CSMRI Site Proposed Plan

Proposed Plan for CSMRI Site

This Proposed Plan identifies the Preferred Alternative (off-site disposal) for cleaning up the affected soil at portions of the former CSMRI Facility, Golden, Colorado (Site) and provides the rationale for its selection. The Plan also includes summaries of other alternatives that were evaluated for use at the Site. This document was prepared by the Colorado School of Mines (the School) for review and comment by the Colorado Department of Public Health and Environment (CDPHE), the local community, and other stakeholders. The School, in consultation with CDPHE, will select a final remedy after reviewing and considering all of the information submitted during a 30-day public comment period. The School, in consultation with CDPHE, may modify the Preferred Alternative or select another response action presented in this Plan based on new information or public comments. Therefore, the public is encouraged to review and comment on all of the alternatives presented in this Proposed Plan.

The School is issuing this Proposed Plan as part of its public participation responsibilities under the Section 300.430(f)(2) of the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) process. The Proposed Plan summarizes information that can be found in greater detail in Remedial Investigation/Feasibility Study (RI/FS) report and other documents contained in the Administrative Record file for this Site. The School and CDPHE encourage the public to review these documents to gain a more comprehensive understanding of the Site and investigation activities that have been conducted at the Site.

Site History

Numerous mineral research projects were conducted at the Site from 1912 until approximately 1987. Some of these projects involved investigating methods to extract metals and radionuclides from mineral ores. The research projects utilized 17 buildings on the Site that were removed in the mid-1990s. A settling pond, located between the building complex and Clear Creek, was used 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.

In January 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. The U.S. Environmental Protection Agency's (EPA) Emergency Response Branch responded in February 1992 and performed a number of activities to stabilize conditions at the Site, including:

- excavation of contaminated sediments and soil,
- stockpiling of the material (the Stockpile - 20,000 cubic yards of sediment and soil),
- decontamination of building drains,
- demolition and removal of several buildings,

Important Dates and Information

Public Comment Period:
January 21, 2004 through February 20, 2004
The School will accept written comment on the Proposed Plan during the public comment period. Comments should be addressed to Linn Havelick, Director of Environmental Health and Safety (see last page of this document for address and email information).

Public Meeting:
February 4, 2004 – 6:30 to 8:00 pm
The School will hold a public meeting to explain the Proposed Plan and all of the alternatives presented in the Feasibility Study. Oral and written comments also will be accepted at the meeting. The meeting will be held at General Research Building, Room 201, 1310 Maple Street on the campus of the Colorado School of Mines, Golden, Colorado.

