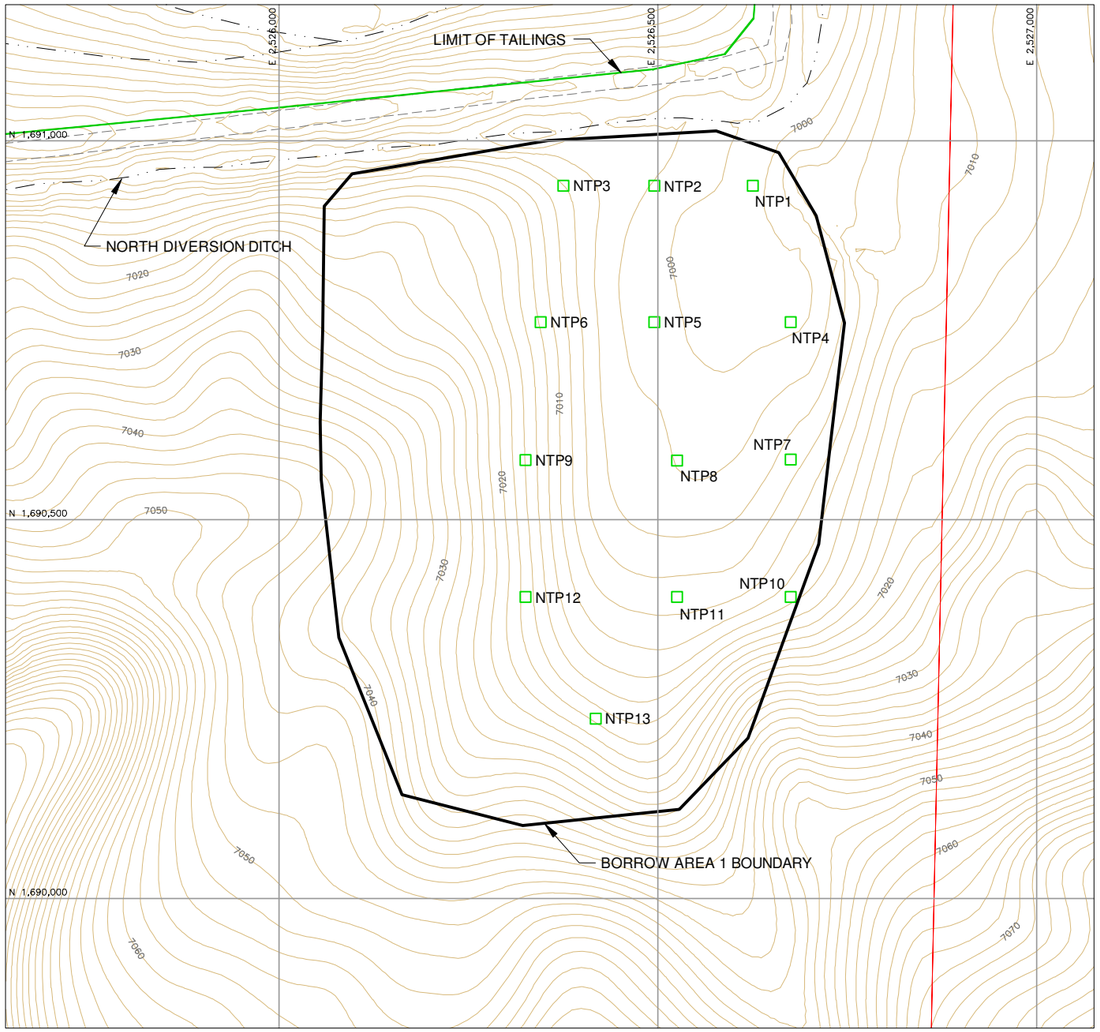
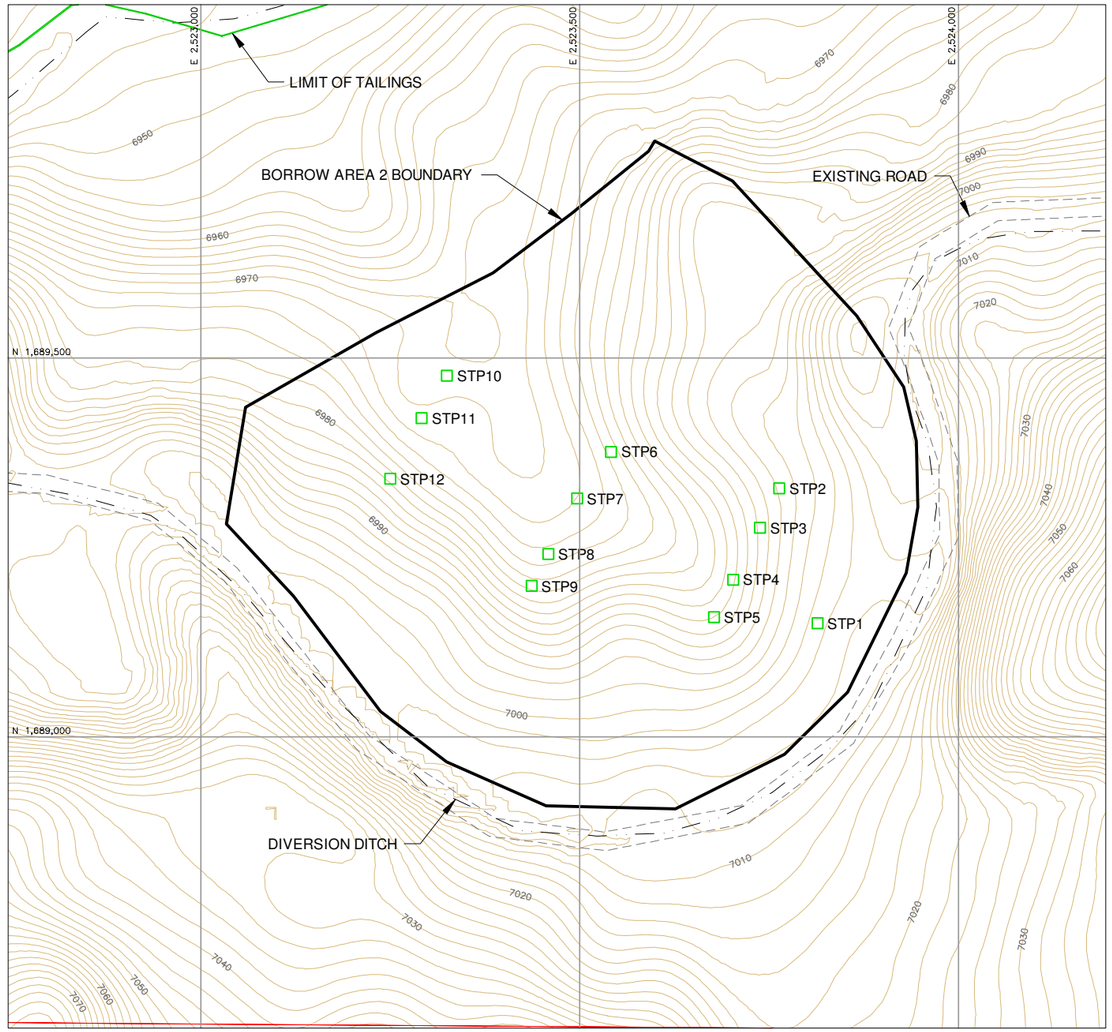


BORROW AREA 1 TEST PIT LOCATIONS



BORROW AREA 2 TEST PIT LOCATIONS

LEGEND:

- NECR CELL BOUNDARY
- PLSS SECTION LINE
- NTP13 APPROXIMATE BORROW TEST PIT LOCATION

SCALE
100' 0 100' 200'

P.O. BOX 3077
Gallup, New Mexico 87305-3077

PROJECT LOCATION: McKINLEY COUNTY, NEW MEXICO
PROJECT: NECR REMOVAL ACTION
TITLE: BORROW AREA TEST PIT LOCATION MAP
FIGURE: BA-2
DATE: JAN 2012
FILE NAME: 1012217D010

MWH

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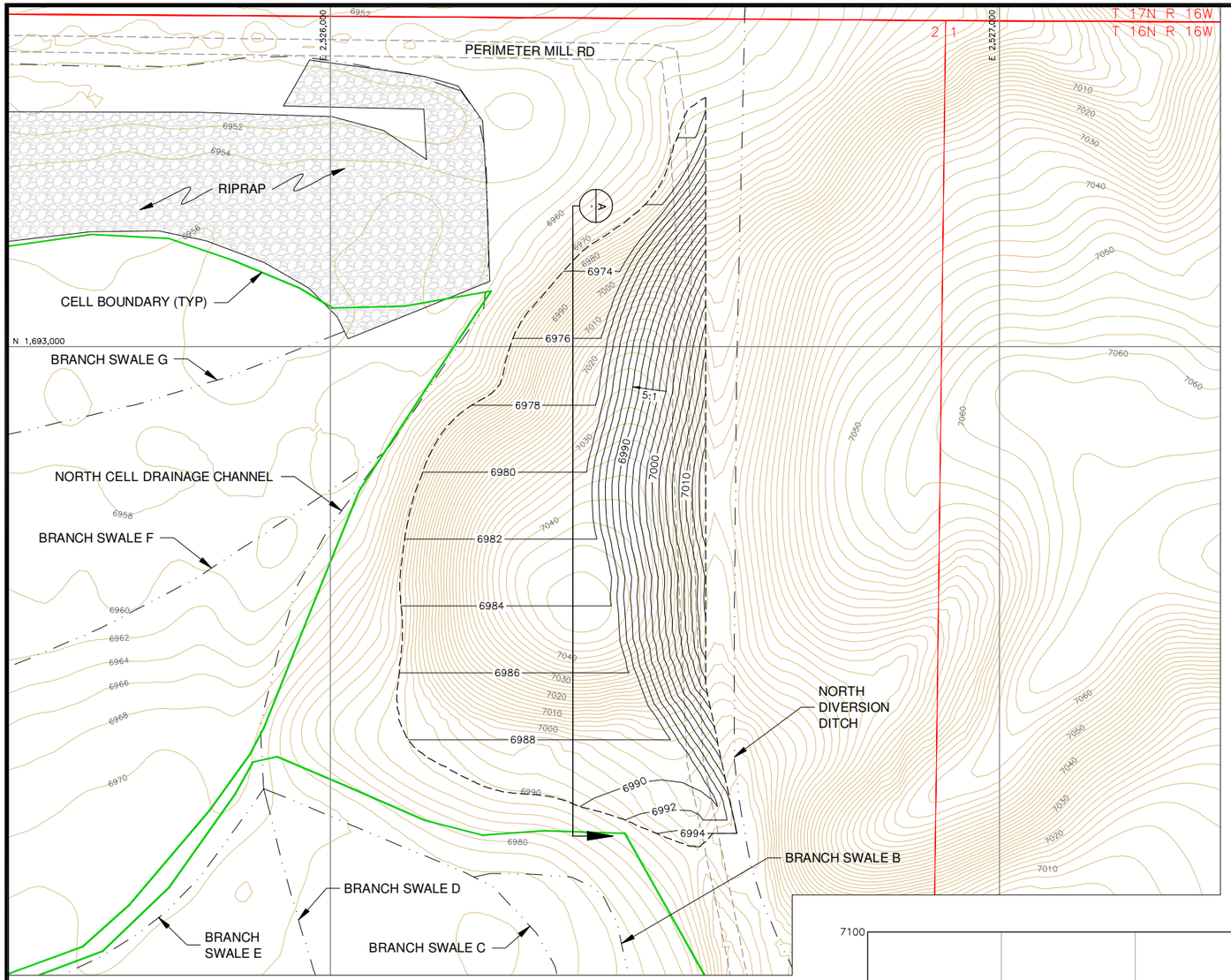


PLAN

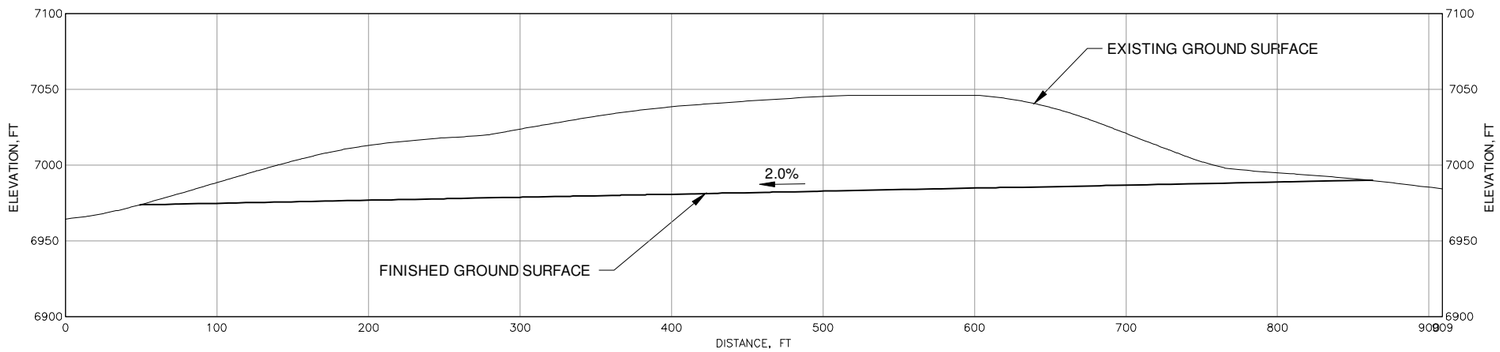
SCALE

100' 0 100' 200'

CONTOUR INTERVAL = 2 FEET

LEGEND:

- 6980 — EXISTING GROUND SURFACE CONTOUR ELEVATION, FT
- 6980 — FINISHED GROUND SURFACE CONTOUR, FT
- EXISTING ROADS
- PLSS SECTION LINE



SECTION A

SCALE

50' 0 50' 100'

P.O. BOX 3077
Gallup, New Mexico 87305-3077

PROJECT LOCATION: McKINLEY COUNTY, NEW MEXICO

PROJECT: NECR REMOVAL ACTION

TITLE: DILCO HILL BORROW AREA

FIGURE: BA-3

DATE: JAN 2012

FILE NAME: 1012217D009

MWH

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APPENDIX A3

SUMMARY OF GEOTECHNICAL DATA

DWYER ENGINEERING, LLC

MEMO

To: Lance Hauer

From: Steve Dwyer

Date: 01/03/2012

Re: Summary of NECR Geotechnical Data available to date

Message:

The following tables summarize the available geotechnical data collected to date from the NECR site. The data includes samples tested by AMEC in 2008 as well as samples collected from the Interim Removal Area in 2011.

AMEC Samples

The AMEC samples were taken from Borrow Pit 1, Borrow Pit 2, and a Topsoil Stockpile. The date of the AMEC results is December 2, 2008.

Table 1. AMEC Results

Sample	Ksat (cm/sec)	% Sand	% Silt	% Clay	USDA Classification
Borrow Pit 1	1.41E-04	35.8	31.9	33.6	Clay Loam
Borrow Pit 2	4.19E-04	46.2	24.1	29.6	Sandy Clay Loam
Topsoil Stockpile	1.27E-04	34.5	31.9	33.6	Clay Loam

Figure 1. AMEC Sample Locations

Interim Removal Area Samples

The soil samples taken from the Interim Removal Area were tested at a local geotechnical laboratory and are summarized as follows:

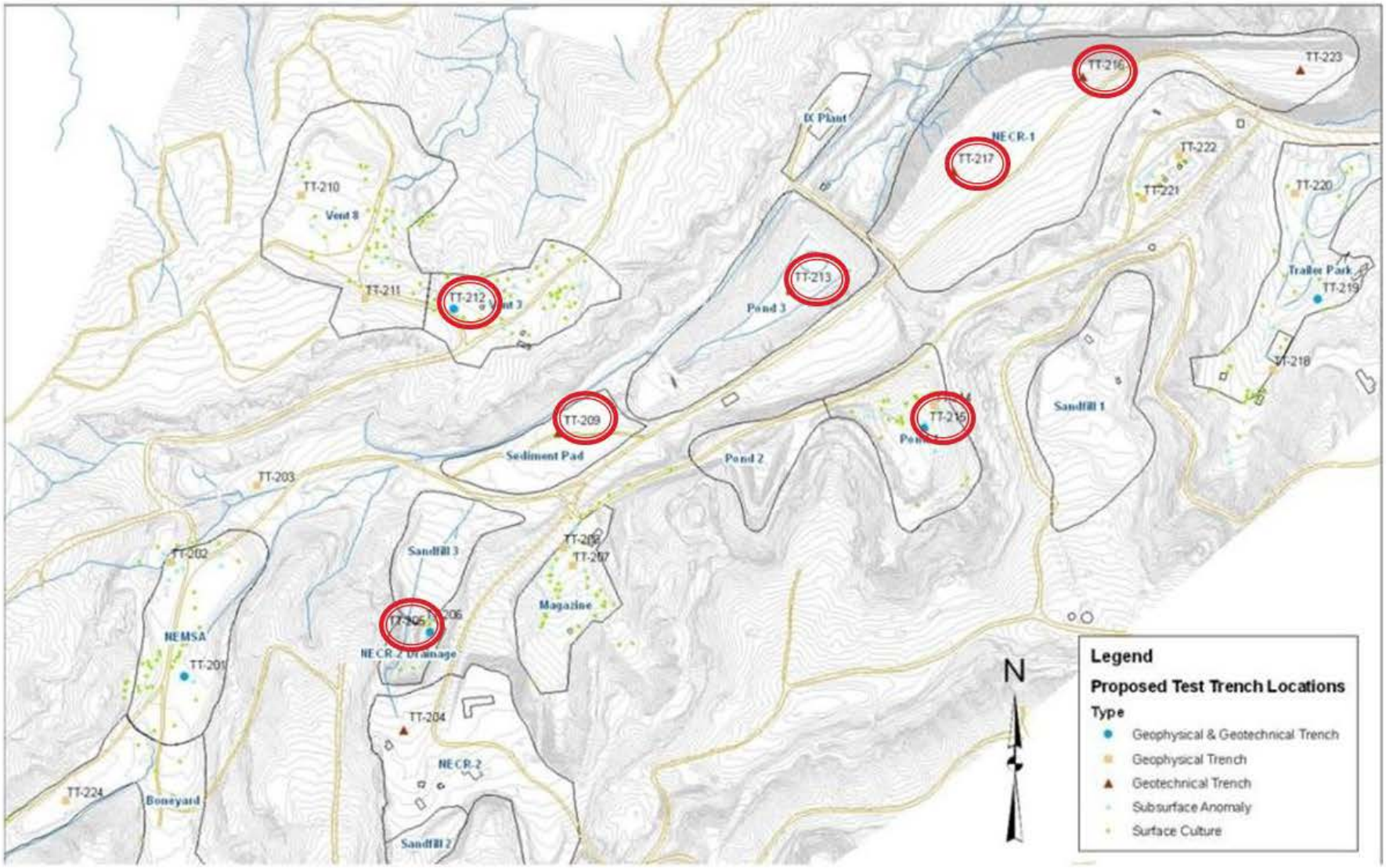

Figure 2. Interim Action Soil Sample Locations

Table 2. Summary of Interim Action Sample Preparations

Summary of Sample Preparation/Volume Changes														
Sample Number	**Proctor Data**		**Target Remold Parameters[1]**			**Actual Remold Data**			**Volume Change Post Saturation[2]**			**Volume Change Post Drying Curve[3]**		
	Opt. Moist. Cont.	Max. Dry Density	Moist. Cont.	Dry Bulk Density	% of Max. Density	Moist. Cont.	Dry Bulk Density	% of Max. Density	Dry Bulk Density	% Volume Change	% of Max. Density	Dry Bulk Density	% Volume Change	% of Max. Density
	(%, g/g)	(g/cm^3)	(%, g/g)	(g/cm^3)	(%)	(%, g/g)	(g/cm^3)	(%)	(g/cm^3)	(%)	(%)	(g/cm^3)	(%)	(%)
TT-205-GT1	13.9	1.78	13.9	1.60	90%	13.9	1.60	89.9%	1.60	---	89.9%	1.60	---	89.9%
TT-209-GT1	11.6	1.88	11.6	1.69	90%	11.4	1.69	90.3%	1.69	---	90.3%	1.72	-1.5%	91.7%
TT-212-GT1	---	---	13.9	1.60	90%	14.4	1.59	89.6%	1.64	-2.6%	92.1%	1.67	-4.6%	94.0%
TT-213-GT1	13.5	1.85	13.5	1.66	90%	13.5	1.66	90.0%	1.66	---	90.0%	1.66	---	90.0%
TT-215-GT1	---	---	13.9	1.60	90%	14.6	1.59	89.5%	1.59	---	89.5%	1.59	---	89.5%
TT-216-GT2	---	---	13.9	1.60	90%	14.1	1.59	89.6%	1.59	---	89.6%	1.59	---	89.6%
TT-217-GT1	11.4	1.84	11.4	1.65	90%	11.4	1.66	90.2%	1.66	---	90.2%	1.69	-2.1%	92.1%

Table 3. Summary of Interim Action Grain Size Distribution

Sample Number	% Gravel (>4.75mm)	% Sand (<4.75mm, >0.075mm)	% Silt (<0.075mm, >0.002mm)	% Clay (<0.002mm)	% Fines Clay + Silt	USDA Classification
TT-205-GT1	5.4	67.5	16.3	10.8	27.1	Sandy Loam
TT-209-GT1	3.1	81.8	7.4	7.6	15.0	Loamy Sand
TT-212-GT1	1.2	80.3	8.4	10.1	18.5	Loamy Sand
TT-213-GT1	1.0	65.2	20.9	13.0	33.9	Sandy Loam
TT-215-GT1	25.5	41.8	21.1	11.7	32.8	Sandy Loam
TT-216-GT2	1.7	56.4	25.9	16.1	42.0	Sandy Loam
TT-217-GT1	0.0	87.9	6.9	5.1	12.1	Sand

Table 4. Summary of Interim Action Hydraulic Properties

Summary of Hydraulic Properties					
Sample Number	α (cm^{-1})	**N** (dimensionless)	θ_r (% vol)	θ_s (% vol)	**K_{sat} (cm/sec)**
TT-205-GT1	0.0525	1.2338	0.00	37.74	2.2E-04
TT-209-GT1	0.0378	1.3596	1.25	35.64	1.8E-03
TT-212-GT1	0.0363	1.4247	2.01	40.83	3.1E-03
TT-213-GT1	0.0184	1.2306	0.00	35.58	1.1E-04
TT-215-GT1	0.0056	1.2674	0.00	36.52	9.7E-06
TT-216-GT2	0.0192	1.2335	0.00	35.95	5.4E-05
TT-217-GT1	0.0381	1.4302	1.33	33.77	2.6E-03

APPENDIX B

PRE-DESIGN STUDIES

APPENDIX B1

LABORATORY TEST REPORTS

APPENDIX B1.1

ANALYTICAL TEST RESULTS

ENERGY LABORATORIES

ENERGY LABORATORIES
www.energylab.com
Analytical Excellence Since 1952
Helena, MT 877-472-0711 • Billings, MT 800-735-4489 • Casper, WY 888-235-0515
Gillette, WY 866-686-7175 • Rapid City, SD 888-672-1225 • College Station, TX 888-690-2218

ANALYTICAL SUMMARY REPORT

January 31, 2014

Montgomery Watson Harza
1475 Pine Grove Rd Ste 109
Steamboat Springs, CO 80477

Workorder No.: C13120735

Project Name: Church Rock Pre-Design Study

Energy Laboratories, Inc. Casper WY received the following 9 samples for Montgomery Watson Harza on 12/20/2013 for analysis.

Sample ID	Client Sample ID	Collect Date	Receive Date	Matrix	Test
C13120735-001	TI-CS02-01 [0-7]inches	11/12/13 0:00	12/20/13	Soil	Cation Exchange Capacity Metals, NH4OAc Extractable Metals, Saturated Paste Conductivity Exchangeable Sodium Percentage Lime as CaCO3 Total Kjeldahl Nitrogen Organic Carbon/Matter Walkely-Black Soluble Metals from Paste pH, Saturated Paste Phosphorus-Olsen CEC NH4AC Soil Extraction Gamma Sample Preparation Lime Percentage NH4AC Soil Extraction Saturated Paste Total Organic Matter Prep Gross Gamma Sodium Adsorption Ratio Saturation Percentage
C13120735-002	TI-CS07-01 [0-6]inches	11/13/13 10:55	12/20/13	Soil	Same As Above
C13120735-003	TI-CS11-01 [0-6]inches	11/13/13 14:35	12/20/13	Soil	Same As Above
C13120735-004	WB-B2-04 [0-10]inches	11/14/13 16:00	12/20/13	Soil	Same As Above
C13120735-005	EB-B4-03 [0-10]inches	12/10/13 11:40	12/20/13	Soil	Same As Above
C13120735-006	SB-B4-01 [0-15]inches	12/12/13 16:45	12/20/13	Soil	Same As Above
C13120735-007	NB-B1-04 [0-15]inches	12/12/13 14:25	12/20/13	Soil	Same As Above
C13120735-008	DH-B3-02 [0-10]inches	12/11/13 14:40	12/20/13	Soil	Same As Above
C13120735-009	Topsoil Stockpile	11/21/13 15:35	12/20/13	Soil	Same As Above

The results as reported relate only to the item(s) submitted for testing. The analyses presented in this report were performed at Energy Laboratories, Inc., 2393 Salt Creek Hwy., Casper, WY 82601, unless otherwise noted. Radiochemistry analyses were performed at Energy Laboratories, Inc., 2325 Kerzell Lane, Casper, WY 82601, unless otherwise noted. Any exceptions or problems with the analyses are noted in the Laboratory Analytical Report, the QA/QC Summary Report, or the Case Narrative.

If you have any questions regarding these test results, please call.

