RECORD OF DECISION

COLORADO SCHOOL OF MINES RESEARCH INSTITUTE SITE
GOLDEN, CO

Revision Date: July 9, 2007
Original ROD Date: March 31, 2004

Prepared for:
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List of Acronyms/Definitions

AEC	U.S. Atomic Energy Commission
ALARA	As Low As Reasonably Achievable
ARAR	Applicable or Relevant and Appropriate Requirements
BFI	Browning-Ferris Industries
bgs	Below Ground Surface
CDOT	Colorado Department of Transportation
CDPHE	Colorado Department of Public Health and Environment
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	U.S. Code of Federal Regulations
COPC	Constituent of Possible Concern
CSMRI	Colorado School Mines Research Institute (the Site)
CSWP	Characterization Survey Work Plan (URS Corporation)
DCGL	Derived Concentration Guideline Level
EPA	U.S. Environmental Protection Agency
GPS	Global Positioning System
HI	Hazard Index (EPA)
HQ	Hazard Quotients (EPA)
IRIS	Integrated Risk Information System
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
MCL	Maximum Contaminant Levels (EPA Drinking Water)
MCLG	Maximum Contaminant Level Goal
mg/kg	Milligram per Kilogram
mrem	Millirem – small unit of radiation dose (one thousandth of a rem)
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
O&M	operation and maintenance
PbB	blood lead
pCi/g	Pico-Curies per Gram
pCi/L	Pico-Curies per Liter
ppm	parts per million

PRP	potentially responsible parties
RA	Remedial Action
RAIS	Risk Assessment Information System
RAO	Remedial Action Objectives
RAOA	Removal Action Options Analysis
RCRA	Resource Conservation and Recovery Act
RESRAD	Pathway analysis computer code developed for implementing U.S. Department of Energy Residual Radioactive Material Guidelines
RfD	reference dose
RI/FS	Remedial Investigation/Feasibility Study
RME	reasonable maximum exposure
RMI	Recycled Materials, Inc.
ROD	Record of Decision
SARA	Superfund Amendments and Reauthorization Act
TCLP	Toxicity Characteristic Leaching Procedure
TEDE	Total Effective Dose Equivalent
UAO	Unilateral Administrative Order (from EPA)
ug/L	micrograms per liter
UMTRCA	Uranium Mill Tailings Radiation Control Act
US	United States
VOC	volatile organic compound
WL	Working Level: Any combination of short-lived radon decay products in one liter of air that will result in the ultimate emission of 1.3 x 105 MeV of potential alpha energy.
yr	year

PART 1: THE DECLARATION

A. Site Name and Location

The Colorado School of Mines Research Institute (CSMRI) Site has historically included the soil stockpile (material removed from the settling pond) formerly located near the Colorado School of Mines (School) softball field, the Fenced Area (including the settling pond), and the Clay Pits area located south of the intersection of Birch and 12th Streets. For the purposes of this document only, the Site is defined as the Fenced Area and the Clay Pits area.

The Site is located on the south side of Clear Creek, east of U.S. Highway 6, in the northeast quarter of the northwest quarter of Section 33, Township 3 South, Range 70 West as shown in Figure 1. The main entrance to the Site is located about 475 feet northwest of the intersection of Birch and 12th Streets in Golden, Colorado. A chain-link fence restricts access to the Site, except for a small area located south of 12th Street known as the Clay Pits area. A settling pond was previously located within the perimeter fence but the pond was cleaned up and closed by the U.S. Environmental Protection Agency (EPA) in 1997 as part of an Emergency Removal Action under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and is not part of the School's remedial action.

The Site (excluding the Clay Pits area and the former settling pond area) covers an area of about six acres and is currently defined by the shaded area shown in Figure 2. The Clay Pits area also is shown in Figure 2. In accordance with CERCLA and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), 40 Code of Federal Regulations (CFR) Parts 300.5 and 300.400(e), the term "on-site" refers to the areal extent of contamination and all suitable areas in proximity to the contamination. Consequently, the Site boundary may be modified or expanded to address the needs of the remedial action.

Groundwater at the Site will continue to be monitored after the remedy is implemented to determine the success of the excavation and offsite disposal of the contaminated soils in improving groundwater quality.

B. Statement of Basis and Purpose

This Record of Decision (ROD) document presents the Selected Remedy for the CSMRI Site (Site), in Golden, Colorado, which was chosen in accordance with CERCLA, as amended by Superfund Amendments and Reauthorization Act (SARA), and, to the extent practicable, the NCP. This decision is based on the Administrative Record file for this Site. The State of Colorado concurs with the Selected Remedy.

On March 31, 2004, a ROD was signed for the CSMRI Site. The 2004 ROD was based on the January 21, 2004 Remedial Investigation and Feasibility Study (2004 RI/FS) prepared by New Horizons Environmental Consultants Inc. (New Horizons) on portions of the Site. The 2004 RI/FS determined the nature and extent of contamination, evaluated alternative remedies, and identified a preferred alternative remedial plan of offsite disposal. After public comment, the 2004 ROD was issued, selecting the preferred remedy of offsite disposal at two separate landfills: one in Idaho and one in Colorado.

The School hired New Horizons to implement the remedy. During New Horizons' field excavation work, New Horizons determined that the actual nature and extent of contamination was significantly greater than that estimated in the 2004 RI/FS. Although New Horizons knew that the nature and extent was significantly greater, it did not know the full extent of the contamination. The School then halted the field work and hired the S.M. Stoller Corporation (Stoller) to investigate the nature and extent of contamination and re-evaluated the previously elected remedy. Stoller performed additional investigative work in 2005-2007.

Stoller prepared a Revised RI/FS in 2007, which revised the 2004 RI/FS. It provided the nature and extent of contamination, re-evaluated alternative remedies, and proposed an offsite disposal remedy that differed from the remedy selected in 2004. The Revised RI/FS incorporated portions of the 2004 RI/FS, replaced some portions, and supplemented other portions.

With respect to the nature and extent of contamination, the 2004 RI/FS estimated 500 cubic yards of soil averaging greater than 3 picoCuries per gram (pCi/g) of Radium 226 (Ra-226) above background would be excavated. This soil was designated to go to the U.S. Ecology Resource Conservation and Recovery Act (RCRA) landfill in Idaho. In addition, the 2004 RI/FS estimated 9,500 cubic yards of soil averaging above background but no more than 3 pCi/g Ra-226 above background would also be excavated. This greater volume of soil was designated to be disposed of at the Foothills RCRA solid waste landfill in Jefferson County, Colorado. The cost of shipping and disposing of the contaminated soils in Idaho was much greater than the cost of shipping and disposing of the soils at the Foothills Landfill. The 3 pCi/g Ra-226 threshold that distinguished between the two types of soil was determined by a Colorado Department of Public Health and Environment (CDPHE) requirement.

The results of Stoller's soil excavation and segregation investigation further demonstrated the reasonableness and necessity of halting the 2004 remedial work and performing further investigation of the Site. Stoller excavated the contaminated soils and made two stockpiles at the Site. Stockpile B consists of approximately 12,500 cubic yards with an average of 13.55 pCi/g Ra-226. Under the 2004 RI/FS and 2004 ROD, all of this soil plus the 1,800 cubic yards of bagged soil would have been shipped and disposed of at the U.S. Ecology facility in Idaho at a cost of $9,689,823. In addition, the excavation and segregation investigation created approximately 200 cubic yards in Stockpile A, which averages 84.75 pCi/g Ra-226. This material would have cost $135,522 to dispose of in Idaho under the 2004 RI/FS and 2004 ROD. New Horizons had estimated the cost of implementing Alternative B to be only $1,540,712.86. Under the 2004 RI/FS and 2004 ROD, none of the contaminated soil would have been shipped and disposed of at the Foothills Landfill, even though 9,500 yards had been estimated to go to the Foothills Landfill. Thus, if New Horizons had continued its field work, there would have been a cost overrun of $8,284,632, or 538 percent above the expected costs under New Horizons' contract to implement the remedy. In addition, the volumes that would have been excavated by New Horizons would have been significantly greater than that estimated by New Horizons in the 2004 RI/FS, because the arsenic background level was changed for the Revised RI/FS to reflect an accurate arsenic background level. Although the 2006 investigation resulted in a similar volume of impacted soil as that estimated in the 2004 RI/FS, the field methods used in the 2004 remedial action would have yielded a much larger volume of impacted material subject to disposal.

This ROD supercedes the 2004 ROD.

C. Assessment of Site

The response action selected in this ROD is necessary to protect the public health or welfare or the environment from actual or threatened releases of hazardous substances into the environment. The remedial investigation found soils with elevated radionuclide activities, primarily radium, thorium, and uranium, in the vicinity of the former buildings and some nearby areas. Elevated metals concentrations, primarily arsenic, cadmium, lead, and mercury also were detected in the Site soils. Uranium concentrations in excess of the Maximum Contaminant level (MCL) were found in groundwater monitoring wells along with concentrations of chlorinated solvents below the MCL.

D. Description of Selected Remedy

The selected remedy involves the excavation and transportation of the affected material to two offsite approved landfills. With Alternative 5B, Stockpile A and Stockpile B would be disposed of at two different landfills. Disposal at two different landfills is necessary since Stockpile A may not meet the landfill acceptance criteria for the landfill where Stockpile B may be accepted for disposal in a manner that best suits the remedy selection criteria under CERCLA for Stockpile B. An estimated 13,000 cubic yards of material would be shipped offsite for disposal. Under Alternative 5B, 200 cubic yards (Stockpile A) will go to the Clean Harbors Deer Trail Landfill in Adams County, Colorado. In the 2007 Revised RI/FS, two options for Stockpile A were identified: the U.S. Ecology landfill in Idaho and the Clean Harbors Deer Trail facility in Colorado. Disposal at Clean Harbors was less expensive than disposal at the USE facility except that the unresolved indemnification issue rendered Clean Harbors less desirable than USE. Since the 2007 RI/FS was published, the indemnity issue has been resolved; therefore, Clean Harbors is now the preferred facility. Stockpile B will be disposed of at the Foothills Landfill in Jefferson County, Colorado. Both landfills have been approved for acceptance of the materials by the landfills and CDPHE.

This alternative would use the temporary access road to U.S. Highway 6. A permit will need to be obtained from the Colorado Department of Transportation (CDOT). Alternative 5B includes loading the stockpiled material into trucks, transportation to the two locations, and re-grading of the stockpile locations.

Groundwater monitoring is required afterward because of current elevated concentrations of uranium. The surface areas will be used for beneficial purposes while the groundwater monitoring is ongoing to show that offsite disposal was effective in returning groundwater quality to acceptable conditions.

Upon completion of the offsite disposal, confirmed by a final Site status survey, the property (except for groundwater) would be available for unrestricted use with institutional controls. Institutional controls of State of Colorado environmental covenants are required to ensure that radon abatement systems are a requirement for any residential structure or building constructed on the Site. Even with the failure of institutional controls, the potential dose due to the radon emanation into a future residence is 42 mrem/yr. This is less than the 100 mrem/yr limit allowing Alternative 5 to comply with Applicable or Relevant and Appropriate Requirements

(ARARs). The owner and operator of the property are responsible for maintaining the institutional control. The CDPHE, the School, and the City of Golden will have the right to enforce the relevant covenants regardless of who owns and operates the property in the future.

In the 2004 RI/FS, RESRAD predicted a dose of 6.0×10^{-2} mrem/yr and a risk of 1.1×10^{-6} (subsistence farmer). These dose and risk levels assumed no backfilling of the Site. Re-grading operations required for storm-water control, safety, and Site restoration would reduce the dose and risk even further (assuming clean fill). The removal of the majority of the Ra-226 significantly reduces potential radon emanation rates. In 2007, RESRAD predicted a dose of 42 mrem/yr above background after both stockpiles are taken to offsite disposal facilities. Radon mitigation systems would reduce exposure levels below 25 mrem/yr and 15 mrem/yr. Alternative 5B is protective of human health and the environment.

E. Statutory Determinations

The Selected Remedy is protective of human health and the environment, complies with federal and state requirements that are applicable or relevant and appropriate to the remedial action, is cost-effective, and utilizes permanent solutions and alternative treatment technologies to the maximum extent practicable. The remedy does not satisfy the statutory preference for treatment as a principal element of the remedy for the following reasons: treatment is not cost effective and there are concerns about the effectiveness of the technology to properly manage the risks at the Site. Because this remedy will implement the institutional controls of environmental covenants requiring radon mitigation systems in all residences with an annual certification of compliance requirement to CDPHE for hazardous substances in soil remaining onsite above levels that allow for unlimited use and unrestricted exposure, a five-year review for soils will not be required for this remedial action. A five-year review will be conducted to determine the effectiveness of the Selected Remedy on impacted groundwater. Monitoring of groundwater will be used to measure the remedial action effectiveness.

F. Data Certification Checklist

The following information is included in the Decision Summary section of this ROD. Additional information can be found in the Administrative Record file for this site:

- Chemicals of concern and their respective concentrations.
- Baseline risk represented by the chemicals of concern.
- Cleanup levels established for chemicals of concern and the basis for these levels.
- How source materials constituting principal threats are addressed.
- Current and reasonably anticipated future land use assumptions and current and potential future beneficial uses of groundwater used in the baseline risk assessment and ROD.
- Potential land and groundwater use that will be available at the Site as a result of the Selected Remedy.
- Estimated capital, annual operation and maintenance (O&M), total present worth costs, discount rate, and the number of years over which the remedy cost estimates are projected.

- Key factor(s) that led to selecting the remedy (i.e., describe how the Selected Remedy provides the best balance of tradeoffs with respect to the balancing and modifying criteria, highlighting criteria key to the decision).

G. Authorizing Signatures

Formally authorized by Colorado School of Mines:

L. D. Havelick July 10, 2007

Linn D. Havelick Date
Director, Environmental Health & Safety

PART 2: THE DECISION SUMMARY

A. Site Name, Location, and Brief Description

The CSMRI Site has historically included the soil stockpile (material removed from the settling pond in 1992) formerly located near the School's softball field, the Fenced Area (including the settling pond), and the Clay Pits area located south of the intersection of Birch and 12th Streets. For the purposes of this document only, the Site is defined as the Fenced Area and the Clay Pits area.

The Site is located on the south side of Clear Creek, east of U.S. Highway 6, in the northeast quarter of the northwest quarter of Section 33, Township 3 South, Range 70 West as shown in Figure 1. The main entrance to the Site is located about 475 feet northwest of the intersection of Birch and 12th Street in Golden, Colorado. A chain-link fence restricts access to the Site, except for a small area located south of 12th Street known as the Clay Pits area. A settling pond was previously located within the perimeter fence but the pond was cleaned up and closed by the EPA in 1997 as part of an Emergency Removal Action under CERCLA and is not part of the School''s remedial action. However, recently a groundwater monitoring well was installed in the former pond area and this well will continue to be monitored. The softball field area, where the pond stockpile had been located, has also been cleaned up and removed from the scope of CSMRI's radioactive materials license for the Site.

The Site (excluding the Clay Pits area and the former settling pond area) covers an area of about six acres as shown in Figure 2. The Clay Pits area also is shown in Figure 2. In accordance with CERCLA and the NCP, 40 CFR Parts 300.5 and 300.400(e), the term "on-site" refers to the areal extent of contamination and all suitable areas in proximity to the contamination. Consequently, the Site boundary may be modified or expanded to address the needs of the remedial action.

Colorado School of Mines is the lead agency for the Site for this remedial action. Its remedial action and its work plans are being reviewed and approved by CDPHE. The School is the source of the cleanup monies for this remedial action. The remedial action is voluntary; it is not the subject of an enforcement action by EPA or CDPHE.

B. Site History and Enforcement Activities

The Site is a former metallurgical and mining research facility. Numerous mineral research projects (some of which involved the mineral extraction and beneficiation of materials that contained levels of radionuclides and/or metals above background) were conducted at the Site from 1912 until approximately 1987. The research projects used 17 buildings on the Site that were subsequently razed in the mid-1990s. An impoundment (settling pond) also was situated between the building complex and Clear Creek to store wastewater generated in the laboratories and research facilities. Wastewater discharged from the buildings was transferred to the settling pond through a system of sumps and floor drains in the buildings. Materials from the research projects had also been disposed of at the Site.

Site research operations ceased in 1987. From approximately 1985 to 1992, CSMRI, the tenant and operator, performed investigation and closure activities.

On January 25, 1992, a water main owned by the City of Golden broke on the Site and began discharging a large volume of water into the settling pond. EPA's Emergency Response Branch responded in February 1992 and performed a number of activities to stabilize conditions at the Site, including:

- excavation of the contaminated sediments and soil,
- stockpiling of the material (the Stockpile),
- decontamination of building drains,
- demolition and removal of several buildings,
- consolidation of existing drums and disposal of compressed gas cylinders,
- sampling of sediments and water, and
- closure of the settling pond.

EPA subsequently contacted many of the entities that had sent materials to the Site and requested that the Stockpile be removed offsite. This culminated in the issuance of a Unilateral Administrative Order (UAO) on December 22, 1994 to certain entities (the respondents). Among other things, the UAO required the respondents to develop and evaluate disposal options for the Stockpile (approximately 20,000 cubic yards) and ultimately implement the selected disposal alternative. Some of the respondents prepared a Removal Action Options Analysis (RAOA) report that was issued on June 12, 1995. The RAOA report identified and evaluated various disposal options for the Stockpile. The Colorado School of Mines and the State of Colorado were the only respondents that subsequently implemented the preferred disposal option. The EPA removal action was completed in 1997.

The School also participated in a mediation in 1997 with some potentially responsible parties (PRPs), including some of the respondents to the UAO. Settlement agreements for reimbursement of some response costs incurred up to May 31, 1997 (but no response costs incurred after May 31, 1997) were executed and some monies paid to EPA and the School as a result of the mediation.

In addition to the mediation, the School filed a lawsuit against many PRPs in 1999. Over the course of the next several years, the School settled with the defendant PRPs and recovered some monies. The lawsuit is no longer pending. Tolling agreements have been entered into with many PRPs pending the final cleanup and determination of cleanup costs.

The School hired AWS Remediation to raze the remaining research buildings from the Site in the mid-1990s. Following demolition of the buildings, the existing pits and basements were backfilled to grade; building foundations and concrete footers were left onsite.

A Characterization Survey Work Plan (CSWP) was prepared by URS Corporation on July 23, 2001. The purpose of the CSWP was to guide field investigation activities to supplement existing data and evaluate the risks associated with the release of residual metals and radioactive materials found in soils within the Fenced Area and the Clay Pits Area. Working in accordance with the CSWP, URS completed the characterization of the concrete and asphalt slabs and issued two Draft Final Reports on February 11, 2002 and May 18, 2002, respectively.

