Energy Fuels Resources (USA) Inc.
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Lakewood, CO, US, 80228
303 974 2140
www.energyfuels.com

DRC-2019-017284

December 23, 2019

Div of Waste Management and Radiation Control

DEC 30 2019

SENT VIA OVERNIGHT DELIVERY

Mr. Ty L. Howard
Director
Division of Waste Management and Radiation Control
Utah Department of Environmental Quality
195 North 1950 West
P.O. Box 144880
Salt Lake City, UT 84114-4880

Re: Application by Energy Fuels Resources (USA) Inc. ("EFRI") for an amendment to State of Utah Radioactive Materials License No. 1900479 for the White Mesa Uranium Mill (the "Mill") to authorize processing of Union Pacific Railroad ("UPRR"), Moffat Tunnel alternate feed material (the "Uranium Material")

Dear Mr. Howard:

Attached pleased find two copies of an application to amend the Mill's Radioactive Materials License No. 1900479 to authorize receipt and processing of the Uranium Material as an alternate feed material primarily for the recovery of uranium and disposal of the resulting tailings in the Mill's tailings impoundments as 11e.(2) byproduct material.

These materials are the solids resulting from mechanical and inorganic treatment of native groundwater pumped for dewatering of the Moffat Railroad Tunnel, conducted in Union Pacific Railroad's ("UPRR") water treatment plant (the "WTP") in Winter Park, Colorado.

If you should have any questions regarding this amendment application, please contact me.

Yours very truly,

Kathy Weinel

ENERGY FUELS RESOURCES (USA) INC.
Kathy Weinel
Quality Assurance Manager

cc: David Frydenlund
Mark Chalmers
Paul Goranson
Logan Shumway
Terry Slade
Scott Bakken

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REQUEST TO AMEND
RADIOACTIVE MATERIAL LICENSE
ENERGY FUELS RESOURCES (USA), INC.
WHITE MESA URANIUM MILL
SAN JUAN COUNTY, UTAH
AND
ENVIRONMENTAL REPORT

for
Processing of
Alternate Feed Material
from
Union Pacific Railroad Moffat Tunnel

Prepared for:

Utah Department of Environmental Quality
Division of Waste Management nd Radiation Control
P.O. Box 144850
Salt Lake City, UT 84114-4850

Prepared by:

Energy Fuels Resources (USA) Inc.
225 Union Boulevard, Suite 600,
Lakewood, CO 80228

December 2019

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ATTACHMENTS

1.0 INTRODUCTION

1.1 White Mesa Mill

Energy Fuels resources (USA), Inc. ("EFRI") operates the White Mesa Uranium Mill (the "Mill") located approximately six miles south of Blanding, Utah. The Mill processes natural (native, raw) uranium ores and alternate feed materials. Alternate feed materials are uranium-bearing materials other than natural ores, that meet the criteria specified in the United States Nuclear Regulatory Commission's ("NRC's") *Interim Position and Guidance on the Use of Uranium Mill Feed Material Other Than Natural Ores* (November 30, 2000) (the "Alternate Feed Guidance"). Alternate feed materials are processed as "ore" at the Mill primarily for their source material content. As a result, all waste associated with this processing is 11e.(2) byproduct material.

1.2 Proposed Action

This is a request for an amendment to State of Utah Radioactive Materials License No. UT 1900479 to authorize receipt and processing of certain uranium containing materials. These materials are the centrifuge cake resulting from mechanical and inorganic treatment of native groundwater pumped for dewatering of the Moffat Railroad Tunnel, conducted in Union Pacific Railroad's ("UPRR") water treatment plant (the "WTP") in Winter Park, Colorado. For ease of reference, the uranium-bearing material that results from this process, described further in Section 2, is referred to herein as "Uranium Material".

1.3 Purpose of Action

The Uranium Material contains greater than 0.45% uranium on a dry basis. The WTP treats pumped groundwater to remove metals and radionuclides prior to discharge of treated water to the Fraser River. The WTP produces filtered solids which are then dewatered in a centrifuge to produce a centrifuge cake that is packaged in closed drums for off-site recovery or disposal. The Uranium Material consists of the centrifuge cake only.

Prior to 2019, UPRR periodically disposed of the Uranium Material at various off-site waste disposal facilities. Because the Uranium Material contains elevated levels of naturally-occurring radionuclides, Colorado Department of Public Health and the Environment ("CDPHE") required in 2018 that UPRR apply for a Radioactive Materials License, and demonstrate that it has identified an off-site location suitable for disposal or recovery of radioactive material.

EFRI has been requested by UPRR to make this application to process the Uranium Material as an alternate feed material at the Mill and to dispose of the resulting tailings in the Mill's tailings management system as 11e.(2) byproduct material. Approval of this application will:

1. allow the recovery of valuable uranium, a resource that would otherwise be lost to direct disposal, and

2. allow UPRR to meet the requirement of the CDPHE to confirm a licensed off-site destination for the Uranium Material.

Reprocessing at the Mill will afford UPRR a cost-effective and productive mechanism for managing the material generated.

1.4 Amendment Application and Environmental Report

This application is intended to fulfill the requirements of an application for an amendment to the Mill's Radioactive Materials License set out in Utah Administrative Code ("UAC") R3I3-22-38 and includes the Environmental Report required by UAC R3I3-24-3 to be contained in such an application.

For ease of review, this application contains a cross reference to the Utah Division of Waste Management and Radiation Control's ("DWMRC's") Interrogatory Template for Review of License Amendment Request and Environmental Report under UAC R313-24 that was provided to EFRI. The cross reference is provided in a table format in Attachment 6.

2.0 MATERIAL COMPOSITION AND VOLUME

2.1 General

The Uranium Material was generated by treatment of natural groundwater from dewatering of the Moffat railroad tunnel ("Moffat Tunnel"). The groundwater contains naturally occurring radioactive material ("NORM") from contact with native rock, and picks up inorganic solids particles as it passes through the tunnel. As a result, the groundwater requires treatment to meet CDPHE discharge standards prior to release to the Fraser River.

2.2 Historical Summary of Sources

Groundwater is pumped from the Moffat Tunnel at approximately 200 gallons per minute ("gpm") for dewatering. Prior to discharge of the pumped water to surface receiving waters, it is pre-treated by an ultrafiltration and centrifugation system to meet CDPHE standards for radionuclides and inorganic constituents.

The Uranium Material was generated from a continuous process, as described below, driven by the requirement to achieve discharge permit limits in the water released from the WTP to the Fraser River. No other water sources or wastes are treated in the WTP.

The Uranium Material is comprised only of the centrifuged solids. No other materials or wastes are added to the Uranium Material. The Uranium Material contains approximately 75-83% moisture content (average 78% moisture) and contains up to 0.49% natural uranium on a dry weight basis.

EFRI has been requested by UPRR to make this application to process the Uranium Material as an alternate feed material at the Mill and to dispose of the resulting tailings in the Mill's tailings management system as 11e.(2) byproduct material, in an effort to provide UPRR with an option for ultimate processing and disposal of the Uranium Material. By providing UPRR with the option of processing the Uranium Material at the Mill, UPRR will be given the option of

recycling the Uranium Material for the recovery of valuable uranium, a resource that would otherwise be lost to direct disposal.

2.3 Quantity of Material

The WTP will be required to operate indefinitely, as long as the Moffat Tunnel remains in service. To date, Uranium Material produced since the start-up of the WTP has been removed from the WTP site and disposed elsewhere. There is no current accumulated backlog of material on site at the WTP. UPRR anticipates that the WTP will continue to produce a maximum of approximately 100 tons per year on a wet basis, or approximately 25 tons per year on a dry basis, indefinitely.

This application anticipates that the Mill could potentially receive the Uranium Material indefinitely. In order to accommodate potential future expansion of the Moffat Tunnel and a range of dewatering rates, EFRI has anticipated dewatering and centrifuge cake production up to twice the current rate, that is, a maximum of approximately 200 tons per year on wet basis and 50 tons per year on a dry basis. Therefore, this request for Amendment is for approval of up to approximately 5,000 tons dry weight of Uranium Material, to ensure that all the Uranium Material is covered by this Amendment.

2.4 Radiochemical Data

The Uranium Material consists of centrifuge dewatering solids from the treatment of naturally-occurring groundwater. The Uranium Material contains approximately 0.5 percent natural uranium and very low levels of other radionuclides, including thorium isotopes, which are present at much lower levels than in other alternate feed materials. The derived air concentrations ("DACs"), radiation protection measures, and emissions control measures used for ores and other alternate feed materials at the Mill are sufficiently protective for the processing of the Uranium Material.

As noted, the process history demonstrates that the Uranium Material results from the treatment of native groundwater for the removal of metals and radionuclides. UPRR has estimated that the current Uranium Material has a uranium content ranging from 0.45 to 0.49 dry weight % natural uranium or 0.53 to 0.58 dry weight % U_3O_8. Natural thorium content will likely range from 0.001 to 0.003 dry weight percent and may be expected to average approximately 0.002 dry weight %. A more detailed radiological characterization of the Uranium Materials (see Section 4.9, below) is contained in the Radioactive Materials Profile Record ("RMPR") (Attachment 2). The radionuclide activity concentration of the Uranium Material is comparable to Arizona Strip ores and alternate feed materials which the Mill is currently licensed to receive (see Section 2.5.1, below).

2.5 Physical and Chemical Data

Physically, the Uranium Material consists of moist centrifuge cake containing residual amounts of uranium and other metals. The chemical characterization data for the Uranium Materials is set out in the RMPR (Attachment 2). As with the radionuclides and as discussed in more detail in Section 4.4 below, all the chemical constituents in the Uranium Material have either been

reported to be, or can be assumed to be, already present in the Mill's tailings system or were reported in other licensed alternate feed materials, at levels generally comparable to or higher than those reported in the Uranium Materials.

2.6 Comparison to Other Ores and Alternate Feed Materials Licensed for Processing at the Mill

2.6.1 Ores and Alternate Feed Materials with Similar Radiological Characteristics

With an average uranium content of approximately 0.45 percent Unat (0.53 U_3O_8), the Uranium Material is comparable to an Arizona Strip ore. Arizona Strip ores typically average approximately 0.6 percent U_3O_8.

The estimated average content of total natural thorium ("Th-nat") of approximately 2.0 pCi/g is far lower than normally encountered with most previously licensed alternate feed materials at the Mill.

The Uranium Material will be handled at the Mill under the Mill's radiation safety program in a manner appropriate for such materials.

2.6.2 Ores and Alternate Feed Materials with Similar Chemical/Metal Characteristics

The Uranium Material is physically and chemically comparable to previously-approved alternate feed materials that the Mill has processed. As discussed in more detail in Section 4.5 below, all the constituents in the Uranium Material have either been reported to be, or can be assumed to be, already present in the Mill's tailings system or were reported in other licensed alternate feed materials, at levels generally comparable to or higher than those reported in the Uranium Material.

3.0 REGULATORY CONSIDERATIONS

3.1 Alternate Feed Guidance

The Alternate Feed Guidance provides that if it can be determined, using the criteria specified in the Alternate Feed Guidance, that a proposed feed material meets the definition of "ore", that it will not introduce a hazardous waste not otherwise exempted (unless specifically approved by the EPA (or State) and the long-term custodian), and that the primary purpose of its processing is for its source material content, the request can be approved.

3.2 Uranium Material Qualifies as "Ore"

According to the Alternate Feed Guidance, for the tailings and wastes from the proposed processing to qualify as 11e.(2) byproduct material, the feed material must qualify as "ore". NRC has established the following definition of ore: Ore is a natural or native matter that may be mined and treated for the extraction of any of its constituents or any other matter from which source material is extracted in a licensed uranium or thorium mill. The Uranium Material is an "other matter" which will be processed primarily for its source material content in a licensed

uranium mill, and therefore qualifies as "ore" under this definition. Further, the uranium concentration of the Uranium Material is greater than 0.05 percent on both a wet and dry basis, and the Uranium Material is an ore, the entire mass of Uranium Material is therefore Source Material.

3.3 Uranium Material Not Subject to RCRA

3.3.1 General

The Alternate Feed Guidance currently provides that if a proposed feed material contains hazardous waste, listed under Section 261.30-33, Subpart D, of 40 CFR (or comparable RCRA authorized State regulations), it would be subject to EPA (or State) regulation under RCRA. However, the Guidance provides that if the licensee can show that the proposed feed material does not consist of a listed hazardous waste, this issue is resolved. NRC guidance further states that feed material exhibiting only a characteristic of hazardous waste (ignitability, corrosivity, reactivity, toxicity) that is being recycled, would not be regulated as hazardous waste and could therefore be approved for extraction of source material, unless it is a residue from water treatment. The Alternate Feed Guidance concludes that if the feed material contains a listed hazardous waste, the licensee can process it only if it obtains EPA (or State) approval and provides the necessary documentation to that effect. The Alternate Feed Guidance also states that NRC staff may consult with EPA (or the State) before making a determination on whether the feed material contains listed hazardous waste.

Subsequent to the date of publication of the Alternate Feed Guidance, NRC recognized that, because alternate feed materials that meet the requirements specified in the Alternate Feed Guidance must be ores, any alternate feed materials that contain greater than 0.05% source material are considered source material under the definition of source material in 10 CFR 40.4 and hence exempt from the requirements of RCRA under 40 CFR 261.4(a)(4). See *Technical Evaluation Report, Request to Receive and Process Molycorp Site Material* issued by the NRC on December 3, 2001 (the "Molycorp TER"). As a result, any such alternate feed ores are exempt from RCRA, regardless of whether they would otherwise have been considered to contain listed or characteristic hazardous wastes. Since the Uranium Material contains greater than 0.05% source material, it is exempt from RCRA, regardless of its process history or constituents, and no further RCRA analysis is required.

Nevertheless, because the Alternate Feed Guidance has not yet been revised to reflect this position recognized by NRC in the Molycorp TER, EFRI will demonstrate below that, even if the Uranium Material were not considered source material, and as such exempt from RCRA, the Uranium Material would not, in any event, contain any RCRA listed hazardous wastes or characteristic hazardous wastes, as required under the Alternate Feed Guidance as currently worded.

3.3.2 EFRI/UDEQ Listed Hazardous Waste Protocol

In a February, 1999 decision regarding the Mill, the Atomic Safety and Licensing Board Presiding Officer suggested there was a general need for more specific protocols for determining if alternate feed materials contain hazardous components. In a Memorandum and Order of

February 14, 2000, the full Commission of the NRC also concluded that this issue warranted further staff refinement and standardization. Cognizant at that time of the need for specific protocols to be used in making determinations as to whether or not any alternate feed materials considered for processing at the Mill contained listed hazardous wastes, EFRI took a proactive role in the development of such a protocol. Accordingly, EFRI established a "Protocol for Determining Whether Alternate Feed Materials are Listed Hazardous Wastes" (November 22, 1999). This Protocol was developed in conjunction with, and accepted by, the State of Utah Department of Environmental Quality ("UDEQ") (Letter of December 7, 1999). Copies of the Protocol and UDEQ letter are provided in Attachment 3. The provisions of the protocol can be summarized as follows:

a) In all cases, the protocol requires that EFRI perform a source investigation to collect information regarding the composition and history of the material, and any existing generator or agency determinations regarding its regulatory status;

b) The protocol states that if the material is known -- by means of chemical data or site history -- to contain no listed hazardous waste, EFRI and UDEQ will agree that the material is not a listed hazardous waste;

c) If such a direct confirmation is not available, the protocol describes the additional chemical process and material handling history information that EFRI will collect and evaluate to assess whether the chemical contaminants in the material resulted from listed or non-listed sources;

d) The protocol also specifies the situations in which ongoing confirmation/acceptance sampling will be used, in addition to the chemical process and handling history, to make a listed waste evaluation;

e) If the results from any of the decision steps indicate that the material or a constituent of the material did result from a RCRA listed hazardous waste or RCRA listed process, the material will be rejected; and

f) The protocol identifies the types of documentation that EFRI will obtain and maintain on file, to support the assessment for each different decision scenario.

The above components and conditions of the Protocol are summarized in a decision tree diagram, or logic flow diagram, included in Attachment 3, and hereinafter referred to as the "Protocol Diagram".

3.3.3 Application of the Listed Hazardous Waste Protocol

EFRI has conducted a RCRA evaluation of the Uranium Material and, specifically, applied the Listed Hazardous Waste Protocol to the Uranium Material. A copy of the analysis is included as Attachment 4. The analysis evaluated the following regulatory history to develop the conclusions enumerated below.

The components of the Uranium Material result either from naturally-occurring constituents of the influent water to the WTP, inorganic solids from the Tunnel from use of the railroad over the years that the groundwater has contacted the Tunnel or its geologic substrata, or from the non-hazardous treatment agents added in the WTP which produced the centrifuge solids/Uranium Material.

Prior to 2019, UPRR disposed of the centrifuge solids in off-site solid waste disposal facilities licensed for the disposal of NORM material. In 2018 CDPHE required that UPRR apply for a CDPHE radioactive materials license. UPRR has received License CO1274-01 in 2019.

The Uranium Material, which has materially not changed in form or content since first being produced in 2017, remains definitional source material as per 40 CFR Part 261.4, and is explicitly exempt from regulation under RCRA. However, for the sake of completeness, EFRI has required the following evaluation to confirm that even if the Uranium Material were not exempt from RCRA, it is not and does not contain, what would otherwise be considered a RCRA-listed waste, or a RCRA characteristic waste.

The Uranium Material has not been classified or treated as listed hazardous waste nor has it been in contact with any listed hazardous wastes.

The RCRA analysis concluded that, based on the information that is available,

1. The Uranium Material would not be a RCRA listed hazardous waste because it is an ore that has a natural uranium content of greater than 0.05 weight percent, is therefore source material and, as a result, is exempt from regulation under RCRA.

2. Even if the Uranium Material were not source material, it would not be a RCRA listed hazardous waste for the following additional reasons:

    a) It was generated from a known process under the control of the generator, who has provided the Affidavit declaring that the Uranium Material is not and does not contain RCRA listed hazardous waste. This determination is consistent with Boxes I and 2 and Decision Diamonds 1 and 2 in the EFRI/UDEQ Protocol Diagram;

    b) No volatile organic compounds are used in the water treatment process that produced the centrifuge solids, and no volatile organic compounds can be expected to be present in the Uranium Material.

    c) No semi-volatile organic compounds are used in the water treatment process that produced the centrifuge solids. One semi-volatile organic compound was detected in one sample, and not in the second sample. The compound does not result from a RCRA listed waste source.

    d) None of the metals in the Uranium Material samples came from RCRA listed hazardous waste sources. This determination is consistent with Box 8 and Decision Diamonds 9 through 11 in the EFRI/UDEQ Protocol Diagram.

3. The Uranium Material, which is a residue from water treatment, does not exhibit any of the RCRA characteristics of ignitability, corrosivity, reactivity, or toxicity for any constituent. As a result, even if not exempt from RCRA under 40 CFR 261.4, the Uranium Material would not be precluded under the Alternate Feed Guidance due to RCRA characteristics.

3.3.4 Radioactive Material Profile Record

Furthermore, in order for EFRI to characterize the Uranium Material, UPRR has completed EFRI's RMPR form, stating that the material is not RCRA listed waste. The certification section of the RMPR includes the following text:

> I certify that the material described in this profile has been fully characterized and that hazardous constituents listed in 10 CFR 40 Appendix A Criterion 13 which are applicable to this material have been indicated on this form. I further certify and warrant to EFRI that the material represented on this form is not a hazardous waste as identified by 40 CFR 261 and/or that this material is exempt from RCRA regulation under 40 CFR 261.4(a)(4).

3.3.5 Conclusion

Because the Uranium Material is an ore that contains greater than 0.05% source material, the Uranium Material is exempt from RCRA under 40 CFR 261.4(a)(4). In addition, based on the site history, the determinations by UPRR, and the analysis of the EFRI's chemical engineering consultant, EFRI has also concluded that, even if not exempted from RCRA under 40 CFR 261.4(a)(4), the Uranium Material does not demonstrate a characteristic of hazardous waste, and on the application of the Listed Hazardous Waste Protocol, Uranium Material from the Facility would not be listed hazardous waste subject to RCRA.

3.4 Uranium Material is Processed Primarily for its Source Material Content

In its Memorandum and Order, February 14, 2000, In the Matter of International Uranium (USA) Corp. (Request for Materials License Amendment), Docket No. 40-8681-MLA-4, the NRC concluded that an alternate feed material will be considered to be processed primarily for its source material content if it is reasonable to conclude that uranium can be recovered from the Uranium Material and that the processing will indeed occur. The Uranium Material will be processed for the recovery of uranium at the Mill. Based on the uranium content of the Uranium Material, its physical and chemical characteristics, and EFRI's success in recovering uranium from a variety of different types of materials, including materials that were similar to the Uranium Materials, at the Mill, it is reasonable to expect that uranium can be recovered from the Uranium Material. As a result, the Uranium Material is an ore that will be processed primarily for the recovery of source material, and the tailings resulting from processing the Uranium Material will therefore be 11e.(2) byproduct material under the definition set out in 10 CFR 40.4.

4.0 AFFECTED ENVIRONMENT

4.1 General

The Mill is a licensed uranium processing facility that has processed to date over 5,000,000 tons of uranium-bearing conventionally mined ores and alternate feed materials primarily for the recovery of uranium, with the resulting tailings being permanently disposed of as 11e.(2) byproduct material in the Mill's tailings management systems. Environmental impacts associated with such previously licensed Mill operations have been thoroughly evaluated and documented in the past. See, for example:

- the original 1979 Final Environmental Statement ("FES") for the Mill,
- Environmental Assessments ("EAs"), dated 1985 and 1997,
- an EA for the Mill's reclamation plan dated 2000,
- EAs for alternate feed materials dated 2001 and 2002, in each case prepared by the NRC,
- the Safety Evaluation Report for the Receipt, Storage and Processing of Fansteel Alternate Feed Material prepared by DWMRC,
- the Safety Evaluation Report for the Receipt, Storage and Processing of Dawn Mining Alternate Feed Material prepared by DWMRC,
- the Safety Evaluation Report for the Receipt, Storage and Processing of SFC Alternate Feed Material prepared by DWMRC, and
- The Technical Evaluation and Environmental Assessment Report prepared in in connection with the 2018 Radioactive Materials License Renewal for the Mill, prepared by DWMRC.

The Uranium Material will also be processed as an alternate feed material at the Mill for the recovery of uranium and the resulting tailings will be permanently disposed of in the Mill's tailings management system as 11e.(2) byproduct material, in a similar fashion to other conventionally mined ores and alternate feed materials that have been processed or licensed for processing at the Mill.

Accordingly, this Environmental Report will focus on the various pathways for potential radiological and non-radiological impacts on public health, safety and the environment and determine if the receipt and processing of the Uranium Material would result in any potential significant *incremental* impacts over and above previously licensed activities.

The pathways that are analyzed are the following:

a) potential impacts from transportation of the Uranium Material to the Mill;
b) potential impacts from radiation released from the Uranium Material while in storage at the Mill;
c) any chemical reactions that may occur in the Mill's process;
d) any potential reactions or inconsistencies with the existing tailings or tailings facilities;
e) potential impacts on groundwater;
f) potential impacts on surface water;

g) potential airborne radiologic impacts;
h) potential radon and gamma impacts; and
i) worker health and safety issues.

These potential pathways will be discussed in the following sections of this document. The findings below will demonstrate that, because all the constituents in the Uranium Material have either been reported to be, or can be assumed to be, already present in the Mill's tailings management system or were reported in other licensed alternate feed materials, at levels generally comparable to or higher than those reported in the Uranium Material, the resulting tailings will not be significantly different from existing tailings at the facility. As a result, there will be no incremental public health, safety or environmental impacts over and above previously licensed activities.

Processing of the Uranium Material involves no new construction, no additional use of land, no modification of the Mill, main circuit, alternate feed circuit, or tailings management system of any significance. The Uranium Material contains no new chemical or radiological constituents beyond those already processed in ores and approved alternate feed materials, or already known or expected to be present in the tailings management system. As a result, there are no anticipated impacts to the environment via any of the above pathways, above those already anticipated in the existing environmental statements and environmental assessments associated with the Mill's approved license, which have addressed, among other issues and requirements:

- Geology and soils,
- Liquid effluents,
- Airborne effluents,
- Direct radiation,
- Management of sanitary wastes,
- Human and ecological receptor hazard assessment,
- Mill accidents,
- Transportation accidents,
- Groundwater impacts,
- Surface water impacts,
- Mill decommissioning,
- Land, structures, site and tailings reclamation,
- Internal inspection program,
- Corporate organization and management,
- Radiological protection training,
- Security,
- Quality assurance for all phases of the milling program,
- Operational effluent monitoring,
- Operational radiological monitoring,
- Meteorological monitoring,
- Capacity of tailings system over the lifetime of the Mill operations,
- Permanent isolation of tailings including slope stability, settlement, and liquefaction potential,

- Consideration of below-grade disposal of tailings,
- Tailings design requirements including site location and layout, site area, geography, land use and demographic surveys, use of adjacent lands and waters, population distribution, demography, meteorology, air models, geology and soils, seismology, hydrologic description of the site, surface water, flooding determination, surface water profiles, channel velocities, shear stresses, groundwater hydrology, radiological surveys, site and uranium mill tailings characteristics, disposal cell cover engineering design, and design of erosion protection covers,
- Groundwater protection standards,
- Liner construction,
- Prevention of overtopping,
- Dike design, construction, and maintenance,
- Cover and closure at end of operations including radon attenuation, gamma attenuation, and cover radioactivity content,
- Effectiveness of final radon barrier including verification and reporting,
- Radium in cover materials,
- Radionuclides other than radium in soils,
- Non-radiological hazards,
- Completion of final radon barrier,
- Preoperational and operational monitoring programs,
- Effluent control during operations including gaseous and airborne particulates, liquids and solids, contaminated equipment, sources and controls of Mill wastes and effluents, sanitary and other Mill waste systems, effluents in the environment, effluent control techniques, external radiation monitoring program, airborne radiation monitoring, exposure calculations, bioassay program, contamination control program, airborne effluent and environmental monitoring program, groundwater and surface water monitoring program, control of windblown tailings and ore,
- Daily tailings inspections,
- Financial surety,
- Costs of long-term surveillance,
- Application for a groundwater discharge permit,
- Groundwater permit compliance monitoring,
- Background groundwater quality determination,
- Submission of data,
- Reporting of mechanical problems or discharge system failures,
- Correction of adverse effects, and
- Out of compliance status and procedures.

4.2 Transportation Considerations

4.2.1 Packaging and Mode of Transportation

The drummed Uranium Material from the Facility will be loaded into closed containers (trailers) at the WTP and transported by road to the Mill.

The Uranium Material will be shipped as Radioactive LSA I (low specific activity) Hazardous Material as defined by the Department of Transportation ("DOT") regulations. UPRR will arrange with a material handling contractor for the proper marking, labeling, placarding, manifesting and transport of each truckload of the Uranium Material. Shipments will be tracked by the shipping company from the Facility until they reach the Mill. Each shipment will be "exclusive use" (i.e., the only material on each vehicle will be the Uranium Material).

The containers and trucks involved in transporting the Uranium Material to the Mill site will be surveyed and decontaminated, as necessary, prior to leaving the WTP. The containers and trucks will be decontaminated again, as necessary, prior to leaving the Mill site.

In the maximum conservative case, UPRR will ship 5 trucks in a day 5 to 6 times per year

4.2.2 Transportation Impacts

For the following reasons, it is not expected that transportation impacts associated with the movement of the Uranium Material by truck from the Facility to the Mill will be significant:

a) Radiological Matters
The transport of radioactive materials is subject to limits on radiation dose rate measured at the transport vehicle as specified in the US Code of Federal Regulations. The external radiation standards for these shipments are specified in 10 CFR 71.47 sections (2) and (3) as less than 200 millirems per hour ("mrem/h") at any point on the outer surface of the vehicle, and less than 10 mrem/h at any point two meters from the outer lateral surfaces of the vehicle. All exclusive use trailer trucks will be scanned by UPRR prior to departure from the WTP to ensure that these limits are satisfied. From a radiologic standpoint, the Uranium Material is within the bounds of other ores and alternate feed materials licensed for processing at the Mill. The Uranium Material will be transported in sealed drums in covered exclusive use box-style trailers, in a similar fashion to other alternate feed materials, and as a result there will be no significant incremental radiological impacts associated with transportation of Uranium Material to the Mill, over and above other previously licensed ores and alternate feed materials at the Mill or from licensed activities at other facilities in the State of Utah.

b) Traffic Volume Matters
(i) *Comparison to Licensed Mill Operations*
Section 4.8.5 of the 1979 FES for the Mill noted that during the operations period, when area mining was at expected peak levels, approximately 68 round trips on local highways would be made by 30-ton ore trucks to the Mill per day (see the 1978 Dames and Moore Environmental Report for the Mill, p. 5-34). In contrast, the maximum quantity of Uranium Material to be produced per year may be expected to be transported in a total of approximately 10 truckloads in total per year, with a truckload containing one 20-ton container, loaded with sealed drums, If all the material to be shipped annually shipped were transported in one day, the maximum

additional truck traffic generated will be no greater than 10 trucks per day or approximately one truck per 2.5 hours for one day per year.

In addition, based on a licensed yellowcake capacity of 4,380 tons U_3O_8 per year (Mill license condition 10.1) a maximum of approximately 8,760,000 pounds of yellowcake would require shipment from the Mill to conversion facilities. This would require approximately 183-275 truck shipments from the Mill per year (based on 40-60 drums per truck, 800 lbs. per drum), or one truck every one to two days based on a seven day work week (one truck every day or so, based on a five-day work week). In contrast, the entire volume of yellowcake to be produced from processing the Uranium Material is expected to be transported in approximately two truckloads over the entire life of the project. These frequencies are minimal in comparison to the estimated yellowcake transport frequency at licensed capacity. Moreover, during the period of transportation of the Uranium Material to the Mill, EFRI does not expect that ore deliveries and alternate feed material deliveries from all other sources together with the Uranium Material would, in total, exceed the truck transportation associated with licensed capacity.

After leaving the WTP, the shipments may travel any of several routes into Utah. The likely route will be from the WTP via US Highway 40 to Interstate Highway 70, and west on Interstate Highway 70 into Utah, then onto Utah State Highway (SH) 191 north of Blanding and south on SH 191 to the Mill.

(ii) *Comparison to Existing Truck Traffic on US Highway 191*

The trucks will travel over Utah Highway 191 either north or south of the Mill, to reach the Mill.

Based on information from the State of Utah Department of Transportation ("UDOT") traffic analysis reports *Traffic on Utah Highways 2016* (with factors for types of truck traffic) accessed at the UDOT web page on February 3, 2019, on average during 2016, 544 multi-unit trucks traveled daily on segments of US Highway 191 north of the Mill. Based on the 2017 UDOT truck traffic information, the maximum of 10 additional trucks per day traveling this route to the Mill during the limited period anticipated for shipment of the Uranium Material represents an increased traffic load of approximately 2 percent for no longer than one day per year or one truck per day for approximately ten days per year. Therefore, the truck traffic to the Mill from this project is expected to be an insignificant portion of existing truck traffic on US Highway 191 and well within the level of truck traffic expected from normal Mill operations.

4.2.3 Transportation Accidents

As discussed in Section 2.3 and Attachment 5, the Uranium Material has a uranium content and radioactivity levels comparable to Arizona Strip ores and previously-approved alternate feed materials, and contains no additional constituents beyond those associated with other ores or alternate feed materials previously transported to the Mill. The Uranium Material will be transported in sealed drums contained in 20-ton transport containers. Therefore the Uranium Material poses no additional hazards during transport above previously licensed activities. Existing accident response and spill response procedures are therefore sufficient for management of potential transportation accidents or spills of the Uranium Material.

4.3 Storage

4.3.1 Manner of Storage

Trucks arriving at the Mill site will be received according to existing Mill procedures. The sealed drums will be unloaded from the trucks onto the ore pad for temporary storage until the material is scheduled for processing.

4.3.2 Environmental Impacts Associated With Storage

Because the Uranium Material does not significantly differ in radiological activity from other ores and alternate feed materials, and because the Uranium Material will be stored in sealed drums on the Mill's ore pad pending processing, there will be no environmental impacts associated with the Uranium Material over and above those associated with other drummed alternate feed materials handled at the Mill on a routine basis. Experience at the Facility has determined that the Uranium Material is stable under ambient environmental conditions and does not require any special handling.

4.4 Process

The Uranium Material will be introduced to the process in either the alternate feed circuit or in the main circuit either alone or in combination with other conventional ores or other alternate feed materials. Because the material is moist with 75 to 90 % moisture content, it is not expected to produce dust upon emptying of drums or introduction into the Mill process. The material will be processed through existing acid leach, solid liquid separation and solvent extraction circuits for the recovery of uranium values. The leaching process will begin either in the main circuit leach tanks with the addition of sulfuric acid, or in the alternate feed circuit. The solution will be advanced through the remainder of the Mill or alternate feed circuit with no significant modifications to either the circuit or the recovery process anticipated. The only wastes or effluents to be generated from processing the Uranium Material are solutions or solids to be transferred to the Mill's existing tailings management system.

Since no significant physical changes to the Mill circuit and no new process chemicals will be necessary to process this Uranium Material, no significant construction impacts beyond those previously assessed will be involved. Recovery of additional contained metals is not anticipated at this time.

As with other alternate feed materials, a Standard Operating Procedure ("SOP") specific to processing of the Uranium Material, addressing processing procedures, personnel safety and radiation or other exposure monitoring will be developed and reviewed by the Mill's Safety and Environmental Review Panel ("SERP'), and Mill personnel will be trained in the approved SOP prior to processing of the Uranium Material.

The effects of introducing the Uranium Material into the Mill's process and tailings were reviewed by EFRI's consulting chemical process engineer. The consulting engineer's Technical Memorandum is included as Attachment 5. Table 5 in this Technical Memorandum provides

comparisons of the concentrations of all known constituents of the Uranium Material to the tailings and other previously processed ores and alternate feed materials. As discussed in Section 4.5 below, and in Attachment 5, the existing tailings system and tailings management system controls are adequate for management of any tailings generated from the Uranium Material.

4.4.1 Mill Accidents and Emergency Response

As discussed in Section 2.4 and Attachment 5, the Uranium Material has a uranium content and radioactivity levels comparable to Arizona Strip ores, and previously-approved alternate feed materials, and contains no additional constituents beyond those associated with other ores or alternate feed materials previously transported to the Mill. Therefore the Uranium Material poses no additional hazards during storage, processing or disposal of tailings. As discussed in Attachment 5, the Uranium Material will not introduce any new hazardous constituents, and processing will not require the introduction of any new processing chemicals. Existing emergency response and spill response procedures are therefore sufficient for management of potential accidents or spills of the Uranium Material on the Mill site.

4.5 Compatibility with EFRI Mill Tailings

4.5.1 Physical Compatibility

The Uranium Material will be received as moist solid cake from centrifugation in the WTP. All the non-uranium components of the material will eventually be discharged to the Mill's tailings management system. Cell 3 and Cell 4A are currently the active tailings cells at the Mill and either could receive tailings from the Uranium Material. However, because filling of Cell 3 is nearing completion, tailings from the Uranium Material will more likely be placed in Cell 4A. The evaluations in this application and its attachments are therefore based on placement of tailings in Cell 4A.

The solutions from the Uranium Material tailings will be recirculated through the mill process for reuse of the acidic properties in the solution. The solids will be only a portion of the total mass of Uranium Material. However, assuming a worst case scenario that all of the solid material ends up in the tailings, it is estimated that for the main processing circuit, the additional load to the tailings is minimal (Attachment 5, Tables 4-1 and 4-2). It is expected that the concentration of the majority of constituents in tailings will decrease after the Uranium Material is deposited in the tailings impoundments.

Based on Tables 4-1 and 4-2, barium concentrations in Cell 4A may increase up to 2 mg/kg over the current level of 0.1 mg/kg in Cell 4A. Again, it should be noted, that the barium level in the Uranium Material is 110 times lower than that of certain other alternate feed materials previously approved and processed at the Mill, such as Molycorp Mountain Pass drummed material.

Cell 4A, which has been in service since October of 2008, has received tailings solids and solutions primarily from conventional ore processing together with a small volume from alternate feed material processing. Cell 4B, placed into service in February 2011, currently serves as an evaporation pond and receives only solutions at this time. Cell 4A has primary and

secondary high-density polyethylene ("HDPE") flexible membrane liners, a geosynthetic clay underliner, and a leak detection system design, selected specifically to meet current standards for uranium mill tailings management.

The constituents in the tailings resulting from processing the Uranium Material are not expected to be significantly different from those in the conventional ores either in composition or in concentration of constituents. The Technical Memorandum on Worker Safety, Environmental Issues and Chemical Compatibility (the "Safety and Compatibility Technical Memorandum", Attachment 5) indicates that all of the constituents found in the Uranium Material have previously been processed in the Mill's circuits and managed in the Mill's tailings system.

The Safety and Compatibility Technical Memorandum identified that the components of the Uranium Material are not expected to have any adverse effect on the Mill processing system or the tailings cells. As described in Attachment 5, it is expected that most of the metal and non-metal impurities entering the leach system with the Uranium Material will be converted to sulfate ions, precipitated, and eventually discharged to the tailings management system.

Every metal and non-metal cation and anion component in the Uranium Material already exists or can be assumed to exist in the Mill's tailings management system, is already addressed in the Mill's groundwater monitoring program, or both. A summary of the anticipated tailings composition before and after the Uranium Material is processed is presented in the Safety and Compatibility Technical Memorandum Attachment 5.

Every identified component in the Uranium Material has been:

1. detected in analyses of the tailings management system;
2. detected in analyses of alternate feed materials licensed for processing at the Mill; or
3. detected in process streams or intermediate products when previous alternate feed materials were processed at the Mill;

at concentrations that are generally comparable to the concentrations in the Uranium Material. However, even if the Uranium Material were to contain some constituents at significantly higher concentrations, due to the limited quantity of Uranium Material, any such increase in the concentration of any analyte in the Mill's tailings management system would not be expected to be significant. The estimated effect on tailings management system composition is discussed in the attached technical memorandum.

The constituents in the Uranium Material are expected to produce no incremental additional environmental, health, or safety impacts in the Mill's tailings system beyond those produced by the Mill's processing of natural ores or previously approved alternate feed materials.

4.5.2 Capacity and Throughput

The amount of tailings that would potentially be generated from processing the Uranium Material is equivalent to the volume that would be generated from processing an equivalent volume of conventional ore. Processing of the Uranium Material will have no effect on the capacity of the tailings management system over the lifetime of the Mill operations beyond that

of processing a similar amount of natural ore. The WTP, as described above, may be expected to ship a total of approximately 5,000 tons of Uranium Material to the Mill over its lifetime. This volume is well within the maximum annual throughput rate and tailings generation rate for the Mill of 720,720 tons per year. EFRI has updated the Tailings Capacity Review, a copy of which is available for review at the Mill. The Tailings Capacity Review confirms that there is more than adequate capacity to accommodate the tailings from the Uranium Material. Additionally, the design of the existing tailings management system has previously been approved by the Utah DWMRC (Cells 4A and 4B), and EFRI is required to conduct regular monitoring of the leak detection systems and of the groundwater in the vicinity of the tailings management system to detect any potential leakage should it occur. A copy of the updated Tailings Capacity Review is available for review at the Mill.

4.5.3 Mill Tailings Closure and Reclamation

Processing of the Uranium Material will have no effects beyond those identified in the approved ERs, ESs, and Reclamation Plans for tailings operational management and closure. The Uranium Material will have no effect on existing approved plans for decommissioning of the Mill, buildings, land or structures, or reclamation of the site. The Uranium Material will have no effect on tailings design components addressing permanent isolation of tailings, slope stability, settlement or liquefaction of reclaimed tailings, or design features addressing disposal cell covers or erosion protection.

Because radionuclide content is within the ranges associated with other ores and alternate feed materials approved for processing at the Mill, there will be no effect on radon attenuation, gamma attenuation or cover radionuclide content. Because it will not affect cover design at closure and reclamation, there will be no effect on the final radon barrier design or its method of emplacement, radium concentration in cover materials, or other cover radionuclide content. Processing of the Uranium Material will have no effect on completion of the final radon barrier or on the timetable for completion of reclamation. Processing of the Uranium Material will not require the acceptance of uranium byproduct material from other sources during closure.

Because processing the Uranium Material will have no effect on reclamation and closure design, construction or timing, it will have no effect on existing and approved financial surety estimates or arrangements, and will not require any changes to costs of long-term surveillance.

4.6 Groundwater

In the 1997 EA, NRC staff concluded that, for a number of reasons, groundwater beneath or in the vicinity of the Mill site will not be adversely impacted by continued operation of the Mill. Because the Mill's tailings management system are not impacting groundwater, the receipt and processing of Uranium Material at the Mill will not have any incremental impacts on groundwater over and above existing licensed operations.

EFRI meets the State of Utah Groundwater Protection Standards by complying with the Mill's current Groundwater Discharge Permit ("GWDP"). The Mill initially applied for a GWDP in 2005. The current version was approved in March 2019. The primary groundwater protection standard in UAC R313-24-4 is a design standard for surface impoundments used to manage

uranium and thorium byproduct material. The design of the Mill's Cell 4A, which will receive tailings from processing the Uranium Material, has been approved by DWMRC as meeting Best Available Technology Requirements for the liners and other components of the containment system.

The GWDP established points of groundwater monitoring compliance, a compliance monitoring program, and agreed to the establishment of intra-well background for comparison with groundwater compliance limits. The GWDP further established requirements for submission of field and laboratory monitoring data, reporting of mechanical problems or discharge system failures, correction of adverse effects, assessment of corrective actions, and notification, reporting and procedures during any out-of-compliance status. Since the issuance of the initial GWDP, the Mill has not sought to discontinue the GWDP.

All constituents identified in the Uranium Material, are already present or can be assumed to be present in the Mill's tailings management system, are already included in the Mill's groundwater monitoring program, or both.

Chemical and radiological make-up of the Uranium Material is similar to other ores and alternate feed materials processed at the Mill, and their resulting tailings will have the chemical composition of typical uranium process tailings, for which the Mill's tailings management system was designed. As a result, the existing groundwater monitoring program at the Mill will be adequate to detect any potential future impacts to groundwater.

As a result, there will be no incremental impacts over and above previously licensed activities.

4.7 Surface Water

There will be no discharge of Mill effluents to local surface waters. All Mill process effluents, and analytical laboratory liquid wastes will be discharged to the Mill's tailings management system for disposal by evaporation. Runoff from the Mill and facilities is directed to the tailings management system. Sanitary wastes are discharged to State-approved leach fields. Since there is no plausible pathway for Uranium Material to impact surface water, and, as indicated in Semi-Annual Effluent Reports filed by the Mill to date, there is no indication of the Mill impacting surface waters, then there will be no incremental impact to surface waters from any airborne particulates associated with processing the Uranium Material.

The Uranium Material will be transported to the Mill in closed steel drums in exclusive use trucks. Upon introduction into the Mill circuit, the Uranium Material will be processed in a similar fashion as other ores and alternate feed materials. The Uranium Material will be moist, with an average moisture content of 78% and is not expected to produce dust during unloading or introduction into the Mill process. There will therefore be no new or incremental risk of discharge to surface waters resulting from the receipt and processing of Uranium Material at the Mill or the disposition of the resulting tailings.

Finally, as the chemical and radiological make-up of the Uranium Material are sufficiently similar to natural ores and other alternate feed materials and the tailings resulting therefrom, that the existing surface water monitoring program at the Mill will be adequate to detect any potential

impacts to surface water. As a result, there will be no incremental impacts over and above previously licensed activities.

4.8 Airborne Radiological Impacts

The chemical and radiological make-up of the Uranium Material will not be significantly different from natural ores and other alternate feed materials that that have been licensed for processing at the Mill in the past. The existing air particulate monitoring program is equipped to handle all such ores and alternate feed materials.

4.9 Radon and Gamma Impacts

As discussed in Section 2 above, the uranium content and radioactivity levels of the Uranium Material is comparable to Arizona Strip ores and previously approved alternate feed materials. In fact, the Ra-226 concentrations are much lower than Arizona Strip ores. Therefore, Rn-222 emanations from the Uranium Material will be significantly lower than from the same quantity of ores. Also, the gamma fields from the U-nat chain are derived primarily from Ra-226, which is very low, less than 12 pCi/g. Therefore, the gamma from the U-nat chain in the Uranium Material will be low. The natural thorium is also very low relative to Arizona Strip ores, averaging 0.002%. Overall, the Uranium Material will therefore pose a lower gamma and radon hazard as other ores and alternate feed materials that have already been processed or licensed for processing at the Mill.

4.10 Safety Measures

4.10.1 General

During unloading of the Uranium Material drums onto the ore pad, while the Uranium Material is being stored in drums on the ore pad pending processing, while feeding Uranium Material into the Mill process and while processing the Uranium Material and disposing of and managing the resulting tailings, the Mill will follow existing Mill SOPs in addition to an SOP to be developed specific to the Uranium Material, as discussed below.

4.10.2 Radiation Safety

a) Existing Radiation Protection Program at the Mill
The radiation safety program which exists at the Mill, pursuant to the conditions and provisions of the Mill's Radioactive Materials License, and applicable State Regulations, is adequate to ensure the protection of the worker and environment, and is consistent with the principle of maintaining exposures of radiation to individual workers and to the general public to levels As Low As Reasonably Achievable ("ALARA"). Employees will be provided with personal protective equipment including full-face respirators, if required. In addition, all workers at the Mill are required to wear personal Optically Stimulated Luminescence ("OSL") badges or the equivalent to detect their exposure to gamma radiation.

b) Gamma Radiation

Gamma radiation levels associated with the Uranium Material are within levels of gamma radiation, or in fact lower than those, associated with other ores and alternate feed materials processed or licensed for processing at the Mill in the past. Gamma exposure to workers will be managed in accordance with existing Mill SOPs.

c) Radon
Radon levels associated with the Uranium Material are within levels of radon associated with other ores and alternate feed materials processed or licensed for processing at the Mill in the past. Radon exposures to workers will be managed in accordance with existing Mill standard operating procedures.

d) Control of Airborne Contamination
The Uranium Material will be moist with a moisture content of 75 to 90%. While stored on the ore pad, the uranium material will remain within the drums used for transport. The Uranium Material will be stored in an area on the ore pad separate from regular traffic and marked as Uranium Material.

Dust suppression techniques will be implemented, if required, while the Uranium Material is being introduced into the Mill process. Once in the Mill process, the Uranium Material will be in a dissolved form, and no special dust suppression procedures will be required. As is the practice at the Mill for other alternate feed materials, the DAC to be used in any analysis of airborne particulate exposure to workers will be developed specifically for the Uranium Material, based on applicable regulations and Mill procedures, in order to take into account the specific radionuclide make-up of the Uranium Material. The Mill has safely received and processed alternate feed materials with comparable concentrations of the radionuclides contained in the Uranium Material, under previous license amendments, and can safely handle the Uranium Material in accordance with existing Mill standard operating procedures.

4.10.3 Occupational Safety

The primary focus of safety and environmental control measures will be to manage potential exposures from radionuclide particulates. Response actions and control measures designed to manage particulate radionuclide hazards will be more than sufficient to manage chemical hazards from the metal oxides (see the conclusions of the Safety and Compatibility Technical Memorandum in Attachment 5).

4.10.4 Vehicle Scan

As stated in Section 4.2.1 above, the shipments of Uranium Material to and from the Mill will be dedicated, exclusive loads. Radiation surveys and radiation levels consistent with applicable DOT regulations will be applied to the exclusive use vehicles. For unrestricted use, radiation levels will be in accordance with applicable values contained in the NRC Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct, Source, or Special Nuclear Material, U.S. NRC, April, 1993. If radiation levels indicate values in excess of the above limits, appropriate decontamination procedures will be implemented.

4.11 Long Term Impacts

The Uranium Material is comprised of similar chemical and radiological components as already exist in the Mill's tailings cells. Existing monitoring programs are therefore adequate, and no new monitoring procedures are required. As a result, there will be no decommissioning, decontamination or reclamation impacts associated with processing the Uranium Material, over and above previously licensed Mill operations.

4.12 Other Operational Considerations

Processing of the Uranium Material will not require changes to corporate organization or administrative procedures, management control programs, management audit and inspection programs, staffing levels or staff qualifications. Processing will not require modifications to the Mill's existing security procedures.

4.13 Added Advantage of Recycling

UPRR has expressed its preference for use of recycling and mineral recovery technologies for the Uranium Material for three reasons: 1) for the environmental benefit of reclaiming valuable minerals; 2) for the added benefit of reducing radioactive material disposal costs; and 3) for the added benefit of minimizing or eliminating any long term contingent liability for the waste materials generated during processing.

UPRR has noted that the Mill has the technology necessary to process materials for the extraction of uranium and to provide for disposal of the 11e.(2) byproduct material, resulting from processing primarily for the uranium, in the Mill's existing tailings management system. As a result, UPRR will contractually require EFRI to recycle the Uranium Material at the Mill for the recovery of uranium.

4.14 Consideration of Alternatives

This application is in response to a request by UPRR for disposal/processing options for solids produced from removal of radionuclides and metals from groundwater at the WTP, in order for UPRR to comply with the conditions of its CDPHE license. The Mill is a facility that has been requested to provide these services, because it is licensed to process materials for the recovery of uranium and is licensed to create, possess and dispose of byproduct materials that are similar to the Uranium Material. Given that removal of the Uranium Material to an offsite facility is required to meet the WTP's license conditions, the only options are as to which offsite facility the Uranium Material will ultimately be sent for reprocessing or disposal. UPRR has determined that the Mill is the only off-site facility capable of re-processing the Uranium Material. Therefore, the alternative to processing/disposal at the Mill would be direct disposal. If direct disposal is utilized, the value of the recoverable uranium in the Uranium Material would not be realized.

5.0 CERTIFICATION

This application and Environmental Report has been submitted as of December 23, 2019 by

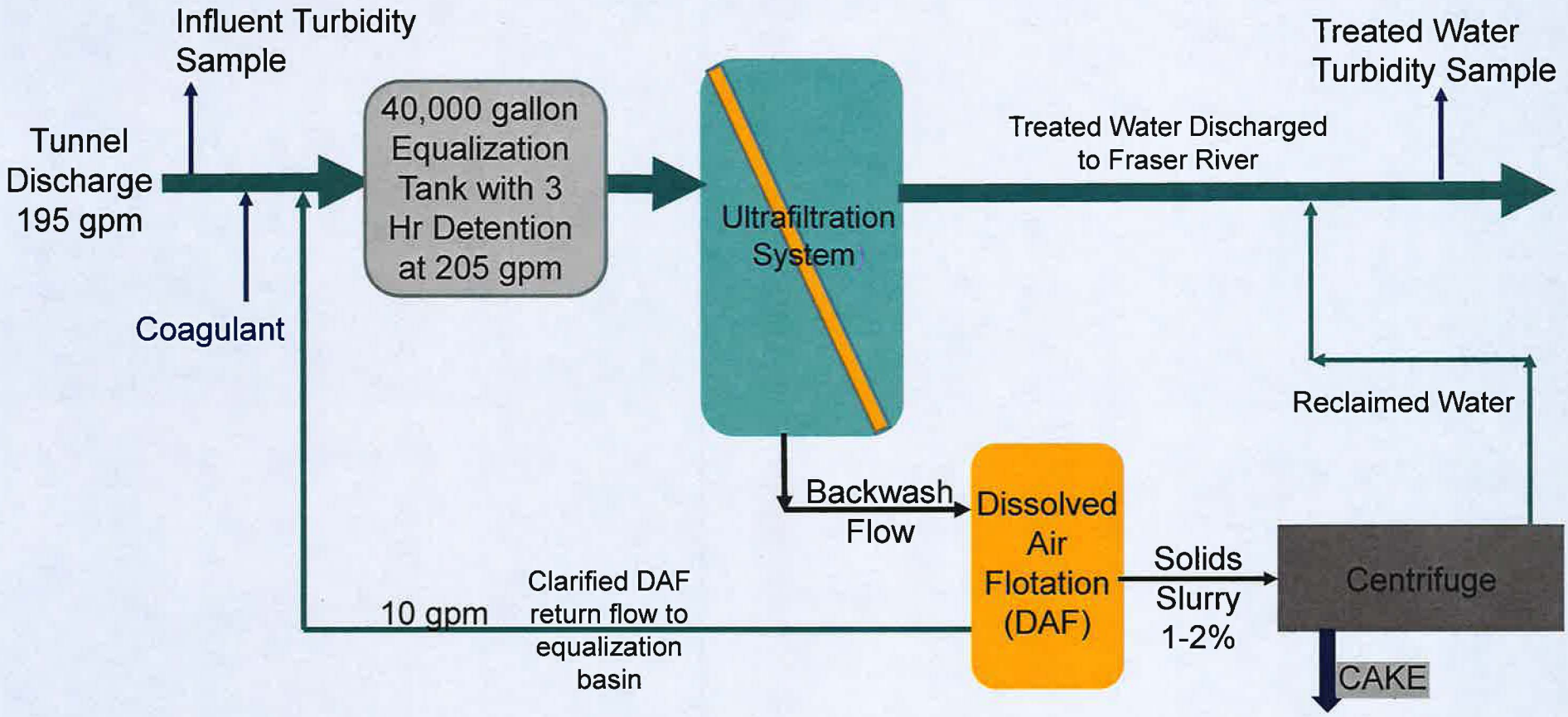
ENERGY FUELS RESOURCES (USA) INC.

