EPA/ROD/R08-94/087
1994

EPA Superfund
Record of Decision:

LOWRY LANDFILL
EPA ID: COD980499248
OU 00
AURORA, CO
03/10/1994

<IMG SRC 94087A>

United States Environmental Protection Agency
Region VIII
999 18th Street - Suite 500
Denver, Colorado 80202-2466

Record of Decision

Lowry Landfill Superfund Site

Arapahoe County, Colorado

March 1994

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List of Acronyms

AAL	allowable ambient levels
AOCs	Administrative Orders on Consent
APEN	Air Pollution Emission Notice
ARARs	applicable or relevant and appropriate requirements
ASC	Additional Site Characterization
ATSDR	Agency for Toxic Substances and Disease Registry
Aurora	City of Aurora
AWQC	Ambient Water Quality Criteria
BNA	base-neutral acid
CAA	Clean Air Act
CALL	Citizens Against Lowry Landfill
CCD	City and County of Denver
CDC	Center for Disease Control
CDD/CDF	Chlorinated Dibenzo-p-dioxin and dibenzofurans
CDH	Colorado Department of Health
CDI	Chronic Daily Intake
CDOW	Colorado Division of Wildlife
CPDES	Colorado Pollution Discharge Elimination System
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CFR	Code of Federal Regulations
cfs	cubic feet per second
CIN	Citizen's Information Network
CHWA	Colorado Hazardous Waste Act
CLP	Contract Laboratory Program
CNAP	Colorado Natural Areas Program
COC	chemicals of concern
COPC	chemicals of potential concern
COSA	Colorado Occupational Health and Safety
CWA	Clean Water Act
CWM	Chemical Waste Management, Inc.
CWP	Conceptual Work Plan
DADS	Denver Arapahoe Disposal Site
Denver	City and County of Denver
DQOs	data quality objectives
EA	Ecological Assessment
EE/CA	Engineering Evaluation/Cost Analysis
EPA	United States Environmental Protection Agency
°F	degrees Fahrenheit
FEMA	Federal Emergency Management Agency
FIT	Field Investigation Team
FS	feasibility study
ft/day	feet per day
ft3/yr	cubic feet per year
FWPCA	Federal Water Pollution Control Act
GMP	gas monitoring probes
GW	ground water
GWTP	ground-water treatment plant
gpm	gallons per minute
HEAST	Health Effects Assessment Summary Table
HEW	United States Department of Health, Education, and Welfare
HI	Hazard Index
HLA	Harding Lawson Associates
HQ	Hazard Quotient
HRS	Hazard Ranking System
HSWA	Hazardous and Solid Waste Amendments
HVOC	hazardous volatile organic chemicals
IDE	Initial Data Evaluation
IRIS	Integrated Risk Information System
IRM	interim remedial measure
kg	kilograms
l	liter
L/DNAPLs	low/dense non-aqueous phase liquids
LFS	landfill solids
LFG	landfill gas
LLMC	Lowry Landfill Monitoring Committee

LOAEL	Lowest Observed Adverse Effect Level
Lowry Site	Lowry Landfill Superfund Site
MCLG	maximum contaminant level goal
MCL	maximum contaminant level
µg	microgram
µg/kg	microgram per kilogram
Metro	Metro Wastewater Reclamation District
mg/kg	milligram per kilogram
mph	miles per hour
NAAQS	National Ambient Air Quality Standards
NC	not calculated
NCP	National Contingency Plan for Oil and Hazardous Substances Pollution
ND	not detected
NESHAPs	National Emissions Standards for Hazardous Pollutants
NOAEL	No Observed Adverse Effects Level
NOV	Notice of Violation
NPL	National Priorities List
NRC	Nuclear Regulatory Commission
NRHP	National Register for Historic Places
NSPS	New Source Performance Standards
O&M	operation and maintenance
OSHA	Occupational Safety and Health Administration
OSWER	Office of Solid Waste and Emergency Response
OUs	operable units
OU 1	Shallow Ground Water and Subsurface Liquids Operable Unit
OU 2	Landfill Solids Operable Unit
OU 3	Landfill Gas Operable Unit
OU 4	Soils Operable Unit
OU 5	Surface Water and Sediments Operable Unit
OU 6	Deep Ground Water Operable Unit
PA	Preliminary Assessment
PAG	Policy Advisory Group
PAHs	polynuclear aromatic hydrocarbons
PCBs	polychlorinated biphenyls
pCi/L	picocuries per liter
PEA	Preliminary Endangerment Assessment
POA	Point of Action
POTW	Publicly Owned Treatment Works
ppb	parts per billion
ppm	parts per million
PRPs	potentially responsible parties
QA/QC	quality assurance/quality control
RA	Risk Assessment
RAO	remedial action objectives
RAGS	Risk Assessment Guidance for Superfund
RCRA	Resource Conservation and Recovery Act of 1976
RfD	reference dose
RI	remedial investigation
RI/FS	remedial investigation/feasibility study
RME	reasonable maximum exposure
ROD	Record of Decision
SAPI	Southeast Area Planning Initiative
SARA	Superfund Amendments and Reauthorization Act of 1986
scfm	standard cubic feet per minute
scf/tn/yr	solid waste cubic feet per ton per year
SED	sediment (abbreviation for sediment alternative number)
SF	slope factors
SOW	Statement of Work
SQL	Sample Quantification Limit
SRU	Site Review and Update
STC	Storage Technology Corporation
SVOC	semivolatile organic compounds
SW	surface water
SWA	Solid Waste Act
SWRA	Surface Water Removal Action
TAG	Technical Advisory Group
TAG	Technical Assistance Grant

TBC	to be considered
TCLP	toxicity characteristic leaching procedure
TEF	Toxicity Equivalent Factors
TEL	threshold effects exposure units
USC	United States Code
UCL	Upper Confidence Limit
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
VOC	volatile organic compounds
WMC	Waste Management of Colorado, Inc.
WRIS	Wildlife Resource Information System (CDOW)

Glossary of Terms

Administrative Order: An agreement between EPA and one or more potentially responsible parties whereby the potentially responsible party or parties agree to perform or pay the cost of site investigations or cleanup.

Administrative Record: A file that is established and maintained by the lead agency and contains all the documents used by EPA to make a decision on the selection of a remedial action. The administrative record is available for public review and a copy is established at or near the site, usually at one of the information repositories.

Alluvium: Sedimentary deposits from streams or rivers.

Applicable Requirements: Those cleanup standards, standards or 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.

Aquifer: A geologic formation, group of formations, or part of a formation capable of yielding a significant amount of ground water to wells or springs.

Baseline Risk Assessment (Baseline RA): Evaluates the potential risks to human health if nothing is done to remediate a site or eliminate the risks. The Baseline RA considers current use and hypothetical future use of the site.

Capital Costs: The costs of items such as buildings, equipment, engineering, and construction.

CERCLA: The Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended by the Superfund Amendments and Reauthorization Act of 1986.

Chemicals of Concern: The most prevalent and toxic site-related chemicals.

Co-Disposal: A technique used at the Lowry Site to dispose of wastes. Liquid industrial wastes were deposited into unlined trenches or pits, and municipal refuse was added to soak up the liquids.

Compliance Boundary: The boundary at the Lowry Site where chemical-specific remediation levels and performance standards must be met.

Contingency Plans: Plans that detail the action to be taken in response to a remedy component failure.

Deep Ground Water (Operable Unit 6): All ground water below the shallow ground water (below the separation layer) to the top of the Pierre Shale, underlying the Laramie-Fox Hills aquifer.

Enclosed Flare: A piece of equipment (a burner) used to burn landfill gas after collection; the burner and flame are enclosed.

Excess Lifetime Cancer Risk: The incremental probability of an individual developing cancer over a lifetime as a result of exposure to a potential carcinogen. A cancer risk of 1 X 10-6 is one additional case of cancer (over background levels) per million people exposed (a one in a million chance of having cancer). The NCP specifics that 1 X 10-6 is an acceptable risk level for multiple contaminants (NCP 300.430[e][2][i][A][2]). EPA uses a 1 X 10-4 to 1 X 10-6 risk level as a "target range" within which to manage risk at Superfund sites.

Exposure: Contact of a chemical with the outer boundary of a human (skin, nose, mouth, skin punctures and lesions) (EPA 1992, Guidelines for Exposure Assessment; Notice, EPA, Federal Register 57[104]; 22888-22938, May 29, 1992).

Exposure Parameter: Factors such as body weight, breathing rate, or time/activity that may be needed to quantify (calculate) human exposure to a contaminant.

Exposure Pathway: The course a chemical or physical agent takes from a source to a receptor. An exposure pathway describes a unique mechanism by which an individual or population is exposed to chemicals or physical agents at or originating from a site. Exposure pathway includes a source or release from a source, an exposure point, and an exposure route. If the exposure point differs from the source, the transport/exposure medium (such as air) or media (in cases of intermedia transport, such as water to air) are also included (EPA 1989, Risk Assessment Guidance for Superfund, Vol I, Human Health Evaluation Manual [Part A], Office of Emergency and Remedial Response, EPA/540/1-89/002).

Exposure Point: A geographical location of potential contact between a receptor and a chemical or physical agent, e.g., a child ingesting soil containing PCBs within the sewage sludge application/leachate injection area (EPA, 1989, Risk Assessment Guidance for Superfund, Vol I, Human Health Evaluation Manual [Part A], Office of Emergency and Remedial Response, EPA/540/1-89/002).

Exposure Point Concentration: Concentration at the point where receptors may be exposed.

Exposure Route: The way a chemical or physical agent comes in contact with a receptor, that is, inhalation, ingestion, dermal contact, e.g., inhalation by a hypothetical future resident of vinyl chloride in landfill gas contained within a home onsite (EPA, 1989, Risk Assessment Guidance for Superfund, Vol I, Human Health Evaluation Manual [Part A], Office of Emergency and Remedial Response, EPA/540/1-89/002).

Exposure Setting: A combination of potential land uses and exposure routes that describes the ways by which a specific type of receptor can contact contaminants, that is, residential setting, occupational setting, recreational setting.

Feasibility Study (FS): A study undertaken to develop and evaluate options for remedial action. The FS emphasizes alternative analysis and is generally performed concurrently and in an interactive fashion with the remedial investigation (RI), using data gathered during the RI. The RI data are used to define the objectives of the response action, to develop remedial action alternatives, and to undertake an initial screening and detailed analysis of the alternatives. The term also refers to a report that describes the results of the study.

Former Tire Pile Area: The approximately 30-acre area in Section 6 of the Lowry Site from which approximately 8 million old tires were removed.

Fund or Trust Fund: The Hazardous Substance Superfund established by Section 9507 of the Internal Revenue Code of 1986.

Ground Water: As defined by Section 101(12) of CERCLA, water in a saturated zone or stratum beneath the surface of land or water.

Hazard Ranking System (HRS): The method used by EPA to evaluate the relative potential of hazardous substance releases to cause health or safety problems, or ecological or environmental damage.

Hydrogeologic: Relating to the science of hydrogeology, which studies the interactions among ground water and geologic formations.

Intake: The measure of exposure expressed as the mass of a chemical that crosses an outer boundary of a human or the chemical per unit body weight per unit time, i.e., milligrams of chemical per kilogram of body weight per day.

Institutional Controls: Rules, regulations, laws, or covenants that may be necessary to assure the effectiveness of a cleanup alternative. Examples of institutional controls include, but are not limited to, deed restrictions, zoning controls, and access restrictions.

Interim Remedial Measures: An early action taken to control a release or threatened release of hazardous substances.

Landfill Gas (Operable Unit 3): Gas generated at the Lowry Site resulting from degradation of the landfill solids and chemical constituents volatilized from contaminant sources such as waste pit liquids, leachate, ground water, surface water (including unnamed creek and Pond 3; Pond 4 will be included if it is in existence), surface and subsurface soils, and solids (saturated and unsaturated).

Landfill Solids (Operable Unit 2): For the solids media, "unsaturated" is defined as material, excluding saturated solids within the waste pits, that is above ground water associated with the shallow ground water at the Lowry Site. The solids media include materials located within the Section 6 area that has received or will receive solid wastes and the area formerly covered with tires. Leachate is defined as the liquids generated during consolidation and/or degradation of the landfill solids or through interaction of water that percolates through the solids media. Leachate within the solids media is included as part of the Landfill Solids OU media. The solids media also includes:

- Unsaturated municipal solid waste (MSW) (e.g., household refuse).
- Unsaturated industrial waste, including drums and their contents.
- Buried and partially buried tires within the unsaturated zone.

- Unsaturated solids contaminated by the migration of waste pit fluids or leachate.

- Unsaturated solids located within waste pits.

- Publicly-owned treatment works (POTW) sludge and sludge from industrial treatment plants disposed of in the landfill within the unsaturated zone.

- Hospital wastes disposed of in the landfill within the unsaturated zone.

- Unsaturated subsurface and surface soils within the Landfill Solids OU area.

- Unsaturated low-level radioactive wastes. These wastes were reportedly disposed of in pits near the southeast corner of Section 6.

- Zones of saturated solids located above the shallow ground water (perched), excluding saturated solids within the waste pits.

Leachate: Contaminated liquids that result from the degradation of refuse or from water percolating through refuse.

National Priorities List (NPL): The list, compiled by EPA pursuant to CERCLA Section 105, of uncontrolled hazardous substance releases in the United States that are priorities for long-term remedial evaluation and response.

Net Present Worth: An analysis of the current value of all costs. Net present worth is calculated based on a 30-year time period and a 5% interest rate.

North Face: The north end of the former landfill that is sloped.

Onsite: The areal extent of contamination and all suitable areas in very close proximity to the contamination necessary for implementation of the response action.

Operable Unit: A term used to describe certain portions of a Superfund site. An operable unit may be established based on a particular type of contamination, contaminated media (e.g., soils, water), source of contamination, and/or geographical location.

Operation and Maintenance: Measures required to maintain the effectiveness of the selected remedy.

Parts per billion (ppb)/parts per million (ppm): Units commonly used to express low concentrations of contaminants. For example, 1 ounce of trichlorethylene (TCE) in 1 million ounces of water is 1 ppm; 1 ounce of TCE in 1 billion ounces of water is 1 ppb.

Point of Action Boundary: The boundary of the Lowry Site where specific performance standards must be achieved. The purpose of the POA boundary is to trigger early remedial actions, so that contaminants do not migrate beyond the compliance boundary.

Potentially Responsible Party (PRP): An individual or company (such as owners, operators, transporters, or generators of hazardous waste) potentially responsible for, or contributing to, the contamination problems at a Superfund site.

Proposed Plan: A document that summarizes EPA's preferred cleanup strategy, the rationale for the preference, and alternatives presented in the detailed analysis of the feasibility study. The Proposed Plan solicits public review and comment on all alternatives under consideration.

Reasonable Maximum Exposure (RME): The RME is the highest exposure that is reasonably expected to occur at a site. It is the product of a few upper-bound exposure parameters with primarily average or typical exposure parameters so that the result represents an exposure that is both protective and plausible, exposure point concentration and exposure frequency and duration, that are a mix of distributions (averages, 95^{th} percentile, etc.) to reflect a 90th percentile.

Receptor: Any organism (such as humans, terrestrials, wildlife, or aquatic) potentially exposed to chemicals of concern.

Record of Decision (ROD): A public document that explains the remedial action plan for a Superfund site or operable unit. A ROD serves three functions:

- It certifies that the remedy selection process was carried out in accordance with CERCLA and, to the extent practicable, with the NCP

- It describes the technical parameters of the remedy, specifying the treatment, engineering, and institutional components, as well as remediation goals

- It provides the public with a consolidated source of information about the site and the chosen remedy, including the rationale behind the selection

- The ROD also provides the framework for the transition into the next phase of the remedial process, Remedial Design (RD)

Relevant and Appropriate Requirements: 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 well suited to the particular site. Only those state standards that are identified in a timely manner are more stringent that federal requirements may be relevant and appropriate.

Remedial Action (RA) or Remedy: Those actions consistent with a permanent remedy taken instead of, or in addition to, removal action in the event of release or threatened release of a hazardous substance into the environment, to prevent or minimize the release of hazardous substances so that they do not migrate to cause substantial danger to present or future public health or welfare or the environment. The term includes, but is not limited to, such actions at the location of the release as storage, confinement, perimeter protection using dikes, trenches, or ditches, clay cover, neutralization, cleanup of diversion, destruction, segregation of reactive wastes, dredging or excavations, repair or replacement of leaking containers, collection of leachate and runoff, onsite treatment or incineration, provision of alternative water supplies, any monitoring reasonably required to assure that such actions protect the public health and welfare and the environment and, where appropriate, post-removal site control activities.

Remedial Action Objectives (RAOs): Objectives developed by EPA at individual Superfund sites that, in connection with chemical-specific remediation goals and performance standards define acceptable levels of risk.

Remedial Design (RD): The technical analysis and procedures which follow the selection of remedy for a site and result in a detailed set of plans and specifications for implementation of the remedial action.

Remedial Investigation (RI): A process undertaken to determine the nature and extent of the problem presented by the release. The RI emphasizes data collection and site characterization, and is generally performed concurrently and in an interactive fashion with the feasibility study. The RI includes sampling and monitoring, as necessary, and the gathering of sufficient information to determine the necessity for remedial action and to support the risk assessment evaluation of remedial alternatives.

Resource Conservation and Recovery Act (RCRA): A Federal law that requires safe and secure procedures to be used in treating, transporting, storing and disposing of hazardous wastes.

Respondent: Identifies the party entering into an Administrative Order on Consent (AOC or Consent Order) with EPA.

Sediments (Operable Unit 5): Sediments in Sections 6 and 31 at the Lowry Site are defined as unconsolidated deposits of particulates that originated from the weathering of rocks and organic matter and were transported by water and deposited in drainage pathways. If a particulate is not a sediment or a landfill solid as defined in OU 2, it is defined as soil.

Settling Defendant: Identifies the party entering into a Consent Decree with the Department of Justice (DOJ) and EPA.

Shallow Ground Water and Subsurface Liquids (Operable Unit 1):

- Ground water within the alluvium and weathered bedrock in the upper Dawson formation. Weathered bedrock is that portion of the Dawson Formation, nearest to the ground surface, that has had an increase in its ability to transmit ground water because of the action of the physical and chemical processes. This portion of the Dawson Formation is more similar to the overlying alluvial aquifer than the underlying unweathered Dawson with respect to its ability to transmit ground water.

- Waste Pit Liquids. Liquids that are within the waste pits.

- Subsurface Leachate and Infiltration. Subsurface leachate is defined to be all liquids that emanate from the waste pits, waste pit solids, and waste pit refuse that are subsurface. Infiltration is water that enters into the ground through the soil surface.

- Saturated subsurface solids, including:

    - Soils that are below the water table
    - Saturated waste pit solids
    - Saturated soils adjacent to waste pits
    - Saturated refuse below the shallow ground-water table

Soils (Operable Unit 4): Soils at the Lowry Site are defined as consolidated and unconsolidated material consisting essentially of mineral and organic matter above the water table.

Subtitle C: A program under RCRA that regulates the management of hazardous waste from the time it is generated until its ultimate disposal.

Subtitle D: A program under RCRA that regulates the management of solid waste.

Superfund Amendments and Reauthorization Act of 1986 (SARA): Amendments to CERCLA, enacted on October 17, 1986.

Surface Water (Operable Unit 5): At the Lowry Site, surface water originates from precipitation, ground-water discharge or leachate seeps and occurs on the surface of the site in drainage subbasins, including the unnamed creek.

Surface Water Removal Action (SWRA): A system at the Lowry Site that separates normal precipitation in the unnamed creek from contaminated leachate that previously surfaced in the creek bed. The contaminated leachate is collected in the system and sent to the onsite treatment facility.

Tire Monofill: An excavation used at the Lowry Site to contain tire shreds.

Toe of the Former Landfill: The northernmost edge of the former landfill.

Vertical Migration: The ability of media such as water, to move vertically upwards or downwards through various subsurface strata.

Section 1.0
Declaration for the Record of Decision

1.1 Site Name and Location

Lowry Landfill
Arapahoe County, Colorado

1.2 Statement of Basis and Purpose

The decision document presents the selected remedy for the Lowry Landfill Superfund site (the Lowry Site), in Arapahoe County, Colorado, chosen in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), and, to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). This decision is based on the administrative record for this Site.

The State of Colorado concurs with the selected remedy.

1.3 Assessment of the Site

Actual or threatened releases of hazardous substances from this site, if not addressed by implementing the selected remedy in this Record of Decision (ROD), may present an imminent and substantial endangerment to public health, welfare, or the environment.