The CSWP identified demolition of the remaining concrete and asphalt materials as an integral part of the Site characterization process. Consequently, in April 2002, the School hired New Horizons to remove the remaining concrete and asphalt slabs and to characterize surface and subsurface soils on the Site. New Horizons prepared a comprehensive set of work plans that guided the characterization activities which were conducted at the Site. These plans were subsequently approved by CDPHE.

During November and December 2002, all remaining concrete and asphalt were transported from the Site and either transported as demolition debris to BFI's Foothills Landfill (BFI) in Golden, Colorado (a permitted Subtitle D solid waste facility) or transported to Recycled Materials, Inc.'s (RMI) plant in Arvada, Colorado for recycling. Detailed documentation regarding the removal of the concrete and asphalt slabs is provided in New Horizons' April 11, 2003 report entitled *Concrete and Asphalt Removal and Disposal (Final Report).*

During December 2002 and January 2003, New Horizons collected surface and subsurface soil samples, which were analyzed for metals and radionuclides. Quarterly groundwater samples were collected for four quarters beginning in February 2003. The results of the Site investigation were presented in a RI/FS and proposed plan, dated January 21, 2004 (the RI/FS). The RI/FS evaluated alternative remedial actions and proposed offsite removal of the affected soils and natural attenuation of the groundwater with continued monitoring as the preferred remedial alternative.

The New Horizons RI produced valuable information on the nature and complicated extent of contaminants at the Site. New Horizons estimated 10,000 cubic yards of contaminated soil, with 9,500 yards averaging less than 3 pCi/g Ra-226 above background and 500 yards averaging greater than 3 pCi/g Ra-226. Following the selection of a proposed plan for offsite disposal of the contaminated soils, New Horizons began implementation of the plan. The plan called for disposal of 500 yards at a landfill in Idaho and 9,500 yards in a local landfill in Colorado. Implementation was halted after only a few weeks due to the discovery of more contaminated soils than had previously been estimated in the 2004 RI/FS resulting in significant uncertainties as to volume and cost increases. Had New Horizons continued with its implementation plan, at least 9,500 cubic yards of soil would have been disposed of in Idaho at an approximate cost of over $10 million, which would have been an $8 million cost over-run. The School retained Stoller to re-evaluate existing site data and formulate a strategy to move the project forward.

Approximately 1,870 cubic yards of soil had been excavated, bagged, and stored on the Site by New Horizons during the 2004 remediation work. This bagged soil had been initially slated for disposal at the U.S. Ecology RCRA facility in Idaho. In December 2004, Stoller collected representative soil samples from a random subset of the 455 super-sack containers staged at the Site to evaluate potential disposal options of the containerized material. The soil in the bags averaged 12.6 pCi/g Ra-226. After considerable negotiations between the School and CDPHE, including litigation, CDPHE agreed to consider a risk assessment that demonstrated that the Foothills Landfill in Jefferson County could safely manage the bagged soils even though they contained concentrations greater than 3 pCi/g Ra-226 above background, which was CDPHE's previous threshold for waste acceptance into the solid waste landfill. The results were submitted to CDPHE in the April 5, 2005 report, *Dose Assessment for the Emplacement of the CSMRI Site*

Containerized and Remaining Subsurface Soil into a RCRA Subtitle D Solid Waste Landfill. CDPHE approved shipment of the bagged soils to the Foothills solid waste landfill in a letter dated August 26, 2005. At CDPHE's request, the dose assessment included a hypothetical scenario of 30,000 cubic yards of soil similar to the soil contained in the bags. This scenario anticipated possible further soil excavation at the Site and prevented the need for having to perform a second dose assessment if soils were excavated that were similar to the soils in the bags. CDPHE also approve this hypothetical scenario.

In May 2005, the School contracted Stoller to examine further Site investigation alternatives to move the project toward completion while maintaining the CERCLA framework.

In October 2005, Stoller obtained CDPHE approval and a CDOT permit to transport the bagged soil offsite via an access lane on Colorado Highway 6 to BFI Foothills Landfill. All bagged soils from the Site were shipped to BFI Foothills Landfill during the period of December 12 through 15, 2005, in accordance with the approved *CSMRI Creekside Site Contaminated Soil Disposal Work Plan*.[1]

In September 2005, Stoller prepared a Background Evaluation Report for the Site. This report summarized and assessed the results of three previous background studies, two by URS in 2000 and 2002, and one by New Horizons in 2004 (included in the 2004 RI/FS), which attempted to establish background concentrations for metals and radioisotopes. CDPHE indicated inadequate soil analytical data existed to justify increasing the proposed cleanup standards for the Site. However, the CDPHE did agree to increasing the background level of arsenic to 38 parts per million (ppm), resulting in a tentative Derived Concentration Guideline Level (DCGL) of 39 ppm. Additionally, the CDPHE agreed to use a total mercury standard to guide characterization with some speciated confirmatory data in support. The School determined that pursuing further background studies at that time in response to CDPHE's concerns would not be cost effective. However, the School and CDPHE agreed that the School could later demonstrate to CDPHE alternative background conditions for different portions of the Site during field excavation work upon field observations and further data. This was a more cost-effective strategy.

CDPHE approved the *CSMRI Creekside Site Final Site Characterization Work Plan*, dated May 12, 2006. The investigation excavated the impacted soil and stockpiled it onsite to determine the nature and extent of contamination. This excavation method is analogous to the method used by the EPA to address the former settling pond at the Site. The New Horizons' baseline risk assessment in the 2004 RI/FS had already demonstrated that some proactive remedial action was necessary at the Site for the remaining contaminated soils.

In 2006 Stoller performed supplemental RI activities to determine the nature and extent of impacts to the Site soils. This effort was successfully completed by performing the following tasks:

- Initial soil segregation: Based on data from the original RI, soil was segregated by metals content and activity. All soil with concentrations of Site Constituents of Potential Concern

[1] A small amount of bagged soils had been shipped by New Horizons to the U.S. Ecology facility in Idaho during the April and May 2004 field work.

(COPCs) above the tentative DCGLs was placed in lined soil stockpiles. Table 1 lists the COPCs and tentative DCGLs.

- Segregation of soil above 100 pCi/g: All soil identified during the original RI as containing total activity above 100 pCi/g was segregated into a separate soil stockpile.
- Site-wide gamma scan: Following initial soil removals, a site-wide gamma scan was completed to identify areas of the Site with remaining elevated activity.
- Continuing soil segregation: Using a series of field and onsite laboratory instruments, soil was assessed for metals and Ra-226 content. All soil exceeding the tentative DCGLs was segregated to a soil stockpile.
- Final gamma scan: Upon completion of the soil segregation activity, a final gamma scan of the entire Site was completed to assess the effectiveness of the characterization.
- Confirmatory sampling: Finally, to confirm the gamma scan, samples were collected and submitted to both the onsite and an offsite laboratory for final confirmatory data.

Table 1
COPCs and Tentative Site DCGLs

Constituent	Tentative DCGL
Metals	**mg/kg**
Arsenic	39
Lead	400
Mercury (total)	23
Molybdenum	390
Vanadium	550
Radioisotopes	**picoCuries/gram**
Radium 226	4.14
Radium 228	4.6
Thorium 228	6.47
Thorium 230	11.53
Thorium 232	3.88
Uranium 234	254.9
Uranium 235	4.97
Uranium 238	21.8

Two soil stockpiles were established for excavated materials: Stockpile A contains material over 100 pCi/g and contains approximately 200 cubic yards of material. Stockpile B contains the majority of the excavated material (less than 100 pCi/g but greater than the tentative DCGLs) and contains approximately 12,500 cubic yards of material. Characterizing the Site soils in this way had the additional cost-savings benefit of excavating soil that would have had to be excavated eventually during the implementation of the remedial options eligible for implementation in the findings of the 2004 RI/FS, which concluded that the impacted material could not be left in place.

Stoller published its finding in a May 2007 Revised RI/FS. The Revised RI/FS also evaluated alternative remedial actions and proposed Alternative 5B, the offsite disposal of the two stockpiles to two different landfills, an environmental covenant requiring radon mitigation systems in all residences onsite, and continued groundwater monitoring to evaluate the impact that soil excavation and offsite disposal have on improving water quality.

A number of historical investigations have been completed at both the Fenced Area and the Clay Pits area. Results from these investigations are included in the following reports:

- *Surface Gamma Ray Scanner Survey*, U.S. Environmental Protection Agency, 1982
- *CSMRI Environmental Assessment*, Jacobs Engineering Group Inc., October 1987
- *Claypits Report to CDPHE*, Robert MacPherson, October 20, 1988
- *Preliminary Assessment of Radiological Risks at CSMRI*, *Creekside,* L. Hersloff, Radiant Energy Management, September 1989
- *Tailings Pond, CSMRI, Creekside Sampling Report,* Industrial Compliance Inc., October 1989
- *Preliminary Assessment of the Potential for Water-Borne Migration of Contaminants in the Claypits,* J. Kunkel, Advanced Science, October 20, 1989
- *CSM Environmental Sampling & Analysis Program: Claypits Site & CSMRI Facility,* James L. Grant & Associates, August 9, 1990
- *Characterization Plan for Claypits & CSMRI Creekside and Table Mountain Research Center Sites,* James L. Grant & Associates, March 22,1991
- *Preliminary Remedial Alternative Evaluation for the CSM Creekside Stockpile,* SR & K, August 25, 1994
- *Removal Action Options Analysis* (RAOA), Multiple authors, June 12, 1995 (three volumes)
- *Concrete and Asphalt Characterization Report*, URS Corporation, May 18, 2002
- *CSMRI Characterization Summary*, New Horizons Environmental Consultants, Inc., August 21, 2003
- *Clay Pits Area Remedial Site Investigation Report, CSMRI Site*, April 2007, Stoller

Site Licensing History

The CSMRI Site licensing and permitting history shows that 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.

Prior to this governmental determination CSMRI applied for permits under 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).

Table 2 presents a chronological summary of the U.S. Atomic Energy Commission (AEC), and Table 3 presents a summary of the State of Colorado licensing actions at the Colorado School of Mines Research Institute site:

Table 2
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 3
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.

Table 3
Summary of State of Colorado Licensing Actions at CSMRI

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: 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 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.

C. Community Participation

Community participation activities for this Site began after the water main break in 1992 and upon the issuance of the UAO in 1994. Many community meetings were held through 1995, including a public meeting and comment period for the RAOA that documented the proposed offsite disposal alternative for the stockpiled soils in 1995. The community participation activities for the 2004 RI/FS and the 2007 Revised RI/FS built upon those prior efforts.

A community open house was held at the School in 2003 prior to the completion of the 2004 RI/FS to solicit input on the ongoing RI/FS activities. In addition, School representatives met with CPDHE and some PRP representatives to solicit input on the ongoing RI/FS activities. The 2004 RI/FS Report and Proposed Plan for the CSMRI Site in Golden, Colorado, were made available to the public in January 2004. They can be found in the Administrative Record file and the information repository maintained at the Golden and School public libraries. The notice of the availability of these two documents was published in the *Golden Transcript*, the *Denver Post*, and the *Rocky Mountain News*. A 30-day public comment period was held, including an extension of time to the public comment period requested by some parties. Moreover, additional comments were accepted from CDPHE after the close of the public comment period but before the publication of this ROD. In addition, a public meeting was held in February 2004 to present the Proposed Plan to a community audience. At this meeting, representatives from CDPHE and the School answered questions about problems at the Site and the remedial alternatives. The

School's response to the comments received during this period is included in the Responsiveness Summary, which is part of this ROD.

After the 2004 field work was halted, the School conferred with CDPHE about ongoing investigative work. After the 2007 revised RI/FS was published on May 15, 2007, notice of its availability was published in local and major newspapers, and letters and e-mails were also sent to stakeholders regarding the availability of the RI/FS and Proposed Plan, and the opportunity for public comment. A 30-day public comment period was held, including a public meeting on May 30, 2007 to present the Proposed Plan and RI/FS results, at which some local residents and CDPHE and PRP representatives attended. Written comments were received from CDPHE and some PRPs within the 30-day comment period. The School's response to comments received during the public comment period is included in the Responsiveness Summary, which is a part of this ROD.

D. Scope and Role of Operable Unit or Response Action

As noted above in Part II.A, numerous Site investigation and cleanup activities have been ongoing for years. The scope of this ROD addresses the last remaining areas that need cleanup at the Site: most of the Fenced Area, the Clay Pits Area, and the groundwater. The former settling pond area (located within the Fenced Area) and the softball field area have already been addressed in prior efforts. The remaining remedial action is being performed under the authority of CERCLA and State laws that authorize the School to take action and expend money on the remediation.

After the two stockpiles have been transported from the Site during the course of the remedial action, the remaining surface areas will be stabilized, including the use of backfill, and used for unrestricted beneficial purposes again, such as recreation. While the recreation is ongoing, the School will continue to monitor the groundwater to demonstrate the effectiveness of offsite disposal of the contaminated soils. After this demonstration, the groundwater will also be available for unrestricted uses. If the demonstration is not made, the groundwater quality issue will be re-evaluated.

E. Site Characteristics

In general, the approximately 6-acre Site slopes gently to the north with a major elevation break above the former settling pond (Figure 2). The majority of the buildings located on the eastern side of the main driveway had shallow foundations resulting in relatively uniform topography after the concrete removal operations had been completed. Buildings on the western side of the Site had fairly deep foundations and removal operations resulted in significantly deeper excavations.

Utilities remaining on the Site at the start of the RI included an overhead electrical line, water mains and a sewer line owned by the City of Golden, and irrigation lines owned by the School. All other utilities had been disconnected prior to the concrete/asphalt removal operation.
The Colorado Historical Society advised that no significant historical or archeological resources are known in the immediate vicinity of the Site. Additionally, the City of Golden's Planning Department also advised that there are no known historical or archeological resources that would affect the FS alternatives evaluation or selection process.

The Site is located immediately south of Clear Creek, the primary surface-water conveyance in the area. Clear Creek is a perennial tributary of the South Platte River with a drainage basin area above the Site of approximately 400 square miles. The headwaters of Clear Creek are located along the Continental Divide near Loveland Basin Ski Area. From the headwaters the stream drops over 8,000 feet in about 50 miles, passing through steep canyons on its way to the Golden area. East of Golden, Clear Creek flows through the plains for about 14 miles to its confluence with the South Platte River in Denver, Colorado.

In the vicinity of the Site, the 100-year flood elevation is 5,682 feet. The 500-year flood level is about 5 feet higher than the 100-year elevation or about 5,687 feet. The elevation at the lowest point of the Site is approximately 5,670 feet (former settling pond area next to Clear Creek), which is in the flood plain. However, the majority of the Site lies between about 5,700 feet and 5,720 feet, which are at least 23 feet above the 100-year elevation and 18 feet above the 500-year elevation.

Chimney Gulch is a small drainage that passes about 100 feet west of the western gate of the Site. Chimney Gulch is a tributary of Clear Creek with a drainage basin of approximately 482 acres. This tributary’s headwaters begin on Lookout Mountain and its confluence with Clear Creek is about 200 feet northwest of the Site. During most of the year, Chimney Gulch is dry. However, when the Welch Ditch is being used, excess water in the ditch is routinely drained into Chimney Gulch and back into Clear Creek.

Clear Creek passes through a historic mining region of the Colorado Mineral Belt. Several reaches of Clear Creek have been designated EPA Superfund Sites because of the extensive mining operations. Numerous mine adits along the stream contribute to seasonally elevated concentrations of metals, primarily manganese and zinc.

The Site is located along the eastern edge of the Rocky Mountain Front Range foothills. The foothills include the areas where “older” deposits were folded and pushed aside as the “younger” Rocky Mountains uplifted. The foothills rock types range from unconsolidated sediment deposits (25 thousand to 1 million years old) to sedimentary rocks (primarily sandstone and shale - 300 million to 63 million years old) to igneous and metamorphic rocks (over 1 billion years old). These formations remain as horizontal layers beneath Denver and the eastern plains. The Clay Pits area is a surface expression of the unconsolidated sediment deposits (Laramie - Fox Hills Sandstone - these deposits have been tilted almost vertical) and the bedrock underlying the Site is a sedimentary rock (Pierre Shale). The Golden fault, a high-angle reverse fault, is present along the eastern edge of the foothills west of the Site (Figure 3).

Weimer’s cross section (Figure 4) shows that the geologic strata are overturned and steeply dipping. Measurements of the strike of the beds in the Clay Pits area show a North 37° West trend with dips ranging from about 70° to 80° to the west (James L. Grant & Associates, Inc., April 1990). Farther east the beds become vertical and then east dipping. The Site is located in an area of surficial deposits overlying the Pierre Shale. Van Horn (1976) characterizes the Golden fault as a moderately to steeply west-dipping reverse fault of large displacement.

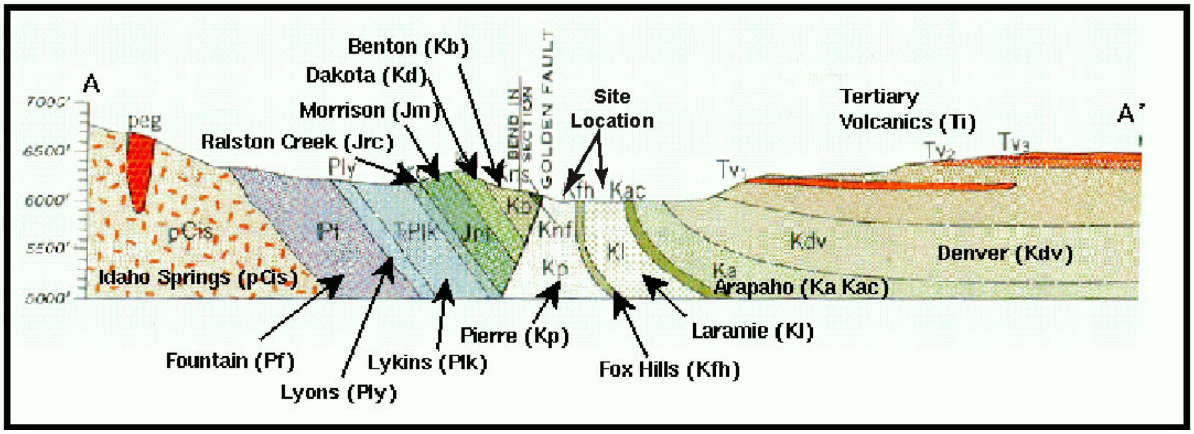

Figure 4 Schematic Representation of Hypothetical Soil Profile with Underlying Parent Rock (Weimer)

Small areas of Pierre Shale are evident along the western end of the former settling pond, exposed by the erosion action of Clear Creek. Weimer (1976) characterized the unit as consisting of dark gray shale with minor, thin laminae of tan-weathered limonitic siltstone and silty, very fine-grained sandstone. Pierre Shale underlies much of the Site, including part of the parking area. The Pierre Shale is estimated to be at least 2,000 feet thick beneath the Site.

