Appendix D

Applicable Regulatory Classification

Table of Contents

List of Tables

1. Introduction

The overall objective of this appendix is to classify and explain the basis and rationale for the regulatory classification of the affected surface and subsurface soil in the Fenced Area of the CSMRI Site (the “Soil”). A similar analysis would apply to the Clay Pits area if contaminated material were to have been found there during the investigation. The appropriate regulatory classification of the Soil is dependent on both the operational history of the research facility and the results of analytical data collected with respect to the Soil. The conclusion of this section is that the Soil is “solid waste” that may be disposed of at a solid waste disposal facility that can demonstrate the ability to safely accept and dispose of the Soil.

The conclusions regarding the regulatory classification of the Soil will be used to determine which specific statutory and regulatory requirements and/or ARARs apply to the Soil. More specifically, the regulatory classification will be used to (1) determine eligibility for currently licensed or permitted offsite disposal facilities for acceptance of the Soil for disposal, (2) determine engineering design, performance criteria, and administrative permitting or licensing requirements for construction of a new disposal facility onsite, and (3) determine design and performance criteria for onsite disposal.

Regulatory classification of the Soil is complicated by the fact that the Site operated as a research facility for approximately 70 years (1916 to 1987) involving thousands of projects. Therefore, in order to specifically determine the appropriate regulatory classification, it is necessary to evaluate a large “universe” of potential regulatory classifications. Three general overall regulatory schemes could potentially govern the handling of the soil: (1) Solid Waste, (2) Hazardous Waste, and (3) regulated Radioactive Material.

These general regulatory schemes further break down into several potential specific material/waste definitions that include:

- Radioactive material,
- Naturally occurring radioactive material (NORM),
- Technologically enhanced naturally occurring radioactive material (TENORM),
- Low-level radioactive waste,
- Special nuclear radioactive material,
- Source material,
- By-product material (11(e)(1) and 11(e)(2)),
- Classified waste,
- Transuranic radioactive material,
- Hazardous waste,
- Mixed waste, and
- Solid waste.

Each of these potential regulatory classifications is discussed in detail in the subsections following the discussion of the operational history.

2. Definitions

Some definitions pertaining to radiation control in Colorado include:

"Radioactive material" means any material, solid, liquid, or gas, which emits ionizing radiation spontaneously [§ 25-11-101(3), C.R.S.]

"Naturally occurring radioactive material", or NORM, means any nuclide that is radioactive in its natural physical state and is not manufactured. "Naturally occurring radioactive material" does not include source material, special nuclear material, or by products of fossil fuel combustion, including but not limited to bottom ash, fly ash, and flue gas emission by-products [§ 25-11-101(2.7), C.R.S.].

"Background radiation" includes NORM (which has not been technologically enhanced) [6 CCR 1007-1, 1.4].

"Technologically enhanced naturally occurring radioactive material", or TENORM, means naturally occurring radionuclides whose radionuclide concentrations are increased by or as a result of past or present human practices [§ 25-11-201(4), C.R.S.]. TENORM does not include background radiation or the natural radioactivity of rocks or soils. TENORM does not include uranium or thorium in source material as defined in the AEA and U.S. NRC regulations. TENORM is considered a subset of NORM.

"Source material" means material, in any physical or chemical form, including ores, which contain by weight one twentieth of 1 percent (0.05 percent) or more of uranium, thorium or any combination thereof. Source material does not include special nuclear material. [6 CCR 1007-1, 1.4]

"By-product material" means:

- Any radioactive material, except special nuclear material, yielded in or made radioactive by exposure to the radiation incident to the process of producing or utilizing special nuclear material (6 CCR 1007-1, 1.4); and
- The tailings or wastes produced by the extraction or concentration of uranium or thorium from ore processed primarily for its source material content, including discrete surface wastes resulting from uranium or thorium solution extraction processes. Underground ore bodies depleted by these solution extraction operations do not constitute "by-product material" within this definition (6 CCR 1007-1, 1.4).

"Waste" means those low-level radioactive wastes that are acceptable for disposal in a land disposal facility. For the purposes of this definition, low-level waste has the same meaning as in the Low-Level Radioactive Waste Policy Act, P.L. 96-573, as amended by P.L. 99-240, effective January 15, 1986; that is, radioactive waste (a) not classified as high-level radioactive waste, spent nuclear fuel, or by-product material as defined in Section 11.e.(2) of the Atomic Energy Act (uranium or thorium tailings and waste) and (b) classified as low-level radioactive waste consistent with existing law and in accordance with (a) by the U.S. Nuclear Regulatory Commission (6 CCR 1007-1, 1.4).

"Waste" is also defined in Part 14 of the radiation regulations as radioactive waste other than:

- Waste generated as a result of the defense activities of the federal government or federal research and development activities;
- High-level waste such as irradiated reactor fuel, liquid waste from reprocessing irradiated reactor fuel, or solids into which any such liquid waste has been converted;
- Waste materials containing transuranic elements with contamination levels greater than one hundred nanocuries (3700 bq) per grain of material;
- By-product material as defined in Section 11(e)(2) of the "Atomic Energy Act of 1954", as amended on November 8, 1978; or
- Waste from mining, milling, smelting, or similar processing of ores and mineral-bearing material primarily for minerals other than radium (6 CCR 1007-1, 14.2).

3. Operational History

The Experimental Plant, also known as "Building 101," was constructed at the Site in 1912. It was a research facility only. Actual mining was not conducted at the Site. There were no production facilities at the Site.

For many years, the Experimental Plant was the only building at the Site. Its purpose was to provide a research facility for mining and metallurgy. The Experimental Plant later became one of 17 buildings at the Site.

Mr. Arthur J. Weinig was the director of the Experimental Plant from 1923 to 1949. In 1949, CSMRI was founded as a non-profit organization. CSMRI conducted research for private industry and government at the Site between 1949 and 1987.

The operational history described below is based upon a review of certain CSMRI organizational and financial records, certain documents produced to EPA from various entities identified as potentially responsible parties (PRPs), interviews (including former CSMRI employees), state and national archives, periodicals, and other records. A number of references are made in the following discussion to documents that were provided as attachments to the RAOA (Volume 3, Removal Action Options Analysis report, June 12, 1995).

3.1 Operational History (1912-1920)

The Experimental Plant was seldom used between 1912 and 1916. A 1912 document states that the Plant was not fully equipped when it opened in 1912 (RAOA, Attachment 1 at 5). Upon arrival to the Experimental Plant for the first time, one researcher writes in a May 1916 letter:

> ... the water capacity of the building is absolutely inadequate for any operation, and upon talking to Dr. Phillips, he realized fully that the mill had evidently never been tried out on any scale whatsoever with the view of working same successfully (RAOA, Attachment 2 at 1).

In 1916, the United States Bureau of Mines (BOM) moved its Denver Experiment Station to the School of Mines Physics Building/Engineering Hall, which is not located at the Site (RAOA, Attachment 3 at 4). Although Engineering Hall is separate from the Experimental Plant, BOM used the Experimental Plant (RAOA, Attachment 3 at 4). The attached agreements indicate that the BOM investigations at the Experimental Plant were under the supervision and direction of BOM. Attachment 4, 1916 Agreement at 2 ¶ 3, 1917 Agreement at 1 ¶ 2, 1918 Agreement at 1 ¶ 2, 1919 Agreement at 1 ¶ 2.

BOM used the Experimental Plant in 1916 for the mechanical concentration of over 200,000 pounds of pitchblende ore (RAOA, Attachments 3 at 4). This pitchblende beneficiation project is relevant for purposes of whether wastes emanating from this project are “low-level radioactive waste.” (The definition of “low level radioactive waste” in Colorado radiation control regulations excludes (1) waste generated from federal research and development activities; (2) waste generated from federal defense activities; and (3) wastes from the processing of ores for minerals other than radium).

The pitchblende beneficiation project involved several parties. BOM contracted with a mining company in Colorado, the National Radium Institute in Denver, and a philanthropist (Mr. Alfred Dupont) in Philadelphia (RAOA, Attachment 5). The mining company provided the pitchblende ore to the National Radium Institute in Denver and paid the costs of the research. BOM provided all the labor and supervision for the research in exchange for pure uranium oxide extracted from the pitchblende. BOM used the uranium oxide for experimentation on “its possible utilization for special steels which we (i.e., BOM) hope may find a use in ordnance” (RAOA, Attachment 5). BOM’s goal was to research national defense related matters. The National Radium Institute gave the extracted radium to Mr. Dupont who in turn donated the radium to several hospitals for medicinal therapeutic uses (RAOA, Attachment 6).