1.4 Description of the Selected Remedy

The selected sitewide remedy is composed of selected alternatives for the six operable units (OUs) identified at the Lowry Site. The sitewide remedy includes operation of elements of the interim remedial measures at the Lowry Site and the Surface Water Removal Action, which includes the ground-water barrier wall/treatment facility. All six of the operable units identified at the Lowry Site (and described in this ROD) are addressed in the selected sitewide remedy. The selected sitewide remedy addresses the potential risks identified at the Site through containment, collection, and treatment. The primary threats at the Lowry Site are posed by: landfill gas; waste-pit liquids; contaminated ground water; and buried drums, drum contents, and contaminated soils within the former tire pile area.

Contaminated ground water will be addressed by containment, collection, and treatment, utilizing an onsite treatment plant. Landfill gas will be addressed by containment, collection, and treatment using enclosed flare technology. Contaminated seepage and surface water are addressed through a drainage and underground collection system in the unnamed creek area as part of the Surface Water Removal Action. The response action identified for the former tire pile area will address principal threats (drums, drum contents, and contaminated soils) through treatment and offsite disposal to reduce the toxicity, mobility, and volume of contaminants. Landfill mass solids and soils are low-level threats at the Lowry Site and are addressed through containment.

Major components of the remedy (as shown in Figure 1-1) include:

- Continued operation of the existing ground-water barrier wall, collection system, and ground-water treatment plant (the Surface Water Removal Action [SWRA]). The existing ground-water treatment plant may be upgraded to increase the capacity of the treatment system and to treat more concentrated liquids from the toe of the landfill, or a new ground-water treatment plant may be constructed to accomplish the same objectives.

- Installation of a ground-water extraction system at the toe of the landfill mass.

- Construction and operation of underground barrier walls and ground-water collection systems on the east and west sides of the Lowry Site.

- Implementation of a ground-water monitoring program along the circumference of the point of action (POA) boundary to detect future releases of contaminants to the east, west, north, and south.

- Construction and operation of an approximately 50-foot-deep upgradient ground-water containment, collection, and diversion system along the southern perimeter of the Lowry Site.

- Annual treatment of approximately 6.4 million gallons of contaminated ground water from the new barrier wall and collection systems and the existing barrier wall using either the existing ground-water treatment plant, an upgraded treatment plant, or a new ground-water treatment plant.

- Implementation of a long-term, sitewide ground-water monitoring program to assess remedy compliance for the shallow ground-water system and potential impacts to deep ground water.

- Monitoring to detect future releases of contaminants to the ground water. Should releases be detected, corrections to the containment systems would be made with the potential for additional extraction wells and/or expansion of the barrier system, and/or other technologies to restrict offsite groundwater migration.

- Excavation, removal, and treatment within the former tire pile area, of surface and subsurface drums, contaminated soils, and waste pits.

- Landfill gas collection using interior and perimeter collection systems and an enclosed flare for treatment.

- Installation of a perimeter gas monitoring system to detect potential landfill gas migration. Should migration be detected, corrections to the system would be made with the potential for installation of additional extraction wells to restrict offsite landfill gas migration.

- Placement of an additional two (2) feet of cover on the north face of the landfill mass.

- Continued maintenance of the landfill mass cover.

- Construction of wetlands to mitigate loss of wetlands areas from SWRA construction activities within unnamed creek.

- Surface-water monitoring to allow detection of future releases of contaminants to surface water.

- Visual monitoring of actual and potential soil erosion.

- Establishment of institutional controls to limit access to the Lowry Site, prohibit such activities as construction on the Lowry Site, and prohibit the use of water beneath the Lowry Site or in the immediate vicinity of the Lowry site. Offsite institutional controls shall serve as an additional measure of protection to enhance the effectiveness of the selected remedy and to act as preventative measures to preserve the implementability and effectiveness of any of the selected remedy contingency measures that EPA determines must be implemented at the Lowry Site.

- A review of the selected remedy at the Lowry Site no less often than each 5 years after the initiation of the remedial action to assure continued protection of human health and the environment.

1.5 Statutory Determinations

The selected sitewide remedy is protective of human health and the environment, complies with Federal and State requirements that are legally applicable or relevant and appropriate to the remedial action, and is cost effective. This remedy utilizes permanent solutions and alternative treatment technologies to the maximum extent practicable. Components of the selected sitewide remedy satisfy the statutory preference for remedies that employ treatment that reduce toxicity, mobility, or volume as a principle element. The size of the landfill mass and inaccessibility of the waste pits, located within and underneath the landfill mass (exclusive of those in the former tire pile area), precludes a remedy in which all contaminants could be excavated and effectively treated. Therefore, consistent with the NCP and EPA guidance Conducting Remedial Investigations/Feasibility Studies for CERCLA Municipal Landfill Sites (EPA OSWER Directive 9355.3-11, February 1991), containment is selected to address the low-level threat from the landfill mass and the primary threats from the waste pits within the landfill mass area. Because treatment of these threats was not found to be practicable, this portion of the selected sitewide remedy does not satisfy the statutory preference for treatment.

Principal threats (drums, drum contents, contaminated soils, and waste pits) in the former tire pile area will be addressed through excavation, treatment, and disposal. Consequently, this component of the remedy satisfies the statutory preference for treatment as a principal element of the remedy.

Because this remedy will result in hazardous substances remaining on the Lowry Site above health-based levels, a review will be conducted no less often than each 5 years after the initiation of the remedial action to assure that the remedy continues to provide adequate protection of human health and the environment.

<IMG SRC 94087AA>
William P. Yellowtail, Regional Administrator March 10, 1994
U.S. Environmental Protection Agency, Region VIII

<IMG SRC 94087AB>
Thomas P. Looby, Director, Office of Environment March 10, 1994
State of Colorado Department of Health
<IMG SRC 94087AC>

Section 2.0
Site Summary

2.1 Site Name, Location, and Description

The Lowry Landfill Superfund Site (the Lowry Site) is located in the western three-quarters of Section 6, Township 5 South, Range 65 West in unincorporated Arapahoe County, Colorado, approximately 15 miles southeast of the City and County of Denver and 2 miles east of Aurora, near the intersection of Easy Quincy Avenue and Gun Club Road; the street address is 3500 South Gun Club Road, Denver, Colorado. The Lowry Site consists of 480 acres, and is a portion of the Denver Arapahoe Disposal Site (DADS), owned by the City and County of Denver (Denver) and operated by Waste Management of Colorado, Inc. (WMC). DADS consists of Sections 4, 6, and 9, Township 5 South, Range 65 West and Selections 31 and 32, Township 4 South, Range 65 West (Figure 2-1).

2.2 Area and Topography

The Lowry Site consists of gentle slopes on the north half of the section and a topographic high on the south half of the section caused by past landfilling activities (Figure 2-1).

2.3 Natural Resource Use

The Lowry Coalition conducted an evaluation of potentially protected resources as part of the OUs 1&6 Remedial Investigation/Feasibility Study (RI/FS). The area for which the evaluation was conducted includes the landfill located north of Quincy Avenue and east of Gun Club Road, and all of Section 6, Range 65W, Township 5S, and the south half of Section 31, Range 65, Township T4S. This area is referred to as the "project area" in the following text.

2.3.1 Evaluation of Threatened and Endangered Species

<u>2.3.1.1 Ecological Setting</u>

The Lowry Site is located in gently rolling short-grass prairie characteristic of the Great Plains physiographic province. The land is largely undisturbed native prairie, disturbed weedy prairie, and areas of unirrigated small grain crops.

Habitats within the Lowry Site boundaries have been disturbed by past and ongoing landfill disposal activities. Aquatic habitats within the Lowry Site boundaries are limited and lack the capacity to support fish. Habitats in Section 6, east of the Lowry Site, are primarily native prairie with an intermittent riparian corridor. Habitats on the south half of Section 31, north of the Lowry Site, include stripped prairie, the Command Post, fallow fields, native prairie, weeded, disturbed prairie, and a wetland along Murphy Creek.

<u>2.3.1.2 Endangered Species</u>

Endangered species that may be present in the vicinity of the Lowry Site, specifically the bald eagle, peregrine falcon, whooping crane, black-footed ferret, and Federal endangered species candidates, are discussed in the following paragraphs. No specific occurrences of listed candidate species have been recorded within 1 mile of the Lowry Site.

Tables 2-1, 2-2, and 2-3 list the wildlife, plant, and threatened and endangered species, respectively, observed or occurring on the Lowry Site or in the vicinity of the Lowry Site.

The United States Fish and Wildlife Service (USFWS) lists the bald eagle (Haliaeetus leucocephalus) as an endangered species in Colorado. Bald eagles are spring and autumn migrants, but uncommon winter residents in the vicinity of the Lowry Site. However, they are common winter residents in suitable nearby habitats. The Lowry Site and adjacent lands are not an important area for bald eagles. Individual eagles have been seen irregularly in the vicinity of the Lowry Site, but these birds are generally flying through the area. The USFWS is not aware of any recent bald eagle sightings. However, a golden eagle nest has been identified at the intersection of Smoky Hill and Gun Club Road.

The peregrine falcon (Falco peregrinus) is a Federal and Colorado endangered species. The gently rolling prairie, on and around the Lowry Site, is not suitable peregrine falcon habitat. There are no suitable nest sites closer than downtown Denver. Airspace in the vicinity of the Lowry Site may be used by migrating peregrines; however, it is more likely that migrants would follow the Front Range (18 miles to the west) for their spring and autumn migrations. The Lowry Site vicinity does not offer any potentially suitable habitat for the peregrine falcon.

Whooping cranes (Grus americana) are one of the rarest of all North American endangered species. Colorado has historically been outside the normal range of the species, except for stragglers migrating between breeding grounds in Canada and wintering grounds in Texas. Habitats adjacent to, and in the vicinity of, the Lowry Site provide a suboptimal crane habitat. There are no large wetlands or water bodies present to provide the horizontal visibility required for secure roosting.

Black-footed ferrets (Mustela nigripes) have historically been associated with the range of prairie dogs (Cynomys ludovicianus) throughout the Great Plains, semi-arid grasslands, and mountain basins of North America. The Lowry Site and adjacent areas occur within the general historic range of the black-footed ferret; however, no black-footed ferret sightings have been confirmed in Colorado in recent years.

Federal candidate species are sensitive wildlife species currently under consideration by the USFWS for addition to the threatened and endangered species list.

2.3.2 Evaluation of Wetland Areas

The following evaluation includes a description of the ecological setting, wetland identification and mapping, and a description of the wetlands on or near the Lowry Site, including a delineation of specific types of wetland vegetation along Murphy Creek in Section 31 and the unnamed creek drainage in Section 6, and an estimate of acreages for each wetland vegetation type.

2.3.2.1 Ecological Setting

The study area used for the wetlands evaluation is within the southern half of Section 31, Township 4S, Range 65W, and Section 6, Township 5S, Range 65W. No natural permanent surface-water source exists within the study area. The land is largely native prairie and areas of dryland crops. Short-grass prairie and dryland crop-field also characterizes much of the area to the north, south, and east of the Lowry Site.

The Lowry Site is drained by unnamed creek, which is an intermittent stream. Most habitats within the Lowry Site have been disturbed by past landfilling or ongoing disposal activities. The irregular topography of the Lowry Site produced by landfill grading activities has created two small basins which collect water from precipitation events.

Wetlands plant species along the unnamed creek drainage in Section 6 include cattail (Typha latifolia and T. angustifolia), three-square (Scirpus americana), and fox-tail barley (Hordeum jubatum).

During the construction of the SWRA, a total of 0.87 acre of wetlands was disturbed. As part of the sitewide remedy, an equal amount of wetlands will be created in another location near the Lowry Site.

2.4 Cultural Resources

During August 1989, an intensive survey of approximately 400 acres of the Lowry Site was performed to identify and evaluate cultural resources for the National Register of Historic Places (NRHP) by the Lowry Coalition. The work was conducted to comply with requirements and responsibilities under the National Historic Preservation Act of 1966, as amended, and its implementing regulations (36 CFR Part 800). No resources were identified for inclusion in the NRHP.

2.5 Adjacent Land Use

Current zoning and land uses by Arapahoe County in the vicinity of the Lowry Site are presented in Figures 2-3 and 2-3. No residences are located onsite.

The areas immediately surrounding the Lowry Site are zoned for agricultural use and mixed use. Much of the area surrounding the Lowry Site is undeveloped and used primarily for cattle ranching and grazing. Some sections are used for production of dryland (no irrigation) winter wheat. A few homes are scattered on these farms and ranches in the areas around the Lowry Site. Two older homes are located roughly one-third and two-thirds of a mile west of the Lowry Site on East Quincy Road.

2.6 Distance to Nearby Populations

A few subdivisions have been built in unincorporated areas near the Lowry Site. Dove Hill is a small subdivision approximately 1 mile south of Section 6. The Trail Ridge, Park View, and Parborough subdivisions are located about 2 miles southwest.

The most intensive nearby urban and residential development is within the corporate limits of the City of Aurora, approximately 2 miles west and north of the Lowry Site. Gun Club Estates and Thunderbird Estates are located 3 and 4 miles north of Section 6, respectively.

A number of schools are located in the general vicinity of the Lowry Site. Eaglecrest High School and Thunder Ridge Junior High, 2 miles to the southwest, are the closest schools. Sunrise Elementary School is within approximately 3 miles of the Lowry Site; other elementary schools are located in a 4- to 5-mile radius.

Overall, based on information provided by the Cherry Creek and the Aurora School Districts, 11 elementary schools, 4 middle schools, and 2 high schools are located within a 5-mile radius of the Lowry Site. Combined enrollment in these schools is about 13, 824 students. Over the past 5 years, the net enrollment gain has been about 8.9 percent, or 1.8 percent per year.

2.7 Future Land Use and Populations

Located in the southeast quadrant of the Denver Metropolitan area, the Lowry Site faces development pressure influenced by the economic growth of the City of Aurora and surrounding area. The City of Aurora anticipates mixed land use for the area surrounding the Lowry Site, as depicted in Figure 2-4. Mixed use includes industrial, commercial, and residential development compatible with anticipated growth in the area.

The area directly south and west of the Lowry Site, as well as a mile to the north and northwest, is zoned for office and industrial use. Under the terms of an ordinance issued by the City of Aurora, new residences may be built as close as 0.5 mile to the south and west of the Lowry Site, as shown in Figure 2-4. More residences may be constructed 1.5 miles directly north and 2 miles northeast. Residences, in addition to business facilities, could also be developed in the mixed-use corridor along the eastern border.

Land use restrictions were imposed on the Lowry Site by former Denver Mayor Federico Peña in June, 1991. Executive Order No. 97 restricts use of the land, surface water, and ground water on the Lowry Site. Specifically, the Executive Order prohibits:

- Direct use or reuse of the surface water or alluvial ground water or ground water in the Dawson and Denver aquifers on or underlying either Section 6 or Section 31 that could cause exposure of humans or animals to contaminants, provided that this restriction shall not interfere with treatment and subsequent use or discharge of any such water.

- Direct use or reuse of ground water in the Arapahoe and Laramie-Fox Hills aquifers underlying Sections 6 and 31 for domestic, residential, or municipal water supply purposes.

- Water production or dewatering wells constructed on Sections 4, 9, and 32 without the express written consent of the Denver Mayor or his designee.

- Agricultural development, residential development, commercial development, day-care centers, preschool, schools, hospitals, nursing homes, community recreational facilities, senior citizen centers, restaurants, hunting, or fishing on Sections 6 and 31.

- Construction of a building or other structure on those portions of Sections 6 and 31 that have been used as a landfill.

2.8 Location in a Floodplain

Murphy Creek, an intermittent stream in a plains environment, flows north immediately east of the Lowry Site. The 100-year floodplain along Murphy Creek has been identified and mapped for the Federal Emergency Management Agency (FEMA).

2.9 General Surface Water and Ground-Water Resources

2.9.1 Surface Water Resources

The Lowry Site is located within the Murphy Creek drainage system, which covers approximately 7,800 acres. The unnamed creek and its tributaries in Section 6, and Murphy Creek and its tributaries to the east and north of Section 6 are included in this system. These streams generally flow north, and flow is ephemeral, usually in response to storm events or snowmelt.

2.9.2 Ground-Water Resources

Sixty-one ground-water wells located within 2 miles to the west, south, and east of Section 6 and within 3 miles to the north of Section 6 were identified in a ground-water well inventory. Figure 2-5 shows the locations of the ground-water supply wells in the vicinity of the Lowry Site. Table 2-4 summarizes the number and uses of wells within the well survey area, including wells that are no longer in use.

Although the main source of drinking water for the Denver metropolitan area comes as surface water from mountain areas, a portion of the metropolitan area's drinking water needs are met by ground water. The Arapahoe Aquifer yields the largest amount of ground water and is a source of drinking water for many households in the metropolitan area. The upper two aquifers, the Denver and the Dawson, serve residents near the Lowry Site. The Laramie-Fox Hills aquifer is also used in the Denver area. Figure 2-6 is a cross-section of the Denver Basin showing the formations or aquifers beneath the Lowry Site.

2.9.2.1 Residential Wells

Generally, residential wells in the area are used for potable water and livestock purposes. Private wells are located in the northeast corner of Section 11, approximately 2 miles north (downgradient) of the Lowry Site. Four of the residential wells that are closest to the Lowry Site were sampled by EPA in 1986. No organics were detected, and all samples were below maximum contaminant levels (MCLs) for inorganics.

2.9.2.2 Industrial Wells

Onsite workers previously used water for industrial and sanitation purposes from a 925-foot deep well located north of the Lowry Site in Section 31 and screened in the Arapahoe Aquifer. This well was recently abandoned and is no longer in use. A new well in Section 6 (No. 43 on Figure 2-5) has been drilled and is used for industrial and sanitation purposes. This new well was screened at a depth of 1,061 to 1,263 feet in the Arapahoe Aquifer. Although no contaminants have been detected in these wells, commercially bottled drinking water is supplied to workers.

Onsite workers also used water for industrial and sanitation uses from a well designated by Denver as B-225 and referred to by the United States Geological Survey (USGS) as 6RDC. The water was not used for human consumption. The well was installed in the southern portion of Section 6 in 1974 and is reportedly 150 feet deep. The exact location, how long the well was in operation, and when and if it was abandoned are unknown. This well may serve as a conduit for contaminant migration to the deeper aquifers and is currently buried by approximately 100 feet of refuse.

It should be noted that in addition to well B-225, seven USGS wells were drilled as part of a study conducted in mid to late 1970 to monitor for water quality and evaluate local hydrological conditions. These wells were reportedly abandoned, however it is not possible to confirm the abandonment because several of the wells have since been buried under approximately 100 feet of municipal refuse.

2.9.2.3 Municipal Wells

The East Cherry Creek Valley Water & Sanitation District (ECCV) owns ground-water rights in the vicinity of the Lowry Site. The ECCV serves unincorporated areas to the west and southwest of Section 6, using a series of deep ground-water wells to supply water for domestic uses. The ECCV regularly samples and tests these wells to measure compliance with requirements of the Safe Drinking Water Act (SDWA). Analytes tested under the SDWA include inorganics, organics, and primary anions and cations. Additionally, the ECCV also tests these samples for radionuclides.

City of Aurora residents are served by the municipal water system, which diverts water from surface reservoirs.

Figure 2-7 shows the drinking water supply sources in the vicinity of the Lowry Site, including the approximate locations of residential homes with private water wells, areas serviced by the ECCV, and nonresidential structures with private water wells.

2.10 Surface and Subsurface Features

Site surface features identified and described on Figure 2-8 include structures, roads, fence boundaries, pipelines and utility lines, surface disposal areas, soil borrow areas, and other notable surface features.

2.10.1 Structures

Facilities within the northwest quarter of Section 6 are the WMC entrance road and gate, the WMC scale house, and the WMC maintenance facility, which surrounded by a maintenance yard adjacent to the entrance road. Denver's existing ground-water treatment plant and ground-water barrier wall are located approximately 0.5 mile east of Gun Club Road and 300 feet north of Section 6.

The Command Post is located in the southeast portion of Section 31 in the southeast corner of the section. The Command Post is the area where drummed wastes from site investigations are stored and managed, and where trailers are located for the workers. The Command Post contains a fenced drum storage facility, a decontamination pad, an office trailer, a storage trailer, and a rock (or drill) core storage shed.

2.10.2 Roads

A paved road extends east from the main entrance along the north section line in Section 6 and into Section 31 to Denver's existing ground-water treatment plant.