Report Approved By:

Stephanie D Waldrop
Reporting Supervisor

Digitally signed by
Stephanie Waldrop
Date: 2014.01.31 12:03:16 -07:00

CLIENT: Montgomery Watson Harza
Project: Church Rock Pre-Design Study
Sample Delivery Group: C13120735

Report Date: 01/31/14

CASE NARRATIVE

LEVEL III COMMENTS
Included with the analysis reports are instrument data reports for all analysis associated with the instrument calibration, QC sample analysis, and sample analysis for Gamma results. All analytical data is within method QA/QC specifications except as noted on analyses and/or QC summary reports, or in this narrative. The analytical report identifies which QC batch ID and sequence QC is associated with each analysis result for a sample. The results of this Analytical Report relate only to the items submitted for analysis. Only the raw data associated with parameters listed on this report should be validated.

BRANCH LABORATORY SUBCONTRACT ANALYSIS
Tests associated with analyst identified as ELI-B were subcontracted to Energy Laboratories, 1120 S. 27th St., Billings, MT, EPA Number MT00005.

LABORATORY ANALYTICAL REPORT

Prepared by Casper, WY Branch

Client: Montgomery Watson Harza
Client Sample ID TI-CS02-01 [0-7]
Project: Church Rock Pre-Design Study
Matrix: Soil

Lab ID: C13120735-001
Collection Date: 11/12/13
DateReceived: 12/20/13
Report Date: 01/31/14

Analyses	Result	Units	QUAL	RL	MCL	Method	Analysis Date / By	Prep Date	Prep Method	RunID	Run Order	BatchID
SATURATED PASTE												
Saturation	43.9	%		0.1		USDA27a	01/07/14 09:35 / rw	01/06/14 12:18	USDA2	SARTORIUS_140107B	2	40253
SATURATED PASTE EXTRACT												
Conductivity, sat. paste	2.95	mmhos/cm		0.01		ASAM10-3	01/07/14 10:55 / rw	01/06/14 12:18	USDA2	COND1-C_140107A	3	40253
pH, sat. paste	7.7	s.u.		0.1		ASAM10-3.2	01/07/14 09:10 / rw	01/06/14 12:18	USDA2	ION 3 STAR PH_140107A	1	40253
Calcium, sat. paste	30.4	meq/L		0.05		SW6010B	01/14/14 17:49 / sf	01/06/14 12:18	USDA2	ICP4-C_140114A	97	40253
Magnesium, sat. paste	8.36	meq/L		0.08		SW6010B	01/14/14 17:49 / sf	01/06/14 12:18	USDA2	ICP4-C_140114A	97	40253
Potassium, sat. paste	0.87	meq/L		0.03		SW6010B	01/14/14 17:49 / sf	01/06/14 12:18	USDA2	ICP4-C_140114A	97	40253
Sodium, sat. paste	1.04	meq/L		0.04		SW6010B	01/14/14 17:49 / sf	01/06/14 12:18	USDA2	ICP4-C_140114A	97	40253
Sodium Adsorption Ratio (SAR)	0.2	unitless		0.1		USDA20B	01/16/14 14:37 / sdw			MISC-SOIL_140116B	1	R182684
CHEMICAL CHARACTERISTICS												
Lime as CaCO3	2.5	%		0.1		USDA23c	01/07/14 11:21 / dm	01/07/14 09:02	USDA23c	ION 3 STAR PH_140107B	3	40270
Organic Matter	1.5	%		0.2		ASA29-3	12/30/13 10:12 / dm	12/30/13 08:37	ASA29-3	OC_131230A	3	40199
Total Kjeldahl Nitrogen	448	mg/kg		10		ASA31-3	01/15/14 11:20 / eli-			SUB-B217865	1	B_R217865
Cation Exchange Capacity	30.5	meq/100g		0.6		SW6010B	12/31/13 18:06 / sf	12/30/13 08:02	USDA19	ICP4-C_131231A	64	40195
Potassium	309	mg/kg-dry		10		SW6010B	12/27/13 17:09 / sf	12/27/13 09:07	ASA13-3	ICP4-C_131227A	80	40182
Sodium	40	mg/kg-dry	D	2		SW6010B	12/27/13 17:09 / sf	12/27/13 09:07	ASA13-3	ICP4-C_131227A	80	40182
Sodium, soluble	10.5	mg/kg-dry	D	1.0		SW6010B	01/30/14 11:12 / sec			PASTE-ALTU_140130A	1	140130ALTU
Exchangeable Sodium Percentage	0.4	%		0.1		USDA20a	01/21/14 13:28 / rw			ANALYST_140121B	1	R182830
Phosphorus, Olsen	7	mg/kg		1		ASA24-5	01/03/14 15:55 / eli-			SUB-B217349	4	B_14010301-PS3
RADIONUCLIDES - GAMMA												
Radium 226	1.5	pCi/g-dry				E901.1	01/15/14 08:20 / dpb	12/24/13 09:11	E901.1	GAM-HPGE_140115A	3	40160
Radium 226 precision (±)	0.6	pCi/g-dry				E901.1	01/15/14 08:20 / dpb	12/24/13 09:11	E901.1	GAM-HPGE_140115A	3	40160
Radium 226 MDC	0.6	pCi/g-dry				E901.1	01/15/14 08:20 / dpb	12/24/13 09:11	E901.1	GAM-HPGE_140115A	3	40160

Report Definitions:
RL - Analyte reporting limit.
MDC - Minimum detectable concentration
MCL - Maximum contaminant level.
D - RL increased due to sample matrix.
ND - Not detected at the reporting limit.

LABORATORY ANALYTICAL REPORT

Prepared by Casper, WY Branch

Client: Montgomery Watson Harza
Client Sample ID TI-CS07-01 [0-6]
Project: Church Rock Pre-Design Study
Matrix: Soil

Lab ID: C13120735-002
Collection Date: 11/13/13 10:55
DateReceived: 12/20/13
Report Date: 01/31/14

Analyses	Result	Units	QUAL	RL	MCL	Method	Analysis Date / By	Prep Date	Prep Method	RunID	Run Order	BatchID
SATURATED PASTE												
Saturation	38.4	%		0.1		USDA27a	01/07/14 09:36 / rw	01/06/14 12:18	USDA2	SARTORIUS_140107B	3	40253
SATURATED PASTE EXTRACT												
Conductivity, sat. paste	0.81	mmhos/cm		0.01		ASAM10-3	01/07/14 10:56 / rw	01/06/14 12:18	USDA2	COND1-C_140107A	4	40253
pH, sat. paste	7.8	s.u.		0.1		ASAM10-3.2	01/07/14 09:10 / rw	01/06/14 12:18	USDA2	ION 3 STAR PH_140107A	2	40253
Calcium, sat. paste	6.27	meq/L		0.05		SW6010B	01/14/14 18:33 / sf	01/06/14 12:18	USDA2	ICP4-C_140114A	109	40253
Magnesium, sat. paste	1.94	meq/L		0.08		SW6010B	01/14/14 18:33 / sf	01/06/14 12:18	USDA2	ICP4-C_140114A	109	40253
Potassium, sat. paste	0.40	meq/L		0.03		SW6010B	01/14/14 18:33 / sf	01/06/14 12:18	USDA2	ICP4-C_140114A	109	40253
Sodium, sat. paste	0.29	meq/L		0.04		SW6010B	01/14/14 18:33 / sf	01/06/14 12:18	USDA2	ICP4-C_140114A	109	40253
Sodium Adsorption Ratio (SAR)	0.1	unitless		0.1		USDA20B	01/16/14 14:37 / sdw			MISC-SOIL_140116B	2	R182684
CHEMICAL CHARACTERISTICS												
Lime as CaCO3	2.1	%		0.1		USDA23c	01/07/14 11:27 / dm	01/07/14 09:02	USDA23c	ION 3 STAR PH_140107B	4	40270
Organic Matter	1.5	%		0.2		ASA29-3	12/30/13 10:15 / dm	12/30/13 08:37	ASA29-3	OC_131230A	4	40199
Total Kjeldahl Nitrogen	392	mg/kg		10		ASA31-3	01/15/14 11:20 / eli-			SUB-B217865	3	B_R217865
Cation Exchange Capacity	24.8	meq/100g		0.6		SW6010B	12/31/13 18:10 / sf	12/30/13 08:02	USDA19	ICP4-C_131231A	65	40195
Potassium	251	mg/kg-dry		10		SW6010B	12/27/13 17:13 / sf	12/27/13 09:07	ASA13-3	ICP4-C_131227A	81	40182
Sodium	10	mg/kg-dry	D	2		SW6010B	12/27/13 17:13 / sf	12/27/13 09:07	ASA13-3	ICP4-C_131227A	81	40182
Sodium, soluble	2.6	mg/kg-dry	D	1.0		SW6010B	01/30/14 11:12 / sec			PASTE-ALTU_140130A	2	140130ALTU
Exchangeable Sodium Percentage	0.1	%		0.1		USDA20a	01/21/14 13:28 / rw			ANALYST_140121B	2	R182830
Phosphorus, Olsen	8	mg/kg		1		ASA24-5	01/03/14 15:56 / eli-			SUB-B217349	5	B_14010301-PS3
RADIONUCLIDES - GAMMA												
Radium 226	1.7	pCi/g-dry				E901.1	01/15/14 08:20 / dpb	12/24/13 09:11	E901.1	GAM-HPGE_140115A	4	40160
Radium 226 precision (±)	0.4	pCi/g-dry				E901.1	01/15/14 08:20 / dpb	12/24/13 09:11	E901.1	GAM-HPGE_140115A	4	40160
Radium 226 MDC	0.5	pCi/g-dry				E901.1	01/15/14 08:20 / dpb	12/24/13 09:11	E901.1	GAM-HPGE_140115A	4	40160

Report Definitions:
RL - Analyte reporting limit.
MDC - Minimum detectable concentration
MCL - Maximum contaminant level.
D - RL increased due to sample matrix.
ND - Not detected at the reporting limit.

LABORATORY ANALYTICAL REPORT

Prepared by Casper, WY Branch

Client: Montgomery Watson Harza
Client Sample ID TI-CS11-01 [0-6]
Project: Church Rock Pre-Design Study
Matrix: Soil

Lab ID: C13120735-003
Collection Date: 11/13/13 14:35
DateReceived: 12/20/13
Report Date: 01/31/14

Analyses	Result	Units	QUAL	RL	MCL	Method	Analysis Date / By	Prep Date	Prep Method	RunID	Run Order	BatchID
SATURATED PASTE												
Saturation	37.5	%		0.1		USDA27a	01/07/14 09:36 / rw	01/06/14 12:18	USDA2	SARTORIUS_140107B	4	40253
SATURATED PASTE EXTRACT												
Conductivity, sat. paste	2.81	mmhos/cm		0.01		ASAM10-3	01/07/14 10:56 / rw	01/06/14 12:18	USDA2	COND1-C_140107A	5	40253
pH, sat. paste	7.7	s.u.		0.1		ASAM10-3.2	01/07/14 09:10 / rw	01/06/14 12:18	USDA2	ION 3 STAR PH_140107A	3	40253
Calcium, sat. paste	23.9	meq/L		0.05		SW6010B	01/14/14 18:36 / sf	01/06/14 12:18	USDA2	ICP4-C_140114A	110	40253
Magnesium, sat. paste	8.23	meq/L		0.08		SW6010B	01/14/14 18:36 / sf	01/06/14 12:18	USDA2	ICP4-C_140114A	110	40253
Potassium, sat. paste	0.95	meq/L		0.03		SW6010B	01/14/14 18:36 / sf	01/06/14 12:18	USDA2	ICP4-C_140114A	110	40253
Sodium, sat. paste	4.19	meq/L		0.04		SW6010B	01/14/14 18:36 / sf	01/06/14 12:18	USDA2	ICP4-C_140114A	110	40253
Sodium Adsorption Ratio (SAR)	1.0	unitless		0.1		USDA20B	01/16/14 14:37 / sdw			MISC-SOIL_140116B	3	R182684
CHEMICAL CHARACTERISTICS												
Lime as CaCO3	3.4	%		0.1		USDA23c	01/07/14 11:33 / dm	01/07/14 09:02	USDA23c	ION 3 STAR PH_140107B	5	40270
Organic Matter	1.3	%		0.2		ASA29-3	12/30/13 10:17 / dm	12/30/13 08:37	ASA29-3	OC_131230A	5	40199
Total Kjeldahl Nitrogen	336	mg/kg		10		ASA31-3	01/15/14 11:20 / eli-			SUB-B217865	4	B_R217865
Cation Exchange Capacity	22.0	meq/100g		0.6		SW6010B	12/31/13 18:14 / sf	12/30/13 08:02	USDA19	ICP4-C_131231A	66	40195
Potassium	268	mg/kg-dry		10		SW6010B	12/27/13 17:16 / sf	12/27/13 09:07	ASA13-3	ICP4-C_131227A	82	40182
Sodium	80	mg/kg-dry	D	2		SW6010B	12/27/13 17:16 / sf	12/27/13 09:07	ASA13-3	ICP4-C_131227A	82	40182
Sodium, soluble	36.2	mg/kg-dry	D	1.0		SW6010B	01/30/14 11:12 / sec			PASTE-ALTU_140130A	3	140130ALTU
Exchangeable Sodium Percentage	0.9	%		0.1		USDA20a	01/21/14 13:28 / rw			ANALYST_140121B	3	R182830
Phosphorus, Olsen	7	mg/kg		1		ASA24-5	01/03/14 15:58 / eli-			SUB-B217349	6	B_14010301-PS3
RADIONUCLIDES - GAMMA												
Radium 226	1.0	pCi/g-dry				E901.1	01/15/14 08:20 / dpb	12/24/13 09:11	E901.1	GAM-HPGE_140115A	5	40160
Radium 226 precision (±)	0.5	pCi/g-dry				E901.1	01/15/14 08:20 / dpb	12/24/13 09:11	E901.1	GAM-HPGE_140115A	5	40160
Radium 226 MDC	0.6	pCi/g-dry				E901.1	01/15/14 08:20 / dpb	12/24/13 09:11	E901.1	GAM-HPGE_140115A	5	40160

Report Definitions:
RL - Analyte reporting limit.
MDC - Minimum detectable concentration
MCL - Maximum contaminant level.
D - RL increased due to sample matrix.
ND - Not detected at the reporting limit.

LABORATORY ANALYTICAL REPORT

Prepared by Casper, WY Branch

Client: Montgomery Watson Harza
Client Sample ID WB-B2-04 [0-10]
Project: Church Rock Pre-Design Study
Matrix: Soil

Lab ID: C13120735-004
Collection Date: 11/14/13 16:00
DateReceived: 12/20/13
Report Date: 01/31/14

Analyses	Result	Units	QUAL	RL	MCL	Method	Analysis Date / By	Prep Date	Prep Method	RunID	Run Order	BatchID
SATURATED PASTE												
Saturation	36.5	%		0.1		USDA27a	01/07/14 09:37 / rw	01/06/14 12:18	USDA2	SARTORIUS_140107B	5	40253
SATURATED PASTE EXTRACT												
Conductivity, sat. paste	2.63	mmhos/cm		0.01		ASAM10-3	01/07/14 10:57 / rw	01/06/14 12:18	USDA2	COND1-C_140107A	6	40253
pH, sat. paste	7.4	s.u.		0.1		ASAM10-3.2	01/07/14 09:10 / rw	01/06/14 12:18	USDA2	ION 3 STAR PH_140107A	4	40253
Calcium, sat. paste	27.3	meq/L		0.05		SW6010B	01/14/14 18:40 / sf	01/06/14 12:18	USDA2	ICP4-C_140114A	111	40253
Magnesium, sat. paste	9.50	meq/L		0.08		SW6010B	01/14/14 18:40 / sf	01/06/14 12:18	USDA2	ICP4-C_140114A	111	40253
Potassium, sat. paste	0.26	meq/L		0.03		SW6010B	01/14/14 18:40 / sf	01/06/14 12:18	USDA2	ICP4-C_140114A	111	40253
Sodium, sat. paste	0.87	meq/L		0.04		SW6010B	01/14/14 18:40 / sf	01/06/14 12:18	USDA2	ICP4-C_140114A	111	40253
Sodium Adsorption Ratio (SAR)	0.2	unitless		0.1		USDA20B	01/16/14 14:37 / sdw			MISC-SOIL_140116B	4	R182684
CHEMICAL CHARACTERISTICS												
Lime as CaCO3	2.8	%		0.1		USDA23c	01/07/14 11:39 / dm	01/07/14 09:02	USDA23c	ION 3 STAR PH_140107B	6	40270
Organic Matter	1.5	%		0.2		ASA29-3	12/30/13 10:19 / dm	12/30/13 08:37	ASA29-3	OC_131230A	6	40199
Total Kjeldahl Nitrogen	280	mg/kg		10		ASA31-3	01/15/14 11:20 / eli-			SUB-B217865	5	B_R217865
Cation Exchange Capacity	25.2	meq/100g		0.6		SW6010B	12/31/13 18:17 / sf	12/30/13 08:02	USDA19	ICP4-C_131231A	67	40195
Potassium	94	mg/kg-dry		10		SW6010B	12/27/13 17:20 / sf	12/27/13 09:07	ASA13-3	ICP4-C_131227A	83	40182
Sodium	23	mg/kg-dry	D	2		SW6010B	12/27/13 17:20 / sf	12/27/13 09:07	ASA13-3	ICP4-C_131227A	83	40182
Sodium, soluble	7.3	mg/kg-dry	D	1.0		SW6010B	01/30/14 11:12 / sec			PASTE-ALTU_140130A	4	140130ALTU
Exchangeable Sodium Percentage	0.3	%		0.1		USDA20a	01/21/14 13:28 / rw			ANALYST_140121B	4	R182830
Phosphorus, Olsen	6	mg/kg		1		ASA24-5	01/03/14 16:02 / eli-			SUB-B217349	7	B_14010301-PS3
RADIONUCLIDES - GAMMA												
Radium 226	1.0	pCi/g-dry				E901.1	01/15/14 08:20 / dpb	12/24/13 09:11	E901.1	GAM-HPGE_140115A	6	40160
Radium 226 precision (±)	0.4	pCi/g-dry				E901.1	01/15/14 08:20 / dpb	12/24/13 09:11	E901.1	GAM-HPGE_140115A	6	40160
Radium 226 MDC	0.5	pCi/g-dry				E901.1	01/15/14 08:20 / dpb	12/24/13 09:11	E901.1	GAM-HPGE_140115A	6	40160

Report Definitions:
RL - Analyte reporting limit.
MDC - Minimum detectable concentration
MCL - Maximum contaminant level.
D - RL increased due to sample matrix.
ND - Not detected at the reporting limit.

LABORATORY ANALYTICAL REPORT

Prepared by Casper, WY Branch

Client: Montgomery Watson Harza
Client Sample ID EB-B4-03 [0-10]
Project: Church Rock Pre-Design Study
Matrix: Soil

Lab ID: C13120735-005
Collection Date: 12/10/13 11:40
DateReceived: 12/20/13
Report Date: 01/31/14

Analyses	Result	Units	QUAL	RL	MCL	Method	Analysis Date / By	Prep Date	Prep Method	RunID	Run Order	BatchID
SATURATED PASTE												
Saturation	43.0	%		0.1		USDA27a	01/07/14 09:37 / rw	01/06/14 12:18	USDA2	SARTORIUS_140107B	6	40253
SATURATED PASTE EXTRACT												
Conductivity, sat. paste	3.30	mmhos/cm		0.01		ASAM10-3	01/07/14 10:57 / rw	01/06/14 12:18	USDA2	COND1-C_140107A	7	40253
pH, sat. paste	7.7	s.u.		0.1		ASAM10-3.2	01/07/14 09:10 / rw	01/06/14 12:18	USDA2	ION 3 STAR PH_140107A	5	40253
Calcium, sat. paste	27.9	meq/L		0.05		SW6010B	01/14/14 18:43 / sf	01/06/14 12:18	USDA2	ICP4-C_140114A	112	40253
Magnesium, sat. paste	13.1	meq/L		0.08		SW6010B	01/14/14 18:43 / sf	01/06/14 12:18	USDA2	ICP4-C_140114A	112	40253
Potassium, sat. paste	0.46	meq/L		0.03		SW6010B	01/14/14 18:43 / sf	01/06/14 12:18	USDA2	ICP4-C_140114A	112	40253
Sodium, sat. paste	3.35	meq/L		0.04		SW6010B	01/14/14 18:43 / sf	01/06/14 12:18	USDA2	ICP4-C_140114A	112	40253
Sodium Adsorption Ratio (SAR)	0.7	unitless		0.1		USDA20B	01/16/14 14:37 / sdw			MISC-SOIL_140116B	5	R182684
CHEMICAL CHARACTERISTICS												
Lime as CaCO3	2.3	%		0.1		USDA23c	01/07/14 11:44 / dm	01/07/14 09:02	USDA23c	ION 3 STAR PH_140107B	7	40270
Organic Matter	0.9	%		0.2		ASA29-3	12/30/13 10:22 / dm	12/30/13 08:37	ASA29-3	OC_131230A	7	40199
Total Kjeldahl Nitrogen	280	mg/kg		10		ASA31-3	01/15/14 11:20 / eli-			SUB-B217865	6	B_R217865
Cation Exchange Capacity	25.5	meq/100g		0.6		SW6010B	12/31/13 18:21 / sf	12/30/13 08:02	USDA19	ICP4-C_131231A	68	40195
Potassium	178	mg/kg-dry		10		SW6010B	12/27/13 17:24 / sf	12/27/13 09:07	ASA13-3	ICP4-C_131227A	84	40182
Sodium	83	mg/kg-dry	D	2		SW6010B	12/27/13 17:24 / sf	12/27/13 09:07	ASA13-3	ICP4-C_131227A	84	40182
Sodium, soluble	33.1	mg/kg-dry	D	1.0		SW6010B	01/30/14 11:12 / sec			PASTE-ALTU_140130A	5	140130ALTU
Exchangeable Sodium Percentage	0.8	%		0.1		USDA20a	01/21/14 13:28 / rw			ANALYST_140121B	5	R182830
Phosphorus, Olsen	6	mg/kg		1		ASA24-5	01/03/14 16:04 / eli-			SUB-B217349	8	B_14010301-PS3
RADIONUCLIDES - GAMMA												
Radium 226	1.1	pCi/g-dry				E901.1	01/15/14 08:20 / dpb	12/24/13 09:11	E901.1	GAM-HPGE_140115A	7	40160
Radium 226 precision (±)	0.4	pCi/g-dry				E901.1	01/15/14 08:20 / dpb	12/24/13 09:11	E901.1	GAM-HPGE_140115A	7	40160
Radium 226 MDC	0.5	pCi/g-dry				E901.1	01/15/14 08:20 / dpb	12/24/13 09:11	E901.1	GAM-HPGE_140115A	7	40160

Report Definitions:
RL - Analyte reporting limit.
MDC - Minimum detectable concentration
MCL - Maximum contaminant level.
D - RL increased due to sample matrix.
ND - Not detected at the reporting limit.

LABORATORY ANALYTICAL REPORT

Prepared by Casper, WY Branch

Client: Montgomery Watson Harza
Client Sample ID SB-B4-01 [0-15]
Project: Church Rock Pre-Design Study
Matrix: Soil

Lab ID: C13120735-006
Collection Date: 12/12/13 16:45
DateReceived: 12/20/13
Report Date: 01/31/14

Analyses	Result	Units	QUAL	RL	MCL	Method	Analysis Date / By	Prep Date	Prep Method	RunID	Run Order	BatchID
SATURATED PASTE												
Saturation	47.9	%		0.1		USDA27a	01/07/14 09:38 / rw	01/06/14 12:18	USDA2	SARTORIUS_140107B	7	40253
SATURATED PASTE EXTRACT												
Conductivity, sat. paste	2.66	mmhos/cm		0.01		ASAM10-3	01/07/14 10:58 / rw	01/06/14 12:18	USDA2	COND1-C_140107A	8	40253
pH, sat. paste	7.8	s.u.		0.1		ASAM10-3.2	01/07/14 09:10 / rw	01/06/14 12:18	USDA2	ION 3 STAR PH_140107A	6	40253
Calcium, sat. paste	26.1	meq/L		0.05		SW6010B	01/14/14 18:51 / sf	01/06/14 12:18	USDA2	ICP4-C_140114A	114	40253
Magnesium, sat. paste	10.3	meq/L		0.08		SW6010B	01/14/14 18:51 / sf	01/06/14 12:18	USDA2	ICP4-C_140114A	114	40253
Potassium, sat. paste	0.72	meq/L		0.03		SW6010B	01/14/14 18:51 / sf	01/06/14 12:18	USDA2	ICP4-C_140114A	114	40253
Sodium, sat. paste	1.20	meq/L		0.04		SW6010B	01/14/14 18:51 / sf	01/06/14 12:18	USDA2	ICP4-C_140114A	114	40253
Sodium Adsorption Ratio (SAR)	0.3	unitless		0.1		USDA20B	01/16/14 14:37 / sdw			MISC-SOIL_140116B	6	R182684
CHEMICAL CHARACTERISTICS												
Lime as CaCO3	6.1	%		0.1		USDA23c	01/07/14 11:50 / dm	01/07/14 09:02	USDA23c	ION 3 STAR PH_140107B	8	40270
Organic Matter	0.8	%		0.2		ASA29-3	12/30/13 10:25 / dm	12/30/13 08:37	ASA29-3	OC_131230A	8	40199
Total Kjeldahl Nitrogen	336	mg/kg		10		ASA31-3	01/15/14 11:20 / eli-			SUB-B217865	7	B_R217865
Cation Exchange Capacity	24.5	meq/100g		0.6		SW6010B	12/31/13 18:25 / sf	12/30/13 08:02	USDA19	ICP4-C_131231A	69	40195
Potassium	292	mg/kg-dry		10		SW6010B	12/27/13 17:42 / sf	12/27/13 09:07	ASA13-3	ICP4-C_131227A	89	40182
Sodium	49	mg/kg-dry	D	2		SW6010B	12/27/13 17:42 / sf	12/27/13 09:07	ASA13-3	ICP4-C_131227A	89	40182
Sodium, soluble	13.2	mg/kg-dry	D	1.0		SW6010B	01/30/14 11:12 / sec			PASTE-ALTU_140130A	6	140130ALTU
Exchangeable Sodium Percentage	0.6	%		0.1		USDA20a	01/21/14 13:28 / rw			ANALYST_140121B	6	R182830
Phosphorus, Olsen	7	mg/kg		1		ASA24-5	01/03/14 16:05 / eli-			SUB-B217349	9	B_14010301-PS3
RADIONUCLIDES - GAMMA												
Radium 226	1.0	pCi/g-dry				E901.1	01/15/14 08:20 / dpb	12/24/13 09:11	E901.1	GAM-HPGE_140115A	8	40160
Radium 226 precision (±)	0.4	pCi/g-dry				E901.1	01/15/14 08:20 / dpb	12/24/13 09:11	E901.1	GAM-HPGE_140115A	8	40160
Radium 226 MDC	0.5	pCi/g-dry				E901.1	01/15/14 08:20 / dpb	12/24/13 09:11	E901.1	GAM-HPGE_140115A	8	40160

Report Definitions:
RL - Analyte reporting limit.
MDC - Minimum detectable concentration
MCL - Maximum contaminant level.
D - RL increased due to sample matrix.
ND - Not detected at the reporting limit.