The various components of the pitchblende work were conducted in different locations. The mining company delivered the pitchblende ore to the National Radium Institute in Denver (RAOA, Attachment 6). BOM brought the pitchblende ore to the Experimental Plant in Golden only for concentration purposes to produce higher-grade material (RAOA, Attachment 2). The concentrates were then delivered to the National Radium Institute in Denver for the extraction of radium and high-grade uranium oxide (RAOA, Attachment 7). The concentration process conducted at the Experimental Plant was mechanical, according to BOM.

BOM also used the Experimental Plant for experiments using a separator for the elimination of impurities from pyrrhotite in order to produce sulfur (RAOA, Attachment 3 at 4-5).

3.2 Operational History (1920-1949)

There is no known information on how the Experimental Plant was used between 1920 and 1923. The Bureau of Mines left Colorado School of Mines in 1920. It is likely that the Experimental Plant was seldom used during this time.

From 1923 to 1949, Mr. Arthur J. Weinig was director of the Experimental Plant. He also ran a consulting business from the Experimental Plant for private industry (RAOA, Attachment 8).

There are few specifics on the type of research conducted at the Experimental Plant under Mr. Weinig’s direction. Some understanding of the specifics, however, can be inferred by an understanding of the general use of the facility. In general, Mr. Weinig researched special problems related to mining and metallurgy, including the testing and examination of ores (RAOA, Attachment 19). The School of Mines used the Experimental Plant for laboratory classes during this time period.

Mr. Weinig's clients included Climax Molybdenum Company, American Metal Company, John J. Raskob *et al.*, London Gold Mining Co., Shenandoah Dives Mining Co., Cuban American Manganese Co., Potash Company of America, Basic Magnesium Inc., and others (RAOA, Attachment 8).

Mr. Weinig had inventions in the following areas: flotation processes for treatment of molybdenum ore, sulfide ore flotation processes, cement manufacturing flotation processes, gold and silver concentrate cyanide treatments, apparatus and process inventions on ball mills, classifiers, screens, tables, meters, flotation machines and cyanidation equipment and a process for treating magnesium ores (RAOA, Attachment 8). Mr. Weinig also wrote a prominent 1933 article, "A Functional Size-Analysis of Ore Grinds" (RAOA, Attachment 8). These types of activities likely occurred at the Experimental Plant during his tenure.

A major client of Mr. Weinig's was Climax Molybdenum Company (Climax). Mr. Weinig assisted Climax to operate the Climax mine near Leadville by working on the design of the flotation mill (RAOA, Attachment 8). Climax's involvement at the Experimental Plant for this time period indicates that much of the research likely involved issues related to the Climax mine near Leadville. Mr. Weinig developed the flotation system for the mine; therefore, significant amounts of flotation studies were likely conducted at the Experimental Plant. Also, many of the ores involved in the research were likely associated with molybdenum.

3.3 Operational History (U.S. Bureau of Mines Operation for 1937-1950)

The BOM returned to the Site and used portions of the Site for a coal experimental station during the 1937-1950 timeframe (RAOA, Attachment 4 at 5-11). BOM used Building 104, which is adjacent to the Experimental Plant, as well as other adjacent structures and pilot plants for various studies and experiments involving subbituminous coal and lignite (RAOA, Attachment 4 at 5, 12-13). A primary significance of the BOM coal experiment station for waste classification purposes is that by-products of fossil fuel combustion, including ashes, are excluded from the definition of Naturally Occurring Radioactive Material (NORM).

BOM describes 18 different studies during this 14-year time period. BOM's 18 studies focused on coal. Arsenic, thorium, and uranium, which are the contaminants of concern at this Site, are hazardous substances generally common to coal and coal fly ash.

An estimate of the weight of the coal materials used by BOM during this time period is between 20.7 million pounds and 5.8 million pounds. Attachment 3.

3.4 Operational History (1949-Present)

In 1949, CSMRI was founded as a non-profit corporation. CSMRI was first incorporated as the Colorado School of Mines Research Foundation, Inc. (CSMRF). In 1969, CSMRF changed its name to the Colorado School of Mines Research Institute (CSMRI). For this report, the organization will be referred to as CSMRI for all time periods.

The CSMRI Articles of Incorporation state that the objects and purposes of CSMRI are, in part, to:

> "Promote, prosecute, encourage and aid scientific and technological investigation and research and to provide or assist in providing the means and facilities by which scientific and technological discoveries, inventions and processes may be developed" (RAOA, Attachment 9).

To accomplish these objects and purposes, CSMRI was "to conduct research, investigation, studies and tests in the fields related to the mineral industries as well as such other fields as may from time to time be deemed advantageous..." (RAOA, Attachment 9).

CSMRI used the CSMRI research facility for mining research. CSMRI also allowed some portions of the CSMRI research facility to be used by private industry for research that was conducted independently.

Although CSMRI was a fledgling organization in 1949 with few employees, it grew to a large research organization with over 300 employees. By 1987, CSMRI ceased all research operations at the Site and continued closure activities that addressed certain environmental matters at the Site.

In 1992, a City of Golden water main broke at the Site, releasing substantial water into the former tailings pond and into Clear Creek. EPA commenced a CERCLA removal action, resulting in the excavation of the tailings pond and some surrounding soils. Prior to excavation, EPA flushed out remaining mobile contamination from the interior of the buildings into the tailings pond. The excavated materials, which were temporarily stored at the Site by EPA at a location that now has the Colorado School of Mines' softball field, are known as the Stockpile that was the subject of EPA's UAO. The volume of the Stockpile was 22,000 cubic yards.

Unlike the time period from 1920 to 1949, many of the specific projects conducted by CSMRI at the Site between 1949 and the mid-1980s are known. CSMRI's research projects are known through "project files" and corporate records that exist today. There are over 30 large filing cabinets full of CSMRI project files located at CSM. Most of these project files contain detailed records of projects conducted in the 1980s and 1970s, with a few records for the 1960s. The CSMRI annual reports from the 1950s and the early 1960s contain a list of the research projects performed by CSMRI.

After the water main broke in 1992, EPA reviewed the CSMRI project files and created a working "waste-in-list" (EPA Waste-in-List). The EPA Waste-in-List includes the entities EPA believes to be potentially responsible for the cleanup costs at the Site, as well as a description of the hazardous substances and the type of research performed. The RAOA contains the decade-by-decade summaries of the EPA Waste-in-List (RAOA, Attachments 10-12).

EPA listed 863 projects from the 1960s through the 1980s project files. By far, the majority of projects involved minerals unrelated to uranium, thorium, or radium. Only 89 of these projects, or 10 percent, were described as uranium leaching, separation, process developing, upgrading, or flotation projects. Only nine of these projects, or 1 percent, were listed as uranium concentration or extraction projects. The difference between these two categories is that a uranium "leaching" project, for example, can simply be a leaching feasibility or amenability study where the project primary objective is to determine the physical or chemical feasibility of leaching, or process development, as opposed to an actual extraction or concentration project. Only one project, or less than 1percent, was described as a thorium extraction or concentration project. There were no projects for radium extraction. Table 1 provides a summary of the projects listed in the EPA's Waste-in-List.

Table 1
1960, 1970, 1980 CSMRI Projects (From EPA's Waste-in-List)

Project Type	Number of Projects	Percent of Total
All Projects	863	100
Total Uranium Projects – Titled "Leaching", "Separation", "Process Developing", "Upgrading", or "Floatation"	89	10
Total Uranium Projects Titled "Concentration" or "Extraction"	9	1
Total Thorium Projects – Titled "Leaching", "Separation", "Process Developing", "Upgrading", or "Floatation"	0	0
Total Thorium Projects Titled "Concentration" or "Extraction"	1	<1
Total Radium-Related Projects	0	0

In addition to summaries of EPA's Waste-in-List, attached to this report are all of the discovered annual reports for projects conducted by CSMRI for specific years during the 1950s and 1960s (RAOA, Attachments 13-20). These lists are copied from CSMRI annual reports and corporate records and are referred to as the "Annual Report Lists."

As compared to the EPA Waste-in-List, a lower frequency of uranium, thorium, and radium projects is seen in the Annual Reports. There are 1,408 projects listed in the Annual Report Lists. Of these, only 11 projects, or less than 1 percent, are listed as uranium projects related to leaching, separation, process developing, upgrading, or flotation. Of the 1,408 projects, only one is listed as a uranium concentration project. For thorium, only two are listed as thorium leaching, separation, process development, upgrading, or flotation projects. And no projects are listed for thorium concentration or extraction. Finally, there are no radium-related projects. Table 2 provides a summary of the projects listed in the Annual Reports.