In the immediate vicinity, exposures of the Fox Hills are limited because of localized faulting. Where exposed, the sandstone is tan to yellow, fine-grained, subrounded, friable, calcareous sandstone with thin beds or laminae of siltstone and gray montmorillonitic claystone. The exposed thickness of the Fox Hills near 12th Street (Figure 4) is about 40 feet; however, the exact thickness is questionable because of faulting and could be as much as 75 feet (Weimer 1976). The Fox Hills underlies a part of the eastern-most practice field and some of the former Site buildings and parking area. The outcrop of this formation is visible to the west of the C1ay Pits site.

The surficial deposits that overlie the bedrock in the vicinity of the Site (Figure 5) include the following (the order presented below does not show the age relationship):

- Louviers Alluvium
- Younger Alluvial Fan Colluvium
- Post-Piney Creek Alluvium
- Artificial Fill

The Louviers deposit is typically a coarse cobbly sand and gravel that is poorly sorted. Generally, there is less than 10 percent silt and clay present. Boulders as large as one-foot across are present, but the common large size is 6 inches. Based on the subsurface work performed at this location, this unit is about 10 feet thick and extends south under the baseball and practice fields to the approximate location shown where it pinches out against the bedrock. The Louviers is overlain by younger alluvial fan, colluvium, and artificial fill deposits. Locally, the post-Piney Creek Alluvium overlies eroded Louviers deposits.

The 2003-2004 subsurface investigation of the Site included 36 test pits and 28 borings. The majority of the subsurface material would be classified colluvium. The eastern portion of the Site is covered with a clay layer that varies in thickness between 5 to 6 feet. Below the clay is a layer of red, brown sandy clay followed by a layer of orange, red, brown clayey sand. These layers vary in thickness from about one foot to three feet. These differences reflect the origin of the colluvium. Potentially, the clay materials have been derived from the Pierre Shale; the reddish-brown sand from the Fountain Formation (present on the west side of the Golden fault); and the brown sand from the Fox Hills formation.

Underlying the colluvial material is an alluvial cobble zone. The cobble zone consists of a small quantity of pinkish, reddish sand intermixed with numerous flat cobbles/boulders (up to 12 inches). Up to 13 feet of this alluvial material was encountered in the borings. This zone could not be penetrated by the backhoe used for the test pits.

Artificial fills areas were identified during the RAOA and are shown in Figure 5. The identified fill was used primarily for highway construction and for enhancing the usable area of the athletic fields and the adjacent area. The fills include tan to brown clay, medium to stiff, silty, sandy, and slightly gravelly (athletic field) and the artificial fill consists of silty clay to clayey sand with some gravel and construction debris (softball field area).

A comparative analysis of the topographic changes in the last several decades was performed as part of the RAOA. The analysis revealed that fills in the baseball field and western-most practice field may have been generated from cuts (up to 15 feet) in the infield portion of the baseball field.

Additional artificial fill was identified during the RI including:

- Sandy, silty cobbles for roadbed construction,
- Imported uniform sand used for fill around foundations and under roads,
- Bricks and miscellaneous building debris mixed with varying mixtures of clay and sand, and
- A variety of bricks, clays, and sands, and miscellaneous debris used for roadbeds and fill around building foundations.

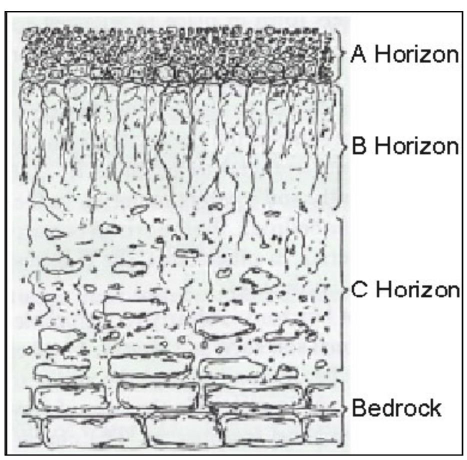

Figure 6 Schematic Representation of a Hypothetical Soil Profile with Underlying Parent Rock

Because of the extensive construction activities on the Site, very little “A” horizon material remained. Small areas of an “A” horizon were encountered along the northern side of the eastern and western access road. A treed area is located along Clear Creek in the northeastern corner of the Site has a shallow “A” horizon underlain by sandy, silty sub-soils. No additional subsurface investigation was completed in this area for the RI. The majority of the Site is covered with “B” or “C” horizon subsoils that were exposed as the buildings and roads were constructed.

Groundwater is present in the following bedrock units: the Laramie/Fox Hills units, the Arapahoe, and some of the Denver. Groundwater is also present in the Louviers Alluvium and post-Piney Creek Alluvium. The Laramie/Fox Hills and the Arapahoe are important aquifers of regional significance and the Louviers Alluvium, post-Piney Creek Alluvium, and the Denver Formation can be locally significant. Regional studies by Robson (1983 and 1984) and Robson, e*t al.,* (1981 a; 1981 b) indicate that the outcrop areas for these units in the area are part of the recharge area. Recharge is primarily expected to occur from direct rainfall and snowmelt infiltration and by percolation from Clear Creek directly through the alluvium. However, RI observations suggest the reach of Clear Creek along the northern Site border may be a gaining reach because of the artesian nature of Laramie Fox Hills aquifer in this area (several seeps are visible in the area).

The most relevant water-bearing unit on the western side of the Site is the alluvial deposit above the weathered Pierre Shale. The Pierre Shale acts as an aquitard, allowing water from infiltration and nearby stream losses to move downgradient to Clear Creek. The Pierre Shale was encountered in four of the borings installed as part of the RI. Depth to the unit varied from about 10-feet below ground surface (bgs) north of the former Building 101N location to about 40 feet bgs near the baseball field. The groundwater zone above the formation varies between about one to four feet above the unit near the former Building 101N location and between about 6 to 15 feet near the baseball field. Groundwater was encountered about 30 feet below the baseball field and about 54 feet below the practice fields during the RAOA.

The most relevant water-bearing unit on the eastern side of the Site is the Laramie Fox-Hills aquifer. The outcrop of the Arapahoe formation appears to be located to the east of the Site and does not influence Site hydrology.

A complex groundwater system underlies the Site because of the area geology. Bedrock in the vicinity is a complicated system of nearly vertical sediment deposits overlying Precambrian, crystalline bedrock. Sediment layers that once were located deep under the Denver Basin were pushed up as a result of the uplift of the Rocky Mountains. The Site is located at the western edge of the Denver Basin aquifer system, which includes the following four aquifers: Dawson, Denver, Arapahoe, and Laramie/Fox Hills. These aquifers are unconfined along these uplifted beds and the potentiometric surface (water table) associated with each aquifer is typically closer to the surface than the majority of the aquifer. The aquifers are confined in the deeper portions of the basin, providing the pressure required to raise the groundwater closer to the surface. This artesian effect appears to be occurring in the portion of the Laramie/Fox Hills aquifer that underlies the Site.

The groundwater direction is governed by the underlying weathered Pierre Shale and appears to be flowing northeasterly toward Clear Creek. The surface expression of the Laramie/Fox Hills Sandstone may influence groundwater movement in the vicinity of the Clay Pits causing a northwestern movement. Weathering has removed any surface expression of the sandstone along Clear Creek so it is difficult to determine if the northwest movement is actually happening.

It appears that the majority of the western Site groundwater comes from surface infiltration from the surrounding foothills, surface irrigation of the baseball/softball fields, and the seasonal influence of the nearby Welch ditch. The eastern Site groundwater appears to be a mixture of the infiltration water and the Laramie/Fox Hills aquifer.

The original operations that generated the affected material no longer exist on the Site. The Site was used for mining-related research projects and was in operation from 1912 until about 1987. Because buildings and equipment were removed prior to the RI, only the residual affected material (primarily soil) remained on the Site.

Source investigations that were conducted as by New Horizons as part of the RI in 2002 and 2003 included a surface gamma survey, collection of surface samples, excavation of test pits for gamma surveys and sample collection, installation of bore holes for gamma surveys and sample collection, and collection of groundwater samples. These 2002-2003 investigations are discussed below. After the presentation of the 2002-2003 investigations is made below, a presentation will be made on the halted field work activities and the subsequent investigation work by Stoller.

The Fenced area and the Clay Pits area were gamma surveyed as part of the RI. The area around the former settling pond adjacent to Clear Creek was excluded because it had previously been surveyed and released by EPA during the 1992 response action. In addition, the density of survey locations was limited in the northeast corner of the Site due to dense vegetation and steep slopes, which made this area relatively inaccessible. Several areas of the Site were inaccessible because of unstable slopes that remained after the removal of the concrete and asphalt slabs and sidewalls. The survey consisted of dividing the Site into an approximate 3.3 meter x 3.3 meter (10 feet x 10 feet) grid and recording a 10-second gamma reading inside each grid square. Each survey coordinate was recorded using a global positioning system (GPS) unit. Additional readings were collected in areas that exhibited elevated gamma readings to better define the extent of the anomaly. Prior to the Site gamma survey, gamma measurements were made in areas adjacent to the fenced area and Clay Pits area. These measurements were used to establish the Site background gamma levels. A total of 3,282 survey points were measured during the surface gamma survey.

Surface soil samples were collected to determine the type, the extent, and activities/ concentrations of the contaminants. The primary focus of the sampling program was metals and radionuclides, but organic compounds were investigated if necessary. Samples were collected from surface soils at 163 locations on the Site in accordance with the approved sampling analysis plan and using the guidance provided in Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM). The Site was divided into 12 sections with up to 10 samples collected from each section. A GPS unit was used to delineate the section boundaries. Once the boundaries were established, sample locations were selected by randomly placing markers in the area.

Thirty-six trenches/test pits and 28 borings were used to investigate the subsurface soils at the Site. The test pit subsurface investigation primarily focused on those areas where drains or pipelines had penetrated building flooring (these locations were identified prior to the removal of the concrete and asphalt slabs and relocated by Flatirons after New Horizons completed the removal operations) and other visually suspect areas identified following the concrete and asphalt removal. The borings were primarily focused in those areas with elevated surface gamma readings.

A backhoe was used to excavate test pits (i.e., pot holes) at 36 locations on the Site. Test pit dimensions varied depending on the site characteristics (pipelines, debris, and soil consistency). The objective was to excavate to at least 10 feet bgs; however, various obstacles prevented completion to this depth on some of the pits. All pits were refilled after completion of the investigation. All surface sample, boring, and test pit locations from the 2004 RI/FS are shown on Figure 7.

A percussion hammer drill rig was used to advance 28 borings on the Site. The borings were primarily used to investigate areas that indicated elevated gamma readings. Most of the borings were completed to 10 feet bgs. Two of the borings were subsequently converted to groundwater monitoring wells.

Portions of walls and floor slabs of Building 103 that had been covered during the original concrete characterization study were subsequently discovered during the concrete removal operations conducted by New Horizons. Test pits CP1 and CP2 were excavated to determine the nature and extent of the buried Building 103 wall remnants and floor slabs.

Two groundwater monitoring wells were installed using two of the borings drilled during the subsurface investigation. The purpose of the installation was to provide additional groundwater (upgradient and downgradient) data for the Site. The upgradient well (CSMR-06) location was positioned along the north-south boundary with the baseball field. The downgradient well (CSMR-07) was positioned north of the former Building 101N foundation and above the former settling pond. CSMRI-06 is 43.5 feet deep and CSMRI-07 is 20 feet deep.

Five existing wells and the two new monitoring wells were sampled as part of the investigation to determine current groundwater conditions in and near the Site. The existing wells included three wells located along Clear Creek (CSMRI-01, -04, and -05), one background well located south of the Clay Pits (CSMRI-02), and one well located downgradient of the Clay Pits (CSMRI-03).

From October 24, 2002 through January 31, 2003, 26 air samples were collected during investigation activities likely to release airborne dust. Activities sampled included excavation of foundations, size reduction of concrete, loading trucks, backhoe operations, and drilling.

Historical site activities left deposits of mining research waste over a large portion of the Site. Contaminants of concern include:

- Metals - Primarily arsenic, lead, and mercury, but the soil analyses included barium, cadmium, chromium, molybdenum, selenium, silver, vanadium, and zinc.
- Radionuclides - Primarily radium, thorium, and uranium, but gamma spectroscopy was used to examine an additional 38 radioisotopes.

All of the surface soil samples contained arsenic at concentrations above the proposed Tier 2 soil standards found in the proposed CDPHE Soil Remediation Objectives policy (1997 and 2003). However, background arsenic concentrations vary greatly in different types of geology. The western states typically have geological formations with elevated arsenic concentrations. The highest arsenic concentrations appear to be around the excavated building formations and around the western side of the site, but a number of areas to the east have concentrations above the background value.

About 21 percent of the surface samples contain lead above CDPHE-proposed soil standards. The highest concentrations of lead appear to again be located in the vicinity of the excavated building formations. Lead concentrations decrease significantly with depth suggesting the lead-affected material was imported to the site.

Mercury was detected in all of the surface soil samples, but the species of mercury was not determined. Mercury can occur as inorganic elemental or metallic mercury (HgO), mercurous Hg (Hg1+), and mercuric Hg (Hg2+) or as organic methylmercury and ethylmercury. The elemental and organic forms of mercury are considered to carry the greatest risk to human health and the environment. Because of the types of research conducted on the Site and the instruments associated with such research, elemental mercury could be present. But the mercury also could come from mineral ores brought to the site, which would be composed of mercury compounds. About 47 percent of the surface soil samples exceed the CDPHE-proposed residential standard for elemental mercury. However, only 3 percent of the samples exceed the CDPHE-proposed residential standard if the material consists of mercury compounds. Mercury concentrations also decrease with depth (average concentration of 0.5 milligram per kilogram [mg/kg] in the upper 2 feet of soil, compared to average concentrations of less than 0.1 in the underlying layers), which again suggested that the mercury-affected material was imported to the Site.

A small number of the soil samples contained cadmium (about one percent), molybdenum (less than two percent), and vanadium (less than one percent) above CDPHE-proposed residential soil standards. All of these samples were co-located with soil that contained elevated concentrations of other metals or radionuclides.

Risk modeling indicates that Ra-226 is the primary radionuclide of concern on the Site. The majority of the radium-affected material appears to be located in the vicinity of the buildings on the western side of the former Main Street (Buildings 101 and 115) with a limited number of outlying areas. Subsurface-soil samples indicate that activities of radium decrease with depth in the vicinity of the former buildings.

Modeling also indicated that Th-230 was a radionuclide of concern over time (decays to radium). As with the radium, thorium appears to be located around the excavated building foundations on the western side of the Site. Thorium activities also decrease with depth in the vicinity of the former buildings.

Uranium also is considered a radionuclide of concern because it contributes over 30 percent of the activity of the surface soil samples. The uranium appears primarily to be co-located with the radium and thorium in the vicinity of the western former buildings. In general, uranium activities also decrease with depth.

The Toxicity Characteristic Leaching Procedure (TCLP) results indicate that the affected material is not hazardous waste and may be disposed of in a licensed solid waste landfill.

Based upon the operational history of the Site and analysis of laws, the affected materials are RCRA solid wastes.

The findings of the groundwater sampling rounds suggest up to three types of water mixing under the Site producing a complex groundwater system. Water infiltrating into the alluvial material from precipitation, irrigation, and surface-water sources (Welch ditch and Chimney Gulch) travels southwest to northeast along the Pierre Shale aquitard toward Clear Creek. Artesian water from Laramie/Fox Hills aquifer appears to move through the more permeable sandstone in a southeast to northwest direction (although some of this movement may be redirected by paleochannels). And the alluvial channel of Clear Creek moves water in a west to east direction. The three water sources then mix somewhere in the vicinity of the Site.

The groundwater sample results suggest the movement of affected material to groundwater. Uranium concentrations increased in two of the downgradient wells (CSMRI-04 and -07) during the July sampling round (concentrations were above EPA's MCL for total uranium). The uranium concentrations decreased during the October sampling round, which suggests the material was no longer moving to groundwater.

The uranium movement is consistent with the precipitation events that occurred during the 2003 season. After an extended dry period a March snowstorm delivered significant precipitation to the area. Spring rains also added to overall soil moisture. Eliminating the Site asphalt and concrete essentially removed a cap that limited the movement of precipitation into the soil column. Removal of the former Building 101N created a depression that now acts as a detention pond during storm events. The bottom of the "pond" is located in the alluvial cobble zone. Calculations showed that precipitation along with the associated ponding would have saturated the soil column and allowed the movement of soluble material and fine particles to groundwater. The return of dry weather for the remainder of the summer and fall dried out the soil column, eliminating the groundwater pathway. Metals also appear in the groundwater samples but at concentrations at or near the detection levels, making it difficult to predict trends.

The two monitoring wells located along Clear Creek contain relatively consistent, low concentrations of a variety of volatile organic compounds (VOCs). Several of these compounds tend to "pancake" at the bottom of an aquifer resulting in a small continuing source of material for an extended time period. A small quantity of these solvents can produce this result. All of the reported VOC concentrations have been below the MCLs with the exception of the fourth round CSMRI-04 sample, which was 0.1 micrograms per liter (ug/L) above the trichloroethene standard (5.0 ug/L).

Using kriging analysis, New Horizons estimated approximately 10,000 cubic yards of affected soil materials would be removed from the Site.

The potential routes of migration associated with the Site currently include:

- Wind erosion, moving material primarily to the east (prevailing winds are from the west),
- Water erosion, transferring material offsite or into Clear Creek,
- Wind borne diffusion, moving radon and radon decay products offsite (again driven by prevailing west winds),
- Plant material transport, moving material taken up by plants as wind or water borne plant debris,
- Particle transfer, moving material via attachment to personnel and/or vehicle, and
- Solute and particle transport, transferring material into the underlying groundwater through percolation and preferential pathways.

The primary COPCs on the Site include metals and radionuclides. These materials are very persistent in the environment. Organic compounds discovered near the baseball field included petroleum hydrocarbons and chlorinated solvents. The combination of these materials provided the proper environment for biodegradation of both materials. Current soil concentrations of the organic compounds are below current proposed CDPHE Soil Screening levels.

Affected material migration prior to the excavation of the asphalt and concrete was minimal, influenced only by minor soil exposure, plant uptake, and water infiltration. An estimated 90 percent of the Site was covered with asphalt or concrete prior to removal operations. Removal and transportation activities resulted in some portion of the material being displaced from its original location. Excavation of large foundation blocks and walls required soil to be moved and additional soil was moved to provide access roads for the trucks. Efforts were made to minimize the disturbed areas, but a small amount of material transfer did occur. However, none of the material left the Site.