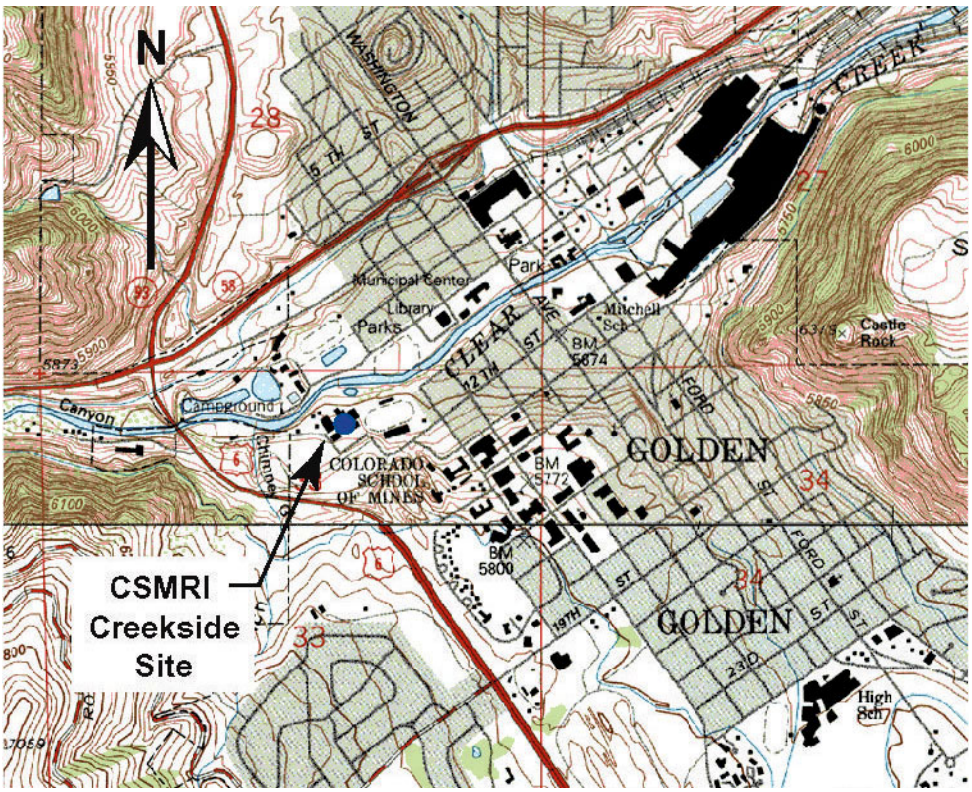
For more information, see the Administrative Record at the following locations:
Arthur Lakes Library
Library Circulation Desk
Colorado School of Mines
1400 Illinois Street
Golden, Colorado 80401
(303) 273-3911
Hours: Mon -Thu 7:30 am to 12:00 am;
Fri 7:30 am to 6:00 pm;
Sat 9:00 am to 5:00 pm;
Sun 1:00 pm to 10:00 pm

Jefferson County Public Library
Golden Public Library
1019 Tenth Street
Golden, Colorado 80401
(303) 279-4585
Hours: Mon – Thu 10:00 am to 9:00 pm;
Fri to Sat 10:00 am to 5:00 pm;
Sun 12:00 pm to 5:00 pm

- consolidation of existing drums and disposal of compressed gas cylinders,
- sampling of sediments and water, and
- closure of the settling pond

After site stabilization, EPA contacted a number of organizations that had made prior use of the Site and requested that the Stockpile be removed. EPA issued a Unilateral Administrative Order (UAO) to a limited number of organizations in 1994. A *Removal Action Options Analysis* (RAOA) report (issued in 1995) that developed and evaluated disposal options was one outcome of the UAO. Ultimately, the School and the State of Colorado were the only organizations that implemented the preferred disposal option. The EPA removal action was completed in 1997. The School has been investigating the Site in consultation with CDPHE since the completion of the removal action.

In November/December 2002, all remaining concrete and asphalt were removed from the Site and with some of the material shipped to a local landfill and the remainder sent to a recycling plant. This activity is documented in the *Concrete and Asphalt Removal and Disposal, Final Report, 2003*.



Site Location Map

Site Characteristics

Between December 2002 and January 2004, New Horizons Environmental Consultants, Inc. conducted a Remedial Investigation/Feasibility Study (RI/FS) at the Site for the School. The RI/FS identified the types, quantities, and locations of contaminants and evaluated a variety of cleanup methods. The RI consisted of many tasks including a Site wide gamma survey, the collection of 165 surface soil samples, the excavation of 36 test pits (56 samples), the drilling of 28 borings (68 samples), and four consecutive quarters of ground-water samples (seven monitoring wells). Surface and subsurface soil samples were analyzed for metals and radionuclides with limited analysis of a variety of organic compounds. Quarterly ground-water samples were collected for four quarters beginning in February 2003. Ground-water samples were analyzed for metals, radionuclides, a variety of organic compounds, and a number of general water-quality analytes. The RI tasks indicated the following:

- Gamma survey: identified a number of areas near the former buildings where the soil had elevated gamma radiation.