By:

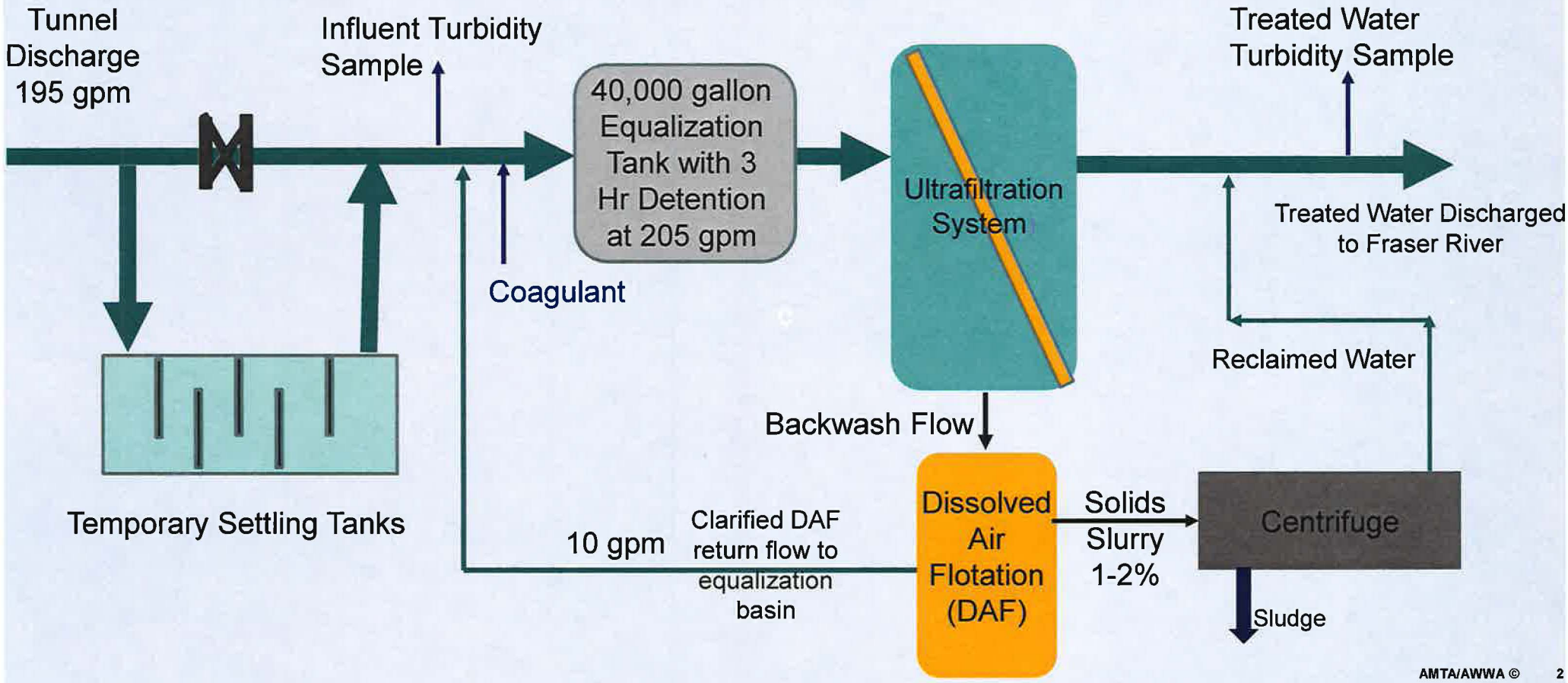
By:_____ Date: 12/23/19
David C. Frydenlund
Chief Financial Officer, General Counsel and Corporate Secretary

ATTACHMENT 1
Union Pacific Moffat Tunnel Facility Information

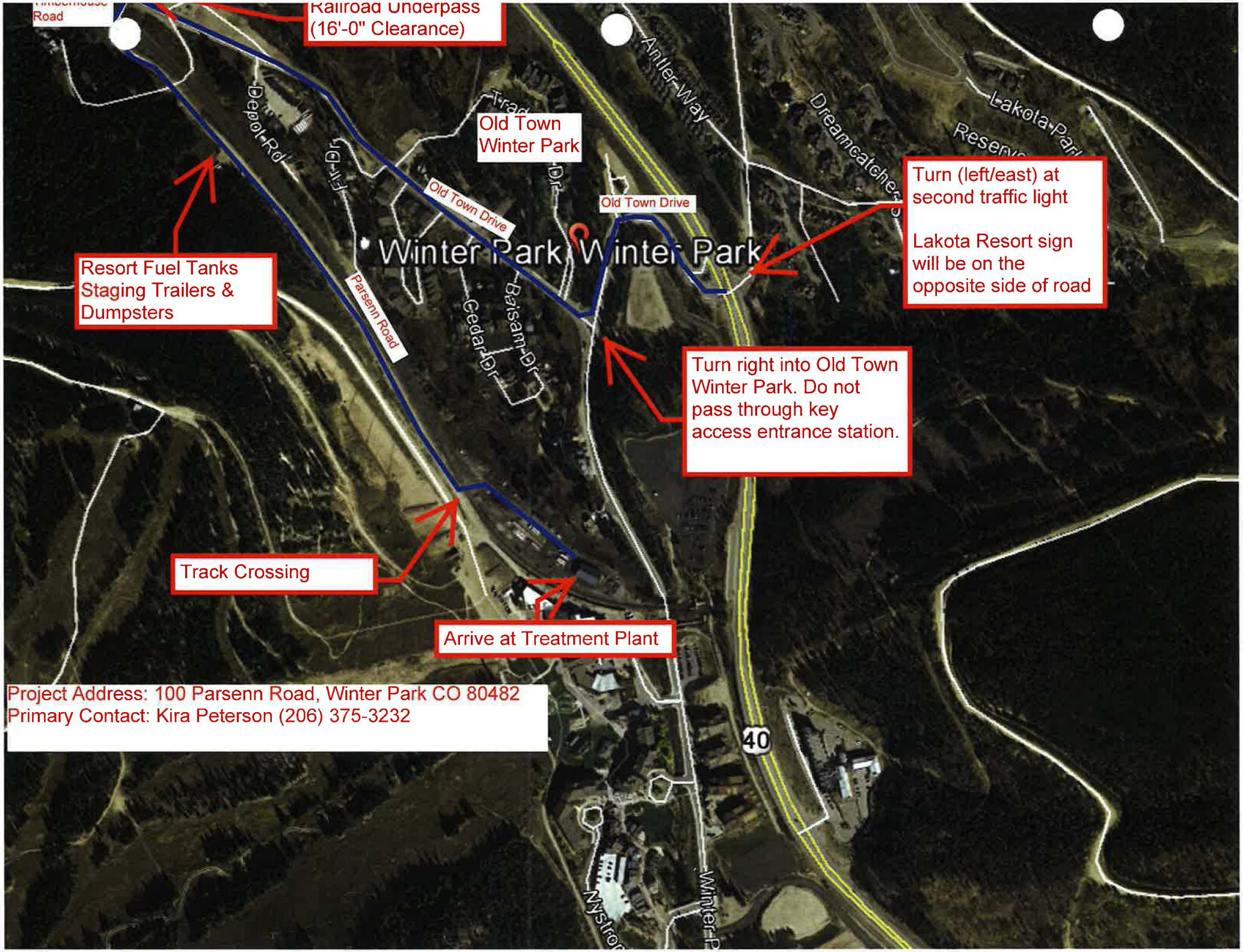
Ultrafiltration Treatment Process Installed 2017



Add'l Pretreatment During Major Construction



200 gpm
Ultrafiltration
System


Railroad Underpass
(16'-0" Clearance)
Old Town
Winter Park
Old Town Drive
Old Town Drive
Winter Park
Winter Park
Depot Rd
Parsenn Road
Cedar Dr
Balsam Dr
Antler Way
Dreamcatcher
Lakota Park
Reserve
Resort Fuel Tanks
Staging Trailers &
Dumpsters
Turn (left/east) at
second traffic light
Lakota Resort sign
will be on the
opposite side of road
Turn right into Old Town
Winter Park. Do not
pass through key
access entrance station.
Track Crossing
Arrive at Treatment Plant
Project Address: 100 Parsenn Road, Winter Park CO 80482
Primary Contact: Kira Peterson (206) 375-3232
40

ATTACHMENT 2
Radioactive Material Profile Record and Affidavit

'RADIOACTIVE MATERIAL PROFILE RECORD

'Name and Title of Person Completing Form: **Jonathan Reed, PE** Phone: **303.877.8603**

Original Submission: Y __X__ N _____; Revision # __N/A__; Date of Revision: __N/A__

Generator Name: **Union Pacific Railroad** Generator/Feed Stream #: __N/A__; Volume of Feed Material __60-100 tons/year__

Contractor Name: __N/A__, Feed Stream Name: __Centrifuge Cake__, Delivery Date: __N/A__

Check all appropriate boxes:

Licensed Y __X__ N___ ***CDPHE License Number CO 1274-01 pending. Union Pacific Railroad (UPRR) is seeking a CDPHE Radioactive Material License. UPRR is currently in the process of finalizing the license application process and anticipates license approval no later than the next 2-5 months.***

NORM/NARM **X**; LLRW ___; MW ___; MW Treated ___; MW Needing Trtmt ___; DOE ___; 11e. (2) ___;

A. CUSTOMER INFORMATION:

GENERAL: Please read carefully and complete this form for one feed stream. This information will be used to determine how to properly manage the material. Should there be any questions while completing this form, contact Energy Fuels Resources (USA) Inc.'s ("EFRI's") Manager of Compliance and Licensing at 303.389.4132. MATERIALS CANNOT BE ACCEPTED AT EFRI'S WHITE MESA MILL UNLESS THIS FORM IS COMPLETED. If a category does not apply, please indicate. This form must be updated annually.

1. GENERATOR INFORMATION

EPA ID# __N/A__ EPA Hazardous Waste Number(s) (if applicable) __N/A__

Mailing Address: __1400 W 52nd Avenue, Denver, CO 80221__

Phone: __(303) 405-5072__ Fax: __(303) 405-5006__

Location of Material (City, ST): __Winter Park, CO__

Generator Contact: __Steven Preston__ Title: __Senior Supervisor__

Mailing Address (if different from above): __Same as above__

Phone: **Same as above** Fax: **Same as above**

B. MATERIAL PHYSICAL PROPERTIES (Should you have any questions while completing this section, contact EFRI's Manager of Compliance and Licensing at 303.389.4132.)

1. PHYSICAL DATA (Indicate percentage of material that will pass through the following grid sizes, e, g, 12" 100%, 4" 96%, 1" 74%, 1/4" 50%, 1/40" 30%, 1/200" .5%) **No Data**

GRADATION OF MATERIAL:

12"	100%
4"	95%
1"	90%
1/4"	84%
1/40"	65%
1/200"	57%

2. DESCRIPTION: Color **Dark Brown** Brown/Multi___ Odor___ Odorless **X**
   Liquid___ Solid___ Sludge **X** Powder/Dust___

3. DENSITY RANGE: (Indicate dimensions) S.G. **65-85 lb. /ft^3** lb. /yd^3

4. GENERAL CHARACTERISTICS (% OF EACH)
   Soil___ Building Debris___ Rubble___ Pipe Scale___ Tailings___ Process Residue_X_ Concrete___
   Plastic/Resin___
   Other constituents and approximate % contribution of each: **100% Inorganic Industrial Wastewater Treatment Plant Residuals**

Generator or Contractor Initials: _____

5. MOISTURE CONTENT: (For soil or soil-like materials).
(Use Std Proctor Method ASTM D-698 or equivalent)

Low Moisture Content: **75 %**
High Moisture Content: **83 %**
Average Moisture Content: **estimated *78%***

DESCRIPTION OF MATERIAL Attach a description of the material (as *Attachment B.6*) with respect to its physical composition and characteristics such as geotechnical or engineering information (for example, if information is available regarding percent [%] sands, clay or debris). **No official geotechnical or engineering information is available. The material is dark brown or gray, with a clay-like consistency. A photograph of the waste material is included in Attachment B.6.**

C. RADIOLOGICAL EVALUATION

1. MATERIAL INFORMATION. For each radioactive isotope listed below, obtain sufficient samples to adequately determine a range and weighted average of activity in the material. If Uranium, Thorium, or other non-gamma emitting nuclides are present in the material, have at least (1) sample evaluated by radiochemistry to determine the concentration of these additional contaminants in the material. EFRI's license assumes daughter products to be present in equilibrium. Add isotope information as necessary for the proposed alternate feed material. Analytical data packages, including quality control information, MUST be included for all data summarized below (as *Attachment C.1*).

Isotope	Composite Sample (pCi/g)	Grab Sample (pCi/g)
Pb 210	ND	ND
U Nat (U238+235+234)	1470.1	1410.6
Th 228	1.52	1.58
Th 230	11.7	11.28
Th 232	ND	2.06
Rad 226	11.7	11.8
Rad 228	ND	2.06
Others (Please Specify)		

ND – Analyte not detected.

(Please Circle)

2. Y **N** Is the radioactivity contained in the feed material Low-Level Radioactive Waste as defined in the Low-Level Radioactive Waste Policy Amendments Act of 1985 or in DOE Order 5820.2A. Chapter III? ***If yes, check "LLRW" block on line 3 of page 1.***

3. **Y (pending)**LICENSED MATERIAL: Is the feed material listed or included on an active Nuclear Regulatory Commission or Agreement State license?
(If Yes) TYPE OF LICENSE: Source __**X**___; Special Nuclear Material _____; By-Product _____; Norm ___; NARM ____;
LICENSING AGENCY: **Colorado Department of Public Health and the Environment**
LICENSE NUMBER: ***CDPHE License Number CO 1274-01 pending. Union Pacific Railroad (UPRR) is seeking a CDPHE Radioactive Material License. UPRR is currently in the process of finalizing the license application process and anticipates license approval no later than the next 2-5 months.***

D. CHEMICAL AND HAZARDOUS CHARACTERISTICS

1. DESCRIPTION AND HISTORY OF MATERIAL

Please attach a description of the material to this profile (as *Attachment D.1 a through f*). Include the following as applicable:
a. The process by which the material was generated. Including available process knowledge of the material.
b. The basis of hazardous material determination or waste characterization determinations.
c. A list of the chemicals and materials used in or commingled with the material.

Generator or Contractor Initials: _____

d. A list of any and all current or former applicable EPA Hazardous Waste Numbers.
e. A list of any and all applicable land-disposal prohibition or hazardous-waste exclusions, extensions, exemptions, effective dates, variances or delistings.
f. Attach any product information or Material Safety Data Sheets associated with the material.

If a category/description listed in a through f above does not apply, describe why it does not.

Please describe the history, and include the following:

The waste material is generated from the treatment of groundwater flowing through a railroad tunnel. The groundwater contains naturally occurring radioactive material (NORM) from the Rocky Mountains and picks up inorganic solids particles as it passes through the tunnel. Upon entering the treatment plant, the groundwater is treated first by the addition of a coagulant, aluminum chlorohydrate (SDS attached, chemical name Calchem CC2000), following by direct filtration in an ultrafiltration membrane system. Backwash water from the ultrafiltration membrane system containing coagulated solids is pumped through a dissolved air flotation system where a very small amount of 7th generation dish soap (<0.001% by volume, SDS attached) is added to assist in thickening of the solids via flotation. The thickened solids are further dewatered using a centrifuge in conjunction with a very small amount of polymer, <0.001% by volume, (Zetag 120L, SDS attached), which is added to the thickened solids prior to addition to the centrifuge. The waste has about 75-90% moisture content and 0.13-0.14% uranium. The generation of the waste is a continuous process, driven by the requirement to achieve NPDES permit limits in the water discharged from the treatment plant back to the Fraser River. The waste does not exceed any TCLP limits designating it as possessing the RCRA toxicity characteristic, nor is it reactive or flammable;, therefore it is not a RCRA characteristic hazardous waste.

(Please Circle)

Y (N) Was this material mixed, treated, neutralized, solidified, commingled, dried, or otherwise processed at any time after generation?
Y (N) Has this material been transported or otherwise removed from the location or site where it was originally generated?
Y (N) Was this material derived from (or is the material a residue of) the treatment, storage, and/or disposal of hazardous waste defined by 40 CFR 261?
Y (N) Has this material been treated at any time to meet any applicable treatment standards?

2. LIST ALL KNOWN AND POSSIBLE CHEMICAL COMPONENTS OR HAZARDOUS WASTE CHARACTERISTICS

The generator may use its knowledge of processes and materials to in lieu of analytical data EXCEPT as required by Section 3. Any "yes" response will require the submission of appropriate analytical data with this RMPR (as *Attachment D.2*).

	Y	N		Y	N		Y	N
General			**Metals**			**Metals (cont'd)**		
Listed Waste		X	Arsenic – TCLP*		X	Nickel – Total*		X
"Derived-From" HW		X	Barium – TCLP*	X		Selenium – Total*		X
Characteristic			Cadmium – TCLP*		X	Silver – Total*		X
Reactive - CN		X	Chromium – TCLP*		X	Thallium – Total*		X
Reactive Sulfide		X	Lead – TCLP*		X	Tin – Total*		X
Ignitable		X	Mercury – TCLP*		X	Uranium – Total*	X	
Corrosive		X	Selenium – TCLP*		X	Vanadium – Total*	X	
Toxic (as determined by TCLP analysis)		X	Silver – TCLP*		X	Zinc – Total*	X	
Organics			Arsenic – Total*	X		**Miscellaneous**		
VOCs		X	Barium – Total*	X		Explosives		X
SVOCs		X	Beryllium – Total*		X	Pyrophorics		X
Pesticides		X	Cadmium – Total*		X	Infectious		X
Herbicides		X	Chromium – Total*		X	Chelating Agents		
Dioxins		X	Cobalt – Total*	X		Residue from WWT Plant	X	

Generator or Contractor Initials: _____

Radioactive Material Profile Record

						(not biologically active, industrial treatment plant treating inorganic material)		
PCBs		X	Copper – Total*	X		**Anions**		
Solvents		X	Iron – Total*	X		Fluoride*	X	
Alcohols		X	Lead – Total*	X		Nitrate*		X
Fuel		X	Manganese – Total*	X		Nitrite*		X
Oil		X	Mercury – Total*	X		Sulfate*	X	
Phenolics		X	Molybdenum – Total*		X	Sulfide*		X

*Analytical data are required for these constituents regardless of generator knowledge of process or materials.

Generator or Contractor Initials: _____

3. REQUIRED ANALYTICAL RESULTS. Generator must submit results of analyses of samples of the material. Results are required from a qualified laboratory for the following analytical parameters. Attach all analytical results and QA/QC documentation available (as *Attachment D.3*). (CAUTION: PRIOR TO ARRANGING FOR LABORATORY ANALYSIS, CHECK WITH EFRI REGARDING UTAH LABORATORY CERTIFICATIONS.) Please summarize results on the blank spaces provided.

Analyte	TCLP Range or Maximum (mg/L) Grab/Composite	Total Concentration Range or Maximum (mg/kg) Grab/Composite
Arsenic	ND/ND	10.0/10.9
Barium	1.46/1.50	276/311
Beryllium	NA	ND/ND
Cadmium	ND/ND	ND/ND
Chromium	ND/ND	ND/ND
Cobalt	NA	6.40/7.31
Copper	NA	114/128
Iron	NA	22,200/30,200
Lead	ND/ND	144/164
Manganese	NA	377/431
Mercury	ND/ND	1.15/1.28
Molybdenum	NA	ND/ND
Nickel	NA	ND/ND
Selenium	ND/ND	ND/ND
Silver	ND/ND	ND/ND
Thallium	NA	ND/ND
Tin	NA	ND/ND
Uranium	NA	4,530/4,890
Vanadium	NA	31.7/34.8
Zinc	NA	426/485
Fluoride	NA	4.14/5.30
Nitrate	NA	ND/ND
Nitrite	NA	ND/ND
Sulfate	NA	74.7/87.9
Sulfide	NA	ND/ND

ND = Not Detected NA-Not analyzed

Additional Required Analytical Information:

pH (liquids only):__**8.03**_____

Paint Filter Liquids Test (Please Circle): (**Pass**) Fail

Free Liquid Present (Please Circle): Yes (**No**)

Is the material a RCRA oxidizer? (Please Circle): Yes (**No**)

4. PRE-SHIPMENT SAMPLES OF MATERIAL TO EFRI

Once permission has been obtained from EFRI, and unless amenability samples have previously been sent to EFRI, please send 5 representative samples of the material to EFRI. A completed chain of custody form must be included with the sampling containers. These samples will be used to establish the material's incoming shipment acceptance parameter tolerances and may be analyzed for additional parameters. Send about two pounds (one liter) for each sample in an air-tight clean glass container via United Parcel Post (UPS) or Federal Express to:

Energy Fuels Resources (USA) Inc., Attn: Sample Control, 6425 S. Highway 191, P.O. Box 809, Blanding, UT 84511
Phone: (435) 678-2221

Generator or Contractor Initials: _____

5. LABORATORY CERTIFICATION INFORMATION. Please indicate below which of the following categories applies to your laboratory data.

   a. All radiologic data used to support the data in item C.1. must be from a certified laboratory.

   __X__UTAH CERTIFIED. The laboratory holds a current certification for the applicable chemical or radiological parameters from the Utah Department of Health insofar as such official certifications are given.

   ____GENERATOR'S STATE CERTIFICATION. The laboratory holds a current certification for the applicable chemical parameters from the generator's State insofar as such official certifications are given, or

   ____GENERATOR'S STATE LABORATORY REQUIREMENTS. The laboratory meets the requirements of the generator's State or cognizant agency for chemical laboratories, or:

   If using a non-Utah certified laboratory, briefly describe the generator state's requirements for chemical analytical laboratories to defend the determination that the laboratory used meets those requirements, especially in terms of whether the requirements are parameter specific, method specific, or involve CLP or other QA data packages.

   b. For analytical work done by Utah-certified laboratories, please provide a copy of the laboratory's current certification letter for each parameter analyzed and each method used for analyses required by this form.

   c. For analytical work done by laboratories which are not Utah-Certified, please provide the following information:

State or Other Agency Contact Person	Generator's State	Telephone Number
Lab Contact Person	Laboratory's State	Telephone Number

E. CERTIFICATION

GENERATOR'S CERTIFICATION: I also certify that where necessary those representative samples were or shall be provided to EFRI and to qualified laboratories for the analytical results reported herein. I also certify that the information provided on this form is complete, true and correct and is accurately supported and documented by any laboratory testing as required by EFRI. I certify that the results of any said testing have been submitted to EFRI. I certify that the material described in this profile has been fully characterized and that hazardous constituents listed in 10 CFR 40 Appendix A Criterion 13 which are applicable to this material have been indicated on this form. I further certify and warrant to EFRI that the material represented on this form is not a hazardous waste as defined by 40 CFR 261 and/or that this material is exempt from RCRA regulation under 40 CFR 261.4(a)(4).

The Generator's responsibilities with respect to the material described in this form are for policy, programmatic, funding and scheduling decisions, as well as general oversight. The Contractor's responsibilities with respect to this material are for the day-to-day operations (in accordance with general directions given by the Generator as part of its general oversight responsibility), including but not limited to the following responsibilities: material characterization, analysis and handling; sampling; monitoring; record keeping; reporting and contingency planning. Accordingly, the Contractor has the requisite knowledge and authority to sign this certification on behalf of itself, and as agent for the Generator, on behalf of the Generator. By signing this certification, the Contractor is signing on its own behalf and on behalf of the Generator.

Generator's or Contractor's Signature _____ Title_Manager, Environ Field Ops Date 3 April 2019
(Sign for the above certifications).
Print Name of Individual Signing above: __Steven L. Preston_____

Generator or Contractor Initials: _____

List of Documentation Required With the Submission of This RMPR

\ttachment B.6 – Waste Photograph **[Description of Physical Attributes of the Material included in body of submission.]**
Attachment C.1 – Radiological Analysis – Data Packages (including all pertinent Quality Control Data)
Attachment D.1 a through f – Material generation process history and description **[Included in body of submission.]**
Attachment D.2 – Analytical data (including all pertinent Quality Control Data) for all yes answers
Attachment D.3 – Analytical Data (including all pertinent Quality Control Data) for total and TCLP metals and anions **[Included in body of submission.]**
Attachment D.4 – Safety Data Sheets for chemicals used in the process: CalChem CC2000, Zetag 120L and Seventh Generation Dish Soap

EXHIBIT C

FORM OF AFFIDAVIT

AFFIDAVIT OF STEVEN L. PRESTON

I , Steven L. Preston, being duly sworn according to law, depose and state as follows:

1. I am presently employed as the Manager, Environmental Field Operations for Union Pacific Railroad ("UPRR") at the company's Winter Park Industrial Wastewater Treatment facility (the "IWT Facility"). In that capacity, I am responsible for managing the subcontracted Facility operations and maintenance. My experience with the IWT Facility dates back to April 2017 when the facility began processing wastewater. I have personal knowledge of the raw materials used, the production processes employed, and the waste handling procedures followed at the Winter Park IWT Facility. I am also familiar with the hazardous waste regulations set out in U.S. Code of Federal Regulations, Title 40261, Subpart D, as amended by the U.S. Federal Register August 6, 1998.

2. UPRR proposes to ship to Energy Fuels' White Mesa Mill near Blanding Utah, uranium-bearing materials for processing as alternate feed materials. All of the proposed alternate feed materials consist of uranium containing semi-solids as product from the Facility's wastewater treatment and sludge recovery operations in the United States and other countries and contain no materials or wastes from any other source.

3. The uranium-bearing materials consist of semi-solid metals containing wastewater treatment facility sludges, which accumulated over a period up to one year at the IWT Facility. The sludges were produced by UPRR's wastewater treatment process. For purposes of this affidavit, the sludges and associated materials shall be "Material."

4. Based on the processing steps employed in the wastewater treatment and sludge recovery operation that generated the Material, the Material does not contain any of the listed

wastes enumerated in U.S. Code of Federal Regulations, Title 40 261, Subpart D as amended by the U.S. Federal Register August 6, 1998.

5. Based on my knowledge of waste management at the IWT Facility, the Material has not been mixed with wastes from any other source, which may have been defined as or which may have contained listed wastes enumerated in U.S. Code of Federal Regulations, Title 40 Section 261, Subpart D as amended by the U.S. Federal Register August 6, 1998.

6. Specifically, the Material does not contain hazardous wastes from non-specific sources (U.S. RCRA F type wastes) because (a) to the extent that the IWT Facility may generate the types of wastes listed in Section 261.31 of Title 40 of the U.S. Code of Federal Regulations, UPRR has not commingled such wastes with the Material; and (b) UPRR has never accepted at the IWT Facility, nor has the Material ever been combined with, wastes from any other source which contain U.S. RCRA F type wastes as defined therein.

7. Specifically, the Material does not contain hazardous wastes from specific sources (U.S. RCRA K type wastes) because (a) UPRR does not operate any of the processes which produce the types of wastes listed in Section 262.31 of Title 40 of the U.S. Code of Federal Regulations, and (b) UPRR has never accepted at the IWT Facility, nor has the Material ever been combined with, wastes from any other source which contain U.S. RCRA K type wastes as defined therein.

8. Specifically, the Material is not U.S. RCRA P or U type waste as defined in Section 261.33 of Title 40 of the U.S. Code of Federal Regulations because (a) it is not and does not contain manufactured or formulated commercially pure grade chemicals, off spec commercial chemical products or manufacturing chemical intermediates, residues from containers that held commercial chemical products or manufacturing chemical intermediates, or any residue or contaminated soil, water or other debris resulting from a spill cleanup of any of the foregoing, in each case as listed in Section 261.33, and (b) UPRR has never accepted, nor has the Material ever been combined with, wastes from any other source which contain U.S. RCRA P or U type wastes as defined therein.

9. Finally, the Material has been regulated by the Colorado Department of Public Health & Environment as source material under 6 CCR 1007-1, PART 18: Licensing Requirements for Uranium and Thorium Processing. As such, the radiological portion of the Material is excluded from the definition of hazardous waste under the Resource Conservation and Recovery Act to the extent set forth therein and in regulations and guidance from the U.S. Nuclear Regulatory Commission and U.S. Environmental Protection Agency.

Sworn to and subscribed before me

this 2nd day of April, 2019

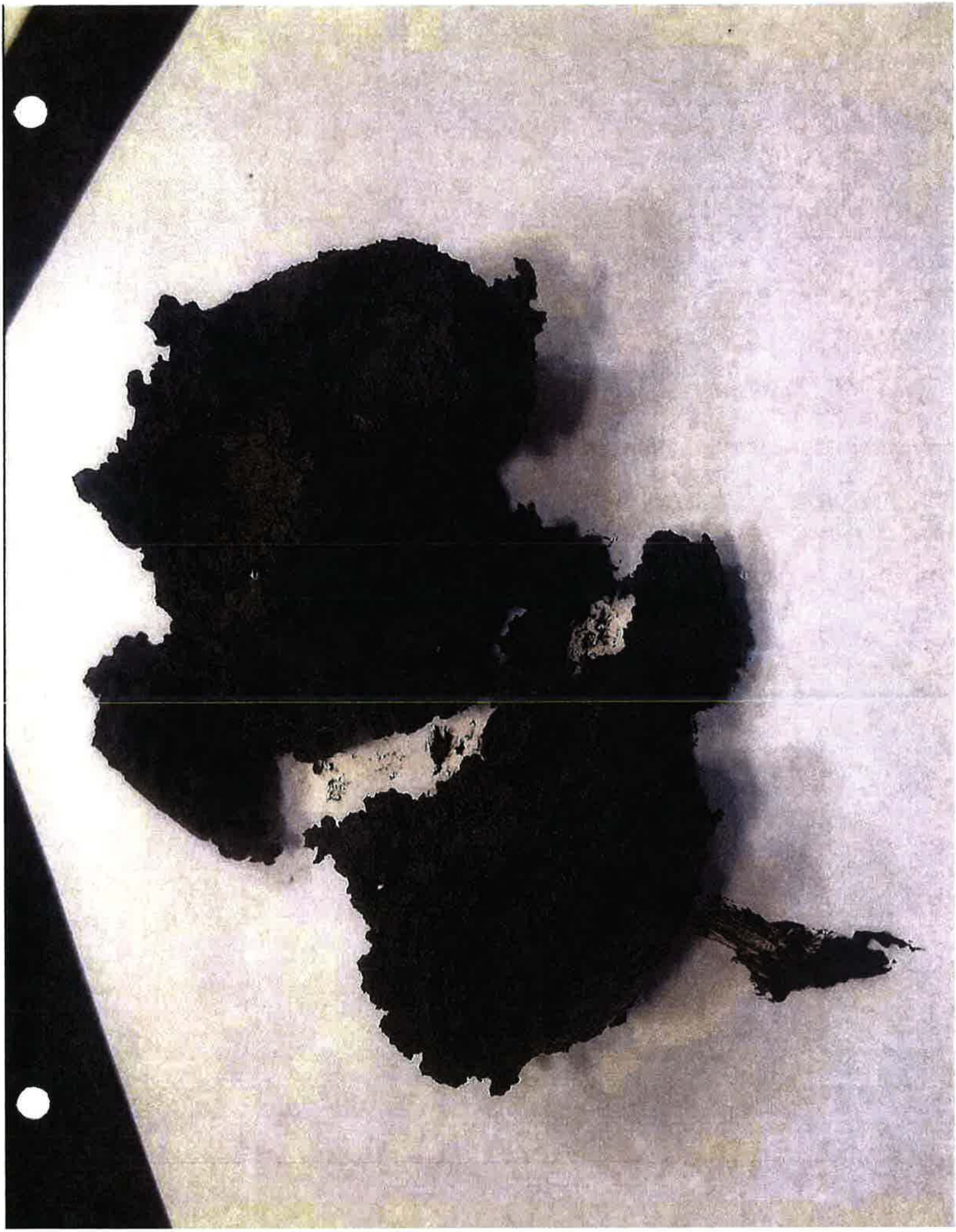
Jennifer Potts

Notary Public

JENNIFER MICHELLE POTTS
NOTARY PUBLIC
STATE OF COLORADO
NOTARY ID 20184041043
MY COMMISSION EXPIRES 10/19/2022

My Commission Expires: 10-19-2022

Attachment B.6
Waste Material Photograph



Attachment C.1
Radiological Analysis – Data Packages

GEL Laboratories LLC
a member of The GEL Group INC

PO Box 30712 Charleston, SC 29417
2040 Savage Road Charleston, SC 29407
P 843.556.8171
F 843.766.1178

gel.com

August 06, 2018

Kira Peterson
CDM Smith
555 17th Street, Suite 500
Denver, Colorado 80202

Re: Radiochemistry Analyses
Work Order: 454139

Dear Kira Peterson:

GEL Laboratories, LLC (GEL) appreciates the opportunity to provide the enclosed analytical results for the sample(s) we received on July 09, 2018. This original data report has been prepared and reviewed in accordance with GEL's standard operating procedures.

Our policy is to provide high quality, personalized analytical services to enable you to meet your analytical needs on time every time. We trust that you will find everything in order and to your satisfaction. If you have any questions, please do not hesitate to call me at (843) 556-8171, ext. 4778.

Sincerely,

Taylor Cannon for
Hope Taylor
Project Manager

Purchase Order: GELP18-0635
Enclosures

GEL LABORATORIES LLC
2040 Savage Road Charleston SC 29407 – (843) 556-8171 – www.gel.com

Certificate of Analysis Report
for

CDMM001 CDM Smith

Client SDG: 454139 GEL Work Order: 454139

The Qualifiers in this report are defined as follows:

* A quality control analyte recovery is outside of specified acceptance criteria

** Analyte is a Tracer compound

** Analyte is a surrogate compound

U Analyte was analyzed for, but not detected above the MDL, MDA, MDC or LOD.

UI Gamma Spectroscopy—Uncertain identification

Where the analytical method has been performed under NELAP certification, the analysis has met all of the requirements of the NELAC standard unless qualified on the Certificate of Analysis.

The designation ND, if present, appears in the result column when the analyte concentration is not detected above the limit as defined in the 'U' qualifier above.

This data report has been prepared and reviewed in accordance with GEL Laboratories LLC standard operating procedures. Please direct any questions to your Project Manager, Hope Taylor.

Reviewed by _____

GEL LABORATORIES LLC
2040 Savage Road Charleston SC 29407 - (843) 556-8171 - www.gel.com

Certificate of Analysis

Report Date: August 6, 2018

Company : CDM Smith
Address : 555 17th Street, Suite 500

Denver, Colorado 80202
Contact: Kira Peterson
Project: Radiochemistry Analyses

Client Sample ID: Winter Park Material Grab
Sample ID: 454139001
Matrix: Sludge
Collect Date: 02-JUL-18 15:00
Receive Date: 09-JUL-18
Collector: Client

Project: CDMM00118
Client ID: CDMM001

Parameter	Qualifier	Result	DL	RL	Units	PF	DF	Analyst	Date	Time	Batch	Method
Rad Gamma Spec Analysis												
Gammaspec, Gamma, Solid (Standard List) "Dry Weight Corrected"												
Lead-210	U	ND	33.4		pCi/g			RXF2	08/01/18	0716	1780600	1
Radium-226		11.8	0.399		pCi/g							
Radium-228		2.06	0.605		pCi/g							
Thorium-228		1.58	0.334		pCi/g							
[illegible]m-230		11.8	0.399		pCi/g							
[illegible]ium-232		2.06	0.605		pCi/g							
Uranium-234		11.8	0.399		pCi/g							
Uranium-235		98.8	1.94		pCi/g							
Uranium-238		1300	13.6		pCi/g							

The following Prep Methods were performed:

Method	Description	Analyst	Date	Time	Prep Batch
Dry Soil Prep	Dry Soil Prep GL-RAD-A-021	CXB7	07/09/18	1412	1780496

The following Analytical Methods were performed:

Method	Description	Analyst Comments
1	DOE HASL 300, 4.5.2.3/Ga-01-R	

Notes:

Column headers are defined as follows:
DF: Dilution Factor
DL: Detection Limit
MDA: Minimum Detectable Activity
MDC: Minimum Detectable Concentration
Lc/LC: Critical Level
PF: Prep Factor
RL: Reporting Limit
SQL: Sample Quantitation Limit

GEL LABORATORIES LLC
2040 Savage Road Charleston SC 29407 - (843) 556-8171 - www.gel.com

Certificate of Analysis

Report Date: August 6, 2018

Company : CDM Smith
Address : 555 17th Street, Suite 500

Denver, Colorado 80202
Contact: Kira Peterson
Project: Radiochemistry Analyses

Client Sample ID: Winter Park Material Composite
Sample ID: 454139002
Matrix: Sludge
Collect Date: 02-JUL-18 15:00
Receive Date: 09-JUL-18
Collector: Client

Project: CDMM00118
Client ID: CDMM001

Parameter	Qualifier	Result	DL	RL	Units	PF	DF	Analyst	Date	Time	Batch	Method
Rad Gamma Spec Analysis												
Gammaspec, Gamma, Solid (Standard List) "Dry Weight Corrected"												
Lead-210	U	ND	45.9		pCi/g			RXF2	08/01/18	0716	1780600	1
Radium-226		11.7	0.446		pCi/g							
Radium-228	UI	ND	1.20		pCi/g							
Thorium-228		1.52	0.395		pCi/g							
T[illegible]um-230		11.7	0.446		pCi/g							
[illegible]m-232	UI	ND	1.20		pCi/g							
Uranium-234		11.7	0.446		pCi/g							
Uranium-235		98.4	2.18		pCi/g							
Uranium-238		1360	17.4		pCi/g							

The following Prep Methods were performed:

Method	Description	Analyst	Date	Time	Prep Batch
Dry Soil Prep	Dry Soil Prep GL-RAD-A-021	CXB7	07/09/18	1412	1780496

The following Analytical Methods were performed:

Method	Description	Analyst Comments
1	DOE HASL 300, 4.5.2.3/Ga-01-R	

Notes:

Column headers are defined as follows:
DF: Dilution Factor
DL: Detection Limit
MDA: Minimum Detectable Activity
MDC: Minimum Detectable Concentration
Lc/LC: Critical Level
PF: Prep Factor
RL: Reporting Limit
SQL: Sample Quantitation Limit

QC Summary

Report Date: August 6, 2018

CDM Smith
555 17th Street, Suite 500
Denver, Colorado
Contact: Kira Peterson

Workorder: 454139

Parmname	NOM	Sample	Qual	QC	Units	RPD%	REC%	Range	Anlst	Date Time
Rad Gamma Spec										
Batch 1780600										
QC1204065828 454139001 DUP										
Lead-210	U	12.0	U	12.5	pCi/g	N/A		N/A	RXF2	08/01/18 08:29
Radium-226		11.8		11.7	pCi/g	0.51		(0%-20%)		
Radium-228		2.06		2.67	pCi/g	26.1		(0% - 100%)		
Thorium-228		1.58		1.53	pCi/g	2.9		(0% - 100%)		
Thorium-230		11.8		11.7	pCi/g	0.51		(0%-20%)		
Thorium-232		2.06		2.67	pCi/g	26.1		(0% - 100%)		
Uranium-234		11.8		11.7	pCi/g	0.51		(0%-20%)		
Uranium-235		98.8		106	pCi/g	6.56		(0%-20%)		
Uranium-238		1300		1440	pCi/g	9.93		(0%-20%)		
QC1204065829 LCS										
Americium-241	488			533	pCi/g		109	(75%-125%)		08/01/18 08:29
Cesium-137	172			173	pCi/g		101	(75%-125%)		
Cobalt-60	127			123	pCi/g		96.6	(75%-125%)		
Lead-210				5600	pCi/g					

QC Summary

Workorder: 454139

Parmname	NOM	Sample	Qual	QC	Units	RPD%	REC%	Range	Anlst	Date Time
Rad Gamma Spec										
Batch 1780600										
Radium-226			U	-0.511	pCi/g				RXF2	08/01/18 08:29
Radium-228			U	-0.564	pCi/g					
Thorium-228			U	0.131	pCi/g					
Thorium-230			U	-0.511	pCi/g					
Thorium-232			U	-0.564	pCi/g					
Uranium-234			U	-0.511	pCi/g					
ium-235			U	-0.544	pCi/g					
Uranium-238			U	-29.2	pCi/g					
QC1204065827 MB										
Lead-210			U	-1.74	pCi/g					08/01/18 07:17
Radium-226			U	-0.00436	pCi/g					
Radium-228			U	0.0656	pCi/g					
Thorium-228			U	0.0364	pCi/g					
Thorium-230			U	-0.00436	pCi/g					
Thorium-232			U	0.0656	pCi/g					
Uranium-234			U	-0.00436	pCi/g					

QC Summary

Workorder: 454139

Parmname	NOM	Sample	Qual	QC	Units	RPD%	REC%	Range	Anlst	Date Time
Rad Gamma Spec										
Batch 1780600										
Uranium-235			U	-0.0732	pCi/g				RXF2	08/01/18 07:17
Uranium-238			U	0.235	pCi/g					

Notes:

The Qualifiers in this report are defined as follows:

- ** Analyte is a Tracer compound
- < Result is less than value reported
- > Result is greater than value reported
- BD Results are either below the MDC or tracer recovery is low
- FA Failed analysis.
- H Analytical holding time was exceeded
- Value is estimated
- K Analyte present. Reported value may be biased high. Actual value is expected to be lower.
- L Analyte present. Reported value may be biased low. Actual value is expected to be higher.
- M M if above MDC and less than LLD
- M REMP Result > MDC/CL and < RDL
- N/A RPD or %Recovery limits do not apply.
- N1 See case narrative
- ND Analyte concentration is not detected above the detection limit
- NJ Consult Case Narrative, Data Summary package, or Project Manager concerning this qualifier
- Q One or more quality control criteria have not been met. Refer to the applicable narrative or DER.
- R Sample results are rejected
- U Analyte was analyzed for, but not detected above the MDL, MDA, MDC or LOD.
- UI Gamma Spectroscopy--Uncertain identification
- UJ Gamma Spectroscopy--Uncertain identification
- UL Not considered detected. The associated number is the reported concentration, which may be inaccurate due to a low bias.
- X Consult Case Narrative, Data Summary package, or Project Manager concerning this qualifier
- Y Other specific qualifiers were required to properly define the results. Consult case narrative.
- ^ RPD of sample and duplicate evaluated using +/-RL. Concentrations are <5X the RL. Qualifier Not Applicable for Radiochemistry.
- h Preparation or preservation holding time was exceeded

QC Summary

Workorder: 454139

Parmname	NOM	Sample	Qual	QC	Units	RPD%	REC%	Range	Anlst	Date	Time

N/A indicates that spike recovery limits do not apply when sample concentration exceeds spike conc. by a factor of 4 or more or %RPD not applicable.
^ The Relative Percent Difference (RPD) obtained from the sample duplicate (DUP) is evaluated against the acceptance criteria when the sample is greater than five times (5X) the contract required detection limit (RL). In cases where either the sample or duplicate value is less than 5X the RL, a control limit of +/- the RL is used to evaluate the DUP result.
* Indicates that a Quality Control parameter was not within specifications.
For PS, PSD, and SDILT results, the values listed are the measured amounts, not final concentrations.

Where the analytical method has been performed under NELAP certification, the analysis has met all of the requirements of the NELAC standard unless qualified on the QC Summary.

Radiochemistry
Technical Case Narrative
CDM Smith (CDMM)
SDG #: 454139

Product: **Dry Weight**
Preparation Method: Dry Soil Prep
Preparation Procedure: GL-RAD-A-021 REV# 23
Preparation Batch: 1780496

The following samples were analyzed using the above methods and analytical procedure(s).

GEL Sample ID#	Client Sample Identification
454139001	Winter Park Material Grab
454139002	Winter Park Material Composite

The samples in this SDG were analyzed on an "as received" basis.

Data Summary:

There are no exceptions, anomalies or deviations from the specified methods. All sample data provided in this report met the acceptance criteria specified in the analytical methods and procedures for initial calibration, continuing calibration, instrument controls and process controls where applicable.

Product: **Gammaspec, Gamma, Solid (Standard List)**
Analytical Method: DOE HASL 300, 4.5.2.3/Ga-01-R
Analytical Procedure: GL-RAD-A-013 REV# 27
Analytical Batch: 1780600

Preparation Method: Dry Soil Prep
Preparation Procedure: GL-RAD-A-021 REV# 23
Preparation Batch: 1780496

The following samples were analyzed using the above methods and analytical procedure(s).

GEL Sample ID#	Client Sample Identification
454139001	Winter Park Material Grab
454139002	Winter Park Material Composite
1204065827	Method Blank (MB)
1204065828	454139001(Winter Park Material Grab) Sample Duplicate (DUP)
1204065829	Laboratory Control Sample (LCS)

The samples in this SDG were analyzed on a "dry weight" basis.

Data Summary:

There are no exceptions, anomalies or deviations from the specified methods. All sample data provided in this report met the acceptance criteria specified in the analytical methods and procedures for initial calibration, continuing calibration, instrument controls and process controls where applicable.

Qualifier Information

Qualifier	Reason	Analyte	Sample	Client Sample
UI	Results are considered a false positive due to low abundance.	Radium-228	454139002	Winter Park Material Composite
		Thorium-232	454139002	Winter Park Material Composite

Certification Statement

Where the analytical method has been performed under NELAP certification, the analysis has met all of the requirements of the NELAC standard unless otherwise noted in the analytical case narrative.

Page: 1 of 1

Project #

GEL Quote #: GELP18-0625

COC Number (1):

PO Number:

GEL Laboratories LLC

gel.com

Chemistry | Radiochemistry | Radiobioassay | Specialty Analytics

Chain of Custody and Analytical Request

GEL Work Order Number: 454139 GEL Project Manager:

GEL Laboratories, LLC
2040 Savage Road
Charleston, SC 29407
Phone: (843) 556-8171
Fax: (843) 766-1178

Client Name: Kira Peterson / Steve Preston Phone # 206-375-3232

Project/Site Name: Winter Park TWTP Union Pacific Fax # or 303-383-2390

Address: 100 Parsons Rd, Winter Park, CO 80482

Collected By: Kira Peterson Send Results To: petersonk@cdmsmith.com

Sample Analysis Requested (5) (Fill in the number of containers for each test)

Sample ID * For composites - indicate start and stop date/time	*Date Collected (mm-dd-yy)	*Time Collected (Military) (hhmm)	QC Code (2)	Field Filtered (3)	Sample Matrix (4)	Should this sample be considered: Radioactive Please supply isotopic info.	Should this sample be considered: (7) Known or possible hazards	Total number of containers	See enclosure	<-- Preservative Type (6)	Comments Note: extra sample is required for sample specific QC
Winter Park Material Grab	7-2-18	1500	NG	-	SL	Unkn		4			
Winter Park Material Composite	↓	↓	C	-	SL	↓		4			

Chain of Custody Signatures

Relinquished By (Signed)	Date	Time	Received by (signed)	Date	Time
1	7-3-18	1530	1	7/9/18	8:15
2			2		
3			3		

TAT Requested: Normal: ✓ Rush: ____ Specify: ____ (Subject to Surcharge)

Fax Results: [ ] Yes [ ] No

Select Deliverable: [ ] C of A [ ] QC Summary [ ] level 1 [ ] Level 2 [ ] Level 3 [ ] Level 4

Additional Remarks:

For Lab Receiving Use Only: Custody Seal Intact? [ ] Yes [ ] No *Cooler Temp:* ____ °C

> *For sample shipping and delivery details, see Sample Receipt & Review form (SRR.)*

Sample Collection Time Zone: [ ] Eastern [ ] Pacific [ ] Central [✓] Mountain [ ] Other: ____

1.) Chain of Custody Number = Client Determined

2.) QC Codes: N = Normal Sample, TB = Trip Blank, FD = Field Duplicate, EB = Equipment Blank, MS = Matrix Spike Sample, MSD = Matrix Spike Duplicate Sample, G = Grab, C = Composite

3.) Field Filtered: For liquid matrices, **indicate** with **a - Y -** for yes the sample was field filtered or **- N -** for sample was not field filtered.

4.) Matrix Codes: DW=Drinking Water, GW=Groundwater, SW=Surface Water, WW=Waste Water, W=Water, ML=Misc Liqcid, SO=Soil, SD=Sediment, SL=Sludge, SS=Solid Waste, **O=Oil**, F=Filter, P=Wipe, U=Urine, F=Fecal, N=Nasal

5.) Sample Analysis Requested: **Analytical** method requested **(i.e.** 8260B, 6010B/7470A) and number of containers provided for each (i.e. *8260B* - 3, *6010B/7470A* - 1).

6.) Preservative Type: HA = Hydrochloric Acid, NI = Nitric Acid, SH = Sodium Hydroxide, SA = Sulfuric Acid, AA = Ascorbic Acid, HX = Hexane, ST = Sodium Thiosulfate, If no preservative is added = leave field blank

7.) *Are there any known or possible hazards associated with these samples?*

RCRA Metals
As = Arsenic Hg= Mercury
Ba = Barium Se= Selenium
Cd = Cadmium Ag= Silver
Cr = Chromium MR= Miscellaneous RCRA metals
Pb = Lead

Characteristic Hazards
FL = Flammable/Ignitable
CO = Corrosive
RE = Reactive

TSCA Regulated
PCB = Polychlorinated biphenyls

Listed Waste
LW= Listed Waste
(F,K,P and U-listed wastes.)
Waste code(s):

Other
OT= Other / Unknown
(i.e.: High/low pH, asbestos, beryllium, irritants, other misc. health hazards, etc.)
Description:

Please provide any additional details below regarding handling and/or disposal concerns. (i.e.: Origin of sample(s), type of site collected from, odd matrices, etc.)

GEL Laboratories LLC

SAMPLE RECEIPT & REVIEW FORM

Client: CDMM	**SDG/AR/COC/Work Order:** 454139
Received By: GM	**Date Received:** 7/9/18
Carrier and Tracking Number	Circle Applicable: FedEx Express / FedEx Ground UPS Field Services Courier Other 7817 0210 6110

Suspected Hazard Information	Yes	No	*If Net Counts > 100cpm on samples not marked "radioactive", contact the Radiation Safety Group for further investigation.
Shipped as a DOT Hazardous?		✓	Hazard Class Shipped: UN#: 2910
COC/Samples marked or classified as radioactive?	✓		Maximum Net Counts Observed* (Observed Counts - Area Background Counts): 100 CPM / mR/Hr Classified as: Rad 1 Rad 2 Rad 3
Is package, COC, and/or Samples marked HAZ?		✓	If yes, select Hazards below, and contact the GEL Safety Group. PCB's Flammable Foreign Soil RCRA Asbestos Beryllium Other:

	Sample Receipt Criteria	Yes	NA	No	Comments/Qualifiers (Required for Non-Conforming Items)
1	Shipping containers received intact and sealed?	✓			Circle Applicable: Seals broken Damaged container Leaking container Other (describe)
2	Chain of custody documents included with shipment?	✓			
3	Samples requiring cold preservation within (0 ≤ 6 deg. C)?* 7/9/18	✓	✓		Preservation Method: Wet Ice Ice Packs Dry ice None Other: *all temperatures are recorded in Celsius TEMP: 2.2
4	Daily check performed and passed on IR temperature gun?	✓			Temperature Device Serial #: IR4-16 Secondary Temperature Device Serial # (If Applicable):
5	Sample containers intact and sealed?	✓			Circle Applicable: Seals broken Damaged container Leaking container Other (describe)
6	Samples requiring chemical preservation at proper pH?		✓		Sample ID's and Containers Affected: If Preservation added, Lot#:
7	Do any samples require Volatile Analysis?			✓	If Yes, Are Encores or Soil Kits present? Yes___ No___ (If yes, take to VOA Freezer) Do VOA vials contain acid preservation? Yes No___ N/A (If unknown, select No) VOA vials free of headspace? Yes No___ N/A Sample ID's and containers affected:
8	Samples received within holding time?	✓			ID's and tests affected:
9	Sample ID's on COC match ID's on bottles?	✓			Sample ID's and containers affected:
10	Date & time on COC match date & time on bottles?	✓			Sample ID's affected:
11	Number of containers received match number indicated on COC?	✓			Sample ID's affected:
12	Are sample containers identifiable as GEL provided?			✓	
13	COC form is properly signed in relinquished/received sections?	✓			

Comments (Use Continuation Form if needed):

NORM - RA-I

PM (or PMA) review: Initials TMC Date 7/10/18 Page 1 of 1

GL-CHL-SR-001 Rev 5

List of current GEL Certifications as of 06 August 2018

State	Certification
Alaska	17-018
Arkansas	88-0651
CLIA	42D0904046
California	2940
Colorado	SC00012
Connecticut	PH-0169
Delaware	SC00012
DoD ELAP/ ISO17025 A2LA	2567.01
Florida NELAP	E87156
Foreign Soils Permit	P330-15-00283, P330-15-00253
Georgia	SC00012
Georgia SDWA	967
Hawaii	SC00012
Idaho Chemistry	SC00012
Idaho Radiochemistry	SC00012
Illinois NELAP	200029
Indiana	C-SC-01
Kansas NELAP	E-10332
Kentucky SDWA	90129
Kentucky Wastewater	90129
Louisiana NELAP	03046 (AI33904)
Louisiana SDWA	LA180011
Maryland	270
Massachusetts	M-SC012
Michigan	9976
Mississippi	SC00012
Nebraska	NE-OS-26-13
Nevada	SC000122018-1
New Hampshire NELAP	205415
New Jersey NELAP	SC002
New Mexico	SC00012
New York NELAP	11501
North Carolina	233
North Carolina SDWA	45709
North Dakota	R-158
Oklahoma	9904
Pennsylvania NELAP	68-00485
Puerto Rico	SC00012
S. Carolina Radiochem	10120002
South Carolina Chemistry	10120001
Tennessee	TN 02934
Texas NELAP	T104704235-18-13
Utah NELAP	SC000122018-26
Vermont	VT87156
Virginia NELAP	460202
Washington	C780
West Virginia	997404

Attachment D.2
Analytical data

American West
ANALYTICAL LABORATORIES

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Kyle F. Gross
Laboratory Director

Jose Rocha
QA Officer

Steve Preston
Union Pacific Railroad
1400 W. 52nd Ave.
Denver, Co 80221

RE: Union Pacific Railroad / Moffat Treatment Residuals Testing

Dear Steve Preston: Lab Set ID: 1806483

American West Analytical Laboratories received sample(s) on 6/21/2018 for the analyses presented in the following report.