Metals and radionuclides present in Site soils in 2003 provided a continuing source of contaminants to the underlying groundwater. Factors including precipitation and ponding, material speciation and solubility, cation exchange capacity, and soil type, pH, and compaction can all affect the movement of the material to groundwater. Minor precipitation events can transport material deeper into the soil column where material concentrations increase until a major event transports the material to groundwater. Groundwater levels also can raise enough to interact with this material periodically. Sandy soil typically provides minimal resistance to transport of radionuclides and metals, while clays and organic materials can adsorb these materials, slowing the movement to groundwater. However, soil acidity and acid rain can reverse the adsorption process (hydrogen cations replace the metal/radionuclide cations), allowing continued material movement. The metal cations also compete with each other for available adsorption sites, continuing downward movement of material through the soil column.

The metal- and radionuclide-affected material identified during the RI were less mobile prior to the removal of the asphalt and concrete "cap". Without the cap the affected material could in 2003 migrate to groundwater more readily. The onsite groundwater is not a drinking water supply. But the groundwater flows into Clear Creek, which is a drinking-water supply for downstream communities. A boundary groundwater well (CSMRI-04) had total uranium concentrations above the MCL during two of the quarterly sampling rounds in 2002-2003. This well is at the point of compliance. Dilution effects would significantly reduce concentrations in Clear Creek but the CDPHE, Water Quality Control Commission requires that uranium levels in surface water be maintained at the lowest practical level. Precipitation events can be expected to continue to move additional material to groundwater.

Radon generated by the natural decay of the radionuclides diffuses through the soil and migrates to the atmosphere. Radon is typically a problem when a building foundation is in contact with the affected soil and the radon is trapped inside the building. There are no buildings on the Site at this time, although there are two valve pits that are part of the baseball field irrigation system.

The U.S. Department of Energy and U.S. Nuclear Regulatory Commission model for site-specific dose assessment of residual radioactivity, RESRAD 6.21 was used to model migration pathways such as wind and water erosion. Because of the limited nature of the groundwater modeling package provided with RESRAD, Visual Modflow Pro in combination with Modflow SURFACT (Waterloo Hydrogeologic) was used by New Horizons in an attempt to model the movement of COPCs to groundwater. Because only limited number of groundwater system parameters had been identified, the programs were primarily used to examine potential pathways for the contaminants.

Obvious particle pathways (material moves down to the Pierre Shale and then to Clear Creek) were predicted by New Horizons using preliminary modeling efforts. A decision was made during the 2004 RI/FS process to focus resources on the control of the source area rather than expending additional resources to generate a complex and expensive model with a large degree of uncertainty. Rough calculations show that saturating the soil column will move material to groundwater either through particle movement or solubility. The exact timing of the contaminant movement and the resulting concentrations are largely dependent on the precipitation amounts.

The previous paragraphs summarize the Site characteristics as presented by New Horizons' in its 2004 RI/FS. The following paragraphs present a summary of the activities since the 2004 ROD was published and New Horizons' 2004 remedial field activities.

The 2004 *Remedial Investigation/Feasibility Study and Proposed Plan* was issued on January 21, 2004. The 2004 Proposed Plan recommended Alternative 5, the removal and offsite disposal of contaminated soils. The School selected Alternative 5 as the final remedial action for the Site and documented the remedy selection in a ROD, which was signed on March 31, 2004.

New Horizons began field work in April 2004. During the 2004 remedial action, six areas were excavated and a seventh area was partially excavated. By May 2004, it was apparent that excavated soil volumes and concentrations and projected costs significantly exceeded previously estimated volumes, concentrations, and costs. Work was halted and the Site stabilized. Approximately 1,870 cubic yards of soil had been excavated, bagged, and stored on the Site by New Horizons during the 2004 remediation work. This bagged soil had been initially slated for disposal at the U.S. Ecology RCRA facility in Idaho.

In December 2004, Stoller sampled the bags. The results were submitted to CDPHE in April 2005. CDPHE approved shipment to the Foothills solid waste landfill. CDPHE also approved a hypothetical scenario of 30,000 cubic yards of soil similar to the soil contained in the bags. This scenario anticipated possible further soil excavation at the Site and prevented the need for having to perform a second dose assessment. The bags were shipped to the landfill in December 2005.

In May 2005, the School contracted Stoller to examine further Site investigation alternatives to move the project toward completion while maintaining the CERCLA framework.

In September 2005, Stoller prepared a Background Evaluation Report for the Site. CDPHE agreed to increase the background level of arsenic to 38 ppm, resulting in a tentative DCGL of 39 ppm. Additionally, the CDPHE agreed to use a total mercury standard to guide characterization with some speciated confirmatory data in support. The School and CDPHE agreed that the School could later demonstrate to CDPHE alternative background conditions for different portions of the Site during field excavation work upon field observations and further data.

Beginning in June 2006, Stoller excavated and segregated contaminated soil above the tentative cleanup goals into two soil stockpiles onsite, with the remainder of the main site (upper terrace) meeting the tentative Site cleanup goals. The lower terrace, including the west end of the flood plain but excluding the location of the former settling pond that was closed by EPA, has been characterized, and a small volume of contaminated soils exceeding the tentative Site cleanup goals will be excavated to the onsite stockpiles in 2007.

Excavated soils had a mean in mg/kg of 40.1 for arsenic, 532.2 for lead, 2.3 for mercury, 89.4 for molybdenum, and 44.1 for vanadium, and a mean of 12.2 pCi/g Ra-226.

Stockpile B consists of approximately 12,500 cubic yards with a mean of 13.55 pCi/g Ra-226. Stockpile A consists of approximately 200 cubic yards has a mean of 71.83 pCi/g Ra-226. The soil in both piles is RCRA solid waste, not hazardous waste.

The creation of the two stockpiles should temporarily eliminate further migration of contaminants to groundwater. When the stockpiles are disposed of at the offsite landfills, the threat of these soils contaminating groundwater will be permanently eliminated.

Stoller then sampled the remaining soils after the soils in excess of DCGLs were excavated and placed into the two stockpiles. The results showed that the upper terraced areas at the Site are below DCGLs. CDPHE determined that the soil in these areas meet the DCGLs.
Stoller collected quarterly groundwater samples since February 2005 from monitoring wells CSMRI-1, CSMRI-2, CSMRI-4, and CSMRI-5; and quarterly surface water samples SW-1 and SW-2 from Clear Creek. In February 2007, monitoring wells CSMRI-1B, -6B, -7B, -8, -9, -10,

and -11 were installed by Stoller to further characterize the groundwater at the CSMRI Site for post-excavation success purposes.

The analytical results indicated no drinking water MCL exceedances for tested dissolved metals at any of the groundwater monitoring wells on the CSMRI Site. Exceedances of the MCL for radioisotopes have historically occurred only in monitoring well CSMRI-4, and only for uranium. However, with the February 2007 installation of monitoring well CSMRI-8, uranium in groundwater has also been detected for the initial sampling event at a concentration of 1,100 μg/l, which exceeds the MCL of 30 μg/l. Historically, monitoring well CSMRI-4 has had elevated concentrations of uranium, but the values have been declining steadily since 1991 to the first quarter 2007 concentration of 48 μg/l. Monitoring well CSMRI-8 will continue to be sampled on a quarterly basis with the other Site wells, and the reason for the elevated level of uranium will be evaluated. Continued elevated uranium readings at this well may indicate the need for taking some further remedial action.

Stoller also characterized the flood plain area east of the former pond. Ra-226 is the only constituent of concern in this area. Approximately 150 cubic yards of soil were excavated and placed in Stockpile B. In February 2007, the excavated areas were resampled. The results showed Ra-226 levels ranging from 3 to 89 pCi/g. Approximately three-quarters of the area previously excavated require further soil excavation to achieve the tentative Site action level of 4.14 pCi/g for Ra-226. When the flood plain dries out enough in the fall of 2007 to allow heavy equipment access, excavation of remaining contaminated soils will continue, followed by confirmation sampling. It is estimated that up to another 200 cubic yards of soil could be excavated from this area. This small additional soil volume added to Stockpile B will not impact the alternatives assessment or remedy selection.

Stoller also investigated the Clay Pits area. The analytical results indicate concentrations of metals and radioisotopes that are generally unremarkable for debris and fill material except for sample CP6-35, which was collected from borehole CP6 at a depth of 35 feet bgs. Lead was detected at a concentration of 30,000 mg/kg at this sampled interval and location. This sample was collected near the base of the debris layer, and material within the core run included ash, scrap wire, dirt, and industrial hose. The presence of the ash and scrap wire and other material may have biased the analytical results for this compound. The average concentration of lead in the samples submitted for analytical testing is 234 mg/kg if this particular elevated detect is excluded from the data set. Radioisotope activity is near background levels, with the highest activity detected in soil sample CP2-19, which showed Ra-226 at 11.7 pCi/g and Th-230 at 12.4 pCi/g. The borehole log for CP-2 at this interval identifies the material as fill with abundant gravel. In all cases, elevated data were defined by clean samples (below Site action levels) beneath the elevated sample. Buried sediment material that could be attributed to the CSMRI pond or ore-like material used to cover the sediment was not observed during this subsurface drilling and sampling program.

F. Current and Potential Future Land and Water Uses

There is no current beneficial land use for the Site. The Site had been used for mining and metallurgical research from 1912 until 1987, when Site research operations ceased.

The Site (except for the Clay Pits area) is surrounded with a chain-link fence and posted. Access is limited to maintenance activities. There are no drinking water supply wells in the immediate vicinity of the Site.

Although the groundwater is not currently used as a drinking water source, it eventually enters the Clear Creek alluvial system. The City of Golden currently uses Clear Creek as the primary drinking water source, but the surface-water diversion is located about 0.9 mile upstream of the Site. Coors Brewing Company uses alluvial wells located about 0.4 mile downstream from the Site. Additional downstream diversions that currently supply drinking water include the Agricultural Ditch (0.6 mile) and the Farmer's Ditch (0.7 mile).

Golden's historic residential district is located near the Site to the east, while Golden public facilities such as a recreation and community center are located just north of the Site across from Clear Creek. The School's football field is located to the east and School athletic fields are located to the west and southwest. The Clay Pits are located to the south of the Site. Clear Creek bounds the Site to the north.

Near-term land use scenarios could include a recreational area, such as athletic fields and a parking lot for recreational users and spectators. Foreseeable land use could include the construction of student housing or academic buildings. Reasonably foreseeable future land use could also include an urban resident considering the persistence of the metals and the longevity of the radionuclides (half-life: Ra-226, 1.6×10^3 years; Th-230, 7.6×10^4 years). The requirements of 40 CFR §192.02 require that remedies for sites with similar radionuclide contaminants provide up to 1,000 years of protection to human health and the environment (at least 200 years). For a CERCLA NCP baseline risk assessment, the conservative subsistence farmer scenario was used as the baseline but was adjusted to the urban resident at CDPHE's suggestion. To provide an overall picture of relative risk, urban residential and recreational scenarios were also provided in the 2004 RI/FS for comparison.

The original Alternative 5 in the 2004 RI/FS used a conservative approach, subsistence farmer to model the onsite receptor. It was assumed that the farm family grew their own food, used cattle grazing on site for milk and meat, used the groundwater, and spent considerable time on the property. At the suggestion of CDPHE, a slightly less conservative receptor, the urban resident, was allowed and adopted in the 2004 ROD. However, the urban resident was specified to be the maximally exposed individual, which is a conservative assumption. The maximally exposed individual leads the life style of an urban resident but consumes groundwater from the Site and has a backyard garden that is a primary source of food (up to 50 percent of fruits and vegetables). The change in receptors resulted in a moderately reduced dose and risk and somewhat higher DCGLs for the radionuclides of concern. The radionuclide DCGLs proposed in the 2004 RI/FS and Proposed Plan were as follows for the subsistence farmer at 15 mrem/yr doses under the RESRAD modeling performed by New Horizons:

Table 4
DCGLs (Subsistence Farmer)

Radionuclide	Subsistence Farmer (15 mrem/yr)
Radium-226	0.84
Radium-228	1.4
Thorium-228	2.7
Thorium-230	3.8
Thorium-232	0.96
Uranium-234	14
Uranium-235	3.2
Uranium-238	15

Note: All units in picocuries per gram

The radionuclide DCGLs developed for the 2004 ROD based on public comments are slightly higher:

Table 5
DCGLs (Urban Resident)

Radionuclide	Urban Resident (15 mrem/yr)
Lead-210	4.44
Polonium-210	192
Radium-226	1.44
Radium-228	2.20
Thorium-228	3.77
Thorium-230	9.83
Thorium-232	1.48
Uranium-234	253
Uranium-235	4.88
Uranium-238	20.2

Note: All units in picocuries per gram

The 2004 ROD radionuclide DCGLs were used in the 2007 Revised RI/FS and are used in this 2007 ROD. As a practical matter, the differences between the subsistence farmer and the urban resident are insignificant, because field excavation activities under either version of the DCGLs would likely have removed a similar amount of soils due to the analytical parameters of field instrumentation and the small differences in activity levels between the prior and the current ones for Ra-226, which is the primary driver of risk at the Site, the variability of activity levels in soils at the Site, and the cost effectiveness strategy of excavating enough affected soil to ensure that a second round of excavation and confirmation sampling be avoided. The change in receptors for radionuclides does not materially alter the remedy selection or its performance.

The assumptions for metals remained the same among the 2004 RI/FS, the 2004 ROD, the 2007 Revised RI/FS, and the 2007 ROD: residential uses.

G. Summary of Site Risks

The baseline risk assessment estimates what risks the Site poses if no action were taken. It provides the basis for taking action and identifies the contaminants and exposure pathways that need to be addressed by the remedial action. This section of the ROD summarizes the results of the baseline risk assessment for this Site.

The baseline risk assessment was performed for the CSMRI Site by New Horizons in 2004 and remains valid as the Baseline Risk Assessment. The 2004 RI/FS concluded that the no further action alternative and leaving the Site in its condition as of 2004 were not acceptable because they were not protective of human health and the environment, and a ROD was issued to document this conclusion. The 2004 remediation was halted because the nature and extent of the contamination was found to have been greater than previously calculated by the investigation in the 2004 RI/FS. Therefore, it was clear as of 2004 that the risks to the subsidence farmer, urban resident, the underlying groundwater, and Clear Creek could only be greater than was previously estimated by the prior risk assessment. Having rejected the no-action alternative in the 2004 RI/FS, and knowing the nature and extent of contamination was greater than previously believed, it was safe to assume that a proactive remedy would be necessary. The 2006 investigation method included the excavation and stockpiling of the impacted soils to determine the nature and extent of contamination. Excavation of the contaminated soils was also one of the necessary elements of the eligible remaining remedial alternatives that would have resulted in a protective remedy. The investigative excavation of the contaminated soils also altered the physical conditions of the Site by taking the *in-situ* contamination and transferring it to one of two stockpiles on Site. The results of the additional investigation performed in 2006 - 2007 confirmed that the nature and extent of contamination were greater than that calculated by the 2004 RI/FS. The baseline risk is greater than that previously believed in 2004. Because the risk was great enough to reject the no-action alternative in 2004, and the risk is now known to be greater than before, there was no need to perform another baseline risk assessment. The baseline conditions are the *in-situ* conditions, not the conditions as currently found with the two stockpiles.

Nonetheless, even if the Site conditions as they exist in April 2007 were selected as the new baseline conditions, with all contaminated soils located *ex-situ* in two stockpiles at the Site, those baseline conditions would still warrant the rejection of the no-action alternative as not being protective of human health and the environment. This conclusion is demonstrated by looking at the impact the current Site conditions have on the 2004 RI/FS risk assessment without having to perform another risk assessment from the beginning of the formal risk assessment process. It is more reasonable and cost effective to build off the prior work and add new information developed during the 2006 – 2007 investigation than to perform another risk assessment.

This Section G will first discuss the baseline risk assessment as performed by New Horizons with the *in-situ* conditions. Afterward, Section G will discuss the risk assessment that evaluates the alternative scenario that the baseline conditions are the current conditions of having all soil contamination located in two stockpiles onsite. This is presented to demonstrate that the no-action remedy must be rejected whether baseline conditions are the *in-situ* conditions or the *ex-situ* conditions. The main impacts caused by the changed Site configuration are the temporary elimination of impacted soil from providing a source for groundwater contamination (the stockpiles are on a liner) and the locally increased risk resulting from all the Site-impacted soil being placed in stockpiles.

The following is the summary of Site risks as of 2004:

Radium, thorium-230, and uranium-238 are the main chemicals of concern at this Site for radionuclides. The metals of arsenic, lead, mercury, and cadmium are the main chemicals of concern for the Site for the metals. The primary metals of concern identified during the RI include arsenic, cadmium, lead, and mercury. Additional metals were identified during the RI but are co-located with the metals of concern. In general, the highest metal concentrations are co-located with the radionuclides, but there are areas where the metals are the primary contaminant. Tables 6 through 14 describe the range of detected concentrations for the chemicals of concern in 2004 samples taken of the surface soils, in subsurface test pits, and subsurface borings.

Table 6
Detected Concentrations of Metal COPCs in 2004 Surface Soils

Metal	Mean	Median	Mode	Std Dev	Minimum	Maximum	Lognormal Mean
Arsenic	30.8	16	13	41.4	1.8	330	17.9
Barium	325	180	170	405	48	2900	228
Cadmium	3.28	0.84	0.02	7.01	ND	51	0.604
Chromium	17.1	15	14	9.27	6	79	15.6
Lead	465	140	140	1280	6.4	14000	153
Mercury	5.89	0.81	0.57	32.4	0.015	400	0.942
Molybdenum	37.6	13	1.8	92.6	0.89	980	13.7
Selenium	1.85	1.2	1.1	1.76	ND	11	1.34
Silver	2.67	0.83	0.02	6.14	ND	58	0.670
Vanadium	45.8	37	29	36.7	15	350	39.2
Zinc	673	260	110	1120	49	7100	314

Notes: All data units are in milligrams per kilogram; ND, not detected.

Table 7
Detected Concentrations of Radioisotope COPCs in 2004 Surface Soils

Isotope	Mean	Median	Mode	Std Dev	Minimum	Maximum	Lognormal Mean
Thorium-228	2.84	1.86	1.48	8.47	0.94	109	2.03
Thorium-230	9.21	3.105	1.25	25	0.75	272	3.98
Thorium-232	2.63	1.685	1.37	8.32	0.76	107	1.85
Uranium-234	6.19	2.46	2.25	11.1	ND	85	3.14
Uranium-235	0.34	0.123	0.0510	0.628	ND	4.9	0.162
Uranium-238	6.2	2.335	1.12	11.3	0.63	88	3.06

Notes: All data units are in picocuries per gram.

Table 8
Detected Concentrations of Radioisotope COPCs in 2004 Surface Soils

Isotope	Mean	Median	Mode	Std Dev	Minimum	Maximum	Lognormal Mean
Bi-212	2.20	2.0	1.5	1.10	ND	8.0	1.99
Bi-214	7.63	3.3	1.3	15.4	0.66	110	3.69
K-40	20.6	20	20	4.00	7.3	36	20.2
Pb-212	2.17	1.9	1.5	0.984	0.76	6.8	2.00
Pb-214	8.71	3.6	1.6	18.8	0.78	150	4.13
Ra-226	10.6	4.6	1.8	22.6	0.93	170	5.07
Ra-228	1.98	1.8	1.4	0.937	0.68	7.3	1.82
Th-234	5.25	3.3	3.8	6.23	0.55	42	3.62
Ti-208	0.626	0.55	0.55	0.295	0.209	2.2	0.575

Notes: All data units are in picocuries per gram.