- Soil samples: discovered elevated concentrations of arsenic, cadmium, lead, and mercury at a number of locations around the Site. Elevated activity levels of radium, thorium, and uranium also were detected.
- Subsurface soil samples: analytical results indicated elevated metals and radionuclides primarily in the upper foot of soil across much of the Site (affected material was found at deeper levels near the some of the former building locations).
- Ground-water samples: analytical results showed elevated [above the EPA and CDPHE Maximum Contamination Levels (MCL)] concentrations of uranium in two monitoring wells during at least one of the sampling rounds. Low concentrations of chlorinated solvents also were detected with one sample containing trichloroethene (TCE) slightly above the MCL during one sampling round.

The metals and radionuclides are at levels that would cause excessive risk if the property were to be converted to residential use. Security fencing is currently used to limit access to the Site. Risks from ground water are not currently an issue because the aquifer in the immediate vicinity is not used as a drinking water source.

Scope of the Action

The proposed remedial alternative is intended to be the final cleanup for the Site. The former settling pond and the softball field area at the Site have already been cleaned up and are considered closed. After cleanup, the Site will be returned to beneficial uses.

Site Gamma Radiation Distribution
(darker colors indicate elevated readings)

Summary of Site Risks/Hazards

Acceptable exposures to known or suspected carcinogens are generally those that represent an excess upper-bound lifetime cancer risk to an individual of between 10^{-4} and 10^{-6}. This translates to between one person in 10,000 or one person in 1,000,000 developing cancer because of exposure to the material. Of the materials found on Site, the radionuclides radium, thorium, and uranium are known carcinogens along with the metals arsenic and chromium (cadmium, lead, and mercury are suspected carcinogens but currently there is insufficient information to predict levels of risk for these metals). EPA uses the 10^{-6} risk level as the point of departure for determining remediation goals. However, the upper boundary of the risk range is not a discrete line at $1x10^{-6}$. A specific risk estimate around 10^{-4} may be considered acceptable if justified based on site-specific conditions.

The affected material (primarily metals) also presents other health concerns that are not associated with cancer. Noncarcinogens are evaluated by their systemic effect on target organs or systems. EPA defines acceptable human exposure levels (including sensitive subgroups) as those that do not cause adverse effects during a lifetime or part of a lifetime, incorporating an adequate margin of safety. This acceptable exposure level is best approximated by a hazard index (HI) of 1. If a HI is less than 1, adverse effects usually are not expected. As the HI increases beyond 1, the possibility of adverse health effects also increases.

Detailed information about possible health effects from the metals and radionuclides found on Site may be found at a number of websites including those listed below:

http://www.atsdr.cdc.gov/toxpro2.html

http://www.epa.gov/iriswebp/iris/index.html
http://www.intox.org/databank/pages/chemical.html

As part of the RI/FS, New Horizons conducted a baseline risk assessment to determine the current and future effects of contaminants on human health and the environment. A subsistence farmer was selected as the potential future receptor for the baseline risk assessment. An urban resident and a recreational user also were evaluated for comparison. Although the ground water is not currently used as a drinking water source, it was assumed that it could be used for this purpose in the future. The possible incursion of neighborhood children onto the Site also was evaluated (of particular concern for the lead-affected soil). The results of the baseline risk assessment indicated that while there is no immediate risk from the Site (assuming security fencing is maintained), no further action at the Site would not be protective of human health and the environment over the long term.