2.10.3 Fencing

The landfill area within Sections 6 and 31 is enclosed by fences. The north and east boundaries of the landfill in Section 31 and the east landfill boundary in Section 6 are enclosed by a 4-foot-high barbed-wire fence. The south and west boundaries of the landfill in Section 6 and the west boundary of Section 31 are enclosed by a 6-foot-high chain-link fence with a 2-foot-high barbed-wire top.

2.10.4 Pipelines and Utility Lines

Pipelines and utility lines exist primarily around the perimeter of the Lowry Site, as shown on Figure 2-8. An underground natural gas pipeline and associated surface vents and access roads trend north-south adjacent to a drainage ditch along the east boundary of the Lowry Site.

2.10.5 Surface Disposal Areas

Currently, active municipal refuse disposal is occurring in the Phase I area of the new landfill in the southwest portion of Section 31 (shown as current landfilling area). The active landfilling area changes as operations progress. An asbestos disposal area is currently located in the northwest portion of Section 6, just southwest of WMC's maintenance facility.

A closed asbestos disposal pit is located in the southeast portion of Section 6. The inactive pit was excavated in the mid 1980s and was approximately 30 feet deep, 100 feet wide, and 1,000 feet long. Asbestos was double bagged and containerized in drums that were covered daily with soil. The pit is currently covered by approximately 60 feet of municipal refuse.

Previous waste disposal practice on the surface of Section 6 consisted of sewage sludge land application and leachate injection (northern part), leachate spraying (north-central part), sewage sludge land application (east-central margin), and oil sludge land application (southeast margin).

The tire piles that covered a large area in the center of Section 6 (approximately 45 acres) were shredded by an onsite tire shredding facility which was operated by WMC. The shredding project began in October 1989 and was completed by April 1992. The tire shreds have been placed in a monofill located on the east side of the landfill in east-central Section 6.

2.10.6 Soil Borrow Areas

The soil borrow area currently being used in Section 6 is located south-southeast of WMC's maintenance facility (Figure 2-8). This area consists of approximately 30 acres. All surficial soils in this area have been removed to a depth of approximately 15 feet. Analysis of surficial soil samples taken from this area indicated that levels of contaminants in the soils were comparable to background levels. EPA, in consultation with CDH, has approved use of the soils as a daily and final cover for the former landfill area. They are currently being used as daily cover for landfilling operations in Section 31.

2.10.7 Surface Drainage and Sediments

EPA has divided surface drainage within the Lowry Site into six subbasins. The drainage patterns are described in detail in the OUs 4&5 RI report.

2.10.8 Subsurface Features

The Lowry Site is located in the Denver Basin, a north-south trending structural depression that extends from Pueblo, Colorado, into Wyoming. The basin is asymmetric with a gently dipping eastern flank bounded by the Great Plains and a very steep to overturned western flank bounded by the Colorado Front Range. Five major bedrock formations are regionally important as aquifers in the basin. In descending stratigraphic order, these formations include the Dawson, Denver, Arapahoe, Laramie, and Fox Hills Formations. Borings and wells drilled at the Lowry Site penetrate the Dawson, Denver, and Arapahoe Formations.

A detailed description of the geology/hydrogeology is presented in the Final RI Report for OUs 1&6. The following are key features of the surficial deposits and Dawson and Denver Formations:

- Surficial sediments that overlie the Dawson Formation. These sediments consist of residual soil, colluvium, and alluvium. Residual soil is produced by the in-place weathering of bedrock and colluvium. These sediments are unconsolidated; poorly to moderately well sorted clays, silts, sands; and some gravels that are Pleistocene to Holocene in age. The alluvial deposits are estimated to be about 20 feet wide along the unnamed creek and occur at depths of 5 to 18 feet.

- The Dawson Formation unconformably overlies the Denver Formation and is the uppermost bedrock of the basin. The Dawson Formation generally consists of 800 to 1,000 feet of arkosic conglomerates and sandstones interbedded with lesser amounts of siltstones, shales, and local lignitic coal beds. The sandstones are poorly cemented at the Lowry Site. The upper portion of the Dawson Formation has been eroded, leaving the lower portion of the Dawson exposed. Approximately 200 to 300 feet of the Lower Dawson is present. The base of the Dawson Formation is generally considered to be the top of the first thick lignite bed; the formation occurs approximately 310 feet below ground surface in the southern portion of Section 6, and approximately 180 feet below ground surface in the central portion of Section 31.

- The Denver Formation is of late Cretaceous and Paleocene age and unconformably underlies the Dawson Formation. The Denver Formation consists of approximately 600 to 1,500 feet of interbedded claystones, siltstones, fine-grained sandstones, minor conglomerates, and lignites. The sandstone units are lenticular and discontinuous. The formation contains an overall greater proportion of fine-grained sediments than either the Arapahoe or the Dawson Formation.

- The Arapahoe Formation, of late Cretaceous age, is a 400- to 700-foot-thick sequence of interbedded conglomerates, sandstones, siltstones, and shales that unconformably overlies the Laramie Formation. The Arapahoe Formation is distinguished from the underlying Laramie Formation and overlying Denver Formation by (1) the larger proportion of conglomerates and sandstones with respect to shales, (2) the absence of significant carbonaceous beds, and (3) a generally lighter color. The Arapahoe Formation contains a greater proportion of coarser-grained sediments and generally lacks the coals beds found in the overlying Denver Formation. Coarser sandstones and conglomerates characterize the lower 100 to 200 feet of the formation, and the upper portion is generally finer grained and darker in color. Limited information is available on the onsite Arapahoe Formation. Well WW40, recently installed by WMC as a water supply, provides the only onsite data regarding the Arapahoe Formation. This well encountered the top of the formation at 1,004 feet below ground surface.

2.10.8.1 Hydrogeologic Conceptual Model

Available ground-water data from the Lowry Site monitoring programs were reviewed to develop a hydrogeologic conceptual model that is described in the Final RI Report for OUs 1&6. The hydrogeologic conceptual model divides the water-bearing units beneath the Lowry Site into a shallow and a deep ground-water system. The division is based on the presence of a separation layer within the lower part of the Lower Dawson Formation. The shallow ground-water system (OU 1) includes all ground water contained within the alluvium and within the Dawson Formation above and including the separation layer. The deep ground-water system (OU 6) consists of all ground water below the separation layer. Figure 2-10 presents a schematic drawing of the conceptual model that depicts the Dawson and Denver Aquifers.

2.10.8.2 OU 1: Shallow Ground-Water System

Ground-water flow in the shallow ground-water system occurs within the weathered and unweathered Dawson Formation, the overlying alluvial deposits, the refuse, and waste-pit solids.

Predominant ground-water flow direction in the unweathered Dawson is toward the north with an estimated mean velocity of 0.03 ft/year. There are also components of flow to the east and west. Recent compliance boundary sampling has detected contaminants in Well U-510. This well is located on the southern border of the Lowry Site and was previously considered to be an upgradient well. Sampling results from this well confirm that contamination has migrated to the south of the waste pit source area.

Additional monitoring wells were installed in Section 7 to evaluate ground-water contamination and flow. Preliminary data show an eastern component of ground-water flow in the weathered Dawson. These data will be incorporated with site data to further refine interpretations of ground-water flow south of the Lowry Site.

2.10.8.3 OU 6: Deep Ground-Water System

Deep ground water is defined as the water-bearing zones below the Dawson Aquifer. These strata include the lower portion of the Dawson formation beneath the Lowry Site and the underlying formations extending vertically through the Arapahoe Aquifer to the base of the Laramie-Fox Hills Aquifer. Ground-water flow within the deep ground-water system is predominantly lateral and to the north.

The Denver Aquifer extends from the base of the separation layer to the top of the Arapahoe Aquifer. A laterally continuous lignite bed extends across the Lowry Site and stratigraphically divides the Denver Aquifer into upper and lower zones.

The Arapahoe Aquifer beneath the Lowry Site extends from the base of the Denver Aquifer to the top of the Laramie-Fox Hills Aquifer.

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Table 2-1
Wildlife Species Observed Within or Near the Lowry Site

Mammals	Birds	Reptiles
Black-tailed Prairie Dog (Cynomys ludovicianus)	Ring-necked Pheasant (Phasianus colchicus)	Plains Garter Snake (Thamnophis radix)
White-tailed Jackrabbit (Lepus townsedii)	Mallard (Anas platyrhynchos)	Gopher Snake (Pituophis melanoleucus)
Coyote (Canis latrans)	Green-winged Teal (Anas crecca)	Short-horned lizard (Phrynosoma douglassi)
Pronghorn (Antilocapra americana)	American Wigeon (Anas Americana)	Prairie Rattlesnakes (Crotalus viridis viridis)
Mule Deer (Odocoileus hemionus)	Red-tailed Hawk (Buteo janaicensis)	
White-tailed Deer (Odocoileus virginianus)	Common Snipe (Capella gallinago)	
	Great Horned Owl (Bubo virgonianus)	
	Black-billed Magpie (Eremophila alpestris)	
	American Robin (Turdus migratorius)	
	Western Meadowlark (Sturnella neglecta)	
	Starling (Sturnus vulgaris)	
	Vesper Sparrow (Poocetus gramineus)	
	Mourning Dove (Zenaida macrowa)	

Table 2-2
Plant Species Noted Within the Vicinity of the Lowry Site

Grasses	Riparian	Wetlands	Wet/Meadows
Needle-and-Thread (Stipa comata)	Plains Cottonwood (Populus sargentii)	Sedges (Carex spp.)	Mallow (Malva sp.)
Sand Grama (Sporobolus cryptandrus)	Peachleaf Willow (Salix amygdaloides)	American Bulrush (Scirpus americanus)	Western Ragweed (Ambrosia psilostachya)
Blue Grama (Bouteloua gracilis)	Skunkbush (Rhus trilobata)	Water Speedwell (Veronica anagallis-aquatica)	Fleabane (Erigeron sp.)
Buffalo Grass (Buchloe dactyloides)		Alkal Muhly (Muhlenbergia asperifolia)	False Gromwell (Onosmadium molle)
Sagebrush (Artemisia frigida)		Common Spike-rush (Eleocharis machrostachya)	Curly Dock (Rumex crispus)
Common Rabbit Brush (Chysothamnus nauseosus)		Licorice (Glycrrhiza Lepidota)	Cockel-lour (Xanthium italicum)
Western Wheat Grass (Agropyron smithii)		Broad-leaved Cattail (Typha latifolia)	Purple-flowered Ground Cherry (Physalis lobata)
Bromes (Bromus spp.)		Sandbar Willow (Salix exigua)	
Three-awn (Aristida longiseta)		Canadian Thistle (Cirsium arvense)	
Cushion Coryphanta (Coryphanta vivipara)		Evening Primrose (Oenothera strigosa)	
Yucca (Yucca sp.)		Horseweed (Conyza canadensis)	
Bull-thistle (Cirsium vulgare)		Foxtail Barley (Hordeum jubatum)	
Red Globe Mallow (Sphaeralcea coceinea)			
Blazing Star (Liatris punetata)			
Prairie Coneflower (Ratibida colonmifera)			
Scurfpea (Psoralea tenuiflora)			

Table 2-3
Potentially Occurring Threatened and Endangered Species Within or Around the Lowry Site

Birds	
Peregrine falcon	Falco peregrinus
Bald Eagle	Haliaeetus leucocephalus
Black tern[a]	Chlidonia niger
Mountain plover[a]	Charadrius montanus
White-faced ibis[a]	Plegadis chihi
Baird's sparrow[a]	Ammodramus bairdii
Amphibians	
Western boreal toad[a]	Bufo boreas boreas
Insects	
Regal fritillary butterfly[a]	Speyeria idalia
Mammals	
Preble's meadow jumping mouse	Zapus hudsonius preblei
Swift fox[a]	Vulpes velos

[a]Species that are candidates for official listing as threatened or endangered species (Federal Register, Vol. 54, No. 4, January 6, 1989; Vol 55, No. 35, February 21, 1990).

Table 2-4
Well Inventory Summary

Use	Well Numbers	Aquifer Designation	Comments
Domestic/Livestock	5, 8, 10, 14 15, 16, 18 19, 21, 22 25, 28, 31 44, 45, 49 50, 51, 52 53, 54, 56 57, 58, 59 60, 61	Denver, Dawson, or unknown	Some wells may be used for only part of the year. Well Nos. 22 and 50 are not currently used but future use is possible. Use of Well No. 59 is unknown but is listed as domestic.
Windmill	4, 6, 7, 23, 42	Denver, Dawson, or unknown	Primarily used for livestock.
Industrial	1, 24	Denver	Well No. 24 is closed.
Industrial	43	Arapahoe	Well No. 43 replaced Well No. 24.
Municipal	29, 32, 36	Arapahoe	Owned by East Cherry Creek Valley Water and Sanitation District.
Municipal	33, 37	Laramie-Fox Hills	Owned by East Cherry Creek Valley Water and Sanitation District.
Municipal	34	Denver	Owned by East Cherry Creek Valley Water and Sanitation District; however, the well is currently not used.
Municipal	35	Denver/Dawson	Owned by East Cherry Creek Valley Water and Sanitation District; however, the well is currently not used.
Unknown	2, 26, 27, 30 38, 39, 40 41, 55, 3 unnumbered wells	Denver, Dawson, or unknown	Locations not verified.

Table 2-4
Well Inventory Summary

Use	Well Numbers	Aquifer Designation	Comments
Municipal permit pending	NA	Arapahoe	Permit application by East Cherry Creek Valley Water and Sanitation District.
Municipal permit pending	NA	Laramie-Fox Hills	Permit application by East Cherry Creek Valley Water and Sanitation District.
Not currently in use	3, 9, 11, 12 13, 17, 20 46, 47, 48	Denver Dawson, or Arapahoe	Well Nos. 46 and 47 are located on property that is in bankruptcy proceedings. Well No. 48 is located in a recreational area that is no longer used.

Notes: NA = Not applicable.

Section 3.0
Site History and Enforcement Activities

3.1 Operational History

In the late 1930s, Denver purchased land southeast of its corporate limits for the purpose of attracting an Army Air Corps Technical School to Denver. In December 1937, the Denver City Council conveyed title of the land, without cost, to the Federal government. From about 1930 to 1962, the U.S. Air Force used the Lowry Site as a bombing range.

In 1962, Denver became aware that the Bombing Range (with certain exceptions for missile launching complexes) had been declared a surplus property by the Federal government. In 1964, the United States conveyed all or portions of the five sections of the Lowry Bombing Range back to Denver by Quitclaim Deed, with the provision that the land be used for public utility purposes; specifically, a landfill.

In February 1966, Denver began operation of a municipal solid waste landfill. Liquid and solid municipal refuse and industrial wastes, including sewage sludge, were accepted until 1980. These materials included hazardous substances, such as volatile organic compounds and heavy metals, listed pursuant to 40 CFR Section 302.4.

From 1966 until 1980, approximately 138 million gallons of waste were disposed of at the Lowry Site, primarily by using a disposal practice known as "co-disposal." Approximately 75 unlined waste pits or trenches were excavated to accommodate a mixture of liquids, industrial waste, and municipal waste. In the southern half of Section 6, the pits were filled about three-quarters full with liquid wastes and topped with 25 to 60 feet of municipal refuse. The waste pits ranged in depth from approximately 15 to 30 feet, length from 100 to 1,100 feet, and width from 50 to 150 feet. No measures are known to have been implemented to prevent leachate or liquid waste seepage from the pits. Consequently, over time, the liquid seeped out of the pits and mixed with the surrounding refuse and ground water. In the north-central portion of Section 6, excavated pits were filled with liquid wastes and municipal refuse, then covered with 2 to 5 feet of native soil and piles of discarded tires. Over time, this liquid seeped out to ground water and to surface water in unnamed creek. Approximately 8 million tires were stockpiled at the Lowry Site in the 1970s.

In addition, land application of wastewater sludge began at the Lowry Site in 1969 and continued into 1986. Approximately 160 acres along the northern and eastern boundaries of Section 6 were utilized for land application of wastewater sludge. The wastewater sludge was applied to the surface and then incorporated into the native soils. After 1980, leachate collected in onsite surface impoundments was injected in the same 160-acre area. Figure 3-1 presents the waste pits, tires, and sludge application areas.

The total volume of liquid wastes disposed of at the landfill is estimated to be 138 million gallons. This estimate was developed from the records kept by the landfill and by the parties disposing of the wastes. The types of wastes disposed of at the Lowry site until 1980 include acid and alkaline sludges; asbestos; caustic liquids and solids; brines, including plating wastes and other water-based sludges; laboratory wastes; organics, including petroleum based oils, grease, chlorinated solvents, and sludges; waste solvents, chemicals, and oil; biomedical wastes; low-level radioactive medical wastes; pesticides and garden chemicals; water-soluble oils; sewage sludge; paint and varnish waste, sludge and thinners; photographic chemicals and industrial solvents; construction waste; municipal refuse; household hazardous waste; appliances; tires; livestock carcasses; and metallic wastes.

Waste Management of Colorado, Inc. (WMC), operator of the landfill and a subsidiary of Waste Management of North America, Inc., began landfill operations on July 30, 1980, under a contract with Denver. At that time, waste disposal in Section 6 was restricted to municipal refuse and at a later time, asbestos waste.

Municipal solid waste (MSW) disposal activities at the Section 6 (Figure 3-1) landfill unit ceased in August of 1990. A minimum 4-foot thick soil cover (except for the north slope) was completed over the landfill unit, which is now closed. One area of Section 6 west of the landfill continues to receive asbestos wastes, which is disposed of in sealed containers. Asbestos disposal is regulated by the Colorado Department of Health (CDH). In addition, Section 6 also contains 7.5 million shredded tires in a monofill to the north of the landfill on the east side of the section, and construction wastes from the Surface Water Removal Action (SWRA) were disposed immediately north of the landfill. Section 31, located north of the Lowry Site, is currently being used for disposal of MSW.

3.2 History of Site Investigations

3.2.1 Site Investigation Activities from 1964 to 1984

Preliminary site investigations at the Lowry Site began in the mid-1970s. Various parties including United States Geological Survey (USGS), EPA, CDH, Denver, and WMC performed site studies before 1984 when the Lowry Site was named a Superfund site through listing on the NPL. These investigations included installation of ground-water monitoring wells, surface-water and sediment sampling, air studies, soil gas monitoring, and surface geophysical surveys.

3.2.2 Preliminary Assessment, Hazard Ranking, and NPL Listing

A preliminary assessment (PA) was conducted of the Lowry Site in June 1982 and a site inspection (SI) was conducted in August 1982. The PA/SI briefly identified contaminant sources, pathways, receptors, and the existing use of the Lowry Site's surrounding environment. The results of the PA/SI were used to apply the Hazard Ranking System (HRS) to the Lowry Site. The HRS results in a cumulative score based on ground-water, surface-water, and air risks. EPA has determined that a score of 28.5 or higher on the HRS is required for a site to be eligible for the NPL. In August 1982, the Lowry Site was given an HRS score of 21. In March 1983, the Lowry Site was reevaluated and assigned a score of 49.35. After a quality analysis (QA) check, the score was revised to 48.36. The Lowry Site was added to the NPL on September 21, 1984.

3.2.3 Phase I RI: February 1985 to April 1986

The first phase of the RI was conducted by EPA and included data collection and analyses of site conditions to evaluate onsite and offsite geologic conditions, types and concentrations of contaminants in all media, locations of buried waste pits, preliminary characterization of site contaminants, and climatological conditions.

The field investigations conducted include geophysical investigations, soil vapor studies, installation of monitoring wells, air monitoring and operation of an onsite meteorological stations, and ground-water, surface-water, soil, sediment, landfill solids, and landfill gas sampling.

The findings of these investigations are described in the Phase I RI report, dated September 1986.

3.2.4 ATSDR Determination

In January 1987, the Agency for Toxic Substances and Disease Registry (ATSDR) conducted an assessment of the public health threat attributed to ground-water contamination and volatile organic compounds (VOCs) being released from the soil. The 1987 health assessment concluded that the Lowry Site was a potential public health hazard.

3.2.5 Phase II RI: January 1987 to October 1989

The second phase of the RI was conducted by EPA and involved remedial planning, preliminary assessment of data and risks, and an extensive sampling program. The investigations included installation of exploratory borings, well points, deep and shallow ground-water wells, and refuse leachate wells; ground-water, refuse, surface-water, waste-pit liquid, soil, and landfill solids sampling; water and liquid level monitoring; limited air monitoring; and continued collection of meteorological data.

EPA issued a series of technical memoranda that constituted Phase II of the RI.