LABORATORY ANALYTICAL REPORT

Prepared by Casper, WY Branch

Client: Montgomery Watson Harza
Client Sample ID NB-B1-04 [0-15]
Project: Church Rock Pre-Design Study
Matrix: Soil

Lab ID: C13120735-007
Collection Date: 12/12/13 14:25
DateReceived: 12/20/13
Report Date: 01/31/14

Analyses	Result	Units	QUAL	RL	MCL	Method	Analysis Date / By	Prep Date	Prep Method	RunID	Run Order	BatchID
SATURATED PASTE												
Saturation	38.3	%		0.1		USDA27a	01/07/14 09:38 / rw	01/06/14 12:18	USDA2	SARTORIUS_140107B	8	40253
SATURATED PASTE EXTRACT												
Conductivity, sat. paste	1.01	mmhos/cm		0.01		ASAM10-3	01/07/14 10:58 / rw	01/06/14 12:18	USDA2	COND1-C_140107A	9	40253
pH, sat. paste	8.0	s.u.		0.1		ASAM10-3.2	01/07/14 09:10 / rw	01/06/14 12:18	USDA2	ION 3 STAR PH_140107A	7	40253
Calcium, sat. paste	5.34	meq/L		0.05		SW6010B	01/14/14 18:54 / sf	01/06/14 12:18	USDA2	ICP4-C_140114A	115	40253
Magnesium, sat. paste	3.18	meq/L		0.08		SW6010B	01/14/14 18:54 / sf	01/06/14 12:18	USDA2	ICP4-C_140114A	115	40253
Potassium, sat. paste	0.16	meq/L		0.03		SW6010B	01/14/14 18:54 / sf	01/06/14 12:18	USDA2	ICP4-C_140114A	115	40253
Sodium, sat. paste	2.37	meq/L		0.04		SW6010B	01/14/14 18:54 / sf	01/06/14 12:18	USDA2	ICP4-C_140114A	115	40253
Sodium Adsorption Ratio (SAR)	1.1	unitless		0.1		USDA20B	01/16/14 14:37 / sdw			MISC-SOIL_140116B	7	R182684
CHEMICAL CHARACTERISTICS												
Lime as CaCO3	6.6	%		0.1		USDA23c	01/07/14 11:54 / dm	01/07/14 09:02	USDA23c	ION 3 STAR PH_140107B	9	40270
Organic Matter	0.4	%		0.2		ASA29-3	12/30/13 10:26 / dm	12/30/13 08:37	ASA29-3	OC_131230A	9	40199
Total Kjeldahl Nitrogen	280	mg/kg		10		ASA31-3	01/15/14 11:20 / eli-			SUB-B217865	8	B_R217865
Cation Exchange Capacity	20.4	meq/100g		0.6		SW6010B	12/31/13 18:28 / sf	12/30/13 08:02	USDA19	ICP4-C_131231A	70	40195
Potassium	136	mg/kg-dry		10		SW6010B	12/27/13 17:45 / sf	12/27/13 09:07	ASA13-3	ICP4-C_131227A	90	40182
Sodium	69	mg/kg-dry	D	2		SW6010B	12/27/13 17:45 / sf	12/27/13 09:07	ASA13-3	ICP4-C_131227A	90	40182
Sodium, soluble	20.9	mg/kg-dry	D	1.0		SW6010B	01/30/14 11:12 / sec			PASTE-ALTU_140130A	7	140130ALTU
Exchangeable Sodium Percentage	1.0	%		0.1		USDA20a	01/21/14 13:28 / rw			ANALYST_140121B	7	R182830
Phosphorus, Olsen	7	mg/kg		1		ASA24-5	01/03/14 16:06 / eli-			SUB-B217349	10	B_14010301-PS3
RADIONUCLIDES - GAMMA												
Radium 226	0.8	pCi/g-dry				E901.1	01/15/14 08:20 / dpb	12/24/13 09:11	E901.1	GAM-HPGE_140115A	9	40160
Radium 226 precision (±)	0.4	pCi/g-dry				E901.1	01/15/14 08:20 / dpb	12/24/13 09:11	E901.1	GAM-HPGE_140115A	9	40160
Radium 226 MDC	0.5	pCi/g-dry				E901.1	01/15/14 08:20 / dpb	12/24/13 09:11	E901.1	GAM-HPGE_140115A	9	40160

Report Definitions:
RL - Analyte reporting limit.
MDC - Minimum detectable concentration
MCL - Maximum contaminant level.
D - RL increased due to sample matrix.
ND - Not detected at the reporting limit.

LABORATORY ANALYTICAL REPORT

Prepared by Casper, WY Branch

Client: Montgomery Watson Harza
Client Sample ID DH-B3-02 [0-10]
Project: Church Rock Pre-Design Study
Matrix: Soil

Lab ID: C13120735-008
Collection Date: 12/11/13 14:40
DateReceived: 12/20/13
Report Date: 01/31/14

Analyses	Result	Units	QUAL	RL	MCL	Method	Analysis Date / By	Prep Date	Prep Method	RunID	Run Order	BatchID
SATURATED PASTE												
Saturation	34.2	%		0.1		USDA27a	01/07/14 09:38 / rw	01/06/14 12:18	USDA2	SARTORIUS_140107B	9	40253
SATURATED PASTE EXTRACT												
Conductivity, sat. paste	1.84	mmhos/cm		0.01		ASAM10-3	01/07/14 10:59 / rw	01/06/14 12:18	USDA2	COND1-C_140107A	10	40253
pH, sat. paste	7.8	s.u.		0.1		ASAM10-3.2	01/07/14 09:10 / rw	01/06/14 12:18	USDA2	ION 3 STAR PH_140107A	8	40253
Calcium, sat. paste	7.07	meq/L		0.05		SW6010B	01/14/14 18:58 / sf	01/06/14 12:18	USDA2	ICP4-C_140114A	116	40253
Magnesium, sat. paste	4.26	meq/L		0.08		SW6010B	01/14/14 18:58 / sf	01/06/14 12:18	USDA2	ICP4-C_140114A	116	40253
Potassium, sat. paste	0.05	meq/L		0.03		SW6010B	01/14/14 18:58 / sf	01/06/14 12:18	USDA2	ICP4-C_140114A	116	40253
Sodium, sat. paste	9.61	meq/L		0.04		SW6010B	01/14/14 18:58 / sf	01/06/14 12:18	USDA2	ICP4-C_140114A	116	40253
Sodium Adsorption Ratio (SAR)	4.0	unitless		0.1		USDA20B	01/16/14 14:37 / sdw			MISC-SOIL_140116B	8	R182684
CHEMICAL CHARACTERISTICS												
Lime as CaCO3	0.4	%	B	0.1		USDA23c	01/07/14 12:00 / dm	01/07/14 09:02	USDA23c	ION 3 STAR PH_140107B	10	40270
Organic Matter	0.2	%		0.2		ASA29-3	12/30/13 10:29 / dm	12/30/13 08:37	ASA29-3	OC_131230A	10	40199
Total Kjeldahl Nitrogen	168	mg/kg		10		ASA31-3	01/15/14 11:20 / eli-			SUB-B217865	9	B_R217865
Cation Exchange Capacity	10.3	meq/100g		0.6		SW6010B	12/31/13 18:32 / sf	12/30/13 08:02	USDA19	ICP4-C_131231A	71	40195
Potassium	42	mg/kg-dry		10		SW6010B	12/27/13 17:49 / sf	12/27/13 09:07	ASA13-3	ICP4-C_131227A	91	40182
Sodium	155	mg/kg-dry	D	2		SW6010B	12/27/13 17:49 / sf	12/27/13 09:07	ASA13-3	ICP4-C_131227A	91	40182
Sodium, soluble	75.6	mg/kg-dry	D	1.0		SW6010B	01/30/14 11:12 / sec			PASTE-ALTU_140130A	8	140130ALTU
Exchangeable Sodium Percentage	3.3	%		0.1		USDA20a	01/21/14 13:28 / rw			ANALYST_140121B	8	R182830
Phosphorus, Olsen	6	mg/kg		1		ASA24-5	01/03/14 16:08 / eli-			SUB-B217349	11	B_14010301-PS3
RADIONUCLIDES - GAMMA												
Radium 226	1.3	pCi/g-dry				E901.1	01/15/14 08:20 / dpb	12/24/13 09:11	E901.1	GAM-HPGE_140115A	10	40160
Radium 226 precision (±)	0.5	pCi/g-dry				E901.1	01/15/14 08:20 / dpb	12/24/13 09:11	E901.1	GAM-HPGE_140115A	10	40160
Radium 226 MDC	0.6	pCi/g-dry				E901.1	01/15/14 08:20 / dpb	12/24/13 09:11	E901.1	GAM-HPGE_140115A	10	40160

Report Definitions:
RL - Analyte reporting limit.
MDC - Minimum detectable concentration
MCL - Maximum contaminant level.
B - The analyte was detected in the method blank.
ND - Not detected at the reporting limit.
D - RL increased due to sample matrix.

LABORATORY ANALYTICAL REPORT

Prepared by Casper, WY Branch

Client: Montgomery Watson Harza
Client Sample ID Topsoil Stockpile
Project: Church Rock Pre-Design Study
Matrix: Soil

Lab ID: C13120735-009
Collection Date: 11/21/13 15:35
DateReceived: 12/20/13
Report Date: 01/31/14

Analyses	Result	Units	QUAL	RL	MCL	Method	Analysis Date / By	Prep Date	Prep Method	RunID	Run Order	BatchID
SATURATED PASTE												
Saturation	51.1	%		0.1		USDA27a	01/07/14 09:39 / rw	01/06/14 12:18	USDA2	SARTORIUS_140107B	10	40253
SATURATED PASTE EXTRACT												
Conductivity, sat. paste	2.30	mmhos/cm		0.01		ASAM10-3	01/07/14 10:59 / rw	01/06/14 12:18	USDA2	COND1-C_140107A	11	40253
pH, sat. paste	7.9	s.u.		0.1		ASAM10-3.2	01/07/14 09:10 / rw	01/06/14 12:18	USDA2	ION 3 STAR PH_140107A	9	40253
Calcium, sat. paste	11.1	meq/L		0.05		SW6010B	01/14/14 19:02 / sf	01/06/14 12:18	USDA2	ICP4-C_140114A	117	40253
Magnesium, sat. paste	7.99	meq/L		0.08		SW6010B	01/14/14 19:02 / sf	01/06/14 12:18	USDA2	ICP4-C_140114A	117	40253
Potassium, sat. paste	0.20	meq/L		0.03		SW6010B	01/14/14 19:02 / sf	01/06/14 12:18	USDA2	ICP4-C_140114A	117	40253
Sodium, sat. paste	7.16	meq/L		0.04		SW6010B	01/14/14 19:02 / sf	01/06/14 12:18	USDA2	ICP4-C_140114A	117	40253
Sodium Adsorption Ratio (SAR)	2.3	unitless		0.1		USDA20B	01/16/14 14:37 / sdw			MISC-SOIL_140116B	9	R182684
CHEMICAL CHARACTERISTICS												
Lime as CaCO3	5.4	%		0.1		USDA23c	01/07/14 12:05 / dm	01/07/14 09:02	USDA23c	ION 3 STAR PH_140107B	11	40270
Organic Matter	0.4	%		0.2		ASA29-3	12/30/13 10:30 / dm	12/30/13 08:37	ASA29-3	OC_131230A	11	40199
Total Kjeldahl Nitrogen	224	mg/kg		10		ASA31-3	01/15/14 11:20 / eli-			SUB-B217865	10	B_R217865
Cation Exchange Capacity	33.5	meq/100g		0.6		SW6010B	12/31/13 18:50 / sf	12/30/13 08:02	USDA19	ICP4-C_131231A	76	40195
Potassium	196	mg/kg-dry		10		SW6010B	12/27/13 17:52 / sf	12/27/13 09:07	ASA13-3	ICP4-C_131227A	92	40182
Sodium	228	mg/kg-dry	D	2		SW6010B	12/27/13 17:52 / sf	12/27/13 09:07	ASA13-3	ICP4-C_131227A	92	40182
Sodium, soluble	84.1	mg/kg-dry	D	1.0		SW6010B	01/30/14 11:12 / sec			PASTE-ALTU_140130A	9	140130ALTU
Exchangeable Sodium Percentage	1.9	%		0.1		USDA20a	01/21/14 13:28 / rw			ANALYST_140121B	9	R182830
Phosphorus, Olsen	4	mg/kg		1		ASA24-5	01/03/14 16:12 / eli-			SUB-B217349	14	B_14010301-PS3
RADIONUCLIDES - GAMMA												
Radium 226	1.0	pCi/g-dry				E901.1	01/15/14 08:20 / dpb	12/24/13 09:11	E901.1	GAM-HPGE_140115A	11	40160
Radium 226 precision (±)	0.5	pCi/g-dry				E901.1	01/15/14 08:20 / dpb	12/24/13 09:11	E901.1	GAM-HPGE_140115A	11	40160
Radium 226 MDC	0.6	pCi/g-dry				E901.1	01/15/14 08:20 / dpb	12/24/13 09:11	E901.1	GAM-HPGE_140115A	11	40160

Report Definitions:
RL - Analyte reporting limit.
MDC - Minimum detectable concentration
MCL - Maximum contaminant level.
D - RL increased due to sample matrix.
ND - Not detected at the reporting limit.

QA/QC Summary Report

Prepared by Casper, WY Branch

Client: Montgomery Watson Harza
Report Date: 01/31/14
Project: Church Rock Pre-Design Study
Work Order: C13120735

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: ASA24-5									Batch: B_14010301-PS3	
Sample ID: LCS	Laboratory Control Sample					Run: SUB-B217349			01/03/14 15:42	
Phosphorus, Olsen		12	mg/kg	1.0	93	50	150			
Sample ID: B13121331-001ADUP	Sample Duplicate					Run: SUB-B217349			01/03/14 15:49	
Phosphorus, Olsen		6.9	mg/kg-dry	1.0				8.3	30	
Sample ID: B13121331-001AMS	Sample Matrix Spike					Run: SUB-B217349			01/03/14 15:51	
Phosphorus, Olsen		18	mg/kg-dry	1.0	96	50	150			
Sample ID: C13120735-008A	Sample Duplicate					Run: SUB-B217349			01/03/14 16:09	
Phosphorus, Olsen		5.2	mg/kg	1.0				12	30	
Sample ID: C13120735-008A	Sample Matrix Spike					Run: SUB-B217349			01/03/14 16:11	
Phosphorus, Olsen		18	mg/kg	1.0	117	50	150			

Qualifiers:

RL - Analyte reporting limit.
MDC - Minimum detectable concentration
ND - Not detected at the reporting limit.

QA/QC Summary Report

Prepared by Casper, WY Branch

Client: Montgomery Watson Harza
Report Date: 01/31/14
Project: Church Rock Pre-Design Study
Work Order: C13120735

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: ASA29-3										Batch: 40199
Sample ID: MB-40199		Method Blank				Run: OC_131230A				12/30/13 10:06
Organic Matter		ND	%	0.2						
Sample ID: LCS1-40199		Laboratory Control Sample				Run: OC_131230A				12/30/13 10:08
Organic Matter		1.45482	%		1.01	80	120			
Sample ID: C13120735-009ADUP		Sample Duplicate				Run: OC_131230A				12/30/13 10:32
Organic Matter		0.395121	%					0.107997	20	

Qualifiers:

RL - Analyte reporting limit.
MDC - Minimum detectable concentration

ND - Not detected at the reporting limit.

QA/QC Summary Report

Prepared by Casper, WY Branch

Client: Montgomery Watson Harza
Report Date: 01/31/14
Project: Church Rock Pre-Design Study
Work Order: C13120735

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: ASA31-3										Batch: B_R217865
Sample ID: C13120735-001A	Sample Duplicate					Run: SUB-B217865				01/15/14 11:20
Total Kjeldahl Nitrogen		448	mg/kg	10				0.0	30	
Sample ID: LCS-1401151120	Laboratory Control Sample					Run: SUB-B217865				01/15/14 11:20
Total Kjeldahl Nitrogen		616	mg/kg	10	94	50	150			
Sample ID: C13120735-001A	Sample Matrix Spike					Run: SUB-B217865				01/15/14 11:22
Total Kjeldahl Nitrogen		3360	mg/kg	10	73	50	150			

Qualifiers:

RL - Analyte reporting limit.
MDC - Minimum detectable concentration
ND - Not detected at the reporting limit.

QA/QC Summary Report

Prepared by Casper, WY Branch

Client: Montgomery Watson Harza
Report Date: 01/31/14
Project: Church Rock Pre-Design Study
Work Order: C13120735

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: ASAM10-3									Analytical Run: COND1-C_140107A	
Sample ID: CCV1_140107A	Continuing Calibration Verification Standard								01/07/14 10:54	
Conductivity, sat. paste		5.00	mmhos/cm	0.010	100	90	110			
Method: ASAM10-3									Batch: 40253	
Sample ID: LCS1-40253	Laboratory Control Sample					Run: COND1-C_140107A			01/07/14 10:55	
Conductivity, sat. paste		3.31	mmhos/cm	0.010	97	80	120			
Sample ID: C13120735-009ADUP	Sample Duplicate					Run: COND1-C_140107A			01/07/14 10:59	
Conductivity, sat. paste		2.24	mmhos/cm	0.010				2.6	20	

Qualifiers:

RL - Analyte reporting limit.
MDC - Minimum detectable concentration
ND - Not detected at the reporting limit.

QA/QC Summary Report

Prepared by Casper, WY Branch

Client: Montgomery Watson Harza
Report Date: 01/31/14
Project: Church Rock Pre-Design Study
Work Order: C13120735

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: ASAM10-3.2										Batch: 40253
Sample ID: C13120735-009ADUP	Sample Duplicate					Run: ORION 3 STAR PH_140107A				01/07/14 09:10
pH, sat. paste		7.91	s.u.	0.10				0.3	20	
Sample ID: LCS1-40253	Laboratory Control Sample					Run: ORION 3 STAR PH_140107A				01/07/14 09:10
pH, sat. paste		7.07	s.u.	0.10	100	90	110			

Qualifiers:

RL - Analyte reporting limit.
MDC - Minimum detectable concentration
ND - Not detected at the reporting limit.

QA/QC Summary Report

Prepared by Casper, WY Branch

Client: Montgomery Watson Harza
Report Date: 01/31/14
Project: Church Rock Pre-Design Study
Work Order: C13120735

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: E901.1										Batch: 40160
Sample ID: LCS-R182728		Laboratory Control Sample				Run: GAM-HPGE_140115A				01/15/14 08:20
Bismuth 214		7.8	pCi/g-dry		90	70	130			
- The LCS sample uses Bi214 for Ra226.										
Sample ID: MB-R182728	2	Method Blank				Run: GAM-HPGE_140115A				01/15/14 08:20
Radium 226		ND	pCi/g-dry							U
Radium 226 precision (±)		ND	pCi/g-dry							
Sample ID: C13120735-009ADUP	3	Sample Duplicate				Run: GAM-HPGE_140115A				01/15/14 08:20
Radium 226		0.7	pCi/g-dry					35	20	R
Radium 226 precision (±)		0.4	pCi/g-dry							
Radium 226 MDC		0.5	pCi/g-dry							
- Duplicate RPD is outside of the acceptance range for this analysis; however, the RER of 0.9 is less than the limit of 2.0. This batch is approved.										

Qualifiers:

RL - Analyte reporting limit.
MDC - Minimum detectable concentration
U - Not detected at minimum detectable concentration
ND - Not detected at the reporting limit.
R - RPD exceeds advisory limit.

QA/QC Summary Report

Prepared by Casper, WY Branch

Client: Montgomery Watson Harza
Report Date: 01/31/14
Project: Church Rock Pre-Design Study
Work Order: C13120735

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: SW6010B									Analytical Run: ICP4-C_131227A	
Sample ID: ICV	2	Initial Calibration Verification Standard							12/27/13 12:43	
Potassium		49.6	mg/L	0.50	99	90	110			
Sodium		50.083	mg/L		1	90	110			
Sample ID: ICSA	2	Interference Check Sample A							12/27/13 12:57	
Potassium		0.00360	mg/L	0.50						
Sodium		-0.29403	mg/L		0					
Sample ID: ICSAB	2	Interference Check Sample AB							12/27/13 13:01	
Potassium		-0.00757	mg/L	0.50						
Sodium		-0.39872	mg/L		0					
Method: SW6010B									Batch: 40182	
Sample ID: MB-40182	2	Method Blank				Run: ICP4-C_131227A			12/27/13 16:54	
Potassium		ND	mg/kg-dry	40						
Sodium		ND	mg/kg-dry	100						
Sample ID: LCS1-40182	2	Laboratory Control Sample				Run: ICP4-C_131227A			12/27/13 16:58	
Potassium		341	mg/kg-dry	42	131	63	136			
Sodium		182.542	mg/kg-dry		1.09	25	100			S
Sample ID: C13120735-009ADIL	2	Serial Dilution				Run: ICP4-C_131227A			12/27/13 17:56	
Potassium		168	mg/kg-dry	10		0	0			
Sodium		202.063	mg/kg-dry		0	0	0			
Sample ID: C13120735-009ADUP	2	Sample Duplicate				Run: ICP4-C_131227A			12/27/13 18:00	
Potassium		197	mg/kg-dry	10				0.8	20	
Sodium		251.97	mg/kg-dry					0.0977984	20	

Qualifiers:

RL - Analyte reporting limit.
MDC - Minimum detectable concentration
ND - Not detected at the reporting limit.
S - Spike recovery outside of advisory limits.

QA/QC Summary Report

Prepared by Casper, WY Branch

Client: Montgomery Watson Harza
Report Date: 01/31/14
Project: Church Rock Pre-Design Study
Work Order: C13120735

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: SW6010B									Analytical Run: ICP4-C_131231A	
Sample ID: ICV		Initial Calibration Verification Standard							12/31/13 14:39	
Sodium		50.7	mg/L	0.50	101	90	110			
Sample ID: ICSA		Interference Check Sample A							12/31/13 14:54	
Sodium		0.0306	mg/L	0.50						
Sample ID: ICSAB		Interference Check Sample AB							12/31/13 14:58	
Sodium		0.0603	mg/L	0.50						
Method: SW6010B									Batch: 40195	
Sample ID: MB-40195		Method Blank				Run: ICP4-C_131231A			12/31/13 17:15	
Sodium		ND	mg/L	100						
Sample ID: LCS1-40195		Laboratory Control Sample				Run: ICP4-C_131231A			12/31/13 17:19	
Sodium		7240	mg/L	150	140	75	138			S
Sample ID: C13120735-009ADIL		Serial Dilution				Run: ICP4-C_131231A			12/31/13 18:53	
Sodium		6900	mg/L	740		0	0		20	N
Sample ID: C13120735-009ADUP		Sample Duplicate				Run: ICP4-C_131231A			12/31/13 18:57	
Sodium		7190	mg/L	150				7.0	20	

Qualifiers:

RL - Analyte reporting limit.

MDC - Minimum detectable concentration

S - Spike recovery outside of advisory limits.

ND - Not detected at the reporting limit.

N - The analyte concentration was not sufficiently high to calculate a RPD for the serial dilution test.

QA/QC Summary Report

Prepared by Casper, WY Branch

Client: Montgomery Watson Harza
Report Date: 01/31/14
Project: Church Rock Pre-Design Study
Work Order: C13120735

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: SW6010B									Analytical Run: ICP4-C_140114A	
Sample ID: ICV	4	Initial Calibration Verification Standard							01/14/14 12:22	
Calcium		49.6	mg/L	0.50	99	90	110			
Magnesium		49.3	mg/L	0.50	99	90	110			
Potassium		48.2	mg/L	0.50	96	90	110			
Sodium		49.1	mg/L	0.50	98	90	110			
Sample ID: ICSA	4	Interference Check Sample A							01/14/14 12:36	
Calcium		465	mg/L	0.50	93	80	120			
Magnesium		498	mg/L	0.50	100	80	120			
Potassium		0.0214	mg/L	0.50						
Sodium		-0.00758	mg/L	0.50						
Sample ID: ICSAB	4	Interference Check Sample AB							01/14/14 12:40	
Calcium		462	mg/L	0.50	92	80	120			
Magnesium		496	mg/L	0.50	99	80	120			
Potassium		0.0212	mg/L	0.50						
Sodium		-0.180	mg/L	0.50						
Method: SW6010B									Batch: 40253	
Sample ID: MB-40253	4	Method Blank				Run: ICP4-C_140114A			01/14/14 17:41	
Calcium		ND	mg/L	10						
Magnesium		ND	mg/L	4						
Potassium		ND	mg/L	8						
Sodium		ND	mg/L	8						
Sample ID: LCS1-40253	4	Laboratory Control Sample				Run: ICP4-C_140114A			01/14/14 17:45	
Calcium		610	mg/L	55	100	70	130			
Magnesium		158	mg/L	8.2	106	70	130			
Potassium		ND	mg/L	42		70	130			S
Sodium		166	mg/L	150	104	70	130			
Sample ID: C13120735-009ADUP	4	Sample Duplicate				Run: ICP4-C_140114A			01/14/14 19:23	
Calcium		216	mg/L	1.0				3.3	30	
Magnesium		93.6	mg/L	1.0				3.6	30	
Potassium		7.40	mg/L	1.0				3.8	30	
Sodium		160	mg/L	1.0				3.1	30	

Qualifiers:

RL - Analyte reporting limit.
MDC - Minimum detectable concentration
ND - Not detected at the reporting limit.
S - Spike recovery outside of advisory limits.