Table 9
Detected Concentrations of Metal COPCs in 2004 Test Pits

Metal	Mean	Median	Mode	Std Dev	Minimum	Maximum	Lognormal Mean
Arsenic	21.9	8.4	11	36.9	0.98	180	9.26
Barium	211	140	120	216	16	1300	156
Cadmium	1.51	0.05	0.05	3.55	ND	17	0.226
Chromium	15.8	14	12	16.5	ND	130	12.7
Lead	502	72.5	16	1680	7.2	12000	83.8
Mercury	5.78	0.3	1.1	29.5	0.004	220	0.32
Molybdenum	43.6	5.3	1.2	115	1	610	7.6
Selenium	3.16	1.2	1.4	4.91	ND	24	1.58
Silver	3.52	0.16	0.02	16.3	ND	120	0.182
Vanadium	38.8	30.5	29	27.4	0.071	130	29.3
Zinc	511	160	75	820	13	3300	191

Notes: All data units are in milligrams per kilogram; ND, not detected.

Table 10
Detected Concentrations of Radionuclide COPCs in 2004 Test Pits

Isotope	Mean	Median	Mode	Std Dev	Minimum	Maximum	Lognormal Mean
Thorium-228	2.46	2	1.4	1.62	0.27	8.3	2.02
Thorium-230	10.8	1.6	1.6	23.7	0.46	102	2.95
Thorium-232	2.32	1.8	1.8	1.55	0.14	7.9	1.89
Uranium-234	8.08	1.6	1.4	16.7	0.28	66	2.52
Uranium-235	0.423	0.089	0.0580	0.88	0.024	3.7	0.135
Uranium-238	8.06	1.55	1.3	16.5	0.27	71	2.55

Notes: All data units are in picocuries per gram.

Table 11
Detected Concentrations of Radionuclide COPCs in 2004 Test Pits

Isotope	Mean	Median	Mode	Std Dev	Minimum	Maximum	Lognormal Mean
Bi-212	2.76	2.4	1.5	1.88	ND	9.7	2.18
Bi-214	15.7	1.75	1.1	59.5	0.39	430	2.94
Co-56	0.324	0.275	0.35	0.25	ND	1.6	0.271
K-40	20.9	22	25	5.95	4.5	41	19.9
Pb-212	2.69	2.3	2.5	1.740	0.17	10	2.19
Pb-214	18.10	1.95	1.3	71.4	0.37	520	3.31
Ra-226	21.8	2.4	1.6	84.1	0.49	610	4.03
Ra-228	2.50	2.1	1.7	1.670	ND	9.4	1.99
Th-234	7.60	2.9	2.9	12.60	ND	59	3.77
Ti-208	0.788	0.655	1.3	0.514	ND	2.9	0.629

Notes: All data units are in picocuries per gram.

Table 12
Detected Concentrations of Metal COPCs in 2004 Borings

Metal	Mean	Median	Mode	Std Dev	Minimum	Maximum	Lognormal Mean
Arsenic	20.5	5.55	1.9	41.1	0.96	180	7.06
Barium	151	120	120	136	43	920	122
Cadmium	2.14	0.025	0.025	7.26	ND	52	0.084
Chromium	14	14	12	3.71	5.9	25	13.5
Lead	182	21	18	431	5	2400	39.5
Mercury	0.568	0.0465	0.014	1.6	0.0058	11	0.078
Molybdenum	10.2	1.6	1.3	25	0.49	160	2.8
Selenium	0.93	0.745	0.2	0.911	ND	4.8	0.639
Silver	1.12	0.02	0.02	2.91	ND	18	0.079
Vanadium	44	28.5	34	118	10	1000	29.6
Zinc	560	85	100	1674	26	13000	155

Notes: All data units are in milligrams per kilogram; ND, not detected.

Table 13
Detected Concentrations of Radionuclide COPCs in 2004 Borings

Isotope	Mean	Median	Mode	Std Dev	Minimum	Maximum	Lognormal Mean
Thorium-228	2.29	2.1	1.4	1.01	0.93	6.7	2.1
Thorium-230	7.7	1.45	1.1	27	0.76	210	2.17
Thorium-232	2.19	1.95	1.5	1.08	0.88	7.5	1.99
Uranium-234	8.62	1.4	1.1	20.1	0.59	110	2.4
Uranium-235	0.52	0.094	0.0560	1.15	ND	5.8	0.139
Uranium-238	8.7	1.3	1.1	20.3	0.64	110	2.42

Notes: All data units are in picocuries per gram.

Table 14
Detected Concentrations of Radionuclide COPCs in 2004 Borings

Isotope	Mean	Median	Mode	Std Dev	Minimum	Maximum	Lognormal Mean
Bi-212	2.30	2.0	1.4	1.22	0.72	8.7	2.07
Bi-214	8.17	1.1	1.6	30.1	0.54	210	1.78
Co-56	0.956	0.15	0.08	3.80	ND	26	0.192
K-40	20.4	19	19	3.68	14	36	20.1
Pb-212	2.21	2	1.2	1.160	1.1	8.3	1.99
Pb-214	9.23	1.25	1.1	34.8	0.58	250	2.01
Ra-226	11.2	1.5	1.3	42.0	0.71	300	2.47
Ra-228	2.04	1.8	1	1.060	0.99	7.2	1.83
Th-234	6.32	2.55	1.4	11.50	ND	62	3.25
Ti-208	0.655	0.565	1	0.347	0.31	2.5	0.591

Notes: All data units are in picocuries per gram.

For the baseline risk assessment, the exposure scenarios examined include a subsistence farmer, an urban resident, and a recreational user. Baseline exposure scenarios were examined for a 30-year period and assumed minimal changes to the current topography (depressions left by the removal of building foundations would remain). Exposure for the subsistence farmer assumes a farmhouse constructed on the existing soil, groundwater as the primary drinking water source (including farm animals), and consumption of crops, meat, and milk produced from the local soil. The urban resident in the 2004 RI/FS baseline risk assessment assumed a house similar to neighborhood housing but drinking water would come from city water mains and minimal consumption of fruits and vegetables raised in a backyard garden. The recreational receptor assumed regular use by a nearby resident who would use the area for a variety of activities. Factors associated with the exposure scenarios are used in the RESRAD and Risk Assessment Information System (RAIS) models. As noted above, the assumptions for the users of the Site were adjusted from a subsistence farmer to an urban resident who is maximally exposed for the 2004 ROD.

To determine the dose for the theoretical receptor (farmer, urban resident, recreational user), the RESRAD model was used to define the property where the individual is exposed for 30 years (6 years as a child and 24 years as an adult). The modeled property consists of an area with Site-specific residual radionuclides to an assumed depth. The model incorporates a large number of parameters to numerically simulate the pathways that the radionuclides can use to affect the receptor. A summary of these parameters is provided in Appendix I of the 2004 RI/FS.

The RAIS model was used to determine to toxicity of nine of the metals, but cadmium and lead were determined using other methods. The literature indicates that radionuclides also have toxicity effects but there are no currently published referenced doses in Integrated Risk Information System (IRIS). Additional reference material was consulted, but no agreed upon reference dose was identified. Typically health effects for radionuclides focus on cancer risks.

IRIS (and other reference material) lists both cadmium and lead as possible human carcinogens but neither has been assigned slope factors because of then ongoing debates about sensitive populations and cancer causing mechanisms. These same debates carry over to the associated hazard quotient determination and there was no reference dose provided for either metal. Estimation of the toxicity associated with each metal is discussed in the following sections. Risk estimates are provided for specific species of arsenic and chromium. The remaining seven metals evaluated during the RI are not currently considered carcinogenic.

Risk and hazard quotients for the water exposure route (use of onsite groundwater) estimated in RAIS using metal concentrations recently measured in the downgradient monitoring wells. The effects of the metals are included in the RAIS results tables (see 2004 RI/FS Section 6.4.4). Risks associated with the radionuclides were determined separately using highest activities measured in the downgradient well (CSMRI-04).

For carcinogens, risks are generally expressed as the incremental probability of an individual's developing cancer over a lifetime as a result of exposure to the carcinogen. Excess lifetime cancer risk is calculated from the following equation:

> Risk = CDI x SF
> where:
> risk = a unitless probability (e.g., 2×10^{-5}) of an individual's developing cancer
> CDI = chronic daily intake averaged over 70 years (mg/kg-day)
> SF = slope factor, expressed as (mg/kg-day)-1.

These risks are probabilities that usually are expressed in scientific notation (e.g., 1×10^{-6}). An excess lifetime cancer risk of 1×10^{-6} indicates that an individual experiencing the reasonable maximum exposure estimate has a 1 in 1,000,000 chance of developing cancer as a result of site-related exposure. This is referred to as an "excess lifetime cancer risk" because it would be in addition to the risks of cancer individuals face from other causes such as smoking or exposure to too much sun. The chance of an individual's developing cancer from all other causes has been estimated to be as high as one in three. EPA's generally acceptable risk range for site-related exposures is 10^{-4} to 10^{-6}.

The potential for noncarcinogenic effects is evaluated by comparing an exposure level over a specified time period (e.g., life-time) with a reference dose (RfD) derived for a similar exposure period. An RfD represents a level that an individual may be exposed to that is not expected to cause any deleterious effect. The ratio of exposure to toxicity is called a hazard quotient (HQ). An HQ <1 indicates that a receptor's dose of a single contaminant is less than the RfD, and that toxic noncarcinogenic effects from that chemical are unlikely. The Hazard Index (HI) is generated by adding the HQs for all chemical(s) of concern that affect the same target organ (e.g., liver) or that act through the same mechanism of action within a medium or across all media to which a given individual may reasonably be exposed. An HI <1 indicates that, based on the sum of all HQs from different contaminants and exposure routes, toxic noncarcinogenic effects from all contaminants are unlikely. An HI > 1 indicates that site-related exposures may present a risk to human health.

The HQ is calculated as follows:

Non-cancer HQ = CDI/RfD
where:
CDI = Chronic daily intake
RfD = reference dose.
CDI and RfD are expressed in the same units and represent the same exposure period (i.e., chronic, subchronic, or short-term).

The baseline risk assessment indicates that taking no future action and leaving the Site in its current condition is not protective of human health and the environment. The subsistence farmer and urban resident would be exposed to excessive risk with current site conditions. Although there are minimal direct risks to the recreational user, the Site would be a continuing problem for the underlying groundwater and Clear Creek. Long-term institutional controls would be necessary to protect neighborhood children from exposure. Erosion controls would need to be maintained to minimize the transport of affected sediment to surrounding areas and eventually into Clear Creek. Radionuclides such as radium-226 and thorium-230 are very persistent in the environment, with half-lives of $1.6x10^3$ and $7.5x10^4$, respectively. Environmental factors such as acid rain can affect metal mobility.

Table 15 summarizes some of the factors used to evaluate the 2004 baseline risk assessment. Overall, there are sufficient risks and hazards associated with the Site to warrant remediation.

Table 15
Factors Used to Evaluate Baseline Risk Assessment

Scenario	Risk < 10^{-6}	Risk <10^{-6} to 10^{-4}	Risk < 10^{-4}	Dose < 15 mrem/yr	Dose < 25 mrem/yr	Ra-226 + Ra-228 <5 pCi/g	Hazard Index <1	PbB <10 ug/L	Soil Lead < 1200 mg/kg	Soil Lead < 400 mg/kg	Protective of Groundwater	Satisfies ALARA
2004 Conditions - Average Soil Activities								Y	Y	Y	N	N
Subsistence Farmer	N	N	N	N	N	N	N					
Urban Resident	N	N	N	N	N	N	N					
Recreational User	N	Y	Y	Y	Y	N	Y					
2004 Conditions - Ra-Biased Soil Activities								Y	Y	Y	N	N
Subsistence Farmer	N	N	N	N	N	N	N					
Urban Resident	N	N	N	N	N	N	N					
Recreational User	N	Y	Y	Y	Y	N	Y					
2004 Conditions - Pb Biased Soil								N	Y	N	N	N

Activities												
Subsistence Farmer	N	N	N	N	N	N	N					
Urban Resident	N	N	N	N	N	N	N					
Recreational User	N	Y	Y	Y	Y	N	Y					

Notes: Y, meets requirement; N does not meet requirement

Because of the uncertainty of the RESRAD radon calculation, the scenarios were modified in the 2004 RI/FS to minimize the radon prediction. Using a basement with a floor located beneath the affected soil layer effectively minimizes the influence of the radon without turning off the radon pathway completely. For comparison, RESRAD was run for the average soil conditions, assuming slab construction (structure built directly on top of the affected soil). Dose and risk numbers calculated during the 2004 RI/FS were as follows:

Subsistence Farmer	Dose 220 mrem/yr	Risk $3.5x10^{-3}$
Urban Resident	Dose 210 mrem/yr	Risk $3.4x10^{-3}$
Recreational User	Dose 0.46 mrem/yr	Risk $9.8x10^{-6}$

These scenarios assumed the contaminated soils consist of a sandy clay, but by changing the permeability parameter to reflect more of a clayey sand, the dose for the subsistence farmer drops to 92 mrem/yr and the risk decreases to $1.5x10^{-3}$. Adding one meter of clay cover material can further decrease the subsistence farmer dose to 4.8 mrem/yr with an associated risk of $7.5x10^{-5}$.

The decay of Ra-226 to radon and its daughters could be a significant component of the total risk/dose to future Site receptors. Therefore, it seems appropriate to consider this in making a risk management decision for the Site. If the radon pathway is not bypassed (lowest level of residence is placed in the affected soil) dose and risk values (assuming a clayey sand soil) are about five times greater than the same scenario without the influence of radon. The "no-action" alternative is unacceptable whether or not radon emanation effects are considered.

When the alternative 2007 baseline conditions of *ex-situ* stockpiles are considered, the impacts are expected to be equal to or greater than those calculated in the 2004 baseline risk assessment. This is because the impacted material remains on Site and, while temporarily prevented from serving as a source of groundwater contamination, if left at the Site indefinitely, will eventually migrate to groundwater. In addition, the location of the stockpiled material would serve as a long-term source of radon into any structure constructed in that location as well as a source of contamination available for uptake by future receptors through the other exposure routes (i.e., dermal absorption, inhalation, and ingestion). As recently modeled, the dose to an urban resident due to radon emanation from the stockpiled material could be as high as 2,087 mrem/year.

The response action selected in this 2007 ROD is necessary to protect the public health or welfare or the environment from actual or threatened releases of hazardous substances into the environment. The cumulative excess carcinogenic risk to an individual exceeds 10^{-4} (using reasonable maximum exposure [RME] assumptions for either the current or reasonably anticipated future land use or current or potential beneficial use of groundwater/surface water). The non-carcinogenic hazard index is greater than one (using RME assumptions for either the current or reasonably anticipated future land use or current or potential use of groundwater/

surface water). The Site contaminants may cause adverse environmental impacts. In addition, chemical-specific standards or other measures that define acceptable risk levels are exceeded and exposure to contaminants above these acceptable levels is predicted for the RME. Examples include soil in excess of State metals and radiation dose standards and groundwater in excess of drinking water standards when that groundwater is a current or potential source of drinking water.

An ecological risk assessment was not performed because of anthropogenic activities at the Site dating back over 100 years. Only one small wooded area by Clear Creek remained relatively undisturbed, but it was insignificant and no sensitive species were located. There is very little natural habitat left at the Site.

H. Remedial Action Objectives

Remedial action (RA) objectives for the Site are designed to prevent or mitigate further release of affected materials to the surrounding environment and to eliminate or minimize risk to human health and the environment. The affected material was the surface and subsurface soil located in the vicinity of the former buildings prior to soil segregation activities. After soil segregation, most of the affected material is located in either Stockpile A or Stockpile B. Potential receptor pathways included direct radiation, inhalation, and ingestion of plants and soil. Another potential exposure pathway is the migration of the affected material to groundwater and subsequent ingestion. The following objectives, originally established for the Site prior to soil segregation activities, remain valid:

- Eliminate or minimize the pathway for dermal contact, inhalation, and ingestion of site-specific radionuclides to human receptors to achieve a level of protection in compliance with the NCP levels of acceptable cancer risk (10^{-4} to 10^{-6}).
- Develop receptor-specific DCGLs to limit unacceptable radiation doses (total effective dose equivalent [TEDE] to less than 25 mrem/yr and 15 mrem/yr, distinguishable from background; and less than 100 mrem/yr above background if institutional controls fail for onsite restricted-use remedies) for the radionuclides found in the affected material (i.e., soil). Radium-226, thorium-228, thorium-230, thorium-232, and uranium-238 are present onsite at activities above tentative DCGLs. Additional radionuclides were identified during the characterization (radium-228, uranium-234, and uranium-235) but at activities consistent with background.
- Prevent exposure to indoor air concentrations of radon gas and radon decay products greater than 4 picocuries per liter (pCi/L) and 0.02 working level (WL), respectively. Exposure to 4 pCi/L of air for radon corresponds to an approximate annual average exposure of 0.02 WL for radon decay products, when assuming residential land use.
- Prevent long-term dermal, inhalation, and ingestion exposures to trace metal-affected materials with concentrations greater than the CDPHE proposed Residential/Unrestricted Land-Use Standards or that generate HIs greater than 1. The primary trace metals of concern are arsenic, lead, mercury, molybdenum, and vanadium.
- Address specific issues associated with the hazards associated with soil containing elevated concentrations of lead (possible access issues with neighborhood children).
- Implement remedial measures that limit groundwater and surface-water concentrations to the MCLs at the points of compliance and to non-zero maximum contaminant level goals

(MCLGs), established under the Safe Drinking Water Act and under Colorado law. Although the affected groundwater is not a current drinking water supply, it eventually enters Clear Creek, which is used by downstream users for drinking water. Uranium and arsenic are the primary groundwater contaminants of concern.

- Prevent offsite migration of affected material that could result in the exposures described above. This includes the groundwater pathway.
- Implement remedial actions that reduce exposures from ionizing radiation to levels that are as low as reasonably achievable (ALARA).
- Comply with soil-, location- and action-specific ARARs. (Table 22)

Table 16 presents the Site action levels agreed to in the CDPHE-approved 2006 Site Characterization Work Plan. These DCGLs, originally developed prior to the 2004 RI/FS, have been considered tentative for all Site work and documentation prior to this point in this document. The tentative DCGLs were agreed to by the School and CDPHE in 2004 and have only been modified for arsenic since that time. These DCGLs, in combination with the environmental covenant, allow the School to comply with all ARARs and allow for future development of the Site. The DCGLs are no longer referred to as "tentative." They are considered final DCGLs.