American West Analytical Laboratories (AWAL) is accredited by The National Environmental Laboratory Accreditation Program (NELAP) in Utah and Texas; and is state accredited in Colorado, Idaho, New Mexico, Wyoming, and Missouri.

All analyses were performed in accordance to the NELAP protocols unless noted otherwise. Accreditation scope documents are available upon request. If you have any questions or concerns regarding this report please feel free to call.

The abbreviation "Surr" found in organic reports indicates a surrogate compound that is intentionally added by the laboratory to determine sample injection, extraction, and/or purging efficiency. The "Reporting Limit" found on the report is equivalent to the practical quantitation limit (PQL). This is the minimum concentration that can be reported by the method referenced and the sample matrix. The reporting limit must not be confused with any regulatory limit. Analytical results are reported to three significant figures for quality control and calculation purposes.

Thank You,

Approved by: _____
Laboratory Director or designee

American West
ANALYTICAL LABORATORIES

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Salt Lake City, UT 84119

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Kyle F. Gross
Laboratory Director

Jose Rocha
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Thank You,

Approved by: _____
Laboratory Director or designee

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Kyle F. Gross
Laboratory Director

Jose Rocha
QA Officer

INORGANIC ANALYTICAL REPORT

Client: Union Pacific Railroad **Contact:** Steve Preston
Project: Union Pacific Railroad / Moffat Treatment Residuals Testing
Lab Sample ID: 1806483-001
Client Sample ID: Winter Park Material Grab
Collection Date: 6/20/2018 1400h
Received Date: 6/21/2018 1055h

Analytical Results TOTAL METALS

Compound	Units	Date Prepared	Date Analyzed	Method Used	Reporting Limit	Analytical Result	Qual
Aluminum	mg/kg-dry	6/25/2018 845h	7/3/2018 1239h	SW6010D	4,770	**72,000**	
Arsenic	mg/kg-dry	6/25/2018 845h	6/25/2018 1529h	SW6020B	9.54	**10.0**	
Barium	mg/kg-dry	6/25/2018 845h	6/25/2018 1529h	SW6020B	17.2	**276**	
Beryllium	mg/kg-dry	6/25/2018 845h	6/25/2018 1529h	SW6020B	7.63	< 7.63	
Cadmium	mg/kg-dry	6/25/2018 845h	6/25/2018 1529h	SW6020B	3.24	< 3.24	
Calcium	mg/kg-dry	6/25/2018 845h	7/3/2018 1410h	SW6010D	477	**9,180**	B
Chromium	mg/kg-dry	6/25/2018 845h	6/25/2018 1529h	SW6020B	38.1	< 38.1	
Cobalt	mg/kg-dry	6/25/2018 845h	6/25/2018 1529h	SW6020B	5.15	**6.40**	
Copper	mg/kg-dry	6/25/2018 845h	6/25/2018 1529h	SW6020B	59.1	**114**	
Iron	mg/kg-dry	6/25/2018 845h	7/3/2018 1344h	SW6010D	715	**22,200**	
Lead	mg/kg-dry	6/25/2018 845h	6/25/2018 1529h	SW6020B	24.8	**144**	
Magnesium	mg/kg-dry	6/25/2018 845h	7/3/2018 1410h	SW6010D	477	**4,840**	
Manganese	mg/kg-dry	6/25/2018 845h	6/25/2018 1529h	SW6020B	15.3	**377**	
Mercury	mg/kg-dry	6/27/2018 1743h	6/28/2018 803h	SW7471B	0.169	**1.15**	
Molybdenum	mg/kg-dry	6/25/2018 845h	6/25/2018 1529h	SW6020B	76.3	< 76.3	
Nickel	mg/kg-dry	6/25/2018 845h	6/25/2018 1529h	SW6020B	76.3	< 76.3	
Potassium	mg/kg-dry	6/25/2018 845h	7/3/2018 1410h	SW6010D	477	**5,030**	
Selenium	mg/kg-dry	6/25/2018 845h	6/25/2018 1529h	SW6020B	32.4	< 32.4	
Silver	mg/kg-dry	6/25/2018 845h	6/25/2018 1529h	SW6020B	5.72	< 5.72	
Sodium	mg/kg-dry	6/25/2018 845h	7/3/2018 1410h	SW6010D	477	**953**	
Thallium	mg/kg-dry	6/25/2018 845h	6/25/2018 1529h	SW6020B	15.3	< 15.3	
Tin	mg/kg-dry	6/25/2018 845h	7/3/2018 1410h	SW6010D	47.7	< 47.7	
Uranium	mg/kg-dry	6/25/2018 845h	6/25/2018 1600h	SW6020B	14.3	**4,530**	
Vanadium	mg/kg-dry	6/25/2018 845h	7/3/2018 1410h	SW6010D	2.38	**31.7**	
Zinc	mg/kg-dry	6/25/2018 845h	6/25/2018 1529h	SW6020B	191	**426**	

B - The method blank was acceptable, as the method blank result is less than 10% of the lowest reported sample concentration.

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ANALYTICAL LABORATORIES

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Kyle F. Gross
Laboratory Director

Jose Rocha
QA Officer

INORGANIC ANALYTICAL REPORT

Client: Union Pacific Railroad **Contact:** Steve Preston
Project: Union Pacific Railroad / Moffat Treatment Residuals Testing
Lab Sample ID: 1806483-002
Client Sample ID: Winter Park Material Composite
Collection Date: 6/20/2018 1400h
Received Date: 6/21/2018 1055h

Analytical Results TOTAL METALS

Compound	Units	Date Prepared	Date Analyzed	Method Used	Reporting Limit	Analytical Result	Qual
Aluminum	mg/kg-dry	6/25/2018 845h	7/3/2018 1241h	SW6010D	4,830	**79,300**	
Arsenic	mg/kg-dry	6/25/2018 845h	6/25/2018 1532h	SW6020B	9.67	**10.9**	
Barium	mg/kg-dry	6/25/2018 845h	6/25/2018 1532h	SW6020B	17.4	**311**	
Beryllium	mg/kg-dry	6/25/2018 845h	6/25/2018 1532h	SW6020B	7.73	< 7.73	
Cadmium	mg/kg-dry	6/25/2018 845h	6/25/2018 1532h	SW6020B	3.29	< 3.29	
Calcium	mg/kg-dry	6/25/2018 845h	7/3/2018 1412h	SW6010D	483	**10,100**	B
Chromium	mg/kg-dry	6/25/2018 845h	6/25/2018 1532h	SW6020B	38.7	< 38.7	
Cobalt	mg/kg-dry	6/25/2018 845h	6/25/2018 1532h	SW6020B	5.22	**7.31**	
Copper	mg/kg-dry	6/25/2018 845h	6/25/2018 1532h	SW6020B	59.9	**128**	
Iron	mg/kg-dry	6/25/2018 845h	7/3/2018 1346h	SW6010D	725	**30,200**	
Lead	mg/kg-dry	6/25/2018 845h	6/25/2018 1532h	SW6020B	25.1	**164**	
Magnesium	mg/kg-dry	6/25/2018 845h	7/3/2018 1412h	SW6010D	483	**5,300**	
Manganese	mg/kg-dry	6/25/2018 845h	6/25/2018 1532h	SW6020B	15.5	**431**	
Mercury	mg/kg-dry	6/27/2018 1743h	6/28/2018 805h	SW7471B	0.157	**1.28**	
Molybdenum	mg/kg-dry	6/25/2018 845h	6/25/2018 1532h	SW6020B	77.3	< 77.3	
Nickel	mg/kg-dry	6/25/2018 845h	6/25/2018 1532h	SW6020B	77.3	< 77.3	
Potassium	mg/kg-dry	6/25/2018 845h	7/3/2018 1412h	SW6010D	483	**5,530**	
Selenium	mg/kg-dry	6/25/2018 845h	6/25/2018 1532h	SW6020B	32.9	< 32.9	
Silver	mg/kg-dry	6/25/2018 845h	6/25/2018 1532h	SW6020B	5.80	< 5.80	
Sodium	mg/kg-dry	6/25/2018 845h	7/3/2018 1412h	SW6010D	483	**1,110**	
Thallium	mg/kg-dry	6/25/2018 845h	6/25/2018 1532h	SW6020B	15.5	< 15.5	
Tin	mg/kg-dry	6/25/2018 845h	7/3/2018 1412h	SW6010D	48.3	< 48.3	
Uranium	mg/kg-dry	6/25/2018 845h	6/25/2018 1603h	SW6020B	14.5	**4,890**	
Vanadium	mg/kg-dry	6/25/2018 845h	7/3/2018 1412h	SW6010D	2.42	**34.8**	
Zinc	mg/kg-dry	6/25/2018 845h	6/25/2018 1532h	SW6020B	193	**485**	

B - The method blank was acceptable, as the method blank result is less than 10% of the lowest reported sample concentration.

INORGANIC ANALYTICAL REPORT

Client: Union Pacific Railroad **Contact:** Steve Preston
Project: Union Pacific Railroad / Moffat Treatment Residuals Testing
Lab Sample ID: 1806483-001
Client Sample ID: Winter Park Material Grab
Collection Date: 6/20/2018 1400h
Received Date: 6/21/2018 1055h

Analytical Results TCLP METALS Method 1311

TCLP Prep Date: 6/26/2018 2050h

Compound	Units	Date Prepared	Date Analyzed	Method Used	Reporting Limit	Analytical Result	Qual
Arsenic	mg/L	6/28/2018 1313h	6/29/2018 1234h	SW6020B	0.0100	< 0.0100	
Barium	mg/L	6/28/2018 1313h	6/29/2018 1234h	SW6020B	0.0500	**1.46**	
Cadmium	mg/L	6/28/2018 1313h	6/29/2018 1234h	SW6020B	0.00350	< 0.00350	
Chromium	mg/L	6/28/2018 1313h	6/29/2018 1234h	SW6020B	0.0200	< 0.0200	
Lead	mg/L	6/28/2018 1313h	6/29/2018 1234h	SW6020B	0.0500	< 0.0500	
Mercury	mg/L	6/28/2018 1640h	6/29/2018 1052h	SW7470A	0.0100	< 0.0100	
Selenium	mg/L	6/28/2018 1313h	6/29/2018 1234h	SW6020B	0.0100	< 0.0100	
Silver	mg/L	6/28/2018 1313h	6/29/2018 1234h	SW6020B	0.0100	< 0.0100	

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Kyle F. Gross
Laboratory Director

Jose Rocha
QA Officer

INORGANIC ANALYTICAL REPORT

Client: Union Pacific Railroad **Contact:** Steve Preston
Project: Union Pacific Railroad / Moffat Treatment Residuals Testing
Lab Sample ID: 1806483-002
Client Sample ID: Winter Park Material Composite
Collection Date: 6/20/2018 1400h
Received Date: 6/21/2018 1055h

Analytical Results TCLP METALS Method 1311

TCLP Prep Date: 6/26/2018 2050h

Compound	Units	Date Prepared	Date Analyzed	Method Used	Reporting Limit	Analytical Result	Qual
Arsenic	mg/L	6/28/2018 1313h	6/29/2018 1237h	SW6020B	0.0100	< 0.0100	
Barium	mg/L	6/28/2018 1313h	6/29/2018 1237h	SW6020B	0.0500	**1.50**	
Cadmium	mg/L	6/28/2018 1313h	6/29/2018 1237h	SW6020B	0.00350	< 0.00350	
Chromium	mg/L	6/28/2018 1313h	6/29/2018 1237h	SW6020B	0.0200	< 0.0200	
Lead	mg/L	6/28/2018 1313h	6/29/2018 1237h	SW6020B	0.0500	< 0.0500	
Mercury	mg/L	6/28/2018 1640h	6/29/2018 1054h	SW7470A	0.0100	< 0.0100	
Selenium	mg/L	6/28/2018 1313h	6/29/2018 1237h	SW6020B	0.0100	< 0.0100	
Silver	mg/L	6/28/2018 1313h	6/29/2018 1237h	SW6020B	0.0100	< 0.0100	

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Kyle F. Gross
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INORGANIC ANALYTICAL REPORT

Client: Union Pacific Railroad **Contact:** Steve Preston
Project: Union Pacific Railroad / Moffat Treatment Residuals Testing
Lab Sample ID: 1806483-001
Client Sample ID: Winter Park Material Grab
Collection Date: 6/20/2018 1400h
Received Date: 6/21/2018 1055h

Analytical Results

Compound	Units	Date Prepared	Date Analyzed	Method Used	Reporting Limit	Analytical Result	Qual
Ammonia (as N)	mg/kg-dry	6/26/2018 705h	6/26/2018 904h	E350.1	117	**245**	
Chloride	mg/kg-dry		7/2/2018 1942h	E300.0	0.473	**6.39**	&
Flashpoint	°F		6/26/2018 1100h	SW1010A	25.0	>200	$
Fluoride	mg/kg-dry		7/2/2018 1942h	E300.0	0.473	**4.14**	&
Nitrate/Nitrite (as N)	mg/kg-dry		6/22/2018 1239h	E353.2	0.0473	< 0.0473	&
pH @ 25° C	pH Units		6/21/2018 1835h	SW9045D	1.00	**8.11**	H
Sulfate	mg/kg-dry		7/2/2018 1942h	E300.0	3.55	**74.7**	&
Sulfide	mg/kg-dry		6/22/2018 652h	SM4500-S2-D	0.142	< 0.142	&

$ - Method 1010A is not an approved procedure for solid materials.
& - Analysis is performed on a 1:1 DI water extract for soils.
H - Sample was received outside of the holding time.

Compound	Date Analyzed	Method Used	Analytical Result	Qual
Paint Filter	6/21/2018 1711h	SW9095B	**no free liquids**	II

H - Sample was received outside of the holding time.

INORGANIC ANALYTICAL REPORT

Client: Union Pacific Railroad **Contact:** Steve Preston
Project: Union Pacific Railroad / Moffat Treatment Residuals Testing
Lab Sample ID: 1806483-002
Client Sample ID: Winter Park Material Composite
Collection Date: 6/20/2018 1400h
Received Date: 6/21/2018 1055h

Analytical Results

Compound	Units	Date Prepared	Date Analyzed	Method Used	Reporting Limit	Analytical Result	Qual
Ammonia (as N)	mg/kg-dry	6/26/2018 705h	6/26/2018 905h	E350.1	112	**342**	
Chloride	mg/kg-dry		7/2/2018 1959h	E300.0	0.471	**8.77**	&
Flashpoint	°F		6/26/2018 1100h	SW1010A	25.0	>200	$
Fluoride	mg/kg-dry		7/2/2018 1959h	E300.0	0.471	**5.30**	&
Nitrate/Nitrite (as N)	mg/kg-dry		6/22/2018 1242h	E353.2	0.0471	< 0.0471	&
pH @ 25° C	pH Units		6/21/2018 1835h	SW9045D	1.00	**8.03**	H
Sulfate	mg/kg-dry		7/2/2018 1959h	E300.0	3.53	**87.9**	&
Sulfide	mg/kg-dry		6/22/2018 652h	SM4500-S2-D	0.141	< 0.141	&

$ - Method 1010A is not an approved procedure for solid materials.
& - Analysis is performed on a 1:1 DI water extract for soils.
H - Sample was received outside of the holding time.

Compound	Date Analyzed	Method Used	Analytical Result	Qual
Paint Filter	6/21/2018 1711h	SW9095B	**no free liquids**	H

H - Sample was received outside of the holding time.

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ORGANIC ANALYTICAL REPORT

Client: Union Pacific Railroad **Contact:** Steve Preston
Project: Union Pacific Railroad / Moffat Treatment Residuals Testing
Lab Sample ID: 1806483-001B
Client Sample ID: Winter Park Material Grab
Collection Date: 6/20/2018 1400h
Received Date: 6/21/2018 1055h
Test Code: 8081-S-3546

Analytical Results Organochlorine Pests TCL GC/ECD Method 8081B/3546

Analyzed: 6/29/2018 1415h **Extracted:** 6/25/2018 1200h
Units: µg/kg-dry **Dilution Factor:** 1 **Method:** SW8081B

Compound	CAS Number	Reporting Limit	Analytical Result	Qual	% TIC Quality
4,4'-DDD	72-54-8	9.42	< 9.42	I,@	
4,4'-DDE	72-55-9	9.42	< 9.42		
4,4'-DDT	50-29-3	9.42	< 9.42		
Aldrin	309-00-2	9.42	< 9.42		
alpha-BHC	319-84-6	9.42	< 9.42		
alpha-Chlordane	5103-71-9	9.42	< 9.42	I	
beta-BHC	319-85-7	9.42	< 9.42		
delta-BHC	319-86-8	9.42	< 9.42		
Dieldrin	60-57-1	9.42	< 9.42	I	
Endosulfan I	959-98-8	9.42	< 9.42		
Endosulfan II	33213-65-9	9.42	< 9.42		
Endosulfan sulfate	1031-07-8	9.42	< 9.42	I	
Endrin	72-20-8	9.42	< 9.42		
Endrin aldehyde	7421-93-4	9.42	< 9.42		
Endrin ketone	53494-70-5	9.42	< 9.42	I,@	
gamma-BHC	58-89-9	9.42	< 9.42		
gamma-Chlordane	5566-34-7	9.42	< 9.42		
Heptachlor	76-44-8	9.42	< 9.42	I	
Heptachlor epoxide	1024-57-3	9.42	< 9.42		
Methoxychlor	72-43-5	23.5	< 23.5	I,@	
Toxaphene	8001-35-2	47.1	< 47.1		

Surrogate (Units: µg/kg-dry)	CAS	Result	Amount Spiked	% REC	Limits	Qual
Surr: Decachlorobiphenyl	2051-24-3	26.4	47.10	56.0	10-180	
Surr: Tetrachloro-m-xylene	877-09-8	19.9	47.10	42.3	10-135	

@ - High RPD due to suspected sample non-homogeneity or matrix interference.
I - Matrix spike recovery indicates matrix interference. The method is in control as indicated by the LCS.
Gel-Permeation Chromatography (GPC) Cleanup, method 3640A, utilized for this sample.

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ORGANIC ANALYTICAL REPORT

Client: Union Pacific Railroad **Contact:** Steve Preston
Project: Union Pacific Railroad / Moffat Treatment Residuals Testing
Lab Sample ID: 1806483-002B
Client Sample ID: Winter Park Material Composite
Collection Date: 6/20/2018 1400h
Received Date: 6/21/2018 1055h
Test Code: 8081-S-3546

Analytical Results Organochlorine Pests TCL GC/ECD Method 8081B/3546

Analyzed: 6/29/2018 1800h **Extracted:** 6/25/2018 1200h
Units: µg/kg-dry **Dilution Factor:** 1 **Method:** SW8081B

Compound	CAS Number	Reporting Limit	Analytical Result	Qual	% TIC Quality
4,4'-DDD	72-54-8	9.37	< 9.37		
4,4'-DDE	72-55-9	9.37	< 9.37		
4,4'-DDT	50-29-3	9.37	< 9.37		
Aldrin	309-00-2	9.37	< 9.37		
alpha-BHC	319-84-6	9.37	< 9.37		
alpha-Chlordane	5103-71-9	9.37	< 9.37		
beta-BHC	319-85-7	9.37	< 9.37		
delta-BHC	319-86-8	9.37	< 9.37		
Dieldrin	60-57-1	9.37	< 9.37		
Endosulfan I	959-98-8	9.37	< 9.37		
Endosulfan II	33213-65-9	9.37	< 9.37		
Endosulfan sulfate	1031-07-8	9.37	< 9.37		
Endrin	72-20-8	9.37	< 9.37		
Endrin aldehyde	7421-93-4	9.37	< 9.37		
Endrin ketone	53494-70-5	9.37	< 9.37		
gamma-BHC	58-89-9	9.37	< 9.37		
gamma-Chlordane	5566-34-7	9.37	< 9.37		
Heptachlor	76-44-8	9.37	< 9.37		
Heptachlor epoxide	1024-57-3	9.37	< 9.37		
Methoxychlor	72-43-5	23.4	< 23.4		
Toxaphene	8001-35-2	46.9	< 46.9		

Surrogate (Units: µg/kg-dry)	CAS	Result	Amount Spiked	% REC	Limits	Qual
Surr: Decachlorobiphenyl	2051-24-3	0	46.86	0	10-180	S
Surr: Tetrachloro-m-xylene	877-09-8	40.3	46.86	86.0	10-135	

Gel-Permeation Chromatography (GPC) Cleanup, method 3640A, utilized for this sample.
S - Surrogate outside recovery limits. Minimum method criteria of one surrogate within established recovery limits was met.

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ORGANIC ANALYTICAL REPORT

Client: Union Pacific Railroad **Contact:** Steve Preston
Project: Union Pacific Railroad / Moffat Treatment Residuals Testing
Lab Sample ID: 1806483-001B
Client Sample ID: Winter Park Material Grab
Collection Date: 6/20/2018 1400h
Received Date: 6/21/2018 1055h
Test Code: 8081-S-3546

Analytical Results Organochlorine Pests TCL GC/ECD Method 8081B/3546

Analyzed: 6/29/2018 1415h **Extracted:** 6/25/2018 1200h
Units: µg/kg-dry **Dilution Factor:** 1 **Method:** SW8081B

Compound	CAS Number	Reporting Limit	Analytical Result	Qual	% TIC Quality
4,4'-DDD	72-54-8	9.42	< 9.42	',@	
4,4'-DDE	72-55-9	9.42	< 9.42		
4,4'-DDT	50-29-3	9.42	< 9.42		
Aldrin	309-00-2	9.42	< 9.42		
alpha-BHC	319-84-6	9.42	< 9.42		
alpha-Chlordane	5103-71-9	9.42	< 9.42	'	
beta-BHC	319-85-7	9.42	< 9.42		
delta-BHC	319-86-8	9.42	< 9.42		
Dieldrin	60-57-1	9.42	< 9.42	'	
Endosulfan I	959-98-8	9.42	< 9.42		
Endosulfan II	33213-65-9	9.42	< 9.42		
Endosulfan sulfate	1031-07-8	9.42	< 9.42	'	
Endrin	72-20-8	9.42	< 9.42		
Endrin aldehyde	7421-93-4	9.42	< 9.42		
Endrin ketone	53494-70-5	9.42	< 9.42	',@	
gamma-BHC	58-89-9	9.42	< 9.42		
gamma-Chlordane	5566-34-7	9.42	< 9.42		
Heptachlor	76-44-8	9.42	< 9.42	'	
Heptachlor epoxide	1024-57-3	9.42	< 9.42		
Methoxychlor	72-43-5	23.5	< 23.5	',@	
Toxaphene	8001-35-2	47.1	< 47.1		

Surrogate	Units: µg/kg-dry	CAS	Result	Amount Spiked	% REC	Limits	Qual
Surr: Decachlorobiphenyl		2051-24-3	26.4	47.10	56.0	10-180	
Surr: Tetrachloro-m-xylene		877-09-8	19.9	47.10	42.3	10-135	

@ - High RPD due to suspected sample non-homogeneity or matrix interference.
' - Matrix spike recovery indicates matrix interference. The method is in control as indicated by the LCS.
Gel-Permeation Chromatography (GPC) Cleanup, method 3640A, utilized for this sample.

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ORGANIC ANALYTICAL REPORT

Client: Union Pacific Railroad **Contact:** Steve Preston
Project: Union Pacific Railroad / Moffat Treatment Residuals Testing
Lab Sample ID: 1806483-001E
Client Sample ID: Winter Park Material Grab
Collection Date: 6/20/2018 1400h
Received Date: 6/21/2018 1055h
Test Code: 8081-W-TCLP

Analytical Results TCLP Pesticides by GC/ECD Method 8081B/1311/3510C

Analyzed: 7/3/2018 2250h **Extracted:** 7/3/2018 1431h **TCLP Prep Date:** 7/2/2018 1200h
Units: mg/L **Dilution Factor:** 1 **Method:** SW8081B

Compound	CAS Number	Reporting Limit	Analytical Result	Qual	% TIC Quality
alpha-Chlordane	5103-71-9	0.000100	< 0.000100		
Chlordane, total	57-74-9	0.00100	< 0.00100		
Endrin	72-20-8	0.000100	< 0.000100		
gamma-BHC	58-89-9	0.000100	< 0.000100		
gamma-Chlordane	5566-34-7	0.000100	< 0.000100		
Heptachlor	76-44-8	0.000100	< 0.000100		
Heptachlor epoxide	1024-57-3	0.000100	< 0.000100		
Methoxychlor	72-43-5	0.000100	< 0.000100		
Toxaphene	8001-35-2	0.00125	< 0.00125		

Surrogate (Units: mg/L)	CAS	Result	Amount Spiked	% REC	Limits	Qual
Surr: Decachlorobiphenyl	2051-24-3	0.000576	0.0007500	76.8	15-149	
Surr: Tetrachloro-m-xylene	877-09-8	0.000427	0.0007500	56.9	11-120	

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ORGANIC ANALYTICAL REPORT

Client: Union Pacific Railroad **Contact:** Steve Preston
Project: Union Pacific Railroad / Moffat Treatment Residuals Testing
Lab Sample ID: 1806483-002E
Client Sample ID: Winter Park Material Composite
Collection Date: 6/20/2018 1400h
Received Date: 6/21/2018 1055h
Test Code: 8081-W-TCLP

Analytical Results TCLP Pesticides by GC/ECD Method 8081B/1311/3510C

Analyzed: 7/3/2018 2313h **Extracted:** 7/3/2018 1431h **TCLP Prep Date:** 7/2/2018 1200h
Units: mg/L **Dilution Factor:** 1 **Method:** SW8081B

Compound	CAS Number	Reporting Limit	Analytical Result	Qual	% TIC Quality
alpha-Chlordane	5103-71-9	0.000100	< 0.000100		
Chlordane, total	57-74-9	0.00100	< 0.00100		
Endrin	72-20-8	0.000100	< 0.000100		
gamma-BHC	58-89-9	0.000100	< 0.000100		
gamma-Chlordane	5566-34-7	0.000100	< 0.000100		
Heptachlor	76-44-8	0.000100	< 0.000100		
Heptachlor epoxide	1024-57-3	0.000100	< 0.000100		
Methoxychlor	72-43-5	0.000100	< 0.000100		
Toxaphene	8001-35-2	0.00125	< 0.00125		

Surrogate (Units: mg/L)	CAS	Result	Amount Spiked	% REC	Limits	Qual
Surr: Decachlorobiphenyl	2051-24-3	0.000565	0.0007500	75.3	15-149	
Surr: Tetrachloro-m-xylene	877-09-8	0.000423	0.0007500	56.4	11-120	

ORGANIC ANALYTICAL REPORT

Client: Union Pacific Railroad **Contact:** Steve Preston
Project: Union Pacific Railroad / Moffat Treatment Residuals Testing
Lab Sample ID: 1806483-001B
Client Sample ID: Winter Park Material Grab
Collection Date: 6/20/2018 1400h
Received Date: 6/21/2018 1055h
Test Code: 8082-S-3546

Analytical Results PCBs by GC/ECD Method 8082A/3546

Analyzed: 6/25/2018 907h **Extracted:** 6/22/2018 1103h
Units: µg/kg-dry **Dilution Factor:** 1 **Method:** SW8082A

Compound	CAS Number	Reporting Limit	Analytical Result	Qual	% TIC Quality
Aroclor 1016	12674-11-2	118	< 118		
Aroclor 1221	11104-28-2	118	< 118		
Aroclor 1232	11141-16-5	118	< 118		
Aroclor 1242	53469-21-9	118	< 118		
Aroclor 1248	12672-29-6	118	< 118		
Aroclor 1254	11097-69-1	118	< 118		
Aroclor 1260	11096-82-5	118	< 118		

Surrogate	Units: µg/kg-dry	CAS	Result	Amount Spiked	% REC	Limits	Qual
Surr: Decachlorobiphenyl		2051-24-3	12.3	23.51	52.2	10-180	
Surr: Tetrachloro-m-xylene		877-09-8	20.8	23.51	88.4	10-145	

Sulfuric acid cleanup method 3665A utilized for this sample.

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ORGANIC ANALYTICAL REPORT

Client: Union Pacific Railroad **Contact:** Steve Preston
Project: Union Pacific Railroad / Moffat Treatment Residuals Testing
Lab Sample ID: 1806483-002B
Client Sample ID: Winter Park Material Composite
Collection Date: 6/20/2018 1400h
Received Date: 6/21/2018 1055h
Test Code: 8082-S-3546

Analytical Results PCBs by GC/ECD Method 8082A/3546

Analyzed: 6/25/2018 919h **Extracted:** 6/22/2018 1103h
Units: µg/kg-dry **Dilution Factor:** 1 **Method:** SW8082A

Compound	CAS Number	Reporting Limit	Analytical Result	Qual	% TIC Quality
Aroclor 1016	12674-11-2	118	< 118		
Aroclor 1221	11104-28-2	118	< 118		
Aroclor 1232	11141-16-5	118	< 118		
Aroclor 1242	53469-21-9	118	< 118		
Aroclor 1248	12672-29-6	118	< 118		
Aroclor 1254	11097-69-1	118	< 118		
Aroclor 1260	11096-82-5	118	< 118		

Surrogate (Units: µg/kg-dry)	CAS	Result	Amount Spiked	% REC	Limits	Qual
Surr: Decachlorobiphenyl	2051-24-3	12.7	23.51	54.1	10-180	
Surr: Tetrachloro-m-xylene	877-09-8	50.8	23.51	216	10-145	S

S - Surrogate outside recovery limits. Minimum method criteria of one surrogate within established recovery limits was met. Sulfuric acid cleanup method 3665A utilized for this sample.

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ORGANIC ANALYTICAL REPORT

Client: Union Pacific Railroad **Contact:** Steve Preston
Project: Union Pacific Railroad / Moffat Treatment Residuals Testing
Lab Sample ID: 1806483-001B
Client Sample ID: Winter Park Material Grab
Collection Date: 6/20/2018 1400h
Received Date: 6/21/2018 1055h
Test Code: 8151-S

Analytical Results Herbicides D-List by GC/ECD Method 8151A/3550C

Analyzed: 6/28/2018 1800h **Extracted:** 6/26/2018 641h
Units: µg/kg-dry **Dilution Factor:** 1 **Method:** SW8151A

Compound	CAS Number	Reporting Limit	Analytical Result	Qual	% TIC Quality
2,4,5-TP	93-72-1	23.5	< 23.5		
2,4-D	94-75-7	47.0	< 47.0		

Surrogate	Units: µg/kg-dry	CAS	Result	Amount Spiked	% REC	Limits	Qual
Surr: DCAA		19719-28-9	98.1	112.9	86.9	10-144	

ORGANIC ANALYTICAL REPORT

Client: Union Pacific Railroad **Contact:** Steve Preston
Project: Union Pacific Railroad / Moffat Treatment Residuals Testing
Lab Sample ID: 1806483-002B
Client Sample ID: Winter Park Material Composite
Collection Date: 6/20/2018 1400h
Received Date: 6/21/2018 1055h
Test Code: 8151-S

Analytical Results Herbicides D-List by GC/ECD Method 8151A/3550C

Analyzed: 6/28/2018 1913h **Extracted:** 6/26/2018 641h
Units: µg/kg-dry **Dilution Factor:** 1 **Method:** SW8151A

Compound	CAS Number	Reporting Limit	Analytical Result	Qual	% TIC Quality
2,4,5-TP	93-72-1	23.5	< 23.5		
2,4-D	94-75-7	46.9	< 46.9		

Surrogate	Units: µg/kg-dry	CAS	Result	Amount Spiked	% REC	Limits	Qual
Surr: DCAA		19719-28-9	78.3	112.7	69.5	10-144	

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ORGANIC ANALYTICAL REPORT

Client: Union Pacific Railroad **Contact:** Steve Preston
Project: Union Pacific Railroad / Moffat Treatment Residuals Testing
Lab Sample ID: 1806483-001E
Client Sample ID: Winter Park Material Grab
Collection Date: 6/20/2018 1400h
Received Date: 6/21/2018 1055h
Test Code: 8151-W-TCLP

Analytical Results Herbicide TCLP List GC/ECD Method 8151A/1311/3510C

Analyzed: 7/5/2018 1917h **Extracted:** 7/3/2018 658h **TCLP Prep Date:** 7/2/2018 1200h
Units: mg/L **Dilution Factor:** 1 **Method:** SW8151A

Compound	CAS Number	Reporting Limit	Analytical Result	Qual	% TIC Quality
2,4,5-TP	93-72-1	0.00100	< 0.00100		
2,4-D	94-75-7	0.00100	< 0.00100		

Surrogate	Units: mg/L	CAS	Result	Amount Spiked	% REC	Limits	Qual
Surr: DCAA		19719-28-9	0.0121	0.01500	80.5	10-177	

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ORGANIC ANALYTICAL REPORT

Client: Union Pacific Railroad **Contact:** Steve Preston
Project: Union Pacific Railroad / Moffat Treatment Residuals Testing
Lab Sample ID: 1806483-002E
Client Sample ID: Winter Park Material Composite
Collection Date: 6/20/2018 1400h
Received Date: 6/21/2018 1055h
Test Code: 8151-W-TCLP

Analytical Results Herbicide TCLP List GC/ECD Method 8151A/1311/3510C

Analyzed: 7/5/2018 2029h **Extracted:** 7/3/2018 658h **TCLP Prep Date:** 7/2/2018 1200h
Units: mg/L **Dilution Factor:** 1 **Method:** SW8151A

Compound	CAS Number	Reporting Limit	Analytical Result	Qual	% TIC Quality
2,4,5-TP	93-72-1	0.00100	< 0.00100		
2,4-D	94-75-7	0.00100	< 0.00100		

Surrogate	Units: mg/L	CAS	Result	Amount Spiked	% REC	Limits	Qual
Surr: DCAA		19719-28-9	0.0139	0.01500	92.4	10-177	

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ORGANIC ANALYTICAL REPORT

Client: Union Pacific Railroad **Contact:** Steve Preston
Project: Union Pacific Railroad / Moffat Treatment Residuals Testing
Lab Sample ID: 1806483-001B
Client Sample ID: Winter Park Material Grab
Collection Date: 6/20/2018 1400h
Received Date: 6/21/2018 1055h
Test Code: 8270-S-3546

Analytical Results SVOA TCL List by GC/MS Method 8270D/3546

Analyzed: 6/25/2018 2019h **Extracted:** 6/22/2018 1621h
Units: µg/kg-dry **Dilution Factor:** 1 **Method:** SW8270D

Compound	CAS Number	Reporting Limit	Analytical Result	Qual	% TIC Quality
1,1'-Biphenyl	92-52-4	1,600	< 1,600		
1,2,4,5-Tetrachlorobenzene	95-94-3	1,600	< 1,600		
2,3,4,6-Tetrachlorophenol	58-90-2	1,600	< 1,600		
2,4,5-Trichlorophenol	95-95-4	1,600	< 1,600		
2,4,6-Trichlorophenol	88-06-2	1,600	< 1,600		
2,4-Dichlorophenol	120-83-2	1,600	< 1,600		
2,4-Dimethylphenol	105-67-9	1,600	< 1,600		
2,4-Dinitrophenol	51-28-5	3,160	< 3,160		
2,4-Dinitrotoluene	121-14-2	1,600	< 1,600		
2,6-Dinitrotoluene	606-20-2	1,600	< 1,600		
2-Chloronaphthalene	91-58-7	1,600	< 1,600		
2-Chlorophenol	95-57-8	1,600	< 1,600		
2-Methylnaphthalene	91-57-6	1,600	< 1,600		
2-Methylphenol	95-48-7	1,600	< 1,600		
2-Nitroaniline	88-74-4	1,600	< 1,600		
2-Nitrophenol	88-75-5	1,600	< 1,600		
3&4-Methylphenol		1,600	< 1,600		
3,3'-Dichlorobenzidine	91-94-1	1,600	< 1,600		
3-Nitroaniline	99-09-2	4,710	< 4,710		
4,6-Dinitro-2-methylphenol	534-52-1	3,160	< 3,160		
4-Bromophenyl phenyl ether	101-55-3	1,600	< 1,600		
4-Chloro-3-methylphenol	59-50-7	1,600	< 1,600		
4-Chloroaniline	106-47-8	1,600	< 1,600		
4-Chlorophenyl phenyl ether	7005-72-3	1,600	< 1,600		
4-Nitroaniline	100-01-6	4,710	< 4,710		
4-Nitrophenol	100-02-7	3,160	< 3,160		
Acenaphthene	83-32-9	1,600	< 1,600		
Acenaphthylene	208-96-8	1,600	< 1,600		
Acetophenone	98-86-2	1,600	< 1,600		

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Jose Rocha
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Lab Sample ID: 1806483-001B
Client Sample ID: Winter Park Material Grab

Analyzed: 6/25/2018 2019h **Extracted:** 6/22/2018 1621h
Units: µg/kg-dry **Dilution Factor:** 1 **Method:** SW8270D

Compound	CAS Number	Reporting Limit	Analytical Result	Qual	% TIC Quality
Anthracene	120-12-7	1,600	< 1,600		
Atrazine	1912-24-9	1,600	< 1,600		
Benz(a)anthracene	56-55-3	1,600	< 1,600		
Benzaldehyde	100-52-7	11,800	< 11,800		
Benzo(a)pyrene	50-32-8	1,600	< 1,600		
Benzo(b)fluoranthene	205-99-2	1,600	< 1,600		
Benzo(g,h,i)perylene	191-24-2	1,600	< 1,600		
Benzo(k)fluoranthene	207-08-9	1,600	< 1,600		
Bis(2-chloroethoxy)methane	111-91-1	1,600	< 1,600		
Bis(2-chloroethyl) ether	111-44-4	1,600	< 1,600		
Bis(2-chloroisopropyl) ether	108-60-1	1,600	< 1,600		
Bis(2-ethylhexyl) phthalate	117-81-7	1,600	< 1,600		
Butyl benzyl phthalate	85-68-7	1,600	< 1,600		
Caprolactam	105-60-2	3,770	< 3,770		
Carbazole	86-74-8	1,600	< 1,600		
Chrysene	218-01-9	1,600	< 1,600		
Dibenz(a,h)anthracene	53-70-3	1,600	< 1,600		
Dibenzofuran	132-64-9	1,600	< 1,600		
Diethyl phthalate	84-66-2	1,600	< 1,600		
Dimethyl phthalate	131-11-3	1,600	< 1,600		
Di-n-butyl phthalate	84-74-2	1,600	< 1,600		
Di-n-octyl phthalate	117-84-0	1,600	< 1,600		
Fluoranthene	206-44-0	1,600	< 1,600		
Fluorene	86-73-7	1,600	< 1,600		
Hexachlorobenzene	118-74-1	1,600	< 1,600		
Hexachlorobutadiene	87-68-3	1,600	< 1,600		
Hexachlorocyclopentadiene	77-47-4	1,600	< 1,600		
Hexachloroethane	67-72-1	1,600	< 1,600		
Indeno(1,2,3-cd)pyrene	193-39-5	1,600	< 1,600		
Isophorone	78-59-1	1,600	< 1,600		
Naphthalene	91-20-3	1,600	< 1,600		
Nitrobenzene	98-95-3	1,600	< 1,600		
N-Nitrosodi-n-propylamine	621-64-7	1,600	< 1,600		
N-Nitrosodiphenylamine	86-30-6	1,600	< 1,600		
Pentachlorophenol	87-86-5	1,600	< 1,600		
Phenanthrene	85-01-8	1,600	< 1,600		

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Jose Rocha
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Lab Sample ID: 1806483-001B
Client Sample ID: Winter Park Material Grab

Analyzed: 6/25/2018 2019h **Extracted:** 6/22/2018 1621h
Units: µg/kg-dry **Dilution Factor:** 1 **Method:** SW8270D

Compound	CAS Number	Reporting Limit	Analytical Result	Qual	% TIC Quality
Phenol	108-95-2	1,600	< 1,600		
Pyrene	129-00-0	1,600	< 1,600		

Surrogate (Units: µg/kg-dry)	CAS	Result	Amount Spiked	% REC	Limits	Qual
Surr: 2,4,6-Tribromophenol	118-79-6	2,490	6,281	39.7	10-237	
Surr: 2-Fluorobiphenyl	321-60-8	1,240	3,140	39.6	17-179	
Surr: 2-Fluorophenol	367-12-4	2,380	6,281	37.8	10-186	
Surr: Nitrobenzene-d5	4165-60-0	1,190	3,140	37.8	10-166	
Surr: Phenol-d6	13127-88-3	2,760	6,281	43.9	10-194	
Surr: Terphenyl-d14	1718-51-0	1,260	3,140	40.1	10-265	

Gel-Permeation Chromatography (GPC) Cleanup, method 3640A, utilized for this sample.

ORGANIC ANALYTICAL REPORT

Client: Union Pacific Railroad **Contact:** Steve Preston
Project: Union Pacific Railroad / Moffat Treatment Residuals Testing
Lab Sample ID: 1806483-002B
Client Sample ID: Winter Park Material Composite
Collection Date: 6/20/2018 1400h
Received Date: 6/21/2018 1055h
Test Code: 8270-S-3546

Analytical Results SVOA TCL List by GC/MS Method 8270D/3546

Analyzed: 6/25/2018 2041h **Extracted:** 6/22/2018 1621h
Units: µg/kg-dry **Dilution Factor:** 1 **Method:** SW8270D

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Laboratory Director

Jose Rocha
QA Officer

Compound	CAS Number	Reporting Limit	Analytical Result	Qual	% TIC Quality
1,1′-Biphenyl	92-52-4	1,600	< 1,600		
1,2,4,5-Tetrachlorobenzene	95-94-3	1,600	< 1,600		
2,3,4,6-Tetrachlorophenol	58-90-2	1,600	< 1,600		
2,4,5-Trichlorophenol	95-95-4	1,600	< 1,600		
2,4,6-Trichlorophenol	88-06-2	1,600	< 1,600		
2,4-Dichlorophenol	120-83-2	1,600	< 1,600		
2,4-Dimethylphenol	105-67-9	1,600	< 1,600		
2,4-Dinitrophenol	51-28-5	3,150	< 3,150		
2,4-Dinitrotoluene	121-14-2	1,600	< 1,600		
2,6-Dinitrotoluene	606-20-2	1,600	< 1,600		
2-Chloronaphthalene	91-58-7	1,600	< 1,600		
2-Chlorophenol	95-57-8	1,600	< 1,600		
2-Methylnaphthalene	91-57-6	1,600	< 1,600		
2-Methylphenol	95-48-7	1,600	< 1,600		
2-Nitroaniline	88-74-4	1,600	< 1,600		
2-Nitrophenol	88-75-5	1,600	< 1,600		
3&4-Methylphenol		1,600	< 1,600		
3,3′-Dichlorobenzidine	91-94-1	1,600	< 1,600		
3-Nitroaniline	99-09-2	4,700	< 4,700		
4,6-Dinitro-2-methylphenol	534-52-1	3,150	< 3,150		
4-Bromophenyl phenyl ether	101-55-3	1,600	< 1,600		
4-Chloro-3-methylphenol	59-50-7	1,600	< 1,600		
4-Chloroaniline	106-47-8	1,600	< 1,600		
4-Chlorophenyl phenyl ether	7005-72-3	1,600	< 1,600		
4-Nitroaniline	100-01-6	4,700	< 4,700		
4-Nitrophenol	100-02-7	3,150	< 3,150		
Acenaphthene	83-32-9	1,600	< 1,600		
Acenaphthylene	208-96-8	1,600	< 1,600		
Acetophenone	98-86-2	1,600	< 1,600		

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Lab Sample ID: 1806483-002B
Client Sample ID: Winter Park Material Composite

Analyzed: 6/25/2018 2041h **Extracted:** 6/22/2018 1621h
Units: µg/kg-dry **Dilution Factor:** 1 **Method:** SW8270D

Compound	CAS Number	Reporting Limit	Analytical Result	Qual	% TIC Quality
Anthracene	120-12-7	1,600	< 1,600		
Atrazine	1912-24-9	1,600	< 1,600		
Benz(a)anthracene	56-55-3	1,600	< 1,600		
Benzaldehyde	100-52-7	11,800	< 11,800		
Benzo(a)pyrene	50-32-8	1,600	< 1,600		
Benzo(b)fluoranthene	205-99-2	1,600	< 1,600		
Benzo(g,h,i)perylene	191-24-2	1,600	< 1,600		
Benzo(k)fluoranthene	207-08-9	1,600	< 1,600		
Bis(2-chloroethoxy)methane	111-91-1	1,600	< 1,600		
Bis(2-chloroethyl) ether	111-44-4	1,600	< 1,600		
Bis(2-chloroisopropyl) ether	108-60-1	1,600	< 1,600		
Bis(2-ethylhexyl) phthalate	117-81-7	1,600	< 1,600		
Butyl benzyl phthalate	85-68-7	1,600	< 1,600		
Caprolactam	105-60-2	3,760	< 3,760		
Carbazole	86-74-8	1,600	< 1,600		
Chrysene	218-01-9	1,600	< 1,600		
Dibenz(a,h)anthracene	53-70-3	1,600	< 1,600		
Dibenzofuran	132-64-9	1,600	< 1,600		
Diethyl phthalate	84-66-2	1,600	< 1,600		
Dimethyl phthalate	131-11-3	1,600	< 1,600		
Di-n-butyl phthalate	84-74-2	1,600	< 1,600		
Di-n-octyl phthalate	117-84-0	1,600	< 1,600		
Fluoranthene	206-44-0	1,600	**2,890**		
Fluorene	86-73-7	1,600	< 1,600		
Hexachlorobenzene	118-74-1	1,600	< 1,600		
Hexachlorobutadiene	87-68-3	1,600	< 1,600		
Hexachlorocyclopentadiene	77-47-4	1,600	< 1,600		
Hexachloroethane	67-72-1	1,600	< 1,600		
Indeno(1,2,3-cd)pyrene	193-39-5	1,600	< 1,600		
Isophorone	78-59-1	1,600	< 1,600		
Naphthalene	91-20-3	1,600	< 1,600		
Nitrobenzene	98-95-3	1,600	< 1,600		
N-Nitrosodi-n-propylamine	621-64-7	1,600	< 1,600		
N-Nitrosodiphenylamine	86-30-6	1,600	< 1,600		
Pentachlorophenol	87-86-5	1,600	< 1,600		
Phenanthrene	85-01-8	1,600	< 1,600		

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Lab Sample ID: 1806483-002B
Client Sample ID: Winter Park Material Composite

Analyzed: 6/25/2018 2041h **Extracted:** 6/22/2018 1621h
Units: µg/kg-dry **Dilution Factor:** 1 **Method:** SW8270D

Compound	CAS Number	Reporting Limit	Analytical Result	Qual	% TIC Quality
Phenol	108-95-2	1,600	< 1,600		
Pyrene	129-00-0	1,600	**2,530**		

Surrogate (Units: µg/kg-dry)	CAS	Result	Amount Spiked	% REC	Limits	Qual
Surr: 2,4,6-Tribromophenol	118-79-6	2,310	6,267	36.9	10-237	
Surr: 2-Fluorobiphenyl	321-60-8	1,170	3,133	37.4	17-179	
Surr: 2-Fluorophenol	367-12-4	2,170	6,267	34.6	10-186	
Surr: Nitrobenzene-d5	4165-60-0	1,070	3,133	34.3	10-166	
Surr: Phenol-d6	13127-88-3	2,460	6,267	39.2	10-194	
Surr: Terphenyl-d14	1718-51-0	1,200	3,133	38.4	10-265	

Gel-Permeation Chromatography (GPC) Cleanup, method 3640A, utilized for this sample.

ORGANIC ANALYTICAL REPORT

Client: Union Pacific Railroad **Contact:** Steve Preston
Project: Union Pacific Railroad / Moffat Treatment Residuals Testing
Lab Sample ID: 1806483-001E
Client Sample ID: Winter Park Material Grab
Collection Date: 6/20/2018 1400h
Received Date: 6/21/2018 1055h
Test Code: 8270-W-TCLP-3511

Analytical Results TCLP SVOA by GC/MS Method 8270D/1311/3511

Analyzed: 6/27/2018 2000h **Extracted:** 6/27/2018 1137h **TCLP Prep Date:** 6/26/2018 2050h
Units: mg/L **Dilution Factor:** 1 **Method:** SW8270D

Compound	CAS Number	Reporting Limit	Analytical Result	Qual	% TIC Quality
2,4,5-Trichlorophenol	95-95-4	0.0471	< 0.0471		
2,4,6-Trichlorophenol	88-06-2	0.0471	< 0.0471		
2,4-Dinitrotoluene	121-14-2	0.0471	< 0.0471		
2-Methylphenol	95-48-7	0.0471	< 0.0471		
3&4-Methylphenol		0.0471	< 0.0471		
Hexachlorobenzene	118-74-1	0.0471	< 0.0471		
Hexachlorobutadiene	87-68-3	0.0471	< 0.0471		
Hexachloroethane	67-72-1	0.0471	< 0.0471		
Nitrobenzene	98-95-3	0.0471	< 0.0471		
Pentachlorophenol	87-86-5	0.0471	< 0.0471		
Pyridine	110-86-1	0.0471	< 0.0471		

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Lab Sample ID: 1806483-001E
Client Sample ID: Winter Park Material Grab

Analyzed: 6/27/2018 2000h **Extracted:** 6/27/2018 1137h **TCLP Prep Date:** 6/26/2018 2050h
Units: mg/L **Dilution Factor:** 1 **Method:** SW8270D

Surrogate	Units: mg/L	CAS	Result	Amount Spiked	% REC	Limits	Qual
Surr: 2,4,6-Tribromophenol		118-79-6	0.0499	0.04711	106	10-310	
Surr: 2-Fluorobiphenyl		321-60-8	0.0262	0.02356	111	10-230	
Surr: 2-Fluorophenol		367-12-4	0.0201	0.04711	42.6	10-120	
Surr: Nitrobenzene-d5		4165-60-0	0.0262	0.02356	111	10-253	
Surr: Phenol-d6		13127-88-3	0.0184	0.04711	39.2	10-110	
Surr: Terphenyl-d14		1718-51-0	0.0317	0.02356	135	10-255	

ORGANIC ANALYTICAL REPORT

Client: Union Pacific Railroad **Contact:** Steve Preston
Project: Union Pacific Railroad / Moffat Treatment Residuals Testing
Lab Sample ID: 1806483-002E
Client Sample ID: Winter Park Material Composite
Collection Date: 6/20/2018 1400h
Received Date: 6/21/2018 1055h
Test Code: 8270-W-TCLP-3511

Analytical Results TCLP SVOA by GC/MS Method 8270D/1311/3511

Analyzed: 6/27/2018 2022h **Extracted:** 6/27/2018 1137h **TCLP Prep Date:** 6/26/2018 2050h
Units: mg/L **Dilution Factor:** 1 **Method:** SW8270D

Compound	CAS Number	Reporting Limit	Analytical Result	Qual	% TIC Quality
2,4,5-Trichlorophenol	95-95-4	0.0491	< 0.0491		
2,4,6-Trichlorophenol	88-06-2	0.0491	< 0.0491		
2,4-Dinitrotoluene	121-14-2	0.0491	< 0.0491		
2-Methylphenol	95-48-7	0.0491	< 0.0491		
3&4-Methylphenol		0.0491	< 0.0491		
Hexachlorobenzene	118-74-1	0.0491	< 0.0491		
Hexachlorobutadiene	87-68-3	0.0491	< 0.0491		
Hexachloroethane	67-72-1	0.0491	< 0.0491		
Nitrobenzene	98-95-3	0.0491	< 0.0491		
Pentachlorophenol	87-86-5	0.0491	< 0.0491		
Pyridine	110-86-1	0.0491	< 0.0491		

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Lab Sample ID: 1806483-002E
Client Sample ID: Winter Park Material Composite

Analyzed: 6/27/2018 2022h **Extracted:** 6/27/2018 1137h **TCLP Prep Date:** 6/26/2018 2050h
Units: mg/L **Dilution Factor:** 1 **Method:** SW8270D

Surrogate	Units: mg/L	CAS	Result	Amount Spiked	% REC	Limits	Qual
Surr: 2,4,6-Tribromophenol		118-79-6	0.0326	0.04907	66.4	10-310	
Surr: 2-Fluorobiphenyl		321-60-8	0.0247	0.02453	101	10-230	
Surr: 2-Fluorophenol		367-12-4	0.0129	0.04907	26.2	10-120	
Surr: Nitrobenzene-d5		4165-60-0	0.0251	0.02453	103	10-253	
Surr: Phenol-d6		13127-88-3	0.0129	0.04907	26.2	10-110	
Surr: Terphenyl-d14		1718-51-0	0.0261	0.02453	107	10-255	

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ORGANIC ANALYTICAL REPORT

Client: Union Pacific Railroad **Contact:** Steve Preston
Project: Union Pacific Railroad / Moffat Treatment Residuals Testing
Lab Sample ID: 1806483-001A
Client Sample ID: Winter Park Material Grab
Collection Date: 6/20/2018 1400h
Received Date: 6/21/2018 1055h

Test Code: 8260-S

Analytical Results VOAs TCL List by GC/MS Method 8260C

Analyzed: 6/23/2018 132h
Units: µg/kg-dry **Dilution Factor:** 0.99 **Method:** SW8260C

Compound	CAS Number	Reporting Limit	Analytical Result	Qual	% TIC Quality
1,1,1-Trichloroethane	71-55-6	9.36	< 9.36		
1,1,2,2-Tetrachloroethane	79-34-5	9.36	< 9.36		
1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1	9.36	< 9.36		
1,1,2-Trichloroethane	79-00-5	9.36	< 9.36		
1,1-Dichloroethane	75-34-3	9.36	< 9.36		
1,1-Dichloroethene	75-35-4	9.36	< 9.36		
1,2,3-Trichlorobenzene	87-61-6	9.36	< 9.36		
1,2,4-Trichlorobenzene	120-82-1	9.36	< 9.36		
1,2-Dibromo-3-chloropropane	96-12-8	23.4	< 23.4		
1,2-Dibromoethane	106-93-4	9.36	< 9.36		
1,2-Dichlorobenzene	95-50-1	9.36	< 9.36		
1,2-Dichloroethane	107-06-2	9.36	< 9.36		
1,2-Dichloropropane	78-87-5	9.36	< 9.36		
1,3-Dichlorobenzene	541-73-1	9.36	< 9.36		
1,4-Dichlorobenzene	106-46-7	9.36	< 9.36		
1,4-Dioxane	123-91-1	234	< 234		
2-Butanone	78-93-3	46.8	< 46.8		
2-Hexanone	591-78-6	23.4	< 23.4		
4-Methyl-2-pentanone	108-10-1	23.4	< 23.4		
Acetone	67-64-1	46.8	< 46.8		
Benzene	71-43-2	9.36	< 9.36		
Bromochloromethane	74-97-5	9.36	< 9.36		
Bromodichloromethane	75-27-4	9.36	< 9.36		
Bromoform	75-25-2	9.36	< 9.36		
Bromomethane	74-83-9	23.4	< 23.4		
Carbon disulfide	75-15-0	9.36	< 9.36		
Carbon tetrachloride	56-23-5	9.36	< 9.36		
Chlorobenzene	108-90-7	9.36	< 9.36		
Chloroethane	75-00-3	9.36	< 9.36		

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Lab Sample ID: 1806483-001A
Client Sample ID: Winter Park Material Grab

Analyzed: 6/23/2018 132h
Units: µg/kg-dry **Dilution Factor:** 0.99 **Method:** SW8260C

Compound	CAS Number	Reporting Limit	Analytical Result	Qual	% TIC Quality
Chloroform	67-66-3	9.36	< 9.36		
Chloromethane	74-87-3	23.4	< 23.4		
cis-1,2-Dichloroethene	156-59-2	9.36	< 9.36		
cis-1,3-Dichloropropene	10061-01-5	9.36	< 9.36		
Cyclohexane	110-82-7	9.36	< 9.36		
Dibromochloromethane	124-48-1	9.36	< 9.36		
Dichlorodifluoromethane	75-71-8	9.36	< 9.36		
Ethylbenzene	100-41-4	9.36	< 9.36		
Isopropylbenzene	98-82-8	9.36	< 9.36		
m,p-Xylene	179601-23-1	9.36	< 9.36		
Methyl Acetate	79-20-9	23.4	< 23.4		
Methyl tert-butyl ether	1634-04-4	9.36	< 9.36		
Methylcyclohexane	108-87-2	9.36	< 9.36		
Methylene chloride	75-09-2	23.4	< 23.4		
o-Xylene	95-47-6	9.36	< 9.36		
Styrene	100-42-5	9.36	< 9.36		
Tetrachloroethene	127-18-4	9.36	< 9.36		
Toluene	108-88-3	9.36	< 9.36		
trans-1,2-Dichloroethene	156-60-5	9.36	< 9.36		
trans-1,3-Dichloropropene	10061-02-6	9.36	< 9.36		
Trichloroethene	79-01-6	9.36	< 9.36		
Trichlorofluoromethane	75-69-4	9.36	< 9.36		
Vinyl chloride	75-01-4	4.68	< 4.68		

Surrogate (Units: µg/kg-dry)	CAS	Result	Amount Spiked	% REC	Limits	Qual
Surr: 1,2-Dichloroethane-d4	17060-07-0	232	234.1	98.9	51-170	
Surr: 4-Bromofluorobenzene	460-00-4	261	234.1	112	50-140	
Surr: Dibromofluoromethane	1868-53-7	236	234.1	101	50-140	
Surr: Toluene-d8	2037-26-5	251	234.1	107	50-140	

Internal standard areas were outside of the QC limits. Reanalysis of sample yielded similar results indicating matrix interference.
Sampling and analytical preparation performed by method 5030A modified for analysis of soil samples collected in 2 or 4 oz jars.