Table 2
1952, 1953, 1954, 1958, 1960, 1961, 1962, 1963 CSMRI Projects (Taken from the Annual Report)

Project Type	Number of Projects	Percent of Total
All Projects	1408	100
Total Uranium Projects – Titled "Leaching", "Separation", "Process Developing", "Upgrading", or "Floatation"	11	<1
Total Uranium Projects Titled "Concentration" or "Extraction"	1	<1
Total Thorium Projects – Titled "Leaching", "Separation", "Process Developing", "Upgrading", or "Floatation	2	<1
Total Thorium Projects Titled "Concentration" or "Extraction"	0	0
Total Radium Related Projects	0	0

Combining the Waste-in-List and the Annual Reports indicates that CSMRI conducted at least 2,271 projects from the 1950s to the 1980s. While these two sources of information are not complete for all the projects conducted at the Site by CSMRI, they would pass any statistical test for capturing a representative random sample of all the projects conducted by CSMRI.

Of the 2,271 projects, no projects are related to radium. Only 100, or 4 percent, are related to uranium leaching, separation, process development, upgrading, and flotation. Only 10 projects, or less than 1 percent, are related to uranium concentration or extraction. Of the 2,271 projects, only two are related to thorium leaching, separation, process development, upgrading, and flotation. Only one is related to thorium extraction or concentration. Table 3 presents a summary of projects from the combined lists.

Table 3
1952, 1953, 1954, 1958, and 1960's to 1980's CSMRI Projects (Combined Lists)

Project Type	Number of Projects	Percent of Total
All Projects	2271	100
Total Uranium Projects – Titled "Leaching", "Separation", "Process Developing", "Upgrading", or "Floatation"	100	4
Total Uranium Projects Titled "Concentration" or "Extraction"	10	<1
Total Thorium Projects – Titled "Leaching", "Separation", "Process Developing", "Upgrading", or "Floatation"	2	<1
Total Thorium Projects Titled "Concentration" or "Extraction"	1	<1
Total Radium Related Projects	0	0

These summaries indicate that the vast majority of research conducted at the facility was not conducted for the study of radioactive materials.

When evaluating the two databases and the statistics, the word "uranium" appeared in 240 of the 2,271 total projects, or 11 percent of the total. The 110 uranium-related projects listed in the above chart are a subset of the 240 projects. However, the other 130 uranium projects did not fall into the categories of leaching, separation, process development, upgrading, flotation, concentration, or extraction. Instead, these uranium projects were, for example, feasibility studies, literature studies, grinding projects, or projects performed at the sponsor's mining site (not at CSMRI) and should be excluded from the relevant statistics. Similarly, of the 2,271 projects, the word "thorium" appeared in nine projects, or less than 1 percent of the total.

Another issue relevant to the waste characterization issue is the disposition of uranium and thorium after the materials were extracted in the few extraction projects. None of the former CSMRI employees interviewed as part of the RAOA recall sending just the extracted materials back to the sponsors. This is further supported by the absence of manifests or licenses to transport extracted materials offsite. The main purpose for conducting extraction research at the Site was to develop the technology and process for extraction. It appears that after the quality of the extracted materials was determined by laboratory analysis, the extracted materials would have been discarded into the tailings pond or wherever the waste materials went after completion of the research.

A review of the above-referenced research databases indicates that the vast majority of projects involved copper, lead, nickel, iron, zinc, coal, oil shale, and gold. The research issues varied widely across a broad range of technical mining-related areas, including development of mining exploration techniques, mineralogical laboratory analyses, refraction techniques, hydraulic transportation methods, rock mechanics, metallurgical processing methods, flotation systems, consulting services to mining sites and mining operations, sulfur studies, pyrometalurgical reactions, liquid ion exchange processing, copper electrolysis, smelting process technologies, halogenation of ores and metallurgical products, fused salt electrolysis, economic feasibility studies, phosphate studies and analysis, handling of limestone, geophysical, petrographic, and stratographic studies, spectrographic studies, x-ray diffraction studies, instrument calibration and construction, fatty acid studies, well log studies, sand heat treatment methods, evaluation of different clays, among other studies. From this partial list, it is clear that relatively little work with radiological materials occurred at the Site.

4. Site Licensing History

The CSMRI Site licensing and permitting history shows that the Soil was and should be regulated as solid waste. The new Stockpiles A and B are similar to the EPA Stockpile for purposes of regulatory classification. The EPA Stockpile originated from the former impoundment area at the facility and certain adjacent areas. The impoundment area was regulated as a RCRA solid waste facility, not a hazardous waste facility. In addition, the EPA Stockpile was removed from the Site as “solid waste” and disposed of at a solid waste disposal facility in Adams County, Colorado.

CSMRI was careful and conservative when obtaining licenses and permits. In doing so, the regulatory programs that provided facility oversight determined which regulatory program(s) was most appropriate for the Site activities. Governmental regulators concluded that the facility regulation would be under the authority of the Solid Waste Disposal Sites and Facilities Act and associated regulations. This conclusion is supported by the analysis provided in this section showing that the Soil is not hazardous waste.

Prior to this governmental determination CSMRI applied for permits under the RCRA, Subtitle C, which regulates hazardous waste management including the permitting for treatment, storage and disposal facilities of hazardous materials. Obtaining a RCRA hazardous waste permit requires a two-part application process. On November 17, 1980, CSMRI applied for and received a Part A permit. On August 24, 1984, EPA requested that CSMRI complete the permitting process by submitting a Part B permit. In undertaking the more detailed Part B application, it became apparent that CSMRI had filed the original Part A application in error and that the facility was not subject to RCRA, Subtitle C, hazardous waste regulations. CSMRI submitted a request for exemption from Subtitle C as provided in 40 CFR part 261.4(b)(7) (this point is discussed in more detail below). The Colorado Department of Health reviewed this information and determined the facility was exempt from Subtitle C of RCRA. RAOA Attachment 21 contains four letters that discuss the RCRA history at the Site.
Although most of the research at the Site was not related to the study of radioactive materials, CSMRI possessed, and continues to possess, a license for the storage, handling and possession of NORM, source, and by-product material (Colorado Radioactive Materials License Number 617-01S).

Tables 4 and 5 present chronological summaries of the U.S. Atomic Energy Commission ("U.S. AEC") and the State of Colorado licensing actions at the Colorado School of Mines Research Institute site:

Table 4
Summary of U.S. AEC Licensing Actions at CSMRI

Time Period	License Details
Terminated 1948	Weinig had License No. R-120 from the U.S. AEC for source material, which terminated in 1948. V2731, V2732. Weinig's clients also may have had separate licenses from the U.S. AEC for research at the Site. V1436.
1958 -1967	The State of Colorado has records of U.S. AEC licensing actions dating from January 1958 through December 1967.
1958 - 1967	U.S. AEC By-product Material License Number: 5-4607-1 (including amendment #1 through amendment #23) dated from January 1958 through December 1967 Issued to: Colorado School of Mines Research Foundation, Inc. Authorized uses: laboratory research; teaching of industrial radioisotopic courses; as a component of a neutron generator for activation analysis; calibration of instruments; measurement of specific gravity of slurry in a pipeline; laboratory tracer studies; monitoring of solutions and slurries; metallurgical studies; neutron generator for activation analysis; experimental curing of thin plastic films deposited on ceramics; studies of molybdenum; geochemical research; to measure wear rate of experimental pipelines and machines and similar laboratory studies; and for the determination of solubility constants.
1966	U.S. AEC Special Nuclear Materials License Number: SNM-972 (for Plutonium), dated August 1966 Issued to: Colorado School of Mines Research Foundation, Inc. Authorized uses: for use in accordance with the procedures described in the licensee's application dated July 20, 1966. Storage only of soil samples.