Human Health Risks/Hazards

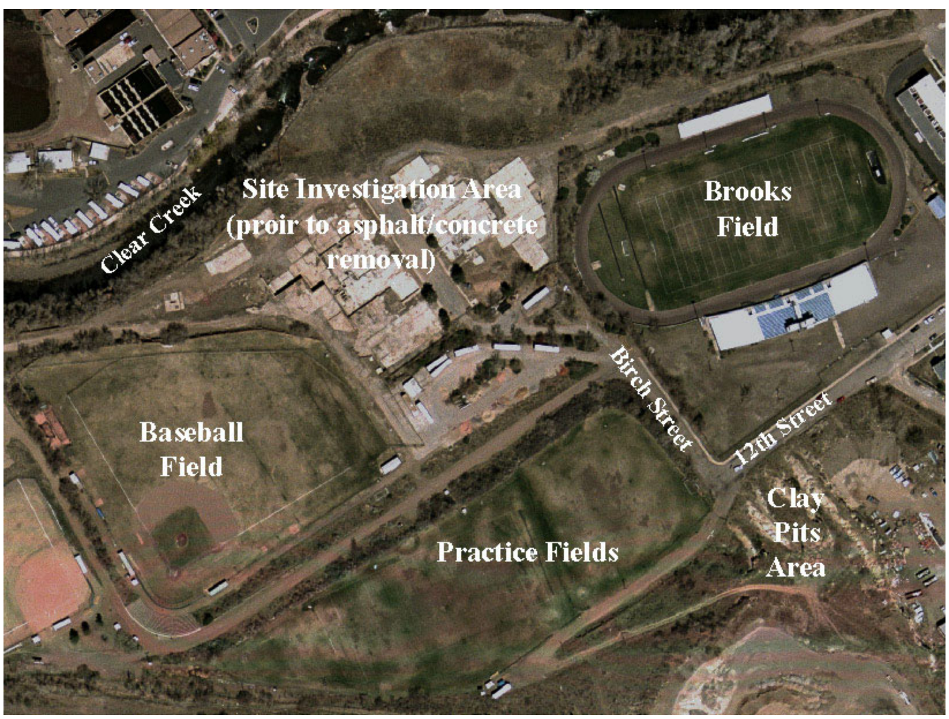
The baseline risk assessment indicated that leaving the affected material in place would result in a risk to an on-site resident in the range of 7.5×10^{-4} to 3.8×10^{-3} (depends on location of residence). A recreational user would experience a risk in the range of 8.7×10^{-6} to 3.7×10^{-5} (assumes limited access to Site). Hazard indexes calculated for the Site range from less than one for the occasional recreational user to up to 3.8 for a full time resident.

Control or removal of the affected material would result in a significant reduction in risk to an on-site resident (for details see Section 8 of the RI/FS).

Ecological Risks/Hazards

Because of the extensive disruption of the Site from the previous operations, there are minimal current risks to the environment. However, without the removal of the affected material the Site would be a long-term source of metals and radionuclide to the underlying ground water, which eventually flows into Clear Creek.

It is the School's current judgement that the Preferred Alternative identified in this Proposed Plan, or one of the other active measures considered in the Proposed Plan, is necessary to protect public health or welfare or the environment from actual or threatened releases of hazardous substances into the environment.



Aerial Photo of Site Area

Remedial Action Objectives

The Remedial Action Objectives (RAO's) for the Site include:

- Eliminate or minimize the pathway for dermal contact, inhalation, and ingestion of site specific radionuclides to human receptors, in order to achieve a level of protection in compliance with the

National Contingency Plan levels of acceptable cancer risk (10^{-4} to 10^{-6}).

- Develop receptor-specific soil cleanup levels to limit unacceptable radiation doses for the radionuclides found in the affected material (i.e., soil).
- Minimize risk associated with radon gas either by source removal or by requiring the installation of radon mitigation systems in any structures constructed on Site.
- 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 hazard indexes greater than 1. Because of the relative concentrations and distribution, arsenic, cadmium, lead, and mercury are the primary trace metals of concern.
- Address specific issues associated with the hazards resulting from the soil containing elevated concentrations of lead (possible access issues with neighborhood children).
- Prevent off-site migration of affected material that could result in the exposures described above. This includes the ground-water pathway.
- Implement remedial measures that limit ground- and surface-water concentrations to non-zero maximum contaminant level goals (MCLGs), established under the Safe Drinking Water Act. While the affected ground water is not a current drinking water supply it eventually enters Clear Creek, which is used by downstream users for drinking water. Uranium, arsenic, barium, and cadmium are the primary ground-water contaminants of concern.
- 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 Applicable or Relevant and Appropriate Requirements (ARARs). (See Section 8.1 and Appendix K of RI/FS for ARAR discussion)