Table 16
Site DCGLs and Cleanup levels

Metal	DCGL (mg/kg)	Site Action Level (inclusive of background) (mg/kg)
Arsenic	1.0	39
Lead	NA	400*
Mercury (elemental)	1.1	1.1
Mercury (compounds)	NA	23
Molybdenum	NA	390
Vanadium	NA	550
Radioisotope	**DCGL (pCi/g)**	**Site Action Level (pCi/g)**
Radium 226	1.44	4.14
Radium 228	2.20	4.6
Thorium 228	3.77	6.47
Thorium 230	9.83	11.53
Thorium 232	1.48	3.88
Uranium 234	253	254.9
Uranium 235	4.88	4.97
Uranium 238	20.2	21.8

[1] NA – Not applicable
* DCGLs not calculated for some metals. Site action levels use ARARs for cleanup goals.

The persistence of the affected material would place receptors at risk for over 1,000 years, and land use could change significantly in that amount of time. Both the urban resident and the recreational user will be evaluated for each scenario because of the future land use uncertainty and because it is reasonably foreseeable that the Site would be used for urban residents by the

School or other future owners of the Site. Additionally, exposures resulting from each alternative must comply with a 1997 NRC rule (10 CFR Part 20, Subpart E), which has been adopted by Colorado (6 CCR 1007-1 4.61.3), which establishes a dose criterion for decommissioning a site. This rule includes a provision that permits decommissioning under restricted release conditions, such as those proposed herein. Under a restricted release (a release including an environmental covenant), the dose to the average member of the critical group must not exceed 25 mrem/yr with the restrictions in place, and, if the restrictions were to fail, the dose due to residual radioactivity must not exceed 100 mrem/yr.

Soil segregation activities completed in 2006 were implemented to characterize the nature and extent of impacted soils on the Site. These activities comply with the results of the 2004 FS in that leaving the impacted material in place was not an option. All viable options evaluated in the 2004 FS required being able to accurately quantify the volume of impacted soil and required the impacted soil to be relocated. The characterization through segregation allows each of the viable options identified in the 2004 FS to be re-considered in the 2007 FS. Therefore, the objectives of the remedial actions listed above remain valid.

I. Description of Alternatives

Five site-specific alternatives were developed in the 2004 RI/FS that use a combination of techniques to protect human health and the environment. The options were arranged according to the amount of excavation required to complete the process and included treatment and non-treatment options. The only issue with these alternatives was that they were based on the fundamental assumption that the extent and nature of impacted soils were determined during the 2004 RI. This assumption was demonstrated to be incorrect during the aborted remedial implementation. Table 17 shows the five alternatives in the 2004 RI/FS.

Table 17
2004 Remedial Action Alternatives

Alternative	Description	Excavation Required?	Institutional Controls Required?
1	No further action	No	Yes
2A	Engineered cap	No	Yes
2B	Engineered cap and slurry wall	No [1]	Yes
3A	Engineered cap with partial removal [2] (areas with combined radium activity > 15 pCi/g)	Yes	Yes
3B	Engineered cap with partial removal [3] (areas with combined radium activity > 5 pCi/g)	Yes	Yes
4A	Onsite solidification with engineered cap	Yes	Yes
4B	Onsite engineered disposal cell	Yes	Yes
5A	Offsite disposal at solid waste facility	Yes	No
5B	Offsite disposal at solid waste facility and portion to specialized waste facility	Yes	No

[1] Some excavation required to install slurry wall
[2] Estimated removed volume between 500 and 1.000 cubic yards
[3] Estimated removed volume about 5,000 cubic yards

The 2004 Remedial Alternative Analysis concluded that in order to reduce the risk and be protective of the environment, community, and groundwater, the most viable alternative was 5B, Offsite Disposal using two waste disposal facilities. After selection of Alternative 5B in the ROD, soil excavation was initiated but was soon halted after it became clear that the nature and extent of the contamination had been underestimated, there was no immediate way to ascertain what the nature and extent was, and the capacity for the contractor to distinguish soil destined for each landfill was not demonstrated. Had this attempt not been halted, over 10,000 cubic yards of the impacted Site soils would have been sent to a specialized waste facility in Idaho at an approximate cost of $10 million, instead of the assumed 500 cubic yards; and none of the impacted Site soil would have gone to the local solid waste landfill, instead of the 9,500 cubic yards assumed in the 2004 RI/FS.

Based on information from this attempt, the Site characterization strategy was revised, and soil segregation was determined to provide more reliable nature and extent information than conventional soil sampling from test pits and borings. The 2006 Site characterization activities were successful and the impacted Site soils were placed in the two lined stockpiles. Remedial action alternatives evaluated for the 2007 Feasibility Study are summarized in Table 18.

Table 18
2007 Remedial Action Alternatives

Alternative	Description	Excavation Required?	Institutional Controls Required?
1	No further action	NA	NA
2A	Leave Stockpile B where it is, install soccer field on top of Stockpile B, ship Stockpile A offsite	No	Yes
2B	Leave both stockpiles where they are, install soccer field on top of both stockpiles	No	Yes
3A	Engineered cap over Stockpile B where it is, ship Stockpile A offsite	Yes	Yes
3B	Engineered cap over both piles where they are	Yes	Yes
4A	Onsite solidification and cap Stockpile B, ship Stockpile A offsite	Yes	Yes
4AA	Onsite solidification and cap both stockpiles	Yes	Yes
4B	Onsite engineered disposal cell for Stockpile B, ship Stockpile A offsite	Yes	Yes
4BB	Onsite engineered disposal cell for both stockpiles	Yes	Yes
5A	Offsite disposal of both stockpiles at one waste facility	Yes	Yes
5B	Offsite disposal of both stockpiles at two waste facilities	Yes	Yes

Alternatives 1, 2, and 3 did not meet the remedial action objectives because they did not provide sufficient reduction of risk from each medium and/or pathway of concern for the Site. Therefore, these alternatives were eliminated from further evaluation, except no action because the NCP requires detailed analysis. Alternatives 2 and 3 were essentially variations on Alternative 1, whereas Alternatives 4 and 5 contain elements that address the protectiveness of human health and the environment.

The following describes the remedy components for each remedy considered in detail.

Description of Remedy Components:

<u>Alternative 1 - No Further Action</u>
Treatment Components:
- None

Containment Components:
- None

Institutional Components:
- None

<u>Alternatives 4A and 4AA – Onsite solidification with engineered cap with or without partial shipment offsite; 4A ships Stockpile A offsite, and 4AA solidifies both stockpiles onsite</u>
Treatment Components:
- Consolidation and stabilization of stockpiled soils onsite using concrete and fly ash.

Containment Components:
- Alternative 4A will require a pilot test to determine the appropriate mixture of concrete, fly ash, and soil.
- Onsite materials will need to be consolidated and solidified. Some crushing of cobbles may be required. An area at a high enough elevation to remain above groundwater fluctuations will be selected for the final placement of the solidified material. Operational concrete and fly ash will be stockpiled onsite, and a batch processor will be brought in to mix the materials. A water supply also will be required. Batches of material will be placed in lifts and solidification will be verified with test cores.
- A cap will be constructed over the structure to limit leaching effects.
- Geotechnical testing would be required to verify proper placement of the cell.
- The affected material will then be placed in the cell. Once the operation is complete, a clay cap (3-feet deep) will be installed over the material.

Institutional Control Components:
- The structure and cap footprint would require institutional controls on about 1 acre of land if one assumes 2:1 slope from the top of the cap. Long-term cap maintenance and groundwater monitoring in the vicinity of the solidified matrix would be required.
- Environmental covenant would prohibit structures on top of cell, and require radon mitigation systems in all residences onsite.

<u>Alternatives 4B and 4BB – Onsite disposal cell with engineered cap with or without partial shipment offsite; 4B ships Stockpile A offsite, and 4BB solidifies both stockpiles onsite</u>
Treatment Components:
- None

Containment Components:
- Onsite materials will need to be consolidated. Some crushing of cobbles may be required. An area at a high enough elevation to remain above groundwater fluctuations will be selected for the final placement of the solidified material.
- A cap will be constructed over the structure to limit leaching effects.
- Geotechnical testing would be required to verify proper placement of the cell.

- A clay sub-liner and geosynthetic liner over the clay would be installed.
- The affected material will then be placed in the cell. Once the operation is complete, a clay cap (3-feet deep) will be installed over the material.

Institutional Control Components:

- The structure and cap footprint would require institutional controls on about 1.5 acres of land if one assumes 4:1 slope into the cell. Long-term cap maintenance and groundwater monitoring in the vicinity of the cell would be required.
- Environmental covenant would prohibit structures on top of cell, and require radon mitigation systems in all residences onsite.

<u>Alternatives 5A and 5B - Offsite disposal at solid-waste landfill or combination of solid-waste and specialized landfills</u>

Treatment Components:

- None

Consolidation Components:

- None

Institutional Control Components:

- After transportation and disposal, groundwater monitoring will occur until it shows that offsite source disposal has been effective or not. An environmental covenant requires radon mitigation systems for all residences onsite.

Common Elements and Distinguishing Features of Each Alternative

Each alternative, except no action, requires work plans, mobilization to the site, and dust control (including perimeter air monitoring) and storm water control measures.

Each alternative, except no action, requires an environmental covenant requiring a radon mitigation system for each residence on site to be maintained by the owner/operator, with the School, CDPHE, and the City having the ability to enforce the covenant against any owner or operator. Residual concentrations of Ra-226 above background require the covenant. The former pond area was remediated and closed under the Uranium Mill Tailings Radiation Control Act (UMTRCA) standard, which is not as low as the standard used for the remainder of the site. Furthermore, residual impacted soils above background concentrations but below DCGLs that remain after excavation will result in doses of 42 mrem/yr for urban residents, including Alternatives 5A and 5B. The environmental covenant will therefore reduce radon exposure to future occupants of the site to less than the required limits of 25 mrem/yr and 15 mrem/yr for the alternatives in the 4 and 5 series, and adds another element for achieving ALARA doses. The naturally high background concentrations of Ra-226 at the Site also support implementation of radon mitigation systems.

The major distinction among remedies is that Alternative 5 takes both stockpiles offsite to landfills, and Alternative 4 leaves the most or all of the stockpiled material onsite.

Key ARARs will be met with each alternative, except no action. Radionuclide contamination affects both soil and groundwater. A key ARAR is the receptor-specific and site-specific DCGLs that limit unacceptable radiation doses (TEDE to less than 25 mrem/yr and 15 mrem/yr, distinguishable from background; and less than 100 mrem/yr above background if institutional controls fail for onsite restricted-use remedies) for the radionuclides found in the affected material (i.e., soil). With the environmental covenant, these DCGLs for soil will be met for all alternatives, except no action. If the covenant fails, which is difficult to predict over a 1,000 year time horizon, exposures should be 42 mrem/yr, which is less than the ARAR of 100 mrem/yr for institutional control failure.

The MCL for uranium is exceeded in two groundwater wells on Site. Alternatives 5A and 5B provide the best prospect of improving groundwater quality and restoring it to levels below the MCL. The onsite remedies of Alternatives 4A and 4B have the possibility of failure and contributing contaminants again to the groundwater. Over a 1,000 year time horizon, it is difficult to predict the likelihood of failure for the onsite remedies. The certainty with the offsite remedies is 100 percent certain because the contaminated soil will be taken to an offsite landfill. There is no chance of contributing contamination again to the groundwater at the Site with the offsite remedies.

Groundwater monitoring is needed for all alternatives to see if the excavation and offsite disposal or containment of the contamination are successful in improving groundwater quality to acceptable conditions. It is not clear at this time if additional measures will be necessary to improve and protect groundwater quality.

ARARs for metals will be met with all alternatives, except no action. There is no chance of contributing to groundwater problems at the Site for the offsite remedies, but some unquantifiable chance for the onsite remedies.

The quantity of waste is the same for all remedies. With 4A and 4AA, the quantity of the waste will increase due to the need for adding concrete and fly ash to stabilize the waste. The degree of hazard remaining on site will be less with 4A and 4B, than with 4AA and 4BB because stockpile A will be taken offsite. The degree of hazard remaining onsite is the lowest with 5A and 5B because both stockpiles will be taken offsite.

Six months are needed to design and construct Alternative 5, and 7 to 8 months for Alternative 4. Groundwater monitoring will likely take two years or more to complete.

The remediation goals for soil will be attained upon completion of Alternatives 4 and 5. Attainment of groundwater goals is uncertain for all alternatives. Analysis of future groundwater monitoring results will determine the time needed to attain groundwater remediation goals.

The least expensive remedy is 5B: $850,000. Alternative 5A will cost $3.2 million. Both of these remedies will need some costs for groundwater monitoring for at least two years, but they will be minimal compared to the costs for 100 years of groundwater monitoring for Alternative 4. The net present value of groundwater monitoring and maintenance costs for Alternative 4 are very high. Each Alternative 4 series will costs over $5 million in total.

Expected Outcomes of Each Alternative
Upon construction, Alternative 5 allows the surface to be used for all uses so long as the covenant is in place. Alternative 4 is the same, except that no structures or certain activities may occur on the cap to ensure the integrity of the cap. No action does not allow use of the site for beneficial purposes. There is a significant loss in property value for Alternative 4 and no action.

For all remedies, the use of groundwater is restricted until future groundwater monitoring and analysis occurs. Two wells currently exceed the MCL for uranium. It is not clear how much time is needed to attain MCLs, nor if the source excavation will succeed.

Summary of Remedial Alternatives

Alternative 1 – No Further Action

Estimated Capital Cost: $0
Estimated Operation and Maintenance Cost (Present Value): $4,070,000
Estimated Present Worth Cost: $460,000
Estimated Construction Timeframe: NA
Estimated Time to Achieve Remedial Action Objectives: Not Achieved

Under Alternative 1, the affected soils would remain in the lined stockpiles, and a comprehensive, long-term program would be required to monitor air quality, surface water quality, groundwater quality, and radiation dose. If this alternative were selected, enhanced storm-water controls would be needed and long-term maintenance of the Site perimeter would be required to limit access and minimize the potential for ingestion and dermal contact.

A major weakness in the no-further action alternative is the failure to provide adequate protection of human health and the environment. Contaminants would not be adequately controlled to limit migration.

Alternative 1 has an additional cost associated with the loss of property value. Appraisal information indicates that without site cleanup, the land value decreases by up to $460,000. The estimated present worth cost would be $4,520,000 if the land value loss were included.

Alternatives 4A and 4AA – Onsite solidification with engineered cap of Stockpile B, with Stockpile A being shipped offsite, or onsite solidification with engineered cap for both stockpiles

Estimated Capital Cost: $1,077,000 (4A); $991,000 (4AA)
Estimated Operation and Maintenance (Present Value) Cost: $4,120,000 (both 4A and 4AA)
Estimated Present Worth Cost: $460,000
Estimated Construction Timeframe: 8 months
Estimated Time to Achieve Remedial Action Objectives: RAOs only partially achieved, monitoring required for at least 100 years

Both versions of Alternative 4A require soil to be solidified and capped. Alternative 4A would have an offsite component, with Stockpile A being shipped to a specialized waste facility. Alternative 4A involves the consolidation and stabilization of onsite soils using concrete and fly ash. Alternative 4 assumes that the affected onsite material (13,000 cubic yards) will be solidified, placed onsite, and capped. Confirmation sampling has already confirmed all soil above DCGLs is in the two stockpiles, and limited additional sampling will be performed to ensure both metal and radionuclide limits are achieved beneath the stockpiles.

Alternative 4A will require a pilot test to determine the appropriate mixture of concrete, fly ash, and soil. After the proper mixture is determined, stockpiled materials will require segregation by soil type. Some crushing of cobbles may be required. An area at a high enough elevation to remain above groundwater fluctuations will be selected for the final placement of the solidified material. Operational concrete and fly ash will be stockpiled onsite, and a batch processor will be brought in to mix the materials. A water supply also will be required. Batches of material will be placed in lifts, and solidification will be verified with test cores.

Alternative 4AA would require the mixing of Stockpile A with Stockpile B to produce a uniform distribution of activity in the resulting soil pile.

After the solidification of the structure has been confirmed, a clay cap (depth of 3 feet) will be constructed over the structure to limit leaching effects. The structure and cap footprint would require institutional controls on about 1 acre of land. Long-term cap maintenance in the vicinity of the solidified matrix would be required. The remaining property would be available for unrestricted use although a limited groundwater monitoring program currently ongoing would continue to monitor the current metal concentrations and radionuclide activities. Some backfill would be required to bring the Site to a useable elevation and to provide storm-water control.

Alternative 4A has the additional cost associated with the loss of property value. Although a remediation process is completed, the land value may still decrease by up to $460,000.

Alternatives 4B and 4BB – Onsite disposal cell with engineered cap of Stockpile B, with Stockpile A being shipped offsite, or onsite disposal cell with engineered cap for both stockpiles

Estimated Capital Cost: $1,126,000 (4B); $1,038,000 (4BB)
Estimated Operation and Maintenance (Present Value) Cost: $4,101,000 (both 4B & 4BB)
Estimated Present Worth Cost: $460,000
Estimated Construction Timeframe: 7 months
Estimated Time to Achieve RAOs: RAOs only partially achieved, monitoring required for at least 100 years

Alternative 4B requires the construction of an engineered disposal cell without solidification. An area above groundwater fluctuations would be selected for the construction of the cell. Allowing a material depth of 10 feet and a 4:1 slope into the cell to allow for equipment movement, the footprint of the cell would be about 1.5 acres. Geotechnical testing would be required to verify proper placement of the cell and a clay sub-liner would be installed. A geosynthetic liner will be installed over the clay to ensure containment. The affected material will then be moved from the stockpile(s) and placed in the cell. When all material is relocated to the cell, a clay cap (3 feet deep) will be installed over the material.

Again, institutional controls would be required for the cell to ensure the integrity of the cap and to monitor groundwater in the vicinity of the cell. Limited groundwater monitoring may be required to monitor the natural attenuation of current metal concentrations and radionuclide activities. Backfill would be required to bring the Site to a useable elevation and to provide storm-water control.

Alternative 4B has the additional cost associated with the loss of property value. Although a remediation process is completed, the land value may still decrease by up to $460,000. The estimated present worth cost would be $5,666,000 for Alternative 4B or $5,612,000 for Alternative 4BB if the land value loss were included.

Alternatives 5A and 5B – Offsite disposal at solid-waste landfill or combination of solid-waste and specialized landfills

Estimated Capital Cost: $5,110,000 (5A); $800,000 (5B)
Estimated Operation and Maintenance (Present Value) Cost: $68,000 (5A); $34,000 (5B)
Estimated Present Worth Cost: $0
Estimated Construction Timeframe: 6 months (5A & 5B)
Estimated Time to Achieve RAOs: 5 years (assumes natural attenuation of groundwater)

Alternative 5 involves the load-out and transportation of the affected material in both stockpiles to an approved landfill. Alternative 5A assumes the material in both stockpiles would be mixed together and shipped to a special solid waste landfill. Alternative 5B assumes that Stockpile A would go to a special waste landfill and Stockpile B would go to the local solid waste landfill.