Table 5
Summary of State of Colorado Licensing Actions at CSMRI

Date	License Details
October 24, 1968	Colorado Radioactive Materials License Number: Colo. 08 – 01 (F) Issued to: Colorado School of Mines Research Foundation, Inc. and Colorado School of Mines Authorized uses: Research, development, and teaching.
March 7, 1969	Amendment No. 2 to License Number: Colo. 08 – 01 (F).
May 25, 1971	Amendment No. 2 to License Number: Colo. 08 – 01 (F).
September 29, 1971	Amendment No. 3 to License Number: Colo. 08 – 01 (F).
February 25, 1972	Amendment No. 4 to License Number: Colo. 08 – 01 (F)
August 16, 1974	Amendment No. 5 to License Number: Colo. 08 – 01 (F)
October 31, 1975	Amendment No. 6 to License Number: Colo. 08 – 01 (F).
	Note: The State does not have record(s) of licensing actions between November 1975 and March 1985.
April 10, 1985	Colorado Radioactive Materials License Number: Colo. 617-01S Issued to: Colorado School of Mines Research Institute. Authorized uses: Possess, use, and store.
March 25, 1986	Amendment No. 1 to License Number: Colo. 617-01S
September 11, 1990	Amendment No. 2 to License Number: Colo. 617-01S. Issued to:

Table 5
Summary of State of Colorado Licensing Actions at CSMRI

	Colorado School of Mines Research Institute Authorized uses: Possess, use, and store.
October 31, 1997	Amendment No. 3 to License No. 617-01
March 30, 2001	Amendment No. 4 to License No. 617-01
February 11, 2002	Amendment No. 5 to License No. 617-01. Issued to: Colorado School of Mines Research Institute Authorized uses: Possess and store naturally occurring, source and by-product.
May 19, 2005	Amendment No. 6 to License No. 617-01 (same authorized uses)
December 15, 2006	Amendment No. 7 to License No. 617-01 (same authorized uses)

The Site was licensed by both the Atomic Energy Commission (AEC) and the State of Colorado for numerous types of radioactive materials over several decades. The current license includes NORM, source material, and by-product material. Previous licenses authorized possession and use of any radioactive materials having atomic numbers 3 through 88 inclusive, americium, and plutonium. The scant available records related to plutonium materials indicate that disposal of certain plutonium materials occurred at Rocky Flats west of Denver (RAOA, Attachment 22). The licenses authorizing the use of americium state that the americium was for the calibration of instruments and for gauges. The amounts of americium for these instruments must have been minute. There are no records related to the disposal of americium.

The AEC sponsored some research projects at CSMRI. See Annual Reports (RAOA, Attachments 13-20). In response to EPA's 104(e) request, the successor to the AEC stated that it could find no records related to any AEC-sponsored projects at CSMRI. However, the U.S. Department of Energy (DOE) admitted that the AEC used the Site for research. DOE admitted this several years ago when the CSMRI Site was considered for remedial action by a federal program administered by DOE. This program, the Formerly Utilized Sites Remedial Action Program (FUSRAP), was created to remediate sites used under the Manhattan Engineer District and the AEC during the early years of nuclear development. In 1987, DOE wrote to CSMRI concluding that the CSMRI Site did not qualify for the FUSRAP program because it could not be determined if the radiological contamination originated from the federal-sponsored work or work conducted under the State radioactive materials license (RAOA, Attachment 23).

There also are numerous general references to defense-related projects at CSMRI, but no files were found during the RAOA investigation and the United States has not produced applicable documents. See April 28, 1995 letter from A. Iatridis to L. Gunderson of EPA.

5. Prior Waste Classifications for Wastes Removed from the Site

Wastes removed from the Site in the last several years confirm that the Soil is solid waste. The 22,000 cubic yards of stockpiled soils, which originated from the former settling pond, soils near the former pond, and mobile materials from the interior of the buildings, were classified and disposed of as solid waste.

During the 2004 halted remedial field work, a total of 1,870 cubic yards of soil were excavated from the Site and placed in super sack bags. Several bags were initially shipped to and disposed of as solid waste at a RCRA facility in Idaho. The remaining 1,776 cubic yards contained in 455 bags were stored onsite. These bags were later shipped to and disposed of as solid waste at the Foothills Landfill in Jefferson County, Colorado, as detailed in the following paragraphs.

In December 2004, Stoller collected representative soil samples from a random subset of the 455 super-sack containers staged at the Site to generate a legitimate data set to evaluate potential disposal options of the containerized material. Details of the sampling were presented in *Sampling Report, CSMRI Site Containerized Material*, April 1, 2005. Results were submitted to CDPHE for review in the April 2005 report, *Dose Assessment for the Emplacement of the CSMRI Site Containerized and Remaining Subsurface Soil into a RCRA Subtitle D Solid Waste Landfill* (Stoller 2005a). After review of the dose assessment report, the CDPHE approved shipment of the bagged radioactive/metals-contaminated soils and up to 30,000 cubic yards of similar soils to a solid waste landfill in a letter dated August 26, 2005.

In order for the landfill to accept this waste stream, analytical data demonstrating the nature of the material were supplied to BFI for review. BFI agreed the material was not hazardous waste and along with the CDPHE approval for them to accept the material, BFI agreed to accept the bagged soils as solid waste for disposal. The bagged soil was shipped to BFI for disposal in December, 2005.

Following completion of the 2006 remedial activities at the Site, Stoller compared the Stockpile B soils to the data used in the risk assessment for the hypothetical 30,000 cubic yards to see if Stockpile B could be disposed of safely at the Foothills Landfill. Table 6 shows the radionuclide sample data from the two data sets with the geometric mean, arithmetic mean, and the maximum and minimum concentrations.

Table 6
Comparison of Bagged Soil Data and Stockpile B Data

	Bagged Soil Data (pCi/g)				Stockpile B Data (pCi/g)			
Radionuclide	**Maximum**	**Minimum**	**Geo Mean**	**Arith. Mean**	**Maximum**	**Minimum**	**Geo Mean**	**Arith. Mean**
Ra-226	43.9	3	10.46	12.60	40.9	4.77	11.51	13.55
Ra-228	4.1	0.81	1.62	1.73	3.42	1.2	2.14	2.21
Th-228	3.90	1.01	1.62	1.69	3.8	1.36	2.03	2.09
Th-230	35.10	1.55	6.76	9.34	28.7	3.15	7.94	9.14
Th-232	3.88	0.94	1.57	1.65	3.69	1.24	1.86	1.92
U-234	44.20	1.74	5.87	8.40	27.2	2.5	6.91	8.27
U-235	2.71	0.07	0.32	0.47	1.9	-0.16	0.67	0.72
U-238	45.80	1.77	5.95	8.57	27.5	2.53	7.05	8.51

A Student's t-test was used to determine if the sample data from Stockpile B collected from June through August 2006 are statistically the same or different from the sample data from the bagged soil collected during December 2004. The results are shown in Table 7.

Table 7
Student's t-test comparison of Bagged Soil Data and Stockpile B Data

Radionuclide	T value	P value
Ra-226	-0.384	0.70
Ra-228	-2.85	0.0062
Th-228	-2.68	0.0097
Th-230	0.105	0.92
Th-232	-1.80	0.077
U-234	0.065	0.95
U-235	-1.66	0.10
U-238	0.0289	0.98

If $p>0.05$ the sample populations are considered statistically equivalent. The null hypothesis is that the mean values of the two sample populations are equivalent. The most commonly used level of significance is 0.05. When the significance level is set at 0.05, any test resulting in a p-value under 0.05 would be significant and you would reject the null hypothesis in favor of the alternative hypothesis. Six of the eight radionuclides satisfied the condition that the p value is greater than 0.05, so the null hypothesis is assumed to be true and the sample populations are determined to be statistically equivalent. It should be noted that the problem of multiple tests occurs when two groups are compared with respect to many variables. The fact that multiple tests are performed make it much more likely than 5 percent that something will be statistically significant at a nominal 0.05 level when there is no real underlying difference between the two groups. Statistical procedures such as Hotelling's T^2 statistic could be used to test the hypothesis that the means of all variables are equal; however, this was determined to be unnecessary in this case. As the risk assessment report showed, the primary risk driver for the CSMRI soil is from the Ra-226, and the results of the statistical test shown above determined that the p value is 0.70 for this radionuclide.

The data presented above demonstrate that the soil in Stockpile B is statistically equivalent to the bagged soil, and thus is already approved for disposal at BFI as solid waste. Approval letters from BFI and CDPHE for disposal of this material are included in Appendix F.

A second comparison was made between the Site Stockpile B soils to the settling pond soil that was stockpiled by the EPA Emergency Removal Action. Table 8 summarizes the results. As can be seen in the table, the Soil that is the subject of this RI/FS has concentrations and activity levels that are comparable to the ones found in the Stockpiled soils that were disposed of as solid waste, and the Ra-226 values are much lower.