Summary of Remedial Alternatives

Alternative 1 – No Further Action

Estimated Capital Cost: $61,100
Estimated Operation and Maintenance Cost (Present Value): $2,107,000
Estimated Present Worth Cost: $2,108,000
Estimated Construction Timeframe: NA
Estimated Time to Achieve Remedial Action Objectives: Not Achieved

Alternative 1 provides a comparative baseline against which other alternatives can be evaluated. Under Alternative 1, the affected soils would remain as is without any removal, treatment, containment, or mitigating technologies being implemented. Only institutional controls would be implemented. Institutional controls are items that limit the accessibility of the Site. Items may be physical barriers such as fencing, signs, monitoring and surveillance systems, or deed restrictions put on the land so that it may not be used for activities that would disturb the affected material. Institutional controls will be used to limit the accessibility of a site where no work was performed (no action). Specifically, the following institutional controls and air and ground-water-monitoring activities will occur as part of this alternative:

- Relocation of the water main by the City of Golden.
- Maintenance of the perimeter security fencing that currently surrounds the Site to prevent public access.
- Maintenance of erosion and sediment controls to minimize off-site migration of affected materials.
- Continuation of other institutional controls such as prohibition of construction and selected land uses on or immediately adjacent to the facility.
- Continuation of an air-monitoring program to provide information regarding potential exposures to nearby residents or users of the adjacent recreational facilities and to use in the periodic reviews.
- Redesign and enhancement of ground-water monitoring system along with implementation of a long-term ground-water-monitoring program to provide information regarding potential contamination of the ground water and to use in the periodic reviews.

Metals and radionuclides migration to ground water and incursions by neighborhood children (external radiation and radionuclide and lead ingestion exposures) present the highest risks for this scenario.

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 $1,920,000. The estimated present worth cost would be $4,028,000 if the land value loss were included.

Alternatives 2A and 2B – Engineered cap with and without slurry wall

Estimated Capital Cost: $1,938,000 (2A); $2,831,000 (2B)
Estimated Operation and Maintenance (Present Value) Cost: $1,126,000 (both 2A & 2B)
Estimated Present Worth Cost: $3,723,000 (2A); $4,617,000 (2B)
Estimated Construction Timeframe: 4 months (2A & 2B)
Estimated Time to Achieve Remedial Action Objectives: RAO's only partially achieved, monitoring required for at least 100 years

Alternative 2 involves the use of an engineered cap to prevent exposure to metals and radionuclides and to control surface water infiltration, preventing material migration to ground water. Alternative 2A examines only a cap while alternative 2B adds a slurry wall to ensure protection of ground water. The cap was assumed to cover the entire Site because of the widespread presence of elevated arsenic concentrations.

If Alternative 2B is selected the first operation would be the installation of a slurry wall. Again because of the widespread presence of arsenic, it was assumed the wall would be installed around the entire Site. The slurry wall is installed using excavation or trenching equipment to make a trench in the soil overlying the bedrock. It is necessary to surround the Site to divert upgradient ground water around the Site (no ground water would pass under the Site) and to prevent downgradient ground water from backing up into the Site during years when flooding occurs. The overlying cap prevents precipitation infiltration.

Fill material will be required to bring the existing Site to a grade appropriate for the installation of the cap. Current Site topography would be inappropriate for a cap because of drainage issues. Depressions formed by the removal of several of the building foundations would need to be filled and the base material would need to be contoured to ensure drainage off of the cap (no ponding is permitted). Borrow areas have been identified on nearby State property, eliminating the need to transport material on roads to the Site, but fill material may need to be imported if the School decides not to disturb these areas.

The nearby borrow area also contains clay suitable for capping material at sufficient quantities to cap the entire Site. A cap thickness of three feet is proposed. Caps are often covered with topsoil and planted with suitable vegetation to limit erosion.

Both alternatives would require long-term institutional controls to ensure the integrity of the cap. Limited use could be made of the area, such as parks and recreational areas, but construction of structures would be discouraged because of the possibility of compromising the cap. Controls would include the redesign and enhancement of the ground-water monitoring system along with implementation of a long-term ground-water-monitoring program to provide information regarding potential contamination of the ground water and to use in the periodic reviews. Subsurface markers/barriers also are recommended above areas contaminated with lead to warn future excavators of the risk.