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Kyle F. Gross
Laboratory Director

Jose Rocha
QA Officer

ORGANIC ANALYTICAL REPORT

Client: Union Pacific Railroad **Contact:** Steve Preston
Project: Union Pacific Railroad / Moffat Treatment Residuals Testing
Lab Sample ID: 1806483-002A
Client Sample ID: Winter Park Material Composite
Collection Date: 6/20/2018 1400h
Received Date: 6/21/2018 1055h
Test Code: 8260-S

Analytical Results VOAs TCL List by GC/MS Method 8260C

Analyzed: 6/23/2018 152h
Units: µg/kg-dry **Dilution Factor:** 0.99 **Method:** SW8260C

Compound	CAS Number	Reporting Limit	Analytical Result	Qual	% TIC Quality
1,1,1-Trichloroethane	71-55-6	9.33	< 9.33		
1,1,2,2-Tetrachloroethane	79-34-5	9.33	< 9.33		
1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1	9.33	< 9.33		
1,1,2-Trichloroethane	79-00-5	9.33	< 9.33		
1,1-Dichloroethane	75-34-3	9.33	< 9.33		
1,1-Dichloroethene	75-35-4	9.33	< 9.33		
1,2,3-Trichlorobenzene	87-61-6	9.33	< 9.33		
1,2,4-Trichlorobenzene	120-82-1	9.33	< 9.33		
1,2-Dibromo-3-chloropropane	96-12-8	23.3	< 23.3		
1,2-Dibromoethane	106-93-4	9.33	< 9.33		
1,2-Dichlorobenzene	95-50-1	9.33	< 9.33		
1,2-Dichloroethane	107-06-2	9.33	< 9.33		
1,2-Dichloropropane	78-87-5	9.33	< 9.33		
1,3-Dichlorobenzene	541-73-1	9.33	< 9.33		
1,4-Dichlorobenzene	106-46-7	9.33	< 9.33		
1,4-Dioxane	123-91-1	233	< 233		
2-Butanone	78-93-3	46.6	< 46.6		
2-Hexanone	591-78-6	23.3	< 23.3		
4-Methyl-2-pentanone	108-10-1	23.3	< 23.3		
Acetone	67-64-1	46.6	< 46.6		
Benzene	71-43-2	9.33	< 9.33		
Bromochloromethane	74-97-5	9.33	< 9.33		
Bromodichloromethane	75-27-4	9.33	< 9.33		
Bromoform	75-25-2	9.33	< 9.33		
Bromomethane	74-83-9	23.3	< 23.3		
Carbon disulfide	75-15-0	9.33	< 9.33		
Carbon tetrachloride	56-23-5	9.33	< 9.33		
Chlorobenzene	108-90-7	9.33	< 9.33		
Chloroethane	75-00-3	9.33	< 9.33		

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Kyle F. Gross
Laboratory Director

Jose Rocha
QA Officer

Lab Sample ID: 1806483-002A
Client Sample ID: Winter Park Material Composite

Analyzed: 6/23/2018 152h
Units: µg/kg-dry **Dilution Factor:** 0.99 **Method:** SW8260C

Compound	CAS Number	Reporting Limit	Analytical Result	Qual	% TIC Quality
Chloroform	67-66-3	9.33	< 9.33		
Chloromethane	74-87-3	23.3	< 23.3		
cis-1,2-Dichloroethene	156-59-2	9.33	< 9.33		
cis-1,3-Dichloropropene	10061-01-5	9.33	< 9.33		
Cyclohexane	110-82-7	9.33	< 9.33		
Dibromochloromethane	124-48-1	9.33	< 9.33		
Dichlorodifluoromethane	75-71-8	9.33	< 9.33		
Ethylbenzene	100-41-4	9.33	< 9.33		
Isopropylbenzene	98-82-8	9.33	< 9.33		
m,p-Xylene	179601-23-1	9.33	< 9.33		
Methyl Acetate	79-20-9	23.3	< 23.3		
Methyl tert-butyl ether	1634-04-4	9.33	< 9.33		
Methylcyclohexane	108-87-2	9.33	< 9.33		
Methylene chloride	75-09-2	23.3	< 23.3		
o-Xylene	95-47-6	9.33	< 9.33		
Styrene	100-42-5	9.33	< 9.33		
Tetrachloroethene	127-18-4	9.33	< 9.33		
Toluene	108-88-3	9.33	< 9.33		
trans-1,2-Dichloroethene	156-60-5	9.33	< 9.33		
trans-1,3-Dichloropropene	10061-02-6	9.33	< 9.33		
Trichloroethene	79-01-6	9.33	< 9.33		
Trichlorofluoromethane	75-69-4	9.33	< 9.33		
Vinyl chloride	75-01-4	4.66	< 4.66		

Surrogate (Units: µg/kg-dry)	CAS	Result	Amount Spiked	% REC	Limits	Qual
Surr: 1,2-Dichloroethane-d4	17060-07-0	261	233.1	112	51-170	
Surr: 4-Bromofluorobenzene	460-00-4	292	233.1	125	50-140	
Surr: Dibromofluoromethane	1868-53-7	250	233.1	107	50-140	
Surr: Toluene-d8	2037-26-5	270	233.1	116	50-140	

Sampling and analytical preparation performed by method 5030A modified for analysis of soil samples collected in 2 or 4 oz jars.

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Laboratory Director

Jose Rocha
QA Officer

ORGANIC ANALYTICAL REPORT

Client: Union Pacific Railroad **Contact:** Steve Preston
Project: Union Pacific Railroad / Moffat Treatment Residuals Testing
Lab Sample ID: 1806483-001D
Client Sample ID: Winter Park Material Grab
Collection Date: 6/20/2018 1400h
Received Date: 6/21/2018 1055h
Test Code: 8260-W-TCLP

Analytical Results TCLP VOAs by GC/MS Method 8260C/1311/5030C

Analyzed: 6/29/2018 858h **TCLP Prep Date:** 6/27/2018 1850h
Units: mg/L **Dilution Factor:** 20 **Method:** SW8260C

Compound	CAS Number	Reporting Limit	Analytical Result	Qual	% TIC Quality
1,1-Dichloroethene	75-35-4	0.0400	< 0.0400		
1,2-Dichloroethane	107-06-2	0.0400	< 0.0400		
1,4-Dichlorobenzene	106-46-7	0.0400	< 0.0400		
2-Butanone	78-93-3	0.200	< 0.200		
Benzene	71-43-2	0.0200	< 0.0200		
Carbon tetrachloride	56-23-5	0.0400	< 0.0400		
Chlorobenzene	108-90-7	0.0400	< 0.0400		
Chloroform	67-66-3	0.0400	< 0.0400		
Tetrachloroethene	127-18-4	0.0400	< 0.0400		
Trichloroethene	79-01-6	0.0400	< 0.0400		
Vinyl chloride	75-01-4	0.0200	< 0.0200		

Surrogate	Units: mg/L	CAS	Result	Amount Spiked	% REC	Limits	Qual
Surr: 1,2-Dichloroethane-d4		17060-07-0	1.10	1.000	110	72-151	
Surr: 4-Bromofluorobenzene		460-00-4	1.11	1.000	111	80-152	
Surr: Dibromofluoromethane		1868-53-7	1.05	1.000	105	72-135	
Surr: Toluene-d8		2037-26-5	1.06	1.000	106	80-124	

The pH of the sample was >2. Analysis was performed within the 7 day holding time.

ORGANIC ANALYTICAL REPORT

Client: Union Pacific Railroad **Contact:** Steve Preston
Project: Union Pacific Railroad / Moffat Treatment Residuals Testing
Lab Sample ID: 1806483-002D
Client Sample ID: Winter Park Material Composite
Collection Date: 6/20/2018 1400h
Received Date: 6/21/2018 1055h
Test Code: 8260-W-TCLP

Analytical Results TCLP VOAs by GC/MS Method 8260C/1311/5030C

Analyzed: 6/29/2018 956h **TCLP Prep Date:** 6/27/2018 1850h
Units: mg/L **Dilution Factor:** 20 **Method:** SW8260C

Compound	CAS Number	Reporting Limit	Analytical Result	Qual	% TIC Quality
1,1-Dichloroethene	75-35-4	0.0400	< 0.0400		
1,2-Dichloroethane	107-06-2	0.0400	< 0.0400		
1,4-Dichlorobenzene	106-46-7	0.0400	< 0.0400		
2-Butanone	78-93-3	0.200	< 0.200		
Benzene	71-43-2	0.0200	< 0.0200		
Carbon tetrachloride	56-23-5	0.0400	< 0.0400		
Chlorobenzene	108-90-7	0.0400	< 0.0400		
Chloroform	67-66-3	0.0400	< 0.0400		
Tetrachloroethene	127-18-4	0.0400	< 0.0400		
Trichloroethene	79-01-6	0.0400	< 0.0400		
Vinyl chloride	75-01-4	0.0200	< 0.0200		

Surrogate Units: mg/L	CAS	Result	Amount Spiked	% REC	Limits	Qual
Surr: 1,2-Dichloroethane-d4	17060-07-0	1.10	1.000	110	72-151	
Surr: 4-Bromofluorobenzene	460-00-4	1.10	1.000	110	80-152	
Surr: Dibromofluoromethane	1868-53-7	1.06	1.000	106	72-135	
Surr: Toluene-d8	2037-26-5	1.06	1.000	106	80-124	

The pH of the sample was >2. Analysis was performed within the 7 day holding time.

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Attachment D.4
Safety Data Sheets

California Aluminum Chemicals

CC 2000

SAFETY DATA SHEET

OSHA HCS (29 CFR 1910.1200)

SECTION 1: PRODUCT AND COMPANY IDENTIFICATION

Product identifier

Chemical Name	Aluminum Chlorohydrate Solution
CAS No.	12042-91-0
Trade Name	CC 2000
Product Code	None

Relevant identified uses of the substance or mixture and uses advised against

Identified Use(s)	Water Treatment Chemical
Uses Advised Against	None
Company Identification	California Aluminum Chemicals LLC 241 Spenker Avenue Modesto, CA 95354
Telephone	(209) 525-3932
Fax	(209) 525-8928

Emergency telephone number

Emergency Phone No.	CHEMTREC 24 hr. (800) 424-9300; Not classified as dangerous for transport.

SECTION 2: HAZARDS IDENTIFICATION

Classification of the substance or mixture

OSHA HCS (29 CFR 1910.1200)	Not classified as dangerous for supply/use.

Label elements

Hazard Symbol	None
Signal word(s)	None
Hazard Statement(s)	None
Precautionary Statement(s)	Avoid contact with skin and eyes. Wear protective gloves/eye protection. IF INHALED: Get medical advice/attention if you feel unwell. IF ON SKIN: Wash with plenty of soap and water. If irritation (redness, rash, blistering) develops, get medical attention. IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing. If irritation develops and persists, get medical attention. IF SWALLOWED: Call a POISON CENTER or doctor/physician if you feel unwell.

Other hazards None

SECTION 3: COMPOSITION/INFORMATION ON INGREDIENTS

Hazardous Ingredient(s)	% wt.*	CAS No.	Hazard classification
Aluminum Chlorohydrate	50	12042-91-0	Not classified as dangerous for supply/use.
Water	50	7732-18-5	Not classified as dangerous for supply/use.

Additional Information - Substances in the product which may present a health or environmental hazard, or which have been assigned occupational exposure limits, are detailed below: **None**

SECTION 4: FIRST AID MEASURES

Description of first aid measures

Inhalation	Get medical advice/attention if you feel unwell.
Skin Contact	Wash affected skin with soap and water. If irritation (redness, rash, blistering) develops, get medical attention.
Eye Contact	Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing. If irritation develops and persists, get medical attention.
Ingestion	Call a POISON CENTER or doctor/physician if you feel unwell.
Most important symptoms and effects, both acute and delayed	None
Indication of any immediate medical attention and special treatment needed	IF SWALLOWED: Immediately call a POISON CENTER or doctor/physician.

SECTION 5: FIRE-FIGHTING MEASURES

Extinguishing Media

-Suitable Extinguishing Media	Non-combustible. As appropriate for surrounding fire.
-Unsuitable Extinguishing Media	None anticipated.
Special hazards arising from the substance or mixture	Combustion or thermal decomposition will evolve toxic and irritant vapours.
Advice for fire-fighters	A self contained breathing apparatus and suitable protective clothing should be worn in fire conditions. Keep containers cool by spraying with water if exposed to fire.

SECTION 6: ACCIDENTAL RELEASE MEASURES

Personal precautions, protective equipment and emergency procedures	Avoid contact with skin and eyes. Wear protective gloves/eye protection.
Environmental precautions	Prevent liquid entering sewers, basements and work pits. Avoid release to the environment.
Methods and material for containment and cleaning up	Cover spills with inert absorbent material. Transfer to a container for disposal or recovery.
Reference to other sections	None
Additional Information	None

SECTION 7: HANDLING AND STORAGE

Precautions for safe handling	Avoid contact with skin and eyes.

Conditions for safe storage, including any incompatibilities

-Storage temperature	Keep in a cool, well ventilated place. Store at temperatures not exceeding 50°C / 122 °F. Protect from sunlight.
-Incompatible materials	This product should be stored away from sources of strong heat, oxidizing chemicals,and reducing agents.
Specific end use(s)	Water Treatment Chemical

SECTION 8: EXPOSURE CONTROLS/PERSONAL PROTECTION

Occupational Exposure Limits

SUBSTANCE.	CAS No.	(8hr TWA) PEL (OSHA)	(8hr TWA) TLV (ACGIH)	(STEL) PEL (OSHA)	(STEL) TLV (ACGIH)	Note:
Aluminum Chlorohydrate, as Al	12042-91-0	15 mg/m3 (T) 5 mg/m3 (R)	1 mg/m3 (R)	-----	-----	-----

- (T) Total Particulate; (R) Respirable Particulate

Recommended monitoring method NIOSH 7013 (Aluminum and compounds, as Al)

Exposure controls

Appropriate engineering controls Not normally required.

Personal protection equipment

Eye/face protection

Wear protective eyewear (goggles, face shield, or safety glasses).

Skin protection (Hand protection/ Other)

Wear suitable gloves if prolonged skin contact is likely. Check with protective equipment manufacturer's data.

Respiratory protection

Normally no personal respiratory protection is necessary. In case of insufficient ventilation, wear suitable respiratory equipment. Check with protective equipment manufacturer's data.

Thermal hazards — Not normally required. Use gloves with insulation for thermal protection, when needed.

Environmental Exposure Controls Avoid release to the environment.

SECTION 9: PHYSICAL AND CHEMICAL PROPERTIES

Information on basic physical and chemical properties

Appearance	Liquid
Color.	Almost colourless to pale yellow
Odor	None
Odor Threshold (ppm)	Not available
pH (Value)	4 - 5
Melting Point (°C) / Freezing Point (°C)	- 5.5 (22 °F)
Boiling point/boiling range (°C):	100 °C (212 °F)
Flash Point (°C)	Non-combustible
Evaporation Rate	Similar to water
Flammability (solid, gas)	Not applicable
Explosive Limit Ranges	Non-combustible

Vapor pressure (Pascal)	Similar to water
Vapor Density (Air=1)	Similar to water
Density (g/ml)	1.34
Solubility (Water)	Miscible
Solubility (Other)	Not available
Partition Coefficient (n-Octanol/water)	Not available
Auto Ignition Point (°C)	Non-combustible
Decomposition Temperature (°C)	Not available
Kinematic Viscosity (cSt)	Similar to water
Explosive properties	Not explosive
Oxidizing properties	Not oxidising
Other information	Not available

SECTION 10: STABILITY AND REACTIVITY

Reactivity	Stable under normal conditions.
Chemical stability	Stable.
Possibility of hazardous reactions	None anticipated.
Conditions to avoid	Incompatible materials.
Incompatible materials	Substances that react with water or aluminum.
Hazardous decomposition product(s)	None anticipated.

SECTION 11: TOXICOLOGICAL INFORMATION

Exposure routes: Inhalation, Skin Contact, Eye Contact

Aluminum Chlorohydrate (CAS No. 12042-91-0):

Acute toxicity	Oral LD50 = 9187 mg/kg (Rat) Dermal LD0 = >2000 mg/kg (Rat)
Irritation / Corrosivity	Unlikely to cause eye irritation. Unlikely to cause skin irritation.
Sensitisation	It is not a skin sensitiser.
Repeated dose toxicity	Not to be expected.
Carcinogenicity	It is unlikely to present a carcinogenic hazard to man.

NTP	IARC	ACGIH	OSHA	NIOSH
No.	No.	No.	No.	No.

Mutagenicity	Negative
Toxicity for reproduction	Negative
Reproductive toxicity	Not to be expected
Other information	None known.

SECTION 12: ECOLOGICAL INFORMATION

Ecotoxicity

Short term	LC50 (96 hr): 609 mg/l (Fathead minnow) LC50 (48 hour): 397 mg/L (Daphnia magna)
Long Term	Not available.
Persistence and degradability	Not readily biodegradable.
Bioaccumulative potential	The product has no potential for bioaccumulation.
Mobility in soil	Not available.
Results of PBT and vPvB assessment	Not classified as PBT or vPvB.
Other adverse effects	Not available.

SECTION 13: DISPOSAL CONSIDERATIONS

Waste treatment methods — Disposal should be in accordance with local, state or national legislation. Consult an accredited waste disposal contractor or the local authority for advice.

SECTION 14: TRANSPORT INFORMATION

	U.S. DOT	Sea transport (IMDG)	Air transport (ICAO/IATA)
UN number			
Proper Shipping Name		**Not classified as dangerous for transport.**	
Transport hazard class(es)			
Packing group			
Environmental hazards			
Special precautions for user			

Transport in bulk according to Annex II of MARPOL73/78 and the IBC Code: Not applicable

SECTION 15: REGULATORY INFORMATION

Safety, health and environmental regulations/legislation specific for the substance or mixture:

TSCA (Toxic Substance Control Act) - Inventory Status: All components listed or polymer exempt.

Designated Hazardous Substances and Reportable Quantities (40 CFR 302.4):

Chemical Name	CAS No.	Typical %wt.	RQ (Pounds)
None	---	---	---

SARA 311/312 - Hazard Categories: None

☐ Fire ☐ Sudden Release ☐ Reactivity ☐ Immediate (acute) ☐ Chronic (delayed)

SARA 313 - Toxic Chemicals (40 CFR 372):

Chemical Name	CAS No.	Typical %wt.
None	---	---

SARA 302 - Extremely Hazardous Substances (40 CFR 355):

Chemical Name	CAS No.	Typical %wt.	TPQ (pounds)
None	---	---	---

California Proposition 65 List:

Chemical Name	CAS No.	Type of Toxicity
None	---	---

SECTION 16: OTHER INFORMATION

The following sections contain revisions or new statements: 1-16.

Date of preparation: April 27, 2015

Hazard Statement(s) and Risk Phrases Listed in: SECTION 2:/ SECTION 3:

Hazard Statement(s)
- None.

Training advice: None.

Disclaimer: We believe the statements, technical information and recommendations contained herein are reliable, but they are given without warranty or guarantee of any kind. The information contained in this document applies to this specific material as supplied. It may not be valid for this material if it is used in combination with any other materials. It is the user's responsibility to satisfy oneself as to the suitability and completeness of this information for the user's own particular use.

SAFETY DATA SHEET

seventh generation

Issue date 20 September 2016 FM000001-00.3, FM000001-01.5, FM000001-02.5, FM000001-03.3

This product is packaged for retail sale and intended for consumer use. The U.S. OSHA Hazard Communication Standard (29 CFR 1910.1200) does not apply to "consumer products" as defined by the U.S. Consumer Product Safety Act and Federal Hazardous Substances Act, including consumer products used in the workplace under typical duration and frequency of exposure as experienced by consumers when used for the intended purpose. This Safety Data Sheet (SDS) is provided as a courtesy to assist with proper use and safe handling. Applicable consumer product use and safety information is provided on the product label and is included for easy reference in Section 16 of this SDS. This SDS is designed to cover both U.S. and Canada. Differences between U.S. and Canadian requirements are noted where applicable.

Section 1: Identification of Product and Company

Product Name	Dish Liquid, Dish Liquid Refill
Synonyms	Natural Dish Liquid, Natural Dish Liquid Refill
Product Use	Hand Dishwashing
Restrictions on Use	Follow directions on the product label

Manufacturer Name	Seventh Generation, Inc.
Address	60 Lake Street, Burlington, VT 05401, USA

Emergency Telephone Number	U.S., Canada
Monday -Friday 8 am - 5 pm ET (except holidays)	1-800-211-4279
Outside these hours	1-800-255-3924 (ChemTel)

Section 2: Hazards Identification

Classification	
U.S.	This product is considered hazardous under the 2012 OSHA Hazard Communication Standard (29 CFR 1910.1200).
Canada	This product is considered hazardous under the WHMIS 2015.

Hazard Category	
Eye Damage/Irritation	Category 2B

Signal Word
WARNING

Hazard Statement(s)
Causes eye irritation

Hazard Pictogram(s)
None

Precautionary Statement(s) - General - Consumer Products
If medical advice is needed, have product container or label at hand. Keep out of reach of children. Read label before use.

Precautionary Statement(s) - Prevention
Wash hands thoroughly after handling.

Precautionary Statement(s) - Response
If in eyes: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing. If eye irritation persists: Get medical advice/attention.

Precautionary Statement(s) - Storage
None

Precautionary Statement(s) - Disposal
None

Hazards not otherwise identified
None known

Percent ingredients with unknown acute toxicity
0% of the product consists of ingredients of unknown acute oral toxicity. Refer to Section 3.

Section 3: Composition, Information on Ingredients

Regardless of hazard classification, Seventh Generation discloses all intentionally added ingredients and, if applicable incidental ingredients ≥1% on the consumer product label.

Ingredient	Function	CAS Number	Concentration[1]	LD50[2]
aqua (water)	diluent	7732-18-5	30% - 100%	Not applicable
sodium lauryl sulfate	cleaning agent	151-21-3	10% - 30%	1288 mg/kg
glycerin	foam stabilizer	56-81-5	1% - 3%	>12600 mg/kg
lauramine oxide	cleaning agent	70592-80-2	1% - 3%	>2000 mg/kg
caprylyl/myristyl glucoside	cleaning agent	68515-73-1 & 110615-47-9	≤1%	>2000 mg/kg
magnesium chloride	viscosity modifier	7786-30-3/7791-18-6	≤1%	>2000 mg/kg
citric acid	pH adjuster	77-92-9	≤1%	3000 mg/kg
essential oils & botanical extracts*	fragrance	mixture	≤1%	>2000 mg/kg
benzisothiazolinone	preservative	2634-33-5	≤1%	1020 mg/kg
methylisothiazolinone	preservative	2682-20-4	≤1%	>100 mg/kg
*Free & Clear: not applicable.				
*Lavender Flower & Mint: cananga odorata (ylang ylang) flower oil, citrus aurantifolia (lime) oil, citrus aurantium dulcis (orange) oil, lavandula hybrida (lavandin) oil, mentha piperita (peppermint) oil, mentha viridis (spearmint) leaf oil. d-Limonene is a component of these essential oils.				
*Clementine Zest & Lemongrass: canarium luzonicum (elemi) gum nonvolatiles, citrus aurantium bergamia (bergamot) fruit oil, citrus aurantium dulcis (orange) oil, citrus nobilis (mandarin orange) peel oil, cymbopogon schoenanthus (lemongrass) oil, tangelo oil. d-Limonene is a component of these essential oils.				
*Fresh Citrus & Ginger: canarium luzonicum (elemi) gum nonvolatiles, cedrol, cinnamomum zeylanicum (cinnamon) bark extract, citrus aurantifolia (lime) oil, citrus aurantium amara (bitter orange) oil, citrus aurantium bergamia (bergamot) fruit oil, citrus aurantium dulcis (orange) oil, citrus limon (lemon) peel oil, coriandrum sativum (coriander) fruit oil, elettaria cardamomum (cardamon) seed oil, eugenia caryophyllus (clove) leaf oil, myristica fragrans (nutmeg) kernel oil, pelargonium graveolens (geranium) flower oil, zingiber officinale (ginger) root oil. d-Limonene is a component of these essential oils.				
*Lavender Flower & Lime: cananga odorata (ylang ylang) flower oil, citrus aurantifolia (lime) oil, citrus aurantium dulcis (orange) oil, lavandula hybrida (lavandin) oil, mentha piperita (peppermint) oil, mentha viridis (spearmint) leaf oil. d-Limonene is a component of these essential oils.				

[1] Where ranges are shown, the exact concentration has been withheld as a trade secret.

[2] LD50 Acute oral toxicity (rat) – This is a value provided by the raw material supplier or scientific literature. It is not a value generated by Seventh Generation by testing using rats. Seventh Generation uses alternative, non-animal based methods and scientific literature to determine the safety classification of our products and their ingredients.

Section 4: First Aid Measures

Eye Contact	Flush eyes with water immediately after contact. Call a physician if irritation develops or persists.
Skin Contact	Rinse thoroughly with water if skin contact occurs. Call a physician if irritation develops or persists.
Ingestion	Drink 4-8 ounces of water or milk immediately. If prolonged nausea or pain occurs call a doctor.
Inhalation	No need for first aid is expected.
Notes to Physician	Treat symptomatically.
Most important symptoms and effects	Acute exposure may result in eye irritation.

Section 5: Fire Fighting Measures

Suitable Extinguishing Media	As appropriate for surrounding fire. Use water, dry chemical, carbon dioxide or foam.
Unsuitable Extinguishing Media	Not available.
Specific Hazards arising from the chemical mixture	Not available.
Hazardous Combustion Products	Not available.
Protective Equipment and Precautions for Firefighters	Fire fighters should wear full protective clothing and self contained breathing apparatus as for surrounding fire.

Section 6: Accidental Release Measures

Personal Precautions	
Industrial Setting	Wear appropriate personal protective equipment (refer to Section 8).
Environmental Precautions	Avoid entry into lakes, streams, ponds or public waterways.
Methods for Containment and Cleaning Up	
Household Setting	Small spills and leaks may be cleaned up and disposed of in normal household trash or diluted and disposed of via sewer.
Industrial Setting	Before attempting clean up, refer to hazard data given. Material may be slippery if spilled and wet. Prevent spill from entering a waterway. Stop spill at source and contain material. Dispose liquid in accordance with all applicable local, state, and federal regulations. Small amounts may be flushed to sewer.

Section 7: Handling and Storage

Safe Handling	
Household Setting	Use as directed on product label.
Industrial Setting	Wear appropriate personal protective equipment (refer to section 8).
Safe Storage	KEEP OUT OF REACH OF CHILDREN AND PETS. Store in original container and keep container closed when not in use. Avoid freezing.
Storage Incompatibilities	None known.

Section 8: Exposure Controls, Personal Protection

Exposure Limits	None known.
Engineering Controls	Not applicable.
Personal Protective Equipment (PPE)	
Household Setting	No special precautions necessary as long as product is used as directed.
Industrial Setting	
Respiratory Protection	None required under normal conditions. General ventilation required.
Eye Protection	Goggles or other protective eye wear may be worn for protection.
Skin Protection	Gloves may be worn for protection.
Hygiene Measures	Handle in accordance with good industrial hygiene and safety practice.

SAFETY DATA SHEET

Section 9: Physical and Chemical Properties

Physical State	Liquid.
Color	Light amber
Clarity	Clear
Odor	Unfragranced: Characteristic of the ingredients. Fragranced: Characteristic of the ingredients.
Odor Threshold	Not available.

pH	7.9 - 8.1
Melting Point	Not available.
Freezing Point	Not available.
Initial Boiling Point and Boiling Range	Not available.
Flash Point	Not available. Aqueous Solution.
Evaporation Rate	Not available.
Upper Explosive Limit (UEL)	Not applicable.
Lower Explosive Limit (LEL)	Not applicable.
Vapor Pressure (mmHg)	Not available.
Specific Gravity (H2O = 1)	1.01 - 1.04
Relative Density	Not available.
Vapor Density (Air = 1)	Not available.
Solubility in Water	Miscible
Partition Coefficient: n-octanol/water	Not available.
Viscosity	Not available.
VOC (weight %)	Not available.

Section 10: Stability and Reactivity

Reactivity	None known.
Chemical Stability	Stable.
Possibility of Hazardous Reactions	None known.
Conditions to Avoid	None known.
Incompatible Materials	
Household Setting	In general, cleaning products should not be mixed with other household chemicals, unless specifically provided for in the use directions.
Industrial Setting	None known.
Hazardous Decomposition Products	None known.

Section 11: Toxicological Information

Potential Route(s) of Exposure	Eyes. Skin. Ingestion.
Effects of Acute Exposure	
Oral Toxicity	LD50 >5000 mg/kg, calculated based on ingredients.
Dermal Toxicity	Not available.
Inhalation Toxicity	Not available.
Eye Contact	Mild irritant, based on in-vitro data.
Skin Contact	Non-irritant, based on Human Repeat Insult Patch Test (HRIPT).
Component Information	Refer to section 3 for ingredient LD50 (acute oral).
Effects of Chronic Exposure	Not expected to have chronic health effects.
Sensitization	Does not indicate a potential for allergic contact sensitization, based on Human Repeat Insult Patch Test (HRIPT).
Carcinogenicity	Not expected to have chronic health effects.
NTP	No Ingredients Listed
IARC	No Ingredients Listed

OSHA	No Ingredients Listed
Reproductive Effects	Not expected to have chronic health effects.
Teratogenicity	Not expected to have chronic health effects.
Mutagenicity	Not expected to have chronic health effects.
Target Organ Effects	Not expected to have chronic health effects.

Section 12: Ecological Information

Ecotoxicity	Not available.
Persistence and Degradability	This product is biodegradable, based on OECD 301B.
Bioaccumulative Potential	Not applicable.
Mobility in Soil	Not available.
Environmental Fate	No adverse effects expected.

Section 13: Disposal Considerations

Product Waste	Any disposal must be in compliance with applicable local, state, provincial and federal laws and regulations.
Household Setting	Product residues in the bottle may be discarded in trash, or diluted with water and disposed via sewer. When used as directed, the product is septic-safe.
Industrial Setting	When disposed as waste in its original form, this product is not considered hazardous waste under Federal regulations, however regulations may vary by state or province and may designate it as hazardous waste. Check with your local waste and waste water authorities. We are aware of the following state waste classifications:
California Hazardous Waste Code	561
Connecticut Hazardous Waste Code	CT04
Michigan Liquid Waste Code	029L
Washington Hazardous Waste Code	WT02
Empty Packaging	Offer empty container for recycling. If recycling is not available, discard in trash.

Section 14: Transport Information

U.S. DOT	Not regulated.
U.S. States	See U.S. DOT for finished product classification for transport.
Waste	Regulated in some states if the product is disposed of in its original form as waste by commercial users/handlers. Refer to Section 13. for applicable state waste codes.
Canadian TDG (Surface Transport)	Not regulated.
IMDG (Marine Transport)	Not regulated.
IATA (Air Transport)	Not regulated.

Section 15: Regulatory Information

U.S.	
Toxic Substances Control Act (TSCA)	This product complies with the inventory requirements of the U.S. Toxic Substances Control Act (TSCA).
California Prop 65	This product is not subject to the labeling requirements of California's Proposition 65.
California Air Resources Board (CARB)	Not applicable.

Canada	
Domestic Substances List (DSL)	This product complies with the inventory requirements under Canada's Domestic Substances List (DSL) or Non-Domestic Substances List (NDSL) or is otherwise in compliance with the New Substances Notification (NSN) regulations or exemptions.
Right to Know	Regardless of hazard classification, Seventh Generation discloses all intentionally added ingredients and, if applicable incidental ingredients ≥1% on the product label. Please refer to Section 3. of this SDS for ingredient listing.
Other	Fragrances used in this product comply with applicable International Fragrance Association (IFRA) guidance.

Section 16: Other Information

Hazardous Materials Identification System (HMIS) Rating Legend: 4-Severe, 3-Serious, 2-Moderate, 1-Slight, 0-Minimal		
	HEALTH	1
	FLAMMABILITY	0
	PHYSICAL HAZARDS	0
	PERSONAL PROTECTION	A

National Fire Protection Association (NFPA) Rating	Not determined

Consumer Product Label Information
HOW TO USE Dispense into sink or directly onto sponge. Wash dishes and rinse thoroughly. NOT FOR USE IN AUTOMATIC DISHWASHERS. KEEP OUT OF REACH OF CHILDREN. If product gets into eyes, flush thoroughly with water. If swallowed, drink plenty of water.

Prepared by	Seventh Generation Inc.
Issuing Date	20 September 2016
Revision Date	20 September 2016
Revision Note	Revised Sections 2., 3., 9., 12. and 16.

Please note: This product is manufactured and marketed for consumer use and should be used as directed on the product label for the intended purpose. Seventh Generation warrants that this product conforms to our standard specification when released to the market and when used according to directions. To the best of our knowledge, the information contained herein is accurate. However, we do not assume any liability whatsoever for the accuracy or completeness of the information contained herein. Final determination of the suitability of any product is the sole responsibility of the user. All products may present unknown hazards and should be used with requisite caution. Although certain hazards are described herein, we cannot guarantee that these are the only hazards that exist.

Other abbreviations used in this document:

DOT – (U.S.) Department of Transportation
EPA – (U.S.) Environmental Protection Agency
IARC – International Agency for Research on Cancer
NTP – (U.S. Department of Health and Human Services) National Toxicology Program
OSHA – (U.S.) Occupational Safety and Health Administration
TDG – (Canadian) Transport of Dangerous Goods
WHMIS – (Canadian) Workplace Hazardous Materials Information System

End of Safety Data Sheet

BASF
We create chemistry

Safety Data Sheet
Zetag® 120L

1. Identification

Product identifier used on the label

Zetag® 120L

Recommended use of the chemical and restriction on use
Recommended use*: Drilling fluid additive

* The "Recommended use" identified for this product is provided solely to comply with a Federal requirement and is not part of the seller's published specification. The terms of this Safety Data Sheet (SDS) do not create or infer any warranty, express or implied, including by incorporation into or reference in the seller's sales agreement.

Details of the supplier of the safety data sheet

Company:
BASF CORPORATION
100 Park Avenue
Florham Park, NJ 07932, USA

Telephone: +1 973 245-6000

Emergency telephone number

CHEMTREC: 1-800-424-9300
BASF HOTLINE: 1-800-832-HELP (4357)

Other means of identification
Chemical family: polyacrylamide, anionic dispersed in: light mineral oil

2. Hazards Identification

According to Regulation 2012 OSHA Hazard Communication Standard; 29 CFR Part 1910.1200

Classification of the product

Skin Corr./Irrit.	2	Skin corrosion/irritation
Eye Dam./Irrit.	2B	Serious eye damage/eye irritation

Label elements

Pictogram:

Signal Word:
Warning

Hazard Statement:

H320	Causes eye irritation.
H315	Causes skin irritation.

Precautionary Statements (Prevention):

P280	Wear protective gloves.
P264	Wash with plenty of water and soap thoroughly after handling.

Precautionary Statements (Response):

P305 + P351 + P338	IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
P303 + P352	IF ON SKIN (or hair): Wash with plenty of soap and water.
P332 + P313	If skin irritation occurs: Get medical advice/attention.
P337 + P311	If eye irritation persists: Call a POISON CENTER or doctor/physician.
P362 + P364	Take off contaminated clothing and wash it before reuse.

Hazards not otherwise classified

If applicable information is provided in this section on other hazards which do not result in classification but which may contribute to the overall hazards of the substance or mixture.

3. Composition / Information on Ingredients

According to Regulation 2012 OSHA Hazard Communication Standard; 29 CFR Part 1910.1200

CAS Number	Weight %	Chemical name
64742-52-5	20.0 - < 50.0%	Distillates (petroleum), hydrotreated heavy naphthenic
64742-47-8	10.0 - 15.0%	Distillates, petroleum
68551-13-3	1.0 - 5.0%	Alcohols, C12-15, ethoxylated propoxylated

4. First-Aid Measures

Description of first aid measures

General advice:
Immediately remove contaminated clothing.

If inhaled:
Keep patient calm, remove to fresh air, seek medical attention.

If on skin:
Wash affected areas thoroughly with soap and water. Seek medical attention.

If in eyes:
Immediately wash affected eyes for at least 15 minutes under running water with eyelids held open, consult an eye specialist.

If swallowed:
Immediately rinse mouth and then drink plenty of water, do not induce vomiting, seek medical attention. Never induce vomiting or give anything by mouth if the victim is unconscious or having convulsions.

Most important symptoms and effects, both acute and delayed

Symptoms: The most important known symptoms and effects are described in the labelling (see section 2) and/or in section 11., Further symptoms and / or effects are not known so far
Hazards: No hazard is expected under intended use and appropriate handling.

Indication of any immediate medical attention and special treatment needed

Note to physician
Treatment: Treat according to symptoms (decontamination, vital functions), no known specific antidote.

5. Fire-Fighting Measures

Extinguishing media

Suitable extinguishing media:
dry powder, foam, water spray

Unsuitable extinguishing media for safety reasons:
water jet

Additional information:
If water is used, restrict pedestrian and vehicular traffic in areas where slip hazard may exist.

Special hazards arising from the substance or mixture

Hazards during fire-fighting:
harmful vapours, nitrous gases, carbon oxides
Evolution of fumes/fog. The substances/groups of substances mentioned can be released in case of fire. Spilled product is slippery underfoot. Very slippery when wet.

Advice for fire-fighters

Protective equipment for fire-fighting:
Wear a self-contained breathing apparatus.

Further information:
The degree of risk is governed by the burning substance and the fire conditions. Contaminated extinguishing water must be disposed of in accordance with official regulations.

6. Accidental release measures

Personal precautions, protective equipment and emergency procedures

Use personal protective clothing. Keep people away and stay on the upwind side.

Environmental precautions

Do not discharge into drains/surface waters/groundwater.

Methods and material for containment and cleaning up

Spills should be contained, solidified, and placed in suitable containers for disposal.

7. Handling and Storage

Precautions for safe handling

Keep away from sources of ignition - No smoking.

Protection against fire and explosion:
Take precautionary measures against static discharges.

Conditions for safe storage, including any incompatibilities

Further information on storage conditions: Freezing will affect the physical condition but will not damage the materials. Thaw and mix before use Store in unopened original containers in a cool and dry place. Avoid wet, damp or humid conditions, temperature extremes and ignition sources.
Protect from temperatures below: 0 °C
Protect from temperatures above: 40 °C

8. Exposure Controls/Personal Protection

Components with occupational exposure limits

Distillates, petroleum	ACGIH TLV	TWA value 200 mg/m3 Non-aerosol (total hydrocarbon vapor); Application restricted to conditions in which there are negligible aerosol exposures. Skin Designation Non-aerosol (total hydrocarbon vapor); The substance can be absorbed through the skin.
Distillates (petroleum), hydrotreated heavy naphthenic	OSHA PEL	PEL 5 mg/m3 Mist ; PEL 500 ppm 2,000 mg/m3 ; TWA value 5 mg/m3 Mist ;
	ACGIH TLV	TWA value 5 mg/m3 Inhalable fraction ; ; Exposure by all routes should be carefully controlled to levels as low as possible. ; Included in the regulation, but with no data values - See the regulation for further details

Personal protective equipment

Respiratory protection:
Wear a NIOSH-certified (or equivalent) organic vapour/particulate respirator.

Hand protection:
Chemical resistant protective gloves

Eye protection:
Tightly fitting safety goggles (chemical goggles) and face shield.

Body protection:
Impermeable protective clothing

General safety and hygiene measures:
Handle in accordance with good industrial hygiene and safety practice. No eating, drinking, smoking or tobacco use at the place of work.

9. Physical and Chemical Properties

Form:	liquid
Odour:	mineral oil-like
Odour threshold:	No data available.
Colour:	off-white
pH value:	3.9 - 4.4 (1 %(m), 25 °C)
Melting point:	not determined
Boiling point:	> 100 °C
Sublimation point:	No data available.
Flash point:	> 93 °C
Flammability:	not highly flammable
Lower explosion limit:	For liquids not relevant for classification and labelling. The lower explosion point may be 5 - 15 °C below the flash point.
Upper explosion limit:	For liquids not relevant for classification and labelling.
Autoignition:	not determined
Vapour pressure:	The product has not been tested. The product has not been tested.
Density:	approx. 1.1 g/cm3 (20 °C)
Relative density:	No data available.
Vapour density:	No data available.
Partitioning coefficient n-octanol/water (log Pow):	Study scientifically not justified.
Self-ignition temperature:	not self-igniting
Thermal decomposition:	No decomposition if stored and handled as prescribed/indicated.
Viscosity, dynamic:	not determined
Solubility in water:	dispersible
Solubility (quantitative):	No data available.
Solubility (qualitative):	No data available.
Evaporation rate:	Value can be approximated from Henry's Law Constant or vapor pressure.
Other Information:	If necessary, information on other physical and chemical parameters is indicated in this section.

10. Stability and Reactivity

Reactivity
No hazardous reactions if stored and handled as prescribed/indicated.

Corrosion to metals:
No corrosive effect on metal.

Oxidizing properties:

not fire-propagating

Chemical stability
The product is stable if stored and handled as prescribed/indicated.

Possibility of hazardous reactions
No hazardous reactions when stored and handled according to instructions.
The product is chemically stable.

Conditions to avoid
Avoid extreme temperatures. Avoid freezing. Avoid all sources of ignition: heat, sparks, open flame.

Incompatible materials
reactive chemicals

Hazardous decomposition products

Decomposition products:
Hazardous decomposition products: No hazardous decomposition products if stored and handled as prescribed/indicated.

Thermal decomposition:
No decomposition if stored and handled as prescribed/indicated.

11. Toxicological information

Primary routes of exposure

Routes of entry for solids and liquids are ingestion and inhalation, but may include eye or skin contact. Routes of entry for gases include inhalation and eye contact. Skin contact may be a route of entry for liquefied gases.

Acute Toxicity/Effects

Acute toxicity
Assessment of acute toxicity: Virtually nontoxic after a single ingestion.

Oral
Type of value: LD50
Species: rat
Value: > 2,000 mg/kg

Irritation / corrosion
Assessment of irritating effects: Irritating to eyes and skin.

Skin
Species: rabbit
Result: Irritant.

Eye
Species: rabbit
Result: Irritant.

Sensitization
Assessment of sensitization: Based on the ingredients, there is no suspicion of a skin-sensitizing potential.

Aspiration Hazard
No aspiration hazard expected.

Chronic Toxicity/Effects

Repeated dose toxicity
Assessment of repeated dose toxicity: Based on our experience and the information available, no adverse health effects are expected if handled as recommended with suitable precautions for designated uses. The product has not been tested. The statement has been derived from the properties of the individual components.

Genetic toxicity
Assessment of mutagenicity: Based on the ingredients, there is no suspicion of a mutagenic effect.

Carcinogenicity
Assessment of carcinogenicity: The whole of the information assessable provides no indication of a carcinogenic effect.

Reproductive toxicity
Assessment of reproduction toxicity: Not expected to cause reproductive toxicity (based on composition).

Teratogenicity
Assessment of teratogenicity: No teratogenic effects reported.

Other Information
The product has not been tested. The statement has been derived from substances/products of a similar structure or composition.

Symptoms of Exposure

The most important known symptoms and effects are described in the labelling (see section 2) and/or in section 11., Further symptoms and / or effects are not known so far

12. Ecological Information

Toxicity

Toxicity to fish
LC50 > 100 mg/l, Fish

Persistence and degradability

Assessment biodegradation and elimination (H2O)
The polymer component of the product is poorly biodegradable.

Bioaccumulative potential

Assessment bioaccumulation potential
Based on its structural properties, the polymer is not biologically available. Accumulation in organisms is not to be expected.

Mobility in soil

Assessment transport between environmental compartments
No data available.

Information on: Anionic polyacrylamide

Adsorption to solid soil phase is expected.

Additional information

Other ecotoxicological advice:
The product has not been tested. The statements on ecotoxicology have been derived from products of a similar structure and composition.

13. Disposal considerations

Waste disposal of substance:
Dispose of in accordance with national, state and local regulations. It is the waste generator's responsibility to determine if a particular waste is hazardous under RCRA.

Container disposal:
Dispose of in a licensed facility. Recommend crushing, puncturing or other means to prevent unauthorized use of used containers.

14. Transport Information

Land transport
USDOT

Not classified as a dangerous good under transport regulations

Sea transport
IMDG

Not classified as a dangerous good under transport regulations

Air transport
IATA/ICAO

Not classified as a dangerous good under transport regulations

15. Regulatory Information

Federal Regulations

Registration status:
Chemical TSCA, US released / listed

EPCRA 311/312 (Hazard categories): Refer to SDS section 2 for GHS hazard classes applicable for this product.

State regulations

State RTK	CAS Number	Chemical name
NJ	64742-47-8	Distillates, petroleum
PA	64742-47-8	Distillates, petroleum

64742-52-5 Distillates (petroleum), hydrotreated heavy naphthenic

Safe Drinking Water & Toxic Enforcement Act, CA Prop. 65:

WARNING: This product can expose you to chemicals including ACRYLAMIDE, which is known to the State of California to cause cancer and birth defects or other reproductive harm. For more information, go to www.P65Warnings.ca.gov.

NFPA Hazard codes:
Health: 2 Fire: 1 Reactivity: 0 Special:

HMIS III rating
Health: 2 Flammability: 1 Physical hazard: 0

16. Other Information

SDS Prepared by:
BASF NA Product Regulations
SDS Prepared on: 2018/08/30

We support worldwide Responsible Care® initiatives. We value the health and safety of our employees, customers, suppliers and neighbors, and the protection of the environment. Our commitment to Responsible Care is integral to conducting our business and operating our facilities in a safe and environmentally responsible fashion, supporting our customers and suppliers in ensuring the safe and environmentally sound handling of our products, and minimizing the impact of our operations on society and the environment during production, storage, transport, use and disposal of our products.

ATTACHMENT 3
EFRI/UDEQ Protocol for Determining Whether Alternate Feed Materials Are RCRA Listed Hazardous Waste

State of Utah

DEPARTMENT OF ENVIRONMENTAL QUALITY
DIVISION OF SOLID AND HAZARDOUS WASTE

Michael O. Leavitt
Governor
Dianne R. Nielson, Ph.D.
Executive Director
Dennis R. Downs
Director

288 North 1460 West
P O Box 144880
Salt Lake City, Utah 84114-4880
(801) 538-6170
(801) 538-6715 Fax
(801) 536-4414 T D D.
www.deq.state.ut.us Web

December 7, 1999

M. Lindsay Ford
Parsons, Behle and Latimer
One Utah Center
201 South Main Street
Suite 1800
Post Office Box 45898
Salt Lake City, Utah 84145-0898

RE: Protocol for Determining Whether Alternate Feed Materials are Listed Hazardous Wastes

Dear Mr. Ford:

On November 22, 1999, we received the final protocol to be used by International Uranium Corporation (IUSA) in determining whether alternate feed materials proposed for processing at the White Mesa Mill are listed hazardous wastes. We appreciate the effort that went into preparing this procedure and feel that it will be a useful guide for IUSA in its alternate feed determinations.

As was discussed, please be advised that it is IUSA's responsibility to ensure that the alternate feed materials used are not listed hazardous wastes and that the use of this protocol cannot be used as a defense if listed hazardous waste is somehow processed at the White Mesa Mill.

Thank you again for your corporation. If you have any questions, please contact Don Verbica at 538-6170.

Sincerely,

Dennis R. Downs, Executive Secretary
Utah Solid and Hazardous Waste Control Board

c: Bill Sinclair, Utah Division of Radiation Control

F:\SHW\HWB\DVERBICA\WP\whitemesa.wpd

Parsons
Behle &
Latimer

One Utah Center
201 South Main Street
Suite 1800
Post Office Box 45898
Salt Lake City, Utah
84145-0898
Telephone 801 532-1234
Facsimile 801 536-6111

A Professional
Law Corporation

November 22, 1999

Don Verbica
Utah Division of Solid & Hazardous Waste
288 North 1460 West
Salt Lake City, Utah

Re: Protocol for Determining Whether Alternate Feed Materials are Listed Hazardous Wastes

Dear Don:

I am pleased to present the final protocol to be used by International Uranium (USA) Corporation ("IUSA") in determining whether alternate feed materials proposed for processing at the White Mesa Mill are listed hazardous wastes. Also attached is a red-lined version of the protocol reflecting final changes made to the document based on our last discussion with you as well as some minor editorial changes from our final read-through of the document. We appreciate the thoughtful input of you and Scott Anderson in developing this protocol. We understand the Division concurs that materials determined not to be listed wastes pursuant to this protocol are not listed hazardous wastes.