Table 8
Comparison of Stockpile B Data and EPA Stockpile Data

Metal/Radionuclide	Units	Stockpile B Data	EPA Stockpile Data	RAOA Composite Sample	Combined EPA and RAOA Data
Arsenic	mg/kg	33.3	75	92	92
Lead	mg/kg	494.7	378	328	400

Table 8
Comparison of Stockpile B Data and EPA Stockpile Data

Metal/Radionuclide	Units	Stockpile B Data	EPA Stockpile Data	RAOA Composite Sample	Combined EPA and RAOA Data
Mercury	mg/kg	4.3	8.0	15	17
Molybdenum	mg/kg	137.0	--	<10	--
Vanadium	mg/kg	38.0	58	--	61
Ra-226	pCi/g	13.55	30	47	31
Ra-228	pCi/g	2.21	--	--	<0.9
Th-228	pCi/g	2.09	--	2.8	1.7
Th-230	pCi/g	9.14	30	24	14
Th-232	pCi/g	1.92	--	3.8	1.6
U-234	pCi/g	8.27	--	--	6.3
U-235	pCi/g	0.72	1.5	--	0.3
U-238	pCi/g	8.51	11	--	6.3

The demolition debris from the 17 buildings were removed and disposed of as solid waste. The remaining concrete building slabs and asphalt were removed from the Site and disposed of as solid waste or recycled as solid waste. Miscellaneous containers of research materials also were disposed of at a solid waste landfill, including containers of niobium ore. Therefore, the classification of the remaining Soil as solid waste is consistent with prior classification of different types of materials removed from the Site as solid waste.

6. Summary of Analytical Data in Regard to Regulatory Classification of the Soil

The analytical results from sampling of the Soil support the classification of the Soil as solid waste. The reader is referred back to the previous section to review this data. General conclusions regarding the data with respect to possible waste classification are presented below:

6.1 Radiochemistry

The radiochemistry results show that radiological isotopes present in the Soil are essentially in secular equilibrium. Secular equilibrium means that when the original radionuclide has a much longer half-life than the decay products, the decay products will eventually reach the same activity level as the original radionuclide. Using the uranium series as an example, uranium-238 decays to uranium-234 to thorium 230 (several intermediate products with very short half-lives have not been included in this discussion). The soil sample results show that uranium-234 is in equilibrium with uranium-238 – average ratio of U-234 to U-238 is equal to one. However, the average ratio of thorium-230 to uranium-238 is equal to 1.1. The difference can be explained by the solubility of thorium and uranium. Thorium is very insoluble and will remain with the parent rock. Uranium has a much higher solubility and can migrate out of the parent rock. Naturally occurring deposits can have thorium activities that are greater than the uranium because of the solubility issue. Site activities including leaching and floatation also could affect thorium activities in waste material.

The activity level of radium-226 with respect to thorium-230 (1.5 to 1) and uranium-238 (1.7 to 1) isotopes further supports the conclusion that radium processing was not occurring at the

CSMRI Site (also see operational history especially the section regarding the BOM 1916-1920 work at the CSMRI site). Radium does not form any soluble complexes and would not be removed from the parent material without special processing.

Looking at the thorium-232 decay chain, the soil data show that the thorium-232 and radium-228 activity levels are the same – average ratio of Th-232 to Ra-228 is one. Again these data indicate that these isotopes are in secular equilibrium.

There is no evidence of enrichment or depletion of uranium-235 with respect to the contaminated stockpiled soils. During the years of Site operation, the technologies for concentrating uranium-235 would also concentrate uranium-234 and uranium-233. The data for uranium-234 show this isotope to be approximately equal in activity to uranium-238. This further supports the fact that there is no known evidence of projects at the Site involving the concentration of uranium for enrichment purposes.

As mentioned above in the operational history section, there have been several unsubstantiated rumors that plutonium may have been disposed of at the Site. CSMRI held licenses allowing the possession of americium and plutonium.

Based on the AEC license, it appears that the limited quantity of americium (less than 0.001 microcurie) that may have been at the Site was for instrument calibration (RAOA, Attachment 38). Therefore, the disposal of americium at the Site is unlikely. The small sample data subset from the 2004 RI/FS indicated the presence of americium only at background activity.

Historical records indicate that Site use of plutonium was limited to research associated with a project known as Rollercoaster. Project Rollercoaster appears to have involved evaluation of soil samples that contained small amounts of plutonium. The purpose of the project according to a June 10, 1968 letter (RAOA, Attachment 38) was to “determine some of the affects that might be anticipated in an high energy explosion of devices containing nuclear material.” The letter also describes that some plutonium in solution (0.1 millicurie) was onsite for use in instrument calibration. As mentioned in the operational history, it appears that this plutonium was transported and disposed of at the Rocky Flats Plant west of Denver. Nevertheless, to be conservative in the event that there were other unreported experiments using plutonium, two surface samples were analyzed for plutonium in the 2004 RI/FS. The small sample data subset indicated the presence of plutonium only at background activity .

6.2 Organic Substances

Organic substances were analyzed during the 2004 RI/FS and the following discussion is based solely on that data. The selected TCLP soil samples were free of SVOCs and VOCs, with one minor exception (one “J” value detection of 2-Butanone) and the area near the baseball field. With the groundwater data, a question as to whether the Soil might contain RCRA-listed hazardous wastes could be raised. In reviewing the data summary, there are only limited organic compounds detected. This suggests that the TCE and PCE may have been used for small batch research experiments rather than a widely used solvent for degreasing purposes. Moreover, CSMRI’s documented compliance history with RCRA suggests that any TCE or PCE used as a solvent or any spills were disposed of at offsite locations (RAOA, Attachment 47).

Based on these data and information on the operational history and previous regulatory determinations for the CSMRI Site, it is reasonable to conclude that the TCE and PCE were most likely used in conjunction with the beneficiation of ore during research and experimentation (also see the summary of operational history). At the time of use, the TCE and PCE were exempt from regulation under RCRA as provided in the 40 CFR 261.4(b)(7) also commonly known as the "Bevill Amendment" exclusion. This point is discussed in more detail in Section 7.8 of this appendix.

Additionally, based on CSMRI RCRA inspection and compliance history, there is no evidence to suggest that TCE or PCE were discarded commercial products, off-specification species, container residues, and spill residues thereof ("U" listed RCRA wastes).

6.3 Inorganic Substances

TCLP tests were conducted during the 2004 RI/FS and the following discussion is based solely on that data. TCLP tests for inorganic substances were conducted on several samples. Results indicate that the majority of the samples contained inorganic substances well below the hazardous waste regulatory concentrations established under RCRA for toxicity.

Based on the above discussion and the results of the data collected on the Soil, it is clear that the Soil would not be considered hazardous waste.

7. Soil Regulatory Classification

The following discussion will evaluate all reasonable possible regulatory classifications for the Soil. As previously discussed, the universe of possible regulatory classifications includes:

- Radioactive material,
- Special nuclear material,
- Transuranic waste material,
- Source material,
- Naturally occurring radioactive material (NORM),
- Technologically enhanced naturally occurring radioactive material (TENORM),
- By-product material (11(e)(1) and 11(e)(2)),
- Low-level radioactive waste,
- Hazardous waste,
- Mixed waste,
- Classified waste, and
- Solid waste.

Each of these possible regulatory classifications for the Soil is discussed below in the context of the preceding operational history, analytical results, and regulatory history at the Site.

The State of Colorado's environmental statutes and regulations regarding the management, storage, treatment, and disposal of solid waste, hazardous waste, and radioactive material are all based on the principle of protecting and improving the health and environment of the people of Colorado. It is important that the regulatory classification(s) applied to the Soil ensures that the most significant hazards of the waste/material are adequately controlled to achieve the purposes of the laws.

7.1 Radioactive Material

"Radioactive material" is defined broadly in the Colorado Radiation Control Act. The term means: any material, solid, liquid, or gas, which emits ionizing radiation spontaneously (§ 25-11-101(3), C.R.S.)

"Radioactive material" also is defined broadly under Colorado's radiation control regulations as any solid, liquid, or gas that emits radiation spontaneously (RH 1.4). This definition is broader than the U.S. NRC's definition of radioactive material derived from the Uranium Fuel Cycle. The State of Colorado was given "primacy" for Colorado's radiation control program in 1968. With the exception of Nuclear Power Plants and Federal Facilities, the CDPHE has the complete (not delegated) responsibility for the licensing of radioactive material in the State of Colorado. The provisions for licensing of some radioactive material are contained in Part 3 of Colorado's Radiation Control Regulations.

Part 3 of Colorado's Radiation Regulations pertains to the licensing of some radioactive materials with specific exemption of source material, by-product material and certain other specific materials. Because of the ubiquitous presence of naturally occurring deposits of radioactive ores and soils, not all radioactive material in Colorado is required to be licensed under the Radiation Control Act. Moreover, background material is not regulated under the Radiation Control Act, because the regulations provide that a radioactive materials license may be terminated if background levels are achieved.