Additional borings and samples may be required for alternative 2A to ensure material has not migrated to areas that potentially can be reached when ground-water levels are high. Soil under the foundation of Building 101N contained elevated radionuclides and metals and is the lowest point on the Site. The significant precipitation event associated with the March 2003 snowstorm may have driven additional affected materials further down into the soil column.

Alternative 2 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 $1,920,000. The estimated present worth cost would be $5,643,000 for Alternative 2A or $6,537,000 for Alternative 2B if the land value loss were included.

Alternatives 3A and 3B – Engineered cap with partial material removal

Estimated Capital Cost: $2,103,000 (3A); $2,806,000 (3B)
Estimated Operation and Maintenance (Present Value) Cost: $1,126,000 (both 3A & 3B)
Estimated Present Worth Cost: $4,083,000 (3A); $5,180,000 (3B)
Estimated Construction Timeframe: 5 months (3A); 8 months (3B)
Estimated Time to Achieve RAOs: RAOs only partially achieved, monitoring required for at least 100 years

Alternative 3 again involves the use of an engineered cap to prevent exposure to metals and radionuclides and to control surface water infiltration, preventing material migration to ground water. The difference in this option is the removal of some of the radionuclide containing material. Alternative 3A would address the areas with combined radium activities in excess of 15 pCi/g. Removal activities would be focused on the areas with elevated gamma radiation. An estimated 500 to 1,000 cubic yards would be removed in this alternative. Alternative 3B would address areas with combined radium activities in excess of 5 pCi/g. About half of the Site has radium activity at this level. An estimated 5,000 cubic yards would be removed for this alternative.

As discussed in the Alternatives 2A and 2B section, fill would be required to prepare the Site for a cap. The capping requirements are the same as Alternative 2. It is assumed that the School borrow area would be used for both the fill and cap material. Both alternatives assume cap constructed of three feet of clay

Alternative 3 has an excavation and removal component. Because the material is not uniformly distributed, soil would be excavated and stockpiled until confirmation sampling is complete. The soil stockpile would then be shipped to an appropriate landfill. Both versions of this alternative would require the construction of the temporary access road to U.S. Highway 6 in order to avoid transporting affected material through the historic district of downtown Golden. The transportation route from U.S. Highway 6 would be dependent on the landfill selection.

Alternative 3A would require between 40 and 80 truckloads to transport the material to the landfill. Alternative 3B would require about 380 truckloads.

Both alternatives would require long-term institutional controls to ensure the integrity of the cap. Limited use could be made of the area, such as parks and recreational areas, but construction of structures would be discouraged because of the possibility of compromising the cap. Controls would include the redesign and enhancement of the ground-water monitoring system along with implementation of a long-term ground-water-monitoring program to provide information regarding potential contamination of the ground water and to use in the periodic reviews. Subsurface markers/barriers are also recommended above areas contaminated with lead to warn future excavators of the risk.

Confirmation samples will be collected to ensure the radium activity limits have been met. However, these alternatives only address radium. Elevated metal concentrations may remain in excavated areas and additional borings and samples may be required to ensure material has not migrated to areas that potentially can be reached by high ground-water levels. Soil in the area around the former Building 101N contains both elevated radionuclides and metals. Metals may have been driven deeper in the soil column by the March 2003 precipitation event.

Alternative 3 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 $1,920,000. The estimated present worth cost would be $6,003,000 for Alternative 3A or $7,100,000 for Alternative 3B if the land value loss were included.