3.3 History of CERCLA Enforcement

In 1988, EPA divided the Lowry Site into six OUs, or study areas. These were grouped according to the contaminated media which they address: OUs 1&6 address shallow ground water, subsurface liquids, and deep ground water; OUs 2&3 address landfill solids and landfill gas; and OUs 4&5 address soils, surface water, and sediments. A complete description of each operable unit may be found in the Glossary of this ROD.

In accordance with the requirements of CERCLA, as amended by SARA, EPA provided the potentially responsible parties (PRPs) with the opportunity to perform the OU RI/FSs at the Lowry Site. Under the terms of negotiated Administrative Orders on Consent (Consent Orders), groups of PRPs performed the OU-specific RI/FSs. The elements of each OU RI/FS are described in a Conceptual Work Plan (CWP), which is attached as an Appendix to each Consent Order.

3.3.1 The 1988 Consent Order for OU 1 RI/FS and the 1989 Amended and Restated Consent Order for OU 6 RI/FS

The purpose of the 1988 Consent Order (Docket No. CERCLA VIII-88-18) for the Shallow Ground Water and Subsurface Liquids OU (OU 1) was to establish requirements for the OU 1 RI/FS to be performed by the Lowry Coalition Respondents. The Lowry Coalition Respondents included Adolph Coors Company, AMAX Research & Development, Inc. (formerly known as AMAX/Extractive Research & Development, Inc.), Asamera Oil (U.S.) Inc., Conoco Inc., Gates Rubber Company, Hewlett Packard Company, Honeywell Inc., International Business Machines (IBM), City of Lakewood, Littleton-Englewood Bi-City Wastewater Treatment Plant, Metro Wastewater Reclamation District (formerly Metropolitan Denver Sewage Disposal District No. 1), Sundstrand Corporation, Syntex Chemicals, Inc., and S.W. Shattuck Chemical Company Inc. The Consent Order was amended in December 1989 to include the Deep Ground Water OU (OU 6). The amended Consent Order is referred to as the Second Amended and Restated Consent Order.

The OUs 1&6 RI report was completed in March 1992, and the FS report was completed in October 1992.

In accordance with the terms of the Consent Order, the Respondents agreed to reimburse the Superfund for all response costs incurred by EPA not inconsistent with the NCP related to the Consent Order. For OUs 1 and 6, EPA has billed a total of $2,002,648.05 for cost recovery (including interest and stipulated penalties) and has collected $1,300,189,58 through September 1993.

3.3.2 The 1990 Administrative Order on Consent for OUs 2&3 RI/FS

The purpose of the 1990 Consent Order (Docket No. CERCLA VIII-90-1) for the Landfill Solids (OU 2) and Landfill Gas (OU 3) OUs was to establish requirements for the OUs 2&3 RI/FS to be performed by Respondents Chemical Waste Management, Inc. (CWM), Waste Management of Colorado, Inc. (WMC), and Denver. The Consent Order for these OUs was signed in January 1990.

The RI report was issued on January 7, 1993, and amended by EPA's comments (May 6, 1993). The FS report was issued on April 8, 1993, and amended by EPA's comments dated May 6, 1993.

Under the terms of the Consent Order, the Respondents agreed to reimburse the United States for all response costs incurred by the United States that are not inconsistent with the NCP related to the Consent Order. Because of the special circumstances of the City and County of Denver's municipal financing restrictions, the Respondents were granted the option of partially reimbursing the United States for each billing until the final accounting was submitted. Upon receipt of the final accounting, Respondents are to reimburse the United States for all response costs, including those costs not previously reimbursed and the associated accrued interest on those costs not previously reimbursed. In accordance with the partial payment provisions, EPA has billed $1,463,016.09 and collected $249,719.50 through September 1993.

3.3.3 The 1991 Consent Order for OUs 4&5 RI/FS

The purpose of the 1991 Consent Order (Docket No. CERCLA VIII-91-04) for the Soils (OU 4) and Surface Water and Sediments (OU 5) OUs was to establish requirements for the OUs 4&5 RI/FS to be performed by Respondents Metro Wastewater Reclamation District (Metro) and Denver. The Consent Order for these OUs was signed in March 1991.

The RI report was issued on January 20, 1993, and amended by EPA's comments dated February 17, 1993. The FS report was issued on April 16, 1993, and amended by EPA's comments dated May 18, 1993.

Under the terms of the Consent Order, the Respondents agreed to reimburse the United States for all response costs incurred by the United States not inconsistent with the NCP related to the Consent Order. Because of the special circumstances of the City and County of Denver's municipal financing restrictions, the Respondents were granted the option of partially reimbursing the United States for each billing until the final accounting was submitted. Upon receipt of the final accounting, Respondents are to reimburse the United States for all response costs, including those costs not previously reimbursed and the associated accrued interest on those costs not previously reimbursed. In accordance with the partial payment provisions, EPA has billed $486,331.50 and collected $75,376.63 through September 1993.

3.3.4 History of the 1984 Barrier Wall Consent Order, the 1986 Barrier Wall Consent Decree, the 1991 Surface Water Removal Action, and the 1993 Modified Consent Decree

In 1984, Respondent Denver entered into a Consent Order with EPA, for the design, construction and operation of an interim remedial measure (IRM). This IRM consisted of a ground-water control and treatment system, commonly referred to as the barrier wall and ground-water treatment plant. The ground-water barrier wall was designed to minimize the offsite migration of contaminated shallow ground water by collecting the contaminated ground water at the barrier wall and pumping it to the ground-water treatment plant.

In 1985, EPA alleged that Denver failed to fulfill certain conditions of the Consent Order and to resolve these alleged violations, entered into a Consent Decree with Denver in January 1986. In June 1986, EPA, CDH, and Denver began discussions regarding implementation of the SWRA. The SWRA would be designed to enhance the existing measures that prevent offsite migration of contaminants from the Lowry Site. In pursuit of this goal, EPA issued an Engineering Evaluation/Cost Analysis (EE/CA) on May 19, 1988, which described and evaluated alternatives for the SWRA.

On October 25, 1990, EPA issued a Responsiveness Summary to provide a written response to the public comments received on the EE/CA for the SWRA. EPA developed and issued an Action Recommendation on November 13, 1990, which defines the basis and scope of the SWRA. The requirements for the SWRA replaced those that had been identified in the 1984 Consent Order and 1986 Consent Decree. The SWRA Consent Order became effective on August 15, 1991.

Final design plans for upgrading the ground-water treatment plant and construction of a collection system within unnamed creek were completed in June of 1992. Construction of both the treatment plant additions and collection system was completed in November of 1992. The upgraded treatment plant is referred to as the existing ground-water treatment plant.

Under the terms of the Consent Order, the Respondents agreed to reimburse the United States for all response costs incurred by the United States not inconsistent with the NCP related to this Consent Order. The Consent Order for the Surface Water Removal Action was attached to the Modified Consent Decree. By attaching the SWRA Consent Order to the Modified Consent Decree, updated performance standards and compliance monitoring requirements, specified for the SWRA, replaced those identified in the 1984 Consent Order and 1986 Consent Decree. Although the SWRA Consent Order became effective on August 15, 1991, the Barrier Wall Modified Consent Decree was not filed with the U.S. District Court until July 13, 1993. On September 29, 1993, the Barrier Wall Modified Consent Decree was signed and entered by United States District Court Chief Judge Sherman Finesilver.

Because of the special circumstances of the Denver's municipal financing restrictions, the Respondents were granted the option of partially reimbursing the United States for each billing until the final accounting was submitted. Upon receipt of the final accounting, Respondents are to reimburse the United States for all response costs, including those costs not previously reimbursed and the associated accrued interest on those costs not previously reimbursed. In accordance with the partial payment provisions, EPA has billed $443,279.76 and collected $56,924.70 through September 1993.

3.3.5 History of the 1989 Drum Removal Action

During a routine inspection of the drum storage area on February 9, 1989, EPA observed that many of the drums were damaged. EPA initiated a drum removal action on March 1, 1989, to allow EPA's Emergency Response Branch to stabilize the drums and control the liquids. In conjunction with this removal action, EPA constructed two temporary lined storage pads to contain the drums and to manage the liquids.

In 1990, EPA conducted Phase II of the Drum Removal Action in cooperation with Denver. This removal action involved: bulking the less contaminated wastes and treating them in the ground-water treatment plant; re-packaging the highly contaminated liquids and solids from the old drums; decontaminating and disposing the empty drums; and decommissioning the temporary drum storage pad.

3.3.6 PRP Search

In accordance with Section 104(e) of CERCLA, as amended by SARA, EPA conducted a search for the parties who generated, treated, stored, or disposed of materials at the Lowry Site (including the owners and operators). This included obtaining information from the parties pertaining to their ability to pay for or perform the cleanup of the Lowry Site. In conjunction with the identification of PRPs at the Lowry Site, EPA:

- Issued requests for information from parties who were known to have involvement with the Lowry Site.
- Issued General Notice letters in May 1988 to the 195 companies believed to have generated, treated, stored, or disposed of hazardous waste at the Lowry Site and the owners and operators of the landfill.
- Developed a Waste-In List to determine the volume and composition of wastes that were generated or transported to the Lowry Site.
- Issued Special Notices to selected groups of PRPs to perform the OU RI/FSs. EPA issued the following Special Notice letters to the PRPs at the Lowry Site:

- On June 24, 1988, EPA issued a Special Notice to 28 PRPs to perform the OU 1 RI/FS. The majority of these PRPs joined together to form a group known as the Lowry Coalition. (This agreement was later amended in December 1989 to include the OU 6 RI/FS.)

- On June 30, 1989, EPA issued a Special Notice to Denver, WMC, and CWM to perform the RI/FS for OUs 2&3.

- On October 19, 1990, EPA issued a Special Notice to Denver and Metro to perform the RI/FS for OUs 4&5.

3.3.7 Bankruptcy Settlements

The United States, on behalf of EPA, entered into bankruptcy settlement with Storage Technology Corporation (STC) which was consummated in 1993. Under the STC settlement, EPA recovered $3,304,672.89 in past response costs, and $4,957,009.33 in future response costs incurred at the Lowry Site. In addition, EPA received payment of $29,133.14 from the bankruptcy trustee for C.W. Silver.

3.3.8 De Minimis Settlements

This subsection discusses the CERCLA Section 122(g) de minimis settlements negotiated with eligible de minimis parties. To qualify as a de minimis PRP:

- The party's volumetic contribution must be 300,000 gallons of waste or less.

- The party's waste stream must not be significantly more toxic or of greater hazardous effect than all other waste streams at the Lowry Site.

- The settlor must have certified that the information provided in its CERCLA Section 104(e) information request response was accurate and complete.

- At the time of the settlement, the settlor must not have been a party to any other litigation pertaining to the Lowry Site against or challenging the EPA.

In March 1993, EPA entered into a Consent Order (Docket No. CERCLA VIII-93-04) with 22 of 144 eligible de minimis PRPs. Respondents entering into this de minimis settlement are listed in Table 3-1. These settlors paid a total of $633,789.81 to the Superfund Trust Fund.

In October 1993, EPA entered into a Consent Order (Docket No. CERCLA VIII-93-21) with three Colorado state agencies and two Colorado state colleges. Respondents entering into this settlement are listed in Table 3-1. These settlors paid a total of $653,570.97 to the Superfund.

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Table 3-1
De Minimis Settlement, Consent Order Docket No. CERCLA VIII-93-04
Effective August 28, 1992
and De Minimis Settlement Consent Order Docket No. CERCLA VIII-93-21
Effective June 2, 1993

Potentially Responsible Party	Amount ($)
Docket No. CERCLA VIII-93-04	
Adams Arapahoe Joint District No. 28J	$1,085.76
Allied Trades, Inc. (now known as Barnett Lumber Co.)	2,262.00
Asarco Inc. Globe Plant	20,358.00
AT&T Industries, Inc.	5,655.00
Burlington Northern Railroad	2,488.20
Camp Dresser & McKee, Inc.	8,991.45
City of Colorado Springs	1,950.98
Cobe Laboratories, Inc.	79,464.06
Lowenstein Theater/Denver Center for the Performing Arts	28.28
Marathon Oil Company	1,131.00
Martin Marietta Corporation-Denver Aerospace	94,975.73
National Wire and Stamping, Inc.	6,141.33
Pepsi-Cola Bottling Company	15,364.64
Samsonite Corporation	30,508.73
Smith Kline Beecham Corporation	6,220.50
U.S. Geological Survey National Water Quality Laboratory	61,271.93
U.S. Air Force	116,866.23
U.S. Defense Logistics Agency	24,259.95
U.S. EPA Region VIII Lab	1,413.75
U.S. Mint, Treasury Department	42,978.00
U.S. Veterans Administration Medical Center	106,133.04
ValleyLab, Inc.	4,241.25
Subtotal	$633,789.81
Docket No. CERCLA VIII-93-21	
Colorado Department of Agriculture	$7,441.98
Colorado Department of Highways	175,203.21
Colorado School of Mines	46,246.59
Colorado Surplus Agency	369,316.74
Colorado State University (Environmental Health Services)	55,362.45
Subtotal	$653,570.97
De Minimis Total	$1,287,360.78

Section 4.0
Highlights of Community Participation

EPA implemented a broad-based, comprehensive community involvement program to keep the community informed about the Lowry Site, and to provide an opportunity for citizens to participate in the Superfund process.

4.1 Community Relations Plan

A Community Relations Plan for the Lowry Site was first developed in 1984. The Community Relations Plan provided a basis for EPA's community involvement program at the Lowry Site by identifying community interests and concerns, and outlining the community relations activities to be conducted. In December 1987, EPA conducted interviews with other agencies, community groups, and individuals as a first step in updating the Community Relations Plan. A draft of the revised Community Relations Plan was issued for public comment in March 1988. The plan was revised based on the comments received and the Revised Community Relations Plan was issued in January 1989.

4.2 Lowry Landfill Monitoring Committee

EPA participated in the Lowry Landfill Monitoring Committee (LLMC), which was established by the Governor of Colorado. This committee met on a quarterly basis for several years. EPA provided information to the committee and offered to assist in distributing information to the public. The purpose of the committee was to provide a channel of communication among industry representatives, private citizens, and the State of Colorado. LLMC meetings were discontinued once all participants were satisfied with the progress at the Lowry Site.

4.3 Technical Advisory Group

In July 1987, EPA organized the Technical Advisory Group (TAG), which was composed of various regulatory agencies, local governmental entities, PRPs, and community organizations interested in Lowry Site activities. The purpose of the TAG was to provide PRPs, municipalities, regulatory agencies, special interest groups, and individuals with the opportunity to participate in the Superfund process at the Lowry Site. Participants exchanged ideas and points-of-view, and reviewed planning documents, technical memoranda, data, and other site-specific information.

TAG meetings were held on a monthly basis through the spring of 1993. TAG members decided to discontinue the monthly meetings in April of 1993 since major activities at the Lowry Site, including the RI/FSs for OUs 2&3 and OUs 4&5, had been recently completed.

4.4 Outreach Program

In 1987, EPA began issuing periodic updates and fact sheets to the public, other regulatory agencies, local governmental entities, PRPs, and community groups (see Table 4.1). These updates/fact sheets reported on the progress of Superfund activities at the Lowry Site. Since that time, 12 updates and numerous fact sheets on specific topics have been issued. These special topic fact sheets have included summaries of site-specific baseline risk assessments and proposed plans for remediation of the Lowry Site.

In September 1991, an 18-minute video of the Lowry Site was produced by EPA and was made available for use by the public. The video's purpose was to explain the basic history of the Lowry Site, the Superfund process, the status of the studies to date, and to provide a tour of the entire site.

Volume 1 (OUs 1&6) of the Baseline Risk Assessment was issued for public comment in February 1992. EPA received significant public comment on Volume 1 and amended the document with a Response to Comments, dated August 20, 1993.

Volumes 2A and 2B (OUs 2&3 and OUs 4&5) of the Baseline Risk Assessment were issued for public comment in December 1992. The final volume, Volume 2C (sitewide issues, lead, and radionuclides), of the Baseline Risk Assessment was issued for a public comment in April of 1993. On July 2, 1993, EPA issued a Response to Comments document for Volumes 2A, 2B, and 2C.

Issuance dates for the RI reports, FS reports, and proposed plans were as follows:

	RI Reports	FS Reports	Proposed Plan
OUs 1&6	March 1992	October 1992	November 1992
OUs 2&3	May 1993	May 1993	September 1993
OUs 4&5	February 1993	May 1993	September 1993

A public comment period for the OUs 1&6 proposed plan was held from November 23, 1992 to March 1, 1993 and a public meeting was held on December 8, 1992 at Eaglecrest High School. The initial 30-day comment period was extended twice (30 days each time), in response to requests from the community.

For the OUs 2&3 and OUs 4&5 proposed plan, a public comment period was held from September 1, 1993 to November 29, 1993 and a public meeting was held on September 21, 1993 at Eaglecrest High School. The initial 30-day comment period was extended twice (30 days each time), in response to requests from the community.

Comments which were received by EPA prior to the end of each of the public comment periods, including those expressed orally at the public meetings, are addressed in the Responsiveness Summary for OUs 1&6, and in the Responsiveness Summary for Ous 2&3 and 4&5, which are attached to this Record of Decision. This decision document presents the selected remedial action for the Lowry Landfill Superfund Site in Arapahoe County, Colorado, chosen in accordance with CERCLA, as amended by SARA and, to the extent practicable, the NCP.

Historically, the following publications have reported on the progress of Superfund-related activities at the Lowry Site: The Denver Post; the Rocky Mountain News; Up the Creek; Westword; the Denver Business Journal; Aurora Daily Sentinel; Community Accent; the Wall Street Journal; Colorado Daily; the Financial Times of Canada; the Littleton Independent; Littleton Report; Englewood Sentinel; the Salt Lake Tribune; Superfund Week; Colorado Association of Commerce and Industry; the Colorado Statesman; Wastetech News; and the Boulder Daily Camera.

4.5 Technical Assistance Grant

SARA provides that technical assistance grants may be awarded to groups who may be affected by a Superfund site. The purpose of these grants is to foster informed public involvement in decisions related to a site by providing funds for a particular group to hire independent technical advisors.

In September 1989, a Technical Assistance Grant was awarded to the Citizens Against Lowry Landfill (CALL). This grant was used to fund reviews and analyses by technical experts.

4.6 Information Repositories

Since 1987, Lowry Site documents and reports have been maintained in two information repositories (libraries). These repositories are accessible to the public and are at the following locations.

EPA Superfund Records Center
999 18th Street
5th Floor North Terrace
Denver, Colorado 80202
(303) 293-1807

Aurora Central Public Library
14949 East Alameda
Aurora, Colorado 80002
(303) 340-2290

The EPA Superfund Records Center contains the complete Administrative Record. The Aurora Central Public Library houses pertinent documents that may be of interest to the public.

Table 4-1
Lowry Landfill Superfund Site
Fact Sheets and Updates

Date	Document	Contents
January 1985	Lowry Landfill Fact Sheet	Activities to be carried out during the RI/FS.
June 1987	Superfund Program Fact Sheet Update, Lowry Landfill RI/FS Phase II	Covered results of the Phase I RI/FS and planned activities for the Phase II RI/FS.
May 1988	Superfund Program Fact Sheet Landfill Site, Contaminated Surface Water	Addressed an Engineering Evaluation/Cost Analysis (EE/CA) for the Surface Water Removal Action (SWRA), announced a public comment period during May and June, and announced a public meeting on May 26, 1988.
June 1988	Lowry Landfill Information Update No. 1	Reviewed the Lowry Site and the six Operable Units (OUs) that divided the Lowry Site for Phase II activities.
October 1988	EPA Superfund Program, Update No. 2, Lowry Landfill Superfund Site	Reviewed RI/FS activities, the Lowry Coalition, and radioactivity at the Lowry Site.
July 27, 1989	Lowry Landfill Superfund Site, Preliminary Endangerment Assessment	Reviewed the results of the PEA.
January 1990	Lowry Landfill Information Update No. 3	Reviewed RI/FS activities and presented the cleanup schedule.
May 1990	Lowry Landfill Information Update No. 4	Further reviewed the Lowry Site, the OUs, and the cleanup schedule.
September 1990	Lowry Landfill Information Update No. 5	Revised the cleanup schedule, presented the de minimis settlement, and reviewed RI/FS activities.
January 1991	Lowry Landfill Information Update No. 6	Reviewed RI/FS activities and asbestos disposal.
April 1991	Lowry Landfill Information Update No. 7	Continued the review of RI/FS activities.
June 1991	Lowry Landfill Information Update No. 8	Continued the review of RI/FS activities.
September 1991	Lowry Landfill Information Update No. 9	Announced the video, a risk assessment workshop, and updated RI/FS activities.
August 1991	Surface Water Removal Action Fact Sheet	The construction schedule and engineering of the SWRA were discussed.
April 1992	Draft Baseline Risk Assessment for Shallow Ground Water and Subsurface Liquids	Explained the baseline risk assessment process and the findings for OUs 1/6.
June 1992	Lowry Landfill Information Update No. 10	Updated RI/FS activities and revised the cleanup schedule.
July 1992	Surface Water Removal Action Notice of Public Meeting	Announced a meeting to discuss final design plans.