QA/QC Summary Report

Prepared by Casper, WY Branch

Client: Montgomery Watson Harza
Report Date: 01/31/14
Project: Church Rock Pre-Design Study
Work Order: C13120735

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: USDA23c										Batch: 40270
Sample ID: MB-40270		Method Blank				Run: ORION 3 STAR PH_140107B				01/07/14 11:08
Lime as CaCO3		0.1	%	0.1						
Sample ID: LCS1-40270		Laboratory Control Sample				Run: ORION 3 STAR PH_140107B				01/07/14 11:15
Lime as CaCO3		4.03	%	0.10	104	80	120			
Sample ID: C13120735-009ADUP		Sample Duplicate				Run: ORION 3 STAR PH_140107B				01/07/14 12:10
Lime as CaCO3		5.30	%	0.10				1.9	20	

Qualifiers:

RL - Analyte reporting limit.
MDC - Minimum detectable concentration
ND - Not detected at the reporting limit.

QA/QC Summary Report

Prepared by Casper, WY Branch

Client: Montgomery Watson Harza
Report Date: 01/31/14
Project: Church Rock Pre-Design Study
Work Order: C13120735

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: USDA27a										Batch: 40253
Sample ID: LCS1-40253		Laboratory Control Sample				Run: SARTORIUS_140107B				01/07/14 09:35
Saturation		45.6	%	0.10	107	80	120			
Sample ID: C13120735-009ADUP		Sample Duplicate				Run: SARTORIUS_140107B				01/07/14 09:39
Saturation		51.0	%	0.10				0.2	20	

Qualifiers:

RL - Analyte reporting limit.
MDC - Minimum detectable concentration
ND - Not detected at the reporting limit.

Workorder Receipt Checklist

Montgomery Watson Harza

C13120735

Login completed by: Tessa Parke
Date Received: 12/20/2013

Reviewed by: BL2000\swaldrop
Received by: dcq

Reviewed Date: 1/10/2014
Carrier name: Ground

Shipping container/cooler in good condition?	Yes ☑	No ☐	Not Present ☐
Custody seals intact on all shipping container(s)/cooler(s)?	Yes ☑	No ☐	Not Present ☐
Custody seals intact on all sample bottles?	Yes ☐	No ☐	Not Present ☑
Chain of custody present?	Yes ☑	No ☐	
Chain of custody signed when relinquished and received?	Yes ☑	No ☐	
Chain of custody agrees with sample labels?	Yes ☑	No ☐	
Samples in proper container/bottle?	Yes ☑	No ☐	
Sample containers intact?	Yes ☑	No ☐	
Sufficient sample volume for indicated test?	Yes ☑	No ☐	
All samples received within holding time? (Exclude analyses that are considered field parameters such as pH, DO, Res Cl, Sulfite, Ferrous Iron, etc.)	Yes ☑	No ☐	
Temp Blank received in all shipping container(s)/cooler(s)?	Yes ☐	No ☐	Not Applicable ☑
Container/Temp Blank temperature:	N/A°C		
Water - VOA vials have zero headspace?	Yes ☐	No ☐	No VOA vials submitted ☑
Water - pH acceptable upon receipt?	Yes ☐	No ☐	Not Applicable ☑

Standard Reporting Procedures:

Lab measurement of analytes considered field parameters that require analysis within 15 minutes of sampling such as pH, Dissolved Oxygen and Residual Chlorine, are qualified as being analyzed outside of recommended holding time.

Solid/soil samples are reported on a wet weight basis (as received) unless specifically indicated. If moisture corrected, data units are typically noted as –dry. For agricultural and mining soil parameters/characteristics, all samples are dried and ground prior to sample analysis.

Contact and Corrective Action Comments:

None

2 Buckets

ENERGY LABORATORIES

Chain of Custody and Analytical Request Record

PLEASE PRINT- Provide as much information as possible.

Company Name: MWH Global	Project Name, PWS, Permit, Etc.: Church Rock Pre-Design Study	Sample Origin State: NM	EPA/State Compliance: Yes ☐ No ☑
Report Mail Address: 3665 JFK Parkway, Bldg. 1, Suite 206, Fort Collins, CO 80525	Contact Name: Jason Cumbers; Phone/Fax: (970) 377-9410	Email:	Sampler: (Please Print) Robert Schaut
Invoice Address: Same	Invoice Contact & Phone: Jason Cumbers (970) 377-9410	Purchase Order:	Quote/Bottle Order:

Special Report/Formats – ELI must be notified prior to sample submittal for the following:

- ☐ DW
- ☐ GSA
- ☐ POTW/WWTP
- ☐ State: ________
- ☐ Other: ________
- ☐ A2LA
- ☐ EDD/EDT(Electronic Data) Format: ________
- ☐ LEVEL IV
- ☐ NELAC

Number of Containers; Sample Type: A W S V B O; Air Water Soils/Solids Vegetation Bioassay Other

ANALYSIS REQUESTED

SEE ATTACHED

Normal Turnaround (TAT)

RUSH

Contact ELI prior to RUSH sample submittal for charges and scheduling – See Instruction Page

Comments:

Shipped by: UPS Ground

Cooler ID(s): 2 Buckets

Receipt Temp: N/A °C

On Ice: Yes No N/A

Custody Seal (Y) N

Intact (Y) N

Signature Match (Y) N

LABORATORY USE ONLY

	SAMPLE IDENTIFICATION (Name, Location, Interval, etc.)	Collection Date	Collection Time	MATRIX	SEE ATTACHED
1	TI - CS02 - 01 (0 - 7")	11/12/13	—	Soil	X
2	TI - CS07 - 01 (0 - 6")	11/13/13	10:55	Soil	X
3	TI - CS11 - 01 (0 - 6")	11/13/13	14:35	Soil	X
4	WB - B2 - 04 (0 - 10')	11/14/13	16:00	Soil	X
5	EB - B4 - 03 (0 - 10')	12/10/13	11:40	Soil	X
6	SB - B4 - 01 (0 - 15')	12/12/13	16:45	Soil	X
7	NB - B1 - 04 (0 - 15')	12/12/13	14:25	Soil	X
8	DH - B3 - 02 (0' - 10')	12/11/13	14:40	Soil	X
9	Topsoil Stockpile	11/21/13	15:35	Soil	
10					

Custody Record MUST be Signed

Relinquished by (print)	Date/Time	Signature	Received by (print)	Date/Time	Signature
Robert Schaut	12/14/13 8AM	[signature]			

Received by Laboratory: Date/Time: 12/20/13 945 Signature: [signature]

Sample Disposal: Return to Client: ________ Lab Disposal: X

In certain circumstances, samples submitted to Energy Laboratories, Inc. may be subcontracted to other certified laboratories in order to complete the analysis requested. This serves as notice of this possibility. All sub-contract data will be clearly notated on your analytical report. Visit our web site at www.energylab.com for additional information, downloadable fee schedule, forms, and links.

Energy Labs - Agronomic Testing
Church Rock Pre-Design Study

Sample ID	Date	Type	Ra-226 activity --- EPA Method 901.1	pH --- Saturated Paste pH (USDA Staff, 1954)	Electrical conductivity --- Solution conductivity (USDA Staff, 1954)	Exchangeable sodium percentage - SAR Estimation (USDA Staff,1954)	Calcium carbonate equivalent - Rapid titration (Agronomy Society of America,1965)	Cation exchange capacity - Na saturated then NH4OAc extracted (Agronomy Society of America,1965)	Percent organic matter Walkley – Black (Agronomy Society of America, 1982)	Nitrogen Kjeldahl (Agronomy Society of America, 1965)	Phosphorous Olsen (Ludwick and Reuss, 1974; Olsen, et al., 1954)	Potassium (K) 1:5 NH4OAc Extract (Ludwick and Reuss, 1974)
TI - CS02 - 01 (0 - 7")	11/12/2013	Bag	1	1	1	1	1	1	1	1	1	1
TI - CS07 - 01 (0 - 6")	11/13/2013	Bag	1	1	1	1	1	1	1	1	1	1
TI - CS11 - 01 (0 - 6")	11/13/2013	Bag	1	1	1	1	1	1	1	1	1	1
WB - B2 - 04 (0 - 10')	11/14/2013	Bag	1	1	1	1	1	1	1	1	1	1
EB - B4 - 03 (0 - 10')	12/10/2013	Bag	1	1	1	1	1	1	1	1	1	1
SB - B4 - 01 (0 - 15')	12/12/2013	Bag	1	1	1	1	1	1	1	1	1	1
NB - B1 - 04 (0 - 15')	12/12/2013	Bag	1	1	1	1	1	1	1	1	1	1
DH - B3 - 02 (0 - 10')	12/11/2013	Bag	1	1	1	1	1	1	1	1	1	1
Topsoil Stockpile	11/21/2013	Bag	1	1	1	1	1	1	1	1	1	1

C13120735, 1-9

Radiochemistry
Level 4 Reporting Checklist Gamma

Method #: EPA 901.1 ***Analyte:*** Ra-226

✓ Energy Labs Batch ID: GEGG 140115A @ 8:20

✓ Omega Data Entry Batch ID: 182728

✓ Instrument ID: DETECTOR 1 (DET 1)

✓ Instrument background check

✓ Instrument efficiency/calibration check

✓ Bench-sheets (Sample run order should include MD 10 samples)

✓ Photocopy of instrument run log

✓ Photocopy of standard source calibration certificate noting manufacturer, stock and/or lot number

____ Photocopy of method control charts for the following:
(provided by QA Dept.)

____ Matrix Duplicates (MD)

✓ Analyst Case Narrative consisting of the following:

✓ A statement documenting the analytes and the method used

✓ Date of analysis

✓ Any instrument adjustment or anomalies encountered during analysis

✓ Printed name and signature of analyst

Analyst Case Narrative

Method #: EPA 901.1 Analyte Ra226 Date/time of analysis: 1-15-14 8:20

Any problems or anomalies encountered during analysis?

No ✓ Yes_____ (please explain below)

Analyst case narrative: ANALYZED SAMPLES ACCORDING TO EPA 901.1 METHOD UTILIZING ORTEC GAMMAVISION SOFTWARE.

Any instrument adjustments or anomalies encountered during analysis?

No ✓ Yes_____ (please explain below)

Analyst case narrative: NO ADJUSTMENTS OR ANOMALIES.

Analyst DAVID BLANDA
Please print

Signature David Blanda

PREP BATCH REPORT

Technician: David Mikesell

Prep Batch 40160 Prep Code: PRP-GAMMA Batch Units: G

Prep Start Date: 12/24/2013 09:10:40

Prep End Date: 12/24/2013 09:16:00

Sample ID	Matrix	pH	Initial Samp Amt	Sol Added	Sol Recov	Fin Vol (mL)	Factor	Balance	PrepStart	PrepEnd
C13120735-001A - D & G	Soil	all DET /	179.68	0	0	179.68	1	Sartorius CP3202	12/24/2013	12/24/2013
C13120735-002A	Soil		182.65	0	0	182.65	1	Sartorius CP3202	12/24/2013	12/24/2013
C13120735-003A	Soil		184.85	0	0	184.85	1	Sartorius CP3202	12/24/2013	12/24/2013
C13120735-004A	Soil		193.65	0	0	193.65	1	Sartorius CP3202	12/24/2013	12/24/2013
C13120735-005A	Soil		190.61	0	0	190.61	1	Sartorius CP3202	12/24/2013	12/24/2013
C13120735-006A	Soil		181.78	0	0	181.78	1	Sartorius CP3202	12/24/2013	12/24/2013
C13120735-007A	Soil		193.81	0	0	193.81	1	Sartorius CP3202	12/24/2013	12/24/2013
C13120735-008A	Soil		199.87	0	0	199.87	1	Sartorius CP3202	12/24/2013	12/24/2013
C13120735-009A	Soil	[redacted]	189.68	0	0	189.68	1	Sartorius CP3202	12/24/2013	12/24/2013

Started 1-15-14 @ 8:20 OB

GEGE

140115A

8:20

LCS [redacted]

12

1-17-14

OB

calc'd

1-15-14

Energy Laboratories, Inc.
Alpha Spectroscopy / Gamma Spectroscopy
Instrument / Maintenance Run Log

Instruments: EGG Ortec Octete PC Alpha Spectroscopy System and EGG Ortec High Purity Germanium Detector

Date	Det. No.	Count Time Min.	Isotope	Batch ID	Associated Samples	Data File Number	Instrument ID		Int	Comments Maintenance Log
							Alpha Spec	Gamma Spec		
1-14-14	3-6,8,11-19	240	Po210	539		Po-539	✓		DJ	
1-14-14	3-6,8,11-18	240	Th	1984		Th-1984	✓		DJ	
1-14-14	11-18	720	↓	↓	Added time for MDC	↓	✓		DJ	
1-15-14	1, 2	10,30,	960	RAD96 Det 2,	C13120735 1-8	→		✓	[illegible]	
1-15-14	3-5,8,11-18	120	Po210	540	/	Po-540	✓		DJ	
1-15-14	4,14	300	Th	1978	added cnt time-MDC	Th-1978	✓		DJ	
1-16-14	1	10,30,60	DCK,BKG		C13120735, 1-9	→		✓	[illegible]	
1-16-14	3-5,8,11-19, 22-24	360	Th	1986		Th-1986	✓		DJ	
1-16-14	↓	240	Th	1988		Th-1988	✓		DJ	

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ACTIVITY DECAY CORRECTIONS
LCS CANS 6 - 10, gbkg

Input Analyte	LCS #	Input Half life Years	Calc Half life Days	Calc Half life Hours	Input Original pCi	Calc Original uCi	Calc Corrected pCi	Calc Corrected nCi	Calc Corrected uCi	Calc Corrected Bq	Input Reference Date	Input Current Date	Calc DPM	Input Measured pCi	Calc Percent Recovery	LCS #	
IPL-6	6	1600	5.84E+05	14025600	47.4	4.74E-05	46.85	0.05	4.69E-05	1.734	4/1/1987	12/26/2013	104.02	43.10	0.92	6	DET1
IPL-6	6	1600	5.84E+05	14025600	47.4	4.74E-05	46.85	0.05	4.69E-05	1.734	4/1/1987	12/26/2013	104.02	41.40	0.88	6	DET2
IPL-7	**7**	**1600**	**5.84E+05**	**14025600**	**8.72**	**8.72E-06**	**8.66**	**0.01**	**8.66E-06**	**0.320**	**2/1/1997**	**1/17/2014**	**19.22**	**7.77**	**0.90**	**7**	**DET1**
IPL-7	7	1600	5.84E+05	14025600	8.72	8.72E-06	8.66	0.01	8.66E-06	0.320	2/1/1997	12/26/2013	19.22	8.23	0.95	7	DET2
IPL-7	7	1600	5.84E+05	14025600	8.72	8.72E-06	8.66	0.01	8.66E-06	0.320	2/1/1997	12/26/2013	19.22	8.84	1.02	7	DET2
IPL-8	8	1600	5.84E+05	14025600	23.93	2.39E-05	23.77	0.02	2.38E-05	0.879	2/1/1997	1/2/2013	52.76	22.60	0.95	8	DET1

Eckert & Ziegler
Isotope Products

24937 Avenue Tibbitts
Valencia, California 91355

Tel 661·309·1010
Fax 661·257·8303

CERTIFICATE OF CALIBRATION
MULTINUCLIDE STANDARD SOURCE

Customer:	ENERGY LABORATORIES	**Source No.:**	1692-18
P.O. No.:	89552	**Reference Date:**	1-Jul-13 12:00 PST
Catalog No.:	EG-ML	**Contained Radioactivity:**	0.9146 µCi 33.84 kBq

Physical Description:

A. Capsule type: Customer supplied 3" can
B. Nature of active deposit: Multinuclide distributed in 1.5g/cc epoxy matrix
C. Active diameter/volume: Approximately 124.1 mL (186.1 grams)
D. Backing: Plastic
E. Cover: Plastic

Gamma-Ray Energy (keV)	Nuclide	Half-life	Branching Ratio (%)	Activity (µCi)	Gammas per second	Total Uncert.
60	Am-241	432.17 ± 0.66 years	36.0	0.02632	350.6	3.0 %
88	Cd-109	462.6 ± 0.7 days	3.63	0.2603	349.6	3.2 %
122	Co-57	271.79 ± 0.09 days	85.6	0.01012	320.5	3.1 %
159	Te-123m	119.7 ± 0.1 days	84.0	0.01317	409.3	3.1 %
320	Cr-51	27.706 ± 0.007 days	9.86	0.3094	1129	3.0 %
392	Sn-113	115.09 ± 0.04 days	64.9	0.04999	1200	3.0 %
514	Sr-85	64.849 ± 0.004 days	98.4	0.05939	2162	3.0 %
662	Cs-137	30.17 ± 0.16 years	85.1	0.04230	1332	3.1 %
898	Y-88	106.630 ± 0.025 days	94.0	0.09347	3251	3.0 %
1173	Co-60	5.272 ± 0.001 years	99.86	0.05012	1852	3.1 %
1333	Co-60	5.272 ± 0.001 years	99.98	0.05012	1854	3.1 %
1836	Y-88	106.630 ± 0.025 days	99.4	0.09347	3438	3.0 %

Method of Calibration:

This source was prepared from weighed aliquots of solutions whose concentrations in µCi/g were determined by gamma spectrometry.

Notes:

- See reverse side for leak test(s) performed on this source.
- EZIP participates in a NIST measurement assurance program to establish and maintain implicit traceability for a number of nuclides, based on the blind assay (and later NIST certification) of Standard Reference Materials (as in NRC Regulatory Guide 4.15).
- Nuclear data was taken from IAEA-TECDOC-619, 1991.
- Overall uncertainty is calculated at the 99% confidence level.
- This source has a working life of 1 year.

Quality Control

16-Jul-13
Date

EZIP Ref. No.: 1692-18

Calibration Data from file: julycc_5th_det1_169218.Clb
Energy Calibration Date: 12/10/2013 Time: 10:50:03
Efficiency Calibration Date: 7/26/2013 Time: 07:55:14

Calibration Description:
12/10/13 calibration energy/efficiency
IPL #1692-18 recal energy calibration perched

Energy Calibration Fit
Energy = -0.4469 +0.243196*Channel +1.47595e-009*Channel**2
FWHM (keV) = 2.7806 +0.001109*Channel -4.93042e-008*Channel**2

Energy/FWHM Table

Channel	Energy(keV)	Fit(keV)	Delta	FWHM	Fit	Delta
246.10	59.54	59.40	0.23%	0.71	0.74	-4.73%
363.33	88.00	87.91	0.10%	0.76	0.77	-1.72%
503.25	122.00	121.94	0.05%	0.78	0.81	-4.09%
655.18	159.00	158.89	0.07%	0.86	0.85	0.90%
1318.39	320.00	320.18	-0.06%	1.14	1.01	11.50%
1612.23	391.00	391.64	-0.16%	1.06	1.08	-1.87%
2114.99	514.00	513.92	0.02%	1.17	1.19	-1.58%
2722.39	662.00	661.64	0.05%	1.33	1.32	1.00%
3694.44	898.00	898.05	-0.01%	1.48	1.51	-1.84%
4826.12	1173.00	1173.28	-0.02%	1.71	1.70	0.71%
5480.96	1333.00	1332.55	0.03%	1.75	1.79	-2.26%
7551.50	1836.00	1836.13	-0.01%	2.05	2.03	0.94%

Efficiency Calibration Fit
Polynomial Uncertainty = 1.3912 %
Coefficients:
-0.329484 -5.959887 0.633715 -0.076489 0.004220 -0.000092

Efficiency Table

Energy	Efficiency	Fit	Delta
59.54	1.4792E-002	1.4791E-002	0.00%
88.00	1.8292E-002	1.8301E-002	-0.05%
122.05	1.8426E-002	1.7693E-002	3.98%
159.03	1.5851E-002	1.5830E-002	0.13%
320.06	8.9257E-003	8.9862E-003	-0.68%
391.58	7.4870E-003	7.4242E-003	0.84%
513.94	5.6263E-003	5.7648E-003	-2.46%
661.60	4.7749E-003	4.6047E-003	3.56%
898.05	3.5676E-003	3.5554E-003	0.34%
1173.18	2.8125E-003	2.8533E-003	-1.45%
1332.77	2.5347E-003	2.5675E-003	-1.29%
1836.10	1.9651E-003	1.9465E-003	0.95%

Calibration Certificate Table

Isotope	Energy	Pct	Halflife	Activity	GPS	Error	Date & Time
Cd-109	88.03	3.63	4.63E+002	9630.85	349.60	3.20%	7/1/2013 12:00:00
Co-57	122.07	85.60	2.72E+002	374.42	320.50	31.00%	7/1/2013 12:00:00
Te-123m	159.07	84.00	1.20E+002	487.26	409.30	3.10%	7/1/2013 12:00:00
Sn-113	391.69	64.90	1.15E+002	1849.00	1200.00	3.00%	7/1/2013 12:00:00
Y-88	898.02	94.00	1.07E+002	3458.51	3251.00	3.00%	7/1/2013 12:00:00
Co-60	1173.24	99.86	1.93E+003	1854.60	1852.00	3.10%	7/1/2013 12:00:00
Co-60	1333.00	99.98	1.93E+003	1854.37	1854.00	3.10%	7/1/2013 12:00:00
Y-88	1836.01	99.40	1.07E+002	3458.75	3438.00	3.00%	7/1/2013 12:00:00
Sn-51	320.00	9.86	2.77E+001	11450.30	1129.00	3.00%	7/1/2013 12:00:00
Sr-85	514.00	98.40	6.48E+001	2197.15	2162.00	3.00%	7/1/2013 12:00:00
Cs-137	661.66	85.10	1.10E+004	1565.22	1332.00	3.10%	7/1/2013 12:00:00
Bi-109	1836.27	3.63	4.63E+002	9220.39	334.70	3.10%	6/1/2009 12:00:00
Am-241	59.72	36.30	1.58E+005	965.84	350.60	3.00%	7/13/2013 12:00:00
	392.00	0.00	0.00E+000	0.00	0.00	5.00%	00:00:00
	514.00	0.00	0.00E+000	0.00	0.00	5.00%	00:00:00
	662.00	0.00	0.00E+000	0.00	0.00	5.00%	00:00:00
Y-88	898.00	94.00	1.07E+002	3458.51	3251.00	3.00%	7/13/2013 12:00:00
	1173.00	0.00	0.00E+000	0.00	0.00	5.00%	00:00:00
	1333.00	0.00	0.00E+000	0.00	0.00	5.00%	00:00:00
Am-241	1836.00	36.30	1.58E+005	965.84	350.60	3.00%	7/1/2013 12:00:00

RS-17

CERTIFICATE OF CALIBRATION IPL 7
GAMMA STANDARD SOURCE CAN

Radionuclide:	Ra-226	Customer.:	ENERGY LABORATORIES
Half Life:	1600 ± 7 years	P.O. No:	C40177
Catalog No.:	EG-0242	Reference Date:	1 February 1997 12:00 PST
Source No.:	548-133-2	Contained Radioactivity:	(Ra-226) 1.423 nCi (52.64 Bq)

Description of Source

a. Capsule type:	Customer supplied can
b. Nature of active deposit:	Metallic salts in epoxy matrix
c. Active diameter/volume:	Approx. 125 ml (mass of epoxy = 163.16 g)
d. Backing:	Steel
e. Cover:	Steel

Radioimpurities:

None detected (other than daughters)

Method of Calibration

The source was prepared from a weighed aliquot of a solution whose concentration in μCi/gram was determined by gamma spectrometry:

Energy peak(s) integrated under:	186	keV.
Branching ratio(s) used:	0.0351	gamma rays per decay.

Uncertainty of Measurement

a. Systematic uncertainty in instrument calibration:	± 3.0%
b. Random uncertainty in assay:	± 3.0%
c. Random uncertainty in weighing(s):	± 0.6%
d. Total uncertainty at the 99% confidence level:	± 4.3%

NIST Traceability

This calibration is traceable to the National Institute of Standards and Technology.

Leak Test(s)

See reverse side for Leak Test(s) applied to this source.

Notes

1. IPL participates in an NIST measurement assurance program to establish and maintain implicit traceability for a number of nuclides, based on the blind assay (and later NIST certification) of Standard Reference Materials (As in NRC Regulatory Guide 4.15).