We also recognize the protocol does not address the situation where, after a material has been determined not to be a listed hazardous waste under the protocol, new unrefutable information comes to light that indicates the material is a listed hazardous waste. Should such an eventuality arise, we understand an appropriate response, if any, would need to be worked out on a case-by-case basis.

Thank you again for your cooperation on this matter. Please call me if you have any questions.

Very truly yours,

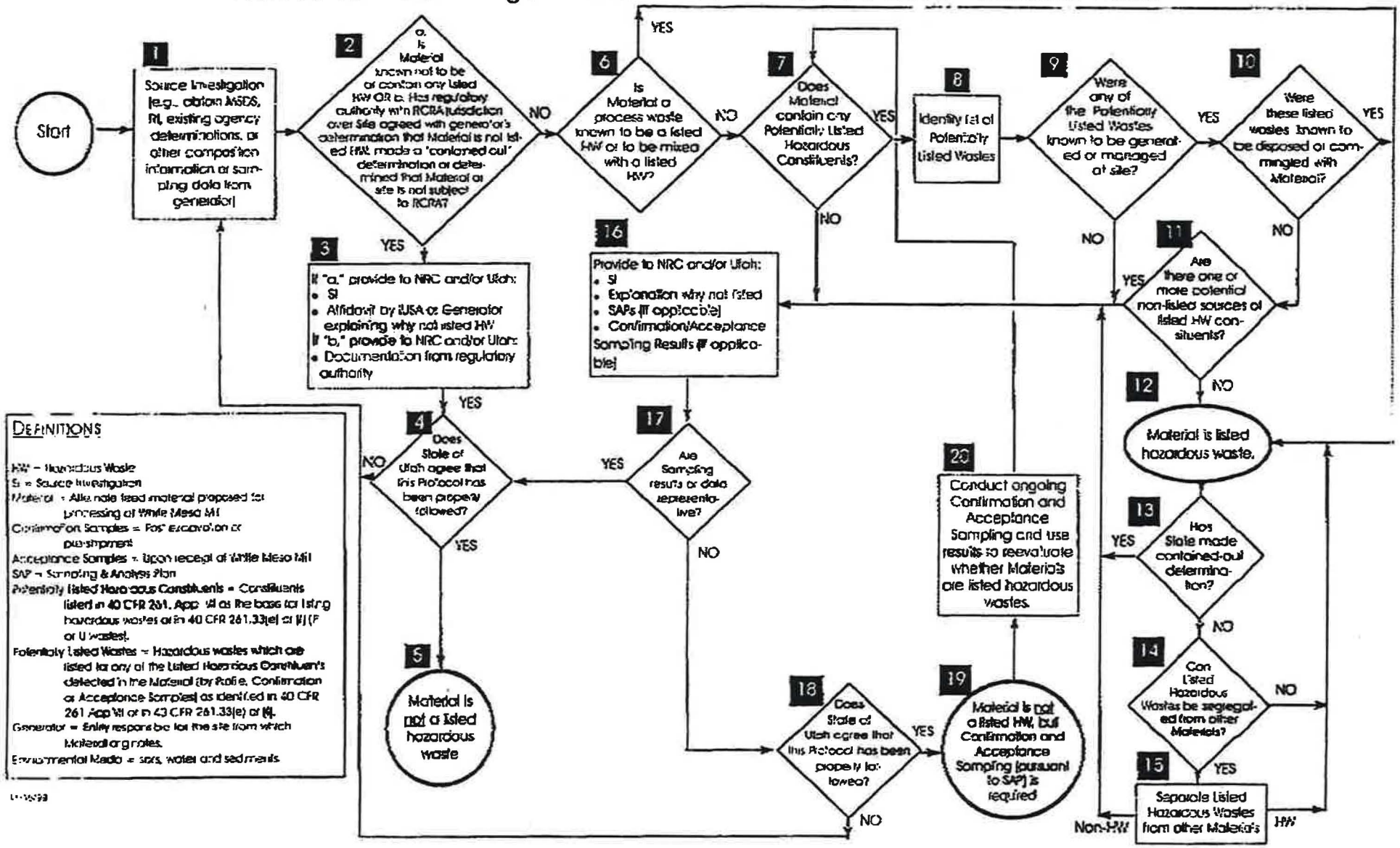
Parsons Behle & Latimer

Lindsay Ford

M. Lindsay Ford

cc: (with copy of final protocol only)
Dianne Nielson
Fred Nelson
Brent Bradford
Don Ostler
Loren Morton
Bill Sinclair
David Frydenlund
David Bird
Tony Thompson

Protocol for Determining if Alternate Feed Material is a Listed Hazardous Waste



PROTOCOL FOR DETERMINING WHETHER ALTERNATE FEED MATERIALS ARE LISTED HAZARDOUS WASTES[1]

NOVEMBER 16, 1999

1. SOURCE INVESTIGATION.

Perform a good faith investigation (a "Source Investigation" or "SI")[2] regarding whether any listed hazardous wastes[3] are located at the site from which alternate feed material[4] ("Material") originates (the "Site"). This investigation will be conducted in conformance with EPA guidance[5] and the extent of information required will vary with the circumstances of each case. Following are examples of investigations that would be considered satisfactory under EPA guidance and this Protocol for some selected situations:

- Where the Material is or has been generated from a known process under the control of the generator: (a) an affidavit, certificate, profile record or similar document from the Generator or Site Manager, to that effect, together with (b) a Material Safety Data Sheet ("MSDS") for the Material, limited profile sampling, or a material composition determined by the generator/operator based on a process material balance.

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[1] This Protocol reflects the procedures that will be followed by International Uranium (USA) Corporation ("IUSA") for determining whether alternate feed materials proposed for processing at the White Mesa Mill are (or contain) listed hazardous wastes. It is based on current Utah and EPA rules and EPA guidance under the Resource Conservation and Recovery Act ("RCRA"), 42 U.S.C. §§ 6901 et seq. This Protocol will be changed as necessary to reflect any pertinent changes to RCRA rules or EPA guidance.

[2] This investigation will be performed by IUSA, by the entity responsible for the site from which the Material originates (the "Generator"), or by a combination of the two.

[3] Attachment 1 to this Protocol provides a summary of the different classifications of RCRA listed hazardous wastes.

[4] Alternate feed materials that are primary or intermediate products of the generator of the material (*e.g.*, "green" or "black" salts) are not RCRA "secondary materials" or "solid wastes," as defined in 40 CFR 261, and are not covered by this Protocol.

[5] EPA guidance identifies the following sources of site- and waste-specific information that may, depending on the circumstances, be considered in such an investigation: hazardous waste manifests, vouchers, bills of lading, sales and inventory records, material safety data sheets, storage records, sampling and analysis reports, accident reports, site investigation reports, interviews with employees/former employees and former owners/operators, spill reports, inspection reports and logs, permits, and enforcement orders. *See e.g.*, 61 Fed. Reg. 18805 (April 29, 1996).

- Where specific information exists about the generation process and management of the Material: (a) an affidavit, certificate, profile record or similar document from the Generator or Site Manager, to that effect, together with (b) an MSDS for the Material, limited profile sampling data or a preexisting investigation performed at the Site pursuant to CERCLA, RCRA or other state or federal environmental laws or programs.
- Where potentially listed processes are known to have been conducted at a Site, an investigation considering the following sources of information: site investigation reports prepared under CERCLA, RCRA or other state or federal environmental laws or programs (*e.g.*, an RI/FS, ROD, RFI/CMS, hazardous waste inspection report); interviews with persons possessing knowledge about the Material and/or Site; and review of publicly available documents concerning process activities or the history of waste generation and management at the Site.
- If material from the same source is being or has been accepted for direct disposal as 11e.(2) byproduct material in an NRC-regulated facility in the State of Utah with the consent or acquiescence of the State of Utah, the Source Investigation performed by such facility.

Proceed to Step 2.

2. SPECIFIC INFORMATION OR AGREEMENT/DETERMINATION BY RCRA REGULATORY AUTHORITY THAT MATERIAL IS NOT A LISTED HAZARDOUS WASTE?

a. Determine whether specific information from the Source Investigation exists about the generation and management of the Material to support a conclusion that the Material is not (and does not contain) any listed hazardous waste. For example, if specific information exists that the Material was not generated by a listed waste source and that the Material has not been mixed with any listed wastes, the Material would not be a listed hazardous waste.

b. Alternatively, determine whether the appropriate state or federal authority with RCRA jurisdiction over the Site agrees in writing with the generator's determination that the Material is not a listed hazardous waste, has made a "contained-out" determination[6] with respect to the Material or has concluded the Material or Site is not subject to RCRA.

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[6] EPA explains the "contained-out" (also referred to as "contained-in") principle as follows:

> In practice, EPA has applied the contained-in principle to refer to a process where a site-specific determination is made that concentrations of hazardous constituents in any given

(footnote continued on next page)

If yes to either question, proceed to Step 3.

If no to both questions, proceed to Step 6.

3. PROVIDE INFORMATION TO NRC AND UTAH.

a. If specific information exists to support a conclusion that the Material is not, and does not contain, any listed hazardous waste, IUSA will provide a description of the Source Investigation to NRC and/or the State of Utah Department of Environmental Quality, Division of Solid and Hazardous Waste (the "State"), together with an affidavit explaining why the Material is not a listed hazardous waste.

b. Alternatively, if the appropriate regulatory authority with RCRA jurisdiction over the Site agrees in writing with the generator's determination that the Material is not a listed hazardous waste, makes a contained-out determination or determines the Material or Site is not subject to RCRA, IUSA will provide documentation of the regulatory authority's determination to NRC and the State. IUSA may rely on such determination provided that the State agrees the conclusions of the regulatory authority were reasonable and made in good faith.

Proceed to Step 4.

4. DOES STATE OF UTAH AGREE THAT ALL PREVIOUS STEPS HAVE BEEN PERFORMED IN ACCORDANCE WITH THIS PROTOCOL?

Determine whether the State agrees that this Protocol has been properly followed (including that proper decisions were made at each decision point). The State shall review the information provided by IUSA in Step 3 or 16 with reasonable speed and advise IUSA if it believes IUSA has not properly followed this Protocol in determining

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(footnote continued from previous page)

> volume of environmental media are low enough to determine that the media does not "contain" hazardous waste. Typically, these so-called "contained-in" [or "contained-out"] determinations do not mean that no hazardous constituents are present in environmental media but simply that the concentrations of hazardous constituents present do not warrant management of the media as hazardous waste. ...
>
> EPA has not, to date, issued definitive guidance to establish the concentrations at which contained-in determinations may be made. As noted above, decisions that media do not or no longer contain hazardous waste are typically made on a case-by-case basis considering the risks posed by the contaminated media.

63 Fed. Reg. 28619, 28621-22 (May 26, 1998) (Phase IV LDR preamble).

that the Material is not listed hazardous waste, specifying the particular areas of deficiency.

If this Protocol has not been properly followed by IUSA in making its determination that the Material is not a listed hazardous waste, then IUSA shall redo its analysis in accordance with this Protocol and, if justified, resubmit the information described in Step 3 or 16 explaining why the Material is not a listed hazardous waste. The State shall notify IUSA with reasonable speed if the State still believes this Protocol has not been followed.

If yes, proceed to Step 5.

If no, proceed to Step 1.

5. MATERIAL IS NOT A LISTED HAZARDOUS WASTE.

The Material is not a listed hazardous waste and no further sampling or evaluation is necessary in the following circumstances:

- Where the Material is determined not to be a listed hazardous waste based on specific information about the generation/management of the Material OR the appropriate RCRA regulatory authority with jurisdiction over the Site agrees with the generator's determination that the Material is not a listed HW, makes a contained-out determination, or concludes the Material or Site is not subject to RCRA (and the State agrees the conclusions of the regulatory authority were reasonable and made in good faith) (Step 2); or
- Where the Material is determined not to be a listed hazardous waste (in Steps 6 through 11, 13 or 15) and Confirmation/Acceptance Sampling are determined not to be necessary (under Step 17).

6. IS MATERIAL A PROCESS WASTE KNOWN TO BE A LISTED HAZARDOUS WASTE OR TO BE MIXED WITH A LISTED HAZARDOUS WASTE?

Based on the Source Investigation, determine whether the Material is a process waste known to be a listed hazardous waste or to be mixed with a listed hazardous waste. If the Material is a process waste and is from a listed hazardous waste source, it is a listed hazardous waste. Similarly, if the Material is a process waste and has been mixed with a listed hazardous waste, it is a listed hazardous waste under the RCRA "mixture rule." If

the Material is an Environmental Medium,[7] it cannot be a listed hazardous waste by direct listing or under the RCRA "mixture rule."[8] If the Material is a process waste but is not known to be from a listed source or to be mixed with a listed waste, or if the Material is an Environmental Medium, proceed to Steps 7 through 11 to determine whether it is a listed hazardous waste.

If yes, proceed to Step 12.

If no, proceed to Step 7.

7. DOES MATERIAL CONTAIN ANY POTENTIALLY LISTED HAZARDOUS CONSTITUENTS?

Based on the Source Investigation (and, if applicable, Confirmation and Acceptance Sampling), determine whether the Material contains any hazardous constituents listed in the then most recent version of 40 CFR 261, Appendix VII (which identifies hazardous constituents for which F- and K-listed wastes were listed) or 40 CFR 261.33(e) or (f) (the P and U listed wastes) (collectively "Potentially Listed Hazardous Constituents"). If the Material contains such constituents, a source evaluation is necessary (pursuant to Steps 8 through 11). If the Material does not contain any Potentially Listed Hazardous Constituents, it is not a listed hazardous waste. The Material also is not a listed hazardous waste if, where applicable, Confirmation and Acceptance Sampling results do not reveal the presence of any "new" Potentially Listed Hazardous Constituents (*i.e.*, constituents other than those that have already been identified by the Source Investigation (or previous Confirmation/Acceptance Sampling) and determined not to originate from a listed source).

If yes, proceed to Step 8.

If no, proceed to Step 16.

8. IDENTIFY POTENTIALLY LISTED WASTES.

Identify potentially listed hazardous wastes ("Potentially Listed Wastes") based on Potentially Listed Hazardous Constituents detected in the Material, *i.e.*, wastes which are listed for any of the Potentially Listed Hazardous Constituents detected in the Material, as

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[7] The term "Environmental Media" means soils, ground or surface water and sediments.

[8] The "mixture rule" applies only to mixtures of listed hazardous wastes and other "solid wastes." *See* 40 CFR § 261.3(a)(2)(iv). The mixture rule does not apply to mixtures of listed wastes and Environmental Media, because Environmental Media are not "solid wastes" under RCRA. *See* 63 Fed. Reg. 28556, 28621 (May 26, 1998).

identified in the then most current version of 40 CFR 261 Appendix VII or 40 CFR 261.33(c) or (f).[9] With respect to Potentially Listed Hazardous Constituents identified through Confirmation and/or Acceptance Sampling, a source evaluation (pursuant to Steps 8 through 11) is necessary only for "new" Potentially Listed Hazardous Constituents (*i.e.*, constituents other than those that have already been identified by the Source Investigation (or previous Confirmation/Acceptance Sampling) and determined not to originate from a listed source).

Proceed to Step 9.

9. WERE ANY OF THE POTENTIALLY LISTED WASTES KNOWN TO BE GENERATED OR MANAGED AT SITE?

Based on information from the Source Investigation, determine whether any of the Potentially Listed Wastes identified in Step 8 are known to have been generated or managed at the Site. This determination involves identifying whether any of the specific or non-specific sources identified in the K- or F-lists has ever been conducted or located at the Site, whether any waste from such processes has been managed at the Site, and whether any of the P- or U-listed commercial chemical products has ever been used, spilled or managed there. In particular, this determination should be based on the following EPA criteria:

Solvent Listings (F001-F005)

Under EPA guidance, "to determine if solvent constituents contaminating a waste are RCRA spent solvent F001-F005 wastes, the [site manager] must know if:

- The solvents are *spent* and *cannot be reused without reclamation* or cleaning.
- The solvents were *used exclusively for their solvent properties.*
- The solvents are spent *mixtures and blends that contained, before use, a total of 10 percent or more (by volume) of the solvents* listed in F001, F002, F004, and F005.

If the solvents contained in the [wastes] are RCRA listed wastes, the [wastes] are RCRA hazardous waste. When the [site manager] does not have guidance information on the use of the solvents and their characteristics before use, the [wastes] cannot be classified as containing a

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[9] For example, if the Material contains tetrachloroethylene, the following would be Potentially Listed Wastes: F001, F002, F024, K019, K020, K150, K151 or U210. *See* 40 CFR 261 App. VII.

listed spent solvent."[10] The person performing the Source Investigation will make a good faith effort to obtain information on any solvent use at the Site. If solvents were used at the Site, general industry standards for solvent use in effect at the time of use will be considered in determining whether those solvents contained 10 percent or more of the solvents listed in F001, F002, F004 or F005.

K-Listed Wastes and F-Listed Wastes Other Than F001-F005

Under EPA guidance, to determine whether K wastes and F wastes other than F001-F005 are RCRA listed wastes, the generator "must know the *generation process information* (about each waste contained in the RCRA waste) described in the listing. For example, for [wastes] to be identified as containing K001 wastes that are described as 'bottom sediment sludge from the treatment of wastewaters from wood preserving processes that use creosote and/or pentachlorophenol,' the [site manager] must know the manufacturing process that generated the wastes (treatment of wastewaters from wood preserving process), feedstocks used in the process (creosote and pentachlorophenol), and the process identification of the wastes (bottom sediment sludge)."[11]

P- and U-Listed Wastes

EPA guidance provides that "P and U wastes cover only unused and unmixed commercial chemical products, particularly spilled or off-spec products. Not every waste containing a P or U chemical is a hazardous waste. To determine whether a [waste] contains a P or U waste, the [site manager] must have direct evidence of product use. In particular, the [site manager] should ascertain, if possible, whether the chemicals are:

- Discarded (as described in 40 CFR 261.2(a)(2)).
- Either off-spec commercial products or a commercially sold grade.
- Not used (soil contaminated with spilled unused wastes is a P or U waste).

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[10] Management of Investigation-Derived Wastes During Site Inspections, EPA/540/G-91/009, May 1991 (emphasis added).

[11] Management of Investigation-Derived Wastes During Site Inspections, EPA/540/G-91/009, May 1991 (emphasis added).

- The sole active ingredient in a formulation."[12]

If Potentially Listed Wastes were known to be generated or managed at the Site, further evaluation is necessary to determine whether these wastes were disposed of or commingled with the Material (Steps 10 and possibly 11). If Potentially Listed Wastes were not known to be generated or managed at the Site, then information concerning the source of Potentially Listed Hazardous Constituents in the Material will be considered "unavailable or inconclusive" and, under EPA guidance,[13] the Material will be assumed not to be a listed hazardous waste.

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12 Management of Investigation-Derived Wastes During Site Inspections, EPA/540/G-91/009, May 1991.

13 EPA guidance consistently provides that, where information concerning the origin of a waste is unavailable or inconclusive, the waste may be assumed not to be a listed hazardous waste. *See e.g.*, Memorandum from Timothy Fields (Acting Assistant Administrator for Solid Waste & Emergency Response) to RCRA/CERCLA Senior Policy Managers regarding "Management of Remediation Waste Under RCRA," dated October 14, 1998 ("Where a facility owner/operator makes a good faith effort to determine if a material is a listed hazardous waste but cannot make such a determination because documentation regarding a source of contamination, contaminant, or waste is *unavailable or inconclusive*, EPA has stated that one may assume the source, contaminant, or waste is not listed hazardous waste"); NCP Preamble, 55 Fed. Reg. 8758 (March 8, 1990) (Noting that "it is often necessary to know the origin of the waste to determine whether it is a listed waste and that, *if such documentation is lacking, the lead agency may assume it is not a listed waste*); Preamble to proposed Hazardous Waste Identification Rule, 61 Fed. Reg. 18805 (April 29, 1996) ("Facility owner/operators should make a good faith effort to determine whether media were contaminated by hazardous wastes and ascertain the dates of placement. The Agency believes that by using available site- and waste-specific information ... facility owner/operators would typically be able to make these determinations. However, as discussed earlier in the preamble of today's proposal, *if information is not available or inconclusive, facility owner/operators may generally assume that the material contaminating the media were not hazardous wastes.*"); Preamble to LDR Phase IV Rule, 63 Fed. Reg. 28619 (May 26, 1998) ("As discussed in the April 29, 1996 proposal, the Agency continues to believe that, *if information is not available or inconclusive, it is generally reasonable to assume that contaminated soils do not contain untreated hazardous wastes* ..."); and Memorandum from John H. Skinner (Director, EPA Office of Solid Waste) to David Wagoner (Director, EPA Air and Waste Management Division, Region VII) regarding "Soils from Missouri Dioxin Sites," dated January 6, 1984 ("The analyses indicate the presence of a number of toxic compounds in many of the soil samples taken from various sites. However, the presence of these toxicants in the soil does not automatically make the soil a RCRA hazardous waste. The origin of the toxicants must be known in order to determine that they are derived from a listed hazardous waste(s). *If the exact origin of the toxicants is not known, the soils cannot be*

(footnote continued on next page)

If yes, proceed to Step 10.

If no, proceed to Step 16.

10. WERE LISTED WASTES KNOWN TO BE DISPOSED OF OR COMMINGLED WITH MATERIAL?

If listed wastes identified in Step 9 were known to be generated at the Site, determine whether they were known to be disposed of or commingled with the Material?

If yes, proceed to Step 12.

If no, proceed to Step 11.

11. ARE THERE ONE OR MORE POTENTIAL NON-LISTED SOURCES OF LISTED HAZARDOUS WASTE CONSTITUENTS?

In a situation where Potentially Listed Wastes were known to have been generated/managed at the Site, but the wastes were not known to have been disposed of or commingled with the Material, determine whether there are potential non-listed sources of Potentially Listed Hazardous Constituents in the Material. If not, unless the State agrees otherwise, the constituents will be assumed to be from listed sources (proceed to Step 12). If so, the Material will be assumed not to be a listed hazardous waste (proceed to Step 16). Notwithstanding the existence of potential non-listed sources at a Site, the Potentially Listed Hazardous Constituents in the Material will be considered to be from the listed source(s) if, based on the relative proximity of the Material to the listed and non-listed source(s) and/or information concerning waste management at the Site, the evidence is compelling that the listed source(s) is the source of Potentially Listed Hazardous Constituents in the Material.

If yes, proceed to Step 16.

If no, proceed to Step 12.

12. MATERIAL IS A LISTED HAZARDOUS WASTE.

The Material is a listed hazardous waste under the following circumstances:

(footnote continued from previous page)

considered RCRA hazardous wastes unless they exhibit one or more of the characteristics of hazardous waste ...").

- If the Material is a process waste and is known to be a listed hazardous waste or to be mixed with a listed hazardous waste (Step 6),
- If Potentially Listed Wastes were known to be generated/managed at the Site and to be disposed of/commingled with the Material (Step 10) (subject to a "contained-out" determination in Step 13), or
- If Potentially Listed Wastes were known to be generated/managed at the Site, were not known to be disposed of/commingled with the Material but there are not any potential non-listed sources of the Potentially Listed Hazardous Constituents detected in the Material (Step 11) (subject to a "contained-out" determination in Step 13).

Proceed to Step 13.

13. HAS STATE OF UTAH MADE A CONTAINED-OUT DETERMINATION.

If the Material is an Environmental Medium, and:

- the level of any listed waste constituents in the Material is "de minimis"; or
- all of the listed waste constituents or classes thereof are already present in the White Mesa Mill's tailings ponds as a result of processing conventional ores or other alternate feed materials in concentrations at least as high as found in the Materials

the State of Utah will consider whether it is appropriate to make a contained-out determination with respect to the Material.

If the State makes a contained-out determination, proceed to Step 16.

If the State does not make a contained-out determination, proceed to Step 14.

14. IS IT POSSIBLE TO SEGREGATE LISTED HAZARDOUS WASTES FROM OTHER MATERIALS?

Determine whether there is a reasonable way to segregate material that is a listed hazardous waste from alternate feed materials that are not listed hazardous wastes that will be sent to IUSA's White Mesa Mill. For example, it may be possible to isolate material from a certain area of a remediation site and exclude that material from Materials that will be sent to the White Mesa Mill. Alternatively, it may be possible to increase

sampling frequency and exclude materials with respect to which the increased sampling identifies constituents which have been attributed to listed hazardous waste.

If yes, proceed to Step 15.

If no, proceed to Step 12.

15. SEPARATE LISTED HAZARDOUS WASTES FROM MATERIALS.

Based on the method of segregation determined under Step 14, materials that are listed hazardous wastes are separated from Materials that will be sent to the White Mesa Mill.

For materials that are listed hazardous wastes, proceed to Step 12.

For Materials to be sent to the White Mesa Mill, proceed to Step 16.

16. PROVIDE INFORMATION TO NRC AND UTAH.

If the Material does not contain any Potentially Listed Hazardous Constituents (as determined in Step 7), where information concerning the source of Potentially Listed Hazardous Constituents in the Material is "unavailable or inconclusive" (as determined in Steps 8 through 11), or where the State of Utah has made a contained-out determination with respect to the Material (Step 13), the Material will be assumed not to be (or contain) a listed hazardous waste. In such circumstances, IUSA will submit the following documentation to NRC and the State:

- A description of the Source Investigation;
- An explanation of why the Material is not a listed hazardous waste.
- Where applicable, an explanation of why Confirmation/Acceptance Sampling has been determined not to be necessary in Step 17.
- If Confirmation/Acceptance Sampling has been determined necessary in Step 17 , a copy of IUSA's and the Generator's Sampling and Analysis Plans.
- A copy of Confirmation and Acceptance Sampling results, if applicable. IUSA will submit these results only if they identify the presence of "new" Potentially Listed Hazardous Constituents (as defined in Steps 7 and 8).

Proceed to Step 17.

17. ARE SAMPLING RESULTS OR DATA REPRESENTATIVE?

Determine whether the sampling results or data from the Source Investigation (or, where applicable, Confirmation/Acceptance Sampling results) are representative. The purpose of this step) is to determine whether Confirmation and Acceptance Sampling (or

continued Confirmation and Acceptance Sampling) are necessary. If the sampling results or data are representative of all Material destined for the White Mesa Mill, based on the extent of sampling conducted, the nature of the Material and/or the nature of the Site (*e.g.*, whether chemical operations or waste disposal were known to be conducted at the Site), future Confirmation/Acceptance Sampling will not be necessary. If the sampling results are not representative of all Material destined for the White Mesa Mill, then additional Confirmation/Acceptance sampling may be appropriate. Confirmation and Acceptance Sampling will be required only where it is reasonable to expect that additional sampling will detect additional contaminants not already detected. For example:

- Where the Material is segregated from Environmental Media, *e.g.*, the Material is containerized, there is a high probability the sampling results or data from the Source Investigation are representative of the Material and Confirmation/Acceptance Sampling would not be required.
- Where IUSA will be accepting Material from a discrete portion of a Site, *e.g.*, a storage pile or other defined area, and adequate sampling characterized the area of concern for radioactive and chemical contaminants, the sampling for that area would be considered representative and Confirmation/Acceptance sampling would not be required.
- Where Material will be received from a wide area of a Site and the Site has been carefully characterized for radioactive contaminants, but not chemical contaminants, Confirmation/Acceptance sampling would be required.
- Where the Site was not used for industrial activity or disposal before or after uranium material disposal, and the Site has been adequately characterized for radioactive and chemical contaminants, the existing sampling would be considered sufficient and Confirmation/Acceptance sampling would not be required.
- Where listed wastes were known to be disposed of on the Site and the limits of the area where listed wastes were managed is not known, Confirmation/Acceptance sampling would be required to ensure that listed wastes are not shipped to IUSA (see Step 14).

If yes, proceed to Step 4.

If no, proceed to Step 18.

18. DOES STATE OF UTAH AGREE THAT ALL PREVIOUS STEPS HAVE BEEN PERFORMED IN ACCORDANCE WITH THIS PROTOCOL?

Determine whether the State agrees that this Protocol has been properly followed (including that proper decisions were made at each decision point). The State shall

review the information provided by IUSA in Step 16 with reasonable speed and advise IUSA if it believes IUSA has not properly followed this Protocol in determining that the Material is not listed hazardous waste, specifying the particular areas of deficiency.

If this Protocol has not been properly followed by IUSA in making its determination that the Material is not a listed hazardous waste, then IUSA shall redo its analysis in accordance with this Protocol and, if justified, resubmit the information described in Step 16 explaining why the Material is not a listed hazardous waste. The State shall notify IUSA with reasonable speed if the State still believes this Protocol has not been followed.

If yes, proceed to Step 19.

If no, proceed to Step 1.

19. MATERIAL IS NOT A LISTED HAZARDOUS WASTE, BUT CONFIRMATION AND ACCEPTANCE SAMPLING ARE REQUIRED.

The Material is not a listed hazardous waste, but Confirmation and Acceptance Sampling are required, as determined necessary under Step 17.

Proceed to Step 20.

20. CONDUCT ONGOING CONFIRMATION AND ACCEPTANCE SAMPLING.

Confirmation and Acceptance Sampling will continue until determined no longer necessary under Step 17. Such sampling will be conducted pursuant to a Sampling and Analysis Plan ("SAP") that specifies the frequency and type of sampling required. If such sampling does not reveal any "new" Potentially Listed Hazardous Constituents (as defined in Steps 7 and 8), further evaluation is not necessary (as indicated in Step 7). If such sampling reveals the presence of "new" constituents, Potentially Listed Wastes must be identified (Step 8) and evaluated (Steps 9 through 11) to determine whether the new constituent is from a listed hazardous waste source. Generally, in each case, the SAP will specify sampling comparable to the level and frequency of sampling performed by other facilities in the State of Utah that dispose of 11e.(2) byproduct material, either directly or that results from processing alternate feed materials.

Proceed to Step 7.

Attachment 1

Summary of RCRA Listed Hazardous Wastes

There are three different categories of listed hazardous waste under RCRA:

- *F-listed wastes from non-specific sources (40 CFR § 261.31(a))*: These wastes include spent solvents (F001-F005), specified wastes from electroplating operations (F006-F009), specified wastes from metal heat treating operations (F010-F012), specified wastes from chemical conversion coating of aluminum (F019), wastes from the production/manufacturing of specified chlorophenols, chlorobenzenes, and chlorinated aliphatic hydrocarbons (F019-F028), specified wastes from wood preserving processes (F032-F035), specified wastes from petroleum refinery primary and secondary oil/water/solids separation sludge (F037-F038), and leachate resulting from the disposal of more than one listed hazardous waste (F039).
- *K-listed wastes from specific sources (40 CFR § 261.32)*: These include specified wastes from wood preservation, inorganic pigment production, organic chemical production, chlorine production, pesticide production, petroleum refining, iron and steel production, copper production, primary and secondary lead smelting, primary zinc production, primary aluminum reduction, ferroalloy production, veterinary pharmaceutical production, ink formulation and coking.
- *P- and U-listed commercial chemical products (40 CFR § 261.33)*: These include commercial chemical products, or manufacturing chemical intermediates having the generic name listed in the "P" or "U" list of wastes, container residues, and residues in soil or debris resulting from a spill of these materials.[1] "The phrase 'commercial chemical product or manufacturing chemical intermediate ...' refers to a chemical substance which is manufactured or formulated for commercial or manufacturing use which consists of the commercially pure grade of the chemical, any technical grades of the chemical that are produced or marketed, and all formulations in which the chemical is the sole active ingredient. It does not refer to a material, such as a manufacturing process waste, that contains any of the [P- or U-listed substances]."[2]

Appendix VII to 40 CFR part 261 identifies the hazardous constituents for which the F- and K-listed wastes were listed.

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[1] P-listed wastes are identified as "acutely hazardous wastes" and are subject to additional management controls under RCRA. 40 CFR § 261.33(e) (1997). U-listed wastes are identified as "toxic wastes." Id. § 261.33(f).

[2] 40 CFR § 261.33(d) note (1997).

State of Utah

DEPARTMENT OF ENVIRONMENTAL QUALITY
DIVISION OF SOLID AND HAZARDOUS WASTE

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December 7, 1999

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Salt Lake City, Utah 84145-0898

RE: Protocol for Determining Whether Alternate Feed Materials are Listed Hazardous Wastes

Dear Mr. Ford:

On November 22, 1999, we received the final protocol to be used by International Uranium Corporation (IUSA) in determining whether alternate feed materials proposed for processing at the White Mesa Mill are listed hazardous wastes. We appreciate the effort that went into preparing this procedure and feel that it will be a useful guide for IUSA in its alternate feed determinations.

As was discussed, please be advised that it is IUSA's responsibility to ensure that the alternate feed materials used are not listed hazardous wastes and that the use of this protocol cannot be used as a defense if listed hazardous waste is somehow processed at the White Mesa Mill.

Thank you again for your corporation. If you have any questions, please contact Don Verbica at 538-6170.

Sincerely,

Dennis R. Downs, Executive Secretary
Utah Solid and Hazardous Waste Control Board

c: Bill Sinclair, Utah Division of Radiation Control

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PROTOCOL FOR DETERMINING WHETHER ALTERNATE FEED MATERIALS ARE LISTED HAZARDOUS WASTES[1]

NOVEMBER 16, 1999

1. SOURCE INVESTIGATION.

Perform a good faith investigation (a "Source Investigation" or "SI")[2] regarding whether any listed hazardous wastes[3] are located at the site from which alternate feed material[4] ("Material") originates (the "Site"). This investigation will be conducted in conformance with EPA guidance[5] and the extent of information required will vary with the circumstances of each case. Following are examples of investigations that would be considered satisfactory under EPA guidance and this Protocol for some selected situations:

- Where the Material is or has been generated from a known process under the control of the generator: (a) an affidavit, certificate, profile record or similar document from the Generator or Site Manager, to that effect, together with (b) a Material Safety Data Sheet ("MSDS") for the Material, limited profile

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[1] This Protocol reflects the procedures that will be followed by ~~an understanding between the Utah Division of Solid and Hazardous Waste, Department of Environmental Quality ("DEQ" or the "State") and~~ International Uranium (USA) Corporation ("IUSA") for determining whether alternate feed materials proposed for processing at the White Mesa Mill are (or contain) listed hazardous wastes. It is based on current Utah and EPA rules and EPA guidance under the Resource Conservation and Recovery Act ("RCRA"), 42 U.S.C. §§ 6901 et seq. This Protocol will be changed as necessary to reflect any pertinent changes to RCRA rules or EPA guidance.

[2] This investigation will be performed by IUSA, by the entity responsible for the site from which the Material originates (the "Generator"), or by a combination of the two.

[3] Attachment 1 to this Protocol provides a summary of the different classifications of RCRA listed hazardous wastes.

[4] Alternate feed materials that are primary or intermediate products of the generator of the material (*e.g.*, "green" or "black" salts) are not RCRA "secondary materials" or "solid wastes," as defined in 40 CFR 261, and are not covered by this Protocol.

[5] EPA guidance identifies the following sources of site- and waste-specific information that may, depending on the circumstances, be considered in such an investigation: hazardous waste manifests, vouchers, bills of lading, sales and inventory records, material safety data sheets, storage records, sampling and analysis reports, accident reports, site investigation reports, interviews with employees/former employees and former owners/operators, spill reports, inspection reports and logs, permits, and enforcement orders. *See e.g.*, 61 Fed. Reg. 18805 (April 29, 1996).

sampling, or a material composition determined by the generator/operator based on a process material balance.

- Where specific information exists about the generation process and management of the Material: (a) an affidavit, certificate, profile record or similar document from the Generator or Site Manager, to that effect, together with (b) an MSDS for the Material, limited profile sampling data or a preexisting investigation performed at the Site pursuant to CERCLA, RCRA or other state or federal environmental laws or programs.
- Where potentially listed processes are known to have been conducted at a Site, an investigation considering the following sources of information: site investigation reports prepared under CERCLA, RCRA or other state or federal environmental laws or programs (*e.g.*, an RI/FS, ROD, RFI/CMS, hazardous waste inspection report); interviews with persons possessing knowledge about the Material and/or Site; and review of publicly available documents concerning process activities or the history of waste generation and management at the Site.
- If material from the same source is being or has been accepted for direct disposal as 11e.(2) byproduct material in an NRC-regulated facility in the State of Utah with the consent or acquiescence of the State of Utah, the Source Investigation performed by such facility.

Proceed to Step 2.

2. SPECIFIC INFORMATION OR AGREEMENT/DETERMINATION BY RCRA REGULATORY AUTHORITY THAT MATERIAL IS NOT A LISTED HAZARDOUS WASTE?

a. Determine whether specific information from the Source Investigation exists about the generation and management of the Material to support a conclusion that the Material is not (and does not contain) any listed hazardous waste. For example, if specific information exists that the Material was not generated by a listed waste source and that the Material has not been mixed with any listed wastes, the Material would not be a listed hazardous waste.

b. Alternatively, determine whether the appropriate state or federal authority with RCRA jurisdiction over the Site agrees in writing with the generator's determination that the

Material is not a listed hazardous waste, has made a "contained-out" determination[6] with respect to the Material or has concluded the Material or Site is not subject to RCRA.

If yes to either question, proceed to Step 3.

If no to both questions, proceed to Step 6.

3. PROVIDE INFORMATION TO NRC AND UTAH.

a. If specific information exists to support a conclusion that the Material is not, and does not contain, any listed hazardous waste, ~~International Uranium (USA) Corporation ("IUSA")~~ will provide a description of the Source Investigation to NRC and/or the State of Utah Department of Environmental Quality, Division of Solid and Hazardous Waste (the "State"), together with an affidavit explaining why the Material is not a listed hazardous waste.

b. Alternatively, if the appropriate regulatory authority with RCRA jurisdiction over the Site agrees in writing with the generator's determination that the Material is not a listed hazardous waste, makes a contained-out determination or determines the Material or Site is not subject to RCRA, IUSA will provide documentation of the regulatory authority's determination to NRC and the State. IUSA may rely on such determination provided that the State agrees the conclusions of the regulatory authority were reasonable and made in good faith.

Proceed to Step 4.

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6 EPA explains the "contained-out" (also referred to as "contained-in") principle as follows:

> In practice, EPA has applied the contained-in principle to refer to a process where a site-specific determination is made that concentrations of hazardous constituents in any given volume of environmental media are low enough to determine that the media does not "contain" hazardous waste. Typically, these so-called "contained-in" [or "contained-out"] determinations do not mean that no hazardous constituents are present in environmental media but simply that the concentrations of hazardous constituents present do not warrant management of the media as hazardous waste. ...
>
> EPA has not, to date, issued definitive guidance to establish the concentrations at which contained-in determinations may be made. As noted above, decisions that media do not or no longer contain hazardous waste are typically made on a case-by-case basis considering the risks posed by the contaminated media.

63 Fed. Reg. 28619, 28621-22 (May 26, 1998) (Phase IV LDR preamble).

4. **DOES STATE OF UTAH AGREE THAT ALL PREVIOUS STEPS HAVE BEEN PERFORMED IN ACCORDANCE WITH THIS PROTOCOL?**

Determine whether the State agrees that this Protocol has been properly followed (including that proper decisions were made at each decision point). The State shall review the information provided by IUSA in Step 3 or 16 ~~promptly~~ with reasonable speed and advise IUSA if it believes IUSA has not properly followed this Protocol in determining that the Material is not listed hazardous waste, specifying the particular areas of deficiency.

If this Protocol has not been properly followed by IUSA in making its determination that the Material is not a listed hazardous waste, then IUSA shall redo its analysis in accordance with this Protocol and, if justified, resubmit the information described in Step 3 or 16 explaining why the Material is not a listed hazardous waste. The State shall notify IUSA ~~promptly~~ with reasonable speed if the State still believes this Protocol has not been followed.

If yes, proceed to Step 5.

If no, proceed to Step 1.

5. **MATERIAL IS NOT A LISTED HAZARDOUS WASTE.**

The Material is not a listed hazardous waste and no further sampling or evaluation is necessary in the following circumstances:

- Where the Material is determined not to be a listed hazardous waste based on specific information about the generation/management of the Material OR the appropriate RCRA regulatory authority with jurisdiction over the Site agrees with the generator's determination that the Material is not a listed HW, makes a contained-out determination, or concludes the Material or Site is not subject to RCRA (and the State agrees the conclusions of the regulatory authority were reasonable and made in good faith) (Step 2); or
- Where the Material is determined not to be a listed hazardous waste (in Steps 6 through 11, 13 or 15) and Confirmation/Acceptance Sampling are determined not to be necessary (under Step 17).

6. **IS MATERIAL A PROCESS WASTE KNOWN TO BE A LISTED HAZARDOUS WASTE OR TO BE MIXED WITH A LISTED HAZARDOUS WASTE?**

Based on the Source Investigation, determine whether the Material is a process waste known to be a listed hazardous waste or to be mixed with a listed hazardous waste. If the Material is a process waste and is from a listed hazardous waste source, it is a listed

hazardous waste. Similarly, if the Material is a process waste and has been mixed with a listed hazardous waste, it is a listed hazardous waste under the RCRA "mixture rule." If the Material is an Environmental Medium,[7] it cannot be a listed hazardous waste by direct listing or under the RCRA "mixture rule."[8] If the Material is a process waste but is not known to be from a listed source or to be mixed with a listed waste, or if the Material is an Environmental Medium, proceed to Steps 7 through 11 to determine whether it is a listed hazardous waste.

If yes, proceed to Step 12.

If no, proceed to Step 7.

7. DOES MATERIAL CONTAIN ANY POTENTIALLY LISTED HAZARDOUS CONSTITUENTS?

Based on the Source Investigation (and, if applicable, Confirmation and Acceptance Sampling), determine whether the Material contains any hazardous constituents listed in the then most recent version of 40 CFR 261, Appendix VII (which identifies hazardous constituents for which F- and K-listed wastes were listed) or 40 CFR 261.33(e) or (f) (the P and U listed wastes) (collectively "Potentially Listed Hazardous Constituents"). If the Material contains such constituents, a source evaluation is necessary (pursuant to Steps 8 through 11). If the Material does <u>not</u> contain any Potentially Listed Hazardous Constituents, it is not a listed hazardous waste. The Material also is not a listed hazardous waste if, where applicable, Confirmation and Acceptance Sampling results do not reveal the presence of any "new" Potentially Listed Hazardous Constituents (*i.e.*, constituents <u>other than those</u> that have not already been identified by the Source Investigation (or previous Confirmation/Acceptance Sampling) and determined not to originate from a listed source).

If yes, proceed to Step 8.

If no, proceed to Step 16.

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[7] The term "Environmental Media" means soils, ground or surface water and sediments.

[8] The "mixture rule" applies only to mixtures of listed hazardous wastes and other "solid wastes." *See* 40 CFR § 261.3(a)(2)(iv). The mixture rule does not apply to mixtures of listed wastes and Environmental Media, because Environmental Media are not "solid wastes" under RCRA. *See* 63 Fed. Reg. 28556, 28621 (May 26, 1998).

8. IDENTIFY POTENTIALLY LISTED WASTES.

Identify potentially listed hazardous wastes ("Potentially Listed Wastes") based on Potentially Listed Hazardous Constituents detected in the Material, *i.e.*, wastes which are listed for any of the Potentially Listed Hazardous Constituents detected in the Material, as identified in the then most current version of 40 CFR 261 Appendix VII or 40 CFR 261.33(e) or (f).[9] With respect to Potentially Listed Hazardous Constituents identified through Confirmation and/or Acceptance Sampling, a source evaluation (pursuant to Steps 8 through 11) is necessary only for "new" Potentially Listed Hazardous Constituents (*i.e.*, constituents other than those that have ~~not~~ already been identified by the Source Investigation (or previous Confirmation/Acceptance Sampling) and determined not to originate from a listed source).

Proceed to Step 9.

9. WERE ANY OF THE POTENTIALLY LISTED WASTES KNOWN TO BE GENERATED OR MANAGED AT SITE?

Based on information from the Source Investigation, determine whether any of the Potentially Listed Wastes identified in Step 8 are known to have been generated or managed at the Site. This determination involves identifying whether any of the specific or non-specific sources identified in the K- or F-lists has ever been conducted or located at the Site, whether any waste from such processes has been managed at the Site, and whether any of the P- or U-listed commercial chemical products has ever been used, spilled or managed there. In particular, this determination should be based on the following EPA criteria:

Solvent Listings (F001-F005)

Under EPA guidance, "to determine if solvent constituents contaminating a waste are RCRA spent solvent F001-F005 wastes, the [site manager] must know if:

- The solvents are *spent* and *cannot be reused without reclamation* or cleaning.
- The solvents were *used exclusively for their solvent properties.*
- The solvents are spent *mixtures and blends that contained, before use, a total of 10 percent or more (by volume) of the solvents* listed in F001, F002, F004, and F005.

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[9] For example, if the Material contains tetrachloroethylene, the following would be Potentially Listed Wastes: F001, F002, F024, K019, K020, K150, K151 or U210. *See* 40 CFR 261 App. VII.

If the solvents contained in the [wastes] are RCRA listed wastes, the [wastes] are RCRA hazardous waste. When the [site manager] does not have guidance information on the use of the solvents and their characteristics before use, the [wastes] cannot be classified as containing a listed spent solvent."[10] The person performing the Source Investigation will make a good faith effort to obtain information on any solvent use at the Site. If solvents were used at the Site, general industry standards for solvent use in effect at the time of use will be considered in determining whether those solvents contained 10 percent or more of the solvents listed in F001, F002, F004 or F005.

K-Listed Wastes and F-Listed Wastes Other Than F001-F005

Under EPA guidance, to determine whether K wastes and F wastes other than F001-F005 are RCRA listed wastes, the generator "must know the *generation process information* (about each waste contained in the RCRA waste) described in the listing. For example, for [wastes] to be identified as containing K001 wastes that are described as 'bottom sediment sludge from the treatment of wastewaters from wood preserving processes that use creosote and/or pentachlorophenol,' the [site manager] must know the manufacturing process that generated the wastes (treatment of wastewaters from wood preserving process), feedstocks used in the process (creosote and pentachlorophenol), and the process identification of the wastes (bottom sediment sludge)."[11]

P- and U-Listed Wastes

EPA guidance provides that "P and U wastes cover only unused and unmixed commercial chemical products, particularly spilled or off-spec products. Not every waste containing a P or U chemical is a hazardous waste. To determine whether a [waste] contains a P or U waste, the [site manager] must have direct evidence of product use. In particular, the [site manager] should ascertain, if possible, whether the chemicals are:

- Discarded (as described in 40 CFR 261.2(a)(2)).
- Either off-spec commercial products or a commercially sold grade.

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10 Management of Investigation-Derived Wastes During Site Inspections, EPA/540/G-91/009, May 1991 (emphasis added).

11 Management of Investigation-Derived Wastes During Site Inspections, EPA/540/G-91/009, May 1991 (emphasis added).

- Not used (soil contaminated with spilled unused wastes is a P or U waste).
- The sole active ingredient in a formulation."[12]

~~If the answer to the question in this step is yes,~~ If Potentially Listed Wastes were known to be generated or managed at the Site, further evaluation is necessary to determine whether these wastes were disposed of or commingled with the Material (Steps 10 and possibly 11). ~~If the answer is no,~~ If Potentially Listed Wastes were not known to be generated or managed at the Site, then information concerning the source of Potentially Listed Hazardous Constituents in the Material will be considered "unavailable or inconclusive" and, under EPA guidance,[13] the Material will be assumed not to be a listed hazardous waste.

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12 Management of Investigation-Derived Wastes During Site Inspections, EPA/540/G-91/009, May 1991.

13 EPA guidance consistently provides that, where information concerning the origin of a waste is ~~not~~ unavailable or inconclusive, the waste may be assumed not to be a listed hazardous waste. *See e.g.*, Memorandum from Timothy Fields (Acting Assistant Administrator for Solid Waste & Emergency Response) to RCRA/CERCLA Senior Policy Managers regarding "Management of Remediation Waste Under RCRA," dated October 14, 1998 ("Where a facility owner/operator makes a good faith effort to determine if a material is a listed hazardous waste but cannot make such a determination because documentation regarding a source of contamination, contaminant, or waste is *unavailable or inconclusive*, EPA has stated that one may assume the source, contaminant, or waste is not listed hazardous waste"); NCP Preamble, 55 Fed. Reg. 8758 (March 8, 1990) (Noting that "it is often necessary to know the origin of the waste to determine whether it is a listed waste and that, *if such documentation is lacking, the lead agency may assume it is not a listed waste*); Preamble to proposed Hazardous Waste Identification Rule, 61 Fed. Reg. 18805 (April 29, 1996) ("Facility owner/operators should make a good faith effort to determine whether media were contaminated by hazardous wastes and ascertain the dates of placement. The Agency believes that by using available site- and waste-specific information ... facility owner/operators would typically be able to make these determinations. However, as discussed earlier in the preamble of today's proposal, *if information is not available or inconclusive, facility owner/operators may generally assume that the material contaminating the media were not hazardous wastes.*"); Preamble to LDR Phase IV Rule, 63 Fed. Reg. 28619 (May 26, 1998) ("As discussed in the April 29, 1996 proposal, the Agency continues to believe that, *if information is not available or inconclusive, it is generally reasonable to assume that contaminated soils do not contain untreated hazardous wastes* ..."); and Memorandum from John H. Skinner (Director, EPA Office of Solid Waste) to David Wagoner (Director, EPA Air and Waste Management Division, Region VII) regarding "Soils from Missouri Dioxin Sites," dated January 6, 1984 ("The analyses indicate the presence of a number of toxic compounds in many of the soil samples taken from various sites. However, the presence of these toxicants in the soil does not automatically make the soil a RCRA

(footnote continued on next page)

If yes, proceed to Step 10.

If no, proceed to Step 16.

10. WERE LISTED WASTES KNOWN TO BE DISPOSED OF OR COMMINGLED WITH MATERIAL?

If listed wastes identified in Step 9 were known to be generated at the Site, determine whether they were known to be disposed of or commingled with the Material?

If yes, proceed to Step 12.

If no, proceed to Step 11.

11. ARE THERE ONE OR MORE POTENTIAL NON-LISTED SOURCES OF LISTED HAZARDOUS WASTE CONSTITUENTS?

In a situation where Potentially Listed Wastes were known to have been generated/managed at the Site, but the wastes were not known to have been disposed of or commingled with the Material, determine whether there are potential non-listed sources of Potentially Listed Hazardous Constituents in the Material. If not, unless the State agrees otherwise, the constituents will be assumed to be from listed sources (proceed to Step 12). If so, the Material will be assumed not to be a listed hazardous waste (proceed to Step 16). Notwithstanding the existence of potential non-listed sources at a Site, the Potentially Listed Hazardous Constituents in the Material will be considered to be from the listed source(s) if, based on the relative proximity of the Material to the listed and non-listed source(s) and/or information concerning waste management at the Site, the evidence is compelling that the listed source(s) is the source of Potentially Listed Hazardous Constituents in the Material.

If yes, proceed to Step 16.

If no, proceed to Step 12.

12. MATERIAL IS A LISTED HAZARDOUS WASTE.

The Material is a listed hazardous waste under the following circumstances:

(footnote continued from previous page)

hazardous waste. The origin of the toxicants must be known in order to determine that they are derived from a listed hazardous waste(s). *If the exact origin of the toxicants is not known, the soils cannot be considered RCRA hazardous wastes* unless they exhibit one or more of the characteristics of hazardous waste ...").

- If the Material is a process waste and is known to be a listed hazardous waste or to be mixed with a listed hazardous waste (Step 6),
- If Potentially Listed Wastes were known to be ~~actually~~ generated/managed at the Site and to be disposed of/commingled with the Material (Step 10) (subject to a "contained-out" determination in Step 13), or
- If Potentially Listed Wastes were known to be ~~actually~~ generated/managed at the Site, were not known to be disposed of/commingled with the Material but there are not any potential non-listed sources of the Potentially Listed Hazardous Constituents detected in the Material (Step 11) (subject to a "contained-out" determination in Step 13).

Proceed to Step 13.

13. HAS STATE OF UTAH MADE A CONTAINED-OUT DETERMINATION.

If the Material is an Environmental Medium, and:

- the level of any listed waste constituents in the Material is "de minimis" ; or
- all of the listed waste constituents or classes thereof are already present in the White Mesa Mill's tailings ponds as a result of processing conventional ores or other alternate feed materials in concentrations at least as high as found in the Materials

the State of Utah will consider whether it is appropriate to make a contained-out determination with respect to the Material.

If the State makes a contained-out determination, proceed to Step 16.

If the State does not make a contained-out determination, proceed to Step 14.

14. IS IT POSSIBLE TO SEGREGATE LISTED HAZARDOUS WASTES FROM OTHER MATERIALS?

Determine whether there is a reasonable way to segregate material that is a listed hazardous waste from alternate feed materials that are not listed hazardous wastes that will be sent to IUSA's White Mesa Mill. For example, it may be possible to isolate material from a certain area of a remediation site and exclude that material from Materials

that will be sent to the White Mesa Mill. Alternatively, it may be possible to increase sampling frequency and exclude materials with respect to which the increased sampling identifies constituents which have been attributed to listed hazardous waste.

If yes, proceed to Step 15.

If no, proceed to Step 12.

15. SEPARATE LISTED HAZARDOUS WASTES FROM MATERIALS.

Based on the method of segregation determined under Step 14, materials that are listed hazardous wastes are separated from Materials that will be sent to the White Mesa Mill.

For materials that are listed hazardous wastes, proceed to Step 12.

For Materials to be sent to the White Mesa Mill, proceed to Step 16.