Table 4-1
Lowry Landfill Superfund Site
Fact Sheets and Updates

Date	Document	Contents
November 1992	Lowry Landfill Information Update No. 11	Reviewed the status of the OUs and featured a summary of the Draft Phase III FS Report for OUs 1/6.
November 1992	Proposed Plan for Operable Units 1 and 6: Shallow Ground Water and Subsurface Liquids and Deep Ground Water	Reviewed and analyzed the final remedies proposed for OUs 1/6.
November 1992	Notice of Public Comment Period Extension for the Proposed Plan for Operable Units 1 and 6	The public comment period was extended twice; it ended on March 1, 1993.
December 1992	Draft Baseline Risk Assessment for Landfill Solids, Landfill Gas, Soils, and Surface Water and Sediment Operable Units	Reviewed the findings of the baseline risk assessment for OUs 2/3 and 4/5.
April 1993	Lowry Landfill Information Update No. 12	Updated the cleanup schedule, the status of the OUs, and other activities.
August 1993	Proposed Plan for OUs 2/3 and 4/5	Reviewed and analyzed the final remedies proposed for OUs 2, 3, 4, and 5.
September 1993	Notice of Public Comment Period Extension of the Proposed Plan for Operable Units 2, 3, 4, and 5	The public comment period was extended twice; it ended on November 29, 1993.

Section 5.0
Scope and Role of Operable Units

The NCP recommends the use of operable units (OUs) in situations in which early actions are necessary to achieve quick risk reduction; when phased analysis is necessary for the size or complexity of the site; or to expedite completion of total site cleanup. An OU may be a discrete action that comprises an incremental step toward comprehensively addressing site problems.

The Lowry Site was divided into six OUs based on the complexity of the contamination problems and the size of the site. At the Lowry Site, OUs were established for each of the environmental media as follows: OU 1-Shallow Ground Water and Subsurface Liquids; OU 2-Landfill Solids; OU 3-Landfill Gas; OU 4-Soils; OU 5-Surface Water and Sediments; and OU 6-Deep Ground Water. To facilitate effective implementation of the RI/FS activities, the OUs were grouped and studied as follows: OUs 1&6, OUs 2&3, and OUs 4&5.

The primary threats to human health and the environment posed by the Lowry Site consist of exposure to and contamination by landfill gas, waste-pit liquids, drums, ground water, and contaminated seepage in the former unnamed creek drainage. Other threats arise from contaminated landfill solids, soils, sediments, and ground water. This ROD summarizes the alternatives considered for all threats and presents the final selected sitewide remedy to address these threats. The overall cleanup strategy at the Lowry Site is to reduce current or future exposure to: landfill gas; waste-pit liquids; seepage in the unnamed creek drainage; and contaminated ground water. Landfill gas, seepage, and ground water will be contained, collected, and treated. Drums, drum contents, and contaminated soils in the former tire pile area will be excavated, treated, and disposed of offsite in a permitted disposal facility.

The selected sitewide remedy is an integration of interim remedial measures and remedies for all the OUs and comprehensively addresses all contaminated media at the Lowry Site. As discussed in the site history section of this ROD, EPA has previously selected interim remedial measures to address the seepage in the unnamed creek and the migration of contaminated ground water in the alluvium underlying the unnamed creek drainage. The migration of contaminated ground water in the alluvium has been addressed through the construction and operation of the ground-water barrier wall and treatment plant. Primary threats from organic and inorganic contaminated seepage in unnamed creek have been addressed through implementation of the SWRA, which included an upgrade of the existing ground-water treatment plant.

The interim remedial measures have been integrated into and are key elements in the selected sitewide remedy. Other key elements of the selected sitewide remedy include: a gas collection and treatment system to address the primary threat of landfill gas and gas migration offsite; barrier walls to contain and treat waste-pit liquids and contaminated ground water; excavation, treatment, and disposal of contaminated solids within the former tire pile area; containment of landfill solids through maintenance of the existing cover and by the addition of 2 feet of cover on the north face of the landfill; and containment of soils by maintaining vegetative covers. this selected sitewide remedy will achieve the sitewide cleanup strategy and partially satisfies the preference for treatment as a principal element.

Section 6.0
Summary of Site Characteristics

This section provides an overview of the Lowry Site's contamination, including the source, nature and extent, concentrations, and volume of contamination. In addition, potential surface and subsurface pathways for contamination migration are summarized. Actual routes of exposure and exposure pathways are discussed in Section 7.0. A general overview of the Lowry Site is presented in Section 2.0.

6.1 Extent of Contamination in Affected Media

The contaminant source discussions are presented by each OU, unless otherwise noted.

The primary sources of contamination at the Lowry Site have been identified as subsurface liquids, waste pits, landfill solids, sewage sludge, injected leachate from Pond 3 (eliminated during implementation of the SWRA), sprayed leachate, and landfill gas.

Between 1964 and 1980, Lowry Landfill accepted solid and liquid municipal and industrial wastes including hazardous substances. Prior to 1976, trenches would first be filled with liquid waste, and then backfilled with solid waste. This method was known as co-disposal. Once filled with waste, a trench would then be covered with soil from the Lowry Site. In approximately 1976, this co-disposal technique was reversed with solid waste first being placed in the trench. Following compaction of the solid waste, the trench would be filled with liquid waste. Once the trench was full, it was covered with soils from the Lowry Site. The reason for the change in method was to promote more immediate absorption of the liquids into the solid waste, and to minimize potential fire hazards created by the open trenches of liquid. The co-disposal waste pits are located in Section 6 within the western two-thirds of the landfilled area and former tire pile area (Figure 6-1).

In addition to the co-disposal and sanitary landfilling techniques, other waste disposal procedures employed at the Lowry Site included sewage sludge land application and leachate land application (leachate injection) on the northern and north-central portions of Section 6, respectively.

Over time, some of the contaminated liquid originally placed into the pits has seeped out of the pits and has mixed with the surrounding solid wastes, ground water, and surface water.

6.1.1 OUs 1&6: Shallow Ground-Water and Subsurface Liquids, and Deep Ground-Water Operable Units

<u>6.1.1.1 Sources of Contamination</u>

Waste pits and landfill solids within and underneath the landfill mass (source area) are the primary sources of ground-water contamination at the Lowry Site. Although media interactions among ground water, soils, surface war, and sediments were studied, the focus of the following discussion is the interaction among ground water, waste pits, and landfill solids.

<u>6.1.1.2 Nature and Extent of Contamination</u>

The hydrogeologic setting underneath the Lowry Site is described in Section 2.0, and in the RI report. There are two major ground-water systems: shallow ground water (which includes the subsurface liquids); and deep ground water. Hydrogeologic studies have shown that the majority of the ground water under the Lowry Site flows laterally to the north. A less significant vertical gradient is present within and between aquifers; it predominantly flows in a downward direction. Vertical gradients generally decrease from south to north and with depth at the Lowry Site.

A variety of contaminants, including organic chemicals and trace metals, have been detected in the shallow ground water directly beneath the Lowry Site. There are several residential wells approximately 2 miles downgradient of the Lowry Site that have been investigated for possible contamination from the ground water at the Lowry Site. To date, there has been no evidence of contamination in these wells.

Data from ground-water monitoring wells and waste-pit liquid well points were grouped together on the basis of hydrogeology, derived from the Lowry Coalition well groupings, as follows: shallow ground-water monitoring wells and waste-pit liquid well points in the source area; ground-water monitoring wells completed in the weathered Dawson Aquifer outside the source area; ground-water monitoring wells completed in the unweathered Dawson Aquifer outside the source area; deep ground-water monitoring wells; and upgradient ground-water monitoring wells outside the source area.

The estimated areal extent of contamination is based on data from existing monitoring wells. Certain portions of the Lowry Site (such as the northwest corner of the Lowry Site, which is outside of the waste pits source area) lack sufficient numbers of wells for an exact determination of the horizontal and vertical extent of contamination. The extent of contamination in these areas will be further refined during the remedial design.

<u>6.1.1.2.1 Waste-Pit Liquid Within the Source Area</u>. The waste pits and associated liquids contain the highest average concentrations of nonhalogenated VOCs (volatile organic compounds), and SVOCs (semivolatile OCs; base/neutral and acid), metals, and radionuclides, as compared to other contaminated ground waters at the Lowry Site.

Toxicity Characteristic Leaching Procedure (TCLP) analyses were performed on waste-pit liquids and waste solids. The liquid analyses were performed by filtering the liquid samples and analyzing the filtered materials. Several VOCs, SVOCs, and one pesticide and metal were detected at or above regulatory levels in the extract from these samples. Based on RCRA toxicity characteristic testing, waste-pit solids and liquids are hazardous.

Analytical results from waste-pit liquid samples indicate a high degree of spatial variability across the Lowry Site. On the basis of field observations and liquid-level measurements recorded during sampling, immiscible phase liquids have been identified in 10 of the approximately 70 waste pits. These phases included both light nonaqueous phase liquids (LNAPLs) and dense nonaqueous phase liquids (DNAPLs). The amount and type of nonaqueous phase liquids (NAPLs) present varied considerably between well points, and in some cases between measurements in the same well point. Figure 6-1 shows the waste-pit well points that contained either LNAPLs or DNAPLs.

The mobile-phase NAPL contamination extent appears to coincide with the horizontal extent of the waste pits (Figure 6-1) and to the vertical extent of the weathered system.

6.1.1.2.2 Saturated Refuse Within the Source Area. Saturated refuse samples were collected from three borings within the source area. VOCs, semivolatiles, and metals were detected. Compared to the waste-pit liquid, waste pit solids, and source area shallow ground-water analytical results, the saturated refuse (saturated solids outside of the waste pits) samples contained similar contaminants at similar or lower concentrations.

6.1.1.2.3 Shallow Ground Water in the Weathered System within the Source Area. VOCs were the most prevalent organic compounds present in the ground water in the weathered system. The SVOCs, pesticides/PCBs, and additional organic compounds were also present in samples from ground water in the weathered system inside the source area. Results of sample analyses indicated that radionuclides, trace metals, and inorganics were frequently present in samples collected from monitoring wells at levels that exceeded Lowry Landfill upgradient values.

In general, similar compounds were detected in samples from waste-pit liquid and ground water in the weathered system. Concentrations of parameters present in samples from waste-pit liquid generally exceeded concentrations of the same parameters present in samples from ground water in the weathered system. The extent of horizontal contamination coincides with the boundaries of the weathered system within the source area as shown in Figure 6-2. The vertical extent of contamination extends to the base of the weathered system throughout the source area. The base of the unweathered system is estimated to be 30 to 50 feet below the ground surface.

6.1.1.2.4 Shallow Ground-Water Upgradient of the Source Area. Parameters detected in samples from the upgradient ground-water monitoring wells (B519, B520, MW003, MW004, MW005, MW22, U509, and U510) include organics, trace metals, and radionuclides. The organics present in samples from upgradient monitoring wells are common laboratory contaminants, and the concentrations are most likely indicative of laboratory artifacts. However, one perimeter upgradient monitoring well, U-510, has confirmed organic contamination, indicating contaminant migration toward the southern boundary of the Lowry Site. Recent sampling of Well U-510 revealed seven organic and eight inorganic compounds. This well is screened from 48 to 58 feet below ground surface.

6.1.1.2.5 Shallow Ground Water in the Weathered and Unweathered Systems Outside of the Source Area. Contamination detected in the weathered system outside of the source area and unweathered Dawson include VOCs, SVOCs, radionuclides, and trace metals. The lateral extent of contamination (Figure 6-2) appears to be generally confined to three areas. The areas are located near (1) unnamed creek (Well A116A), (2) the existing barrier wall (Wells B214, GW1074, A115, GW1144, GW106A, B307, and U701), and (3) east of the Command Post (Well MW23). Maximum contamination was detected in Well B712, which is located at the toe of the landfill mass, approximately 100 yards to the east of unnamed creek.

6.1.1.2.6 Deep Ground Water. The deep ground-water system includes the water-bearing zones beneath the Dawson Aquifer, which includes the upper and lower Denver aquifers. Contaminants within the deep ground-water monitoring wells include organics, dissolved NAPL compounds, radionuclides, and trace metals. Several deep monitoring wells were installed at the Lowry Site. Results from these wells indicate that the extent of impacted deep ground water is limited to Wells B504 and C702Q2, shown in Figure 6-3. These wells are screened at 105 to 125 feet, and 162 to 172 feet below ground surface, respectively. The average concentration of organics in deep ground water is substantially lower compared to the average concentrations of organics in shallow ground water. The presence of contaminants in monitoring well C702Q2 was generally not confirmed between sampling events.

Computer modeling results indicate that, in the absence of any remedial action, it would take approximately 200 years for contamination from the source area to reach the lignite layer. The areal extent of contamination in deep ground water is provided in Figure 6-3.

6.1.1.3 Concentrations of Contaminants

Tables 6-1 through 6-5 present the chemical concentration data summary for each hydrogeologic grouping.

6.1.1.4 Volume Estimates

The total volume of potentially contaminated ground water at the Lowry Site was estimated as follows:

6.1.1.4.1 Shallow Ground Water. The volume of potentially contaminated shallow ground water is estimated to be in the range of 900 million to 2 billion gallons. A broad range is observed because of differing methods of estimating the volume of contaminated shallow ground water. Twelve million gallons of the ground water are considered to be in the saturated alluvium.

6.1.1.4.2 Deep Ground Water. The volume of potentially impacted deep ground water is estimated to be in the range of 93 million to 1.2 billion gallons.

6.1.1.4.3 Saturated Refuse. The volume of liquid within saturated refuse was estimated to be approximately 14 million gallons.

6.1.1.4.4 Waste-Pit Liquid. The current volume of liquid within the saturated waste pits is estimated to be approximately 95 million gallons.

6.1.2 OU 2: Landfill Solids

The following includes discussions of landfill solids OU media in both the landfill mass and the former tire pile area.

6.1.2.1 Source of Contamination

The primary sources of contamination of the landfill solids in both the landfill mass and the former tire pile area are the waste-pit liquids and the municipal refuse.

6.1.2.2 Nature and Extent of Contamination Within the Landfill Mass

The nature of contamination within the landfill mass includes volatile and semivolatile organics, metals, pesticides, PCBs, and radionuclides. The extent of landfill solids is shown in Figure 6-4. The former landfill occupies approximately 195 acres and is estimated to average 80 to 100 feet in thickness. The areal extent of the landfill is shown in Figure 6-1.

6.1.2.3 Concentrations of Contaminants Within the Landfill Mass

The detection frequencies of the following VOCs exceeded 10 percent: 1,1-dichloroethane; 1,1,1-trichloroethane; 1,2-dichloroethane; 2-butanone; 4-methyl-2-pentanone; acetone; chloroform; methylene chloride; tetrachloroethylene; and trichloroethylene. The data generally show the highest concentration of VOCs to be associated with unsaturated solids samples from within or below suspended waste pits, thereby reflecting the impacts of residual waste-pit liquid contamination. Concentrations of VOCs are usually lowest in post-1980 samples. No samples exceeded established standards for TCLP VOCs.

Phthalates were the most commonly detected SVOC. There is no apparent areal distribution trend (for example, similar ranges of concentrations from areas with suspended liquid waste pits as with areas with saturated waste pits, medical waste, or no waste pits). There is however, a general vertical trend with the highest phthalate concentrations found in the post-1980 solids. In general, phthalate concentrations decreased with depth. Phthalates are common plasticizer chemicals and the noted trend may, therefore, reflect the increased use of plastics and plastic containers over time.

Phenol was detected at the highest frequency. As with the phthalate, there is no apparent areal distribution trend for phenol; however, there does not appear to be a general decrease in phenol concentrations with depth. A number of polyaromatic hydrocarbons (PAHs) were also detected.

PCBs and pesticides were also detected in some of the samples. There are no distinct areal or vertical distribution trends for any of the metals. The concentrations of the more toxic metals (such as arsenic, cadmium, chromium, and mercury) are generally below 50 mg/kg with the exception of lead, which had a maximum detection of 1,410 mg/kg. No samples exceeded established standards for TCLP metals. For radionuclides, the values measured are generally low and within the background concentrations established for soils as part of the OUs 4&5 RI.

Table 6-6 presents a summary of chemicals detected in unsaturated solids within the landfill mass and their concentrations.

6.1.2.4 Nature and Extent of Contamination Within the Former Tire Pile Area

The former tire pile area, occupying approximately 54 acres, is located immediately north of the main landfill mass and is shown in Figure 6-4. The measured depth to ground water in this area generally ranges from approximately 2 to 11 feet. The tires that were formerly stockpiled in the area have been shredded and placed into a monofill cell by WMC under contract to Denver. As part of the SWRA effort, an engineered collection system and cover were placed in the unnamed creek drainage. Waste pit disposal operations occurred in three general areas within the tire pile area.

A geophysical investigation consisting of an electromagnetic survey was performed in conjunction with confirmatory trenching to estimate the number of buried drums in the former tile pile area of the Lowry Landfill. Nine confirmatory trenches were excavated in areas identified as anomalies by the geophysical investigation. Twelve corroded drums were encountered in four of the six anomalous areas. Data from the trenching efforts suggest that there may be as many as 1,350 buried drums. Appendix E of the feasibility study for OUs 2&3 estimates that approximately 19 percent (257 drums) of the total estimate of buried drums may contain liquids. Based on treatability study results, the feasibility study also suggested that, on the average, approximately 5 gallons of liquid may be present in each of the estimated 257 liquid-filled drums; this provides the basis for an estimated yield of a total liquid volume of no less than 1,300 gallons of liquid waste.

6.1.2.5 Concentrations of Contaminants Within the Former Tire Pile Area

Organic chemicals including volatile organics, semi-volatile organics, pesticides, PCBs, and inorganics including metals and cyanide were detected in subsurface solid samples in the former tire pile area. A summary of these chemicals appears in Table 6-7. The unsaturated solids are a source that contributes to ground-water contamination.

6.1.2.6 Volume Estimates

Landfill solids volumes were calculated for pre-1980 solids (co-disposal practices were ceased on August 11, 1980), post-1980 solids, and total solids. Both the total saturated solids and total unsaturated solids volumes were calculated for the landfill mass. Estimated landfill solids volumes are as follows:

- Volume of pre-1980 Solids-3.2 X 106 yd3g
- Volume of post-1980 Solids-8.9 X 106 yd3
- Total Volume of Solids-1.2 X 107 yd3
- Volume of Saturated Solids-2.2 X 105 yd3
- Volume of Unsaturated Solids-1.2 X 107 yd3

These calculations show that about 74 percent of the total solids at the Lowry Site were disposed of after 1980, and approximately 98 percent of the total solids volume is unsaturated.

6.1.3 OU 3: Landfill Gas

6.1.3.1 Source of Contamination

The primary sources of contaminants in the landfill gas are subsurface liquids, saturated and unsaturated landfill solids, and leachate.

6.1.3.2 Nature and Extent of Contamination

As with other municipal solid waste landfills, methane gas and other gases are generated at the Lowry Site from the degradation of solids and chemical constituents present in the landfill mass. RI data were used to characterize the nature and extent of methane and other gases generated at the Lowry Site. Following the completion of the low permeability landfill cap in 1992, methane gas excursions outside the landfill perimeter have been observed on a regular basis at Wells GMP-3, GMP-6A, GMP-7, and GMP-9. Figure 6-5 shows the general source and extent of contamination.

Ambient air was sampled during the Phase I, Phase II, and ASC monitoring programs. No evidence of site-related contaminants was found in the ambient air data.

6.1.3.3 Concentrations of Contaminants

Frequently detected chemicals in landfill gas include 1,1,1-trichloroethane, 1,1-dichloroethane, carbon disulfide, chloroethane, methylene chloride, tetrachloroethylene, trichlorethylene, methane, and vinyl chloride. These compounds were detected most frequently in both waste-pit gas samples and samples from refuse located above waste pits. Concentrations of the VOCs generally decreased with distance from the waste pits. The decrease in concentrations is attributed to the dilution of the volatiles carried within the methane generated from the refuse. Concentrations of contaminants in samples collected at the refuse surface, in areas with underlying waste pits, were approximately 1.5 to 10 times lower than concentrations in samples taken directly above the refuse/waste-pit interface. Concentrations of contaminants in samples collected at the refuse surface in areas without underlying waste pits were approximately 1 to 8 times lower than concentrations in samples taken from the same zone in areas with underlying waste pits.