The analytical data for the Soil show that the Soil has solid material that emits ionizing radiation spontaneously. The Soil, therefore, is radioactive material. However, that does not mean that the Soil is licensed or should be licensed under the Radiation Control Act. The term "radioactive material" does not exclude the Soil from being classified as solid waste.

7.2 Special Nuclear Material

Special nuclear material (6 CCR 1007-1, 1.4) is defined as:

- plutonium, uranium-233, uranium enriched in the isotope 233 or in the isotope 235, and any other material that the U.S. Nuclear Regulatory Commission, pursuant to the provision of Section 51 of the Atomic Energy Act of 1954, as amended, determines to be special nuclear material, but does not include source material;
- any material artificially enriched by any of the forgoing but does not include source material.

Comparing the Soil to the special nuclear material definition indicates the following:

- The data indicate that the activity level of uranium-234 and uranium-238 are approximately equal and the Soil is not enriched in uranium-235. Therefore, the Soil does not show enrichment or depletion of key uranium isotopes.
- Plutonium and americium are present at background activities in the Soil.

- The operational history and CERCLA 104(e) information responses do not indicate activity that special nuclear material was disposed of at the Site.

Based on this information, the Soil is not special nuclear material.

7.3 Transuranic Waste Material

Although not specifically defined, a provision in Part 14 of the radiation control regulations defines in part, by exclusion, the term “waste” as follows:

> 3. Waste materials containing transuranic elements with contamination levels greater than one hundred nanocuries (3700 bq) per gram of material;

“Transuranic” is defined as: “radionuclides with atomic numbers greater than 92” (§ 25-11-201(3)(b), CRS).

The licensing history for the CSMRI Site shows a very inclusive range of radioactive substances that could be possessed under the licenses. Specifically, the licenses included any substances with atomic numbers 3 - 88, uranium- and thorium-bearing substances, plutonium and americium (RAOA, Attachment 38). Plutonium and americium were the only transuranic substances authorized for use at the Site. Therefore, there is no reason to believe that any transuranic elements (other than plutonium and americium) were used or authorized to be used at the Site.

Based on the preceding discussion, and the apparent limited amounts of americium (instrument calibration sources and measuring devices) and plutonium (background), it is concluded that the third provision under the “waste” definition in Part 14 of the Colorado radiation regulations does not apply to the Soil.

Based on this information, the Soil is not transuranic material.

7.4 Source Material

The radioactive materials license for the Site includes source material. The issue, therefore, is whether the Soil is “source material.” If not, then the Soil is not subject to the Site’s radioactive materials license. “Source material” means material, in any physical or chemical form, including ores, that contain by weight one-twentieth of one-percent (0.05 percent) or more of uranium, thorium, or any combination thereof (R.H. 1.4). Source material does not include special nuclear material (R.H. 1.4).

Where “source material” is found in any chemical mixture, compound, solution, or alloy in which the source material is by weight less than 1/20 of 1 percent (0.05) of the mixture, compound, solution, or alloy, the person receiving, possessing, using, owning, or transferring the source material is exempt from the regulatory requirements in Part 3 which otherwise requires licensing (R.H. 3.2.1). Thus, even if source material caused the elevated levels in the Soil, the mixture is exempt from Part 3 of the radiation regulations. Moreover, even if the mixture were not exempt, which it would be, the mixture is a candidate for exemption under section 1.5.1 of the radiation regulations, if such an exemption were applicable.

Under U.S. NRC regulations, the term "source material" has two meanings. It is important not to confuse the two NRC meanings with Colorado regulations. As defined in 10 CFR § 40.4, "source material" means: (1) uranium or thorium, or any combination thereof, in any physical or chemical form or (2) ores which contain by weight 0.05 percent or more of uranium, thorium, or any combination thereof. Colorado's regulations adopt the latter NRC meaning; thus excluding from Colorado licensing requirements any source material that contains uranium or thorium regardless of its percentage by weight of the host material.

The combination of uranium and thorium in the analytical data shows that the Soil is less than 0.05 percent by weight. Therefore, the Soil is not source material subject to Colorado radioactive materials licensing requirements.

7.5 NORM (Including TENORM)

The radioactive materials license for the Site also includes NORM. The issue then is whether the Soil is NORM and subject to the license for purposes of disposal. NORM, or "naturally occurring radioactive material," is defined by Colorado statute [§ 25-11-101(2.7), CRS] as:

> "any nuclide that is radioactive in its natural physical state and is not manufactured. [NORM] does not include source material, special nuclear material, or by-products of fossil fuel combustion, including but not limited to bottom ash, fly ash, and flue-gas emission by-products."

There are no state regulations implementing the NORM definition, except that "background radiation" includes NORM (R.H. 1.4) (Background radiation is not regulated). Also there are no federal laws regulating NORM. CDPHE is prohibited from regulating the disposal of NORM [§25-11- 104(1)(b), CRS]. This legislative directive indicates that no materials are to be regulated as NORM for disposal until after federal disposal regulations are promulgated.

The Colorado General Assembly reaffirmed this statutory policy by expressly acknowledging that NORM (which is unregulated under the radiation control laws), including a subset of NORM known as "technologically enhanced" NORM (or TENORM), may be disposed of as solid waste in solid waste landfills in Colorado without being subject to, or requiring, a radioactive materials license [§ 25- 11-201(1)(c), CRS].

The Colorado NORM disposal legislation was enacted in the 1990s, several years after the Experimental Plant ceased to operate. No materials were brought to the Experimental Plant at the time the State of Colorado first had authority to use the term NORM. Thus, NORM cannot apply to the Soil. Colorado did not and does not have authority to regulate the Soil as NORM under the Radiation Control Act. The inclusion of NORM in the CSMRI radioactive materials license is not valid.

Assuming that NORM could apply to the disposal of the Soil, the Soil should not be classified as NORM. The statutory definition of NORM excludes source material and by-products of fossil fuel combustion. As explained above, numerous coal experiments, including combustion, were conducted at the Experimental Plant. Moreover, to the extent the Soil is considered exempt from source material licensing, because the uranium and thorium weight is below the regulatory threshold, the Soil should not be characterized as NORM because two of the exclusions apply to it. Finally, given that the Soil can be disposed of without undue hazard to the public health and safety and property, these materials should be exempt under R.H. 1.5.1.

Based on this information the Soil is not NORM.

7.6 By-Product Material

The third category of radioactive materials covered by the radioactive materials license for this Site is by-product material. The issue is whether the Soil is by-product material. Part 18 of Colorado's Radiation Regulations establishes procedures, criteria, and terms and conditions upon which the CDPHE issues licenses for the operation of source material milling facilities and for the disposition of by-product material (R.H. 18.1.1). The state radiation control regulations (R.H. 1.4) define "By-product material" in two ways:

- Any radioactive material, except special nuclear material, yielded in or made radioactive by exposure to the radiation incident to the process of producing or utilizing special nuclear material; and
- The tailings or wastes produced by the extraction or concentration of uranium or thorium from ore processed primarily for its source material content, including discrete surface wastes resulting from uranium or thorium solution extraction processes. Underground ore bodies depleted by these solution extraction operations do not constitute "by-product material" within this definition.

The State definition is modeled after the federal Atomic Energy Act of 1954 (AEA) and its definition of by-product material [42 U.S.C. § 2014(e)]. Material regulated under the first part of the definition is commonly referred to as "11(e)(1) material," while material regulated by the second part of the definition is commonly referred to as "11(e)(2) material." These references are based on the definitional sections of the Uranium Mill Tailings Radiation Control Act of 1978 (UMTRCA), which amended the AEA and added these two definitions of by-product material.

Because there is no evidence of management or processing of special nuclear material at the Site, the Soil is not 11(e)(1) material.

Whether the Soil is 11(e)(2) material depends in part on the meaning of the phrase "from ore processed primarily for its source material content." Congressional legislative history, case law, Nuclear Regulatory Commission guidance, and prior CDPHE decisions at this Site indicate that 11(e)(2) jurisdiction was not intended to regulate a research facility like the Site. Rather, 11(e)(2) jurisdiction covers licensed full-scale production milling operations that are part of the nuclear fuel cycle. The Site, and all wastes generated at the Site, therefore, are not subject to 11(e)(2) jurisdiction and cannot be subject to the radioactive materials license as 11(e)(2) by-product material.

The AEA was enacted in 1954 to promote the development, use, and control of atomic energy (Kerr- McGee, 1990). The AEA gave licensing authority to the AEC to license certain activities involving "special nuclear material," "source material," and "by-product material." Byproduct material was originally defined in the AEA by the definition currently found in 11(e)(1). The AEA did not regulate waste materials generated from the extraction or concentration of source material.