16. PROVIDE INFORMATION TO NRC AND UTAH.

If the Material does not contain any Potentially Listed Hazardous Constituents (as determined in Step 7), where information concerning the source of Potentially Listed Hazardous Constituents in the Material is "unavailable or inconclusive" (as determined in Steps 8 through 11), or where the State of Utah has made a contained-out determination with respect to the Material (Step 13), the Material will be assumed not to be (or contain) a listed hazardous waste. In such circumstances, IUSA will submit the following documentation to NRC and the State:

- A description of the Source Investigation;
- An explanation of why the Material is not a listed hazardous waste.
- Where applicable, an explanation of why Confirmation/Acceptance Sampling has been determined not to be necessary in Step 17.
- If Confirmation/Acceptance Sampling has been determined necessary in Step 17 , a copy of IUSA's and the Generator's Sampling and Analysis Plans.
- A copy of Confirmation and Acceptance Sampling results, if applicable. IUSA will submit these results only if they identify the presence of "new" Potentially Listed Hazardous Constituents (as defined in Steps 7 and 8).

Proceed to Step 17.

17. ARE SAMPLING RESULTS OR DATA REPRESENTATIVE?

Determine whether the sampling results or data from the Source Investigation (or, where applicable, Confirmation/Acceptance Sampling results) are representative. The purpose

of this step) is to determine whether Confirmation and Acceptance Sampling (or continued Confirmation and Acceptance Sampling) are necessary. If the sampling results or data are representative of all Material destined for the White Mesa Mill, based on the extent of sampling conducted, the nature of the Material and/or the nature of the Site (*e.g.*, whether chemical operations or waste disposal were known to be conducted at the Site), future Confirmation/Acceptance Sampling will not be necessary. If the sampling results are not representative of all Material destined for the White Mesa Mill, then additional Confirmation/Acceptance sampling may be appropriate. Confirmation and Acceptance Sampling will be required only where it is reasonable to expect that additional sampling will detect additional contaminants not already detected. For example:

- Where the Material is segregated from Environmental Media, *e.g.*, the Material is containerized, there is a high probability the sampling results or data from the Source Investigation are representative of the Material and Confirmation/Acceptance Sampling would not be required.
- Where IUSA will be accepting Material from a discrete portion of a Site, *e.g.*, a storage pile or other defined area, and adequate sampling characterized the area of concern for radioactive and chemical contaminants, the sampling for that area would be considered representative and Confirmation/Acceptance sampling would not be required.
- Where Material will be received from a wide area of a Site and the Site has been carefully characterized for radioactive contaminants, but not chemical contaminants, Confirmation/Acceptance sampling would be required.
- Where the Site was not used for industrial activity or disposal before or after uranium material disposal, and the Site has been adequately characterized for radioactive and chemical contaminants, the existing sampling would be considered sufficient and Confirmation/Acceptance sampling would not be required.
- Where listed wastes were known to be disposed of on the Site and the limits of the area where listed wastes were managed is not known, Confirmation/Acceptance sampling would be required to ensure that listed wastes are not shipped to IUSA (see Step 14).

If yes, proceed to Step 4.

If no, proceed to Step 18.

18. DOES STATE OF UTAH AGREE THAT ALL PREVIOUS STEPS HAVE BEEN PERFORMED IN ACCORDANCE WITH THIS PROTOCOL?

Determine whether the State agrees that this Protocol has been properly followed (including that proper decisions were made at each decision point). The State shall review the information provided by IUSA in Step 16 ~~promptly~~ with reasonable speed and advise IUSA if it believes IUSA has not properly followed this Protocol in determining that the Material is not listed hazardous waste, specifying the particular areas of deficiency.

If this Protocol has not been properly followed by IUSA in making its determination that the Material is not a listed hazardous waste, then IUSA shall redo its analysis in accordance with this Protocol and, if justified, resubmit the information described in Step 16 explaining why the Material is not a listed hazardous waste. The State shall notify IUSA ~~promptly~~ with reasonable speed if the State still believes this Protocol has not been followed.

If yes, proceed to Step 19.

If no, proceed to Step 1.

19. MATERIAL IS NOT A LISTED HAZARDOUS WASTE, BUT CONFIRMATION AND ACCEPTANCE SAMPLING ARE REQUIRED.

The Material is not a listed hazardous waste, but Confirmation and Acceptance Sampling are required, as determined necessary under Step 17.

Proceed to Step 20.

20. CONDUCT ONGOING CONFIRMATION AND ACCEPTANCE SAMPLING.

Confirmation and Acceptance Sampling will continue until determined no longer necessary under Step 17. Such sampling will be conducted pursuant to a Sampling and Analysis Plan ("SAP") that specifies the frequency and type of sampling required. If such sampling does not reveal any "new" Potentially Listed Hazardous Constituents (as defined in Steps 7 and 8), further evaluation is not necessary (as indicated in Step 7). If such sampling reveals the presence of "new" constituents, Potentially Listed Wastes must be identified (Step 8) and evaluated (Steps 9 through 11) to determine whether the new constituent is from a listed hazardous waste source. Generally, in each case, the SAP will specify sampling comparable to the level and frequency of sampling performed by other facilities in the State of Utah that dispose of 11e.(2) byproduct material, either directly or that results from processing alternate feed materials.

Proceed to Step 7.

Attachment 1

Summary of RCRA Listed Hazardous Wastes

There are three different categories of listed hazardous waste under RCRA:

- *F-listed wastes from non-specific sources (40 CFR § 261.31(a))*: These wastes include spent solvents (F001-F005), specified wastes from electroplating operations (F006-F009), specified wastes from metal heat treating operations (F010-F012), specified wastes from chemical conversion coating of aluminum (F019), wastes from the production/manufacturing of specified chlorophenols, chlorobenzenes, and chlorinated aliphatic hydrocarbons (F019-F028), specified wastes from wood preserving processes (F032-F035), specified wastes from petroleum refinery primary and secondary oil/water/solids separation sludge (F037-F038), and leachate resulting from the disposal of more than one listed hazardous waste (F039).
- *K-listed wastes from specific sources (40 CFR § 261.32)*: These include specified wastes from wood preservation, inorganic pigment production, organic chemical production, chlorine production, pesticide production, petroleum refining, iron and steel production, copper production, primary and secondary lead smelting, primary zinc production, primary aluminum reduction, ferroalloy production, veterinary pharmaceutical production, ink formulation and coking.
- *P- and U-listed commercial chemical products (40 CFR § 261.33)*: These include commercial chemical products, or manufacturing chemical intermediates having the generic name listed in the "P" or "U" list of wastes, container residues, and residues in soil or debris resulting from a spill of these materials.[1] "The phrase 'commercial chemical product or manufacturing chemical intermediate ...' refers to a chemical substance which is manufactured or formulated for commercial or manufacturing use which consists of the commercially pure grade of the chemical, any technical grades of the chemical that are produced or marketed, and all formulations in which the chemical is the sole active ingredient. It does not refer to a material, such as a manufacturing process waste, that contains any of the [P- or U-listed substances]."[2]

Appendix VII to 40 CFR part 261 identifies the hazardous constituents for which the F- and K-listed wastes were listed.

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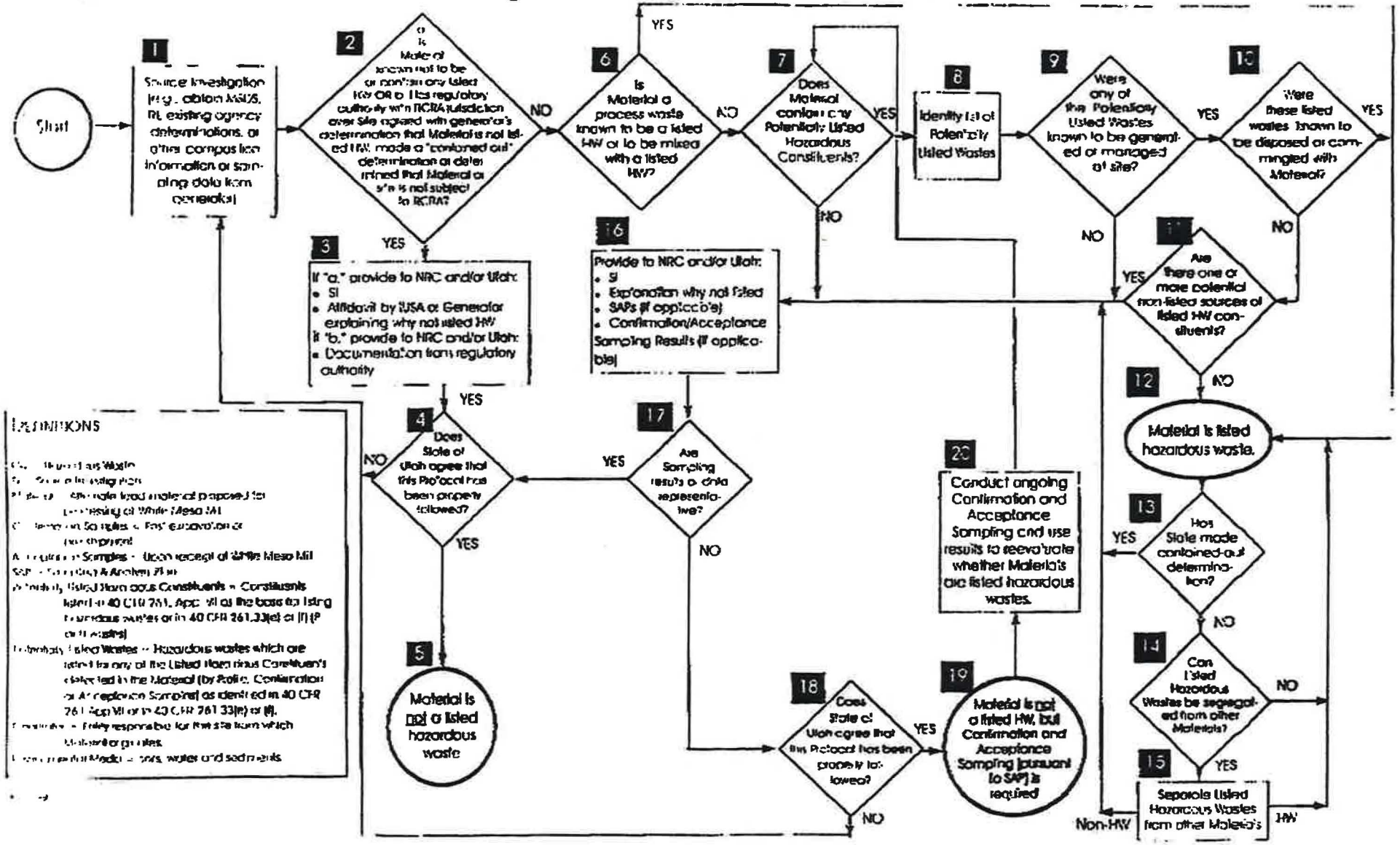
1 P-listed wastes are identified as "acutely hazardous wastes" and are subject to additional management controls under RCRA. 40 CFR § 261.33(e) (1997). U-listed wastes are identified as "toxic wastes." Id. § 261.33(f).

2 40 CFR § 261.33(d) note (1997).

Protocol for Determining if Alternate L[illegible]d Material is a Listed Hazardous Waste



Technical Memorandum

To:	David C. Frydenlund	**From:**	Jo Ann Tischler
Company:	Energy Fuels Resources (USA), Inc.	**Date:**	July 27, 2019
Re:	Review of Chemical Contaminants in Union Pacific Uranium Material to Determine the Potential Presence of RCRA Characteristic or RCRA Listed Hazardous Waste		
CC:			

1.0 Introduction

This report summarizes the characterization of the Union Pacific Railroad ("UPRR") Moffat Tunnel Uranium Material (the "Uranium Material"), also referred to as the "centrifuge cake" or "centrifuge solids" to determine whether or not the Uranium Material is or contains any listed or characteristic hazardous waste as defined by the Resource Conservation and Recovery Act ("RCRA"). The results of this characterization will provide information for Energy Fuels Resources (USA), Inc. ("EFRI") to determine the requirements necessary for an amendment to its White Mesa Uranium Mill ("Mill") State of Utah Radioactive Materials License No. UT1900479 (the "License") to permit the processing of the Uranium Material as an alternate feed material at the Mill.

In accordance with the definitions in the Atomic Energy Act, as amended, and 10 Code of Federal Regulations ("CFR") 40.4, ores with natural uranium content of 0.05 weight percent or higher are classified as source material and, as per 40 CFR Part 261.4, are exempt from regulation under RCRA. As summarized in the Radioactive Material Profile Record ("RMPR"), the Uranium Material has a uranium content of approximately 0.45 to 0.49 dry weight percent natural uranium (0.53 to 0.58 dry weight percent U_3O_8). This Uranium Material is therefore source material, and is categorically exempt from RCRA.

Although the Uranium Material is exempt from regulation under RCRA, EFRI nonetheless requires a due diligence evaluation of potential materials to be processed, to assess:

1. Whether the material is, or contains, any hazardous constituents that would be regulated as RCRA listed hazardous waste, if the Uranium Material were not categorically exempt from RCRA as a uranium ore or 11e.(2) byproduct material or a categorically exempt solid waste.

2. Whether the material contains any constituents that could generate a worker safety or environmental hazard under the conditions under which it will be processed at the Mill.

3. Whether the material contains any constituents that would be incompatible with the Mill's tailings management system.

This memorandum provides the evaluation of the regulatory status of the Uranium Material relative to RCRA. Evaluation of potential safety and environmental hazards, and compatibility with the Mill's tailings management system are provided in a separate memorandum.

2.0 Site History and Background

The Uranium Material was generated by treatment of groundwater from dewatering of the Moffat railroad tunnel ("Moffat Tunnel"). The groundwater contains naturally occurring radioactive material ("NORM") from contact with native rock, and picks up inorganic solids particles as it passes through the tunnel. As a result, the groundwater requires treatment to meet Colorado Department of Public Health and Environment ("CDPHE") discharge standards prior to release to the Fraser River.

Groundwater is pumped from the Moffat Tunnel at approximately 200 gallons per minute ("gpm") for dewatering. Prior to discharge of the pumped water to surface receiving waters, it is pre-treated by an ultrafiltration and centrifugation system to meet CDPHE standards for radionuclides and inorganic constituents.

The Uranium Material was generated from a continuous process, as described below, driven by the requirement to achieve discharge permit limits in the water released from the water treatment plant ("WTP") to the Fraser River. No other water sources or wastes are treated in the WTP.

The Uranium Material is comprised only of the centrifuged solids. No other materials or wastes are added to the Uranium Material. The Uranium Material contains approximately 75-90% moisture content and 0.13-0.14% natural uranium on a wet basis or up to 0.49% natural uranium on a dry basis.

A chronology of the site history is listed below.

2008 to 2016	Moffat Tunnel water characterization sampling
2017	Treatment plant constructed
2017	Beginning of dewatering and treatment
2017 through 2018	Centrifuge solids (Uranium Material) was collected in shipping containers and disposed at off site waste management locations
2018	UPRR submits application for CDPHE radiological materials license for Uranium Material
2019	Centrifuge solids are drummed for eventual transfer to EFRI
2019	Anticipated receipt of CDPHE license for Uranium Material

NRC's Alternate Feed Guidance currently provides that if a proposed feed material contains hazardous waste, listed under Section 261.30-33, Subpart D, of 40 CFR (or comparable RCRA authorized State regulations), it would be subject to EPA (or State) regulation under RCRA. However, the Guidance provides that if the licensee can show that the proposed feed material does not consist of a listed hazardous waste, this issue is resolved. NRC guidance further states that feed material exhibiting only a characteristic of hazardous waste (ignitability, corrosivity, reactivity, toxicity) that is being recycled, would not be regulated as hazardous waste and could therefore be approved for extraction of source material. The Alternate Feed Guidance concludes that if the feed material contains a listed hazardous waste, the licensee can process it only if it obtains EPA (or State) approval and provides the necessary documentation to that effect. The Alternate Feed Guidance also states that NRC staff may consult with EPA (or the State) before making a determination on whether the feed material contains listed hazardous waste.

Subsequent to the date of publication of the Alternate Feed Guidance, NRC recognized that, because alternate feed materials that meet the requirements specified in the Alternate Feed Guidance must be ores, any alternate feed materials that contain greater than 0.05% source material are considered source material under the definition of source material in 10 CFR 40.4 and hence exempt from the requirements of RCRA under 40 CFR 261.4(a)(4). See Technical Evaluation Report Request to Receive and Process Molycorp Site Material issued by the NRC on December 3, 2001 (the "Molycorp TER"). As a result, any such alternate feed ores are exempt from RCRA, regardless of whether they would otherwise have been considered to contain listed or characteristic hazardous· wastes. Since the Uranium Material contains greater than 0.05% source material, it is exempt from RCRA, regardless of its process history or constituents, and no further RCRA analysis is required. Further, the Uranium Material has been classified as 11e.(2) byproduct material by NRC under 40 CFR 261.4(a)(4). 11e.(2) byproduct material is exempt from RCRA, and for this reason also the Uranium Material is exempt from RCRA.

Nevertheless, because the Alternate Feed Guidance has not yet been revised to reflect this position recognized by NRC in the Molycorp TER, the remainder of this memorandum will demonstrate that, even if the Uranium Material were not considered source material or 11e.(2) byproduct material, and as such exempt from RCRA, the Uranium Material would not, in any event, contain any RCRA listed hazardous wastes, as required under the Alternate Feed Guidance as currently worded.

2.1 Description of Process Which Generated the Uranium Material

The Uranium Material consists of the centrifuge solids from the WTP, as described below.

Upon entering the treatment plant, the groundwater from tunnel dewatering is treated first by the addition of a coagulant, Calchem CC2000 aluminum chlorohydrate, followed by direct filtration in an ultrafiltration membrane system. Backwash water from the ultrafiltration membrane system containing coagulated solids is pumped through a dissolved air flotation system where a very small amount of 7th generation dish soap (<0.001% by volume) is added to assist in thickening of the solids via flotation. The thickened solids are further dewatered using a centrifuge. A small amount of Zetag 120L polymer, <0.001% by volume, is added to the thickened solids before the solids enter the centrifuge.

During major construction, e.g. rail extension or tunnel expansion, an additional setting step is added upstream of the treatment plant. Settling tanks are used in this situation to settle construction related particulate matter. No other treatment chemicals are added.

Per the process description provided by UPRR for production of the centrifuge cake, the chemical reagents used in the above processes included:

- Calchem CC2000 Aluminum chlorohydrate used as coagulant
- Seventh Generation dish soap used as a thickener for flotation
- Zetag 120L hydrocarbon polymer to enhance centrifugation

The presence of residuals or reaction byproducts from these compounds would be expected in the Uranium Material, as discussed in the sections below.

Schematic flow sheets depicting the process which produced the Uranium Material during normal operations and construction periods, are provided in Figures 1 and 2.

3.0 Basis and Limitations of this Evaluation

The Uranium Material to be processed at the EFRI White Mesa Mill consists solely of the centrifuged solids from the WTP.

Physical and chemical analyses have been performed at different times to characterize the raw water to be treated, to evaluate performance of the WTP, or to characterize the centrifuge solids for off site management.

For development of treatment requirements prior to WTP construction, raw water from the Moffat Tunnel West Portal was analyzed quarterly from 2008 through 2016 for metals and other inorganic parameters.

Centrifuge solids, as well as intermediate streams in the WTP, were analyzed for a limited number of organic and inorganic parameters during the WTP startup period in 2017.

Subsequent to discussions with EFRI in 2018, UPRR collected additional samples which were analyzed for a full suite of parameters by a Utah certified laboratory. UPRR collected a first sample representing short term centrifuge performance and Uranium Material composition by sampling centrifuge cake from one day's operation. Four additional samples were collected over a two week period of operation, and composited, to represent Uranium Material composition over time.

The evaluations are summarized in the table below.

Summary of UPRR Moffat Analyses

Sample Name/Laboratory	Sampling/Analysis Date(s)	Analyses	Number of Composite Samples
American West Analytical Laboratories Centrifuge Cake Characterization	June 2018	VOCs, SVOCs, pesticides, herbicides, TCLP (metals and organics), major ions, total metals, ammonia and nitrate N, radionuclides	1 random sample accumulated over one day's run, and 1 composite of 4 additional samples over two weeks run.
WTP Startup Solids Characterization	April 2017	Total metals, TCLP metals, TCLP organics	Approximately 10 samples from throughout the WTP. (Not every sample was analyzed for every parameter)
Moffat Tunnel West Portal Raw Water Monitoring	2008 through 2016	Major ions, dissolved metals, total metals, cyanide, uranium	119 (not every sample was analyzed for every parameter)

As discussed in Section 2.0, above, the Uranium Material contains greater than 0.05% source material, and is exempt from RCRA, regardless of its process history or chemical composition, and no further RCRA analysis is required. The following evaluation of characterization data is provided to demonstrate that even if the Uranium Material were not categorically exempt from RCRA, it is not and does not contain RCRA listed hazardous waste.

The sampling was representative of a continuous process stream under the control of the generator from a process which did not vary appreciably over time.

The various analyses addressed a full range of volatile organic compounds ("VOCs"), semivolatile organic compounds ("SVOCs'), pesticides, arochlors and other compounds that could potentially have reached groundwater, or centrifuge solids, from natural and man-made sources. Analyses provided with the RMPR were performed by laboratories possessing State of Utah and/or NELAC certification for the analyses performed. As a result, these studies provide sufficiently representative characterization to assess the regulatory status, worker safety environmental hazards, and chemical and processing properties of the Uranium Material.

The following RCRA evaluation is based on information from the following sources:

1. Current Moffat Uranium Material analytical data 2018
2. TestAmerica analyses April 2017
3. Raw water influent data provided by UPRR for sampling from 2008 through 2016
4. Material Safety Information Sheet for Insoluble Mineral Fraction provided by UPRR, 2019
5. Correspondence and discussion with UPRR personnel throughout 2018 and 2019.
6. EFRI Protocol for Determining Whether Alternate Feeds Are Listed Hazardous Wastes (EFRI, November 1999).
7. RMPR for the UPRR Uranium Material (March 2019).
8. Basis of Hazardous Material and Waste Determinations from the RMPR (March 2019)
9. Affidavit of Steven L. Preston UPRR Environmental Field Operations Manager (April 2, 2019).

EFRI has developed a "Protocol for Determining Whether Alternate Feed Materials are Listed Hazardous Wastes" (November 22, 1999) ("the Protocol"). The Protocol has been developed in conjunction with, and accepted by, the State of Utah Department of Environmental Quality ("UDEQ") (Letter of December 7, 1999). Copies of the Protocol and UDEQ letter are provided in Attachment 2 of this Report. The RCRA evaluation and recommendations in this Report were developed in accordance with the Protocol.

4.0 Application of Protocol to Uranium Material

4.1 Source Investigation

Several of the information sources enumerated above were used to perform the Source Investigation indicated in Box 1 of the flow diagram (the "Protocol Diagram") that forms part of the Protocol.

The following sections describe the status of the Uranium Material relative to RCRA Characteristic and RCRA Listed Hazardous Waste regulations, and relative to the specific parameters identified in the EFRI/UDEQ Hazardous Waste Protocol. Although alternate feed materials are being recycled to recover uranium and hence are permitted to contain constituents

that may be considered RCRA characteristic wastes in other circumstances, for completeness, this Report also determines whether or not the Uranium Material contains any such constituents.

4.2 Determination Methods in the EFRI / UDEQ Protocol

4.2.1 Regulatory History of the UPRR Uranium Material

Prior to 2019, UPRR disposed of the centrifuge solids in off-site solid waste disposal facilities licensed for the disposal of NORM material. In 2018 CDPHE required that UPRR apply for a CDPHE radioactive material license. UPRR has applied for the license, which is expected to be in place in 2019, prior to shipment of any Uranium Material to EFRI.

The Uranium Material, which has materially not changed in form or content since first being produced in 2017, remains definitional source material as per 40 CFR Part 261.4, and is explicitly exempt from regulation under RCRA. However, for the sake of completeness, EFRI has required the following evaluation to confirm that even if the Uranium Material were not exempt from RCRA, it is not and does not contain, what would otherwise be considered a RCRA-listed waste, or a RCRA characteristic waste.

The Uranium Material has not been classified or treated as listed hazardous waste nor has it been in contact with any listed hazardous wastes.

4.2.2 Evaluation of Potential RCRA Listings Associated with Specific Contaminants

For potential alternate feeds that are not exempt from RCRA, the Protocol describes additional steps EFRI will take to assess whether contaminants associated with any potential RCRA waste listings are present, and the likelihood that they resulted from RCRA listed hazardous wastes or RCRA listed processes. These steps include tabulation of all potential listings associated with each known chemical contaminant in the material, and the review of chemical process and material/waste handling history at the site to assess whether the known chemical contaminants in the material resulted from listed or non-listed sources. This evaluation is described in Box 8 and Decision Diamonds 9 through 11 in the Protocol Diagram.

If the results of the evaluation indicate that the contaminants are not listed waste, the Protocol specifies an additional assessment of whether the data on which this determination was made is sufficiently representative, or whether an ongoing acceptance sampling program should be implemented, and a similar evaluation performed on any new constituents identified during acceptance sampling.

In the case of the Uranium Material, Steps 9 through 11 are not required as indicated by the statements provided in the Affidavit of Steven Preston of UPRR. However, for the sake of a thorough due diligence evaluation, Steps 9 through 11 were completed, and the results are presented below.

4.0 RCRA Review of Chemical Constituents

Determination of whether the Uranium Material is, or contained, potential RCRA-listed waste included consideration of source history provided by UPRR, and through communications with

UPRR personnel and contractor personnel from January 2018 to date, as well as the analytical efforts summarized in Section 3.0 above.

4.1 Overview

As discussed below, the components of the Uranium Material result either form naturally-occurring constituents of the influent water to the WTP, or from the non-hazardous treatment agents added in the WTP which produced the centrifuge solids/Uranium Material.

The Uranium Material does not contain any "P" or "U" listed wastes as it contains no discarded commercial chemical products, off-specification species, container residues, and spill residues thereof. Any chemicals used in the WTP which generated the Uranium Material were used for their intended purpose and are not waste materials. None of the chemicals used in treatment were associated RCRA hazardous wastes.

There were no processes conducted at the site which fall under the category of "F" listed hazardous wastes from non-specific sources as designated in the following seven categories:

- Spent solvent wastes (F001-F005)
- Wastes from electroplating and other metal finishing operations (F006-F012, F019)
- Dioxin-bearing wastes (F020-F023 and F026-F028)
- Wastes from the production of certain chlorinated aliphatic hydrocarbons (F024, F025)
- Wastes from wood preserving (F032, F034, and F035)
- Petroleum refinery wastewater treatment sludges (F037 and F038)
- Multi-source leachate (F039)

There were no processes conducted at the site which fall under the category of "K" listed hazardous wastes from specific sources designated in the following 13 categories:

- Wood preservation (K001)
- Inorganic pigment manufacturing (K002 –K008)
- Organic chemicals manufacturing (K009-K030, K083, K085, K093-K096, K103-K105, K107-K118, K136, K149-K151, K156-K159, K161, K174-K175, K181)
- Inorganic chemicals manufacturing (K071, K073, K106, K176-178)
- Pesticides manufacturing (K031-K043, K097-K099, K123-K126, K131-K132)
- Explosives manufacturing (K044-K047)
- Petroleum refining (K048-52, K170-K172)
- Iron and steel production (K061-K062)
- Primary aluminum production (K088)
- Secondary lead production (K069, K100)
- Veterinary pharmaceuticals manufacturing (K084, K101-K102)
- Ink formulation (K086)
- Coking (K060, K087, K141-K145, K147-K148)

Evaluation of RCRA listings associated with the inorganic ions and metals analyzed in the Uranium Material is provided in attached Tables 1 and 2 respectively. The single SVOC identified in one of the two samples analyzed, is evaluated in Table 3.

4.2 Volatile Organic Compounds

The Uranium Material consists of solid residuals, centrifuge cake, from treatment of groundwater from tunnel dewatering. No VOCs were used in the treatment unit. No VOCs would be anticipated, and none were detected, in the Uranium Material.

4.3 Semivolatile Organic Compounds

One SVOC, fluoranthene, was detected in one of the two samples of the centrifuge solids. The RCRA listings associated with fluoranthene, K001, K022 and K035 apply to fluoranthene from wood treating, creosote manufacture, coking, or phenol/acetone production. As mentioned above, none of these processes were conducted on the WTP site. Fluoranthene is a common multi-ring asphaltic compound present in paving materials, roadbeds, roofing material and other common construction materials and may have been introduced from one of these sources. Alternatively the compound may have been introduced with the naphthenic distillates added before centrifugation. .

The single potential RCRA listing associated with the fluoranthene, which is not applicable to the Uranium Material, is documented in attached Table 3.

4.4 Non-Metal Inorganic Compounds

AWAL analytical results in the Uranium Material indicate that low levels of ammonia as nitrogen ("ammonia as N"), chloride, fluoride, and sulfate are present in the Uranium Material. Moffat Tunnel raw water analyses indicate that each of these analytes, except ammonia as N, is present in the raw water influent to the WTP. Nitrate/nitrite nitrogen was analyzed and not detected in the Uranium Material.

Ammonia as N was introduced with the non-hazardous dish detergent used as a thickener in the dissolved air flotation step. Neither the detergent nor the process are associated with any RCRA hazardous waste listings. Evaluation of potential RCRA listings associated with the remaining inorganic analytes, and why they are not applicable to the Uranium Material, is provided in detail in the attached Table 1.

Inorganic nitrate/nitrite and inorganic ammonia nitrogen have also been analyzed in the raw water influent samples, but not detected in the Uranium Material. Inorganic nitrate/nitrite compounds and inorganic ammonia nitrogen are not associated with any RCRA hazardous waste listings, therefore, these analytes have not been included in Table 1.

4.5 Metals

Analytical results indicate that the metals aluminum, arsenic, barium, calcium, cobalt, copper, iron, lead, magnesium, manganese, mercury, molybdenum, nickel, potassium, sodium, vanadium, and zinc were present in the Uranium Material.

No RCRA listings are associated with cobalt, iron, magnesium, or molybdenum. Evaluation of potential RCRA listings associated with the remainder of the analyzed metals, and why they are not applicable to the Uranium Material, is provided in detail in the attached Table 2.

4.6 Summary of RCRA Listed Waste Findings

Based on the information presented above, none of the constituents in the Uranium Material would be indicative of RCRA listed hazardous waste, even if the Uranium Material were not already exempt from RCRA as source material. Review of the analytical data, the, process history, and raw water characterization confirms that all of the constituents in the material are consistent with those expected to result from the WTP described in Section 2.0

5.0 RCRA Characteristics

The Uranium Material is a centrifuged dewatered moist solids from inorganic groundwater treatment. As a result it would not be ignitable, corrosive, or reactive per the RCRA definitions of these characteristics. A Uranium Material sample collected during 2017 was analyzed for eight RCRA TCLP metals and 31 RCRA TCLP organic compounds. Two Uranium Material samples collected during 2018 were also analyzed for eight RCRA TCLP metals and 8 RCRA TCLP organic compounds. In all samples collected over both sampling events, no analyzed constituent exceeded its respective TCLP threshold for RCRA toxicity characteristic as defined in Table 1 of 40 CFR Part 261.24(b). Therefore, the test results confirm that that the Uranium Material does not have the RCRA characteristic of toxicity. These results are summarized in the attached Table 4.

Two Uranium Material samples collected during 2018 were tested for corrosivity. No samples exhibited a pH of 2.0 or lower, or a pH of 12.5 or higher. These results confirm that the Uranium Material does not have the RCRA characteristic of corrosivity.

The Uranium is not an oxidizer, an ignitable compressed gas, or a solid that can cause a fire and sustain combustion. In addition, two samples of Uranium Material collected during 2018 were tested for flash point. The sample did not exhibit a flash point of <140°F. These results confirm that the Uranium Material does not have the RCRA characteristic of ignitability.

The Affidavit from Steven Preston of UPRR affirms that the Uranium Material has never been classified for shipment or off-site management as a RCRA characteristic waste. This is consistent with the source of the constituents and the WTP that produced the Uranium Material.

As discussed in the introduction to this report, the Uranium Material is exempt from regulation under RCRA; however, even if it were classified as a characteristic hazardous waste, alternate feed materials are permitted to contain RCRA characteristic wastes under NRC's Alternate Feed Guidance (10 CFR 40, Appendix A).

Based on all of the above information, the Uranium Material is not a RCRA characteristic hazardous waste.

6.0 Conclusions and Recommendations

In summary, the following conclusions can be drawn from the RCRA analysis of the analytical data and information presented above:

1. The Uranium Material is not a RCRA listed hazardous waste because it is an ore that has a natural uranium content of greater than 0.05 weight percent, is therefore source material and, as a result, is exempt from regulation under RCRA.

2. Even if the Uranium Material were not source material, it would not be a RCRA listed hazardous waste for the following additional reasons:

   a) It was generated from a known process under the control of the generator, who has provided the Affidavit declaring that the Uranium Material is not and does not contain RCRA listed hazardous waste. This determination is consistent with Boxes I and 2 and Decision Diamonds 1 and 2 in the EFRI/UDEQ Protocol Diagram;

   b) No VOCs are used in the water treatment process that produced the centrifuge solids, and no volatile organic compounds can be expected to be present in the Uranium Material.

   c) No SVOCs are used in the inorganic mineral process that produced the centrifuge solids. One semi-volatile organic compound was detected in one sample, and not in the second sample. The compound does not result form a RCRA listed waste source.

   d) None of the metals in the Uranium Material samples came from RCRA listed hazardous waste sources. This determination is consistent with Box 8 and Decision Diamonds 9 through 11 in the EFRI/UDEQ Protocol Diagram.

3. The Uranium Material does not exhibit any of the RCRA characteristics of ignitability, corrosivity, reactivity, or toxicity for any constituent.

8.0 References

- Austin, G.T. *Shreve's Chemical Process Industries, Fifth Edition.* McGraw Hill. New York 1984.

- Title 10 Code of Federal Regulations; Chapter I – *Nuclear Regulatory Commission, Part 40 – Domestic Licensing of Source Material: 40.4 – Definitions* (10 CFR 40.4)

- Title 40 Code of Federal Regulations; Protection of the Environment, Part 261 – *Identification and Listing of Hazardous Waste: Subpart A, 261.4 – Exclusions: Subpart B – Criteria for Identifying the Characteristics of Hazardous Waste and for Listing Hazardous Waste.*

- Sax, N. Irving and Lewis, Richard L. Sr. *Hawley's Condensed Chemical Dictionary, 11th Edition.* Van Nostrand Reinhold. New York 1987.

ATTACHMENT 4
Review of Chemical Constituents in Moffat Tunnel Uranium Material to Determine the Potential Presence of
RCRA Characteristic or RCRA Listed Hazardous Waste

Technical Memorandum

To:	David C. Frydenlund	**From:**	Jo Ann Tischler
Company:	Energy Fuels Resources (USA), Inc.	**Date:**	December 23, 2019
Re:	Review of Chemical Contaminants in Union Pacific Uranium Material to Determine the Potential Presence of RCRA Characteristic or RCRA Listed Hazardous Waste		
CC:			

1.0 Introduction

This report summarizes the characterization of the Union Pacific Railroad ("UPRR") Moffat Tunnel Uranium Material (the "Uranium Material"), also referred to as the "centrifuge cake" or "centrifuge solids" to determine whether or not the Uranium Material is or contains any listed or characteristic hazardous waste as defined by the Resource Conservation and Recovery Act ("RCRA"). The results of this characterization will provide information for Energy Fuels Resources (USA), Inc. ("EFRI") to determine the requirements necessary for an amendment to its White Mesa Uranium Mill ("Mill") State of Utah Radioactive Materials License No. UT1900479 (the "License") to permit the processing of the Uranium Material as an alternate feed material at the Mill.

In accordance with the definitions in the Atomic Energy Act, as amended, and 10 Code of Federal Regulations ("CFR") 40.4, ores with natural uranium content of 0.05 weight percent or higher are classified as source material and, as per 40 CFR Part 261.4, are exempt from regulation under RCRA. As summarized in the Radioactive Material Profile Record ("RMPR"), the Uranium Material has a uranium content of approximately 0.45 to 0.49 dry weight percent natural uranium (0.53 to 0.58 dry weight percent U_3O_8). This Uranium Material is therefore source material, and is categorically exempt from RCRA.

Although the Uranium Material is exempt from regulation under RCRA, EFRI nonetheless requires a due diligence evaluation of potential materials to be processed, to assess:

1. Whether the material is, or contains, any hazardous constituents that would be regulated as RCRA listed hazardous waste, if the Uranium Material were not categorically exempt from RCRA as a uranium ore or 11e.(2) byproduct material or a categorically exempt solid waste.

2. Whether the material contains any constituents that could generate a worker safety or environmental hazard under the conditions under which it will be processed at the Mill.

3. Whether the material contains any constituents that would be incompatible with the Mill's tailings management system.

This memorandum provides the evaluation of the regulatory status of the Uranium Material relative to RCRA. Evaluation of potential safety and environmental hazards, and compatibility with the Mill's tailings management system are provided in a separate memorandum.

2.0 Site History and Background

The Uranium Material was generated by treatment of groundwater from dewatering of the Moffat railroad tunnel ("Moffat Tunnel"). The groundwater contains naturally occurring radioactive material ("NORM") from contact with native rock, and picks up inorganic solid as it passes through the Tunnel. As a result, the groundwater requires treatment to meet Colorado Department of Public Health and Environment ("CDPHE") discharge standards prior to release to the Fraser River.

Groundwater is pumped from the Moffat Tunnel at approximately 200 gallons per minute ("gpm") for dewatering. Prior to discharge of the pumped water to surface receiving waters, it is pre-treated by an ultrafiltration and centrifugation system to meet CDPHE standards for radionuclides and inorganic constituents.

The Uranium Material was generated from a continuous process, as described below, driven by the requirement to achieve discharge permit limits in the water released from the water treatment plant ("WTP") to the Fraser River. No other water sources or wastes are treated in the WTP.

The Uranium Material is comprised only of the centrifuged solids. No other materials or wastes are added to the Uranium Material. The Uranium Material contains approximately 75-90% moisture content and 0.13-0.14% natural uranium on a wet basis or up to 0.49% natural uranium on a dry basis.

A chronology of the site history is listed below.

2008 to 2016	Moffat Tunnel water characterization sampling
2017	Treatment plant constructed
2017	Beginning of dewatering and treatment
2017 through 2018	Centrifuge solids (Uranium Material) was collected in shipping containers and disposed at off site waste management locations
2018	UPRR submits application for CDPHE radiological materials license for Uranium Material
2019	Centrifuge solids are drummed for eventual transfer to EFRI
2019	UPRR receives CDPHE license for Uranium Material

NRC's Alternate Feed Guidance currently provides that if a proposed feed material contains hazardous waste, listed under Section 261.30-33, Subpart D, of 40 CFR (or comparable RCRA authorized State regulations), it would be subject to EPA (or State) regulation under RCRA. However, the Guidance provides that if the licensee can show that the proposed feed material does not consist of a listed hazardous waste, this issue is resolved. NRC guidance further states that feed material exhibiting only a characteristic of hazardous waste (ignitability, corrosivity, reactivity, toxicity) that is being recycled, would not be regulated as hazardous waste and could therefore be approved for extraction of source material unless it is a residue from water treatment. The Alternate Feed Guidance concludes that if the feed material contains a listed hazardous waste, the licensee can process it only if it obtains EPA (or State) approval and provides the necessary documentation to that effect. The Alternate Feed Guidance also states that NRC staff

may consult with EPA (or the State) before making a determination on whether the feed material contains listed hazardous waste.

Subsequent to the date of publication of the Alternate Feed Guidance, NRC recognized that, because alternate feed materials that meet the requirements specified in the Alternate Feed Guidance must be ores, any alternate feed materials that contain greater than 0.05% source material are considered source material under the definition of source material in 10 CFR 40.4 and hence exempt from the requirements of RCRA under 40 CFR 261.4(a)(4). See Technical Evaluation Report Request to Receive and Process Molycorp Site Material issued by the NRC on December 3, 2001 (the "Molycorp TER"). As a result, any such alternate feed ores are exempt from RCRA, regardless of whether they would otherwise have been considered to contain listed or characteristic hazardous· wastes. Since the Uranium Material contains greater than 0.05% source material, it is exempt from RCRA, regardless of its process history or constituents, and no further RCRA analysis is required.

Nevertheless, because the Alternate Feed Guidance has not yet been revised to reflect this position recognized by NRC in the Molycorp TER, the remainder of this memorandum will demonstrate that, even if the Uranium Material were not considered source material, and as such exempt from RCRA, the Uranium Material would not, in any event, contain any RCRA listed or characteristic hazardous wastes, as required under the Alternate Feed Guidance as currently worded.

2.1 Description of Process Which Generated the Uranium Material

The Uranium Material consists of the centrifuge solids from the WTP, as described below.

Upon entering the treatment plant, the groundwater from tunnel dewatering is treated first by the addition of a coagulant, Calchem CC2000 aluminum chlorohydrate, followed by direct filtration in an ultrafiltration membrane system. Backwash water from the ultrafiltration membrane system containing coagulated solids is pumped through a dissolved air flotation system where a very small amount of 7th Generation dish soap (<0.001% by volume) is added to assist in thickening of the solids via flotation. The thickened solids are further dewatered using a centrifuge. A small amount of Zetag 120L polymer, <0.001% by volume, is added to the thickened solids before the solids enter the centrifuge.

During major construction, e.g. rail extension or tunnel expansion, an additional settling step is added upstream of the treatment plant. Settling tanks are used in this situation to settle construction related particulate matter. No other treatment chemicals are added.

Per the process description provided by UPRR for production of the centrifuge cake, the chemical reagents used in the above processes included:

- Calchem CC2000 Aluminum chlorohydrate used as coagulant
- Seventh Generation dish soap used as a thickener for flotation
- Zetag 120L hydrocarbon polymer to enhance centrifugation

The presence of residuals or reaction byproducts from these compounds would be expected in the Uranium Material, as discussed in the sections below.

Schematic flow sheets depicting the process which produced the Uranium Material during normal operations and construction periods, are provided in Figures 1 and 2.

3.0 Basis and Limitations of this Evaluation

The Uranium Material to be processed at the EFRI White Mesa Mill consists solely of the centrifuged solids from the WTP.

Physical and chemical analyses have been performed at different times to characterize the raw water to be treated, to evaluate performance of the WTP, or to characterize the centrifuge solids for off site management.

For development of treatment requirements prior to WTP construction, raw water from the Moffat Tunnel West Portal was analyzed quarterly from 2008 through 2016 for metals and other inorganic parameters.

Centrifuge solids, as well as intermediate streams in the WTP, were analyzed for a limited number of organic and inorganic parameters during the WTP startup period in 2017.

Subsequent to discussions with EFRI in 2018, UPRR collected additional samples which were analyzed for a full suite of parameters by a Utah certified laboratory. UPRR collected a first sample representing short term centrifuge performance and Uranium Material composition by sampling centrifuge cake from one day's operation. Four additional samples were collected over a two week period of operation, and composited, to represent Uranium Material composition over time.

The evaluations are summarized in the table below.

Summary of UPRR Moffat Analyses

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WTP Startup Solids Characterization	April 2017	Total metals, TCLP metals, TCLP organics	Approximately 10 samples from throughout the WTP. (Not every sample was analyzed for every parameter)
Moffat Tunnel West Portal Raw Water Monitoring	2008 through 2016	Major ions, dissolved metals, total metals, cyanide, uranium	119 (not every sample was analyzed for every parameter)

As discussed in Section 2.0, above, the Uranium Material contains greater than 0.05% source material, and is exempt from RCRA, regardless of its process history or chemical composition, and no further RCRA analysis is required. The following evaluation of characterization data is provided to demonstrate that even if the Uranium Material were not categorically exempt from RCRA, it is not and does not contain RCRA listed or characteristic hazardous waste.

The sampling was representative of a continuous process stream under the control of the generator from a process which did not vary appreciably over time.

The various analyses addressed a full range of volatile organic compounds ("VOCs"), semivolatile organic compounds ("SVOCs'), pesticides, arochlors and other compounds that could potentially have reached groundwater, or centrifuge solids, from natural and man-made sources. Analyses provided with the RMPR were performed by laboratories possessing State of Utah and/or NELAC certification for the analyses performed. As a result, these studies provide sufficiently representative characterization to assess the regulatory status, worker safety environmental hazards, and chemical and processing properties of the Uranium Material.

The following RCRA evaluation is based on information from the following sources:

1. Current Moffat Uranium Material analytical data 2018
2. TestAmerica analyses April 2017
3. Raw water influent data provided by UPRR for sampling from 2008 through 2016
4. Material Safety Information Sheet for Insoluble Mineral Fraction provided by UPRR, 2019
5. Correspondence and discussion with UPRR personnel throughout 2018 and 2019.
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7. RMPR for the UPRR Uranium Material (March 2019).
8. Basis of Hazardous Material and Waste Determinations from the RMPR (March 2019)
9. Affidavit of Steven L. Preston UPRR Environmental Field Operations Manager (April 2, 2019).

EFRI has developed a "Protocol for Determining Whether Alternate Feed Materials are Listed Hazardous Wastes" (November 22, 1999) ("the Protocol"). The Protocol has been developed in conjunction with, and accepted by, the State of Utah Department of Environmental Quality ("UDEQ") (Letter of December 7, 1999). Copies of the Protocol and UDEQ letter are provided in Attachment 2 of this Report. The RCRA evaluation and recommendations in this Report were developed in accordance with the Protocol.

4.0 Application of Protocol to Uranium Material

4.1 Source Investigation

Several of the information sources enumerated above were used to perform the Source Investigation indicated in Box 1 of the flow diagram (the "Protocol Diagram") that forms part of the Protocol.

The following sections describe the status of the Uranium Material relative to RCRA Characteristic and RCRA Listed Hazardous Waste regulations, and relative to the specific parameters identified in the EFRI/UDEQ Hazardous Waste Protocol. As the Uranium Material is

a residue from a water treatment facility, were it not exempt from RCRA as source material, it is not permitted to contain constituents that may be considered RCRA characteristic wastes. For completeness, this Report also determines whether or not the Uranium Material contains any such constituents.

4.2 Determination Methods in the EFRI / UDEQ Protocol

4.2.1 Regulatory History of the UPRR Uranium Material

Prior to 2019, UPRR disposed of the centrifuge solids in off-site solid waste disposal facilities licensed for the disposal of NORM material. In 2018 CDPHE required that UPRR apply for a CDPHE radioactive materials license. UPRR received License CO 1274-01 in 2019.

The Uranium Material, which has materially not changed in form or content since first being produced in 2017, remains definitional source material as per 40 CFR Part 261.4, and is explicitly exempt from regulation under RCRA. However, for the sake of completeness, EFRI has required the following evaluation to confirm that even if the Uranium Material were not exempt from RCRA, it is not and does not contain, what would otherwise be considered a RCRA-listed waste, or a RCRA characteristic waste.

The Uranium Material has not been classified or treated as listed hazardous waste nor has it been in contact with any listed hazardous wastes.

4.2.2 Evaluation of Potential RCRA Listings Associated with Specific Contaminants

For potential alternate feed materials that are not exempt from RCRA, the Protocol describes additional steps EFRI will take to assess whether contaminants associated with any potential RCRA waste listings are present, and the likelihood that they resulted from RCRA listed hazardous wastes or RCRA listed processes. These steps include tabulation of all potential listings associated with each known chemical contaminant in the material, and the review of chemical process and material/waste handling history at the site to assess whether the known chemical contaminants in the material resulted from listed or non-listed sources. This evaluation is described in Box 8 and Decision Diamonds 9 through 11 in the Protocol Diagram.

If the results of the evaluation indicate that the contaminants are not listed waste, the Protocol specifies an additional assessment of whether the data on which this determination was made is sufficiently representative, or whether an ongoing acceptance sampling program should be implemented, and a similar evaluation performed on any new constituents identified during acceptance sampling.

In the case of the Uranium Material, Steps 9 through 11 are not required as indicated by the statements provided in the Affidavit of Steven Preston of UPRR. However, for the sake of a thorough due diligence evaluation, Steps 9 through 11 were completed, and the results are presented below.

5.0 RCRA Review of Chemical Constituents

Determination of whether the Uranium Material is, or contained, potential RCRA-listed waste included consideration of source history provided by UPRR, and through communications with

UPRR personnel and contractor personnel from January 2018 to date, as well as the analytical efforts summarized in Section 3.0 above.

5.1 Overview

As discussed below, the components of the Uranium Material result either from naturally-occurring constituents of the influent water to the WTP, from inorganic solids from the tunnel, or from the non-hazardous treatment agents added in the WTP which produced the centrifuge solids/Uranium Material. Like the dissolved constituents of influent water to the WTP, any solids from the Tunnel would consist of materials from natural sources, such as sediments or soils, and are not from RCRA listed waste sources.
The Uranium Material does not contain any "P" or "U" listed wastes as it contains no discarded commercial chemical products, off-specification species, container residues, or spill residues thereof. Any chemicals used in the WTP which generated the Uranium Material were used for their intended purpose and are not waste materials. None of the chemicals used in treatment were associated RCRA hazardous wastes.

There were no processes conducted at the site which fall under the category of "F" listed hazardous wastes from non-specific sources as designated in the following seven categories:

- Spent solvent wastes (F001-F005)
- Wastes from electroplating and other metal finishing operations (F006-F012, F019)
- Dioxin-bearing wastes (F020-F023 and F026-F028)
- Wastes from the production of certain chlorinated aliphatic hydrocarbons (F024, F025)
- Wastes from wood preserving (F032, F034, and F035)
- Petroleum refinery wastewater treatment sludges (F037 and F038)
- Multi-source leachate (F039)

There were no processes conducted at the site which fall under the category of "K" listed hazardous wastes from specific sources designated in the following 13 categories:

- Wood preservation (K001)
- Inorganic pigment manufacturing (K002 –K008)
- Organic chemicals manufacturing (K009-K030, K083, K085, K093-K096, K103-K105, K107-K118, K136, K149-K151, K156-K159, K161, K174-K175, K181)
- Inorganic chemicals manufacturing (K071, K073, K106, K176-178)
- Pesticides manufacturing (K031-K043, K097-K099, K123-K126, K131-K132)
- Explosives manufacturing (K044-K047)
- Petroleum refining (K048-52, K170-K172)
- Iron and steel production (K061-K062)
- Primary aluminum production (K088)
- Secondary lead production (K069, K100)
- Veterinary pharmaceuticals manufacturing (K084, K101-K102)
- Ink formulation (K086)
- Coking (K060, K087, K141-K145, K147-K148)

Evaluation of RCRA listings associated with the inorganic ions and metals analyzed in the Uranium Material is provided in attached Tables 1 and 2 respectively. The single SVOC identified in one of the two samples analyzed, is evaluated in Table 3.

5.2 Volatile Organic Compounds

The Uranium Material consists of solid residuals, centrifuge cake, from treatment of groundwater from tunnel dewatering. No VOCs were used in the treatment unit or are expected in the tunnel. No VOCs would be anticipated, and none were detected, in the Uranium Material.

5.3 Semivolatile Organic Compounds

One SVOC, fluoranthene, was detected in one of the two samples of the centrifuge solids. The RCRA listings associated with fluoranthene, K001, K022 and K035 apply to fluoranthene from wood treating, creosote manufacture, coking, or phenol/acetone production. As mentioned above, none of these processes were conducted on the WTP site. Additionally, wood treating was not conducted in the tunnels and any residuals from pre-treated wood used for railroad ties or structures are not RCRA listed wastes. Fluoranthene is a common multi-ring asphaltic compound present in paving materials, roadbeds, roofing material and other common construction materials and may have been introduced from one of these sources. Alternatively the compound may have been introduced with the naphthenic distillates added before centrifugation.

The single potential RCRA listing associated with the fluoranthene, which is not applicable to the Uranium Material, is documented in attached Table 3.

Semivolatile constituents associated with fuels, lubricants, and soot from the transit of railroad equipment are not RCRA listed wastes. No other semi-volatile constituents were identified.

5.4 Non-Metal Inorganic Compounds

AWAL analytical results in the Uranium Material indicate that low levels of ammonia as nitrogen ("ammonia as N"), chloride, fluoride, and sulfate are present in the Uranium Material. Moffat Tunnel raw water analyses indicate that each of these analytes, except ammonia as N, is present in the raw water influent to the WTP. Nitrate/nitrite nitrogen was analyzed and not detected in the Uranium Material.

Ammonia as N was introduced with the non-hazardous dish detergent used as a thickener in the dissolved air flotation step. Neither the detergent nor the process are associated with any RCRA hazardous waste listings. Evaluation of potential RCRA listings associated with the remaining inorganic analytes, and why they are not applicable to the Uranium Material, is provided in detail in the attached Table 1.

Inorganic nitrate/nitrite and inorganic ammonia nitrogen have also been analyzed in the raw water influent samples, but not detected in the Uranium Material. Inorganic nitrate/nitrite compounds and inorganic ammonia nitrogen are not associated with any RCRA hazardous waste listings, therefore, these analytes have not been included in Table 1.

5.5 Metals

Analytical results indicate that the metals aluminum, arsenic, barium, calcium, cobalt, copper, iron, lead, magnesium, manganese, mercury, molybdenum, nickel, potassium, sodium, vanadium, and zinc were present in the Uranium Material.

No RCRA listings are associated with cobalt, iron, magnesium, or molybdenum. Evaluation of potential RCRA listings associated with the remainder of the analyzed metals, and why they are not applicable to the Uranium Material, is provided in detail in the attached Table 2.

Metal constituents associated with fuels, lubricants, soot, and track erosion from the transit of railroad equipment are not RCRA listed wastes.