Gas concentrations detected within the former tire pile area are considerably higher than those detected outside the landfill mass. For example, benzene was detected at a maximum concentration of 18,000 µg/m3 within the former tire pile area and 500 µg/m3 outside the landfill mass; vinyl chloride was detected at a maximum concentration of 680,000 µg/m3 within the former tire pile area, and 7,000 µg/m3 outside the landfill mass.

Headspace samples taken with Summa canisters from monitoring wells in the waste pits provide an indication of the amount of chemicals volatilizing from the ground water. Chemicals detected in greater than 50 percent of the samples include 1,2-dichloroethylene, benzene, chloroethane, ethylbenzene, toluene, xylene, and vinyl chloride. These data provide information on the mixture and amount of chemicals emitted from ground water and those that contribute to landfill gas volumes.

Volatile organics were also collected in gas samples taken outside the landfill mass but within the Lowry Site boundary. Soil gas samples taken from outside the landfill mass indicate the presence of five chemicals: 1,1,1-trichloroethane, benzene, ethylbenzene, toluene, and xylene. The compounds detected in these samples were also detected in gas samples taken from within the landfill mass or from gas probes adjacent to the landfill. Of the nine locations from which samples were analyzed, three samples showed consistent and positive detects-two on the north, and one on the southwest side of the landfill. Chloroform was the most frequently detected chemical (7 out of 10 samples) in the remaining gas monitoring wells. All other chemicals were detected in two or less samples.

Combustible gas was first detected in perimeter gas monitoring wells in August 1991. Four out of 13 probes (GMP-3, GMP-6A, GMP-7 and GMP-9) were found to contain measurable levels of combustible gas. Since August 1991, the frequency of monitoring has been increased to a monthly basis and the same four gas wells have continued to show detectable levels of combustible gas, although the percent of detected methane varies from month to month. Table 6-8 summarizes the methane data obtained from the perimeter gas monitoring wells.

Table 6-9 presents the summary data for all the landfill gas samples.

6.1.3.4 Volume Estimates

In 1987, WMC conducted a gas recovery study for the Lowry Landfill and estimated gas generation rates were shown to be approximately 170 standard cubic feet per ton of solid waste per year (scf/tn/yr). The Lowry Site contains approximately 5 million tons of solids. Therefore, the gas generation rate is estimated to be 1,600 standard cubic feet per minute (scfm). This generation rate is an "estimated maximum" and is expected to decrease with time.

6.1.4 OU 4: Soil

6.1.4.1 Source of Contamination

Four distinct areas of the Lowry Site (not including the landfill mass) were used for waste disposal (Figure 6-6) and contribute to surface soil contamination. The areas are distinct either because of the type of waste disposed or the method of disposal. These areas are identified as: the sewage sludge application/leachate injection area; the sewage sludge application area; the leachate spraying area; and the former tire pile area. Figure 6-6 depicts the approximate boundaries of each area.

6.1.4.2 Nature and Extent of Contamination

For the purposes of this discussion, surface soil is defined as zero to 12 inches in depth. Subsurface soil is defined as soil from a depth of 1 to 10 feet.

6.1.4.2.1 Sewage Sludge Application/Leachate Injection Area. This area is approximately 200 acres in size and is in the northern portion of Section 6. Of the areas in which surface soils were sampled, this area exhibited the greatest number of organic chemicals detected. Thirty-eight organic chemicals were detected, although 68 percent of these were detected only once or twice. PCB-1260 was detected in eight samples within this area. This is the only area of the soils media in which PCB-1260 was detected in more than one sample. Although 2,3,7,8-TCDD was not detected in samples from this area, nine other more highly chlorinated dioxins and furan isomers were detected in one sample out of two analyzed for these compounds.

Eighteen inorganic constituents were detected, with one constituent, selenium, detected only once in 11 samples. The inorganic chemicals that were detected were distributed throughout the area. The highest concentrations of inorganic constituents were detected in two adjacent sample locations near the unnamed creek channel. Eighteen samples were analyzed for radionuclides and four naturally-occurring isotopes were detected in the majority of these samples.

6.1.4.2.2 Sewage Sludge Application Area. This area is comprised of approximately 40 acres. Nine organic chemicals were detected in surface soil in this area. Five of these chemicals-benzoic acid, chloroform, 4,4'-DDD, di-n-octylphthalate, and toluene were detected only once with methylene chloride and phenol detected twice. Only 4-chloroaniline and bis(2-ethylhexyl)phthalate were consistently detected in samples from this area. Background inorganic constituents, except selenium and thallium (no positive detections), were detected consistently throughout the area. No samples were analyzed for radionuclides from this area.

6.1.4.2.3 Leachate Spraying Area. The leachate spraying area occupies an area of approximately 4 acres. Three organic chemicals, benzene, bis(2-ethylhexyl)phthalate, and methylene chloride were each detected once out of the seven samples in surface soil taken from this area. Chloroform was detected in one of two samples. Cyanide, selenium, silver, and thallium were not detected above the detection limit, and mercury was detected once. All other typical inorganic constituents were detected consistently in samples from this area. Radionuclides were detected in the two samples taken.

6.1.4.2.4 Former Tire Pile Area. The former tire pile area occupies an area of approximately 54 acres. Thirty-four organic chemicals were positively detected in samples from this area. The following pesticides were detected in more than one sample: alpha chlordane, DDT, dieldrin, endrin aldehyde, gamma chlordane, and methoxychlor. Alpha chlordane in more than half of the sample locations and nine PAHs were detected at one sample location along unnamed creek. Twelve inorganic constituents were detected at sample locations throughout the former tire pile area. Mercury was detected in two samples, selenium in one sample, and cadmium, cyanide, silver, and thallium were not detected over the detection limit in this area. Soil samples were not analyzed for radionuclides.

6.1.4.2.5 Subsurface Soil. Organic chemicals, including VOCs, pesticides and PCBs were detected infrequently in subsurface soil. The following organic chemicals were detected at a frequency greater than 10 percent: 2-butanone, 4-chloroaniline, acetone, methylene chloride, bis(2-ethylhexyl)phthalate, DDT, endrin, and PCB-1260. Subsurface samples from the sewage sludge application area, leachate spraying area, and tire pile area were analyzed for radionuclides. Eight radionuclides, including plutonium-239, potassium-40, strontium-90, thorium-228, -230, and -232, uranium-234, and uranium-2-38, were detected at a frequency of 100 percent. Lead-210 was detected at a frequency of 75 percent.

6.1.4.3 Concentrations of Contaminants

The following summaries are based on an evaluation of data collected from the zero to 12-inch soil horizon and the subsurface soil interval of 1 to 10 feet.

6.1.4.3.1 Sewage Sludge Application/Leachate Injection Area. The minimum and maximum detected and the mean concentrations of organic chemicals detected in surface soil samples taken from this area are presented in Table 6-10. The mean was calculated by using one-half the detection limit as a place holder for samples without a value above the detection limit. Compared to the other areas identified under OU 4, this area displayed the maximum concentrations of organics. Specifically, the following three chemicals detected at concentrations exceeding 1,000 μg/kg: 4-chloroaniline, bis(2-ethylhexyl)phthalate, and PCB-1260.

Summary data for inorganic constituents are also presented in Table 6-10. Maximum concentrations of inorganics for the Lowry Site, excluding manganese and aluminum, were detected within this area.

6.1.4.3.2 Sewage Sludge Application Area. Summary data for organic chemicals in surface soil samples are presented in Table 6-11. The most frequently detected chemicals, 4-chloroaniline and bis(2-ethylhexyl)phthalate had maximum concentrations of about 500 μg/kg. Table 6-11 also presents inorganic summary data. The maximum concentration of manganese for the Lowry Site was detected in this area.

6.1.4.3.3 Leachate Spraying Area. Summary data for organic chemicals in surface soil samples from the leachate spraying area are presented in Table 6-12. There were four organic chemicals that were each detected only once. The maximum concentration of these chemicals was less than 25 μg/kg. The exception was bis(2-ethylhexyl)phthalate, with a maximum concentration of 215 μg/kg. Table 6-12 also presents inorganic summary data. Concentrations of inorganic constituents are generally lower than those detected in other areas.

6.1.4.3.4 Former Tire Pile Area. For this area, the minimum, maximum, and the mean concentrations of detected organic chemicals in surface soil samples are presented in Table 6-13. Although six pesticides were present in more than one sample, none were detected at concentrations greater than 2 μg/kg. Table 6-13 also presents inorganic summary data. The maximum concentration of aluminum for the Lowry Site was detected in the former tire pile area.

6.1.4.3.5 Subsurface Soil. The data summary for subsurface soil, presented in Table 6-14, does not distinguish between areas. All subsurface soil samples were grouped because of the limited number of samples and detected constituents. No consistent distribution of organic chemical concentrations could be determined with available sample data. In general, inorganic constituent concentrations decrease with increasing depth. In the sewage sludge application area, zinc, lead, cadmium, nickel, and chromium exhibited lower concentrations in subsurface soil than in the zero to 12-inch horizon. In the leachate spraying area, concentrations of inorganics remained relatively unchanged throughout the soil profile. The maximum concentration of arsenic, 18,000 µg/kg, was detected in the leachate spraying area at the 4.5- to 6-foot interval. Two radionuclides, thorium-228 and potassium-40, were detected in background samples.

Reported onsite concentrations for these radionuclides are comparable to the background concentrations.

6.1.4.4 Volume Estimates

For purposes of estimating the volume of soil in OU 4, an aerial extent of approximately 103 acres (excluding the former tire pile area) and an average excavation depth of 15 feet was assumed. This depth was based on the detection of arsenic at 18,000 µg/kg at 6 feet below ground surface and the depth of the current borrow area. The total volume of soil in OU 4 is estimated as approximately 2.5 million cubic yards.

6.1.5 OU 5: Surface Water

The SWRA, implemented in 1992, eliminated the offsite migration of contaminated seepage from unnamed creek. The SWRA collects the unnamed creek base flow in a subsurface drain and maintains flows that are in contact with the ground-water table until the ground water is captured at the barrier wall. At the barrier wall, the base flows are pumped to the existing ground-water treatment plant. The existing ground-water treatment plant was recently upgraded to treat larger quantities and a more expansive list of contaminants. A soil cap was placed within the onsite unnamed creek channel as well.

6.1.5.1 Past Source of Contamination

Seeps have historically been observed in locations along the banks of the unnamed creek near the center of Section 6. The sources of these seeps are believed to be the waste pits, ground-water discharge, and seepage from the toe of the landfill. The seeps contributed to perennial contaminated surface water flows in the unnamed creek. Prior to the SWRA, surface water would flow into the area previously occupied by Pond 3, which was located along the unnamed creek upstream of the barrier wall. Previously, water that collected in Pond 3 would infiltrate through the bottom of the pond and into the subsurface (upgradient of the barrier wall); it was then collected for treatment. During periods of high precipitation, Pond 3 would overflow; this caused contaminated runoff to flow within the offsite portion of the unnamed creek channel.

6.1.5.2 Nature and Extent of Contamination

Prior to implementation of the SWRA, numerous sampling events detected at least 20 organic chemicals in surface water in unnamed creek-from the toe of the landfill to the area previously occupied by Pond 3. Within the unnamed creek drainage, between the area previously occupied by Pond 3 and the confluence of Murphy Creek, the detection of organic chemicals was infrequent and generally not reproducible because of dilution and low perennial flow. Inorganic constituents follow the same concentration pattern as organics; twice the number of inorganic constituents were detected (with a frequency over 50 percent) in Section 6 than beyond the area previously occupied by Pond 3.

6.1.5.3 Concentrations of Contaminants

The highest concentrations of organic chemicals that were detected in unnamed creek prior to implementation of the SWRA were found in samples collected in the surface drainage between the toe of the landfill and the area previously occupied by Pond 3. Significantly lower concentrations were detected in samples downstream of the area previously occupied by Pond 3. Historical data are summarized in Table 6-15 according to the geographic location of the samples:

- Toe of the landfill to the area previously occupied by Pond 3 (Group 1);
- Downstream of the area previously occupied by Pond 3 to the confluence of unnamed creek with Murphy Creek (Group 2); and
- Beyond the confluence with Murphy Creek to Section 30 (Group 3).

Generally, concentrations of inorganic constituents were also highest in unnamed creek between the toe of the landfill and the area previously occupied by Pond 3. These historical data are also summarized in Table 6-15.

6.1.5.4 Volume Estimates

Through implementation of the SWRA, measurable quantities of surface-water flow within unnamed creek have been eliminated. The SWRA collection system is designed to collect ground-water flow of up to 13 gallons per minute (gpm). Although the volume of ground-water flow into the collection system is not known, the treatment plant has reportedly processed approximately three million gallons in a 9-month period.

6.1.6 OU 5: Sediments

Implementation of the SWRA eliminates the offsite transport of surface water and suspended sediments in unnamed creek. As part of the SWRA, a soil cap was constructed in the onsite unnamed creek channel (see Figure 11-2 for approximate location of the collection system soil cap). Contaminated sediments within unnamed creek are currently covered by the SWRA soil cap.

6.1.6.1 Past Source of Contamination

The potential sources of sediment contamination in the unnamed creek were discussed in Subsection 6.1.5.1. Sediments within the unnamed creek in Section 6 are now covered by the SWRA soil cap.

6.1.6.2 Nature and Extent of Contamination

Prior to the implementation of the SWRA, at least 15 organic chemicals were detected in sediments within the onsite unnamed creek channel. Few organic chemicals were detected in sediments downstream of the area previously occupied by Pond 3.

Inorganic constituents were detected above background levels throughout the creek channel as well as beyond the confluence of unnamed creek and Murphy Creek.

6.1.6.3 Concentrations of Contaminants

The concentrations of sediment contaminants are discussed separately for Section 6 sediments and Section 31 sediments.

6.1.6.3.1 Section 6. Prior to implementation of the SWRA, elevated concentrations of organic chemicals were detected in the sediments of unnamed creek. Specifically, these chemicals were found in samples collected from the portion of the creek channel that is within the former tire pile area. For example, 1,1,1-trichloroethane, toluene, and total xylenes were detected at maximum concentrations greater than 100 mg/kg. Significantly lower organic concentrations were detected upstream of this area, in the general vicinity of the toe of the landfill. All sediments in Section 6 were covered as part of the SWRA.

Elevated concentrations of barium, chromium, and lead were detected in sediment samples from within the creek channel in the former tire pile area, in close proximity to the waste pits on the east side of the former creek. Historical data for sediments in Section 6 are summarized in Table 6-16.

6.1.6.3.2 Section 31. Samples collected downstream of the barrier wall in Section 31 exhibited inconsistent detections of organic chemicals. The area downstream of Section 31 can be divided into two smaller geographical segments to more easily discuss contaminants detected:

- From Section 31 to confluence with Murphy Creek; and
- From the confluence with Murphy Creek to Section 31 northern boundary line.

Fifteen organic chemicals were detected in the segment from Section 31 to the confluence with Murphy Creek. Eleven of these chemicals were detected only once. Of those chemicals detected more than once, bis(2-ethylhexyl)phthalate had the highest detection frequency at 50 percent. PCBs, toluene, and acetone had detection frequencies between 30 and 40 percent. With the exception of 2,4-dinitrophenol (detected once out of 11 samples), which was detected at 2.7 mg/kg, maximum concentrations of these organic compounds were below one mg/kg.

Five organic compounds were detected in the segment from the confluence with Murphy Creek to the northern boundary of Section 31. Three of these were detected only once. Bis(ethylhexyl)phthalate and octochlorodibenzodioxin were detected more than once (three and two detections, respectively). The maximum concentrations of these organic compounds was 0.3 mg/kg for di-n-butylphthalate which is at the detection limit. The maximum concentration of octochlorodibenzodioxin was 0.00012 mg/kg.

Seventeen inorganic constituents (out of 19 analyzed for) were detected within the segment from Section 31 to the confluence with Murphy Creek. Two, cyanide and tin, were detected only once. The remaining fifteen compounds had detection frequencies greater than 40 percent. Two inorganic chemicals not detected in these sediment samples were antimony and silver. Average concentrations of most inorganic constituents were approximately the same as those calculated for Section 6. However, average concentrations of barium, chromium, mercury, and lead were ½ to an order of magnitude lower than those calculated for Section 6.

Eighteen inorganic constituents (out of 19 analyzed for) were in the segment from the confluence with Murphy Creek to the northern boundary of Section 31. Four constituents, silver, iron, antimony, and tin were detected only once. The remaining constituents had detection frequencies between 20 and 88 percent. Cadmium was not detected in a single sediment sample from within this segment. Average concentrations of most inorganic constituents were approximately the same as those calculated for Section 6. However, average concentrations of arsenic, barium, chromium, manganese, mercury, and lead were ½ to an order of magnitude lower than those concentrations calculated for Section 6.

6.1.6.4 Volume Estimates

According to the OUs 4&5 feasibility study, the SWRA soil cap covers an area of approximately 320,000 square feet in size. This estimate includes the areas previously occupied by Ponds 3 and 4 (Pond 4 was previously located directly west of the existing treatment plant). The volume of contaminated sediments that were left in place and covered by SWRA soil cap was not estimated. The volume of sediments in the unnamed creek segment of Section 31 is estimated to be 23,700 cubic yards.

6.2 Surface and Subsurface Pathways of Migration

Conceptual models were developed for each OU and were designed to detail potential contaminant sources, potential routes of migration, and contaminant fate and transport. The models focused the RI/FS site characterization activities and formed the basis of the pathways identified in the baseline risk assessment(s).

The sources of contamination at the Lowry Site include subsurface liquids, waste pits, landfill solids, sewage sludge, injected surface water from Ponds 2 and 3, sprayed surface water from Pond 2, and landfill gas. These sources have released, and will continue to release, contaminants to environmental media. The environmental media may then act as secondary sources for distributing contamination throughout the environment and to human and environmental receptors.

Sampling of these media was conducted during the pre-Phase I, the Phase I and Phase II RI, and the OUs 1&6, 2&3, and 4&5 Additional Site Characterization (ASC) efforts to assess media interactions and their potential as secondary sources of contamination. Interactions were evaluated as part of each OU RI Report. However, only the significant pathways of migration are discussed here. Significant pathways have been chosen based on their contribution to site risk.

The significant pathways of migration include subsurface liquids to shallow ground water, subsurface liquids and shallow ground water to surface water and sediments, volatiles from subsurface liquids to landfill gas, landfill solids to landfill gas to the atmosphere, leachate from landfill solids to shallow ground water, contaminated surface water to shallow ground water, and shallow ground water to deep ground water.

6.2.1 Subsurface Liquids to Shallow Ground Water

Contaminants from the waste pits have migrated into both the weathered Dawson shallow ground-water system and the unweathered Dawson formation. Migration primarily occurs in a horizontal direction. In certain areas of the Lowry Site, waste pits and shallow ground water have no hydraulic separation. As a result, the waste-pit liquids and shallow ground water have co-mingled.

Although contaminants in the waste-pit liquids are similar to contaminants in the shallow ground water, individual comparisons of analytical results between waste pit well points and adjacent shallow ground-water monitoring wells indicate variable trends. The differences in contaminant occurrence and concentrations between the well points and adjacent monitoring wells could result from one or more of the following conditions: variability in geology; lack of contaminant migration, or variability in the rate, volume, and pattern of contaminant migration from the waste pits; location of a waste pit in relation to the water table; the influence of other waste pits on the monitoring wells; the presence and possible migration of multiple liquid phases in the waste pits; or contaminant migration from the waste pit along pathways not encountered by the adjacent monitoring wells.

6.2.2 Subsurface Liquids and Shallow Ground Water to Surface Water and Sediments

Data collected during Phase I and Phase II investigations confirmed that the shallow ground-water and subsurface liquids located within or just below the landfill mass flowed to the north and discharged to the unnamed creek. Available data also support the conclusion that the shallow ground-water and subsurface liquids in the former tire pile area were discharged to the surface water through seeps located along the banks of unnamed creek. These ground-water discharges contributed to the base flow within unnamed creek. For the area north of the former tire piles, available data support the conclusion that the shallow ground-water system was recharged through surface water infiltration.

Subsurface sand channels have also been identified at the Lowry Site. These sand channels promote enhanced subsurface fluid flow and provide another mechanism for subsurface liquids to intermingle with shallow ground water.