Estimated transport times were determined assuming the closest solid waste landfill for alternative 5B. Foothills Landfill on Colorado Highway 93 is approximately 8 miles north of the Site. Transportation times will increase if other facilities are selected.

Upon completion of the offsite disposal, all of the property would be available for residential and other use with an environmental covenant. Backfill material would be required to bring the Site to a useable elevation and for storm-water control and safety.

Because all of the affected material would be removed from the Site, Alternative 5 would not experience the loss in property value associated with the other alternatives.

J. Comparative Analysis of Alternatives

Nine criteria are used to evaluate the different remediation alternatives individually and against each other in order to select a remedy. The nine criteria fall into three groups. The first group, the threshold criteria, includes overall protection of human health and the environment and compliance with the ARARs. If an alternative does not meet these criteria, it is not eligible for future consideration. The second group, the balancing criteria, includes long-term effectiveness and permanence, reduction of toxicity, mobility, or volume through treatment, short effectiveness, implementability, and cost. These criteria are weighed against each other to determine a preferred option. The last group, the modifying criteria, includes State and community acceptance. The modifying criteria are often used to make a final selection.

The following sections profile the relative performance of each of the alternatives against the other alternatives. The nine evaluation criteria are individually discussed in the following sections. Detailed discussion of the alternative evaluation can be found in Sections 7.0 and 8.0 of the 2007 Revised RI/FS.

A brief summary of the alternatives and the nine evaluation criteria is presented in Table 19.

Table 19
Evaluation of Alternatives

Alternative	Protective of Human Health & Environment	ARAR Compliance	Long-term Effectiveness and Permanence	Reduction of Toxicity, Mobility, or Volume through Treatment	Short-term Effectiveness	Implementability (Feasibility)	Cost Ranking[1]	State Acceptance	Community Acceptance
1 - No further action	N	N	N	N	Y	L	2	N	N
4A - Onsite solidification and cap stockpile B, ship stockpile A offsite	Y	N	U	Y	Y	M	6	U	U
4AA - Solidify both stockpiles and cap	Y	N	U	Y	Y	M	4	U	U
4B - Onsite engineered disposal cell for stockpile B, ship stockpile A offsite	Y	N	U	N	Y	M	7	U	U
4BB - Onsite engineered disposal cell for both stockpiles	Y	N	U	N	Y	M	5	U	U
5A - Offsite disposal at solid waste facility	Y	Y	Y	N	Y	H	3	Y	Y
5B - Offsite disposal at two waste facilities	Y	Y	Y	N	Y	H	1	Y	Y

Notes: Y, addresses criteria; N, does not address criteria; U, uncertainty associated with this element; Implementability factors, highly feasible (H) through problematic (L); Rankings range lowest to highest cost
[1] Costs account for loss of property value for onsite remedies.

- *Overall protection of human health and the environment,*

Overall protection of human health and the environment addresses whether each alternative provides adequate protection of human health and the environment and describes how risks posed through each exposure pathway are eliminated, reduced, or controlled, through treatment, engineering controls, and/or institutional controls.

Alternative 1, the no-further action alternative, does not provide adequate protection of human health and the environment because it does not adequately address the exposure pathways. The alternative does not address the migration of metals and radionuclides to groundwater.

Unauthorized Site access by neighborhood children also is a possibility with this alternative. Trespassers have already breached the existing security fence on a number of occasions. With a 1,000-year time horizon access to the Site is reasonably foreseeable.

Alternatives 4 and 5 effectively address the direct exposure pathways by either preventing access to the material using caps and a variety of containment options or by removing the material from the Site. In each case, institutional controls would be required to ensure that radon abatement systems are a requirement for any structure or building constructed on the Site. In the absence of institutional controls, the potential dose due to radon emanation into a residential structure ranges from 42 mrem/yr (Alternatives 5A and 5B) to 2,087 mrem/yr (Alternatives 1, 4AA, and 4BB). Alternative 5 would provide the most protection to human health and the environment.

Groundwater fluctuations and the presence of a City of Golden water main provide potential mechanisms for migration of affected material. Some uncertainty would remain for the groundwater pathway and long-term effectiveness of institutional controls for Alternative 4 (cap integrity). The only alternative with minimal uncertainty is Alternative 5.

Because the "no further action" alternative is not protective of human health and the environment, it was eliminated from consideration under the remaining eight criteria.

- *Compliance with ARARs*

Section 121 (d) of CERCLA and NCP §300,430(f)(1)(ii)(B) require that remedial actions at CERCLA sites at least attain legally applicable or relevant and appropriate Federal and State requirements, standards, criteria, and limitations which are collectively referred to as "ARARs," unless such ARARs are waived under CERCLA section 121(d)(4).

Applicable requirements are those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under Federal environmental or State environmental or facility siting laws that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance found at a CERCLA site. Only those State standards that are identified by a state in a timely manner and that are more stringent than Federal requirements may be applicable. Relevant and appropriate requirements are those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under Federal environmental or State environmental or facility siting laws that, while not "applicable" to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is to the particular site. Only those State standards that are identified in a timely manner and are more stringent than Federal requirements may be relevant and appropriate.

Compliance with ARARs addresses whether a remedy will meet all of the applicable or relevant and appropriate requirements of other Federal and State environmental statutes or provides a basis for invoking a waiver.

Alternative 1 does not meet the ARARs that have been identified for the Site. Alternatives 4A, 4AA, 4B, and 4BB do not meet ARARs. With the failure of institutional controls, the dose to the urban resident exceeds 100 mrem/yr in each case. Alternatives 5A and 5B are compliant with ARARs by offsite disposal of the affected material.

Alternative 5 has the least uncertainty associated with the site-specific ARARs.

- *Long-term effectiveness and permanence*

Long-term effectiveness and permanence refers to expected residual risk and the ability of a remedy to maintain reliable protection of human health and the environment over time, once clean-up levels have been met. This criterion includes the consideration of residual risk that will remain onsite following remediation and the adequacy and reliability of controls.

Alternatives 4 and 5 would sufficiently address residual risk although some uncertainty is associated with the groundwater pathway for the 4 series alternatives. The alternatives that involve a cap would have a degree of uncertainty associated with long-term permanence. Cap breakdown could result in significant risks to human health and the environment. The solidification process used for Alternative 4 also could be a problem in the future (other solidification structures have failed over time). Alternative 5 meets the long-term effectiveness and permanence criteria because the material leaves the Site.

- *Reduction of toxicity, mobility, or volume through treatment*

Reduction of toxicity, mobility, or volume through treatment refers to the anticipated performance of the treatment technologies that may be included as part of a remedy.

Alternatives 4A and 4AA are the only alternatives that address the material through treatment. Toxicity and mobility are addressed because the matrix prevents material migration and reduces toxicity through reduced bioavailability. Properly maintained the solidified matrix would be expected to remain intact for an extended period of time. But there is some question about the leaching of arsenic and mercury.

Alternatives in the 4 series use caps to address toxicity and mobility by limiting contact and infiltration. Onsite volumes are reduced or eliminated in Alternatives 4A, 4B, and 5, with the elimination of all affected material for Alternative 5. Alternatives in 5 produce no net reduction in metals or radionuclides, just relocation.

- *Short-term effectiveness*

Short-term effectiveness addresses the period of time needed to implement the remedy and any adverse impacts that may be posed to workers, the community, and the environment during construction and operation of the remedy until cleanup levels are achieved.

Alternatives 4-5 involve some short-term risk to workers and the surrounding community. A low to moderate risk would be associated with the truck traffic required to move equipment or material (i.e., traffic accidents). Access to State Highway 6 would limit the risk to the immediate neighborhood but could affect the local county (or counties).

Worker exposure would be the greatest for Alternative 4A because of the mixing and grinding operations. Alternatives 4B, 5A, and 5B would have lesser risk. Worker risks would be mitigated by material handling equipment and safety equipment.

Alternative 5 has the highest short-term risk for the surrounding community because of the number of loads of affected soil. The risk applies only to traffic accidents, not to exposure to affected soils. The remaining alternatives would have a lesser effect on the community because of limited transportation operations.

- *Implementability*

Implementability addresses the technical and administrative feasibility of a remedy from design through construction and operation. Factors such as availability of services and materials, administrative feasibility, and coordination with other governmental entities are also considered.

Alternatives 4 and 5 are technically feasible. Each alternative involves standard construction and earth-moving techniques. Alternatives 4A and 4AA have the most uncertainty because a concrete/soil mixture would need to be determined. Proper installation of a disposal cell can be problematic (Alternatives 4B and 4BB). Alternatives 4 and 5 are sensitive to weather conditions especially during the winter months.

Alternatives 4 and 5 require truck access to the Site. It is likely that CDOT will issue another use permit to allow transport of additional soil using Highway 6.

Alternative 4 may require a solid waste disposal license for onsite solidification or disposal cells. Again the CERCLA exemption may apply but have substantive requirements. If no license is required, the administrative feasibility for the leaving the material in place is medium to high because of the continuing requirements of the monitoring and institutional controls; otherwise it is low.

For Alternative 5, some existing landfills are authorized to accept wastes similar to the Site material, although ones in Adams County have uncertainty. The landfills must demonstrate the ability to protect human health and the environment. The administrative feasibility for these sites to accept the elevated materials is high

- *Cost*

The least expensive alternative is Alternative 5B. Table 20, reprinted from the 2007 Revised RI/FS, presents the costs for each alternative:

Table 20
Cost Information for Each Alternative

Cost Breakout	Alternative Cost (in thousands of dollars)						
	1	4A	4AA	4B	4BB	5A	5B
Mobilization	0	58	58	65	65	28	28
Construct Site Facilities Costs	0	72	72	103	103	180	102
Soil Movement Costs	0	175	175	149	149	147	77

Table 20
Cost Information for Each Alternative

Cost Breakout	Alternative Cost (in thousands of dollars)						
	1	4A	4AA	4B	4BB	5A	5B
Solidification Costs	0	321	324	0	0	0	0
Construct Cell Costs		0	0	242	242	0	0
Disposal Costs	0	54	0	54	0	2870	580
Engineering Cap Costs	0	321	321	446	446	0	0
Stabilize Site and Monitoring Costs	4070	4,120	4,120	4,101	4,101	34	34
Demobilization	0	42	42	32	32	26	26
Total	4070	5184	5132	5206	5152	3285	847
Rank	3	6	4	7	5	2	1
Ratio to Least Expensive	4.8:1	6.1:1	6.1:1	6.1:1	6.1:1	3.8:1	1

- *State acceptance*

The School and CDPHE prefer the offsite disposal alternative (Alternative 5). Onsite disposal is opposed by CDPHE.

- *Community acceptance*

The local community prefers offsite disposal (Alternative 5). Onsite disposal is not supported.

K. Principal Threat Wastes

The principal threat wastes (i.e., the source materials) are radionuclides and metals in the surface and subsurface soils. Only Alternative 4 provides for treatment of these wastes through solidification. Given the high cost and technical uncertainties of Alternative 4 in comparison to Alternative 5, Alternative 5 is a preferred alternative.

L. Selected Remedy

The preferred alternative presented in the 2007 Revised RI/FS was the offsite disposal of the affected material at two landfills, with ongoing groundwater monitoring and an environmental covenant, or Alternative 5B. After consideration of input and comments by reviewers of the 2007 Revised RI/FS including CDPHE and the local community, especially the administrative feasibility comments, Alternative 5B is chosen as the selected remedy. The purpose of this document, the ROD, is to notify interested parties of the selected remedy and provide information about the decision process.

Summary of Rationale for the Selected Remedy

The preferred alternative meets the threshold criteria and provides the best balance of tradeoffs among the other alternatives with respect to the balancing and modifying criteria. The preferred alternative was selected over the other alternatives because it is expected to achieve substantial and long-term risk reduction for the Site. It also is the least expensive remedy. The alternative also allows residential future use for more of the property than the other alternatives, which is the most protective and preferred type of cleanup, and is a reasonably foreseeable use for the Site. Radionuclides and metals in the groundwater in the vicinity of the Site are expected to return to acceptable values after the stockpiles are disposed of offsite. Eliminating the risk of recontamination of the groundwater and exposing users of the property is better than leaving contaminated materials on Site with the uncertainty of remedy failure over 1,000 years. Alternative 5 reduces the risk within a reasonable timeframe and at reasonable cost (compared to the other alternatives). Alternative 4 does not comply with ARARs if there is a failure of institutional controls, but Alternative 5 does comply with ARARs is there is such failure. Alternative 5B is protective of human health and the environment, complies with ARARs, is cost effective, and provides a long-term effective and permanent solution.

Description of the Selected Remedy
Alternative 5B involves the transportation and disposal of the two stockpiles to two offsite disposal facilities. Stockpile A has been approved for disposal at Clean Harbors Deer Trail facility in Last Chance. Stockpile B has been approved for disposal at the local Foothills Landfill.

The Foothills Landfill route from the Site starts at the temporary access on U.S. Route 6 and continues north along State Route 93 to the landfill. The total distance is about 8 miles. The Clean Harbors route follows Route 6, to Route 58 east, to I-70 east to Last Chance. The total distance is approximately 83 miles. Trucks hauling the material will be loaded on Site and may require screening prior to entry and exit from the Site.

Quarterly groundwater monitoring will be performed for two years. Monitoring will include measurement of field parameters (dissolved oxygen, pH, specific conductance, and temperature) and the collection and analysis of groundwater samples for identified contaminants of concern, primarily uranium.

The following nine tasks break down components of the remedy:

Task 1 – Update the Administrative Record
Make hard-copy reproductions of all field notes, field drawings, log books, chain of custody documents, sample logs, sample results, transmittal letters, project-related correspondence, subcontractor invoices, and subcontractor daily report forms and turn over this package to the School for inclusion in the Administrative Record.

Task 2 – Work Control Documents
Prepare, submit for review, and finalize the documents necessary to complete the soil disposal. Documents will provide details of the material load-out, transportation, health and safety requirements, CDOT requirements, and final confirmatory sampling. These documents will conform to State requirements as well as applicable federal regulations and will consist of the following.

> **Material Transportation Plan** – This plan will detail the traffic control devices employed to safely transport the material off site. Also included in this document will be any and all CDOT requirements as well as any requirements of the receiving landfills.
> **Material Disposal Work Plan** – This document will detail the equipment, personnel, procedures, and project controls that will be implemented during the soil removal. Also

detailed will be the collection and analysis of confirmatory samples from beneath the stockpiles.

Health and Safety Plan – This document will detail the procedures, engineering controls, and personnel monitoring required to ensure the health and safety of all persons involved with this effort.

All final documents will be submitted to the School in both hard copy and in PDF formats.

Task 3 – Re-Activate CDOT Access Permit
Contact CDOT, provide CDOT the requested traffic plans and signage diagrams to allow for the use of the temporary access to Highway 6. Due to the repetitive nature of this request (starting with New Horizons to remove demolition debris, reactivated by Stoller for the bag disposal), CDOT may require extraordinary efforts to attain this permit.

Task 4 – Soil Load-out
Perform load-out of soil and site stabilization work. Soil will be loaded into haul trucks and transported to the appropriate disposal facility. Collect and maintain all records, including radiological scans of each truck prior to departure from the site. The number of trucks used each day will be optimized to match the turnaround time so as to eliminate stand-by time. Soil load out will be performed so as to match the hours of operation of the receiving disposal facility.

Besides each truck being radiologically screened prior to each departure from the site, trucks will be scanned for free release at the end of the job. All earth moving equipment will also be screened for free release prior to demobilization from the site. This procedure will ensure that no contamination or contaminated soil remains in or on the equipment.

Task 5 – Soil Shipment
Transport soil to disposal facilities. Departing trucks will be prepared and monitored in a similar manner to those during the containerized soil removal in 2005.

Per the BFI Foothills Landfill risk assessment, GPS readings of the location of the soil within the landfill will be taken to ensure compliance with the risk document.

Task 6 – Confirmatory Sampling
Design and implement a cost effective sampling program to demonstrate to the CDPHE and all interested parties the complete excavation and transportation of all stockpiled soils from the site. Soil samples will be analyzed by the shielded sodium iodide with a statistically significant number being submitted to the laboratory for confirmation.

Task 7 – Site Stabilization and Demobilization
Design and oversee the implementation of a site stabilization program, with direct input from Golden storm water control personnel that protects the waters of the State from impacts due to storm water runoff. Remove from site all equipment and support facilities involved with this project.

Task 8 – Final Remedial Implementation Report
Prepare a final report consistent with the NCP that details the remedy implementation and request license termination. The report will also detail all remaining groundwater monitoring and deed restrictions. All documentation generated during the soil disposal will be included as well as final confirmatory sample results and summary statistics for both beneath the soil stockpiles and the entire Site. The report will be submitted to the CDPHE for their approval.

Task 9 – Groundwater Monitoring
Conduct regularly scheduled sampling of the groundwater monitor wells and air filter pumps and inspection of the storm-water control system at the CSMRI site in Golden, Colorado

Table 21
Summary of Estimated Remedy Costs

Task	Cost (in dollars)
Complete Update of Administrative Record	$23,800
Prepare Work Plans	$22,000
Re-activate CDOT Access Permit	$4,000
Load Out Soil	$184,000
Transport Soil to Landfills	$211,000
Disposal Fees at Landfills	$400,000
Collect and Analyze Confirmatory Samples	$12,000
Site Stabilization and Demobilization	$8,500
Prepare Final Report -	$23,000
Groundwater Monitoring and Analysis	$112,000
Total Estimated Cost	**$1,000,300**

Expected Outcomes of Selected Remedy
Upon completion of the offsite disposal, the soils and surface of the Site will be available for all uses with the implementation of the environmental covenant requiring radon mitigation systems in all residences on Site. The remedy will improve environmental and ecological conditions at the Site: contaminants will be taken away from the Site. It is also desirable for socio-economic and community reasons to have the Site returned to a broader range of beneficial uses. Backfill material is required for storm water control and safety.

The soil DCGLs will be met upon completion of the remedy. However, an environmental covenant is needed to attain the 25 mrem/yr and 15 mrem/yr ARARs, which includes attainment of CERCLA's cancer risk ranges. Without a covenant, the residual soil concentrations above background for Ra-226 will result in a dose of 42 mrem/yr to an individual living on Site, in excess of ARARs.

The status of the groundwater is uncertain. At this time it may not be used for drinking. Two groundwater wells exceed the 30 ug/L MCL for uranium. The success of excavating and taking the contaminated soil offsite on improving groundwater quality is unknown. It will not be determined until after sufficient monitoring has occurred.