2. This source has a Ra-226 concentration of 8.722 pCi/g

ID #: 3132
Opened:
Gamma-Standard Source-548-133-2
Expires: 2/1/1999
Rec'd: 2/1/1997
Energy Laboratories, Inc 2393 Salt Creek Hwy
Casper WY 82602

Chris U. Ha
QUALITY CONTROL

24 Jan 97
Date Signed

ISOTOPE PRODUCTS LABORATORIES
1800 N. KEYSTONE STREET
BURBANK, CALIFORNIA 91504
818·843·7000 FAX 818·843·6168

IPL Ref. No.: 548-133-2

```
 ORTEC     g v - i (  15) wan32  G53W2.06  15-JAN-2014 08:22:58 Page    1
Energy Laboratory              Spectrum name: QA000714.Spc


Sample description
     011514pckdet1


Spectrum Filename: C:\User\QA000714.Spc

Acquisition information
       Start time:                15-Jan-2014 08:12:50
       Live time:                600
       Real time:                606
       Dead time:                  1.02 %
       Detector ID:                   2

Detector system
     Det 1


Calibration
       Filename:                  apr13mb_16th_det1_1671271.Clb
     10/9/13 mb calibration polynomial energy re-cal
     IPL #1671271

       Energy Calibration
            Created:              09-Oct-2013 13:50:38
            Zero offset:         -0.317 keV
            Gain:                 0.243 keV/channel
            Quadratic:            2.269E-09 keV/channel^2

       Efficiency Calibration
            Created:              25-Apr-2013 08:44:34
            Type:                 Polynomial
            Uncertainty:          1.119 %
            Coefficients:        -0.379781  -4.955815   0.632347
                                 -0.076310   0.004092  -0.000084

Library Files
       Main analysis library:     qaeff.Lib
       Library Match Width:       0.500

Analysis parameters
       Analysis engine:            wan32   G53W2.06
       Start channel:             200 (    48.31keV )
       Stop channel:             8144 (  1980.10keV )
       Peak rejection level:      20.000%
       Peak search sensitivity:    3
       Sample Size:                1.0000E+00
       Activity scaling factor:    2.7000E+01/(  1.0000E+00*  1.0000E+00) =
                                   2.7000E+01
       Detection limit method:     LLD - ORTEC method (US-NRC)

       Random error:               1.0000000E+00
       Systematic error:           1.0000000E+00
       Fraction Limit:             0.000%
       Background width:           best method (based on spectrum).

       Half lives decay limit:    12.000
```

ORTEC g v - i (15) wan32 G53W2.06 15-JAN-2014 08:22:58 Page 2
Energy Laboratory Spectrum name: QA000714.Spc

Activity range factor: 2.000
Min. step backg. energy 0.000

Corrections	Status	Comments
Decay correct to date:	YES	15-Feb-2004 12:00:00
Decay during acquisition:	YES	
Decay during collection:	NO	
True coincidence correction:	NO	
Peaked background correction:	NO	
Absorption (Internal):	NO	
Geometry correction:	NO	
Random summing:	YES	Slope 1.0000E+00
		Net factor 1.0000E+00

Energy Calibration
Normalized diff: 0.0991

- -

***** S U M M A R Y O F N U C L I D E S I N S A M P L E *****

Nuclide	Time of Count Activity pCi/g	Time Corrected Activity pCi/g	Uncertainty Counting pCi/g	2 Sigma Total pCi/g	MDA
CO-60	1.5060E+04	5.5468E+04	2.3966E+03	2.8104E+03	1.516E+03
CS-137	3.8293E+04	4.8090E+04	1.0655E+03	1.6985E+03	1.977E+03
AM-241	2.8802E+04	2.9263E+04	7.3673E+02	1.3089E+03	1.689E+03

< - MDA value printed.
A - Activity printed, but activity < MDA.
B - Activity < MDA and failed test.
C - Area < Critical level.
F - Failed fraction or key line test.
H - Halflife limit exceeded

---------- S U M M A R Y ----------

Total Activity (48.3 to 1980.1 keV) 8.2154781E+04 pCi/g
Total Decayed Activity (48.3 to 1980.1 keV) 1.3282133E+05 pCi/g

********* S U M M A R Y O F D I S C A R D E D P E A K S *********
1332.50 - CO-60

! - Peak is part of a multiplet and this area went negative during deconvolution.
? - Peak is too narrow.
@ - Peak is too wide at FW25M, but ok at FWHM.
% - Peak fails sensitivity test.
$ - Peak identified, but first peak of this nuclide failed one or more qualification tests.
+ - Peak activity higher than counting uncertainty range.
- - Peak activity lower than counting uncertainty range.
= - Peak outside analysis energy range.

ORTEC g v - i (15) wan32 G53W2.06 15-JAN-2014 08:22:58 Page 3
Energy Laboratory Spectrum name: QA000714.Spc

& - Calculated peak centroid is not close enough to the
library energy centroid for positive identification.
P - Peakbackground subtraction

- -

Analyzed by: ______________________________
Dave Blaida

Reviewed by: ______________________________
Supervisor

Laboratory: Energy Laboratory

QA_HHQPHFD1033701_00670.Rpt

GammaVision V6.01 QA Background Report 1/15/2014 08:54:33

Detector:	2 Det 1
Measurement Number:	670
Data Acquired On:	1/15/2014 08:24:34
Real Time:	1800.00 Sec.
Live Time:	1799.14 Sec.
Status:	OK

	Minimum	Low	Actual	High	Maximum
Background (CPS):	1.96	2.21	2.39	2.70	2.95

ORTEC g v - i (15) wan32 G53W2.06 16-JAN-2014 09:10:40 Page 1
Energy Laboratory Spectrum name: QA000715.Spc

Sample description
011614pckdet1

Spectrum Filename: C:\User\QA000715.Spc

Acquisition information
Start time: 16-Jan-2014 09:00:33
Live time: 600
Real time: 606
Dead time: 1.02 %
Detector ID: 2

Detector system
Det 1

Calibration
Filename: apr13mb_16th_det1_1671271.Clb
10/9/13 mb calibration polynomial energy re-cal
IPL #1671271

Energy Calibration
Created: 09-Oct-2013 13:50:38
Zero offset: -0.317 keV
Gain: 0.243 keV/channel
Quadratic: 2.269E-09 keV/channel^2

Efficiency Calibration
Created: 25-Apr-2013 08:44:34
Type: Polynomial
Uncertainty: 1.119 %
Coefficients: -0.379781 -4.955815 0.632347
-0.076310 0.004092 -0.000084

Library Files
Main analysis library: qaeff.Lib
Library Match Width: 0.500

Analysis parameters
Analysis engine: wan32 G53W2.06
Start channel: 200 (48.31keV)
Stop channel: 8144 (1980.10keV)
Peak rejection level: 20.000%
Peak search sensitivity: 3
Sample Size: 1.0000E+00
Activity scaling factor: 2.7000E+01/(1.0000E+00* 1.0000E+00) =
2.7000E+01
Detection limit method: LLD - ORTEC method (US-NRC)

Random error: 1.0000000E+00
Systematic error: 1.0000000E+00
Fraction Limit: 0.000%
Background width: best method (based on spectrum).

Half lives decay limit: 12.000

ORTEC g v - i (15) wan32 G53W2.06 16-JAN-2014 09:10:40 Page 2
Energy Laboratory Spectrum name: QA000715.Spc

Activity range factor: 2.000
Min. step backg. energy 0.000

Corrections	Status	Comments
Decay correct to date:	YES	15-Feb-2004 12:00:00
Decay during acquisition:	YES	
Decay during collection:	NO	
True coincidence correction:	NO	
Peaked background correction:	NO	
Absorption (Internal):	NO	
Geometry correction:	NO	
Random summing:	YES	Slope 1.0000E+00
		Net factor 1.0000E+00

Energy Calibration
Normalized diff: 0.0781

***** S U M M A R Y O F N U C L I D E S I N S A M P L E *****

Nuclide	Time of Count Activity pCi/g	Time Corrected Activity pCi/g	Uncertainty Counting pCi/g	2 Sigma Total pCi/g	MDA
CO-60	1.5190E+04	5.5968E+04	1.7207E+03	2.2703E+03	1.524E+03
CS-137	3.8354E+04	4.8169E+04	1.0660E+03	1.7005E+03	1.978E+03
AM-241	2.9247E+04	2.9716E+04	6.8716E+02	1.2958E+03	1.576E+03

< - MDA value printed.
A - Activity printed, but activity < MDA.
B - Activity < MDA and failed test.
C - Area < Critical level.
F - Failed fraction or key line test.
H - Halflife limit exceeded

S U M M A R Y

Total Activity (48.3 to 1980.1 keV) 8.2790836E+04 pCi/g
Total Decayed Activity (48.3 to 1980.1 keV) 1.3385288E+05 pCi/g

********* S U M M A R Y O F D I S C A R D E D P E A K S *********

! - Peak is part of a multiplet and this area went negative during deconvolution.
? - Peak is too narrow.
@ - Peak is too wide at FW25M, but ok at FWHM.
% - Peak fails sensitivity test.
$ - Peak identified, but first peak of this nuclide failed one or more qualification tests.
+ - Peak activity higher than counting uncertainty range.
- - Peak activity lower than counting uncertainty range.
= - Peak outside analysis energy range.

ORTEC g v - i (15) wan32 G53W2.06 16-JAN-2014 09:10:40 Page 3
Energy Laboratory Spectrum name: QA000715.Spc

& - Calculated peak centroid is not close enough to the
    library energy centroid for positive identification.
P - Peakbackground subtraction

- -

Analyzed by: ______________________________
Dave Blaida

Reviewed by: ______________________________
Supervisor

Laboratory: Energy Laboratory

QA_HHQPHFD1033701_00671.Rpt

GammaVision V6.01 QA Background Report 1/16/2014 09:42:21

Detector:	2 Det 1
Measurement Number:	671
Data Acquired On:	1/16/2014 09:12:22
Real Time:	1800.00 Sec.
Live Time:	1799.14 Sec.
Status:	OK

	Minimum	Low	Actual	High	Maximum
Background (CPS):	1.96	2.21	2.42	2.70	2.95

Page 1

```
 ORTEC     g v - i ( 143) wan32  G53W2.06  17-JAN-2014 09:18:10 Page    1
Energy Laboratory               Spectrum name: 011614ipl7lcsdet1.An1


Sample description
     011614ipl7lcsdet1


Spectrum Filename: C:\User\011614ipl7lcsdet1.An1

Acquisition information
       Start time:                16-Jan-2014 15:49:27
       Live time:               3600
       Real time:               3602
       Dead time:                  0.06 %
       Detector ID:                   2

Detector system
     Det 1


Calibration
       Filename:                  julycc_5th_det1_169218.clb
     12/10/13 calibration energy/efficiency
     IPL #1692-18  recal energy calibration perched

       Energy Calibration
            Created:              10-Dec-2013 10:50:03
            Zero offset:         -0.447 keV
            Gain:                 0.243 keV/channel
            Quadratic:            1.476E-09 keV/channel^2

       Efficiency Calibration
            Created:              26-Jul-2013 07:55:14
            Type:                 Polynomial
            Uncertainty:          1.391 %
            Coefficients:        -0.329484  -5.959887   0.633715
                                 -0.076489   0.004220  -0.000092

Library Files
       Main analysis library:     Norman.lib
       Library Match Width:       0.500

Analysis parameters
       Analysis engine:           wan32   G53W2.06
       Start channel:           200 (    48.19keV )
       Stop channel:           8144 (  1980.24keV )
       Peak rejection level:     20.000%
       Peak search sensitivity:  3
       Sample Size:              1.6316E+02
       Activity scaling factor:  2.7000E+01/(  1.0000E+00*  1.6316E+02) =
                                 1.6548E-01
       Detection limit method:   Nureg 4.16

       Random error:             1.0000000E+00
       Systematic error:         1.0000000E+00
       Fraction Limit:           0.000%
       Background width:         best method (based on spectrum).

       Half lives decay limit:   12.000
```

ORTEC g v - i (143) wan32 G53W2.06 17-JAN-2014 09:18:10 Page 2
Energy Laboratory Spectrum name: 011614ipl7lcsdet1.An1

Activity range factor: 2.000
Min. step backg. energy 0.000

Corrections	Status	Comments
Decay correct to date:	YES	01-Feb-1997 16:00:00
Decay during acquisition:	NO	
Decay during collection:	NO	
True coincidence correction:	NO	
Peaked background correction:	YES	011108bkg1000mindet1.Pbc 15-Jan-2008 17:02:27
Absorption (Internal):	NO	
Geometry correction:	NO	
Random summing:	YES	Slope 1.0000E+00 Net factor 1.0000E+00

Energy Calibration
Normalized diff: 0.0981

***** S U M M A R Y O F N U C L I D E S I N S A M P L E *****

Nuclide		Time of Count Activity pCi/g	Time Corrected Activity pCi/g	Uncertainty Counting pCi/g	1 Sigma Total pCi/g	MDA
Ra-228	B<	1.4440E+00	1.1150E+01			
Ra-226	<	6.1892E+00	6.2348E+00			
Bi-214		7.7677E+00	7.8250E+00	4.8240E-01	4.9479E-01	7.156E-01
Pb-214		8.0222E+00	8.0814E+00	3.7933E-01	3.9600E-01	5.576E-01
Ir-192	B<	8.33E-02	>12 Halflives			
Sb-124	B<	1.27E-01	>12 Halflives			
Sc-46		1.0871E+00	>12 Halflives	1.6414E-01	1.6485E-01	3.728E-01
Pb-210	No in-range peaks					
Th-228	<	8.7290E+00	4.1053E+03			
Th-230	<	3.0449E+01	3.0454E+01			
Cs-137	<	2.2641E-01	3.3456E-01			
Co-60	B<	1.7837E-01	1.6584E+00			
Am-241	<	4.1258E-01	4.2395E-01			
K-40	<	2.4792E+00	2.4792E+00			
U-235	<	3.7080E-01	3.7080E-01			
Th-234	B<	2.44E+01	>12 Halflives			
Cs-134	<	2.2992E-01	6.8701E+01			
Pb-212	<	3.9927E-01	3.9927E-01			
Ra-224	<	6.97E+00	>12 Halflives			
I-131	B<	1.30E-01	>12 Halflives			
Mn-54	<	1.64E-01	>12 Halflives			
Tl-208	<	2.13E-01	>12 Halflives			
Bi-212	<	9.44E-01	>12 Halflives			
Ra-223	<	8.72E-01	>12 Halflives			
Pa-234	<	5.56E-01	>12 Halflives			
Eu-154	<	6.3805E-01	2.4260E+00			

ORTEC g v - i (143) wan32 G53W2.06 17-JAN-2014 09:18:10 Page 3

```
Eu-152  <    7.2676E-01    1.7551E+00
Na-22   <    1.7855E-01    1.6403E+00
Zn-65   <      6.40E-01 >12 Halflives
Ba-133  <    2.5399E-01    7.7793E-01
Ru-103 B<      8.33E-02 >12 Halflives
Be-7   B<      1.15E+00 >12 Halflives
I-125    No in-range peaks
Tl-201 B<      1.23E+00 >12 Halflives
Pa-234 B<      3.25E-01 >12 Halflives
Np-237 B<    1.2986E+00    1.2986E+00
Ce-144 B<      9.57E-01 >12 Halflives
Eu-155  <    5.4772E-01    5.8565E+00
  < - MDA value printed.
  A - Activity printed, but activity < MDA.
  B - Activity < MDA and failed test.
  C - Area < Critical level.
  F - Failed fraction or key line test.
  H - Halflife limit exceeded
---------------------------   S U M M A R Y   ----------------------------
Total Activity (   48.2 to  1980.2 keV) 1.5789982E+01  pCi/g
Total Decayed Activity (   48.2 to  1980.2 keV) 1.5906395E+01  pCi/g

*********  S U M M A R Y   O F   D I S C AR D E D   P E A K S  *********
  911.07 % Ra-228     969.10 % Ra-228    1001.00 % Th-234    1115.52 % Zn-65
 1173.00 % Co-60     1274.50 & Na-22     1274.54   Eu-154    1333.00 % Co-60
 1408.00 % Eu-152    1460.80 & K-40

  ! - Peak is part of a multiplet and this area went
      negative during deconvolution.
  ? - Peak is too narrow.
  @ - Peak is too wide at FW25M, but ok at FWHM.
  % - Peak fails sensitivity test.
  $ - Peak identified, but first peak of this nuclide
      failed one or more qualification tests.
  + - Peak activity higher than counting uncertainty range.
  - - Peak activity lower than counting uncertainty range.
  = - Peak outside analysis energy range.
  & - Calculated peak centroid is not close enough to the
      library energy centroid for positive identification.
  P - Peakbackground subtraction
```

- -

Analyzed by: _____
Dave Blaida

Reviewed by: _____
Supervisor

Laboratory: Energy Laboratory

```
 ORTEC     g v - i ( 143) wan32  G53W2.06  16-JAN-2014 15:48:12 Page    1
Energy Laboratory               Spectrum name: 011614blankdet1.An1


Sample description
     011614blankdet1


Spectrum Filename: C:\User\011614blankdet1.An1

Acquisition information
       Start time:                16-Jan-2014 14:31:23
       Live time:               3598
       Real time:               3600
       Dead time:                  0.05 %
       Detector ID:                   2

Detector system
     Det 1


Calibration
       Filename:                  julycc_5th_det1_169218.Clb
     12/10/13 calibration energy/efficiency
     IPL #1692-18  recal energy calibration perched

       Energy Calibration
            Created:              10-Dec-2013 10:50:03
            Zero offset:         -0.447 keV
            Gain:                 0.243 keV/channel
            Quadratic:            1.476E-09 keV/channel^2

       Efficiency Calibration
            Created:              26-Jul-2013 07:55:14
            Type:                 Polynomial
            Uncertainty:          1.391 %
            Coefficients:        -0.329484  -5.959887   0.633715
                                 -0.076489   0.004220  -0.000092

Library Files
       Main analysis library:     Norman.lib
       Library Match Width:       0.500

Analysis parameters
       Analysis engine:            wan32   G53W2.06
       Start channel:            200 (    48.19keV )
       Stop channel:            8144 (  1980.24keV )
       Peak rejection level:      20.000%
       Peak search sensitivity:   5
       Sample Size:               1.0000E+00
       Activity scaling factor:   2.7000E+01/(  1.0000E+00*  1.0000E+00) =
                                  2.7000E+01
       Detection limit method:    Nureg 4.16

       Random error:              1.0000000E+00
       Systematic error:          1.0000000E+00
       Fraction Limit:            0.000%
       Background width:          best method (based on spectrum).

       Half lives decay limit:   12.000
```

ORTEC g v - i (143) wan32 G53W2.06 16-JAN-2014 15:48:12 Page 2
Energy Laboratory Spectrum name: 011614blankdet1.An1

Activity range factor: 2.000
Min. step backg. energy 0.000

Corrections	Status	Comments
Decay correct to date:	YES	30-Apr-1999 12:00:00
Decay during acquisition:	YES	
Decay during collection:	NO	
True coincidence correction:	NO	
Peaked background correction:	YES	011108bkg1000mindet1.Pbc 15-Jan-2008 17:02:27
Absorption (Internal):	NO	
Geometry correction:	NO	
Random summing:	YES	Slope 1.0000E+00 Net factor 1.0000E+00

Energy Calibration
Normalized diff: 1.0000

- -

***** S U M M A R Y O F N U C L I D E S I N S A M P L E *****

Nuclide	Time of Count Activity pCi/l	Time Corrected Activity pCi/l	Uncertainty 2 Sigma Counting pCi/l	Total pCi/l	MDA
Ra-228 B<	1.9071E+02	1.1242E+03			
Ra-226 <	6.4834E+02	6.5249E+02			
Bi-214 B<	8.8903E+01	8.9472E+01			
Pb-214 <	7.4387E+01	7.4862E+01			
Ir-192 B<	7.35E+00	>12 Halflives			
Sb-124 B<	3.19E+01	>12 Halflives			
Sc-46 <	3.01E+01	>12 Halflives			
Pb-210	No in-range peaks				
Th-228 <	1.2075E+03	2.5197E+05			
Th-230 <	2.2300E+03	2.2303E+03			
Cs-137 <	2.2302E+01	3.1299E+01			
Co-60 B<	2.6796E+01	1.8559E+02			
Am-241 <	4.6072E+01	4.7172E+01			
K-40 <	4.0462E+02	4.0462E+02			
U-235 <	3.8968E+01	3.8968E+01			
Th-234 B<	2.62E+03	>12 Halflives			
Cs-134 <	2.8073E+01	3.9514E+03			
Pb-212 <	4.4432E+01	4.4432E+01			
Ra-224 <	4.82E+02	>12 Halflives			
I-131 B<	2.01E+01	>12 Halflives			
Mn-54 <	2.87E+01	>12 Halflives			
Tl-208 <	3.88E+01	>12 Halflives			
Bi-212 <	2.13E+02	>12 Halflives			
Ra-223 <	1.38E+02	>12 Halflives			
Pa-234 <	5.28E+01	>12 Halflives			
Eu-154 <	5.8463E+01	1.8634E+02			

ORTEC g v - i (143) wan32 G53W2.06 16-JAN-2014 15:48:12 Page 3

Eu-152	<	1.1862E+02	2.5497E+02
Na-22	<	2.6211E+01	1.3255E+03
Zn-65	<	6.29E+01	>12 Halflives
Ba-133	<	2.3187E+01	6.1259E+01
Ru-103	B<	2.32E+01	>12 Halflives
Be-7	B<	1.03E+02	>12 Halflives
I-125	No in-range peaks		
Tl-201	B<	1.16E+02	>12 Halflives
Pa-234	B<	4.14E+01	>12 Halflives
Np-237	B<	8.3617E+01	8.3618E+01
Ce-144	B<	1.06E+02	>12 Halflives
Eu-155	<	5.7604E+01	4.5043E+02

< - MDA value printed.
A - Activity printed, but activity < MDA.
B - Activity < MDA and failed test.
C - Area < Critical level.
F - Failed fraction or key line test.
H - Halflife limit exceeded

S U M M A R Y

Total Activity (48.2 to 1980.2 keV) 0.0000000E+00 pCi/l
Total Decayed Activity (48.2 to 1980.2 keV) 0.0000000E+00 pCi/l

********* S U M M A R Y O F D I S C AR D E D P E A K S *********

911.07	?	Ra-228	969.10	%	Ra-228	1001.00 ? Th-234	1115.52 % Zn-65
1120.51	%	Sc-46	1173.00	&	Co-60	1274.50 % Na-22	1274.54 ? Eu-154
1333.00	&	Co-60	1408.00	?	Eu-152	1460.80 % K-40	

! - Peak is part of a multiplet and this area went negative during deconvolution.
? - Peak is too narrow.
@ - Peak is too wide at FW25M, but ok at FWHM.
% - Peak fails sensitivity test.
$ - Peak identified, but first peak of this nuclide failed one or more qualification tests.
+ - Peak activity higher than counting uncertainty range.
- - Peak activity lower than counting uncertainty range.
= - Peak outside analysis energy range.
& - Calculated peak centroid is not close enough to the library energy centroid for positive identification.
P - Peakbackground subtraction

Analyzed by: _____
Dave Blaida

Reviewed by: _____
Supervisor

Laboratory: Energy Laboratory

ORTEC g v - i (143) wan32 G53W2.06 15-JAN-2014 11:01:56 Page 1
Energy Laboratory Spectrum name: C13120735.1.An1

Sample description
C13120735.1

Spectrum Filename: C:\User\C13120735.1.An1

Acquisition information
Start time: 15-Jan-2014 09:25:39
Live time: 3598
Real time: 3600
Dead time: 0.05 %
Detector ID: 2

Detector system
Det 1

Calibration
Filename: julycc_5th_det1_169218.Clb
12/10/13 calibration energy/efficiency
IPL #1692-18 recal energy calibration perched

Energy Calibration
Created: 10-Dec-2013 10:50:03
Zero offset: -0.447 keV
Gain: 0.243 keV/channel
Quadratic: 1.476E-09 keV/channel^2

Efficiency Calibration
Created: 26-Jul-2013 07:55:14
Type: Polynomial
Uncertainty: 1.391 %
Coefficients: -0.329484 -5.959887 0.633715
-0.076489 0.004220 -0.000092

Library Files
Main analysis library: Norman.lib
Library Match Width: 0.500

Analysis parameters
Analysis engine: wan32 G53W2.06
Start channel: 80 (19.01keV)
Stop channel: 8144 (1980.24keV)
Peak rejection level: 20.000%
Peak search sensitivity: 3
Sample Size: 1.7968E+02
Activity scaling factor: 2.7000E+01/(1.0000E+00* 1.7968E+02) =
1.5027E-01
Detection limit method: Nureg 4.16

Random error: 1.0000000E+00
Systematic error: 1.0000000E+00
Fraction Limit: 0.000%
Background width: best method (based on spectrum).