5.6 Summary of RCRA Listed Waste Findings

Based on the information presented above, none of the constituents in the Uranium Material would be indicative of RCRA listed hazardous waste, even if the Uranium Material were not already exempt from RCRA as source material. Review of the analytical data, the, process history, and raw water characterization confirms that all of the constituents in the material are consistent with those expected to result from tunnel dewatering or from the WTP as described above.

6.0 RCRA Characteristics

The Uranium Material is a centrifuged dewatered moist solids from inorganic groundwater treatment. As a result it would not be ignitable, corrosive, or reactive per the RCRA definitions of these characteristics. A Uranium Material sample collected during 2017 was analyzed for eight RCRA TCLP metals and 31 RCRA TCLP organic compounds. Two Uranium Material samples collected during 2018 were also analyzed for eight RCRA TCLP metals and 8 RCRA TCLP organic compounds. In all samples collected over both sampling events, no analyzed constituent exceeded its respective TCLP threshold for RCRA toxicity characteristic as defined in Table 1 of 40 CFR Part 261.24(b). Therefore, the test results confirm that the Uranium Material does not have the RCRA characteristic of toxicity. These results are summarized in the attached Table 4.

Two Uranium Material samples collected during 2018 were tested for corrosivity. No samples exhibited a pH of 2.0 or lower, or a pH of 12.5 or higher. These results confirm that the Uranium Material does not have the RCRA characteristic of corrosivity.

The Uranium is not an oxidizer, an ignitable compressed gas, or a solid that can cause a fire and sustain combustion. In addition, two samples of Uranium Material collected during 2018 were tested for flash point. The sample did not exhibit a flash point of <140°F. These results confirm that the Uranium Material does not have the RCRA characteristic of ignitability.

The Affidavit from Steven Preston of UPRR affirms that the Uranium Material has never been classified for shipment or off-site management as a RCRA characteristic waste. This is consistent with the source of the constituents and the WTP that produced the Uranium Material.

As discussed in the introduction to this report, the Uranium Material is exempt from regulation under RCRA; therefore, even if it exhibited characteristics of hazardous waste, it would still be permitted alternate feed material under under NRC's Alternate Feed Guidance (10 CFR 40, Appendix A).

Based on all of the above information, the Uranium Material is not a RCRA characteristic hazardous waste.

7.0 Conclusions and Recommendations

In summary, the following conclusions can be drawn from the RCRA analysis of the analytical data and information presented above:

1. The Uranium Material is not a RCRA listed hazardous waste because it is an ore that has a natural uranium content of greater than 0.05 weight percent, is therefore source material and, as a result, is exempt from regulation under RCRA.

2. Even if the Uranium Material were not source material, it would not be a RCRA listed hazardous waste for the following additional reasons:

   a) It was generated from a known process under the control of the generator, who has provided the Affidavit declaring that the Uranium Material is not and does not contain RCRA listed hazardous waste. This determination is consistent with Boxes I and 2 and Decision Diamonds 1 and 2 in the EFRI/UDEQ Protocol Diagram;

   b) No VOCs are used in the water treatment process that produced the centrifuge solids, and no volatile organic compounds can be expected to be present in the Uranium Material.

   c) No SVOCs are used in the inorganic mineral process that produced the centrifuge solids. One semi-volatile organic compound, fluoranthene, was detected in one sample, and not in the second sample. If present, it did not result from wood treating. Even if it resulted from pre-treated railroad ties, that source is not a RCRA listed source. The compound does not indicate a RCRA listed waste.

   d) None of the metals in the Uranium Material samples came from RCRA listed hazardous waste sources. This determination is consistent with Box 8 and Decision Diamonds 9 through 11 in the EFRI/UDEQ Protocol Diagram.

3. The Uranium Material does not exhibit any of the RCRA characteristics of ignitability, corrosivity, reactivity, or toxicity for any constituent.

8.0 References

- Austin, G.T. *Shreve's Chemical Process Industries, Fifth Edition*. McGraw Hill. New York 1984.

- Title 10 Code of Federal Regulations; Chapter I – *Nuclear Regulatory Commission, Part 40 – Domestic Licensing of Source Material: 40.4 – Definitions* (10 CFR 40.4)

- Title 40 Code of Federal Regulations; Protection of the Environment, Part 261 – *Identification and Listing of Hazardous Waste: Subpart A, 261.4 – Exclusions: Subpart B – Criteria for Identifying the Characteristics of Hazardous Waste and for Listing Hazardous Waste*.

- Sax, N. Irving and Lewis, Richard L. Sr. *Hawley's Condensed Chemical Dictionary, 11th Edition*. Van Nostrand Reinhold. New York 1987.

TABLE 1 (Rev. 0): SUMMARY OF POTENTIAL RCRA LISTINGS IN 40 CFR 261 and APPENDIX VII ASSOCIATED WITH NON-METALS IN URANIUM MATERIAL

INORGANIC CHLORIDES[1]

Commercial Chemicals Acutely Toxic U List	Commercial Chemicals Acutely Hazardous P List	Non-Specific Sources F List	Specific Sources K List	Industrial Uses and Sources of U or P Listed Element or Compound	Is This Listing Applicable to Uranium Material?
U216 Thallium chloride				Chlorination catalyst, sun lamp monitors.	No. There would be no reason for this compound to be present as pure product, byproduct, or off-spec product on the WTP site or in the tunnels.
	P033 Cyanogen chloride			Organic synthesis, tear gas, warning agent in fumigant gases.	No. There would be no reason for this compound to be present as pure product, byproduct, or off-spec product on the WTP site or in the tunnels.
	P095 Carbonic dichloride (phosgene)			Used in organic synthesis for production of urethanes, plastics and pesticides. Formerly used as choking agent in combat gas.	No. There would be no reason for this compound to be present as pure product, byproduct, or off-spec product on the WTP site or in the tunnels.
		NONE			No F Listings
			NONE		No K Listings

FLUORIDE

Commercial Chemicals Acutely Toxic U List	Commercial Chemicals Acutely Hazardous P List	Non-Specific Sources F List	Specific Sources K List	Industrial Uses and Sources of U or P Listed Element or Compound	Is This Listing Applicable to Uranium Material?
U033 Carbonic difluoride, Carbon oxyfluoride, Carbonyl fluoride				Used in organic synthesis for addition of carbon groups to other structures.	No. There would be no reason for this compound to be present as pure product, byproduct, or off-spec product on the WTP site or in the tunnels. Fluoride was present as a constituent of raw groundwater influent to treatment.
U075 Dichlorodifluoro methane				Used as refrigerant in air conditioners, and direct contact freezing. Used in plastics manufacture, and as solvent and blowing agent.	No. There would be no reason for this compound to be present as pure product, byproduct, or off-spec product on the WTP site or in the tunnels. Fluoride was present as a constituent of raw groundwater influent to treatment.
U134 Hydrogen fluoride				Catalyst in refinery alkylation, isomerization, condensation, dehydration, and polymerization processes. Used for organic and inorganic flourination reactions, production of fluorine gas and aluminum fluoride, some uranium leaching processes, and as additive to solid rocket propellant.	No. There would be no reason for this compound to be present as pure product, byproduct, or off-spec product on the WTP site or in the tunnels. Fluoride was present as a constituent of raw groundwater influent to treatment.
	P043 Diisoproplyfluorophosphate			Insecticide	No. There would be no reason for this compound to be present as pure product, byproduct, or off-spec product on the WTP site or in the tunnels. Fluoride was present as a constituent of raw groundwater influent to treatment.
	P056 Fluorine			Production of metallic fluorides and fluorocarbons, fluoridation compounds for toothpaste and water treatment.	No. There would be no reason for this compound to be present as pure product, byproduct, or off-spec product on the WTP site or in the tunnels. Fluoride was present as a constituent of raw groundwater influent to treatment.
	P057 2-fluoroacetamide			Primarily as a rodenticide.	No. There would be no reason for this compound to be present as pure product, byproduct, or off-spec product on the WTP site or in the tunnels. Fluoride was present as a constituent of raw groundwater influent to treatment.

TABLE 1 (Rev. 0): SUMMARY OF POTENTIAL RCRA LISTINGS IN 40 CFR 261 and APPENDIX VII ASSOCIATED WITH NON-METALS IN URANIUM MATERIAL

	P058 Fluoroacetic acid sodium salt			Primarily as a rodenticide.	No. There would be no reason for this compound to be present as pure product, byproduct, or off-spec product on the WTP site or in the tunnels. Fluoride was present as a constituent of raw groundwater influent to treatment.
		NONE			No F Listings
			NONE		No K Listings

SULFATES

Commercial Chemicals Acutely Toxic U List	**Commercial Chemicals Acutely Hazardous P List**	**Non-Specific Sources F List**	**Specific Sources K List**	**Industrial Uses and Sources of U or P Listed Element or Compound**	**Is This Listing Applicable to Uranium Material?**
NONE					No U Listings
	NONE				No P Listings
		NONE			No F Listings
			K131 Dimethyl sulfate in wastewater from the reactor and spent sulfuric acid from the acid dryer from the production of methyl bromide		No. Uranium Material is not from this industry. Sulfates was present in raw groundwater influent to treatment, and in the detergent used as thickener in the floatation unit.

TABLE 2 (Rev. 0): SUMMARY OF POTENTIAL RCRA LISTINGS IN 40 CFR 261 and APPENDIX VII ASSOCIATED WITH METALS IN URANIUM MATERIAL

ALUMINUM

Commercial Chemicals Acutely Toxic U List	Commercial Chemicals Acutely Hazardous P List	Non-Specific Sources F List	Specific Sources K List	Industrial Uses and Sources of U or P Listed Element or Compound	Is This Listing Applicable to Uranium Material?
NONE				---	No U Listings
	P006 Aluminum phosphide			Insecticide, fumigant, semiconductor manufacturing.	No. There would be no reason for this compound to be present as pure product, byproduct, or off-spec product on the WTP site or in the tunnels. Aluminum is present in raw water influent and in pre-filtration coagulant.
		NONE		---	No F Listings
			NONE	---	No K Listings

ARSENIC

Commercial Chemicals Acutely Toxic U List	Commercial Chemicals Acutely Hazardous P List	Non-Specific Sources F List	Specific Sources K List	Industrial Uses and Sources of U or P Listed Element or Compound	Is This Listing Applicable to Uranium Material?
U136 Dimethyl arsenic acid (cacodylic acid)				Used as herbicide for Johnson grass on cotton, in timber thinning, as a soil sterilizing agent, and as a chemical warfare agent.	No. There would be no reason for this compound to be present as pure product, byproduct, or off-spec product on the WTP site or in the tunnels.
	P011 Arsenic trioxide			Used in production of pigments, aniline colors, ceramic enamels, and decolorizing glass, insecticides, herbicides, rodenticides, wood and hide preservatives, and sheep dip.	No. There would be no reason for this compound to be present as pure product, byproduct, or off-spec product on the WTP site or in the tunnels.
	P012 Arsenic Pentoxide			Used in production of arsenates, insecticides, dyeing and printing, weed killers, and colorization of glass. Also used in metal adhesives.	No. There would be no reason for this compound to be present as pure product, byproduct, or off-spec product on the WTP site or in the tunnels.
		F032 Wastewater from wood preserving processes using creosote and pentachlorophenol			No. Uranium Material is not from this industry. Arsenic originated in raw water influent to treatment.
		F034 Wastewater from wood preserving processes using creosote and pentachlorophenol			No. Uranium Material is not from this industry.
		F035 Wastewaters from wood preserving processes using inorganic preservatives			No. Uranium Material is not from this industry. Arsenic originated in raw water influent to treatment.
		F039 Leachates from land disposal of wastes F20 to F22 and F26 to F28		---	No. Uranium Material is not from this industry. Arsenic originated in raw water influent to treatment.

TABLE 2 (Rev. 0): SUMMARY OF POTENTIAL RCRA LISTINGS IN 40 CFR 261 and APPENDIX VII ASSOCIATED WITH METALS IN URANIUM MATERIAL

			K021 Spent catalyst from fluoromethane production	---	No. Uranium Material is not from this industry. Arsenic originated in raw water influent to treatment.
			K031 Byproduct salts from MSMA and cacodylic acid production	---	No. Uranium Material is not from this industry. Arsenic originated in raw water influent to treatment.
			K060 Ammonia still lime sludge from coking	---	No. Uranium Material is not from this industry. Arsenic originated in raw water influent to treatment.
			K084 Wastewater sludge from veterinary pharmaceutical production	---	No. Uranium Material is not from this industry. Arsenic originated in raw water influent to treatment.
			K101 Distillation tar residues from veterinary pharmaceutical production	---	No. Uranium Material is not from this industry. Arsenic originated in raw water influent to treatment.
			K102 Residue from decolorization of veterinary pharmaceuticals	---	No. Uranium Material is not from this industry. Arsenic originated in raw water influent to treatment.
			K161 Purification solids, baghouse dust and floor sweepings from dithiocarbamate acids production	---	No. Uranium Material is not from this industry. Arsenic originated in raw water influent to treatment.
			K171 Spent hydrotreating catalyst from petroleum refining	---	No. Uranium Material is not from this industry. Arsenic originated in raw water influent to treatment.
			K172 Spent hydrorefining catalyst from petroleum refining	---	No. Uranium Material is not from this industry. Arsenic originated in raw water influent to treatment.
			K176 Baghouse filters from the production of antimony oxide, and intermediate metals.		No. Uranium Material is not from this industry. Arsenic originated in raw water influent to treatment.
			K177 Slag from production or speculative accumulation of antimony or antimony oxides	---	No. Uranium Material is not from this industry. Arsenic originated in raw water influent to treatment.

TABLE 2 (Rev. 0): SUMMARY OF POTENTIAL RCRA LISTINGS IN 40 CFR 261 and APPENDIX VII ASSOCIATED WITH METALS IN URANIUM MATERIAL

BARIUM

Commercial Chemicals Acutely Toxic U List	Commercial Chemicals Acutely Hazardous P List	Non-Specific Sources F List	Specific Sources K List	Industrial Uses and Sources of U or P Listed Element or Compound	Is This Listing Applicable to Uranium Material?
NONE				---	No U Listings
	P013 Barium Cyanide			Used in metallurgy and electroplating.	No. There would be no reason for this compound to be present as pure product, byproduct, or off-spec product on the WTP site or in the tunnels. Barium originated in raw water influent to treatment.
		NONE		---	No F Listings
			NONE	---	No K Listings

CALCIUM

Commercial Chemicals Acutely Toxic U List	Commercial Chemicals Acutely Hazardous P List	Non-Specific Sources F List	Specific Sources K List	Industrial Uses and Sources of U or P Listed Element or Compound	Is This Listing Applicable to Uranium Material?
U032 Calcium chromate				Used as a pigment, corrosion inhibitor, oxidizing agent, battery depolarizer, coatin g for light metal alloys.	No. There would be no reason for this compound to be present as pure product, byproduct, or off-spec product on the WTP site or in the tunnels. Calcium originated in raw water influent to treatment.
	P021 Calcium cyanide			Rodenticide, fumigant for greenhouses, flour mills, grain, seed, and citrus trees, gold leaching, and synthesis of other cyanides.	No. There would be no reason for this compound to be present as pure product, byproduct, or off-spec product on the WTP site or in the tunnels.
		NONE		---	No F Listings.
			NONE	---	No K Listings.

COPPER

Commercial Chemicals Acutely Toxic U List	Commercial Chemicals Acutely Hazardous P List	Non-Specific Sources F List	Specific Sources K List	Industrial Uses and Sources of U or P Listed Element or Compound	Is This Listing Applicable to Uranium Material?
NONE				---	No U Listings
	P029 Cuprous or Cupric Cyanide			Used in metallurgy and electroplating, insecticides, anti-foulants in paints, catalysts in organic synthesis..	No. There would be no reason for this compound to be present as pure product, byproduct, or off-spec product on the WTP site or in the tunnels. Copper originated in raw water influent to treatment.
		NONE		---	No F Listings
			NONE	---	No K Listings

TABLE 2 (Rev. 0): SUMMARY OF POTENTIAL RCRA LISTINGS IN 40 CFR 261 and APPENDIX VII ASSOCIATED WITH METALS IN URANIUM MATERIAL

LEAD

Commercial Chemicals Acutely Toxic U List	Commercial Chemicals Acutely Hazardous P List	Non-Specific Sources F List	Specific Sources K List	Industrial Uses and Sources of U or P Listed Element or Compound	Is This Listing Applicable to Uranium Material?
U 144 lead acetate				Textile dyeing, chrome pigments, gold cyanide leaching, lab reagent, hair dye. May be present as antifoulant in paints, waterproofing, varnishes.	No. There would be no reason for this compound to be present as pure product, byproduct, or off-spec product on the WTP site or in the tunnels. .
U 145 lead phosphate				Stabilizing agent added to plastic resins.	No. There would be no reason for this compound to be present as pure product, byproduct, or off-spec product on the WTP site or in the tunnels.
U146 lead subacetate				Decolorizing agent added to sugar solutions in food products.	No. There would be no reason for this compound to be present as pure product, byproduct, or off-spec product on the WTP site or in the tunnels.
	P110 Tetraethyl lead			Synthesized solely as a gasoline anti-knock additive.	No. There would be no reason for this compound to be present as pure product, byproduct, or off-spec product on the WTP site or in the tunnels.
		F035 Wood treating wastewater		---	No. Uranium Material is not from this industry. Lead originated in raw water influent to treatment.
		F037 Refinery oil/water separator solids		---	No. Uranium Material is not from this industry. Lead originated in raw water influent to treatment.
		F038 Refinery secondary oil/water separator solids		---	No. Uranium Material is not from this industry Lead originated in raw water influent to treatment.
		F039 Leachates from land disposal of wastes F20 to F22 and F26 to F28		---	No. Uranium Material is not from this industry. Lead originated in raw water influent to treatment.
			K002 Wastewater treatment sludge from production of chrome yellow pigment	---	No. Uranium Material is not from this industry. Lead originated in raw water influent to treatment.
			K003 Wastewater treatment sludge from production of chrome molybdate orange pigment	---	No. Uranium Material is not from this industry. Lead originated in raw water influent to treatment.
			K005 Wastewater treatment sludge from production of chrome green pigment	---	No. Uranium Material is not from this industry. Lead originated in raw water influent to treatment.
			K046 Wastewater treatment sludge from production of lead based explosive initiators	---	No. Uranium Material is not from this industry. Lead originated in raw water influent to treatment.
			K048 Petroleum refining dissolved air flotation ("DAF") solids	---	No. Uranium Material is not from this industry. Lead originated in raw water influent to treatment.

TABLE 2 (Rev. 0): SUMMARY OF POTENTIAL RCRA LISTINGS IN 40 CFR 261 and APPENDIX VII ASSOCIATED WITH METALS IN URANIUM MATERIAL

			K049 Petroleum refining slop oil emulsion solids	---	No. Uranium Material is not from this industry. Lead originated in raw water influent to treatment.
			K051 Petroleum refining API separator solids	---	No. Uranium Material is not from this industry. Lead originated in raw water influent to treatment.
			K052 Petroleum refining leaded tank bottoms	---	No. Uranium Material is not from this industry. Lead originated in raw water influent to treatment.
			K061 Steel electric furnace emission control dust/sludge	---	No. Uranium Material is not from this industry. Lead originated in raw water influent to treatment.
			K062 Iron and steel manufacturing pickle liquor	---	No. Uranium Material is not from this industry. Lead originated in raw water influent to treatment.
			K064 Acid plant blowdown thickener slurry/sludge from primary copper production blowdown	---	No. Uranium Material is not from this industry. Lead originated in raw water influent to treatment.
			K069 Emission control dust/sludge from secondary lead smelting	---	No. Uranium Material is not from this industry. Lead originated in raw water influent to treatment.
			K086 Solvent, caustic and water wash sludges from ink formulation	---	No. Uranium Material is not from this industry. Lead originated in raw water influent to treatment.
			K100 Waste solution from acid leaching of emission control dust/sludge from secondary lead smelting	---	No. Uranium Material is not from this industry. Lead originated in raw water influent to treatment. waste sources.
			K176 Baghouse filters from the production of antimony oxide, and intermediate metals.		No. Uranium Material is not from this industry. Lead originated in raw water influent to treatment.

MANGANESE

Commercial Chemicals Acutely Toxic U List	**Commercial Chemicals Acutely Hazardous P List**	**Non-Specific Sources F List**	**Specific Sources K List**	**Industrial Uses and Sources of U or P Listed Element or Compound**	**Is This Listing Applicable to Uranium Material?**
NONE				---	No U Listings
	P196 Manganese dimethyldithio carbamate			Primarily as a pesticide.	No. There would be no reason for this compound to be present as pure product, byproduct, or off-spec product on the WTP site or in the tunnels. Manganese originated with raw water influent to treatment.
		NONE		---	No F Listings
			NONE	---	No K Listings

TABLE 2 (Rev. 0): SUMMARY OF POTENTIAL RCRA LISTINGS IN 40 CFR 261 and APPENDIX VII ASSOCIATED WITH METALS IN URANIUM MATERIAL

MERCURY

Commercial Chemicals Acutely Toxic U List	Commercial Chemicals Acutely Hazardous P List	Non-Specific Sources F List	Specific Sources K List	Industrial Uses and Sources of U or P Listed Element or Compound	Is This Listing Applicable to Uranium Material?
U151 Mercury metal Hg				Dental amalgams, organic and inorganic reaction catalyst, cathodes for chlorine/ caustic production cells, mirror coating, vapor and arc lamps, nuclear power reactors, boiler fluids. Also present in instruments and used in extractive metallurgy.	No. There would be no reason for this compound to be present as pure product, byproduct, or off-spec product on the WTP site or in the tunnels.
	P065 Mercury Fulminate			Due to relatively high detonation velocity, used primarily as an explosive initiator in military explosives. Too unstable for most other uses.	No. There would be no reason for this compound to be present as pure product, byproduct, or off-spec product on the WTP site or in the tunnels.
	P092 Acetato-O-phenyl mercury or phenyl mercuric acetate			Used as a fungicide, anti-mildew agent, and as a topical spermicide	No. There would be no reason for this compound to be present as pure product, byproduct, or off-spec product on the WTP site or in the tunnels.
		NONE		---	No F Listings
			K071 Brine purification muds from mercury cell chlorine production	---	No. Uranium Material is not from this industry. Mercury originated with raw water influent to treatment.
			K106 Wastewater treatment sludge from mercury cell chlorine production	---	No. Uranium Material is not from this industry. Mercury originated with raw water influent to treatment.

NICKEL

Commercial Chemicals Acutely Toxic U List	Commercial Chemicals Acutely Hazardous P List	Non-Specific Sources F List	Specific Sources K List	Industrial Uses and Sources of U or P Listed Element or Compound	Is This Listing Applicable to SFC Sludge?
NONE				---	No U Listings
	P073 Nickel carbonyl			Electroplated nickel coatings, reagent chemical	No. There would be no reason for this compound to be present as pure product, byproduct, or off-spec product on the WTP site or in the tunnels.
	P074 Nickel Cyanide			Metallurgy, electroplating	No. There would be no reason for this compound to be present as pure product, byproduct, or off-spec product on the WTP site or in the tunnels.
		F006 Wastewater treatment sludge from electroplating		---	No. Uranium Material is not wastewater treatment sludge from electroplating.
			NONE	---	No K Listings

TABLE 2 (Rev. 0): SUMMARY OF POTENTIAL RCRA LISTINGS IN 40 CFR 261 and APPENDIX VII ASSOCIATED WITH METALS IN URANIUM MATERIAL

POTASSIUM

Commercial Chemicals Acutely Toxic U List	Commercial Chemicals Acutely Hazardous P List	Non-Specific Sources F List	Specific Sources K List	Industrial Uses and Sources of U or P Listed Element or Compound	Is This Listing Applicable to Uranium Material?
NONE				---	No U Listings
	P098 Potassium cyanide			Extraction of gold and silver from ores, reagent in analytical chemistry, insecticide, fumigant, electroplating.	No. There would be no reason for this compound to be present as pure product, byproduct, or off-spec product on the WTP site or in the tunnels.
	P099 Potassium silver cyanide			Silver plating, bactericide, antiseptic.	No. There would be no reason for this compound to be present as pure product, byproduct, or off-spec product on the WTP site or in the tunnels.
		NONE			No F Listings
			K161 Metam-sodium Purification solids, baghouse dust and sweepings form dithiocarbamate production.	Dithiocarbamate production	No. Uranium Material is not from this industry. Potassium originated with raw water influent to treatment.

SODIUM

Commercial Chemicals Acutely Toxic U List	Commercial Chemicals Acutely Hazardous P List	Non-Specific Sources F List	Specific Sources K List	Industrial Uses and Sources of U or P Listed Element or Compound	Is This Listing Applicable to Uranium Material?
U236 3,3'-[(3,3'-dimethyl[1,1'-biphenyl]-4,4'-diyl)bis(azo)bis[5-amino-4-hydroxy]-, tetrasodium salt				---	No. There would be no reason for this compound to be present as pure product, byproduct, or off-spec product on the WTP site or in the tunnels.
	P058 Fluoroacetic acid sodium salt			Rodenticide	No. There would be no reason for this compound to be present as pure product, byproduct, or off-spec product on the WTP site or in the tunnels.
	P105 Sodium azide			Air bag inflator, intermediate in explosive manufacture, preservative in diagnostic medicines.	No. There would be no reason for this compound to be present as pure product, byproduct, or off-spec product on the WTP site or in the tunnels.
	P106 Sodium Cyanide			Manufacture of dyes, pigments, nylon, chelating compounds, insecticides, fumigants. Extraction of gold and silver from ores, electroplating, metal cleaning, heat treatment, ore flotation.	No. There would be no reason for this compound to be present as pure product, byproduct, or off-spec product on the WTP site or in the tunnels.

TABLE 2 (Rev. 0): SUMMARY OF POTENTIAL RCRA LISTINGS IN 40 CFR 261 and APPENDIX VII ASSOCIATED WITH METALS IN URANIUM MATERIAL

		NONE			No F Listings
			K161 Metam-sodium Purification solids, baghouse dust and sweepings form dithiocarbamate production.	Dithiocarbamate production	No. Uranium Material is not from this industry. Sodium originated with raw water influent to treatment.

VANADIUM

Commercial Chemicals Acutely Toxic U List	**Commercial Chemicals Acutely Hazardous P List**	**Non-Specific Sources F List**	**Specific Sources K List**	**Industrial Uses and Sources of U or P Listed Element or Compound**	**Is This Listing Applicable to Uranium Material?**
NONE				---	No U Listings
	P119 Ammonium vanadate			Intermediate in production of vanadium oxide. Used in DeNOx catalysts for emissions controls, and to produce ceramic colorants.	No. There would be no reason for this compound to be present as pure product, byproduct, or off-spec product on the WTP site or in the tunnels. Vanadium originated with raw water influent to treatment.
	P120 Vanadium pentoxide			Used in steel ceramics industries. Used in inorganic and organic synthesis in dye, paint, varnish, glass, pesticides, and ink manufacture.	No. There would be no reason for this compound to be present as pure product, byproduct, or off-spec product on the WTP site or in the tunnels.
		NONE			No F Listings
			NONE		No K Listings

ZINC

Commercial Chemicals Acutely Toxic U List	**Commercial Chemicals Acutely Hazardous P List**	**Non-Specific Sources F List**	**Specific Sources K List**	**Industrial Uses and Sources of U or P Listed Element or Compound**	**Is This Listing Applicable to Uranium Material?**
U249 Zinc phosphide (10 wt. % or less)				Rodenticide	No. There would be no reason for this compound to be present as pure product, byproduct, or off-spec product on the WTP site or in the tunnels.
	P121 Zinc cyanide			Metal plating, chemical reagent, insecticide.	No. There would be no reason for this compound to be present as pure product, byproduct, or off-spec product on the WTP site or in the tunnels.
	P122 Zinc phosphide (greater than10 wt. %)			Rodenticide	No. There would be no reason for this compound to be present as pure product, byproduct, or off-spec product on the WTP site or in the tunnels. .
	P205 Zinc dimethyl dithiocarbamate, Ziram			Fungicide, accelerator in rubber synthesis.	No. There would be no reason for this compound to be present as pure product, byproduct, or off-spec product on the WTP site or in the tunnels.
		NONE		---	No F Listings
			K161 Ziram pesticides	Rodenticide	No. Uranium material is not from this industry. Zinc originated with raw water influent to treatment.

TABLE 2 (Rev. 0): SUMMARY OF POTENTIAL RCRA LISTINGS IN 40 CFR 261 and APPENDIX VII ASSOCIATED WITH METALS IN URANIUM MATERIAL

TABLE 3: SUMMARY OF POTENTIAL RCRA LISTINGS IN 40 CFR 261 AND APPENDIX VII ASSOCIATED WITH ORGANICS IN URANIUM MATERIAL

FLUORANTHENE

Commercial Chemicals Acutely Toxic U List	Commercial Chemicals Acutely Hazardous P List	Non-Specific Sources F List	Specific Sources K List	Industrial Uses and Sources of U or P Listed Element or Compound	Is This Listing Applicable to Uranium Material
U120				Present in coal, coal tar, coal slag, road asphalt, and roofing tar.	No. Not used or stored as a reagent or product. Likely present from road material runoff, which is not a RCRA-listed source.
	None			Present in coal, coal tar, coal slag, road asphalt, and roofing tar.	No P Listings. Likely present from road material runoff, which is not a RCRA-listed source.
		F034		Present in coal, coal tar, coal slag, road asphalt, and roofing tar.	No. No creosote or wood treating operations. Compounds from pre-treated railroad ties are not a RCRA-listed source. Likely present from road material runoff, which is not a RCRA listed source.
			K001, K022, K035 Wood treating wastes; wastes from distillation of phenol/acetone from cumene; sludges from production of creosote	Present in coal, coal tar, coal slag, road asphalt, and roofing tar.	No. No wood treating, creosote, coking or phenol/acetone operations. Compounds from pre-treated railroad ties are not a RCRA-listed source. Likely present from road material runoff, which is not a RCRA-listed source.

Table 4
Maximum TCLP Versus RCRA TCLP Characteristic Limits

RCRA Toxicity Characteristic Metals and Organics	TCLP Maximum Analytical Result in Uranium Material 2017	TCLP Maximum Analytical Result in Uranium Material 2018	TCLP Threshold Limit (mg/L)
Arsenic (As)	<0.5	<0.0100	5.0
Barium (Ba)	1.4	1.5	100.0
Cadmium (Cd)	0.0040 J	<0.0350	1.0
Chromium (Cr)	0.0091 J	<0.0200	5.0
Lead (Pb)	0.056 J B	<0.0500	5.0
Mercury (Hg)	<0.0020	<0.0100	0.2
Selenium (Se)	<0.10	<0.0100	1.0
Silver (Ag)	0.0082 J	<0.0100	5.0
Chlordane	<0.0050	<0.0001	0.03
Endrin	<0.0005	<0.0001	0.02
gamma-BHC (Lindane)	<0.00050	<0.0001	0.4
Heptachlor	<0.00050	<0.0001	0.0
Methoxychlor	<0.0010	<0.0001	10.0
Toxaphene	<0.020	<0.00125	0.5
2,4,5-TP	<0.010	<0.0010	1.0
2,4-D	<0.040	<0.0010	10.0
Benzene	<0.010	NA	0.5
2 Butanone	<0.10	NA	200.0
Carbon tetrachloride	<0.010	NA	0.5
Chlorobenzene	<0.010	NA	100.0
Chloroform	<0.010	NA	6.0
1,4-Dichlorobenzene	<0.010	NA	7.5
1,2-Dichlorobenze	<0.010	NA	0.5
1,2-Dichloroethene	<0.010	NA	0.5
1,1-Dichloroethylene	<0.010	NA	0.7
Tetrachloroethene	<0.010	NA	0.5
Trichlroethene	<0.010	NA	0.5
Vinyl Chloride	<0.010	NA	0.2
2,4-Dintirotoluene	<0.050	NA	0.13
Hexachlorobenzene	<0.050	NA	0.13
Hexachlorobutadiene	<0.050	NA	0.5
Hexachloroethane	<0.050	NA	3.0
m+p Cresol	<0.050	NA	400.0
Nitrobenzene	<0.050	NA	2.0
o-Cresol	<0.050	NA	200.0
Pentachlorohenol	<0.25	NA	100.0
Pyridene	<0.10	NA	5.0
2,4,5-Trichlorophenol	<0.050	NA	400.0
2,4,6-Trichlorophenol	<0.025	NA	2.0

NOTES:

1. TCLP threshold limit values are established in 40 CFR 261.24 Table 1.
2. TCLP Analytical results are maximum from 2017 TestAmerica and 2018 AWAL laboratory data.
3. All TCLPs results, except barium, were below detection limits in all samples.
4. B indicated analyte was ientified in the blank sample; J indicates it is tentatively identified.

ATTACHMENT 5
Review of Chemical Constituents in Moffat Tunnel Uranium Material to Determine Worker Safety and Environmental Issues and Chemical Compatibility at the EFRI White Mesa Mill

TECHNICAL MEMORANDUM

To:	David C. Frydenlund, Kathy Weinel	**From:**	Jo Ann Tischler
Company:	Energy Fuels Resources (USA) Inc.	**Date:**	December 23, 2019
Re:	Review of Chemical Contaminants in Union Pacific Railroad Uranium Material to Determine Worker Safety and Environmental Issues and Chemical Compatibility at the White Mesa Mill		

1.0 Introduction

This report summarizes the characterization of the Union Pacific Railroad ("UPRR") Moffat Tunnel Uranium Material (the "Uranium Material"), also referred to as the "centrifuge cake" or "centrifuge solids", to determine whether processing the Uranium Material at the Energy Fuels Resources (USA), Inc. ("EFRI") White Mesa Mill (the "Mill") may pose any worker safety or environmental hazards, or may be incompatible with the Mill's existing tailings management system. The results will provide information to EFRI to determine the requirements, if any, for changes to worker safety practices, or potential incompatibilities to the Mill for the processing of Uranium Material as an alternate feed material. This report will also provide comparison of constituents of the Uranium Material and the EFRI groundwater ("GW") monitoring program to identify any constituents which are not covered under the EFRI GW monitoring program and whether these additional parameters need to be added to the sampling requirements.

The following questions were considered for the evaluation of potential safety and environmental hazards and compatibility with the Mill's tailings management system and GW monitoring requirements:

1) Will any constituents of the Uranium Material volatilize at the known conditions on the Mill site or in the Mill circuits? If so, will they create any potential environmental, worker health, or safety impacts?
2) Will the Uranium Material or any of its constituents create a dust or off-gas hazard at the known conditions on the Mill site or in the Mill circuit? If so, will they create any potential environmental, worker health, or safety impacts?
3) Will any constituents of the Uranium Material react with other materials in the Mill circuits?
4) Will any constituents of the Uranium Material create any impacts on the tailings management system?
5) Does the Uranium Material contain any constituents that are not present in the current Mill GW monitoring program and not sufficiently represented by the Mill's groundwater monitoring analyte list and need to be added to the analyte list?
6) What, if any, limitations on feed acceptance criteria or added operational controls are recommended in connection with processing the Uranium Material at the Mill?

An evaluation of the regulatory status of the Uranium Material relative to the Resource Conservation and Recovery Act ("RCRA") regulations is provided in a separate technical memorandum.

2.0 Basis and Limitations of This Evaluation

The following contamination evaluation is based on:

The evaluation in this memorandum is based on information from the following sources:

1. Current Moffat Uranium Material analytical data 2018.
2. TestAmerica analyses April 2017.
3. Raw water influent data provided by UPRR for sampling from 2008 through 2016.
4. Material Safety Information Sheet for Insoluble Mineral Fraction provided by UPRR, 2019.
5. Correspondence and discussion with UPRR personnel throughout 2018 and 2019.
6. EFRI Protocol for Determining Whether Alternate Feed Materials Are Listed Hazardous Wastes (EFRI, November 1999).
7. RMPR for the UPRR Uranium Material (March 2019).
8. Basis of Hazardous Material and Waste Determinations from the RMPR (March 2019).
9. Affidavit of Steven L. Preston UPRR Environmental Field Operations Manager (April 2, 2019).

3.0 Site History and Background

The Uranium Material was generated by treatment of groundwater from dewatering of the Moffat railroad tunnel ("Moffat Tunnel"). The groundwater contains naturally occurring radioactive material ("NORM") from contact with native rock, and picks up inorganic solids particles as it passes through the tunnel. As a result, the groundwater requires treatment to meet Colorado Department of Public Health and Environment ("CDPHE") discharge standards prior to release to the Fraser River.

Groundwater is pumped from the Moffat Tunnel at approximately 200 gallons per minute ("gpm") for dewatering. Prior to discharge of the pumped water to surface receiving waters, it is pre-treated by an ultrafiltration and centrifugation system to meet CDPHE standards for radionuclides and inorganic constituents.

The Uranium Material was generated from a continuous process, as described below, driven by the requirement to achieve discharge permit limits in the water released from the water treatment plant ("WTP") to the Fraser River. No other water sources or wastes are treated in the WTP.

The Uranium Material is comprised only of the centrifuged solids. No other materials or wastes are added to the Uranium Material. The Uranium Material contains approximately 75-90% moisture content and 0.13-0.14% natural uranium on a wet basis or up to 0.49% natural uranium on a dry basis.

A chronology of the site history is listed below.

2008 to 2016	Moffat Tunnel water characterization sampling
2017	Treatment plant constructed
2017	Beginning of dewatering and treatment

2017 through 2018	Centrifuge solids (Uranium Material) was collected in shipping containers and disposed at off site waste management locations
2018	UPRR submits application for CDPHE radiological materials license for Uranium Material
2019	Centrifuge solids are drummed for eventual transfer to EFRI
2019	UPRR receives CDPHE license for Uranium Material

The Uranium Material results specifically from the centrifugation of precipitates from inorganic treatment of pumped groundwater, as discussed below.

3.1 Description of Process which Generated the Uranium Material

Upon entering the treatment plant, the groundwater from tunnel dewatering is treated first by the addition of a coagulant, Calchem CC2000 aluminum chlorohydrate, followed by direct filtration in an ultrafiltration membrane system. Backwash water from the ultrafiltration membrane system containing coagulated solids is pumped through a dissolved air flotation system where a very small amount of 7th generation dish soap (<0.001% by volume) is added to assist in thickening of the solids via flotation. The thickened solids are further dewatered using a centrifuge. A small amount of Zetag 120L polymer, <0.001% by volume, is added to the thickened solids before the solids enter the centrifuge.

During major construction, e.g. rail extension or tunnel expansion, an additional settling step is added upstream of the treatment plant. Settling tanks are used in this situation to settle construction related particulate matter. No other treatment chemicals are added.

Per the process description provided by UPRR for production of the centrifuge cake, the chemical reagents used in the above processes included:

- Calchem CC2000 Aluminum chlorohydrate used as coagulant
- Seventh Generation dish soap used as a thickener for flotation
- Zetag 120L hydrocarbon polymer to enhance centrifugation

The presence of residuals or reaction byproducts from these compounds would be expected in the Uranium Material, as discussed in the sections below.

Schematic flow sheets depicting the process which produced the Uranium Material during normal operations and construction periods, are provided in Figures 1 and 2.

4.0 Assumptions Regarding White Mesa Mill Processing of the Uranium Material

This evaluation was based on the following process assumptions:

1. The Mill will process the Uranium Material in either the main circuit or alternate feed circuit alone or in combination with natural ores or other alternate feed materials.
2. The Uranium Material will be delivered to the Mill by truck in 200 liter (55 gallon) drums. The drums will be shipped in closed cargo containers, such as Container Express (Conex), Sea Box, Intermodal Containers (IMCs) or the equivalent.

3. The drums will be unloaded from the trucks onto the ore pad for temporary storage until the material is scheduled for processing. Drums may be stored until sufficient material is received on site for processing.
4. The Uranium Material will be added to the circuit in a manner similar to that used for the normal processing of conventional ores and other alternate feed materials.
5. The material is a dewatered moist material with high water content. It is not expected to generate dust during unloading or during feed to the Mill.
6. The Mill does not anticipate any significant modifications to the leaching circuit or recovery process areas for the processing of the Uranium Material.
7. Cell 3 and Cell 4A are currently the active tailings cells at the Mill, and either could receive tailings from the Uranium Material. However, because filling of Cell 3 is nearing completion, tailings from the Uranium Material will more likely be placed in Cell 4A. The evaluations in this attachment are therefore based on placement of tailings in Cell 4A. For purposes of comparison, calculations of concentration changes in the tailings management system have been prepared both for Cell 3 and Cell 4A.

5.0 Chemical Composition of the Uranium Material and Potential Effects in the Mill Process

5.1 Composition

The Uranium Material to be processed at the EFRI White Mesa Mill consists solely of the centrifuged solids from the water treatment plant.

Physical and chemical analyses have been performed at different times to characterize the raw water to be treated, to evaluate performance of the WTP, or to characterize the centrifuge solids for off site management.

For development of treatment requirements prior to WTP construction, raw water from the Moffat Tunnel West Portal was analyzed quarterly from 2008 through 2016 for metals and other inorganic parameters.

Centrifuge solids, as well as intermediate streams in the WTP, were analyzed for a limited number of organic and inorganic parameters during the WTP startup period in 2017.

Subsequent to discussions with EFRI in 2018, UPRR collected additional samples which were analyzed for a full suite of parameters by a Utah certified laboratory. UPRR collected a first sample representing short term centrifuge performance and Uranium Material composition by sampling centrifuge cake from one day's operation. Four additional samples were collected over a two week period of operation, and composited, to represent Uranium Material composition over time.

The evaluations are summarized in the table below.

Table 1
Summary of UPRR Moffat Analyses

Sample Name/Laboratory	Sampling/Analysis Date(s)	Analyses	Number of Composite Samples
American West Analytical Laboratories Centrifuge Cake Characterization	June 2018	VOCs, SVOCs, pesticides, herbicides, TCLP (metals and organics), major ions, total metals, ammonia and nitrate N, radionuclides	1 random sample accumulated over one day's run, and 1 composite of 4 additional samples over two weeks run.
WTP Startup Solids Characterization	April 2017	Total metals, TCLP metals, TCLP organics	Approximately 10 samples from throughout the WTP. (Not every sample was analyzed for every parameter)
Moffat Tunnel West Portal Raw Water Monitoring	2008 through 2016	Major ions, dissolved metals, total metals, cyanide, uranium	119 (not every sample was analyzed for every parameter)

The sampling was representative of a continuous process stream under the control of the generator from a process which did not vary appreciably over time.

The various analyses addressed a full range of volatile organic compounds ("VOCs"), semivolatile organic compounds ("SVOCs"), pesticides, arochlors and other compounds that could potentially have reached groundwater, or centrifuge solids, from natural and man-made sources. Analyses provided with the RMPR were performed by laboratories possessing State of Utah and/or NELAC certification for the analyses performed. As a result, these studies provide sufficiently representative characterization to assess the regulatory status, worker safety environmental hazards, and chemical and processing properties of the Uranium Material.

The Uranium Material is a dewatered product of insoluble minerals precipitated from physical and inorganic treatment of native groundwater. The material exhibits a relatively neutral to slightly alkaline pH of 8.0.

The drums, containing the centrifuge cake, will be opened and fed to the Mill process in an appropriate manner to minimize dust, both for the purposes of worker safety and environmental protection. As mentioned above, the moist centrifuge cake is not expected to produce dust during unloading or introduction in the Mill process.

The solid portion of the Uranium Material consists primarily of the inert silica based sediments precipitated from the dewatering water, along with percent levels of natural materials from the host rock such as iron, calcium and potassium, and aluminum residual from the inorganic water treatment steps in the WTP that removed the radionuclides and other inorganic analytes prior to water discharge.

The majority of the minerals will be converted to sulfate forms in the leach system. The soluble sulfate forms are stable and non-reactive and will be removed from the circuit in post-leach steps and discharged to the Mill's tailings management system.

All the non-uranium components of the material will eventually be discharged to the tailings management system. Components that are removed as tailings solids will be discharged to Cell 4A or Cell 3, as discussed above. Process solutions will be discharged to whichever of the basins are being used for evaporation of Mill solutions at the time of processing.

All the known Uranium Material components in their anticipated mineral states are compatible with, or will be converted by reaction with either aqueous sulfuric acid or carbonate, either of which may be used for leaching the Uranium Material, and with any other chemicals and materials to which they may be exposed in the Mill following the leach circuit. It should be noted that, other than the uranium compounds, and moderate levels of mineral cations from the host rock, all other constituents are present at very low levels in the Uranium Material.

Individual components in the Uranium Material have been grouped into classes of constituents, and discussed below.

5.2 Organic Constituents

5.2.1 Volatile Organic Compounds

The Uranium Material was produced from mechanical and inorganic treatment of native groundwater. No VOCs were expected to be present in the groundwater, and none were introduced in the WTP. No VOCs were identified in the Uranium Material.

5.2.2 SemiVolatile Organic Compounds

No SVOCs were expected to be present in the groundwater, and none were introduced in the WTP. One SVOC, fluoranthene, was identified in one of the two samples of the Uranium Material at 0.289 mg/kg (0.000029 %) and was not detected in the other sample. The compound may have been introduced with the naphthenic distillates added before centrifugation. Alternatively, it may have resulted from pre-treated railroad ties. In any case, the compound is non-reactive and, if actually present, is at far too low a concentration to have any effect in the Mill process. The Mill has processed hundreds of thousands of tons of alternate feed materials, such as the Ashland alternate feed materials, containing fluoranthene with no adverse effects to the Mill or the tailings management system.

5.3 Inorganic Constituents

Analyses of inorganic constituents is provided in the analytical reports included with the RMPR and summarized in Attachments D.1 of the RMPR.

5.3.1 Non-Metal Inorganic Compounds

As discussed above, the Uranium Material resulted from inorganic treatment of native water. The primary non-native analytes in the Uranium Material result from the moderate levels of treatment additives added to the WTP. Low levels of treatment materials were added to the WTP. Nitrogen is expected to be present at trace to low levels from the treatment additives in the WTP.

Ammonia as N

Ammonia nitrogen is present at low levels in the methylisothioazolinone preservative in the Seventh Generation dish soap used as a thickener for the dissolved air flotation ("DAF") step in the WTP.

Ammonia nitrogen was present in the Uranium Material at a maximum of 294 mg/kg (0.029%). The level of ammonia nitrogen is too low to have any measurable effect on the Mill process. The Mill was designed and licensed to handle 100% anhydrous ammonia for use in downstream processes following leaching. The trace ammonia nitrogen in the Uranium Material inconsequential in comparison.

Fluorides

Fluoride was present at trace levels in the groundwater influent to the WTP, and was identified in the centrifuge solids/Uranium Material at less than 5 mg/kg.

Fluorides have been introduced into the Mill's circuit with natural ores and alternate feed materials at levels as high as 460,000 mg/kg. The Mill has handled fluoride compounds in the Mill circuit and tailings management system with no adverse process, environmental, or safety issues.

Chlorides

Chloride was present in the influent water to the WTP and is a component of the CalChem aluminum chlorohydrate coagulant and a low level constituent of the Seventh Generation dish soap used as a thickener. Chloride has been introduced into the Mill with other alternate feed materials, at concentrations ranging up to 89,900 mg/kg. The Mill has handled chloride compounds in the Mill circuit and tailings management system with no adverse process, environmental, or safety issues.

In conclusion, all of the anions in the Uranium Material have been introduced into the Mill at levels greater than those identified in the analytical data and assay data. A summary of the anion content of previous alternate feed materials, and the source of the feed information, has been tabulated in the attached Table 5.

5.3.2 Metals

As mentioned above, data from analyses in 2018 was used to characterize the inorganic constituents in the Uranium Material. These constituents can be categorized based on their elemental characteristics and chemical properties as indicated in Table 2.

Table 2: Classes of Metals in UPRR Uranium Material

Class	Component of the Uranium Material
Alkali Metals	Sodium, Potassium
Alkaline Earths	Barium, Calcium, Magnesium
Transition Metals	Chromium, Cobalt, Copper, Iron, Manganese, Mercury, Molybdenum, Nickel, Vanadium, Zinc
Other Metals	Aluminum, Lead

Metalloids	Arsenic

None of the incompatibilities described below or in Table 3 are applicable to the components as they will be present in the Uranium Material. None of the components will be present in pure or concentrated reduced metal form or as pure or concentrated metal oxides. None of the fluoridated, sulfite, or cyanide, compound or hydroxylated (caustic) forms in Table 3 of the alkali metals or alkaline earths are expected to be present. None of the components will be exposed to any of the incompatible agents identified in the table.

Alkali Metals

The alkali metals, sodium, and potassium, were present in influent water to the WTP. Sodium is frequently the alkaline ionic end of commercial detergents and soaps, which are frequently sodium alkyl sulfate compounds. Sodium was a trace component of organic sodium lauryl sulfate dish soap added to the WTP during dissolved air floatation.

The alkali metals are expected to be present in the Uranium Material and were identified at a maximum of 0.1 and 0.53 percent, respectively. They are expected to be present in mineral silicate and salt forms in the sediments contained in the centrifuge solids. The Mill routinely processes alternate feed materials with higher levels of these cations; for example, Fansteel ("FMRI") alternate feed material contained 13,000 mg/kg (1.3 percent) sodium. Sodium is also present in several of the reagents used in the Mill at even higher concentrations than the Uranium Material or alternate feed materials.

Alkaline Earths

The alkaline earth metals, barium, calcium, and magnesium were present in the influent to the WTP and all are expected to be present in the centrifuge solids. Magnesium was also introduced as a trace component of Seventh Generation dish soap added to the WTP during dissolved air flotation. Barium, calcium and magnesium together comprise less than 16,000 mg/kg (1.6 percent) of the mass of Uranium Material, with barium at a maximum of 311 mg/kg, calcium at a maximum of 10,100 mg/kg, and magnesium at a maximum of 5,300 mg/kg.

As described above, none of the alkaline earths will be present as pure metals or metal oxides. Hazards associated with pure metals and pure oxides are not applicable and will not be discussed further.

All other compound and complex forms of the alkaline earths anticipated in the Uranium Material are compatible with either acid leach or alkaline leach solutions and any other process chemicals to which they may be exposed in the Mill circuit. They will be removed as sulfates or other insoluble salts, and discharged to the tailings management system. They do not pose any incompatibility hazards in the Mill process.

Transition Metals

The transition metals, chromium, cobalt, copper, iron, manganese, mercury, molybdenum, nickel, vanadium, and zinc were present at varying levels in the influent water to the WTP. All are expected to be present in the centrifuge solids produced, at the WTP and are consistent with the low levels detected in the AWAL data. They are expected to be present in carbonate, silicate and other mineral forms in the sediments removed in the WTP, but not as pure metals or oxide forms.

Hazards associated with pure metals and high concentration oxides of these metals are not applicable and will not be discussed further.

All other compound and complex forms of the transition metals anticipated in the Uranium Material are compatible with acid leach solutions, and any other process chemicals to which they may be exposed in the Mill circuit. Their very low levels will be removed as sulfates, and discharged to the tailings management system. They do not pose any incompatibility hazards in the Mill process.

Other Metals

Aluminum was introduced to the WTP as a component of the aluminum chlorohydrate coagulant added to the WTP. Aluminum was present at a maximum of 7.6 percent in the AWAL 2018 samples of the Uranium Material.

The AWAL data shows lead present in the Uranium Material at very low levels, on average 139 mg/kg (0.014 percent). Lead was present in the influent water to the WTP, and was not introduced in any of the WTP additives.

Manufacturers' Safety Data Sheet ("SDS') and National Institute for Occupational Safety and Health ("NIOSH") safety hazard information indicate that the metals aluminum and lead and their lower oxides, are incompatible with strong oxidizers, halogen gases, and some acids. Aluminum and lead will be present as mineral salt and silicate forms in the centrifuge solids. Neither of these metals will be present as pure metals or as metal oxides. Both will be converted to sulfates once reacted with sulfuric acid. Hazards associated with pure metals or metal oxides are not applicable and will not be discussed further.

All other compound and complex forms of these two metals are compatible with acid leach solutions and any other process chemicals to which they may be exposed in the Mill circuit. They will be dissolved or precipitated as sulfate salts, and discharged to the tailings management system. They do not pose any incompatibility hazards in the Mill process.

The Mill has previously processed alternate feed materials with comparable or higher levels of aluminum, ranging up to 13 percent aluminum, with no incompatibility issues in the Mill process. The Mill has processed alternate feed materials with substantially higher levels of lead, such as the Molycorp lead-iron filter cake alternate feed with up to 23.6 percent lead, with no adverse effects to workers, the Mill process or the environment.

Metalloids

The metalloid, arsenic, was present in influent water to the WTP. Arsenic was identified at a maximum of 11 mg/kg in the Uranium Material.

Arsenic is expected to be present in mineral forms, not as pure metal or oxides, and the minimal concentrations of arsenic identified in the available data are too low to be of any concern in the Mill circuit. Hazards associated with pure metals and oxides will not be discussed further.

All other compound and complex forms of arsenic that could be potentially present in the Uranium Material are compatible with acid leach solutions and any other process chemicals to which they may be exposed in the Mill circuit. They will be removed as sulfates or other insoluble salts, and discharged to the tailings management system. They do not pose any incompatibility hazards in the Mill process.

6.0 Potential Worker Safety Issues

The Uranium Material is a moist cake, expected to have an average moisture content of approximately 78%. The Mill is equipped with drum-emptying equipment at several locations, in both the main circuit and alternate feed circuit, and Mill personnel are experienced in the use of several different mechanisms to empty drums contents with a wide range of handling properties. As mentioned above, the Uranium Material is not expected to produce dusting during unloading or introduction to the Mill process.