Congress later enacted UMTRCA in 1978 to regulate source material mill tailings. The House Report for UMTRCA described the need for this legislation (Kerr-McGee at 3, 1990 - emphasis added) as follows:

Uranium mills are part of the nuclear fuel cycle. They extract uranium from ore for eventual use in nuclear weapons and power plants, leaving radioactive sand-like waste - commonly called uranium mill tailings - in generally unattended piles. As a result of many years of uranium ore processing, about 140 million tons have now accumulated at active and inactive milling sites.

UMTRCA brought these mill tailings into the regulatory scheme by adding the 11(e)(2) definition.

The Nuclear Regulatory Commission (the successor to the AEC) chair at the time, Dr. Joseph Hendrie, who proposed the specific language, stated that the significance of the phrase "processed primarily for its source material content" was that "the language was intended to avoid bringing within NRC jurisdiction radioactive wastes resulting from activities not connected with the nuclear fuel cycle, which would be left to EPA regulation" (Kerr-McGee at 6, 1990 - emphasis added). Dr. Hendrie and the chair of a Congressional committee had the following exchange:

<u>Mr. Dingell:</u> I am curious about why you include in that word "processed" primarily for source material content. There are other ores that are being processed that do contain thorium and uranium in amounts and I assume equal in value to those you are discussing here.

Is there any reason why we ought not give you the same authority with regard to those ores?

<u>Dr. Hendrie:</u> Mr. Chairman, the intent of the language is to keep NRC's regulatory authority primarily in the field of the nuclear fuel cycle. Not to extend this out into such things as phosphate mining and perhaps even limestone mining which are operations that do disturb the radium-bearing crust of the earth and produce some exposure but those other activities are not connected with the nuclear fuel cycle, EPA is looking at those and those appear to me to be things that ought to be left to EPA regulation under the Resource Conservation and Recovery Act and general authorities (UMTRCA, 1978).

Given the ambiguous language of the 11(e)(2) definition, the United States Court of Appeals in the Kerr-McGee case relied on the legislative history and intent and held that the definition was intended to regulate materials in the course of the nuclear fuel cycle (Kerr-McGee at 6-8).

In partial response to the Kerr-McGee case, the NRC issued guidance that defined the word "ore" as found in the 11(e)(2) definition. 57 Fed. Reg. 20532-20533 [guidance was finalized at 60 Fed. Reg. 49296, September 22, 1995]. The word "ore" is not defined by statute or regulation. The NRC guidance defines "ore" as follows:

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 materials is extracted in a licensed uranium or thorium mill (57FR20532-3).
One of the two major considerations of the NRC in drafting this definition of ore was that it should remain:

> tied into the nuclear fuel cycle. Because the extraction of uranium in a licensed mill remains the primary purpose of processing the feed material, it excludes secondary uranium side-stream recovery operations at mills processing ore for other metals. Thus, tailings from such side-stream operations at facilities that are not licensed as uranium or thorium mills, would not meet the definition of 11(e)(2) by-product material (57FR20532).

Thus, the 11(e)(2) definition is not intended to cover secondary uranium side-stream operations at mills processing ores for other metals.

The Site Experimental Plant and the research facilities were not a licensed uranium or thorium mill whose "primary purpose was processing feed material" in the nuclear fuel cycle. The Site was not part of the nuclear fuel cycle. The Site was a research center that researched and developed technologies and methods for the full breadth of the mining industry. The 11(e)(2) definition is intended to regulate full-scale production uranium milling operations with enormous amounts of uranium ores as part of the nuclear fuel cycle, not a research center used for many types of research projects with few uranium ore-related projects. Therefore, the 11(e)(2) jurisdiction should not apply to any of the research projects where uranium or thorium were extracted or concentrated from source material. Assuming that the Soil was in fact affected by projects that may be candidates for 11(e)(2) by-product classification, the Soil is not "by-product material."

CDPHE has already agreed that the Experimental Plant at the Site was not a full-scale mill and, therefore, was not subject to 11(e)(2) by-product jurisdiction. When Colorado School of Mines demolished the Experimental Plant building and removed it from the Site as solid waste for disposal at a solid waste disposal facility, even though some of the building materials exhibited radiological characteristics above background levels, CDPHE stated:

> AWS has adequately shown, on pages II-9 through II-16 of the Plan, that the radiologically effected material is not a hazardous waste, low level radioactive waste, source material, NORM, or 11.e.(1) by-product material. Also the Plan argues the materials should not be considered 11.e.(2) by-product because the Experimental Plant was not a "mill" in the usual sense (page II- 12 through II-14) even if the four effected areas were the result of "milling" activity. The RCD agrees with this analysis. The analysis of this Plan is not in conflict with arguments presented by the State in its Regulatory Classification of Contaminated Soils in its report of June 12, 1995 for the CSMRI Creekside site. Similarly the RCD has considered the issue of what constitutes milling in relation to another site, and has concluded that crushing and grinding, such as was performed in building 101, is not milling in the usual sense (G. Mallory and D. Simpson, written communication, Apr. 16, 1996).

Therefore, the Soil is not 11(e)(2) by-product material and the Soil is not subject to the radioactive materials license for the Site.

Nevertheless, assuming that any residue from these few uranium and thorium projects could be characterized as 11(e)(2) by-product material, it would be unfair to characterize the soil as 11(e)(2) by-product material for disposal purposes. Given the statistical evaluation of the operational history, the extraction of uranium and thorium was a small part of the research conducted at the Site. Only 11 of 2,271 projects were listed as for uranium or thorium extraction or concentration from Source material. That is less than 1-percent or 0.48-percent of all projects. Thus, it is highly unlikely that the elevated levels of radionuclides were in fact caused solely by 0.48 percent of the total projects conducted. Many ores with mineral values other than uranium and thorium also contain these radionuclides as constituents, and are not classified as source material. The volume of such ores, and the quantity of uranium and thorium associated with these ores, is significantly greater than the volume of source material ores and the source material contained in them.

Furthermore, assuming the selected materials are 11(e)(2) by-product material, these materials are a candidate for exemption from the radiation control regulations because there would be no undue hazard to public health and safety or property by disposal of these materials as proposed by this plan (R.H. 1.5.1).

For these reasons, the identification of the Soil containing elevated concentrations of radioactivity as by-product material is not justified even if some ores classified as source material were utilized in research and development activities at the Site.
Because of the reasons presented in this section, the Soil is not by-product material.

Thus, the Soil is not any of the three types of materials regulated by the radioactive materials license for the Site (NORM, source, and by-product). The radioactive materials license does not apply to the Soil. Nonetheless, that conclusion does not end the inquiry into what is the appropriate regulatory classification of the Soil for disposal purposes. Other possible waste classifications should be explored.

7.7 Low-Level Radioactive Material

Part 14 of the Colorado radiation regulations establishes licensing requirements for land disposal of low-level radioactive waste. R.H. 14.2 states that: “waste” means radioactive waste other than:

- Waste generated as a result of the defense activities of the federal government of federal research and development activities;
- High level waste such as irradiated reactor fuel, liquid waste from reprocessing irradiated reactor fuel, or solids into which any such liquid waste has been converted;
- Waste materials containing transuranic elements with contamination levels greater than one hundred nanocuries (3700 bq) per gram of material;
- By-product material as defined in Section 11(e)(2) of the “Atomic Energy Act of 1954”, as amended on November 8, 1978:* or

- Waste from the mining, milling, smelting, or similar processing of ores and mineral-bearing material primarily for mineral other than radium;*

(* The disposal of these materials is licensed under Part III of the regulations.)
In evaluating the elements of this definition of waste, it is apparent that elements 1 and 5 are important with respect to the Soil. Regarding element 1 of the definition, it is clear from the operational history that much of the work conducted at CSMRI was for federal research and development activities, including defense-related activities. In fact, 33 different federal agencies were clients of CSMRI and many of these clients had multiple projects. This exclusion of federal research and development is especially relevant to the 1916-1920 BOM work. Of equal importance regarding the BOM work is the fact that the pitchblende ore work at the experimental plant was not primarily for the purposes of radium extraction. As discussed in the operational history, the Experimental Plant was only used to grind and separate higher grade pitchblende ore from lower grade ore. No processing or extraction of radium took place at the Site.

The beneficiated pitchblende ore was sent to the National Radium Institute in Denver. Once at the National Radium Institute, the BOM processed the ore, removing uranium oxide for its possible utilization in special steels for ordnance. The National Radium Institute also gave extracted radium to Mr. Dupont who in turn donated the radium to hospitals.