The majority of the organic compounds which were detected in the shallow ground water and subsurface liquids were also detected in surface water, and at a similar frequency of detection. A similar correlation was observed between OU 1 and sediments, although OU 1 contaminants were typically detected less frequently in sediments. Concentrations of organics detected in shallow ground water (OU 1) were typically higher than in either the surface water or the sediments.

Based on the correlation between contaminant levels in sediments and their location with respect to waste pits, contaminants from the waste pits have migrated through the ground water and discharged via seeps to surface water in the unnamed creek.

Although analytical results indicate that ground-water discharge to the unnamed creek has historically impacted surface water and sediments onsite, implementation of the SWRA has isolated these media and prevents offsite migration of contaminated surface water.

6.2.3 Volatiles from Subsurface Liquids to Landfill Gas

Analyses have shown that both the waste pit and refuse gas samples contained similar organic compounds. Because these two types of samples were collected at various elevations above the waste pits, the results indicate that: (1) within the refuse, waste-pit vapors and waste-pit gases are highly mobile and widely dispersed in the subsurface; and/or (2) that the refuse serves as a source for gas generation.

Similar types of volatile organic compounds are seen in the landfill gas and source area shallow ground water, and substantiate that there are interactions between the media.

6.2.4 Landfill Solids to Landfill Gas to Atmosphere

Significant pathways of migration between the landfill solids, landfill gas, and the atmosphere are as follows:

- Gas produced within the landfill mass migrates primarily by advective flow toward the landfill perimeter and into the atmosphere.

- The highest contaminant concentrations and the greatest number of contaminants at the perimeter tend to occur closest to the landfill margin.

- The composition and concentrations of VOCs detected in perimeter areas are consistent with gas compositions within the landfill mass.

- Soil gas VOC concentrations in the former tire pile area are consistent with VOC concentrations within the waste pits; gas contamination by VOCs in the former tire pile area is characterized by localized sources.

6.2.5 Contaminated Surface Water to Shallow Ground Water

Seepage within unnamed creek transported contaminants to the sediments and surface water. The potential contribution of contamination from sediments and surface water to the shallow ground water depends on the amount of precipitation runoff and recharge that occurred within unnamed creek.

Prior to implementation of the SWRA, surface water was observed to infiltrate into the subsurface through the bed of unnamed creek. A comparison of surface water data (from the area previously occupied by Pond 3) to ground-water data (from wells located along the unnamed creek north of the former tire pile area) indicates recharge from contaminated surface water potentially impacted ground water in the former tire pile area.

Comparisons indicate, however, that other sources, including subsurface liquids, have also had a significant impact on ground-water quality in this area. Completion of the SWRA eliminated potential recharge to the shallow ground-water system underlying unnamed creek.

6.2.6 Shallow Ground Water to Deep Ground Water

Hydraulic gradient data indicate that downward vertical gradients exist between the shallow and deep ground water. Chemical analyses from the deep ground water indicate the presence of low levels of organic contamination near Wells B504 and C702Q2. A potential exists for contaminated shallow ground water to migrate to the deep ground water.

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Table 6-1
Summary of Chemical Concentration Date for
Waste Pit Liquids Well Points and Shallow Ground-Water
Monitoring Wells in the Source Area

Chemical Name (a)	No. of Analyses	No. of Detects	Frequency of Detects (b) (%) Organics (μg/l)	Minimum (c) Detected Concentration	Maximum (c) Detected Concentration	Average (d) Detect
1,1,1-Trichloroethane	141	58	41	3.000000	2768511.3	101.41
1,1,2,2-Tetrachloroethane	140	1	1	66.000000	66	18
1,1,2-Trichloroethane	141	3	2	3.000000	104.1	16.71
1,1-Dichloroethane	140	76	54	2.000000	1051621.6	219.44
1,1-Dichloroethylene	140	49	35	0.800000	140000	41.75
1,2,3,4,6,7,8-Heptachlordibenzo-p-Dioxin	39	29	74	0.000050	0.928	0.0013
1,2,3,4,6,7,8-Heptachlorodibenzofuran	39	25	64	0.000020	0.142	0.0001
1,2,3,4,7,8,9-Heptachlorodibenzo-p-Dioxin	39	19	49	0.000003	0.0167	0.000041
1,2,3,4,7,8,9-Heptachlorodibenzofuran	39	13	33	0.000020	0.0167	0.000032
1,2,3,4,7,8-Hexachlorodibenzo-p-Dioxin	39	13	33	0.000007	0.0082	0.000016
1,2,3,4,7,8-Hexachlorodibenzofuran	39	22	56	0.000003	0.0172	0.000032
1,2,3,6,7,8-Hexachlorodibenzo-p-Dioxin	39	25	64	0.000010	0.0486	0.0001
1,2,3,6,7,8-Hexachlorodibenzofuran	39	13	33	0.000003	0.0048	0.000013
1,2,3,7,8,9-Hexachlorodibenzofuran	39	3	8	0.000008	0.00022	0.000009
1,2,3,7,8-Pentachlorodibenzo-p-Dioxin	39	9	23	0.000004	0.0026	0.000010
1,2,3,7,8-Pentachlorodibenzofuran	39	8	21	0.000009	0.0013	0.000009
1,2,4-Trichlorobenzene	120	5	4	8.500000	1663.3	13.13
1,2-Dichlorobenzene	120	18	15	4.000000	180	13.52
1,2-Dichloroethane	141	77	55	3.000000	1800000	221.56
1,2-Dichloroethene (Total)	141	51	36	1.000000	160000	61.10
1,2-Dichloropropane	141	11	8	1.000000	268.2	16.31
1,4-Dichlorobenzene	120	21	18	2.000000	321.1	15.08
2,3,4,6,7,8-Hexachlorodibenzofuran	39	12	31	0.000010	0.0034	0.000014
2,3,4,7,8-Pentachlorodibenzofuran	39	11	28	0.000007	0.0019	0.000011
2,3,7,8-Tetrachlorodibenzodioxin	41	10	24	0.000005	0.0011	0.000007
2,3,7,8-Tetrachlorodibenzofuran	41	29	71	0.000002	0.0014	0.000030
2,4,5-T	25	5	20	2.300000	90	2.45
2,4,5-TP	27	8	30	1.000000	48.5	3.36
2,4,5-Trichlorophenol	97	1	1	18.000000	18	59
2,4,6-Trichlorophenol	99	2	2	13.000000	15	16.50
2,4-D	26	3	12	46.000000	2450	13.55
2,4-Dichlorophenol	99	8	8	22.000000	164	21.70
2,4-Dimethylphenol	98	28	29	9.000000	3900	47.11
2,4-Dinitrophenol	85	1	1	500.000000	500	47
2-Butanone (MEK)	127	47	37	17.000000	230000	383.85
2-Chloronaphthalene	116	1	1	11.000000	11	13
2-Chlorophenol	97	1	1	8.000000	8	17
2-Hexanone	141	4	3	48.900000	269.9	25.73
2-Methylnaphthalene	125	35	28	3.000000	43900	32.44
2-Methylphenol	115	34	30	14.000000	7500	31.57

Table 6-1
Summary of Chemical Concentration Data for
Waste Pit Liquids Wells Points and Shallow Ground-Water
Monitoring Wells in the Source Area

Chemical Name (a)	No. of Analyses	No. of Detects	Frequency of Detects (b) (%)	Minimum (c) Detected Concentration	Maximum (c) Detected Concentration	Average (d) Detect
4,4'-DDD	102	4	4	0.140000	1.06	0.13
4,4'-DDE	102	2	2	0.280000	0.34	0.12
4,4'-DDT	102	3	3	0.080000	0.66	0.12
4-Methyl-2-Pentanone (MIBK)	140	72	51	4.000000	956573.7	220.51
4-Methylphenol	119	51	43	1.600000	200000	66.26
Acenaphthene	119	3	3	5.900000	120.1	13
Acetone (2-Propanone)	140	68	49	4.000000	2984870	1041.47
Aldicarb	22	1	5	60.000000	60	2.4
Aldicarb Sulfoxide	22	1	5	23.000000	23	2.1
Alpha Chlordane	71	3	4	0.380000	1.2	0.19
Alpha-BHC	102	3	3	0.150000	0.71	0.07
Aniline	20	3	15	21.000000	41	57.31
Anthracene	116	1	1	3.400000	3.4	14
Benzene	140	97	69	1.000000	974172.9	131.53
Benzo(a)Anthracene	116	1	1	83.800000	83.8	13
Benzoic Acid	76	24	32	15.600000	30200	315.42
Benzyl Alcohol	96	8	8	7.200000	1930	30.40
bis(2-Chloroethyl)Ether	115	1	1	3.000000	3	15
bis(2-Etherlhexyl)Phthalate	117	27	23	1.000000	21500	43.17
Bromodichloromethane	141	1	1	3.000000	3	13
Bromoform	140	1	1	13.000000	13	17
Butylbenzylphthalate	116	6	5	18.100000	1010.3	16.71
Carbaryl	23	5	22	2.000000	97	3.34
Carbazole	30	2	7	7.000000	12	15.43
Carbofuran	23	3	13	6.000000	640	3.13
Carbon Disulfide	141	14	10	15.000000	14180.2	46.66
Carbon Tetrachloride	141	6	4	14.600000	26000	21.91
Chlorobenzene	141	19	13	2.000000	5200	18.29
Chloroethane	139	25	18	2.000000	257.1	36.54
Chloroform	141	20	14	0.600000	56000	26.06
Chloromethane	141	3	2	2.000000	18	20.91
Chrysene	116	2	2	20.000000	72	12.76
cis-1,3-Dichloropropene	141	1	1	5.000000	5	16
Delta-BHC	102	1	1	0.030000	0.03	0.060
Di-N-Butylphthalate	116	11	9	2.000000	266.6	13.93
Di-N-Octylphthalate	116	4	3	5.700000	1205.8	14.78
Dibenzofuran	118	1	1	4.000000	4	12
Dibromochloromethane	141	1	1	7.000000	7	16
Dicamba	26	6	23	0.800000	250	2.46
Dieldrin	102	3	3	0.140000	1.3	0.13
Diethylphthalate	101	12	12	6.800000	340	19.06

Table 6-1

Summary of Chemical Concentration Data for Waste Pit Liquids Well Points and Shallow Ground-Water Monitoring Wells in the Source Area

Chemical Name (a)	No. of Analyses	No. of Detects	Frequency of Detects (b) (%)	Minimum (c) Detected Concentration	Maximum (c) Detected Concentration	Average (d) Detect
Endosulfan II	102	1	1	0.640000	0.64	0.12
Endrin	102	3	3	0.060000	1.1	0.13
Endrin Aldehyde	11	2	18	1.000000	2.98	0.17
Endrin Ketone	101	3	3	0.760000	1.78	0.14
Ethylbenzene	141	71	50	3.000000	3514995	107.22
Ethylene Glycol	26	1	4	650000.000000	650000	2,000
Ethylenedibromide	24	3	13	0.120000	0.28	0.02
Fluoranthene	117	3	3	25.900000	200	13.18
Fluorene	117	7	6	2.000000	241.4	13.14
Gamma Chlordane	71	1	1	0.620000	0.62	0.71
Gamma-BHC (Lindane)	102	4	4	0.025000	1.02	0.07
Heptachlor	101	2	2	0.470000	1.5	0.07
Heptachlor Epoxide	102	2	2	0.240000	0.94	0.06
Heptachlorodibenzodioxins	22	3	14	0.090000	0.23	0.0023
Heptachlorodibenzofurans	68	33	49	0.000061	0.784	0.00054
Hexachlorodibenzodioxins	78	21	27	0.000020	0.098	0.00017
Hexachlorodibenzofurans	82	23	28	0.000006	0.195	0.00016
Isophorone	118	12	10	3.000000	1376340	23.25
MCPA	24	1	4	650.000000	650	400
Methoxychlor	102	2	2	0.120000	14	0.36
Methylene Chloride	140	56	40	3.000000	440000	107.37
N-Nitrosodiphenylamine	117	6	5	10.000000	5972	17.84
Naphthalene	127	53	42	2.000000	109622	31.66
Octachlorodibenzodioxins (Total)	61	36	59	0.000021	14.93	0.01
Octachlorodibenzofurans (Total)	61	29	48	0.000154	1.16	0.00071
PCB-1242 (Aroclor 1242)	107	1	1	19.350000	19.35	1.2
PCB-1260 (Aroclor 1260)	108	5	5	15.000000	493	1.39
Pentachlorodibenzodioxins (Total)	75	13	17	0.000009	0.0301	0.000036
Pentachlorodibenzofurans (Total)	77	24	31	0.000005	0.0657	0.000091
Pentachlorophenol	95	8	8	4.000000	4125	81.11
Phenanthrene	117	15	13	4.200000	1690	22.26
Phenol	102	38	37	3.000000	29000	60.92
Pyrene	117	5	4	36.300000	230	14.30
Styrene	140	4	3	17.000000	28101.4	20.10
Tetrachlorodibenzodioxin (Dioxin)	77	17	22	0.000002	0.0064	0.000021
Tetrachlorodibenzofuran (Dioxin)	89	24	27	0.000008	0.0107	0.000060
Tetrachloroethylene	141	51	36	0.900000	341360.5	84.61
Toluene	140	97	69	0.900000	10938360	627.65
Total Heptachlorodibenzo-P-Dioxin	40	29	73	0.000050	1.73	0.0019
Total Xylenes	141	88	62	5.000000	2279915.6	436.11

Table 6-1

Summary of Chemical Concentrations Data for Waste Pit Liquids Well Points and Shallow Ground-Water Monitoring Wells in the Source Area

Chemical Name (a)	No. of Analyses	No. of Detects	Frequency of Detects (b) (%)	Minimum (c) Detected Concentration	Maximum (c) Detected Concentration	Average (d) Detect
Trans-1,3-Dichloropropene	141	2	1	2.200000	3	14.86
Trichloroethylene	141	78	55	4.000000	772347.3	110.16
Vinyl Chloride	141	48	34	2.600000	1800	54.23
Inorganics (µg/I)						
Aluminum	113	83	73	3.500000	310000	3099.21
Antimony	109	10	9	4.066400	1170	30.53
Arsenic	105	77	73	2.200000	1550	68.08
Barium	114	109	96	13.900000	16600	410.70
Beryllium	114	12	11	0.870000	12	3.02
Boron	44	35	80	80.702200	34700	1504.12
Cadmium	114	45	39	2.500000	517	16.51
Chromium (Total)	114	52	46	0.712900	1660	24.99
Cobalt	114	71	62	5.400000	328	30.40
Copper	113	52	46	4.700000	1550	82.07
Cyanide	109	26	24	5.300000	6910	37.26
Ferrous Iron	21	21	100	200.000000	1720000	58535.20
Fluoride	50	34	68	160.000000	1760000	3496.15
Lead	92	45	49	1.000000	506	36.61
Manganese	114	113	99	182.000000	69600	2952.23
Mercury	114	25	22	0.210000	3.3	0.20
Nickel	114	85	75	13.000000	2000	161.01
Selenium	102	45	44	1.800000	6540	82.88
Silver	107	19	18	0.660000	78	7.20
Thallium	76	16	21	0.342100	763	29.75
Tin	9	1	11	200.000000	200	68
Vanadium	114	44	39	1.800000	760	74.03
Zinc	114	79	69	4.600000	28800	247.26
Radionuclides (pCi/l)						
Actinium-228	67	2	3	5.000000	80.7	11
Americium-241	39	1	3	2.000000	2000000	79
Americium-241 (Alpha)	7	1	14	0.100000	1500000	7.9
Bismuth-214	79	41	52	1.060000	200	13.54
Cerium-143	6	6	100	25.000000	92	43.81
Cesium-136	59	1	2	1.500000	15	3.7
Cesium-137	68	3	4	1.500000	19	2.52
Cobalt-57	59	1	2	1.500000	5	2.2
Cobalt-60	67	2	3	1.500000	22	2.49

Table 6-1

Summary of Chemical Concentrations Data for Waste Pit Liquids Well Points and Shallow Ground-Water Monitoring Wells in the Source Area

Chemical Name (a)	No. of Analyses	No. of Detects	Frequency of Detects (b) (%)	Minimum (c) Detected Concentration	Maximum (c) Detected Concentration	Average (d) Detect
Iodine-124	59	1	2	2.000000	300	12
Iron-59	67	1	1	2.500000	32	3.1
Lead-210	2	1	50	3.000000	11	5.7
Lead-212	20	9	45	3.250000	47	10.55
Lead-212-Bismuth	48	10	21	2.500000	108	5.24
Lead-214	79	39	49	0.904000	202.5	16.36
Neodynium-147	59	1	2	15.000000	150	29
Plutonium-239	42	19	45	0.020000	25	0.47
Potassium-40	89	51	57	25.000000	1930	153.49
Radium-226	12	6	50	0.350000	75.4	2.85
Sodium-22	59	1	2	1.500000	4	1.9
Strontium-90	58	6	10	0.000002	4.5	0.44
Thallium-208	67	5	7	4.500000	650	7.14
Thorium-228	63	10	16	1.000000	105	4.70
Thorium-230	13	10	77	0.040000	75	1.99
Thorium-232	51	25	49	0.035000	146	1.08
Tritium	57	45	79	25.000000	7500	601.39
Uranium-234	13	11	85	0.100000	49	4.02
Uranium-235	38	4	11	10.000000	25	17.60
Uranium-238	45	32	71	0.050000	426.7	2.96
Uranium-Natural	9	6	67	1.200000	150	5.68
Zirconium-95	60	1	2	2.500000	8	3.8

Notes:

a. Only chemicals detected at least once in the source area well grouping are presented.
b. Method of calculation: (number of samples with detected concentrations/number of samples within this well grouping)
c. Minimum/Maximum detected concentration values (only two figures are significant).
d. Geometric mean of the median concentrations from all wells in this well grouping including ½ the detection limit for non-detects (only two figures are

Source: Appendix A, Baseline Risk Assessment (EPA, 1992).