7.0 Radiation Safety

The Uranium Material consists of centrifuge dewatering solids from the treatment of naturally-occurring groundwater. The Uranium Material contains approximately 0.5 percent natural uranium and very low levels of other radionuclides, including thorium isotopes, which are present at much lower levels than in other alternate feed materials. The derived air concentrations ("DACs"), radiation protection measures, and emissions control measures used for ores and other alternate feed materials at the Mill are sufficiently protective for the processing of the Uranium Material.

8.0 Potential Air Emissions Impacts

Discussions in the previous sections demonstrate that the Uranium Material is too moist to generate a dust impact during drum unloading or feed to the Mill, based on its moisture content of approximately 78%. Engineering controls already in place at the Mill will be sufficient to prevent the generation or dispersion of particulate emissions. In addition, once introduced into the Mill, the constituents in the material will almost immediately be converted to sulfates or other stable aqueous ionic forms, which are non-volatile and produce no off gases.

Because the metals and ions in the Uranium Material are present at ppm levels or fractional percent levels, they are not expected to generate a significant increase in load on the existing demisters or air pollution control devices systems.

9.0 Potential Effects on Tailings Management System

9.1 Tailings Cell Liner Material Compatibility

9.1.1 Effect on Tailings Composition

The Uranium Material will be received as drummed moist solids removed from the centrifuge in the WTP. Tailings from processing of the Uranium Material will be sent to one of the active tailings cells at the Mill, Cell 3 or Cell 4A. Subsequent to the closure of Cell 3 tailings could be sent to Cell 4B or to a similarly designed new cell, depending on the timing of material shipments, and the status of the cells of the tailings management system at the time of receipt. For the purposes of this assessment, it has been assumed that the tailings from the Uranium Material will be transferred to either Cell 3 or Cell 4A.

The solutions from the Uranium Material tailings will be recirculated through the Mill process for reuse. The solids will be only a portion of the total mass of Uranium Material sent to the Mill from the Facility. However, assuming a worst case scenario that all of the solid material ends up in the

tailings management system, the additional load to the tailings management system will be minimal.

Cell 4A was placed into service in October of 2008 and received conventional ore tailings solids and, since July 2009, conventional ore tailings solutions. Cell 4B was authorized for use and placed into service in February 2011. Cell 4B, to date, has been used only as an evaporation pond. Hence, for this analysis, it is reasonable to use known information on the composition of Cell 4A and/or Cell 3.

Cell 3 is a mature cell, later in its operational life cycle, and contains a larger volume/mass of tailings, and relatively higher concentrations of most constituents than newer cells. Cell 4A is a newer cell, early in its operational life, and contains a lower volume/mass of tailings and relatively low concentrations of most constituents. As mentioned earlier in Sections 4.0 and 9.1, the filling of Cell 3 is nearing completion and the majority, or all, of the tailings from the Uranium Material is most likely to be placed in Cell 4A. However, Cell 3 provides an approximate representation of the relative concentrations of constituents that can be expected to be seen in Cell 4A later in its operating life. Therefore, for comparison purposes, the effect of the Uranium Material on the concentrations in the tailings management system was prepared for both Cell 4A and Cell 3.

The constituents in the tailings solids and liquids resulting from the processing of Uranium Material are not expected to be significantly different from those resulting from processing of conventional ores or previously approved alternate feed materials. The Uranium Material contains generally lower concentrations of every constituent than has been received in previously approved alternate feed materials, in many cases two or more orders of magnitude lower than other alternate feed materials. Tables 4-1 and 4-2, which provide the potential tailings composition Cells 4A, and Cell 3, respectively before and after processing of the Uranium Material, indicate that all of the constituents found in the Uranium Material have been processed in the Mill's main circuit and/or the alternate feed circuit and are present in the tailings system.

As described above, it is expected that most of the metal and non-metal components entering the leach system with the Uranium Material will be converted to sulfate ions, and eventually discharged to the tailings management system.

Every metal and non-metal cation and anion component in the Uranium Material already exists in the Mill's tailings management system and/or is analyzed under the GW monitoring program.

Every component in the Uranium Material has been:

1. detected in analyses of the tailings management system;
2. detected in analyses of alternate feed materials licensed for processing at the Mill; or
3. detected in process streams or intermediate products when previous alternate feed materials were processed at the Mill; at concentrations that are generally comparable or higher than the concentrations in the Uranium Material.

As can be seen from Tables 4-1 and 4-2, the very low levels of most constituents in the Uranium Material are estimated to reduce the resulting concentrations in the tailings management system, in some cases significantly. A few constituents are estimated to raise the current concentration in Cell 4A or Cell 3 by no more than a few mg/kg.

Based on the calculations in Table 4-1, the concentrations of aluminum, iron, mercury, lead, and barium will increase most notably in the tailings cells after processing the Uranium Material.

Aluminum and iron are expected to result in the largest increases in concentrations, of 613 and 189 mg/kg, respectively in Cell 4A. Aluminum and iron are common constituents of the Mill's tailings and of many natural sands, rock and ore, regardless of source and are components of the natural background media of the Mill itself. They are expected to remain relatively inert in the conditions of the tailings management system regardless of concentrations. The Mill has processed thousands of tons of natural ores with far greater levels of residual iron and aluminum.

With respect to barium, the Mill has previously processed Uranium Materials, specifically the Molycorp material, with barium concentrations as high as 3.6% or 100 times higher than is present in the Uranium Material. As discussed in the 2004 and later GWDP SOB documents, and in the 2011 Dawn Mining license amendment application, barium has a strong tendency to precipitate to inert solid in the presence of the high levels of sulfate as exist in the tailings solutions. Also, as discussed in these documents, barium's geochemical behavior is well represented by calcium, which is monitored in the tailings solutions and groundwater monitoring program.

The Mill has processed alternate feed materials from uranium/lead precipitation pond solids, such as the Molycorp alternate feed material, with lead concentrations as high as 26% lead, or nearly 2,000 times greater than is present in the Uranium Material. Lead is also present in natural uranium ores and is the ultimate decay product of uranium and thorium. That is the tailings management system was designed to contain lead in any proportion.

Mercury is the metal with the single lowest concentration in any cell at any time, and ranges from 6 orders of magnitude (1 million times) lower than the other metals, to 9 orders of magnitude (1 billion times) lower than the major ions, in tailings solutions. The complexity of tailings solutions composition, and the analytical laboratory's need to perform high dilutions to achieve reportable results of the higher concentration analytes, makes it difficult to achieve dependably reproducible results for very low concentration species like mercury. As a result, mercury concentrations have ranged over three orders of magnitude (1,000 times) in Cell 3 and two orders of magnitude (100 times) in Cell 4. The simple arithmetic average value used in the calculations for each of the two cells may not be representative of the actual range of mercury concentrations in the respective cell solutions.

However, regardless of the apparent theoretical increase in mercury concentrations in either cell, the resulting estimated concentrations are still minutely small compared to all the other constituents, specifically 0.2 mg/kg in Cell 3 and 0.01 mg/kg in Cell 4A. Additionally, mercury is monitored in both the tailings solutions and the groundwater monitoring program. Therefore, the resulting concentration of mercury in the tailings, after processing the Uranium Material, is not a concern.

Additionally, over its operating life, Cell 4A is expected to receive up to 1.9 million tons of tailings solids from ores and alternate feed materials, and the eventual resulting concentration of any of the constituents discusses above will be much lower than indicated in Table 4-1.

As a result of the factors discussed above, the resulting concentrations of aluminum, barium, iron, lead or mercury in the tailings, after processing the Uranium Material, are not a concern.

9.1.2 Liner Resistivity and Suitability

As discussed above, the majority, or all, of the tailings from the Uranium Material is expected to be placed in Cell 4A. For the purpose of completeness, the evaluation below addressed both Cell 3 and Cell 4A.

Cell 3 was constructed with a polyvinyl chloride ("PVC") membrane liner. Cell 4A (as well as Cell 4B) has a high-density polyethylene ("HDPE") liner.

Mitchell (1985) studied the chemical resistivity of both PVC and HDPE at a pH range of 1.5 to 2.5 standard units using sulfuric acid. This study concluded that PVC performed satisfactorily under these conditions, HDPE performed better, and both were structurally stable under these acidic conditions. Haxo, et. al. (EPA 1991) evaluated the performance of PVC (s well as other vinyl and polyethylene liner materials) in leachate solutions containing metals, salts and volatile hydrocarbons, such as chloroform. Although most of the materials softened during the first 12 months of exposure, due to the normal wetting process when exposed to solutions, the PVC and some of the ethylene materials subsequently re-hardened and recovered and retained their tensile properties for the long term performance.

According to Gulec, et al. (2005), a study on the degradation of HDPE liners under acidic conditions (synthetic acid mine drainage), HDPE was found to be chemically resistant to solutions similar to the tailings solutions at the Mill. Battelle Laboratories (Farnsworth and Hymas, 1989) studied the performance of five synthetic geomembrane liner materials in a complex synthetic solution at elevated temperatures of 90°C (194°F), containing high levels of anions, including ammonia nitrogen, chloride, fluoride, and sulfate ions, along with over 20 of the same metals and metal oxides found in the Mill's tailings and the Uranium Material. In the post-immersion stress/break tests after 120 days exposure, HDPE was determined to be the best performing material of all those tested.

It can be concluded that the PVC liner of Cell 3 and the HDPE liners of Cell 4A are suitable for the chemical and mineral composition of tailings expected from the Uranium Material in the sulfuric acid conditions to be encountered in the tailings management system

9.1.3 Conclusions Regarding Tailings Management System Effects

The constituents in the Uranium Material, are expected to produce no incremental additional environmental, health, or safety impacts in the Mill's tailings management system beyond those produced by the Mill's processing of natural ores or previously approved alternate feed materials. Since the impacts of all the constituents on the tailings management system are already anticipated for normal Mill operations, and permitted under the Mill's license, they have not been re-addressed in this evaluation.

10.0 Groundwater Monitoring Program

The chemical and radiological make-up of the Uranium Material is similar to other ores and alternate feed materials processed at the Mill, and their resulting tailings will have the chemical composition of typical process tailings from the ores and previously approved feeds, for which the Mill's tailings management system was designed.

Specifically, each of the constituents of the Uranium Material

- is monitored under the Mill's current GWDP, or
- has been evaluated in the environmental evaluations for one or more previously approved alternate feed materials, and it has been determined that one or more analytes monitored under the GWDP is an effective indicator for the constituent.

As a result, the existing groundwater monitoring program at the Mill will be adequate to detect any potential future impacts to groundwater for any constituent in the Uranium Material.

11.0 Conclusions and Recommendations

The majority of constituents in the Uranium Material are present at lower levels than the majority of alternate feed materials and even some natural ores previously processed at the Mill. While elevated levels of a few constituents in the Uranium Material may be present, no additional material management requirements during handling and processing will be needed.

Based on the foregoing information, it can be concluded that:

1. All the constituents in the Uranium Material have either been reported to be, or can be assumed to be, already present in the Mill tailings management system or were reported in other alternate feed materials processed at the Mill, at levels generally comparable to those reported in the Uranium Material.

2. All the constituents in the Uranium Material have either been reported to be, or can be assumed to be, previously introduced into the Mill process, with no adverse effects to the process, or worker health and safety.

3. All the known impurities in the Uranium Material have either been reported to be, or can be assumed to be, previously introduced into the Mill tailings management system, with no adverse effects to the tailings management system, or human health and safety.

4. The Uranium Material will reduce the respective concentrations of most constituents in tailings. For several constituents whose concentration may be expected to increase in the short term, these concentrations are not a concern to the tailings solution stability, system integrity, or groundwater quality for the reasons discussed in Sections 9.0 and 10.0, above.

5. There will be no significant incremental environmental impacts from the processing of Uranium Material beyond those that are already anticipated in the Environmental Impact Statements for the Mill.

6. Spill response and control measures designed to minimize particulate radionuclide hazards will be more than sufficient to manage chemical hazards from the constituents of the Uranium Material.

12s.0 References

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- Title 10 Code of Federal Regulations; Appendix A – Nuclear Regulatory Commission, Part 40 – *Domestic Licensing of Source Material: Criteria Relating to the Operation of Uranium Mills and the Disposition of Tailings or Wastes Produced by the Extraction or Concentration of Source Material From Ores Processed Primarily for Their Source Material Content* (10 CFR 40 Appendix A)

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Table 3: Incompatibilities and Chemical Hazards for Components of Uranium Material

Component	Chemical Symbol	Maximum Concentration Reported (mg/kg)	Incompatibilities	Will constituent be present in this chemical form?	Will constituent be exposed to these incompatible agents?
Aluminum	Al	11,000	As Al_2O_3 – chlorine trifluoride, hot chlorinated rubber, acids, oxidizers	As di-aluminum trioxide	Sulfuric acid only. Al_2O_3 will not be present at greater than 1%, and will be consumed by the overabundance of sulfuric in the leach system.
			As Al – Strong oxidizers and acids, halogenated hydrocarbons	No	None present except sulfuric acid. Al is not present as reduced Al, but as aluminum oxide.
			As pure powder - varies	No	---
			As Al salts and alkyls - varies	No. Aqueous solutions on ly	---
Ammonia	NH4	190	Strong oxidizers, halogens, acids, salts of silver and zinc	No. Will only be present as ammonium oxides, hydrates.	None present except sulfuric acid. NH4 will only be present at low levels as ammonium oxides and hydrates.
Arsenic	As	11	As metal and inorganic compounds – strong oxidizers, bromine azide	Yes. As inorganic salts	No. None present except moderate oxidizers only, if used.
			As organic compounds - varies	No.	---
			As AsH_3 (arsine) – strong oxidizers, chlorine, nitric acid	No.	No. Mild oxidizer only if used.
Barium	Ba	550	As Barium oxides – reacts with water to form hydroxides; reacts with N_2O_4, hydroxylamines, SO_3, H_2S	Will be in oxide form.	No.
Calcium	Ca	13,000	As Ca oxides – react with water	No.	Water only.
			As Ca hydroxides – react with water	No.	No.
			As $CaSO_4$ – diazomethane, aluminum, phosphorous, water	No.	Water only.
			As $CaSiO_3$ or $CaOSiO_2$ – none listed	No.	---
Chloride	Cl^-	110	As inorganic salts – none. As phosphorus pentachloride – magnesium oxide	Only as trace inorganic salts. Not as phosphorus pentachloride.	No.
Cobalt	Co	20	As CoO - none	No.	---
Copper	Cu	860	As CuO – acetylene, zirconium	No.	No.
Fluoride	F	20,000	Varies with compound form. As inorganic salts - none	Yes.	---

Table 3: Incompatibilities and Chemical Hazards for Components of Uranium Material

Component	Chemical Symbol	Maximum Concentration Reported (mg/kg)	Incompatibilities	Will constituent be present in this chemical form?	Will constituent be exposed to these incompatible agents?
Iron	Fe	20,000	As Fe_2O_3 – calcium hypochlorite, carbon monoxide, hydrogen peroxide	No.	No.
			As $Fe_2(SO_4)_3$ – decomposes at high temperature	No.	No.
			As $As_2Fe_2O_6$ – decomposes on heating to yield fumes of arsenic and iron	No.	No.
Lead	Pb	6,100	As PbO – strong oxidants, aluminum powder, sodium; also decomposes on heating to form lead fumes	No.	No. None present except moderate oxidizers only, if used.
Magnesium	Mg	4,200	As $MgCO_3$ – acids, formaldehyde	No.	None present except sulfuric acid. No issues: Mg will not be present in the carbonate form.
			As MgO – chlorine, trifluoride, phosphorus pentachloride	No.	No.
Manganese	Mn	4,400	As $Mn(OH)_3$ MN_2O_3, MnO - none	No.	---
Mercury	Hg	0.88	As metal and inorganic compounds – acetylene, ammonia, chlorine dioxide, azides, calcium, sodium carbide, lithium, rubidium, copper	No. Will be present as oxide only.	No.
			As organic compounds – strong oxidizers such as chlorine gas	No.	No.
Molybdenum	Mo	4.8	As metal – strong oxidizers	No.	No. Moderate oxidizers only, if used.
			As soluble compounds - varies	Yes.	---
Nickel	Ni	150	As NiO- iodine, H_2S	No.	No.
Potassium	K	7,200	As KCN – strong oxidizers (such as acids, acid salts, chlorates, and nitrates).	No.	No.
			As KOH - acids, water, metals, halogenated hydrocarbons, maleic anhydride. Will not be present in these forms.	No.	No. None present except water and sulfuric acid. No issues. K2O will only be present at low (less than percent) levels.
Sodium	Na	13,000	As Na_2AlF_6 – strong oxidizers	No.	No. Moderate oxidizers only, if used
			As NaN_3 – acids, metals, water	No.	No. None present except sulfuric acid. No issues: Na will not be present as sodium azide (NaN_3)

Table 3: Incompatibilities and Chemical Hazards for Components of Uranium Material

Component	Chemical Symbol	Maximum Concentration Reported (mg/kg)	Incompatibilities	Will constituent be present in this chemical form?	Will constituent be exposed to these incompatible agents?
			As Sodium bisulfate (dry product) - heat	No.	No.
			As NaCN – strong oxidizers (such as acids, acid salts, chlorates, nitrates)	No.	No.
			As NaF – strong oxidizers	No.	No.
			As Sodium fluoroacetate – none reported	No.	---
			As NaOH – water, acids, flammable liquids, organic halogens, aluminum, tin, zinc, nitromethane	No.	No. None present except sulfuric acid. No issues: NaO will be present at extremely low levels.
			As sodium metabisulfite - heat	No.	---
Sulfate	SO_4	18,000	As calcium sulfate - Diazomethane, aluminum, phosphorus, water	Will only be present in inorganic salt form.	Water only.
			As ferrous sulfate – alkalies, soluble carbonates, oxidizing materials	No.	No.
			As ferrous sulfate – carbon steel, brass, nylon	No.	No.
Vanadium	V	18	As dust or fume - lithium, chlorine trifluoride	No.	No.
Zinc	Zn	180	As ZnO - none	No.	---

Note: None of the above incompatibilities are applicable to the components as they will be present in the Uranium Material. None of the components will be present in pure/reduced metal form or as pure high concentration metal oxides. None of the components will be exposed to any of the incompatible agents identified in the table.

Sources: NIOSH Pocket Guide to Chemical Hazards accessed September 2018; Wiley Guide to Chemical Incompatibilities Richard Pohanish & S. Greene 2009

Table 4-1 Comparison of Uranium Material to Tailings and Alternate Feed Materials - Cell 4A

Component	A Estimated Average Conc. in Uranium Material (mg/kg or ppm)[1]	B Estimated Mass in Uranium Material (tons)[2]	C Conc. Range in Mill Tailings before Processing Uranium Material (mg/L or *ppm*)[3A]	D Estimated Average Conc. in Mill Tailings before Processing Uranium Material (mg/L or ppm)[3B, 3C]	E Estimated Current Analyte Mass in Mill Tailings (tons)[4]	F Mass in Mill Tailings after Uranium Material Processing (tons)[5]	G Conc. in Mill Tailings after Uranium Material Processing (ppm)[6]	H Difference between Column G and D (Incremental Increase in Mill Tailings Conc. after Uranium Material Processing) (ppm)[7]	I Increase in Mill Tailings Conc. after Uranium Material Processing (%)[8]	J Conc. in Ores and Other Alternate Feed Materials (mg/kg or ppm)[9]
Inorganic Nitrogen[10]	293.5	1.47	31-9133	3,410	2,046	2,047.5	3,384	-25.8	-0.8	350,000 [11]
Chloride	7.6	0.04	4530-10,100	6,489	3,893	3,893.4	6,435	-53.6	-0.8	89,900 [11]
Fluoride	4.7	0.02	0.3-2,030	962.6	578	577.6	955	-7.9	-0.8	460,000 [11]
Aluminum (Al)	75,650	378.25	1,510	1,510	906	1,284.3	2,123	612.7	40.6	2,000-160,000
Arsenic (As)	10.5	0.05	60.5-626	143	86	85.9	142	-1.1	-0.8	3.5-16,130
Barium (Ba)	294	1.47	0.10	0.10	0.06	1.5	3	2.4	2428.9	21-36,200
Calcium (Ca)	9,640	48.20	445-707	604	362	410.4	678	74.7	12.4	up to 217,000
Cobalt (Co)	6.9	0.03	9.44-41	27.0	16	16.2	27	-0.2	-0.6	9-350,400
Copper (Cu)	121	0.61	99.2-683	428	257	257.5	426	-2.5	-0.6	8-296,000
Iron (Fe)	26,200	131.00	2280-5320	3,350	2,010	2,141.0	3,539	188.8	5.6	up to 164,000
Lead (Pb)	139	0.70	5.27-16.4	12	7	7.7	13	1.1	9.0	9-236,000
Magnesium (Mg)	5,070	25.35	2,230-7,030	4,064.00	2,438	2,463.8	4,072	8.3	0.2	1,020-43,400
Manganese (Mn)	384	1.92	112-307	187	112	113.9	188	1.6	0.9	172-3,070
Mercury (Hg)	1.22	0.01	0.0008-0.015	0.004	0.002	0.008	0.014	0.0101	287.2	0.0004-14
Potassium (K)	5,280	26.40	558-2020	1,138.0	683	709.2	1,172	34.2	3.0	17-7,740
Sodium (Na)	1,110	5.55	5,980-17,600	9,880.0	5,928	5,933.6	9,808	-72.5	-0.7	13,000
Vanadium (V)	33.3	0.17	237-1,090	732	439	439.1	726	-5.8	-0.8	10-25,000
Zinc (Zn)	456	2.28	142-406	250,900	150,540	150,542.3	248,830	-2069.8	-0.8	8-14,500

Notes to Table 4:

1. The concentration in the Uranium Material is from 2018 AWAL Laboratory data. Values reported as less than (<) were used as reported.
2. Estimated mass in the Uranium Material is calculated by multiplying column B by an assumed 5,000 dry tons of Uranium Material.
3. Cell 4A Mill tailings range and average concentrations were taken from Mill tailings samples to date, as summarized in the Annual Tailngs Characterization Report except for Al and Ba. These metals were analyzed by AWAL Laboratories in additional samples collected in 2019.
4. Estimated current mass in Mill tailings Cell 4A is approximately 600,000 dry tons.
5. Mass in Mill tailings after Uranium Material processing is calculated by adding columns B and E.
6. The concentration in Mill tailings after Uranium Material processing is calculated by dividing column F by 605,000, which is the existing volume of tailings in Cell 4A of 600,000 dry tons plus the assumed 5,000 dry tons of Uranium Material.
7. The increase in Mill tailings concentration after Uranium Material processing (ppm) shows the increase (decrease) in concentration of each constituent in the Mill's tailings, stated in ppm of the total mass of tailings in Cell 4A, which is calculated as the difference between column G and column D.
8. The increase in Mill tailings concentration after Uranium Material processing is the ratio of Column D to Column H expressed in %
9. The concentration in other alternate feeds represents some selected concentrations for constituents found in characterization data for other alternate feed materials licensed for processing at the Mill, for comparison purposes.
10. Inorganic nitrogen shown here is ammonia nitrogen.
11. Sources of data for cations in other feeds is provided in Table 5.
12. All organic results except fluoranthene were non-detect. Fluoranthene was ND in one of two sample and 0.29 mg/kg in the other.

Table 4-2 Comparison of Uranium Material to Tailings and Alternate Feed Materials - Cell 3

Component	A Estimated Average Conc. in Uranium Material (mg/kg or ppm)[1]	B Estimated Mass in Uranium Material (tons)[2]	C Conc. Range in Mill Tailings before Processing Uranium Material (mg/L or *ppm*)[3A]	D Estimated Average Conc. in Mill Tailings before Processing Uranium Material (mg/L or ppm)[3B, 3C]	E Estimated Current Analyte Mass in Mill Tailings (tons)[4]	F Mass in Mill Tailings after Uranium Material Processing (tons)[5]	G Conc. in Mill Tailings after Uranium Material Processing (ppm)[6]	H Difference between Column G and D (Incremental Increase in Mill Tailings Conc. after Uranium Material Processing) (ppm)[7]	I Increase in Mill Tailings Conc. after Uranium Material Processing (%)[8]	J Conc. in Ores and Other Alternate Feed Materials (mg/kg or ppm)[9]
Inorganic Nitrogen[10]	293.5	1.47	29-10,600	6,945	18,166	18,167.5	6,932	-13.5	-0.2	350,000 [11]
Chloride	7.6	0.04	2,460-115,000	26,545	69,434	69,433.8	26,491	-53.7	-0.2	89,900 [11]
Fluoride	4.7	0.02	0.6-46,500	5,873	15,362	15,362.0	5,861	-11.9	-0.20	460,000 [11]
Aluminum (Al)	75,650	378.25	330-2530	1,827	4,779	5,157.1	1,968	140.6	7.7	2,000-160,000
Arsenic (As)	10.5	0.05	0.87-489	120.6	315	315.5	120	-0.2	-0.2	3.5-16,130
Barium (Ba)	294	1.47	0.021-0.1	0.048	0.13	1.6	0.6	0.6	1,168.2	21-36,200
Calcium (Ca)	9,640	48.20	148-887	488	1,276	1,324.7	505	17.4	3.6	up to 217,000
Cobalt (Co)	6.9	0.03	4.44-120	62	162	162.2	62	-0.1	-0.2	9-350,400
Copper (Cu)	121	0.61	9.72-3,000	589	1,541	1,541.3	588	-1.0	-0.2	8-296,000
Iron (Fe)	26,200	131.00	262-15,400	5,543	14,499	14,629.8	5,582	38.8	0.7	up to 164,000
Lead (Pb)	139	0.70	15.8-20.5	9.6	25	25.8	10	0.2	2.6	9-236,000
Magnesium (Mg)	5,070	25.35	1,910-84,400	18,031	47,164	47,189.0	18,004	-26.8	-0.1	1,020-43,400
Manganese (Mn)	384	1.92	82-5,690	1,435	3,754	3,755.4	1,433	-2.17	-0.151	172-3,070
Mercury (Hg)	1.22	0.01	0.0024-0.873	0.173	0	0.459	0.2	0.002	1.14	0.0004-14
Potassium (K)	5,280	26.40	133-6657	2,223	5,815	5,841.1	2,229	5.58	0.25	17-7,740
Sodium (Na)	1,110	5.55	2,120-59,800	22,600	59,115	59,120.4	22,556	-43.58	-0.19	13,000
Vanadium (V)	33.3	0.17	5.6-10,300	1,880	4,918	4,917.7	1,876	-3.7	-0.2	10-25,000
Zinc (Zn)	456	2.28	142-406	2,100	5,493	5,495.3	2,097	-3.4	-0.2	8-14,500

Notes to Table 4:

1. The concentration in the Uranium Material is from 2018 AWAL Laboratory data. Values reported as less than (<) were used as reported.
2. Estimated mass in the Uranium Material is calculated by multiplying column B by an assumed 5,000 dry tons of Uranium Material.
3. Cell 3 Mill tailings range and average concentrations were taken from Mill tailings samples to date, as summarized in the Annual Tailngs Characterization Report Values for Al and Ba were taken from Utah SOB for initial Utah GW Discharge Permit
4. Estimated current mass in Mill tailings Cell 3 is approximately 2,615,700 dry tons based on Mill tailings cell capacity estimate 2019.
5. Mass in Mill tailings after Uranium Material processing is calculated by adding columns B and E.
6. The concentration in Mill tailings after Uranium Material processing is calculated by dividing column F by 2,617,900, which is the existing volume of tailings in Cell 3 of 2,615,700 dry tons plus the assumed 5,000 dry tons of Uranium Material.
7. The increase in Mill tailings concentration after Uranium Material processing (ppm) shows the increase (decrease) in concentration of each constituent in the Mill's tailings, stated in ppm of the total mass of tailings in Cell 3, which is calculated as the difference between column G and column D.
8. The increase in Mill tailings concentration after Uranium Material processing is the ratio of Column D to Column H expressed in %
9. The concentration in other alternate feeds represents some selected concentrations for constituents found in characterization data for other alternate feed materials licensed for processing at the Mill, for comparison purposes.
10. Inorganic nitrogen shown here is ammonia nitrogen.
11. Sources of data for cations in other feeds is provided in Table 5.
12. All organic results except fluoranthene were non-detect. Fluoranthene was ND in one of two sample and 0.29 mg/kg in the other.

Table 5
Selected Chemicals Present in Alternate Feed Materials

Chemical	Value in Tailings Table 4 for Concentration in Other Alternate Feed Materials	Supporting or Additional Information	Source
Aluminum	94,000 mg/kg 160,000 mg/kg	Fansteel Metals Resources pond alternate feed material Sequoyah Fuels Corporation pond alternate feed material	FMRI application 2013 SFC application 2011
Ammonia Nitrogen	Used as Mill reagent at 100% anhydrous.	A 108,000 pound (31,000 gallon) inventory of 100% anhydrous ammonia is used to prepare concentrated ammonia solutions introduced into the yellowcake precipitation area. Ammonia in this form is added far downstream of feed area and is never in contact with ores or feeds. (These concentrations far exceed those of the alternate feed.)	Mill process description, 1991 RML renewal application and 2007 RML renewal application
Barium	36,244 mg/kg	3.62 % in Molycorp Mt. Pass drummed material alternate feed	Molycorp characterization data in amendment request December 2000.
Chloride	89,900 mg/kg	Maximum sample from Molycorp ponds alternate feed, 89,900 mg/kg	TTLC table from December 2000 Molycorp Amendment Request
Fluoride	460,000 mg/kg	Honeywell/Converdyne/Allied Signal alternate feed, up to 2% U, 98% calcium fluoride and fluoride impurities (48% or 480,000 mg/kg F based on all being as CaF_2)	MSDS for CaF_2 product.
Lead	236,000 mg/kg	Molycorp Pond materials 236,000 to 262,000 mg/kg (23% to 26%) lead	Molycorp amendment request December 2000

Attachment 6
Cross Index to DWMRC Interrogatory Template for Review of License Amendment Requests and Environmental Reports under UAC R313-24

Cross Index to UAC R3 :4 Interrogatory Template

DRC Interrogatory Number	Topic	Regulatory Basis	Where Addressed in This Document	Where Addressed in Other Documents
UAC R313-24-3-01A/01	Environmental Analysis - Radiological and Nonradiological impacts	UAC R313-24-3	Section 1.0-1.4, 2.3, 2.5, 4.1, Attachment 5	ER Lic. App 3.1-3.10; ER Cell 4B 9.0
	Geology and Soils (Land)	RG 3.8, Section 6.1.4.1	Section 4.1	ER Lic. App. 3.4.1-3.4.4, 3.5; Rec Plan 1.6; ER Cell 4B 6.0
	Exposure Pathways	RG 3.8, Section 5.2.1	Section 4.1	ER Lic. App. 3.13.2.2, Figure 3.13-1; Dames and Moore 5.2; ER Cell 4B 10.1
	Liquid Effluents	RG 3.8, Section 5.2.2	Section 4.1, 4.6, 4.8	Rec. Plan 2.2.3.2; Dames and Moore 5.2
	Airborne Effluents	RG 3.8, Section 5.2.3	Section 4.1, 4.8	GW Permit App. 2.6; Dames and Moore 2.7.4, Dames and Moore 5.2
	Direct Radiation	RG 3.8, Section 5.2.4	Section 2.3, 4.1, 4.9, 4.10	Dames and Moore 2.7.4
	Effects of Sanitary and Other Waste Discharges	RG 3.8, Section 5.4	Section 4.1	Dames and Moore 5.4
	Other Effects	RG 3.8, Section 5.5	Section 4.1, 4.2.2	Dames and Moore 5.5
	Hazard Assessment	NUREG-1620, Section 4.3.3.1	Section 4.1, Attachment 4	GW Permit App. 2.6-2.7
	Exposure Assessment	NUREG-1620, Section 4.3.3.2	Section 4.1	GW Permit App. 2.6-2.7
	Accidents	DG-3024, Section 6	Section 4.1, 4.2.3	ER Lic. App. 4.0
	Mill Accidents Involving Radioactivity	RG 3.8, Section 7.1	Section 4.1, 4.4.1	ER Lic. App. 4.0
	Other Accidents	RG 3.8, Section 7.3	Section 4.1, 4.2.3	ER Lic. App. 4.0
	Summary of Annual Radiation Doses	RG 3.8, Section 5.2.5	Section 4.1	ER Lic. App Tables 3.13-3, 3.13-4
UAC R313-24-3-01B/01	Environmental Analysis - Impact on Waterways and Groundwater	UAC R313-24-3	Section 4.1, 4.6, 4.7	GW Permit App. 2.5-2.7; ER Cell 4B 10.0
	Surface Water	RG 3.8, Section 6.1.1	Section 4.1, 4.7	ER Lic. App. 3.7.1.1-3.7.1.3; Rec Plan 1.4.1-1.4.3, 1.7.5.5
	Physical and Chemical Parameters (Ground Water)	RG 3.8, Section 6.1.2.2	Section 4.1, 4.6, Attachment 4	GWDP Table 2
UAC R313-24-3-01C/01	Environmental Analysis - Alternatives	UAC R313-24-3	Section 4.1, 4.14	ER Lic. App. 2.0-2.4
	Alternatives to the Proposed Action	RG 3.8, Section 10	Section 4.1, 4.14	ER Lic. App 2.1, 2.4
	Benefit - Cost Analysis	RG 3.8, Section 11	Section 4.1, 4.13	ER Lic. App. 5.0; Rec Plan Attachment C
UAC R313-24-3-01D/01	Environmental Analysis - Long-Term Impacts	UAC R313-24-3	Section 4.1, 4.5.3, 4.11	ER Lic. App. 5.0; ER Cell 4B 14.0
	Mill Decommissioning	DG-3024, Section 8.1	Section 4.1, 4.5.3	Rec. Plan 3.2.3,
	Site and Tailings Reclamation	DG-3024, Section 8.2	Section 4.1, 4.5.3	Rec. Plan 3.2.1, 3.2.2.;
	Decommissioning and Reclamation	RG 3.8, Section 9	Section 4.1, 4.5.3	Rec. Plan Attachment A, 3.2.1, 3.2.2

DRC Interrogatory Number	Topic	Regulatory Basis	Where Addressed in This Document	Where Addressed in Other Documents
	Decommissioning Plan for Land and Structures	NUREG-1620, Section 5.2.3	Section 4.1, 4.5.3	Rec. Plan 3.2.1
10CFR40.26(c)(2)-02/01	General License	UAC R313-24-4		Satisfied by ongoing compliance with mill license
10CFR40.31(H)-03/01	Application for Specific Licenses	UAC R313-24-4		Satisfied by ongoing compliance with mill license
	Corporate Organization and Administrative Procedures	DG-3024, Section 5.1	Section 4.1, Section 4.12	Satisfied by ongoing compliance with mill license
	Management Control Program	DG-3024, Section 5.2	Section 4.1, Section 4.12	Satisfied by ongoing compliance with mill license
	Management Audit and Inspection Program	DG-3024, Section 5.3	Section 4.1, Section 4.12	Satisfied by ongoing compliance with mill license
	Qualifications	DG-3024, Section 5.4	Section 4.1, Section 4.12	Satisfied by ongoing compliance with mill license
	Training	DG-3024, Section 5.5	Section 4.1, 4.4, 4.10.2, 4.12	Satisfied by ongoing compliance with mill license
	Security	DG-3024, Section 5.6	Section 4.1, 4.12	Satisfied by ongoing compliance with mill license
	Quality Assurance	DG-3024, Section 7	Section 4.1	Satisfied by ongoing compliance with mill license
	References	DG-3024	Section 4.1	Satisfied by ongoing compliance with mill license
10CFR40.4(c)-04/01	Terms and Conditions of Licenses	UAC R313-24-4	Section 4.1	Satisfied by ongoing compliance with mill license
10CFR40.40.42(K)(3)(I)-05/01	Expiration, Termination, Decommissioning	UAC R313-24-4	Section 4.1	Satisfied by ongoing compliance with mill license
10CFR40.61-06/01	Records	UAC R313-24-4		Satisfied by ongoing compliance with mill license
10CFR40.65(A)(1)-07/01	Effluent Monitoring Reporting Requirements	UAC R313-24-4	Section 4.1	Rec. Plan 1.7.5.4
	Mill Effluent Monitoring (Proposed Operational Monitoring Program	RG 3.8, Section 6.2.1.1	Section 4.1	Rec. Plan 1.7.5.4
	Enviromental Radiological Monitoring (Proposed Operational Monitoring Program)	RG 3.8, Section 6.2.1.2	Section 4.1	Rec Plan 2.3.2.1 9 (c), (d); ER Cell 4B 10.4
	Meteorological Monitoring (Proposed Operational Monitoring Program)	RG 3.8, Section 6.2.3	Section 4.1	Rec. Plan 1.1.1-1.1.3, 2.3.2.1(d), 1.7.5.6; ER Cell 4B 2.2
10CFR40.INTRODUCTION-08/01	Capacity of Tailings or Waste Systems Over the Lifetime of Mill Operations	UAC R313-24-4	Section 4.1, 4.5.2	GW Permit App. 2.15.2.3

Cross Index to UAC R3 :4 Interrogatory Template

DRC Interrogatory Number	Topic	Regulatory Basis	Where Addressed in This Document	Where Addressed in Other Documents
10CFR40APPENDIX A, Introduction-09/01	Alternative Requirements	UAC R313-24-4	Section 4.1	ER Lic. App 2.1-2.4
10CFR40 APPENDIX A, CRITERION 1-10/01	Permanent Isolation Without Ongoing Maintenance	UAC R313-24-4	Section 4.1, 4.5.3	Rec Plan 3.2.3.1
	Slope Stability	NUREG-1620, Section 2.2.3	Section 4.1, 4.5.3	Rec Plan 3.3.6
	Settlement	NUREG-1620, Section 2.3.3	Section 4.1, 4.5.3	Rec Plan 3.3.6
	Liquidifacation Potential	NUREG-1620, Section 2.4.3	Section 4.1, 4.5.3	Rec Plan 3.3.6
10CFR40, APPENDIX A, CRITERION 2-11/01	Proliferation	UAC R313-24-4	Section 4.1	Rec Plan 3.3.6
10CFR40, APPENDIX A, CRITERION 3-12/01	Placement Below Grade	UAC R313-24-4	Section 4.1	GW Permit App. 2.5.1.5
10CFR40, APPENDIX A, CRITERION 4-13/01	Location and Design Requirements	UAC R313-24-4	Section 4.1	Rec. Plan 3.1
	Site Location and Layout	RG 3.8, Section 2.1	Section 4.1	Rec Plan 1.1, Figure 3.2-1; ER Lic. App 3.2
	Site Area	RG 3.8 Section 3.1	Section 4.1	Rec Plan 1.1, Figure 1-2, Figure 3.2-1
	Geography	DG-3024, Section 2.1.1	Section 4.1	Rec Plan 1.1-1.3
	Land Use and Demographic Surveys (Land)	RG 3.8, Section 6.1.4.2	Section 4.1	FES 2.5; ER Cell 4B 3.0
	Uses of Adjacent Lands and Waters	RG 3.8, Section 2.2	Section 4.1	FES 2.5; ER Cell 4B 3.0
	Population Distribution	RG 3.8, Section 2.3	Section 4.1	ER Lic. App. Figure 3.9-1; FES 2.4.1.2; ER Cell 4B 4.0
	Demography	DG-3024, Section 2.1.2	Section 4.1	FES 2.4.1.2, 2.4.1.3, 2.4.2
	Meteorology	RG 3.8, Section 2.8	Section 4.1	Rec Plan 1.1, 1.7.5.6; ER Cell 4B 2.0
		DG-3024, Section 2.2	Section 4.1	Rec Plan 1.1, 1.7.5.6; ER Cell 4B 2.0
		RG 3.8, Section 6.1.3.1	Section 4.1	Rec Plan 1.1, 1.7.5.6; ER Cell 4B 2.0
	Models (Air)	RG 3.8, Section 6.1.3.2	Section 4.1	ER Lic App. 3.3.2
	Geology and Soils	RG 3.8, Section 2.5	Section 4.1	Rec Plan 1.6
		DG-3204, Section 2.4.1	Section 4.1	Rec Plan 1.6
	Seismology	RG 3.8, Section 2.6	Section 4.1	Rec Plan 1.6.2.4, 1.6.2.5
		DG-3024, Section 2.4.2	Section 4.1	Rec Plan 1.6.3, 1.6.3.1, 1.6.3.2
	Hydrological Description of Site	NUREG-1620, Section 3.1.3	Section 4.1	Rec Plan 1.5.1.2, 1.5.1.3, Figure 1.5-1, 1.5-3; ER Cell 4B Appendix A
	Surface Water (Hydrology)	RG 3.8, Section 2.7.2	Section 4.1	GWDP I.F.10

Cross Index to UAC R3 :4 Interrogatory Template

DRC Interrogatory Number	Topic	Regulatory Basis	Where Addressed in This Document	Where Addressed in Other Documents
		DG-3024, Section 2.3.2	Section 4.1	GWDP I.F.10
	Flooding Determinations	NUREG-1620, Section 3.2.3	Section 4.1	GW Permit App. 2.13
	Surface Water Profiles, Channel Velocities, and Shear Stresses	NUREG-1620, Section 3.3.3	Section 4.1	GW Permit App. 2.4
	Ground Water (Hydrology)	RG 3.8 Section 2.7.1	Section 4.1	Rec Plan 1.5.1.2, 1.5.1.3, Figure 1.5-1, 1.5-3
		DG-3024, Section 2.3.1	Section 4.1	Rec Plan 1.5.1.2, 1.5.1.3, Figure 1.5-1, 1.5-3
	Radiological Surveys	RG 3.8, Section 6.1	Section 4.1	ER Cell 4B 10.3-10.4
	Site and Uranium Mill Tailings Characteristics	NUREG-1620, Section 2.1.3	Section 4.1, 4.5.1, Attachment 5	Rec. Plan 2.2
	Disposal Cell Cover Engineering Design	NUREG-1620, Section 2.5.3	Section 4.5.3	GW Permit App. 2.7.2.4; Rec Plan 3.2.2.1
	Design of Erosion Protection Covers	NUREG-1620, Section 3.5.3	Section 4.5.3	GW Permit App. 2.7.2.4; Rec Plan 3.2.2.1, 3.3.5
10CFR40, APPENDIX A, CRITERION 5A(1)-14/01	Groundwater Protection Standards	UAC R313-24-4, NUREG-1620 section 4.2.3	Section 4.1, 4.6	GWDP I.A Table 1, I.B, I.C Table 2, I.E
CRITERION 5A(2)-15/01	Liner	UAC R313-24-4	Section 4.1, 4.6	GWDP I.D.2, I.E.8 (c), I.E.7(f)
10CFR40, APPENDIX A, CRITERION 5A(3)-16/01	Exemption from Groundwater Protection Standards	UAC R313-24-4	Section 4.6	Rec. Plan 2.3.1.1 (a)
10CFR, APPENDIX A, CRITERION 5A(4)-17/01	Prevent Overtopping	UAC R313-24-4	Section 4.1	Rec Plan 2.2.3.1, 2.2.3.2
10CFR APPENDIX A, CRITERION 5A(5)-18/01	Dikes	UAC R313-24-4	Section 4.1	Rec Plan 2.2.3.1, 2.2.3.2
10CFR APPENDIX A, CRITERION 6(1)-19/01	Cover and Closure at End of Milling Operations	UAC R313-24-4	Section 4.1, 4.5.3	GW Permit App. 2.19
	Radon Attenuation	NUREG -1620, Section 5.1.3.1	Section 4.1, 4.5.3	GW Permit App. 2.19; Rec Plan 3.3.2
	Gamma Attenuation	NUREG-1620, Section 5.1.3.2	Section 4.1, 4.5.3	GW Permit App. 2.19; Rec Plan 3.3.2
	Cover Radioactivity Content	NUREG-1620, Section 5.1.3.3	Section 4.1, 4.5.3	GW Permit App. 2.19; Rec Plan 3.3.6, 3.3.8; ER Cell 4B Figure 13
10CFR40, APPENDIX A, CRITERION 6(2)-20/01	Verify Effectiveness of Final Radon Barrier	UAC R313-24-4	Section 4.1, 4.5.3	Rec Plan. 3.2, 3.2.3.1; GW Permit App. 2.19.4
10CFR40, APPENDIX A, CRITERION 6(3)-21/01	Phased Emplacement of Final Radon Barrier	UAC R313-24-4	Section 4.5.3	Rec Plan. 3.2, 3.2.3.1; ER Cell 4B Table 5

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DRC Interrogatory Number	Topic	Regulatory Basis	Where Addressed in This Document	Where Addressed in Other Documents
10CFR40, APPENDIX A, CRITERION 6(5)-23/01	Elevated Raduim Concentrations in cover Materials	UAC R313-24-4	Section 4.5.3	GW Permit App. 2.19; Rec Plan 3.3.6, 3.3.8
	Cover Radioactivity Content	NUREG-1620, Section 5.1.3.3	Section 4.1, 4.5.3	GW Permit App. 2.19; Rec Plan 3.3.6, 3.3.8; ER Cell 4B Figure 13
10CFR40, APPENDIX A, CRITERION 6(6)-24/01	Concentrations of Radionuclides other than Radium in Soil	UAC R313-24-4	Section 4.5.3	GW Permit App. 2.19; Rec Plan 3.3.5
	Background Radiological Characteristics	RG 3.8, Section 2.1	Section 4.1	Lic. App. 3.13.1; ER Cell 4B 9.0
10CFR40, APPENDIX A, CRITERION 6(7)-25/01	Nonradiological Hazards	UAC R313-24-4	Attachment 5	Dames and Moore 3.3.1; ER Cell 4B 9.0
	Regional Nonradiological Characteristics	RG 3.8, Section 2.11	Section 4.1	Dames and Moore 3.3.1; ER Cell 4B 9.0
	Concentrations of Nonradiocative Wastes	RG 3.8, Section 5.3	Section 4.5.1, Attachment 5	Dames and Moore 3.3.1; ER Cell 4B 9.0
10CFR40, APPENDIX A, CRITERION 6A(1)-26/01	Completion of Final Radon Barrier	UAC R313-24-4	Section 4.5.3	Rec Plan. 3.2, 3.2.3.1; GW Permit App. 2.19.4
10CFR40, APPENDIX A, CRITERION 6A(2)-27/01	Extending Time for Milestones Performance	UAC R313-24-4	Section 4.5.3	Rec Plan. 3.2, 3.2.3.1; GW Permit App. 2.19.4
10CFR40, APPENDIX A, CRITERION 6A(3)-28/01	Accepting Uranium Byproduct Material from Other Sources During Closure	UAC R313-24-4	Section 4.5.3	License Condition 9.11
10CFR40, APPENDIX A, CRITERION 7-29/01	Preoperational and Operational Monitoring Programs	UAC R313-24-4	Section 4.1	Rec Plan 2.3.2
10CFR40, APPENDIX A, CRITERION 8-30/01	Effluent Control During Operations	UAC R313-24-4	Section 4.1	GW Permit App. 2.15
	Gaseous and Airbourne Particulate Materials	DG-3024, Section 4.1	Section 4.1	GW Permit App. 2.15
	Liquids and Solids	DG-3024, Section 4.2	Section 4.1	GW Permit App. 2.15
	Contaminated Equipment	DG-3024, Section 4.3	Section 4.1	GW Permit App. 2.15
	Sources of Mill Wastes and Effluents	RG 3.8, Section 3.4	Section 4.4	GW Permit App. 2.15; Dames and Moore 3.3
	Control of Mill Wastes and Effluents	RG 3.8, Section 3.5	Section 4.4	GW Permit App. 2.15; Dames and Moore 3.4
	Sanitary and Other Mill Waste Systems	RG 3.8 Section 3.6	Section 4.1	GW Permit App. 2.15; Dames and Moore 3.5
	Effluents in the Environment	RG 3.8, Section 5.1.2	Section 4.1	GW Permit App. 2.15; Dames and Moore 3.3
	Effluent Control Techniques	DG-3024, Section 5.7.1	Section 4.1	GW Permit App. 2.15; Dames and Moore 3.3
	External Radiation Exposure Monitoring Program	DG-3024, Section 5.7.2	Section 4.1	GW Permit App. 2.15
	Airborne Radiation Monitoring Program	DG-3024, Section 5.7.3	Section 4.1	GW Permit App. 2.15; ER Lic. App 3.3.2
	Exposure Calculations	DG-3024, Section 5.7.4	Section 4.1	Rec. Plan Attachment F

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DRC Interrogatory Number	Topic	Regulatory Basis	Where Addressed in This Document	Where Addressed in Other Documents
	Bioassay Program	DG-3024, Section 5.7.5	Section 4.1	Rec Plan 3.2
	Contamination Control Program	DG-3024, Section 5.7.6	Section 4.1	Rec Plan 3.2
	Airborne Effluent and Environmental Monitoring Programs	DG-3024, Section 5.7.7	Section 4.1	GW Permit App. 2.9; Rec Plan 2.3; Dames and Moore 3.3; ER Cell 4B Appendix C
	Groundwater and Surface Water Monitoring Programs	DG-3024, Section 5.7.8	Section 4.1	GWDP I.E, I.F; Rec Plan 2.3.1.1; ER Cell 4B 10.2
	Control of Windblown Tailings and Ore	DG-3024, Section 5.7.9	Section 4.1	Rec Plan 3.2.3.1
10CFR40, APPENDIX A, CRITERION 8A-31/01	Daily Inspections	UAC R313-24-4	Section 4.1	Rec Plan 2.3.2.2(a)
10CFR40, APPENDIX A, CRITERION 9-32/01	Financial Surety Arrangements	UAC R313-24-4	Section 4.5.3	Surety 2010
	Financial Assurance	DG-3024, Section 8.3	Section 4.5.3	Surety 2010
	Maintaining Financial Surety	NUREG-1620, Section 4.4.3(10)	Section 4.5.3	Surety 2010
10CFR40, APPENDIX A, CRITERION 10-33/01	Costs of Long-Term Surveillance	UAC R313-24-4	Section 4.5.3	Surety 2010
UAC R317-6-6.1-34/01	Duty to Apply for a Groundwater Discharge Permit	UAC R313-24-4	Section 4.1, 4.6	GWDP IV.D
UAC R317-6-6.3-35/01	Groundwater Discharge Permit Application	UAC R313-24-4	Section 4.1, 4.6	GWDP IV
UAC R317-6.6.4-36/01	Issuance of Discharge Permit	UAC R313-24-4	Section 4.1, 4.6	GWDP IV
UAC R317-6-6.9-37/01	Permit Compliance Monitoring	UAC R313-24-4	Section 4.1, 4.6	GWDP III
	Examination of Compliance and Monitoring Program	NUREG -1620, Section 4.3.3.4	Section 4.1, 4.6	GWDP I.F.1
UAC R317-6-6.10-38/01	Background Water Quality Determination	UAC R313-24-4	Section 4.1, 4.6	GWDP I.B; ER Lic App. 3.7.3.2 (c)
UAC R317-6-6.10-39/01	Commencement and Discontinuance of Groundwater Discharge Operations	UAC R313-24-4	Section 4.6	GW Permit App. 2.19
UAC R317-6-6.12-40/01	Submission of Data	UAC R313-24-4	Section 4.6	GWDP I.F.1
UAC R317-6-6.13-41/01	Reporting of Mechanical Problems or Discharge System Failures	UAC R313-24-4	Section 4.6	GWDP I.G; GW Permit App 2.15
UAC R317-6-6.10-42/01	Correction of Adverse Effects	UAC R313-24-4	Section 4.6	GWDP I.G
	Corrective Action Assessment	NUREG-1620, Section 4.3.3.3	Section 4.6	GWDP I.G
UAC R317-6-6.10-43/01	Out-of-Compliance Status	UAC R313-24-4	Section 4.6	GWDP I.G
UAC R317-6-6.10-44/01	Procedure When a Facility is Out-of-Compliance	UAC R313-24-4	Section 4.6	GWDP I.H

DRC Interrogatory Number	Topic	Regulatory Basis	Where Addressed in This Document	Where Addressed in Other Documents
UAC R317-6-6.10-45/01	Groundwater Discharge Permit Transfer	UAC R313-24-4	Section 4.6	GWDP IV.L

Notes:

If not stated otherwise, section number refers to section in the license amendment application, not its attachments.

References:

GWDP - "*Ground Water Discharge Permit UGW370004*". July 14, 2011

ER Cell 4B - "*Environmental Report in Support of Construction Tailings Cell 4B*". Revised and Resubmitted September 11, 2009

GW Permit App. - "*Permit Renewable Application. State of Utah Ground Water Discharge Permit NO. UGW370004*". September 1, 2009

Rec. Plan - "*Reclamation Plan White Mesa Mill Blanding, Utah. Radioactive Material License NO. UT1900479 Revision 4.0*". November 2009

ER Lic. App. - "*White Mesa Uranium Mill License Renewal Application. State of Utah Radioactive Materials License No. UT1900479". Volume 4 of 5 (Environmental Report).* February 28, 2007

Dames and Moore - "*Environmental Report. White Mesa Uranium Project. San Juan County, Utah for Energy Fuels Nuclear, Inc*". Prepared by Dames and Moore. January 30, 1978

FES - "*Final Environmental Statement related to operation of White Mesa Uranium Project. Energy Fuels Nuclear, Inc*". May 1979.

Surety 2010 - *"Revised Cost Estimates for Reclamation of the White Mesa Mill and Tailings Management System"*. November 23 2010.

License Condition - "*Utah Department of Environmental Quality Division of Radiation Control Radioactive Material License*". License #UT1900479. June 2010