In addition, as shown in the operational history, there are no other known projects that involved radium work. Under element 5 of the definition of waste, there is a clear exclusion of ores and mineral-bearing material work on substances other than radium. The operational history shows thousands of projects on ores and mineral-bearing substances that are not for radium processing. Finally, as discussed previously, the analytical data on the Soil support the operational history in that the data show the radium isotopes to be approximately equal to or greater than the corresponding uranium and thorium isotopes. No extraction of radium took place at the Site.

By letter dated April 30, 2004, the Rocky Mountain Low-Level Radioactive Waste Board (Board) agreed that the soil is not low-level radioactive waste. The Board has jurisdiction of LLW in Colorado.

Based on the above discussion and the other information presented in this document, it is clear that the Soil fits the exclusion under the definition of waste provided in Part 14. Therefore, the Soil is not low level radioactive waste.

7.8 Hazardous Waste

The federal statute governing the treatment, storage, and disposal of hazardous wastes is the Federal Solid Waste Disposal Act as amended by the Resource Conservation and Recovery Act (RCRA) of 1976, as amended. The regulations for implementing the hazardous waste portion of RCRA are known as the Subtitle C regulations. Subtitle C regulations became effective on May 19, 1980.

Many criteria and exemptions affect the implementation of Subtitle C of RCRA. Of particular significance with regard to the Soil is an amendment of November 19, 1980 that excluded “solid waste from the extraction, beneficiation and processing of ores and minerals (including coal), including phosphate rock and overburden from mining of uranium ore." This amendment is commonly known as the Bevill Amendment and was put into place until EPA could make a final determination on how to handle certain mining-related wastes. Since 1980, there have been several studies and actions to delineate which mining-related wastes would remain exempt from being regulated as hazardous waste. From 1980 to 1989 the Bevill exclusion exempted all solid waste from the exploration, mining, milling, smelting, and refining of ores and mineral. In September 1989, EPA promulgated a final rule that removed all but 20 mineral processing wastes from exclusion from being regulated as a hazardous waste. CSMRI operations at the Site ceased by 1987. Currently, all extraction and beneficiation processes relating to ore and mineral bearing substances are still excluded from being regulated as hazardous waste.

Under RCRA Subtitle C, a non-exempt waste can be considered hazardous if any of the following factors apply to the substance: it is a listed hazardous waste or it shows the characteristic of ignitability, corrosivity; reactivity; or toxicity. Colorado has been delegated the authority by EPA to administer the federal RCRA program pursuant to state law. Colorado has adopted the above-referenced federal Bevill exclusion and the definitions of hazardous waste.

With regard to the Soil, at the time of disposal, all of the activities described in the operational history of the Site indicate that the Soil is covered by the Bevill exemption and is therefore not defined as hazardous waste. This conclusion that the Soil meets the criteria for exemption from regulation as a hazardous waste was previously independently determined by the Colorado Department of Health between 1985 and 1988, (RAOA, Attachment 21), as well as in 1995 when CDPHE approved the disposal of the Stockpiled soils as solid waste.

Notwithstanding the fact that the Soil is excluded from being regulated as hazardous waste, a review of the factors that apply to non-exempt materials shows that the Soil still would not be classified as hazardous waste. The TCLP samples indicated the Soil does not contain toxic wastes, sufficient organic material to be ignitable, extreme pH characteristics, or sufficient cyanide or sulfide to be reactive. A single TCLP sample was above the limit for lead, but the sample was intentionally biased to a small area with elevated lead concentrations. The average characteristic of the Soil would be below TCLP limits and, therefore, not toxic.

Based on the above discussion, the Soil is not hazardous waste.

7.9 Mixed Waste

"Mixed Waste" means a waste that contains both RCRA hazardous waste and source by-product, or special nuclear material subject to the jurisdiction of the AEA. The preceding discussions show that the Soil is not hazardous waste and does not fall within the specific definitions of source, special nuclear, or by-product material subject to AEA jurisdiction. Therefore, the Soil is not mixed waste.

7.10 Classified Waste

The Colorado General Assembly enacted a relatively new radioactive materials waste category called "classified material" [§ 25-11-201(1)(a), CRS]. However, this category of "classified material" is only applicable to material intended to be sent to a "facility" required to be licensed pursuant to the Colorado Radiation Control Act [§§ 25-11-201 (1.6), 25-11-203(1), (2), CRS].

Moreover, nothing in the recent legislation applies to the treatment, storage, management, processing, or disposal of solid waste, which may include NORM and "technologically enhanced" NORM [§ 25-11-201(1)(c), CRS]. The School does not intend to dispose of the Soil at a facility required to be licensed pursuant to the Colorado Radiation Control Act. Therefore, the Soil is not "classified material."

7.11 Solid Waste

The federal and state solid waste laws and regulations are very broad in scope and can govern almost any discarded material. Under Colorado state regulations (6 CCR 1007-2, 1.2) solid waste means: "any garbage, refuse, sludge from waste treatment plant, water supply treatment plant, air pollution control facility, or other discarded material." The contaminated Soil meets this definition because it contains discarded material.

The definition of solid waste (6 CCR 1007-2, 1.2) goes on to exclude " ... materials handled at facilities licensed pursuant to the provisions on "Radiation Control Act" in Title 25, Article 11, Colorado Revised Statutes…"

This provision of the definition eliminates duplicative regulation of a single facility. While the Site did have general licenses to handle, store, and possess certain radioactive materials, the Soil is not any of the types of radioactive materials that were subject to the licenses and is, therefore, not excluded from the definition of a solid waste. This exclusion language in the solid waste regulation does not exclude all solid wastes handled or generated at a licensed facility. It only excludes those materials that are regulated under the radiation control act and regulations. This is confirmed by the Colorado General Assembly that expressly acknowledged that NORM and TENORM could be disposed of as solid waste without requiring a radioactive materials license [§ 25-11-201(1)(c), CRS].

From the operational history, it is apparent that the Site was a mining and mineralogical research facility. The solid waste regulations govern research mining and milling wastes. In fact, the Bevill exemption would not be necessary if research mining and milling wastes were not solid wastes.

The conclusion that the Soil is solid waste is supported by prior CDPHE decisions that found that the EPA Stockpiled soils, the buildings, the concrete and asphalt, the bagged soils, and miscellaneous contaminated wastes from research operations were all found to be solid waste that could be disposed of at solid waste landfills in Colorado.
Finally, CDPHE has already determined that Stockpile B, which is currently located at the Site, may be disposed of as solid waste at the Foothills Landfill (Dec 18, 2006 letter from CDPHE to Colorado School of Mines). CDPHE's determination is supported by a risk assessment demonstrating that the landfill may safely manage these materials.

8. Regulatory Waste Classification Conclusion

The preceding discussion outlines complex regulatory, operational and technical information regarding the Soil.

The preceding analysis has shown the following:

- The Soil contains radioactive material at very low concentrations.
- The Soil is NOT special nuclear material, transuranic with respect to plutonium and americium, source material, NORM or TENORM, by-product material, low-level radioactive waste, hazardous waste, mixed waste, or classified waste.
- The Soil is solid waste.

This report recommends that the Soil be classified as solid waste. The two driving factors are the minimal amount of radioactive material in the Soil and the regulatory evaluation of these materials.

Under both federal and state law, broad general authority exists to protect human health and the environment under the regulatory authority of the federal RCRA Subtitle D regulations and the state regulations pertaining to solid waste disposal facilities. These regulations allow those technical measures to be put into place that prevent risks to human health and the environment. In essence the solid waste rules and regulations allow the Soil to be treated and disposed of utilizing a risk-based approach that is consistent with the mandates established in CERCLA and the NCP.

Solid waste disposal sites and facilities must comply with the health laws and standards, rules and regulations of the CDPHE, the Water Quality Control Commission, the Air Quality Control Commission, and all applicable local laws and ordinance (6 CCR 1007-2, Section 2.1.1). No facility shall constitute a hazard to human health (6 CCR 1007-2, Section 2.1.3). Consequently, in order to ensure protection of human health and the environment, the disposal of the Soil will use some of the additional substantive portions of the radiation control regulations during the handling, transportation, and disposal of the Soil, if necessary.

The Soil consists of materials that do not require a radioactive materials license. The solid waste disposal act and regulations will provide the general framework to be used in determining the appropriate technical and procedural disposal criteria for both onsite and offsite alternatives. The radiation control regulations will be used to augment the technical and procedural requirements of the solid waste regulation to ensure protection of human health and the environment for the radioactive elements in the Soil. The augmentation to the technical requirements of the solid waste regulations will require that the radiation control regulations be used as a guide for determining technical and procedural disposal criteria. This will ensure protection of human health and the environment.