Half lives decay limit: 12.000

ORTEC g v - i (143) wan32 G53W2.06 15-JAN-2014 11:01:56 Page 2
Energy Laboratory Spectrum name: C13120735.1.An1

Activity range factor: 2.000
Min. step backg. energy 0.000

Corrections	Status	Comments
Decay correct to date:	YES	24-Dec-2013 12:00:00
Decay during acquisition:	YES	
Decay during collection:	NO	
True coincidence correction:	NO	
Peaked background correction:	YES	011108bkg1000mindet1.Pbc 15-Jan-2008 17:02:27
Absorption (Internal):	NO	
Geometry correction:	NO	
Random summing:	YES	Slope 1.0000E+00 Net factor 1.0000E+00

Energy Calibration
Normalized diff: 0.1945

***** S U M M A R Y O F N U C L I D E S I N S A M P L E *****

Nuclide		Time of Count Activity pCi/g	Time Corrected Activity pCi/g	Uncertainty Counting pCi/g	2 Sigma Total pCi/g	MDA
Ra-228	B<	1.8482E+00	1.8616E+00			
Ra-226	<	4.6075E+00	4.6076E+00			
Bi-214	#	1.4502E+00	1.4502E+00	5.7086E-01	5.7232E-01	5.900E-01
Pb-214	<	4.3494E-01	4.3495E-01			
Ir-192	B<	1.3999E-01	1.7184E-01			
Sb-124	B<	1.1214E-01	1.4428E-01			
Sc-46		4.4662E-01	5.3525E-01	1.9018E-01	1.9077E-01	1.039E-01
Pb-210	<	3.2127E+00	3.2187E+00			
Th-228	<	9.1301E+00	9.3309E+00			
Th-230	<	2.2478E+01	2.2478E+01			
Cs-137	<	1.2413E-01	1.2430E-01			
Co-60	B<	1.6203E-01	1.6331E-01			
Am-241	<	2.1997E-01	2.1999E-01			
K-40		1.3698E+01	1.3698E+01	3.0981E+00	3.1220E+00	2.252E+00
U-235	<	2.7634E-01	2.7634E-01			
Th-234	B<	1.4566E+01	2.7341E+01			
Cs-134	<	1.4424E-01	1.4717E-01			
Pb-212		1.2170E+00	1.2170E+00	2.4375E-01	2.4624E-01	2.769E-01
Ra-224	<	3.7563E+00	2.4849E+02			
I-131	B<	1.5263E-01	1.0077E+00			
Mn-54	<	1.4900E-01	1.5641E-01			
Tl-208	<	2.50E-01	>12 Halflives			
Bi-212	<	1.47E+00	>12 Halflives			
Ra-223	<	7.8605E-01	2.9651E+00			
Pa-234	<	3.76E-01	>12 Halflives			
Eu-154	<	3.2539E-01	3.2693E-01			

ORTEC g v - i (143) wan32 G53W2.06 15-JAN-2014 11:01:56 Page 3

Eu-152	<	8.0301E-01	8.0552E-01
Na-22	<	1.9556E-01	1.9871E-01
Zn-65	<	3.5671E-01	3.7957E-01
Ba-133	<	1.0334E-01	1.0375E-01
Ru-103	B<	1.8432E-01	2.7105E-01
Be-7	B<	7.3764E-01	9.8007E-01
I-125	B<	1.6428E+00	2.1143E+00
Tl-201	B<	9.3292E-01	1.3639E+02
Pa-234	B<	3.51E-01	>12 Halflives
Np-237	B<	1.0382E+00	1.0382E+00
Ce-144	B<	7.4386E-01	7.8464E-01
Eu-155	<	2.0129E-01	2.0298E-01

- All peaks for activity calculation had bad shape.
* - Activity omitted from total
& - Activity omitted from total and all peaks had bad shape.
< - MDA value printed.
A - Activity printed, but activity < MDA.
B - Activity < MDA and failed test.
C - Area < Critical level.
F - Failed fraction or key line test.
H - Halflife limit exceeded

------------------------- S U M M A R Y ---------------------------

Total Activity (19.0 to 1980.2 keV) 1.6811813E+01 pCi/g
Total Decayed Activity (19.0 to 1980.2 keV) 1.6900480E+01 pCi/g

********* S U M M A R Y O F D I S C A R D E D P E A K S *********

911.07 % Ra-228	969.10 % Ra-228	1001.00 % Th-234	1115.52 % Zn-65
1173.00 ? Co-60	1274.50 Na-22	1274.54 % Eu-154	1333.00 % Co-60
1408.00 ? Eu-152			

! - Peak is part of a multiplet and this area went negative during deconvolution.
? - Peak is too narrow.
@ - Peak is too wide at FW25M, but ok at FWHM.
% - Peak fails sensitivity test.
$ - Peak identified, but first peak of this nuclide failed one or more qualification tests.
+ - Peak activity higher than counting uncertainty range.
- - Peak activity lower than counting uncertainty range.
= - Peak outside analysis energy range.
& - Calculated peak centroid is not close enough to the library energy centroid for positive identification.
P - Peakbackground subtraction

- -

ORTEC g v - i (143) wan32 G53W2.06 15-JAN-2014 11:01:56 Page 4
Energy Laboratory Spectrum name: C13120735.1.An1

Analyzed by: ______________________________
Dave Blaida

Reviewed by: ______________________________

Supervisor

Laboratory: Energy Laboratory

```
 ORTEC     g v - i ( 143) wan32  G53W2.06  15-JAN-2014 12:08:56 Page    1
Energy Laboratory               Spectrum name: C13120735.2.An1


Sample description
     C13120735.2


Spectrum Filename: C:\User\C13120735.2.An1

Acquisition information
       Start time:                 15-Jan-2014 11:02:59
       Live time:                3598
       Real time:                3600
       Dead time:                   0.05 %
       Detector ID:                    2

Detector system
     Det 1


Calibration
       Filename:                   julycc_5th_det1_169218.Clb
     12/10/13 calibration energy/efficiency
     IPL #1692-18  recal energy calibration perched

       Energy Calibration
            Created:               10-Dec-2013 10:50:03
            Zero offset:          -0.447 keV
            Gain:                  0.243 keV/channel
            Quadratic:             1.476E-09 keV/channel^2

       Efficiency Calibration
            Created:               26-Jul-2013 07:55:14
            Type:                  Polynomial
            Uncertainty:           1.391 %
            Coefficients:         -0.329484  -5.959887   0.633715
                                  -0.076489   0.004220  -0.000092

Library Files
       Main analysis library:      Norman.lib
       Library Match Width:        0.500

Analysis parameters
       Analysis engine:            wan32   G53W2.06
       Start channel:             80 (    19.01keV )
       Stop channel:            8144 (  1980.24keV )
       Peak rejection level:      20.000%
       Peak search sensitivity:    3
       Sample Size:                1.8265E+02
       Activity scaling factor:    2.7000E+01/(  1.0000E+00*  1.8265E+02) =
                                   1.4782E-01
       Detection limit method:     Nureg 4.16

       Random error:               1.0000000E+00
       Systematic error:           1.0000000E+00
       Fraction Limit:             0.000%
       Background width:           best method (based on spectrum).

       Half lives decay limit:    12.000
```

ORTEC g v - i (143) wan32 G53W2.06 15-JAN-2014 12:08:56 Page 2
Energy Laboratory Spectrum name: C13120735.2.An1

Activity range factor: 2.000
Min. step backg. energy 0.000

Corrections	Status	Comments
Decay correct to date:	YES	24-Dec-2013 12:00:00
Decay during acquisition:	YES	
Decay during collection:	NO	
True coincidence correction:	NO	
Peaked background correction:	YES	011108bkg1000mindet1.Pbc 15-Jan-2008 17:02:27
Absorption (Internal):	NO	
Geometry correction:	NO	
Random summing:	YES	Slope 1.0000E+00 Net factor 1.0000E+00

Energy Calibration
Normalized diff: 0.1679

***** S U M M A R Y O F N U C L I D E S I N S A M P L E *****

Nuclide		Time of Count Activity pCi/g	Time Corrected Activity pCi/g	Uncertainty Counting pCi/g	2 Sigma Total pCi/g	MDA
Ra-228	B<	1.6083E+00	1.6200E+00			
Ra-226	<	4.3884E+00	4.3885E+00			
Bi-214		1.7316E+00	1.7316E+00	4.3648E-01	4.3919E-01	4.621E-01
Pb-214		1.5309E+00	1.5310E+00	3.7515E-01	3.7761E-01	5.171E-01
Ir-192	B<	1.1764E-01	1.4450E-01			
Sb-124	B<	1.5064E-01	1.9397E-01			
Sc-46	<	2.1036E-01	2.5224E-01			
Pb-210	<	3.2392E+00	3.2453E+00			
Th-228	<	8.8435E+00	9.0386E+00			
Th-230	<	2.7891E+01	2.7891E+01			
Cs-137	<	1.4136E-01	1.4155E-01			
Co-60	B<	1.4671E-01	1.4788E-01			
Am-241	<	3.1939E-01	3.1942E-01			
K-40		1.6544E+01	1.6544E+01	3.3574E+00	3.3895E+00	2.215E+00
U-235	<	2.5688E-01	2.5688E-01			
Th-234	B<	1.4330E+01	2.6949E+01			
Cs-134	<	1.5593E-01	1.5911E-01			
Pb-212		1.2510E+00	1.2510E+00	2.4742E-01	2.5002E-01	2.832E-01
Ra-224	<	4.1197E+00	2.7608E+02			
I-131	B<	2.0739E-01	1.3773E+00			
Mn-54	<	2.1459E-01	2.2529E-01			
Tl-208	#H	4.2052E-01	>12 Halflives	1.6758E-01	1.6799E-01	1.890E-01
Bi-212	<	1.24E+00	>12 Halflives			
Ra-223	<	9.1294E-01	3.4579E+00			
Pa-234	<	4.03E-01	>12 Halflives			
Eu-154	<	3.2010E-01	3.2162E-01			

ORTEC g v - i (143) wan32 G53W2.06 15-JAN-2014 12:08:56 Page 3

Eu-152	<	6.4945E-01	6.5148E-01
Na-22	<	1.2437E-01	1.2638E-01
Zn-65	<	5.1347E-01	5.4647E-01
Ba-133	<	1.3412E-01	1.3465E-01
Ru-103	B<	7.4410E-02	1.0955E-01
Be-7	B<	8.2648E-01	1.0991E+00
I-125	B<	1.7443E+00	2.2466E+00
Tl-201	B<	7.9603E-01	1.1818E+02
Pa-234	B<	3.88E-01	>12 Halflives
Np-237	B<	9.9616E-01	9.9616E-01
Ce-144	B<	6.2688E-01	6.6136E-01
Eu-155	<	3.9468E-01	3.9801E-01

- All peaks for activity calculation had bad shape.
* - Activity omitted from total
& - Activity omitted from total and all peaks had bad shape.
< - MDA value printed.
A - Activity printed, but activity < MDA.
B - Activity < MDA and failed test.
C - Area < Critical level.
F - Failed fraction or key line test.
H - Halflife limit exceeded

----------------------------- S U M M A R Y -----------------------------

Total Activity (19.0 to 1980.2 keV) 2.1058031E+01 pCi/g
Total Decayed Activity (19.0 to 1980.2 keV) 2.1058117E+01 pCi/g

********* S U M M A R Y O F D I S C AR D E D P E A K S *********

911.07 % Ra-228	969.10 % Ra-228	1001.00 % Th-234	1115.52 % Zn-65
1120.51 % Sc-46	1173.00 ? Co-60	1274.50 ? Na-22	1274.54 ? Eu-154
1333.00 % Co-60	1408.00 ? Eu-152		

! - Peak is part of a multiplet and this area went negative during deconvolution.
? - Peak is too narrow.
@ - Peak is too wide at FW25M, but ok at FWHM.
% - Peak fails sensitivity test.
$ - Peak identified, but first peak of this nuclide failed one or more qualification tests.
+ - Peak activity higher than counting uncertainty range.
- - Peak activity lower than counting uncertainty range.
= - Peak outside analysis energy range.
& - Calculated peak centroid is not close enough to the library energy centroid for positive identification.
P - Peakbackground subtraction

- -

□

Analyzed by: ______________________________
Dave Blaida

Reviewed by: ______________________________

Supervisor

Laboratory: Energy Laboratory

ORTEC g v - i (2191) wan32 G53W2.06 15-JAN-2014 13:22:47 Page 1
Energy Laboratory Spectrum name: C13120735.3.An1

Sample description
C13120735.3

Spectrum Filename: C:\User\C13120735.3.An1

Acquisition information
Start time: 15-Jan-2014 12:09:51
Live time: 3598
Real time: 3600
Dead time: 0.05 %
Detector ID: 2

Detector system
Det 1

Calibration
Filename: julycc_5th_det1_169218.clb
12/10/13 calibration energy/efficiency
IPL #1692-18 recal energy calibration perched

Energy Calibration
Created: 10-Dec-2013 10:50:03
Zero offset: -0.447 keV
Gain: 0.243 keV/channel
Quadratic: 1.476E-09 keV/channel^2

Efficiency Calibration
Created: 26-Jul-2013 07:55:14
Type: Polynomial
Uncertainty: 1.391 %
Coefficients: -0.329484 -5.959887 0.633715
-0.076489 0.004220 -0.000092

Library Files
Main analysis library: Norman.lib
Library Match Width: 0.500

Analysis parameters
Analysis engine: wan32 G53W2.06
Start channel: 80 (19.01keV)
Stop channel: 8144 (1980.24keV)
Peak rejection level: 20.000%
Peak search sensitivity: 3
Sample Size: 1.8485E+02
Activity scaling factor: 2.7000E+01/(1.0000E+00* 1.8485E+02) =
1.4606E-01
Detection limit method: Nureg 4.16

Random error: 1.0000000E+00
Systematic error: 1.0000000E+00
Fraction Limit: 0.000%
Background width: best method (based on spectrum).

Half lives decay limit: 12.000

Activity range factor: 2.000
Min. step backg. energy 0.000

Corrections	Status	Comments
Decay correct to date:	YES	24-Dec-2013 12:00:00
Decay during acquisition:	YES	
Decay during collection:	NO	
True coincidence correction:	NO	
Peaked background correction:	YES	011108bkg1000mindet1.Pbc 15-Jan-2008 17:02:27
Absorption (Internal):	NO	
Geometry correction:	NO	
Random summing:	YES	Slope 1.0000E+00 Net factor 1.0000E+00

Energy Calibration
Normalized diff: 0.1628

***** S U M M A R Y O F N U C L I D E S I N S A M P L E *****

Nuclide		Time of Count Activity pCi/g	Time Corrected Activity pCi/g	Uncertainty Counting pCi/g	2 Sigma Total pCi/g	MDA pCi/g
Ra-228	B	1.0175E+00	1.0249E+00	4.2980E-01	4.3076E-01	1.596E+00
Ra-226	A	1.0753E+00	1.0753E+00	2.5841E+00	2.5843E+00	4.374E+00
Bi-214	F	1.0138E+00	1.0138E+00	5.2236E-01	5.2314E-01	6.251E-01
Pb-214		1.3547E+00	1.3548E+00	3.5972E-01	3.6174E-01	3.989E-01
Ir-192	#B	2.9675E-02	3.6467E-02	8.3077E-02	8.3084E-02	1.070E-01
Sb-124	F	2.3244E-01	2.9947E-01	2.1391E-01	2.1408E-01	1.866E-01
Sc-46	A	1.2014E-01	1.4412E-01	1.2256E-01	1.2263E-01	2.564E-01
Pb-210	#	4.8133E+00	4.8224E+00	2.4816E+00	2.4841E+00	2.964E+00
Th-228	#A	-1.7011E+00	-1.7387E+00	-3.5183E+01	-3.5183E+01	7.146E+00
Th-230	#A	3.8395E+00	3.8395E+00	1.3300E+01	1.3301E+01	2.303E+01
Cs-137	#A	-1.7392E-02	-1.7417E-02	1.7535E+02	1.7535E+02	1.207E-01
Co-60	#B	-3.0352E-02	-3.0593E-02	1.9464E+02	1.9464E+02	1.450E-01
Am-241	#A	-6.6988E-03	-6.6995E-03	-2.3306E-01	-2.3306E-01	2.394E-01
K-40		1.4911E+01	1.4911E+01	3.1761E+00	3.2037E+00	2.189E+00
U-235	A	6.6520E-02	6.6520E-02	1.4739E-01	1.4740E-01	2.685E-01
Th-234	F	4.8029E+01	9.0446E+01	3.6178E+01	3.6361E+01	1.416E+01
Cs-134	#A	6.0777E-02	6.2020E-02	8.7992E-02	8.8009E-02	1.584E-01
Pb-212		1.1764E+00	1.1764E+00	2.2946E-01	2.3194E-01	2.505E-01
Ra-224	A	1.1179E+00	7.5586E+01	1.3076E+02	1.3078E+02	3.283E+00
I-131	B	1.0074E-01	6.7169E-01	6.1699E-01	6.1728E-01	1.146E-01
Mn-54	#A	1.3251E-01	1.3914E-01	1.3770E-01	1.3775E-01	1.927E-01
Tl-208	H	4.4050E-01	>12 Halflives	1.6345E-01	1.6392E-01	1.828E-01
Bi-212	#	2.3745E+00	>12 Halflives	1.2697E+00	1.2715E+00	1.322E+00
Ra-223	A	8.1633E-01	3.1007E+00	3.1306E+00	3.1319E+00	9.920E-01
Pa-234	A	3.9910E-02	>12 Halflives	2.0733E-01	2.0733E-01	3.700E-01
Eu-154	A	0.0000E+00	0.0000E+00	1.3165E+03	1.3165E+03	7.163E-01

Eu-152	#A	5.0665E-02	5.0823E-02	7.1392E-02	7.1406E-02	8.198E-01
Na-22	#A	1.1877E-01	1.2069E-01	9.3826E-02	9.3887E-02	1.229E-01
Zn-65	A	1.9570E-02	2.0830E-02	1.8112E-01	1.8112E-01	3.609E-01
Ba-133	A	1.1495E-01	1.1541E-01	1.3362E-01	1.3366E-01	1.835E-01
Ru-103	#B	3.1622E-02	4.6596E-02	8.5072E-02	8.5093E-02	9.510E-02
Be-7	#B	0.0000E+00	0.0000E+00	1.0601E+03	1.0601E+03	5.944E-01
I-125	F	1.8410E+00	2.3726E+00	1.7508E+00	1.7530E+00	1.723E+00
Tl-201	#B	3.8069E-01	5.7117E+01	8.9264E+01	8.9294E+01	8.709E-01
Pa-234	#B	8.3680E-02	>12 Halflives	1.6104E-01	1.6107E-01	2.741E-01
Np-237	#B	0.0000E+00	0.0000E+00	1.2810E+03	1.2810E+03	8.773E-01
Ce-144	F	1.3371E+00	1.4108E+00	1.0913E+00	1.0920E+00	8.481E-01
Eu-155	A	0.0000E+00	0.0000E+00	3.3163E+02	3.3163E+02	2.031E-01

- All peaks for activity calculation had bad shape.
* - Activity omitted from total
& - Activity omitted from total and all peaks had bad shape.
< - MDA value printed.
A - Activity printed, but activity < MDA.
B - Activity < MDA and failed test.
C - Area < Critical level.
F - Failed fraction or key line test.
H - Halflife limit exceeded

---------- S U M M A R Y ----------

Total Activity (19.0 to 1980.2 keV) 1.7442120E+01 pCi/g
Total Decayed Activity (19.0 to 1980.2 keV) 1.7442156E+01 pCi/g

********* S U M M A R Y O F D I S C A R D E D P E A K S *********
1173.00 - Co-60

! - Peak is part of a multiplet and this area went negative during deconvolution.
? - Peak is too narrow.
@ - Peak is too wide at FW25M, but ok at FWHM.
% - Peak fails sensitivity test.
$ - Peak identified, but first peak of this nuclide failed one or more qualification tests.
+ - Peak activity higher than counting uncertainty range.
- - Peak activity lower than counting uncertainty range.
= - Peak outside analysis energy range.
& - Calculated peak centroid is not close enough to the library energy centroid for positive identification.
P - Peakbackground subtraction

- -

Analyzed by: _____
Dave Blaida

Reviewed by: _____
Supervisor

ORTEC g v - i (2191) wan32 G53W2.06 15-JAN-2014 13:22:47 Page 4
Energy Laboratory Spectrum name: C13120735.3.An1

Laboratory: Energy Laboratory

```
 ORTEC     g v - i (2191) wan32  G53W2.06  15-JAN-2014 14:32:39 Page    1
Energy Laboratory               Spectrum name: C13120735.4.An1


Sample description
     C13120735.4


Spectrum Filename: C:\User\C13120735.4.An1

Acquisition information
       Start time:                 15-Jan-2014 13:25:02
       Live time:                3598
       Real time:                3600
       Dead time:                  0.05 %
       Detector ID:                   2

Detector system
     Det 1


Calibration
       Filename:                   julycc_5th_det1_169218.Clb
     12/10/13 calibration energy/efficiency
     IPL #1692-18  recal energy calibration perched

       Energy Calibration
            Created:               10-Dec-2013 10:50:03
            Zero offset:          -0.447 keV
            Gain:                  0.243 keV/channel
            Quadratic:             1.476E-09 keV/channel^2

       Efficiency Calibration
            Created:               26-Jul-2013 07:55:14
            Type:                  Polynomial
            Uncertainty:           1.391 %
            Coefficients:         -0.329484  -5.959887   0.633715
                                  -0.076489   0.004220  -0.000092

Library Files
       Main analysis library:      Norman.lib
       Library Match Width:        0.500

Analysis parameters
       Analysis engine:            wan32   G53W2.06
       Start channel:             80 (    19.01keV )
       Stop channel:            8144 (  1980.24keV )
       Peak rejection level:      20.000%
       Peak search sensitivity:    3
       Sample Size:                1.9365E+02
       Activity scaling factor:    2.7000E+01/(  1.0000E+00*  1.9365E+02) =
                                   1.3943E-01
       Detection limit method:     Nureg 4.16

       Random error:               1.0000000E+00
       Systematic error:           1.0000000E+00
       Fraction Limit:             0.000%
       Background width:           best method (based on spectrum).

       Half lives decay limit:    12.000
```

ORTEC g v - i (2191) wan32 G53W2.06 15-JAN-2014 14:32:39 Page 2
Energy Laboratory Spectrum name: C13120735.4.An1

Activity range factor: 2.000
Min. step backg. energy 0.000

Corrections	Status	Comments
Decay correct to date:	YES	24-Dec-2013 12:00:00
Decay during acquisition:	YES	
Decay during collection:	NO	
True coincidence correction:	NO	
Peaked background correction:	YES	011108bkg1000mindet1.Pbc 15-Jan-2008 17:02:27
Absorption (Internal):	NO	
Geometry correction:	NO	
Random summing:	YES	Slope 1.0000E+00 Net factor 1.0000E+00

Energy Calibration
Normalized diff: 0.1902

***** S U M M A R Y O F N U C L I D E S I N S A M P L E *****

Nuclide		Time of Count Activity pCi/g	Time Corrected Activity pCi/g	Uncertainty Counting 2 Sigma pCi/g	Total pCi/g	MDA pCi/g
Ra-228	F	1.5019E+00	1.5129E+00	5.0740E-01	5.0918E-01	1.391E+00
Ra-226	#A	0.0000E+00	0.0000E+00	1.0201E+04	1.0201E+04	4.407E+00
Bi-214	#F	1.0410E+00	1.0411E+00	4.3292E-01	4.3391E-01	5.154E-01
Pb-214		9.1519E-01	9.1522E-01	3.9976E-01	4.0059E-01	5.229E-01
Ir-192	#F	1.9056E-01	2.3429E-01	1.6366E-01	1.6379E-01	1.454E-01
Sb-124	#B	7.7922E-02	1.0045E-01	1.5541E-01	1.5544E-01	1.653E-01
Sc-46	A	2.0485E-01	2.4584E-01	1.7851E-01	1.7865E-01	2.114E-01
Pb-210	#A	4.7155E-01	4.7244E-01	1.9244E+00	1.9244E+00	2.974E+00
Th-228	A	1.2386E+00	1.2660E+00	4.2403E+00	4.2404E+00	7.418E+00
Th-230	A	1.9954E+01	1.9954E+01	2.0134E+01	2.0139E+01	2.780E+01
Cs-137	#A	-1.2298E-04	-1.2315E-04	-5.4012E-02	-5.4012E-02	1.300E-01
Co-60	#B	3.1419E-02	3.1670E-02	6.0874E-02	6.0880E-02	1.384E-01
Am-241	#A	-6.3944E-03	-6.3950E-03	-1.4728E-01	-1.4728E-01	1.747E-01
K-40		1.4081E+01	1.4081E+01	3.0164E+00	3.0423E+00	2.090E+00
U-235		2.7985E-01	2.7985E-01	1.5949E-01	1.5969E-01	2.183E-01
Th-234	B	2.0172E+01	3.8045E+01	3.6928E+01	3.6960E+01	2.408E+01
Cs-134	#A	2.7246E-02	2.7805E-02	8.3260E-02	8.3264E-02	1.589E-01
Pb-212		9.9776E-01	9.9776E-01	2.2606E-01	2.2787E-01	2.780E-01
Ra-224	A	1.9878E+00	1.3575E+02	1.4981E+02	1.4985E+02	3.606E+00
I-131	#B	3.7509E-02	2.5122E-01	6.7715E-01	6.7718E-01	1.093E-01
Mn-54	#A	1.3640E-02	1.4323E-02	6.7375E-02	6.7376E-02	1.513E-01
Tl-208	H	4.9055E-01	>12 Halflives	2.0251E-01	2.0298E-01	2.248E-01
Bi-212	#A	4.1287E-01	>12 Halflives	7.5621E-01	7.5629E-01	1.304E+00
Ra-223	A	4.1450E-01	1.5794E+00	2.2687E+00	2.2692E+00	8.250E-01
Pa-234	A	1.2502E-01	>12 Halflives	2.2146E-01	2.2149E-01	3.771E-01
Eu-154	#A	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	3.019E-01

ORTEC g v - i (2191) wan32 G53W2.06 15-JAN-2014 14:32:39 Page 3

Eu-152	#A	1.2769E-01	1.2809E-01	2.6402E-01	2.6404E-01	6.126E-01
Na-22	#A	-1.8829E-02	-1.9135E-02	1.4895E+02	1.4895E+02	1.173E-01
Zn-65	#A	-1.0082E-02	-1.0733E-02	-5.3676E-01	-5.3676E-01	5.235E-01
Ba-133	#A	2.7590E-02	2.7700E-02	9.9994E-02	9.9997E-02	1.675E-01
Ru-103	#B	1.5093E-02	2.2260E-02	6.2960E-02	6.2966E-02	8.136E-02
Be-7	#B	1.1999E+00	1.5977E+00	1.6667E+00	1.6679E+00	1.383E+00
I-125	#B	9.5856E-01	1.2361E+00	1.8354E+00	1.8360E+00	1.958E+00
Tl-201	#B	5.0705E-02	7.6987E+00	5.3059E+01	5.3060E+01	6.101E-01
Pa-234	#B	2.0857E-01	>12 Halflives	2.9556E-01	2.9566E-01	3.762E-01
Np-237	#B	0.0000E+00	0.0000E+00	1.2814E+03	1.2814E+03	8.754E-01
Ce-144	F	2.2833E+00	2.4094E+00	1.5329E+00	1.5344E+00	6.075E-01
Eu-155	A	9.7986E-02	9.8817E-02	1.1998E-01	1.2000E-01	2.634E-01

- All peaks for activity calculation had bad shape.
* - Activity omitted from total
& - Activity omitted from total and all peaks had bad shape.
< - MDA value printed.
A - Activity printed, but activity < MDA.
B - Activity < MDA and failed test.
C - Area < Critical level.
F - Failed fraction or key line test.
H - Halflife limit exceeded

---------- S U M M A R Y ----------

Total Activity (19.0 to 1980.2 keV) 1.5078738E+01 pCi/g
Total Decayed Activity (19.0 to 1980.2 keV) 1.5078738E+01 pCi/g

********* S U M M A R Y O F D I S C A R D E D P E A K S *********
1173.00 + Co-60

! - Peak is part of a multiplet and this area went negative during deconvolution.
? - Peak is too narrow.
@ - Peak is too wide at FW25M, but ok at FWHM.
% - Peak fails sensitivity test.
$ - Peak identified, but first peak of this nuclide failed one or more qualification tests.
+ - Peak activity higher than counting uncertainty range.
- - Peak activity lower than counting uncertainty range.
= - Peak outside analysis energy range.
& - Calculated peak centroid is not close enough to the library energy centroid for positive identification.
P - Peakbackground subtraction

Analyzed by: _____
Dave Blaida

Reviewed by: _____
Supervisor

ORTEC g v - i (2191) wan32 G53W2.06 15-JAN-2014 14:32:39 Page 4
Energy Laboratory Spectrum name: C13120735.4.An1

Laboratory: Energy Laboratory

ORTEC g v - i (2191) wan32 G53W2.06 15-JAN-2014 15:43:24 Page 1
Energy Laboratory Spectrum name: C13120735.5.An1

Sample description
C13120735.5

Spectrum Filename: C:\User\C13120735.5.An1

Acquisition information
Start time: 15-Jan-2014 14:33:15
Live time: 3598
Real time: 3600
Dead time: 0.05 %
Detector ID: 2

Detector system
Det 1

Calibration
Filename: julycc_5th_det1_169218.Clb
12/10/13 calibration energy/efficiency
IPL #1692-18 recal energy calibration perched

Energy Calibration
Created: 10-Dec-2013 10:50:03
Zero offset: -0.447 keV
Gain: 0.243 keV/channel
Quadratic: 1.476E-09 keV/channel^2

Efficiency Calibration
Created: 26-Jul-2013 07:55:14
Type: Polynomial
Uncertainty: 1.391 %
Coefficients: -0.329484 -5.959887 0.633715
-0.076489 0.004220 -0.000092

Library Files
Main analysis library: Norman.lib
Library Match Width: 0.500

Analysis parameters
Analysis engine: wan32 G53W2.06
Start channel: 80 (19.01keV)
Stop channel: 8144 (1980.24keV)
Peak rejection level: 20.000%
Peak search sensitivity: 3
Sample Size: 1.9061E+02
Activity scaling factor: 2.7000E+01/(1.0000E+00* 1.9061E+02) =
1.4165E-01
Detection limit method: Nureg 4.16

Random error: 1.0000000E+00
Systematic error: 1.0000000E+00
Fraction Limit: 0.000%
Background width: best method (based on spectrum).