M. Statutory Determinations

The purpose of this section is to provide a brief, site-specific description of how the Selected Remedy satisfies the statutory requirements of CERCLA §121 (as required by NCP §300.430(f)(5)(ii)). The following sections describe how Alternative 5B meets the nine criteria.

The selected remedy requires the offsite disposal of the Stockpiled contaminated soil, an environmental covenant requiring radon mitigation systems for residences, and groundwater monitoring.

Overall protection of human health and the environment
In the 2004 RI/FS, RESRAD predicted a dose of 6.0×10^{-2} mrem/yr and a risk of 1.1×10^{-6} (subsistence farmer); the corresponding hazard index from residual metals was calculated to be 0.58 for the Site after the material has left the Site. These dose and risk levels assumed no backfilling of the Site. Re-grading operations required for storm-water control, safety, and Site restoration (to allow beneficial use of the Site) would reduce the dose and risk even further (assuming clean fill). The offsite disposal of the majority of the Ra-226 above background significantly reduces potential radon emanation rates.

In 2007, RESRAD predicted a dose of 42 mrem/yr above background after both stockpiles are taken to offsite disposal facilities and DCGLs have been attained for the Site soils. A radon mitigation system will reduce exposure levels below 25 mrem/yr and 15 mrem/yr, which also attains CERCLA's acceptable carcinogenic risk range.

Groundwater quality at the down gradient Site boundaries, along Clear Creek (which is a drinking water source), exceeds the MCL for uranium. Continued monitoring of the groundwater is necessary to determine the affect that offsite disposal of soils above DCGLs has upon improving groundwater quality and returning it to below the MCL. It is anticipated that offsite disposal will eliminate the source material that is causing the exceedance of the MCL. But, that cannot be determined until after additional groundwater monitoring is performed and an opportunity to see the effects over a critical time period.

Alternative 5B is protective of human health and the environment.

Compliance with Applicable or Relevant and Appropriate Requirements (ARARs)
Alternative 5B complies with ARARs identified in the 2007 Revised RI/FS, with the exception of the uranium MCL at the Site boundary and the anti-degradation standard. The proposed groundwater and surface-water monitoring program is designed to demonstrate the effectiveness of the remedy in attaining the MCL over the long term.

The principal ARARs are presented in Table 22.

Table 22
ARARs for Soils, Groundwater, and Surface Water

Media	Site-Specific Applicable or Relevant and Appropriate Requirements and To Be Considered
Soil	10 CFR §20.1402 and 1403, NRC Standards for Protection Against Radiation, Radiological Criteria for Unrestricted and Restricted Use – Requires that exposures to onsite receptors do not result in a dose in excess of 25 mrem/yr plus ALARA, and 100 mrem/yr if institutional controls fail for restricted use cleanups.
	6 CCR 1007-1, §4.61.2 – 4.61.3, Colorado Radiation Control regulations, Radiological Criteria for Unrestricted and Restricted Use - Requires that exposures to onsite receptors do not result in a dose in excess of 25 mrem/yr plus ALARA, and 100 mrem/yr if institutional controls fail for restricted use cleanups.
	EPA Memorandum, Establishment of Cleanup Levels for CERCLA Sites with Radioactive Contamination, OSWER No. 9200.4-18, August 1997 – Uses a risk-based approach to recommend limiting exposures to less than 15 mrem/yr for NCP compliance.
	EPA Memorandum, Reassessment of Radium and Thorium Soil Concentrations and Annual Dose Rates, July 22, 1996 – Initial discussion that resulted in the recommended 15 mrem/yr dose.
	EPA Memorandum, Use of Soil Cleanup Criteria in 40 CFR 192 as Remediation Goals for CERCLA Sites, Directive No. 9200.4-25, February 1998 – Clarification of the use of 40 CFR 192 for the development of radionuclide soil standards.
	40 CFR §192.12, Subpart B; 6 CCR 1007-1, Part 18 Appendix A —Standards for Cleanup of Land and Buildings Contaminated with Residual Radioactive Materials from Inactive Uranium Processing Sites, Standards – Limits radium-226 surface activities (up to 15 cm) to 5 pCi/g and subsurface activities (greater than 15 cm) to 15 pCi/g. For occupied or habitable structures it requires that remedial efforts result in an annual radon decay product concentration (including background) of less than 0.2 WL (in any case the concentration should not exceed 0.3 WL). And interior gamma shall not exceed background by more than 20 microroentgens per hour.
	40 CFR §192.02, Subpart A; 6 CCR 1007-1, Part 18 Appendix A —Standards for the Control of Residual Radioactive Materials from Inactive Uranium Processing Sites, Standards – Specifies that the control of residual radioactive materials and their listed constituents shall be designed to be effective for up to 1,000 years, and in any case for at least 200 years. Also imposes limits on acceptable radon air concentrations and requires groundwater monitoring when necessary.
	CDPHE, Proposed Soil Remediation Objectives Policy Document, December 1997, as updated
	CDPHE, Revised Proposed Residential/Unrestricted Land-Use Standards, 2003, as updated
	EPA Region 9 Memorandum, Region 9 PRGs Table 2002 Update, October 2002 – Describes risk-based approach to soil cleanup and provides table of preliminary remediation goals for soils. CDPHE recommends the use of these PRGs for materials not covered by their proposed soil standards.
Groundwater and Surface Water	40 CFR §192.02 Standards, §192.03 Monitoring, §192.04 Corrective Action, Subpart A—Standards for the Control of Residual Radioactive Materials from Inactive Uranium Processing Sites – Details the requirements specific to groundwater.
	40 CFR §192.20 Guidance for implementation, §192.20 Criteria for applying supplemental standards, Subpart C – Implementation – Additional groundwater requirements.
	40 CFR 141.11, National Primary Drinking Water Regulations, Maximum contaminant levels for inorganic chemicals.
	40 CFR 141.15, National Primary Drinking Water Regulations, Maximum contaminant levels for uranium, radium-226, radium-228, and gross alpha particle radioactivity in community water systems.
	40 CFR 141.51, National Primary Drinking Water Regulations, Maximum contaminant level goals for inorganic contaminants.

Table 22
ARARs for Soils, Groundwater, and Surface Water

Media	Site-Specific Applicable or Relevant and Appropriate Requirements and To Be Considered
	40 CFR 141.55, National Primary Drinking Water Regulations, Maximum contaminant level goals for radionuclides.
	5 CCR 1003-1, Colorado Primary Drinking Water Regulations, Maximum contaminant levels for uranium and arsenic, among other substances.
	5 CCR 1002-41, Colorado Department Of Health, Water Quality Control Commission Regulation No. 41, Basic Standards for Ground Water.
	5 CCR 1002-8, §3.1.1, Colorado Department Of Health, Water Quality Control Commission Regulation No. 8, Establishes basic standards, anti-degradation standard, and system for classifying State water.
	5 CCR 1002-38, Colorado Department Of Health, Water Quality Control Commission Regulation No. 38, Classifications And Numeric Standards South Platte River Basin (including Clear Creek as a tributary), Laramie River Basin, Republican River Basin, Smoky Hill River Basin.
	5 CCR 1002-31, Colorado Department Of Public Health And Environment, Water Quality Control Commission, Regulation No. 31, The Basic Standards And Methodologies For Surface Water, Section 31.8 Antidegradation Rule.

Long-Term Effectiveness and Permanence
Disposal at an offsite landfill successfully and permanently mitigates the potential long-term effects associated with the elevated metals and radionuclides on the Site. This alternative provides all uses for the soils at the Site in combination with the environmental covenant. The permanence and long-term effectiveness with regard to groundwater will be evaluated over time with monitoring.

Reduction of Toxicity, Mobility, or Volume through Treatment
This alternative does not reduce the toxicity, mobility, or volume of affected soil through treatment. All of the material is moved to an offsite landfill where it can be properly managed, but no treatment will occur. Treatment is not used because it is not as reliable as offsite disposal, it is more expensive, it may lead to more contamination of groundwater, and it may expose individuals onsite given the 1,000 year time horizon.

Short Term Effectiveness
Excavation and transport activities pose an elevated short-term exposure risk to onsite workers, transportation workers, and nearby residents due to airborne particulate generation. Direct exposure of workers during implementation of this alternative would be minimized through use of appropriate safety measures and procedural controls. Table 23 summarizes RESRAD predicted worker doses and risks associated with excavation activities. Conservative parameters were used in the model to predict upper limits for the operation. Assumptions included direct access to the soil when in fact workers will spend most of their time in excavation equipment. Area factors also must be considered for the worker exposure.

Table 23
RESRAD-Predicted Worker Doses for Excavation Activities under Alternative 5

Worker Exposure	Dose (mrem/yr)	Risk
Entire Site – 6 months	2.0	$4.2x10^{-5}$
Elevated Areas – 1 month	1.4	$3.2x10^{-5}$

Hazards associated with metals would be expected to be minimal during remedial operations. Risks associated with inhalation of fugitive dusts are controllable through air monitoring, the use of appropriate health and safety equipment, and dust suppression techniques. Air monitoring also would be used to identify potential offsite risks to the neighboring community.
A low to moderate risk to the local area would be associated with the truck traffic required to move equipment and material (i.e., traffic accidents). Access to State Highway 6 would limit the risk to the immediate neighborhood but could affect the local county (or counties). A somewhat higher risk is associated with transportation of the material through the neighborhood.

Based on worker risk assessment evaluations, there is a small incremental short-term risk of potential adverse health consequences during a transportation-related accident. Exposure times would result in a risk significantly lower than the $1x10^{-6}$ threshold (assumes cleanup operations are completed within 24 hours and the only receptors are emergency response personnel). Typically access to transportation related spills is not allowed to members of the general public.

An accident involving an overturned truckload of affected material would have a small environmental risk if the material were to enter a drainage channel. However, the environmental risk would be limited because of the nature of the material (soil versus liquid) and containment procedures followed by emergency response teams.

Access to U.S. Highway 6 would eliminate the need to transport material and equipment through nearby residential areas. In the event that access to U.S. Highway 6 is not available, truck traffic through the 12th Street Historic District will likely result in public annoyance due to short-term noise and vibration in a residential area. Some operational noise would be expected that could be noticed by nearby residents.

Implementability
The technical feasibility of offsite disposal at a landfill relies on use of conventional excavation and transport technology. Necessary equipment is readily available for implementation of this alternative.

Factors involving the administrative feasibility of the alternative include obtaining approval from CDOT for access to State Highway 6 and meeting the landfill acceptance criteria requirements. New Horizons completed physical construction of an access lane on Highway 6 in 2004 under CDOT Access Permit No. 603100. Stoller used this access lane for disposal of the bagged soil in December 2005 under CDOT Access Permit 605167. It is likely that CDOT would issue another use permit to allow transport of additional soil using this access point.

The Foothills Landfill and the Clean Harbors Deer Trail Landfill are administratively feasible. In April 2005, Stoller prepared a risk assessment, *Dose Assessment for the Emplacement of the*

CSMRI Site Containerized and Remaining Subsurface Soil into a RCRA Subtitle D Solid Waste Landfill, which was approved by CDPHE on August 26, 2005. In order for the landfill to accept the bagged soil waste stream, analytical data demonstrating the nature of the material were supplied to BFI/Allied Waste for review. BFI/Allied Waste agreed that the material was not hazardous waste and with the CDPHE approval for them to accept the material; BFI/Allied Waste agreed to accept the waste stream. Since then, both CDPHE and BFI/Allied Waste have agreed that Stockpile B may be disposed of at the Foothills Landfill.

Cost

Cost elements associated with Alternative 5B include loading the stockpiled material into trucks, transportation to two locations, and re-grading of the Site. Stockpile A would go to the Clean Harbors facility in Eastern Colorado, and Stockpile B would go to the Foothills Landfill also in Colorado. Afterward a limited amount of groundwater monitoring is required. The total present value of these cost elements is estimated at $1.0 million. Property values are not significantly affected by this alternative because the land will be available for residential and other use with the environmental covenant. Because the remedy is the least expensive remedy, and it best attains ARARs and protectiveness in relation to the other alternatives, the costs are proportional to its overall effectiveness consistent with the NCP.

State Acceptance

The School and CDPHE prefer Alternative 5B.

Community Acceptance

Comments received during an open house and a public meeting indicated that local residents preferred Alternative 5B.

Five-Year Review Requirements

The environmental covenant, with its annual certification of compliance requirements eliminates the need for a five-year review for soils, which contain Ra-226 above background at levels that do not allow for unrestricted uses. A five-year review may be required for groundwater. It will depend upon the results of the groundwater monitoring over the next two years.

N. Documentation of Significant Changes from Preferred Alternative of Proposed Plan

There are no significant changes from the preferred alternative identified in the Proposed Plan. The Proposed Plan for the CSMRI Site was released for public comment in May 2007. The Proposed Plan identified Alternative 5B, offsite disposal at two landfills, as the Preferred Alternative for soil remediation. Although the School is using the Clean Harbors landfill for Stockpile A instead of the U.S. Ecology facility, which was recommended as part of the Proposed Plan, the only reason that Clean Harbors was not recommended in the Proposed Plan was the indemnity issue. That issue has since been resolved so the selection of Clean Harbors is consistent with the Proposed Plan and is not a significant difference. The School reviewed all written and oral comments submitted during the public comment period. It was determined that no significant changes to the remedy, as originally identified in the Proposed Plan, were necessary or appropriate.

References

Advanced Sciences, Inc., 1989. Preliminary Assessment of the Potential for Water-Borne Migration of Contaminants in the Claypits, J. Kunkel, Advanced Science, October 20.

CDPHE Proposed Soil Remediation Objectives policy (1997 and 2003)

EPA, 1982. U.S. Environmental Protection Agency, Surface Gamma Ray Scanner Survey, 1982.

Grant, 1990. James L. Grant & Associates, Task 1: Site Characterization and Pathways Analysis, Claypits Site and CSMRI Facility, Golden, Colorado, Project No. 809334, April 30.

Industrial Compliance Inc., 1989. Tailings Pond, CSMRI, Creekside Sampling Report, October.

Jacobs, 1987. CSMRI Environmental Assessment, Jacobs Engineering Group Inc., October 1987.

MacPherson, 1988. Claypits Report to CDPHE, Robert MacPherson, October 20, 1988

New Horizons, 2003a. *Concrete and Asphalt Removal and Disposal* [Final Report], April 11.

New Horizons, 2003b. CSMRI Characterization Summary, August 21.

New Horizons, 2004. Remedial Investigation / Feasibility Study and Proposed Plan, Colorado School of Mines Research Institute Site, Golden, Colorado, January 21.

Radiant Energy Management, 1989. Preliminary Assessment of Radiological Risks at CSMRI, Creekside, L. Hersloff, September.

Removal Action Options Analysis (RAOA), Multiple authors, June 12, 1995 (3 vols.)

Robson 1983 and 1984

Robson *et al* 1981a and 1981b

SR & K, 1994. Preliminary Remedial Alternative Evaluation for the CSM Creekside Stockpile, August 25.

Stoller, 2007. Clay Pits Area Remedial Site Investigation Report, CSMRI Site, April

URS Corporation, 2001. Characterization Survey Work Plan (CSWP), July 23, 2001

URS Corporation, 2002. Concrete and Asphalt Characterization Report, May 18.

Van Horn 1976

Waterloo Hydrogeologic

Weimer 1976

PART 3: RESPONSIVENESS SUMMARY

A. Stakeholder Issues and Lead Agency Responses

The 2007 Revised RI/FS was published in May 2007. Only CDPHE submitted written substantive comments. A couple of oral comments were made during the public meeting by a local resident.

A summary of the comments received and the School's responses to the comments are listed below.

CDPHE Comments

CDPHE stated that Alternative 5 is consistent with CDPHE's approval of taking certain soils (Stockpile B) to the Foothills Landfill. CDPHE said it is reviewing the RI/FS and the Proposed Plan under the context of the CSMRI radioactive materials license, not CERCLA, especially the technical information, and that the only oversight it is providing is under the license. CDPHE said it will not provide comments on all of the documents, including approval of the documents. CDPHE said the CSMRI Site is not a Superfund Site. In addition, CDPHE said it disagrees with the waste characterization and that CDPHE participated in that process. CDPHE also stated that the RI/FS does not address groundwater monitoring, does not adequately characterize groundwater contamination, or address the clay pits area.

<u>School Response</u>:

EPA's removal action at the Site was first initiated in 1992 at CDPHE's request with Superfund money. EPA spent over $2 million of Superfund monies here. EPA then issued a CERCLA Order under Superfund authority. The Site is a Superfund site. When EPA's removal action ended in 1997, CDPHE asked EPA to defer enforcement lead to CDPHE because CDPHE believed that it could complete the cleanup without EPA. EPA agreed. For the last 10 years, the School has voluntarily worked to clean up the Site under CERCLA, consistent with the NCP. All of the work plans confirm this. CDPHE reviewed and approved every single one of them. All of this work was done by the School with CDPHE approval. The School's work is under CERCLA even though it simultaneously addresses the radiation control issues. As has been the practice for many years at this Site, the School's work plans will be submitted to CDPHE for review and approval prior to execution of field work.

The comment about disagreeing with waste characterization is confusing. Both CDPHE and the School agree that the wastes at issue may go to the landfills identified in the Revised RI/FS. There is no disagreement here. CDPHE previously approved these landfills. CDPHE has been a part of the process and approved each waste disposal decision along the way during the last 15 years, including the most recent proposal.

The Revised RI/FS has an entire section on the Clay Pits area investigation and results (Section 4.5 and Appendix G), which was investigated pursuant to a CDPHE-approved plan. Moreover, the Revised RI/FS addresses groundwater and reports data generated pursuant to CDPHE-approved plans (Section 4.6). The Revised RI/FS does state that groundwater monitoring will continue, as outlined in the CDPHE-approved work plans. All investigation, including groundwater monitoring, and clay pits investigation, has been pre-approved by CDPHE. It is unclear what CDPHE finds incomplete. CDPHE has not identified what is incomplete. Perhaps because CDPHE has not completed its technical review, it did not have time to review the relevant sections of the Revised RI/FS.

Local Resident Comments
One resident stated during the public meeting that he supported the Proposed Plan and the notice for the public meeting was probably not adequate as reflected by the low attendance at the meeting.

<u>School Response</u>:
The School not only complied with all NCP public notice requirements, but it went above and beyond the notice requirements to get the word out to many stakeholders. Low attendance does not mean that notice was not adequate. It may also be due to lack of interest.

PRP Comments
One commentator writing on behalf of some PRPs wrote a letter to say that those PRPs are not going to submit comment on the Proposed Plan, and that they reserve their rights “in regard to the CSMRI matter” and their failure to comment is not acquiescence in action taken by the School at the Site.

<u>School Response</u>
No substantive response is necessary because no substantive comments were submitted. PRPs cannot provide comments after the end of the public comment period and they cannot raise issues in court that could have and should have been raised during the public comment period.

B. Technical and Legal Issues

These issues were addressed in Part IIIA. No expansion on them is necessary here.