Alternatives 4A and 4B – On-site solidification with engineered cap or on-site engineered disposal cell

Estimated Capital Cost: $3,462,000 (4A); $3,130,000 (4B)
Estimated Operation and Maintenance (Present Value) Cost: $1,126,000 (both 4A & 4B)
Estimated Present Worth Cost: $5,568,000 (4A); $5,095,000 (4B)
Estimated Construction Timeframe: 8 months (4A); 7 months (4B)
Estimated Time to Achieve RAOs: RAOs only partially achieved, monitoring required for at least 100 years

Both versions of Alternative 4 require capping, but for this alternative the cap would only cover limited areas. Alternative 4A involves the consolidation and stabilization of on-site soils using concrete and fly ash. Alternative 4B includes the consolidation of material and the construction of an engineered disposal cell. Alternative 4 assumes that all of the affected on-site material (about 10,000 cubic yards) will be solidified or placed in a disposal cell. Confirmation sampling will be performed to ensure both metal and radionuclide limits are achieved.

Alternative 4A will require a pilot test to determine the appropriate mixture of concrete, fly ash, and soil. Once the proper mixture is determined, on-site materials will need to be excavated and segregated into soil types. Some crushing of cobbles may be required. An area at a high enough elevation to remain above ground-water fluctuations will be selected for the final placement of the solidified material. Operational concrete and fly ash will be stockpiled on site 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.

Once the solidification of the structure has been confirmed, a clay cap (depth of three feet) will be constructed over the structure to limit leaching effects. About 0.85 acre of property would be required for the solidified matrix. Long-term cap maintenance and ground-water monitoring in the vicinity of the solidified matrix would be required. The remaining property would be available for unrestricted use although a limited ground-water-monitoring program may be required to monitor the natural attenuation of 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.

Transportation requirements for this option include materials and equipment. The U.S. Highway 6 temporary access would be the preferred route to avoid movement of large equipment through local neighborhoods.

Alternative 4B requires the construction of an engineered disposal cell. An area above ground-water fluctuations would be selected for the construction of the cell. About one acre of property would be required for the disposal cell. The affected material would be excavated from the Site and placed in the cell. Once the removal operation is complete, a clay cap (3-feet deep) will be installed over the material. Again institutional controls would be required for the one-acre cell to ensure the integrity of the cap and to monitor ground water in the vicinity of the cell. Limited ground-water 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.

As with Alternative 4A, the U.S. Highway 6 temporary access would be the preferred route to avoid movement of large equipment through local neighborhoods.

Variations of Alternative 4 could include the solidification or containment of a portion of the affected material. However, solidification or containment of all of the material does allow for unrestricted use of the majority of the property.

Alternative 4 has the additional cost associated with the loss of property value for the portion of the property that contains the disposal area. Although a remediation process is completed, the land value may still decrease by up to $352,000 (could be more because of the perception associated with a nearby disposal area). The estimated present worth cost would be $5,920,000 for Alternative 4A or $5,447,000 for Alternative 4B if the land value loss were included.

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

Estimated Capital Cost: $272,900 (5A); $286,800 (5B)
Estimated Operation and Maintenance (Present Value) Cost: $226,300 (both 5A & 5B)
Estimated Present Worth Cost: $3,380,000 (5A); $3,714,000 (5B)
Estimated Construction Timeframe: 6 months (5A & 5B)
Estimated Time to Achieve RAOs: 5 years (assumes natural attenuation of ground water)

Alternative 5 involves the excavation and removal of all of the affected material to an approved landfill. Alternative 5A assumes all of the material can be placed in a local solid-waste landfill. Alternative 5B assumes that landfill acceptance criteria may require some of the material to be transported to a specialized landfill. Both versions of this alternative would require the construction of the temporary access road to U.S. Highway 6. The transportation route from U.S. Highway 6 would be dependent on the landfill selection.

Excavated material would be stockpiled prior to shipping to maximize the use of the trucks (eliminates waiting time for trucks). Alternative 5A would require about 760 truckloads to transport the material to the landfill. Alternative 5B would require between 680 and 720 truckloads to the solid-waste facility and the equivalent of 40 to 80 truckloads to the specialized waste facility (or shipping site).

Upon completion of the off-site disposal, all of the property would have unrestricted use. 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.

Evaluation of the 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, include 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 RI/FS.