Half lives decay limit: 12.000

ORTEC g v - i (2191) wan32 G53W2.06 15-JAN-2014 15:43:24 Page 2
Energy Laboratory Spectrum name: C13120735.5.An1

Activity range factor: 2.000
Min. step backg. energy 0.000

Corrections	Status	Comments
Decay correct to date:	YES	24-Dec-2013 12:00:00
Decay during acquisition:	YES	
Decay during collection:	NO	
True coincidence correction:	NO	
Peaked background correction:	YES	011108bkg1000mindet1.Pbc 15-Jan-2008 17:02:27
Absorption (Internal):	NO	
Geometry correction:	NO	
Random summing:	YES	Slope 1.0000E+00 Net factor 1.0000E+00

Energy Calibration
Normalized diff: 0.1184

***** S U M M A R Y O F N U C L I D E S I N S A M P L E *****

Nuclide		Time of Count Activity pCi/g	Time Corrected Activity pCi/g	Uncertainty Counting pCi/g	2 Sigma Total pCi/g	MDA pCi/g
Ra-228	F	1.2438E+00	1.2529E+00	4.3050E-01	4.3194E-01	1.106E+00
Ra-226	A	1.2185E+00	1.2185E+00	2.4344E+00	2.4347E+00	4.099E+00
Bi-214		1.0577E+00	1.0577E+00	4.0241E-01	4.0351E-01	4.888E-01
Pb-214		1.0505E+00	1.0505E+00	3.8949E-01	3.9061E-01	4.581E-01
Ir-192	F	1.7006E-01	2.0917E-01	1.5831E-01	1.5842E-01	1.444E-01
Sb-124	#B	1.4491E-01	1.8692E-01	2.0472E-01	2.0479E-01	1.853E-01
Sc-46		3.1358E-01	3.7647E-01	2.2197E-01	2.2222E-01	2.541E-01
Pb-210	#	4.2871E+00	4.2952E+00	2.1865E+00	2.1888E+00	2.789E+00
Th-228	A	3.4030E+00	3.4786E+00	5.2287E+00	5.2293E+00	8.753E+00
Th-230	#A	2.5858E+00	2.5858E+00	9.6696E+00	9.6698E+00	1.774E+01
Cs-137	#A	-1.0170E-02	-1.0184E-02	-1.3507E-01	-1.3507E-01	1.320E-01
Co-60	#B	-2.9435E-02	-2.9670E-02	1.8877E+02	1.8877E+02	1.406E-01
Am-241	#A	4.5271E-02	4.5275E-02	1.5724E-01	1.5725E-01	2.753E-01
K-40	#	1.4925E+01	1.4925E+01	3.1265E+00	3.1546E+00	2.123E+00
U-235	A	1.1379E-01	1.1379E-01	1.3715E-01	1.3718E-01	2.455E-01
Th-234	B	4.3751E+00	8.2625E+00	3.9049E+00	3.9191E+00	1.733E+01
Cs-134	#	2.1524E-01	2.1966E-01	1.6050E-01	1.6062E-01	1.923E-01
Pb-212		1.3257E+00	1.3257E+00	2.5651E-01	2.5932E-01	3.008E-01
Ra-224	A	1.7243E+00	1.1883E+02	1.5960E+02	1.5963E+02	3.855E+00
I-131	#B	4.6719E-02	3.1419E-01	6.8476E-01	6.8481E-01	1.589E-01
Mn-54	#A	1.3858E-02	1.4554E-02	9.8855E-02	9.8856E-02	1.793E-01
Tl-208	H	5.2716E-01	>12 Halflives	1.8575E-01	1.8634E-01	2.043E-01
Bi-212	#	2.1217E+00	>12 Halflives	1.3782E+00	1.3794E+00	1.583E+00
Ra-223	#A	7.2763E-01	2.7805E+00	2.3522E+00	2.3535E+00	8.146E-01
Pa-234	A	1.1863E-01	>12 Halflives	2.2587E-01	2.2590E-01	3.861E-01
Eu-154	#A	2.4971E-01	2.5091E-01	2.8972E-01	2.8981E-01	3.871E-01

Eu-152	#A	-1.0183E-01	-1.0215E-01	7.8384E+02	7.8384E+02	6.223E-01
Na-22	#A	-1.9129E-02	-1.9440E-02	7.9817E+02	7.9817E+02	3.123E-01
Zn-65	A	7.5285E-02	8.0157E-02	2.0659E-01	2.0660E-01	3.712E-01
Ba-133	A	7.6923E-03	7.7231E-03	2.6268E-02	2.6269E-02	1.104E-01
Ru-103	#B	9.2002E-02	1.3580E-01	1.5681E-01	1.5691E-01	1.280E-01
Be-7	#B	3.7191E-01	4.9552E-01	7.5992E-01	7.6018E-01	9.322E-01
I-125	#	4.3055E+00	5.5549E+00	2.2112E+00	2.2207E+00	1.845E+00
Tl-201	#B	1.5025E-01	2.3060E+01	5.8025E+01	5.8033E+01	6.349E-01
Pa-234	#B	8.1153E-02	>12 Halflives	1.9057E-01	1.9059E-01	3.032E-01
Np-237	#B	0.0000E+00	0.0000E+00	1.2783E+03	1.2783E+03	8.742E-01
Ce-144	F	1.9611E+00	2.0697E+00	1.6391E+00	1.6402E+00	7.315E-01
Eu-155	#A	6.7897E-02	6.8474E-02	1.8216E-01	1.8216E-01	3.015E-01

- All peaks for activity calculation had bad shape.
* - Activity omitted from total
& - Activity omitted from total and all peaks had bad shape.
< - MDA value printed.
A - Activity printed, but activity < MDA.
B - Activity < MDA and failed test.
C - Area < Critical level.
F - Failed fraction or key line test.
H - Halflife limit exceeded

---------- S U M M A R Y ----------

Total Activity (19.0 to 1980.2 keV) 2.2664307E+01 pCi/g
Total Decayed Activity (19.0 to 1980.2 keV) 2.3913780E+01 pCi/g

********* S U M M A R Y O F D I S C A R D E D P E A K S *********
1173.00 & Co-60

! - Peak is part of a multiplet and this area went negative during deconvolution.
? - Peak is too narrow.
@ - Peak is too wide at FW25M, but ok at FWHM.
% - Peak fails sensitivity test.
$ - Peak identified, but first peak of this nuclide failed one or more qualification tests.
+ - Peak activity higher than counting uncertainty range.
- - Peak activity lower than counting uncertainty range.
= - Peak outside analysis energy range.
& - Calculated peak centroid is not close enough to the library energy centroid for positive identification.
P - Peakbackground subtraction

- -

Analyzed by: _____
Dave Blaida

Reviewed by: _____
Supervisor

Laboratory: Energy Laboratory

ORTEC g v - i (2191) wan32 G53W2.06 16-JAN-2014 08:59:33 Page 1
Energy Laboratory Spectrum name: C13120735.6.An1

Sample description
C13120735.6

Spectrum Filename: C:\User\C13120735.6.An1

Acquisition information
Start time: 15-Jan-2014 15:44:05
Live time: 3598
Real time: 3600
Dead time: 0.05 %
Detector ID: 2

Detector system
Det 1

Calibration
Filename: julycc_5th_det1_169218.Clb
12/10/13 calibration energy/efficiency
IPL #1692-18 recal energy calibration perched

Energy Calibration
Created: 10-Dec-2013 10:50:03
Zero offset: -0.447 keV
Gain: 0.243 keV/channel
Quadratic: 1.476E-09 keV/channel^2

Efficiency Calibration
Created: 26-Jul-2013 07:55:14
Type: Polynomial
Uncertainty: 1.391 %
Coefficients: -0.329484 -5.959887 0.633715
-0.076489 0.004220 -0.000092

Library Files
Main analysis library: Norman.lib
Library Match Width: 0.500

Analysis parameters
Analysis engine: wan32 G53W2.06
Start channel: 80 (19.01keV)
Stop channel: 8144 (1980.24keV)
Peak rejection level: 20.000%
Peak search sensitivity: 3
Sample Size: 1.8178E+02
Activity scaling factor: 2.7000E+01/(1.0000E+00* 1.8178E+02) =
1.4853E-01
Detection limit method: Nureg 4.16

Random error: 1.0000000E+00
Systematic error: 1.0000000E+00
Fraction Limit: 0.000%
Background width: best method (based on spectrum).

Half lives decay limit: 12.000

ORTEC g v - i (2191) wan32 G53W2.06 16-JAN-2014 08:59:33 Page 2
Energy Laboratory Spectrum name: C13120735.6.An1

Activity range factor: 2.000
Min. step backg. energy 0.000

Corrections	Status	Comments
Decay correct to date:	YES	24-Dec-2013 12:00:00
Decay during acquisition:	YES	
Decay during collection:	NO	
True coincidence correction:	NO	
Peaked background correction:	YES	011108bkg1000mindet1.Pbc 15-Jan-2008 17:02:27
Absorption (Internal):	NO	
Geometry correction:	NO	
Random summing:	YES	Slope 1.0000E+00 Net factor 1.0000E+00

Energy Calibration
Normalized diff: 0.1477

***** S U M M A R Y O F N U C L I D E S I N S A M P L E *****

Nuclide		Time of Count Activity pCi/g	Time Corrected Activity pCi/g	Uncertainty Counting pCi/g	2 Sigma Total pCi/g	MDA pCi/g
Ra-228	F	1.3845E+00	1.3947E+00	5.4563E-01	5.4703E-01	1.201E+00
Ra-226	A	9.1778E-01	9.1781E-01	2.3961E+00	2.3963E+00	4.076E+00
Bi-214	F	9.6484E-01	9.6486E-01	4.3882E-01	4.3966E-01	5.420E-01
Pb-214		1.0190E+00	1.0191E+00	3.7961E-01	3.8069E-01	4.415E-01
Ir-192	#B	9.1446E-02	1.1253E-01	1.1423E-01	1.1427E-01	1.213E-01
Sb-124	#B	2.5325E-02	3.2685E-02	9.4980E-02	9.4984E-02	1.341E-01
Sc-46		2.9521E-01	3.5457E-01	1.7965E-01	1.7993E-01	1.645E-01
Pb-210	A	1.8806E+00	1.8841E+00	2.4627E+00	2.4631E+00	3.444E+00
Th-228	A	1.3884E+00	1.4193E+00	4.8251E+00	4.8252E+00	8.381E+00
Th-230	A	7.8088E+00	7.8088E+00	1.6565E+01	1.6566E+01	2.525E+01
Cs-137	#A	9.9936E-02	1.0008E-01	8.5331E-02	8.5378E-02	1.205E-01
Co-60	#B	6.5640E-02	6.6166E-02	7.9427E-02	7.9449E-02	1.474E-01
Am-241	#A	9.3997E-02	9.4006E-02	2.3684E-01	2.3685E-01	3.440E-01
K-40		1.4514E+01	1.4514E+01	3.1639E+00	3.1901E+00	2.226E+00
U-235	A	6.8922E-02	6.8922E-02	1.2496E-01	1.2498E-01	2.340E-01
Th-234	F	2.3444E+01	4.4337E+01	2.5598E+01	2.5660E+01	1.440E+01
Cs-134	#A	-2.0141E-02	-2.0556E-02	-2.2339E-01	-2.2339E-01	1.567E-01
Pb-212		1.2543E+00	1.2543E+00	2.4898E-01	2.5157E-01	2.859E-01
Ra-224	A	1.3913E+00	9.6791E+01	1.5569E+02	1.5572E+02	3.769E+00
I-131	#B	9.6040E-02	6.4863E-01	7.4025E-01	7.4047E-01	1.520E-01
Mn-54	#A	-3.6472E-02	-3.8308E-02	-1.9915E-01	-1.9915E-01	1.578E-01
Tl-208	H	4.3524E-01	>12 Halflives	2.4419E-01	2.4450E-01	2.704E-01
Bi-212	#	2.5285E+00	>12 Halflives	1.7707E+00	1.7721E+00	1.884E+00
Ra-223	#A	-9.0902E-02	-3.4840E-01	2.9423E+03	2.9423E+03	4.839E-01
Pa-234	A	1.6786E-01	>12 Halflives	2.0745E-01	2.0750E-01	3.444E-01
Eu-154	#A	3.9041E-02	3.9228E-02	8.3950E-02	8.3958E-02	3.531E-01

ORTEC g v - i (2191) wan32 G53W2.06 16-JAN-2014 08:59:33 Page 3

Eu-152	#A	4.5979E-01	4.6124E-01	4.2964E-01	4.2983E-01	6.526E-01
Na-22	#A	-9.6261E-03	-9.7831E-03	-1.0255E-01	-1.0255E-01	1.603E-01
Zn-65	A	2.9329E-01	3.1231E-01	2.9700E-01	2.9713E-01	4.408E-01
Ba-133	A	6.3264E-02	6.3518E-02	1.2113E-01	1.2114E-01	1.928E-01
Ru-103	#B	6.0294E-02	8.9077E-02	9.2254E-02	9.2324E-02	9.187E-02
Be-7	#B	3.0332E-01	4.0438E-01	8.6461E-01	8.6476E-01	1.101E+00
I-125	#F	2.6515E+00	3.4228E+00	2.2655E+00	2.2691E+00	2.031E+00
Tl-201	#B	1.6205E-01	2.5152E+01	5.3024E+01	5.3034E+01	5.921E-01
Pa-234	#B	8.9823E-02	>12 Halflives	1.6674E-01	1.6677E-01	2.729E-01
Np-237	#B	0.0000E+00	0.0000E+00	1.4070E+03	1.4070E+03	9.597E-01
Ce-144	F	1.0543E+00	1.1128E+00	1.3440E+00	1.3444E+00	6.630E-01
Eu-155	A	2.0200E-01	2.0372E-01	1.6659E-01	1.6665E-01	3.752E-01

- All peaks for activity calculation had bad shape.
* - Activity omitted from total
& - Activity omitted from total and all peaks had bad shape.
< - MDA value printed.
A - Activity printed, but activity < MDA.
B - Activity < MDA and failed test.
C - Area < Critical level.
F - Failed fraction or key line test.
H - Halflife limit exceeded

---------- S U M M A R Y ----------

Total Activity (19.0 to 1980.2 keV) 1.7152647E+01 pCi/g
Total Decayed Activity (19.0 to 1980.2 keV) 1.7162807E+01 pCi/g

********* S U M M A R Y O F D I S C A R D E D P E A K S *********
1173.00 - Co-60

! - Peak is part of a multiplet and this area went negative during deconvolution.
? - Peak is too narrow.
@ - Peak is too wide at FW25M, but ok at FWHM.
% - Peak fails sensitivity test.
$ - Peak identified, but first peak of this nuclide failed one or more qualification tests.
+ - Peak activity higher than counting uncertainty range.
- - Peak activity lower than counting uncertainty range.
= - Peak outside analysis energy range.
& - Calculated peak centroid is not close enough to the library energy centroid for positive identification.
P - Peakbackground subtraction

- -

Analyzed by: _____
Dave Blaida

Reviewed by: _____
Supervisor

Laboratory: Energy Laboratory

ORTEC g v - i (2191) wan32 G53W2.06 16-JAN-2014 11:08:00 Page 1
Energy Laboratory Spectrum name: C13120735.7.An1

Sample description
C13120735.7

Spectrum Filename: C:\User\C13120735.7.An1

Acquisition information

Start time:	16-Jan-2014 10:05:30
Live time:	3598
Real time:	3600
Dead time:	0.05 %
Detector ID:	2

Detector system
Det 1

Calibration
Filename: julycc_5th_det1_169218.Clb
12/10/13 calibration energy/efficiency
IPL #1692-18 recal energy calibration perched

Energy Calibration

Created:	10-Dec-2013 10:50:03
Zero offset:	-0.447 keV
Gain:	0.243 keV/channel
Quadratic:	1.476E-09 keV/channel^2

Efficiency Calibration

Created:	26-Jul-2013 07:55:14
Type:	Polynomial
Uncertainty:	1.391 %
Coefficients:	-0.329484 -5.959887 0.633715
	-0.076489 0.004220 -0.000092

Library Files

Main analysis library:	Norman.lib
Library Match Width:	0.500

Analysis parameters

Analysis engine:	wan32 G53W2.06
Start channel:	80 (19.01keV)
Stop channel:	8144 (1980.24keV)
Peak rejection level:	20.000%
Peak search sensitivity:	3
Sample Size:	1.9381E+02
Activity scaling factor:	2.7000E+01/(1.0000E+00* 1.9381E+02) = 1.3931E-01
Detection limit method:	Nureg 4.16
Random error:	1.0000000E+00
Systematic error:	1.0000000E+00
Fraction Limit:	0.000%
Background width:	best method (based on spectrum).
Half lives decay limit:	12.000

ORTEC g v - i (2191) wan32 G53W2.06 16-JAN-2014 11:08:00 Page 2
Energy Laboratory Spectrum name: C13120735.7.An1

Activity range factor: 2.000
Min. step backg. energy 0.000

Corrections	Status	Comments
Decay correct to date:	YES	24-Dec-2013 12:00:00
Decay during acquisition:	YES	
Decay during collection:	NO	
True coincidence correction:	NO	
Peaked background correction:	YES	011108bkg1000mindet1.Pbc 15-Jan-2008 17:02:27
Absorption (Internal):	NO	
Geometry correction:	NO	
Random summing:	YES	Slope 1.0000E+00 Net factor 1.0000E+00

Energy Calibration
Normalized diff: 0.1685

***** S U M M A R Y O F N U C L I D E S I N S A M P L E *****

Nuclide		Time of Count Activity pCi/g	Time Corrected Activity pCi/g	Uncertainty Counting pCi/g	2 Sigma Total pCi/g	MDA pCi/g
Ra-228	F	1.5367E+00	1.5484E+00	7.4407E-01	7.4534E-01	9.840E-01
Ra-226	A	1.1691E+00	1.1691E+00	2.4081E+00	2.4084E+00	4.059E+00
Bi-214	#F	8.0351E-01	8.0353E-01	4.2435E-01	4.2495E-01	5.216E-01
Pb-214		8.6459E-01	8.6462E-01	3.3321E-01	3.3410E-01	3.805E-01
Ir-192	#F	1.5953E-01	1.9772E-01	1.7514E-01	1.7523E-01	1.558E-01
Sb-124	#B	0.0000E+00	0.0000E+00	1.5737E+02	1.5737E+02	8.536E-02
Sc-46	#	2.6137E-01	3.1591E-01	1.4128E-01	1.4156E-01	9.631E-02
Pb-210	A	1.6672E+00	1.6705E+00	1.7820E+00	1.7824E+00	2.609E+00
Th-228	A	4.2631E+00	4.3613E+00	4.7121E+00	4.7132E+00	7.776E+00
Th-230	#A	8.7483E+00	8.7483E+00	1.7762E+01	1.7763E+01	2.539E+01
Cs-137	#	2.9626E-01	2.9669E-01	1.6062E-01	1.6084E-01	1.650E-01
Co-60	#B	1.0682E-01	1.0771E-01	9.1265E-02	9.1315E-02	1.383E-01
Am-241	#A	1.6643E-02	1.6645E-02	1.4078E-01	1.4078E-01	2.438E-01
K-40		1.3765E+01	1.3765E+01	2.9831E+00	3.0081E+00	2.088E+00
U-235	A	7.7811E-02	7.7811E-02	1.4027E-01	1.4029E-01	2.540E-01
Th-234	B	3.2890E+00	6.3585E+00	3.4226E+00	3.4322E+00	1.350E+01
Cs-134	#A	-1.1205E-02	-1.1444E-02	-2.4168E-01	-2.4168E-01	2.009E-01
Pb-212		1.0570E+00	1.0570E+00	2.3059E-01	2.3258E-01	2.797E-01
Ra-224	A	3.8228E-01	3.0789E+01	1.6626E+02	1.6626E+02	3.603E+00
I-131	#F	2.1195E-01	1.5290E+00	1.0325E+00	1.0334E+00	1.236E-01
Mn-54	#A	3.7548E-02	3.9505E-02	1.3727E-01	1.3728E-01	1.956E-01
Tl-208	#H	4.7973E-01	>12 Halflives	1.5273E-01	1.5332E-01	1.581E-01
Bi-212	#A	-1.2175E-01	>12 Halflives	2.3335E+03	2.3335E+03	1.523E+00
Ra-223	#A	5.8718E-02	2.3573E-01	1.6540E+00	1.6540E+00	7.125E-01
Pa-234	A	3.1316E-02	>12 Halflives	2.3992E-01	2.3992E-01	4.242E-01
Eu-154	#A	0.0000E+00	0.0000E+00	1.0254E+03	1.0254E+03	5.781E-01

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Eu-152	#A	-1.0015E-01	-1.0048E-01	7.7099E+02	7.7099E+02	6.121E-01
Na-22	#A	6.9250E-02	7.0418E-02	7.3117E-02	7.3143E-02	1.172E-01
Zn-65	#A	-3.2818E-02	-3.5022E-02	1.0152E+03	1.0152E+03	5.051E-01
Ba-133	A	1.0831E-01	1.0876E-01	1.1416E-01	1.1420E-01	1.666E-01
Ru-103	#B	2.7647E-02	4.1400E-02	9.0640E-02	9.0655E-02	1.016E-01
Be-7	#B	2.0321E-01	2.7362E-01	7.1351E-01	7.1360E-01	8.987E-01
I-125	#B	7.5615E-01	9.8477E-01	1.4483E+00	1.4488E+00	1.622E+00
Tl-201	#B	0.0000E+00	0.0000E+00	1.5060E+05	1.5060E+05	4.776E-01
Pa-234	#B	2.1579E-01	>12 Halflives	1.9599E-01	1.9615E-01	2.743E-01
Np-237	B	3.9321E-01	3.9321E-01	4.7385E-01	4.7408E-01	7.789E-01
Ce-144	B	2.0059E-01	2.1211E-01	7.1226E-01	7.1228E-01	7.642E-01
Eu-155	A	1.7122E-01	1.7273E-01	2.2600E-01	2.2604E-01	3.242E-01

- All peaks for activity calculation had bad shape.
* - Activity omitted from total
& - Activity omitted from total and all peaks had bad shape.
< - MDA value printed.
A - Activity printed, but activity < MDA.
B - Activity < MDA and failed test.
C - Area < Critical level.
F - Failed fraction or key line test.
H - Halflife limit exceeded

---------- S U M M A R Y ----------

Total Activity (19.0 to 1980.2 keV) 1.5686782E+01 pCi/g
Total Decayed Activity (19.0 to 1980.2 keV) 1.5686806E+01 pCi/g