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

All of the alternatives, except the "no further action" alternative, provide a degree of protection to human health and the environment, primarily through disposal or a combination of engineering and institutional controls. Metals and radionuclides are very persistent in the environment (limited treatment options are available) and the most cost-effective methods involve containing the material. Some uncertainty would remain for the ground-water pathway and long-term effectiveness of institutional controls for Alternatives 2 and 3 (cap integrity). These same uncertainties would be a problem to a lesser extent for Alternative 4. 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*

Most of the ARARs are met for Alternatives 2 through 4. Alternative 5 would meet all of the ARARs assuming the natural attenuation of the ground water is successful.

- *Long-term effectiveness and permanence*

Because of the requirement for a cap for Alternatives 2 through 4, the long-term effectiveness and permanence of these options may be questionable. The solidification process used for Alternative 4A 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 is removed from the Site.

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

With the exception of Alternative 4A, none of the alternatives use treatment to reduce toxicity, mobility, or volume. Although there are a number of technologies available to treat soils contaminated with similar material, the processes are typically expensive and have varying degrees of success. While treatment associated with Alternative 4A does reduce the toxicity (through lessening bioavailability) and mobility of the material, the volume of material would actually increase.

- *Short-term effectiveness*

Alternatives 3 through 5 would have additional short-term risks because of the excavation of the material (increasing exposure to the material through radiation exposure and inhalation). A somewhat lesser risk would be associated with Alternative 2 because there is no excavation associated with this option. Alternatives 3 and 5 also would have additional risks associated with the transportation of the materials (i.e., traffic accidents).

- *Implementability*

All of the alternatives use proven technology, but developing the proper concrete/soil mixture for Alternative 4A could be problematic. Alternatives 2 through 4 use varying degrees of on-site disposal and may require a permit unless an on-site waiver were possible. Alternatives 3 and 5 have uncertainties associated with the acceptance criteria for the landfills where the material would be sent.

- *Cost*

The least expensive alternative is Alternative 5 (see Section 8.0 of the RI/FS). If the value of the land is considered, Alternative 5 has significantly less cost than the other alternatives because it allows unrestricted future use of the property.

- *State acceptance*

In preliminary discussions with CDPHE, the off-site disposal alternative (Alternative 5) was the preferred alternative. This also is the School's preferred alternative. On-site disposal would be difficult to justify to the CDPHE because of recent events including the Shattuck Superfund site.

- *Community acceptance*

Comments received during and after a community outreach meeting conducted in December 2003 indicated that a significant number of community members supported the off-site disposal plan (Alternative 5). On-site disposal would be difficult to justify to the public because of recent events including the Shattuck Superfund site.

Summary of the Preferred Alternative

The Preferred Alternative for cleaning up the Site is to excavate the affected material and dispose of it off-site (Alternative 5).

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. The alternative also allows unrestricted future use of the property, which is the most protective and preferred type of cleanup. Radionuclides and metals in the ground water in the vicinity of the Site are expected to return to background values after the source material is removed. Alternative 5 reduces the risk within a reasonable timeframe and at reasonable cost (compared to the other alternatives).

Based on the information available at this time, the School and CDPHE believe the Preferred Alternative would be protective of human health and the environment, comply with the ARARs, be cost effective, and provide a long-term effective and permanent solution. The Preferred Alternative can change in response to public comment or new information.

Community Participation

The School and CDPHE provide information regarding the cleanup of the Site to the public through public meetings, the Administrative Record file for the Site, and announcements published in the Denver Post and the Golden Transcript. The School and CDPHE encourage the public to gain a more comprehensive understanding of the Site and the remedial activities and investigations that have been conducted at the Site.

The dates for the public comment period, the date location and time of the public meeting, and the locations of the Administrative Record files, are provided on the front page of this Proposed Plan.

For further information about the Site please contact:

Mr. Linn Havelick
Director of Environmental Health and Safety
Colorado School of Mines
Chauvenet Hall, Rm. 194
1015 14th Street
Golden, CO 80401
lhavelic@mines.edu
Phone: 303-273-3998
FAX: 303-384-208