********* S U M M A R Y O F D I S C A R D E D P E A K S *********
911.07 - Ra-228 1173.00 - Co-60

! - Peak is part of a multiplet and this area went negative during deconvolution.
? - Peak is too narrow.
@ - Peak is too wide at FW25M, but ok at FWHM.
% - Peak fails sensitivity test.
$ - Peak identified, but first peak of this nuclide failed one or more qualification tests.
+ - Peak activity higher than counting uncertainty range.
- - Peak activity lower than counting uncertainty range.
= - Peak outside analysis energy range.
& - Calculated peak centroid is not close enough to the library energy centroid for positive identification.
P - Peakbackground subtraction

- -

Analyzed by: _____
Dave Blaida

Reviewed by: _____
Supervisor

Laboratory: Energy Laboratory

```
 ORTEC     g v - i (2191) wan32  G53W2.06  16-JAN-2014 12:12:38 Page    1
Energy Laboratory               Spectrum name: C13120735.8.An1


Sample description
     C13120735.8


Spectrum Filename: C:\User\C13120735.8.An1

Acquisition information
       Start time:                 16-Jan-2014 11:09:00
       Live time:                3598
       Real time:                3600
       Dead time:                   0.06 %
       Detector ID:                    2

Detector system
     Det 1


Calibration
       Filename:                   julycc_5th_det1_169218.Clb
     12/10/13 calibration energy/efficiency
     IPL #1692-18  recal energy calibration perched

       Energy Calibration
            Created:               10-Dec-2013 10:50:03
            Zero offset:          -0.447 keV
            Gain:                  0.243 keV/channel
            Quadratic:             1.476E-09 keV/channel^2

       Efficiency Calibration
            Created:               26-Jul-2013 07:55:14
            Type:                  Polynomial
            Uncertainty:           1.391 %
            Coefficients:         -0.329484  -5.959887   0.633715
                                  -0.076489   0.004220  -0.000092

Library Files
       Main analysis library:      Norman.lib
       Library Match Width:        0.500

Analysis parameters
       Analysis engine:             wan32   G53W2.06
       Start channel:              80 (    19.01keV )
       Stop channel:             8144 (  1980.24keV )
       Peak rejection level:       20.000%
       Peak search sensitivity:    3
       Sample Size:                1.9987E+02
       Activity scaling factor:    2.7000E+01/(  1.0000E+00*  1.9987E+02) =
                                   1.3509E-01
       Detection limit method:     Nureg 4.16

       Random error:               1.0000000E+00
       Systematic error:           1.0000000E+00
       Fraction Limit:             0.000%
       Background width:           best method (based on spectrum).

       Half lives decay limit:    12.000
```

ORTEC g v - i (2191) wan32 G53W2.06 16-JAN-2014 12:12:38 Page 2
Energy Laboratory Spectrum name: C13120735.8.An1

Activity range factor: 2.000
Min. step backg. energy 0.000

Corrections	Status	Comments
Decay correct to date:	YES	24-Dec-2013 12:00:00
Decay during acquisition:	YES	
Decay during collection:	NO	
True coincidence correction:	NO	
Peaked background correction:	YES	011108bkg1000mindet1.Pbc 15-Jan-2008 17:02:27
Absorption (Internal):	NO	
Geometry correction:	NO	
Random summing:	YES	Slope 1.0000E+00 Net factor 1.0000E+00

Energy Calibration
Normalized diff: 0.1524

***** S U M M A R Y O F N U C L I D E S I N S A M P L E *****

Nuclide		Time of Count Activity pCi/g	Time Corrected Activity pCi/g	Uncertainty Counting pCi/g	2 Sigma Total pCi/g	MDA pCi/g
Ra-228	F	1.6424E+00	1.6549E+00	5.7696E-01	5.7883E-01	1.444E+00
Ra-226	A	1.6020E+00	1.6021E+00	2.5966E+00	2.5970E+00	4.330E+00
Bi-214	F	1.3365E+00	1.3366E+00	5.4570E-01	5.4700E-01	5.925E-01
Pb-214		1.3671E+00	1.3671E+00	3.9162E-01	3.9351E-01	4.396E-01
Ir-192	#B	1.4971E-02	1.8562E-02	6.6641E-02	6.6643E-02	9.737E-02
Sb-124	#B	0.0000E+00	0.0000E+00	1.9710E+02	1.9710E+02	1.008E-01
Sc-46		4.3804E-01	5.2964E-01	2.0656E-01	2.0709E-01	1.720E-01
Pb-210		3.9480E+00	3.9557E+00	2.5876E+00	2.5892E+00	3.278E+00
Th-228	A	5.0740E+00	5.1911E+00	5.4020E+00	5.4033E+00	8.822E+00
Th-230	#A	0.0000E+00	0.0000E+00	2.7103E+04	2.7103E+04	1.593E+01
Cs-137	#A	2.0638E-02	2.0668E-02	4.8394E-02	4.8398E-02	1.013E-01
Co-60	#B	-2.3195E-02	-2.3387E-02	-1.2425E-01	-1.2425E-01	1.493E-01
Am-241	#A	3.6122E-02	3.6126E-02	2.0987E-01	2.0988E-01	3.183E-01
K-40	#	1.4947E+01	1.4947E+01	3.3449E+00	3.3712E+00	2.547E+00
U-235	A	1.2906E-01	1.2906E-01	1.4888E-01	1.4892E-01	2.611E-01
Th-234	B	4.7263E+00	9.1489E+00	4.0672E+00	4.0839E+00	1.700E+01
Cs-134	#A	-2.9497E-02	-3.0127E-02	1.6346E+02	1.6346E+02	1.149E-01
Pb-212		1.2827E+00	1.2827E+00	2.4633E-01	2.4907E-01	2.885E-01
Ra-224	A	1.4160E+00	1.1501E+02	1.7377E+02	1.7380E+02	3.587E+00
I-131	#B	9.5815E-02	6.9385E-01	1.2031E+00	1.2033E+00	1.619E-01
Mn-54	#A	-4.3111E-02	-4.5362E-02	-4.0473E-01	-4.0474E-01	1.524E-01
Tl-208	H	6.5586E-01	>12 Halflives	1.7874E-01	1.7969E-01	1.764E-01
Bi-212	#	2.3343E+00	>12 Halflives	1.3625E+00	1.3640E+00	1.509E+00
Ra-223	#A	7.0029E-02	2.8190E-01	1.7510E+00	1.7510E+00	7.645E-01
Pa-234	A	1.0280E-01	>12 Halflives	2.2333E-01	2.2335E-01	3.837E-01
Eu-154	#A	0.0000E+00	0.0000E+00	1.6152E+03	1.6152E+03	6.925E-01

ORTEC g v - i (2191) wan32 G53W2.06 16-JAN-2014 12:12:38 Page 3

Eu-152	#A	2.7095E-01	2.7184E-01	3.3029E-01	3.3038E-01	5.935E-01
Na-22	#	1.2408E-01	1.2618E-01	9.1536E-02	9.1604E-02	1.137E-01
Zn-65	A	8.7015E-02	9.2871E-02	1.9309E-01	1.9310E-01	3.393E-01
Ba-133	#A	8.0644E-02	8.0979E-02	9.6282E-02	9.6309E-02	1.479E-01
Ru-103	#F	2.5347E-01	3.7985E-01	2.1070E-01	2.1126E-01	1.442E-01
Be-7	#B	3.5469E-01	4.7786E-01	8.5036E-01	8.5058E-01	9.866E-01
I-125	#B	1.2221E+00	1.5924E+00	1.4691E+00	1.4703E+00	1.499E+00
Tl-201	#B	4.6672E-01	8.7090E+01	1.2769E+02	1.2774E+02	8.760E-01
Pa-234	#B	3.0958E-01	>12 Halflives	2.5998E-01	2.6023E-01	3.205E-01
Np-237	B	1.7991E-01	1.7991E-01	5.2468E-01	5.2473E-01	8.900E-01
Ce-144	B	6.9190E-01	7.3174E-01	8.4669E-01	8.4694E-01	8.176E-01
Eu-155	#A	8.6337E-02	8.7099E-02	2.1502E-01	2.1503E-01	3.396E-01

- All peaks for activity calculation had bad shape.
* - Activity omitted from total
& - Activity omitted from total and all peaks had bad shape.
< - MDA value printed.
A - Activity printed, but activity < MDA.
B - Activity < MDA and failed test.
C - Area < Critical level.
F - Failed fraction or key line test.
H - Halflife limit exceeded

---------- S U M M A R Y ----------

Total Activity (19.0 to 1980.2 keV) 1.8035023E+01 pCi/g
Total Decayed Activity (19.0 to 1980.2 keV) 1.8126657E+01 pCi/g

********* S U M M A R Y O F D I S C A R D E D P E A K S *********
1173.00 & Co-60

! - Peak is part of a multiplet and this area went negative during deconvolution.
? - Peak is too narrow.
@ - Peak is too wide at FW25M, but ok at FWHM.
% - Peak fails sensitivity test.
$ - Peak identified, but first peak of this nuclide failed one or more qualification tests.
\+ - Peak activity higher than counting uncertainty range.
\- - Peak activity lower than counting uncertainty range.
= - Peak outside analysis energy range.
& - Calculated peak centroid is not close enough to the library energy centroid for positive identification.
P - Peakbackground subtraction

- -

Analyzed by: _____
Dave Blaida

Reviewed by: _____
Supervisor

Laboratory: Energy Laboratory

ORTEC g v - i (2191) wan32 G53W2.06 16-JAN-2014 13:26:58 Page 1
Energy Laboratory Spectrum name: C13120735.9.An1

Sample description
C13120735.9

Spectrum Filename: C:\User\C13120735.9.An1

Acquisition information
Start time: 16-Jan-2014 12:13:27
Live time: 3598
Real time: 3600
Dead time: 0.05 %
Detector ID: 2

Detector system
Det 1

Calibration
Filename: julycc_5th_det1_169218.Clb
12/10/13 calibration energy/efficiency
IPL #1692-18 recal energy calibration perched

Energy Calibration
Created: 10-Dec-2013 10:50:03
Zero offset: -0.447 keV
Gain: 0.243 keV/channel
Quadratic: 1.476E-09 keV/channel^2

Efficiency Calibration
Created: 26-Jul-2013 07:55:14
Type: Polynomial
Uncertainty: 1.391 %
Coefficients: -0.329484 -5.959887 0.633715
-0.076489 0.004220 -0.000092

Library Files
Main analysis library: Norman.lib
Library Match Width: 0.500

Analysis parameters
Analysis engine: wan32 G53W2.06
Start channel: 80 (19.01keV)
Stop channel: 8144 (1980.24keV)
Peak rejection level: 20.000%
Peak search sensitivity: 3
Sample Size: 1.8968E+02
Activity scaling factor: 2.7000E+01/(1.0000E+00* 1.8968E+02) =
1.4235E-01
Detection limit method: Nureg 4.16

Random error: 1.0000000E+00
Systematic error: 1.0000000E+00
Fraction Limit: 0.000%
Background width: best method (based on spectrum).

Half lives decay limit: 12.000

ORTEC g v - i (2191) wan32 G53W2.06 16-JAN-2014 13:26:58 Page 2
Energy Laboratory Spectrum name: C13120735.9.An1

Activity range factor: 2.000
Min. step backg. energy 0.000

Corrections	Status	Comments
Decay correct to date:	YES	24-Dec-2013 12:00:00
Decay during acquisition:	YES	
Decay during collection:	NO	
True coincidence correction:	NO	
Peaked background correction:	YES	011108bkg1000mindet1.Pbc 15-Jan-2008 17:02:27
Absorption (Internal):	NO	
Geometry correction:	NO	
Random summing:	YES	Slope 1.0000E+00 Net factor 1.0000E+00

Energy Calibration
Normalized diff: 0.1650

***** S U M M A R Y O F N U C L I D E S I N S A M P L E *****

Nuclide		Time of Count Activity pCi/g	Time Corrected Activity pCi/g	Uncertainty Counting pCi/g	2 Sigma Total pCi/g	MDA pCi/g
Ra-228	F	1.8758E+00	1.8901E+00	5.4029E-01	5.4290E-01	1.243E+00
Ra-226	A	9.2842E-01	9.2845E-01	2.3690E+00	2.3692E+00	4.024E+00
Bi-214	F	9.5056E-01	9.5059E-01	5.3939E-01	5.4006E-01	5.985E-01
Pb-214		7.0721E-01	7.0723E-01	3.3155E-01	3.3215E-01	5.025E-01
Ir-192	F	1.6476E-01	2.0437E-01	1.6036E-01	1.6046E-01	1.384E-01
Sb-124	#B	9.4386E-02	1.2302E-01	1.2277E-01	1.2281E-01	1.308E-01
Sc-46		2.8391E-01	3.4341E-01	1.6066E-01	1.6095E-01	1.182E-01
Pb-210	#	4.3205E+00	4.3290E+00	2.6015E+00	2.6034E+00	3.183E+00
Th-228	A	3.3877E+00	3.4660E+00	5.3375E+00	5.3381E+00	8.929E+00
Th-230	#A	4.1576E+00	4.1576E+00	1.2641E+01	1.2642E+01	2.104E+01
Cs-137	#A	8.9044E-02	8.9173E-02	1.2257E-01	1.2259E-01	1.699E-01
Co-60	#B	1.3998E-01	1.4114E-01	1.0310E-01	1.0317E-01	1.413E-01
Am-241	#A	-2.1391E-02	-2.1393E-02	2.9205E+02	2.9205E+02	1.745E-01
K-40	#	1.2820E+01	1.2820E+01	2.9183E+00	2.9405E+00	2.133E+00
U-235	A	3.0649E-02	3.0649E-02	1.3177E-01	1.3177E-01	2.472E-01
Th-234	B	6.4712E+00	1.2543E+01	5.7304E+00	5.7527E+00	1.450E+01
Cs-134	#A	-1.9302E-02	-1.9715E-02	-2.1425E-01	-2.1425E-01	1.502E-01
Pb-212		1.1659E+00	1.1659E+00	2.3103E-01	2.3345E-01	2.604E-01
Ra-224	A	8.4565E-01	6.9277E+01	1.7206E+02	1.7207E+02	3.604E+00
I-131	#B	8.3802E-02	6.0920E-01	6.4471E-01	6.4494E-01	1.026E-01
Mn-54	#A	-3.4953E-02	-3.6782E-02	-2.7042E-01	-2.7042E-01	1.693E-01
Tl-208	#H	7.2457E-01	>12 Halflives	2.0082E-01	2.0185E-01	1.877E-01
Bi-212	#	3.8608E+00	>12 Halflives	2.2981E+00	2.3006E+00	2.243E+00
Ra-223	A	5.6110E-01	2.2648E+00	2.5037E+00	2.5045E+00	8.423E-01
Pa-234	#A	-1.6987E-02	>12 Halflives	6.5885E+02	6.5885E+02	3.625E-01
Eu-154	A	0.0000E+00	0.0000E+00	6.7632E+02	6.7632E+02	4.509E-01

ORTEC g v - i (2191) wan32 G53W2.06 16-JAN-2014 13:26:58 Page 3

Eu-152	#A	-1.0233E-01	-1.0267E-01	7.8778E+02	7.8778E+02	6.254E-01
Na-22	#A	2.5767E-02	2.6204E-02	5.2830E-02	5.2836E-02	1.198E-01
Zn-65	#A	-2.8380E-02	-3.0294E-02	-9.0306E-01	-9.0306E-01	2.473E-01
Ba-133	A	1.6776E-01	1.6846E-01	1.2729E-01	1.2738E-01	2.093E-01
Ru-103	#B	4.6226E-02	6.9329E-02	1.3208E-01	1.3211E-01	1.344E-01
Be-7	#F	1.1524E+00	1.5534E+00	1.1234E+00	1.1252E+00	9.637E-01
I-125	#B	1.7513E+00	2.2831E+00	2.2897E+00	2.2912E+00	2.246E+00
Tl-201	#B	3.4511E-02	6.5058E+00	4.6517E+01	4.6518E+01	4.821E-01
Pa-234	#B	1.3894E-01	>12 Halflives	1.9425E-01	1.9432E-01	3.004E-01
Np-237	#B	0.0000E+00	0.0000E+00	1.2965E+03	1.2965E+03	8.861E-01
Ce-144	B	3.8382E-01	4.0597E-01	5.3835E-01	5.3847E-01	5.797E-01
Eu-155	A	2.3968E-01	2.4180E-01	3.2504E-01	3.2509E-01	4.293E-01

- All peaks for activity calculation had bad shape.
* - Activity omitted from total
& - Activity omitted from total and all peaks had bad shape.
< - MDA value printed.
A - Activity printed, but activity < MDA.
B - Activity < MDA and failed test.
C - Area < Critical level.
F - Failed fraction or key line test.
H - Halflife limit exceeded

---------- S U M M A R Y ----------

Total Activity (19.0 to 1980.2 keV) 1.5862253E+01 pCi/g
Total Decayed Activity (19.0 to 1980.2 keV) 1.5876553E+01 pCi/g

********* S U M M A R Y O F D I S C A R D E D P E A K S *********
1173.00 - Co-60

! - Peak is part of a multiplet and this area went negative during deconvolution.
? - Peak is too narrow.
@ - Peak is too wide at FW25M, but ok at FWHM.
% - Peak fails sensitivity test.
$ - Peak identified, but first peak of this nuclide failed one or more qualification tests.
+ - Peak activity higher than counting uncertainty range.
- - Peak activity lower than counting uncertainty range.
= - Peak outside analysis energy range.
& - Calculated peak centroid is not close enough to the library energy centroid for positive identification.
P - Peakbackground subtraction

- -

Analyzed by: _____
Dave Blaida

Reviewed by: _____
Supervisor

Laboratory: Energy Laboratory

```
 ORTEC     g v - i (2191) wan32  G53W2.06  16-JAN-2014 14:29:48 Page    1
Energy Laboratory                Spectrum name: C13120735.9dup.An1


Sample description
     C13120735.9dup


Spectrum Filename: C:\User\C13120735.9dup.An1

Acquisition information
       Start time:                16-Jan-2014 13:27:17
       Live time:               3598
       Real time:               3600
       Dead time:                 0.05 %
       Detector ID:                  2

Detector system
     Det 1


Calibration
       Filename:                  julycc_5th_det1_169218.Clb
     12/10/13 calibration energy/efficiency
     IPL #1692-18  recal energy calibration perched

       Energy Calibration
            Created:              10-Dec-2013 10:50:03
            Zero offset:         -0.447 keV
            Gain:                 0.243 keV/channel
            Quadratic:            1.476E-09 keV/channel^2

       Efficiency Calibration
            Created:              26-Jul-2013 07:55:14
            Type:                 Polynomial
            Uncertainty:          1.391 %
            Coefficients:        -0.329484  -5.959887   0.633715
                                 -0.076489   0.004220  -0.000092

Library Files
       Main analysis library:     Norman.lib
       Library Match Width:       0.500

Analysis parameters
       Analysis engine:           wan32   G53W2.06
       Start channel:            80 (    19.01keV )
       Stop channel:           8144 (  1980.24keV )
       Peak rejection level:     20.000%
       Peak search sensitivity:   3
       Sample Size:               1.8968E+02
       Activity scaling factor:   2.7000E+01/(  1.0000E+00*  1.8968E+02) =
                                  1.4235E-01
       Detection limit method:    Nureg 4.16

       Random error:              1.0000000E+00
       Systematic error:          1.0000000E+00
       Fraction Limit:            0.000%
       Background width:          best method (based on spectrum).

       Half lives decay limit:   12.000
```

ORTEC g v - i (2191) wan32 G53W2.06 16-JAN-2014 14:29:48 Page 2
Energy Laboratory Spectrum name: C13120735.9dup.An1

Activity range factor: 2.000
Min. step backg. energy 0.000

Corrections	Status	Comments
Decay correct to date:	YES	24-Dec-2013 12:00:00
Decay during acquisition:	YES	
Decay during collection:	NO	
True coincidence correction:	NO	
Peaked background correction:	YES	011108bkg1000mindet1.Pbc 15-Jan-2008 17:02:27
Absorption (Internal):	NO	
Geometry correction:	NO	
Random summing:	YES	Slope 1.0000E+00 Net factor 1.0000E+00

Energy Calibration
Normalized diff: 0.1245

***** S U M M A R Y O F N U C L I D E S I N S A M P L E *****

Nuclide		Time of Count Activity pCi/g	Time Corrected Activity pCi/g	Uncertainty Counting pCi/g	2 Sigma Total pCi/g	MDA pCi/g
Ra-228	B	1.3621E+00	1.3725E+00	7.8030E-01	7.8126E-01	1.420E+00
Ra-226	A	3.3126E-01	3.3127E-01	2.5553E+00	2.5553E+00	4.406E+00
Bi-214	F	7.3463E-01	7.3465E-01	3.7317E-01	3.7374E-01	4.984E-01
Pb-214		7.7265E-01	7.7267E-01	3.7593E-01	3.7656E-01	4.695E-01
Ir-192	B	1.1568E-01	1.4356E-01	1.1818E-01	1.1825E-01	1.238E-01
Sb-124	#B	7.5508E-02	9.8471E-02	1.5053E-01	1.5055E-01	1.663E-01
Sc-46		3.3743E-01	4.0831E-01	1.7681E-01	1.7719E-01	1.312E-01
Pb-210		3.1848E+00	3.1911E+00	1.9802E+00	1.9816E+00	2.737E+00
Th-228	A	4.4409E+00	4.5439E+00	5.0809E+00	5.0820E+00	8.378E+00
Th-230	#A	3.3260E+00	3.3260E+00	1.0624E+01	1.0624E+01	1.929E+01
Cs-137	A	1.6475E-01	1.6499E-01	1.4719E-01	1.4726E-01	1.881E-01
Co-60	#B	5.5171E-02	5.5631E-02	5.1020E-02	5.1044E-02	1.413E-01
Am-241	A	1.4458E-01	1.4459E-01	1.8809E-01	1.8812E-01	2.759E-01
K-40		1.2976E+01	1.2976E+01	2.9348E+00	2.9574E+00	2.133E+00
U-235	A	7.1959E-02	7.1959E-02	1.3793E-01	1.3794E-01	2.519E-01
Th-234	B	3.6693E+00	7.1225E+00	3.9954E+00	4.0057E+00	1.932E+01
Cs-134	A	1.4169E-01	1.4473E-01	1.2822E-01	1.2828E-01	1.769E-01
Pb-212		1.2796E+00	1.2796E+00	2.3733E-01	2.4015E-01	2.577E-01
Ra-224	A	2.0968E+00	1.7347E+02	1.6503E+02	1.6510E+02	3.235E+00
I-131	#B	7.3286E-02	5.3511E-01	8.9285E-01	8.9298E-01	1.172E-01
Mn-54	#A	-4.8918E-02	-5.1484E-02	-5.7440E-01	-5.7440E-01	1.721E-01
Tl-208	#H	5.7540E-01	>12 Halflives	1.9719E-01	1.9785E-01	1.949E-01
Bi-212		3.1875E+00	>12 Halflives	1.6805E+00	1.6828E+00	1.717E+00
Ra-223	#A	8.4612E-01	3.4259E+00	3.2010E+00	3.2024E+00	9.305E-01
Pa-234	A	9.8533E-02	>12 Halflives	2.4327E-01	2.4329E-01	4.195E-01
Eu-154	#A	7.6675E-02	7.7057E-02	1.7555E-01	1.7556E-01	3.238E-01

ORTEC g v - i (2191) wan32 G53W2.06 16-JAN-2014 14:29:48 Page 3

Eu-152	#A	2.8550E-01	2.8644E-01	3.4803E-01	3.4812E-01	6.254E-01
Na-22	#A	-1.9223E-02	-1.9549E-02	3.3428E+02	3.3428E+02	1.852E-01
Zn-65	A	1.4325E-01	1.5293E-01	2.0066E-01	2.0071E-01	3.253E-01
Ba-133	#A	-2.9396E-03	-2.9519E-03	-1.5173E-01	-1.5173E-01	1.884E-01
Ru-103	#B	5.0078E-02	7.5173E-02	1.1623E-01	1.1627E-01	1.192E-01
Be-7	B	6.0212E-01	8.1224E-01	9.2724E-01	9.2782E-01	9.548E-01
I-125	#B	2.5753E-02	3.3594E-02	3.4750E-01	3.4750E-01	1.144E+00
Tl-201	#B	4.4002E-01	8.3922E+01	1.3645E+02	1.3649E+02	9.887E-01
Pa-234	#B	2.7183E-01	>12 Halflives	2.6675E-01	2.6694E-01	3.405E-01
Np-237	#B	0.0000E+00	0.0000E+00	1.3653E+03	1.3653E+03	9.307E-01
Ce-144	F	1.7841E+00	1.8873E+00	1.5232E+00	1.5241E+00	7.421E-01
Eu-155	A	3.9363E-01	3.9712E-01	3.2726E-01	3.2739E-01	3.994E-01

- All peaks for activity calculation had bad shape.
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& - Activity omitted from total and all peaks had bad shape.
< - MDA value printed.
A - Activity printed, but activity < MDA.
B - Activity < MDA and failed test.
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F - Failed fraction or key line test.
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---------- S U M M A R Y ----------

Total Activity (19.0 to 1980.2 keV) 1.4255527E+01 pCi/g
Total Decayed Activity (19.0 to 1980.2 keV) 1.4255527E+01 pCi/g

********* S U M M A R Y O F D I S C A R D E D P E A K S *********
911.07 - Ra-228

! - Peak is part of a multiplet and this area went negative during deconvolution.
? - Peak is too narrow.
@ - Peak is too wide at FW25M, but ok at FWHM.
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$ - Peak identified, but first peak of this nuclide failed one or more qualification tests.
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& - Calculated peak centroid is not close enough to the library energy centroid for positive identification.
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- -

Analyzed by: _____
Dave Blaida

Reviewed by: _____
Supervisor

ORTEC g v - i (2191) wan32 G53W2.06 16-JAN-2014 14:29:48 Page 4
Energy Laboratory Spectrum name: C13120735.9dup.An1

Laboratory: Energy Laboratory