Table 6-2
Summary of Chemical Concentration Data for
Downgradient Weathered Dawson Monitoring Wells
Outside of the Source Area

Chemical Name (a)	No. of Analyses	No. of Detects	Frequency (b) of Detects (%)	Minimum (c) Detected Concentration	Maximum (c) Detected Concentration	Average (d) Detect
Organics (µg/l)						
1,1,1-Trichloroethane	33	16	48	2.80	5300.00	26.27
1,1,2-Trichloroethane	33	4	12	3.90	13.00	3.92
1,1-Dichloroethane	33	14	42	2.50	770.00	14.77
1,1-Dichloroethylene	33	12	36	16.00	750.00	13.05
1,2,3,4,6,7,8-Heptachlordibenzo-p-Dioxin	13	2	15	0.000010	0.000290	0.0000087
1,2,3,4,6,7,8-Heptachlorodibenzofuran	13	1	8	0.000002	0.000002	0.0000021
1,2,3,4,7,8,9-Heptachlorodibenzo-p-Dioxin	13	1	8	0.000030	0.000030	0.0000029
1,2,3,4,7,8,9-Heptachlorodibenzofuran	13	1	8	0.000008	0.000008	0.0000032
1,2,3,4,7,8-Hexachlorodibenzo-p-Dioxin	13	1	8	0.000020	0.000020	0.0000025
1,2,3,4,7,8-Hexachlorodibenzofuran	13	1	8	0.000001	0.000001	0.0000018
1,2,3,6,7,8-Hexachlorodibenzo-p-Dioxin	13	1	8	0.000020	0.000020	0.0000023
1,2,4-Trichlorobenzene	26	1	4	1.30	1.30	5.5
1,2-Dichloroethane	33	10	30	5.00	200.00	6.33
1,2-Dichloroethene (Total)	33	12	36	5.80	610.00	10.61
1,2-Dichloropropane	33	7	21	2.10	75.00	4.92
1,4-Dichlorobenzene	26	1	4	10.00	10.00	6.4
2,3,4,6,7,8-Hexachlorodibenzofuran	13	2	15	0.000004	0.000004	0.000003
2,3,7,8-Tetrachlorodibenzofuran	13	2	15	0.000004	0.000007	0.000002
2,4-D	11	1	9	1.50	1.50	1.3
2,4-Dichlorophenol	24	1	4	5.70	5.70	5.6
2,4-Dimethylphenol	24	1	4	13.00	13.00	6.0
2-Butanone (MEK)	26	4	15	2.30	12.00	5.57
2-Hexanone	33	1	3	3.50	3.50	6.6
2-Methylphenol	24	1	4	8.00	8.00	5.8
4-Bromophenyl-Phenylether	26	1	4	10.00	10.00	6.4
4-Methyl-2-Pentanone (MIBK)	33	1	3	8.70	8.70	7.1
4-Methylphenol	24	1	4	13.00	13.00	6.0
4-Nitroaniline	26	1	4	50.00	50.00	32
Acenaphthene	26	1	4	2.00	2.00	5.7
Acetone (2-Propanone)	33	6	18	9.80	180.00	11.72
Aldicarb Sulfoxide	11	1	9	1.00	1.00	0.56
Benzene	33	4	12	5.20	44.00	4.08
Benzo(G,H,I)Perylene	26	1	4	10.00	10.00	6.4
Benzoic Acid	19	3	16	2.00	9.10	19.60
bis(2-Ethylhexyl)Phthalate	25	3	12	1.00	5.60	5.29
Bromodichloromethane	33	1	3	3.00	3.00	3.5
Bromoform	33	1	3	17.00	17.00	3.9
Carbon Disulfide	33	3	9	10.00	12.00	4.76
Chloroform	33	8	24	2.60	21.00	4.36
Delta-BHC	20	1	5	0.01	0.01	0.02
Di-N-Butylphthalate	26	1	4	2.00	2.00	5.7
Dibromochloromethane	33	1	3	7.00	7.00	3.7

Table 6-2

Summary of Chemical Concentration Data for Downgradient Weathered Dawson Monitoring Wells Outside of the Source Area

Chemical Name (a)	No. of Analyses	No. of Detects	Frequency (b) of Detects (%)	Minimum (c) Detected Concentration	Maximum (c) Detected Concentration	Average (d) Detect
Diethylphthalate	26	1	4	2.00	2.00	5.7
Dinoseb	9	1	11	0.10	0.10	0.82
Ethylbenzene	33	1	3	38.00	38.00	3.5
Heptachlorodibenzofurans	13	1	8	0.000004	0.000004	0.0000026
Hexachlorodibenzodioxins	13	3	23	0.00001	0.00019	0.000006
Hexachlorodibenzofurans	13	1	8	0.000003	0.000003	0.0000023
Methylene Chloride	33	12	36	1.60	110.00	6.29
N-Nitroso-Di-N-Propylamine	26	1	4	0.86	0.86	5.3
Octachlorodibenzodioxins (Total)	13	1	8	0.00007	0.00007	0.0000030
Octachlorodibenzofurans (Total)	13	1	8	0.000004	0.000004	0.00000053
Pentachlorodibenzodioxins (Total)	14	1	7	0.00003	0.00003	0.00000041
Pentachlorodibenzofurans (Total)	13	1	8	0.000002	0.000002	0.00000019
Phenol	24	2	8	2.10	3.80	5.86
Pyrene	26	1	4	2.10	2.10	5.7
Tetrachlorodibenzodioxin (Dioxin)	13	1	8	0.000006	0.000006	-
Tetrachloroethylene	33	14	42	2.00	790.00	12.15
Toluene	33	4	12	1.00	4.00	3.22
Total Heptachlorodibenzo-P-Dioxin	13	1	8	0.0005	0.0005	0.0000079
Total Xylenes	33	3	9	14.00	360.00	6.00
Trichloroethylene	33	14	42	3.00	400.00	10.20
Vinyl Chloride	33	1	3	6.80	6.80	6.2
Inorganics (µg/l)						
Aluminum	29	6	21	7.90	507.00	57.51
Antimony	29	3	10	0.80	1.60	9.01
Arsenic	29	11	38	3.90	55.20	5.22
Barium	29	19	66	10.72	236.00	36.68
Boron	11	10	91	42.06	661.00	238.54
Chromium (Total)	29	12	41	0.25	19.07	2.15
Cobalt	28	8	29	0.76	78.00	5.19
Copper	28	8	29	1.61	42.21	5.75
Fluoride	12	1	8	600.00	600.00	350
Lead	29	4	14	0.80	8.00	2.41
Manganese	28	18	64	8.64	23800.00	72.52
Mercury	29	2	7	0.20	0.48	0.14
Nickel	28	15	54	0.95	138.00	11.16
Selenium	27	11	41	5.00	414.00	10.16
Silver	29	1	3	0.90	0.90	2.6
Thallium	26	8	31	0.30	1.60	3.06
Tin	16	1	6	50.00	50.00	20
Vanadium	29	2	7	1.91	24.00	8.16
Zinc	28	22	79	2.10	250.00	20.98

Table 6-2
Summary of Chemical Concentration Data for
Downgradient Weathered Dawson Monitoring Wells
Outside of the Source Area

Chemical Name (a)	No. of Analyses	No. of Detects	Frequency (b) of Detects (%)	Minimum (c) Detected Concentration	Maximum (c) Detected Concentration	Average (d) Detect
Radionuclides (pCi/l)						
Antimony-125	13	1	8	3.50	10.00	5.1
Antimony-126	13	1	8	3.00	15.00	4.9
Bismuth-214	13	4	31	3.50	32.70	6.7
Cerium-139	13	1	8	1.50	5.00	2.2
Chromium-51	13	1	8	15.00	40.00	2.4
Europium-152	13	1	8	4.00	10.00	5.6
Europium-155	13	1	8	4.50	10.00	6.8
Iodine-132	13	1	8	10.00	15000.00	100
Iodine-133	6	1	17	10000.00	1000000.00	100,000
Iron-59	13	1	8	3.00	10.00	4.7
Lanthanum-140	13	2	15	3.00	20.00	6.05
Lead-212-Bismuth	13	3	23	3.00	17.80	5.20
Lead-214	13	3	23	5.00	24.80	10.13
Mercury-203	13	1	8	1.50	4.00	2.4
Neptunium-239	12	1	8	150.00	6000000.00	3,100
Plutonium-239	13	1	8	0.03	0.45	0.15
Potassium-40	13	1	8	25.00	100.00	39
Radium-224	13	4	31	30.00	100.00	46.69
Ruthenium-106	13	1	8	10.00	40.00	18
Scandium-106	13	1	8	2.00	6.00	2.9
Silver-110	13	1	8	1.50	6.00	2.4
Sodium-22	13	2	15	1.50	5.00	2.13
Strontium-85	13	1	8	1.50	5.00	2.6
Strontium-90	13	1	8	0.10	2.00	0.34
Technetium-96	13	2	15	5.00	1500.00	41.44
Thallium-208	13	1	8	5.00	16.80	6.4
Thorium-228	13	1	8	3.00	15.70	4.9
Thorium-230	11	2	18	0.04	5.20	0.12
Thorium-232	13	2	15	0.03	0.15	0.06
Tin-113	13	1	8	1.00	3.00	1.7
Tritium	13	4	31	20.00	350.00	68.41
Uranium-234	13	11	85	0.20	21.00	2.15
Uranium-235	13	2	15	10.00	40.00	17.43
Uranium-238	13	8	62	0.05	17.00	1.18
Xenon-131M	13	1	8	100.00	1000.00	260
Xenon-133	13	1	8	25.00	1500.00	82
Zinc-65	13	2	15	3.00	10.00	4.55
Zirconium-95	13	1	8	3.00	6.00	4.3

Notes:

a. Only chemicals detected at least once in the source area well grouping are presented.
b. Method of calculation: (number of samples with detected concentrations/number of samples within this well grouping)
c. Minimum/Maximum detected concentration values (only two figures are significant).
d. Geometric mean of the median concentrations from all wells in this well grouping including ½ the detection limit for non-detects (only two figures are significant).

Table 6-3

Summary of Chemical Concentration Data for Downgradient Unweathered Dawson Monitoring Wells Outside the Source Area

Chemical Name (a)	No. of Analyses	No. of Detects	Frequency (b) of Detects (%)	Minimum (c) Detected Concentration	Maximum (c) Detected Concentration	Average (d) Detect
Organics (µg/l)						
1,1,1-Trichloroethane	101	8	8	3.00	77.00	3.30
1,1-Dichloroethane	102	7	7	2.00	35.00	2.72
1,1-Dichloroethylene	102	5	5	1.00	5.00	2.45
1,2,3,4,6,7,8-Heptachlordibenzo-p-Dioxin	14	2	14	0.00001	0.00006	0.000007
1,2,3,4,7,8-Hexachlorodibenzofuran	14	1	7	0.000003	0.000003	0.0000019
1,2,3,6,7,8-Hexachlorodibenzofuran	14	1	7	0.00001	0.00001	0.0000019
1,2,3,7,8,9-Hexachlorodibenzofuran	14	2	14	0.00001	0.00001	0.000003
1,2-Dichloroethane	102	6	6	5.00	459.00	3.14
2,3,4,6,7,8-Hexachlorodibenzofuran	14	2	14	0.00001	0.00001	0.000003
2,3,7,8-Tetrachlorodibenzofuran	14	1	7	0.00001	0.00001	0.0000019
2,4,5-T	12	1	8	0.30	0.30	0.30
2-Butanone (MEK)	72	3	4	1.10	7.90	4.85
2-Hexanone	102	3	3	1.30	5.00	4.65
4-Methyl-2-Pentanone (MIBK)	102	2	2	1.60	2.00	4.59
Acetone (2-Propanone)	102	24	24	3.00	140.00	11.31
Benzene	102	1	1	11.00	11.00	2.7
bis(2-Ethylhexyl)Phthalate	93	8	9	1.00	33.00	4.08
Chloroform	102	4	4	0.30	5.00	2.31
Di-N-Butylphthalate	93	3	3	4.00	4.80	4.67
Heptachlorodibenzofurans	14	1	7	0.00001	0.00001	0.0000026
Hexachlorodibenzofurans	15	1	7	0.00001	0.00001	0.0000024
Methylene Chloride	102	13	13	0.90	640.00	2.72
Pentachlorodibenzofurans (Total)	14	1	7	0.00002	0.00002	0.0000034
Phenol	93	2	2	3.40	6.00	5.26
Propoxur	14	1	7	2.00	2.00	0.65
Tetrachlorodibenzofuran (Dioxin)	14	1	7	0.000004	0.000004	0.0000024
Tetrachloroethylene	102	4	4	1.00	31.00	2.78
Toluene	102	9	9	1.00	3.00	1.96
Total Heptachlorodibenzo-P-Dioxin	14	1	7	0.0001	0.0001	0.0000074
Trichloroethylene	102	2	2	8.00	8.00	2.62
Inorganics (µg/l)						
Aluminum	89	25	28	2.40	4900.00	62.31
Antimony	81	6	7	0.61	164.00	11.70
Arsenic	84	9	11	1.75	20.90	1.77
Barium	89	72	81	8.90	545.00	33.19
Beryllium	89	2	2	1.10	1.20	0.68
Boron	33	27	82	26.50	843.00	147.90
Cadmium	89	2	2	2.80	5.60	1.92
Chromium (Total)	89	16	18	0.43	34.00	3.22

Table 6-3

Summary of Chemical Concentration Data for Downgradient Unweathered Dawson Monitoring Wells Outside the Source Area

Chemical Name (a)	No. of Analyses	No. of Detect	Frequency (b) of Detects (%)	Minimum (c) Detected Concentration	Maximum (c) Detected Concentration	Average (d) Detect
Cobalt	89	10	11	0.56	4.90	1.51
Copper	89	16	18	1.40	47.00	6.21
Cyanide	80	5	6	10.00	180.00	8.80
Fluoride	31	18	58	140.00	1750.00	352.64
Lead	73	13	18	0.88	12.00	1.66
Manganese	89	85	96	1.80	603.00	121.99
Mercury	89	9	10	0.26	2.00	0.19
Nickel	89	17	19	1.40	40.00	6.97
Selenium	86	13	15	1.90	188.00	2.77
Silver	83	7	8	3.40	14.00	2.74
Thallium	82	13	16	0.25	1.30	1.18
Tin	17	1	6	102.00	102.00	11
Vanadium	89	6	7	1.41	26.00	4.04
Zinc	89	46	52	3.50	200.00	15.57
Radionuclides (pCi/l)						
Americium-241 (Alpha)	10	2	20	0.04	2000000.00	10.1
Antimony-122	29	4	14	0.15	800.00	19
Antimony-125	29	1	3	4.00	10.00	5.1
Arsenic-76	27	1	4	0.01	8000000.00	1,300
Barium-140	29	1	3	3.50	30.00	8.5
Bismuth-214	35	11	31	3.00	92.00	8.4
Cadmium-109	29	1	3	30.00	150.00	54
Cerium-139	29	1	3	1.50	5.00	2.3
Cerium-143	3	3	100	35.00	50.00	41.21
Cerium-144	35	1	3	10.00	460.00	27
Cesium-134	35	1	3	1.50	60.00	3.7
Cesium-137	35	1	3	1.50	20.30	2.8
Chromium-51	29	1	3	10.00	60.00	20
Cobalt-57	29	1	3	1.50	5.00	2.3
Cobalt-60	35	2	6	1.50	17.00	2.8
Iodine-124	29	1	3	0.50	200.00	2.8
Iodine-131	29	1	3	1.00	30.00	16
Iodine-132	29	1	3	0.25	300.00	15
Lanthanum-140	29	3	10	1.00	20.00	3.7
Lead-212	7	4	57	8.49	25.00	14.38
Lead-212-Bismuth	28	1	4	2.50	15.90	4.3
Lead-214	35	11	31	5.00	89.50	13.07
Plutonium-239	29	6	21	0.03	45.00	0.2
Potassium-40	35	2	6	25.00	163.00	54
Radium-226	7	3	43	0.20	30.00	1.2
Radium-228	29	1	3	5.00	25.00	10
Rubidium-83	29	1	3	2.50	10.00	4.0

Table 6-3

Summary of Chemical Concentration Data for Downgradient Unweathered Dawson Monitoring Wells Outside the Source Area

Chemical Name (a)	No. of Analyses	No. of Detect	Frequency (b) of Detects (%)	Minimum (c) Detected Concentration	Maximum (c) Detected Concentration	Average (d) Detect
Ruthenium-106	35	1	3	10.00	87.50	23
Scandium-46	29	1	3	1.50	7.00	2.8
Silver-110	29	1	3	1.50	6.00	2.5
Strontium-90	29	2	7	0.15	1.90	0.43
Thallium-208	35	1	3	4.50	15.00	7.6
Thorium-228	30	2	7	2.50	10.00	4.0
Thorium-230	16	5	31	0.05	6.30	0.20
Thorium-232	29	12	41	0.02	17.00	0.30
Thorium-234	29	1	3	25.00	100.00	49
Tritium	30	3	10	15.00	1000.00	50
Uranium-234	21	15	71	0.10	3.80	0.6
Uranium-235	31	4	13	0.10	40.00	15
Uranium-238	33	12	36	0.02	190.00	0.3
Uranium-Natural	6	4	67	0.15	2.35	1.00
Yttrium-88	29	2	7	1.50	5.00	2.1
Zinc-65	35	1	3	2.50	27.00	5.4

Notes:

a. Only chemical detected at least once in the source area well groupings are presented.

b. Method of calculation: (number of samples with detected concentrations/number of samples within this well grouping)

c. Minimum/Maximum detected concentration values (only two figures are significant).

d. Geometric mean of the median concentrations from all wells in the well grouping including ½ the detection limit for non-detects (only two figures are significant).

Table 6-4
Summary of Chemical Concentration Data for Deep Ground-Water Monitoring Wells

Chemical Name (a)	No. of Analyses	No. of Detects	Frequency (b) of Detects (%)	Minimum (c) Detected Concentration	Maximum (c) Detected Concentration	Average (d) Detect
		Organics (µg/l)				
1,1,1-Trichloroethane	44	11	25	3.00	23000.00	4.76
1,1,2-Trichlorethane	44	1	2	2.00	2.00	2.4
1,1-Dichloroethane	44	10	23	86.00	1900.00	4.43
1,1-Dichloroethylene	44	9	20	54.00	560.00	4.26
1,2,3,4,6,7,8-Heptachlorodibenzofuran	5	1	20	0.00008	0.00008	0.000011
1,2,3,4,7,8-Hexachlorodibenzofuran	5	1	20	0.00003	0.00003	0.0000061
1,2,3,6,7,8-Hezachlorodibenzofuran	5	1	20	0.00002	0.00002	0.0000049
1,2-Dichloroethene (Total)	45	1	2	7.00	7.00	2.8
1,2-Dichloropropane	44	1	2	2.00	2.00	2.4
2,3,4,6,7,8-Hexachlorodibenzofuran	5	1	20	0.00002	0.00002	0.0000053
4-Methyl-2-Pentanone (MIBK)	44	3	7	10.00	600.00	5.51
Acetone (2-Propanone)	44	9	20	5.30	1100.00	16.68
Aluminum	37	15	41	7.29	30100.00	116.49
Benzene	44	3	7	2.00	47.00	3.48
bis(2-Ethylhexy)Phthalate	34	6	18	3.00	30.00	6.35
Boron	12	11	92	39.10	602.00	157.60
Carbon Disulfide	44	1	2	24.00	24.00	3.2
Chloroform	44	1	2	2.00	2.00	2.4
Di-N-Butylphthalate	34	3	9	2.40	6.00	4.70
Di-N-Octylphthalate	34	1	3	18.00	18.00	6.2
Ethylbenzene	44	1	2	22.00	22.00	3.2
Heptachlorodibenzofuran	5	1	20	0.000110	0.000110	0.000014
Hexachlorodibenzodioxins	5	1	20	0.000005	0.000005	0.0000042
Hexachlorodibenzofurans	5	1	20	0.000090	0.000090	0.0000088
Manganese	37	29	78	1.80	9100.00	34.50
Methoxychlor	30	1	3	0.11	0.11	0.19
Methylene Chloride	44	6	14	2.90	13000.00	3.53
Naphthalene	34	1	3	2.80	2.80	4.7
Octachlorodibenzodioxins (Total)	5	2	40	0.00004	0.00010	0.00005
Octachlorodibenzofurans (Total)	5	1	20	0.00008	0.00008	0.000035
Pentachlorodibenzofurans (Total)	5	1	20	0.00003	0.00003	0.0000048
Phenol	34	1	3	2.40	2.40	5.0
Tetrachlorodibenzofuran (Dioxin)	5	1	20	0.00003	0.00003	0.0000028
Tetrachloroethylene	44	11	25	2.90	5000.00	5.01
Toluene	44	12	27	1.80	1200.00	5.17
Total Heptachlorodibenzo-P-Dioxin	5	1	20	0.00002	0.00002	0.000014
Total Xylenes	44	8	18	15.00	750.00	3.94
Trichloroethylene	44	4	9	9.00	290.00	3.65
		Inorganics (µg/l)				
Arsenic	33	4	12	1.70	30.00	1.93
Barium	37	32	86	28.00	1050.00	61.28
Beryllium	37	1	3	1.20	1.20	0.96

Table 6-4
Summary of Chemical Concentration Data for Deep Ground-Water Monitoring Wells

Chemical Name (a)	No. of Analyses	No. of Detects	Frequency (b) of Detects (%)	Minimum (c) Detected Concentration	Maximum (c) Detected Concentration	Average (d) Detect
Chromium (Total)	37	5	14	0.48	60.00	3.89
Cobalt	37	2	5	7.30	35.00	7.75
Copper	37	4	11	7.40	72.00	6.36
Cyanide	36	1	3	25.70	25.70	5.8
Fluoride	17	14	82	350.00	970.00	631.30
Lead	32	6	19	1.10	26.00	1.75
Mercury	37	4	11	0.13	1.70	0.20
Nickel	37	3	8	2.20	162.00	13.81
Selenium	30	2	7	1.80	2.90	1.36
Thallium	31	2	6	0.33	0.91	1.38
Vanadium	37	5	14	1.90	90.00	5.41
Zinc	37	22	59	3.80	275.00	17.13
Radionuclides (pCi/l)						
Americium-241	10	2	20	0.31	1500000.00	160.69
Americium-241 (Alpha)	5	1	20	0.21	1500000.00	140
Arsenic-76	8	1	13	4.50	3500000.00	180
Barium-133	10	1	10	1.50	5.00	2.3
Bismuth-214	14	9	64	4.50	141.00	21.74
Cadmium-109	12	2	17	40.00	430.00	64.45
Cerium-143	2	2	100	18.00	51.00	30.30
Iron-59	14	1	7	3.00	26.75	6.6
Lead-212	6	3	50	3.25	31.00	11.11
Lead-212-Bismuth	8	1	13	3.50	6.00	4.3
Lead-214	14	8	57	5.00	148.00	28.13
Neodynium-147	10	1	10	15.00	100.00	36
Plutonium-239	12	3	25	0.03	0.60	0.1
Radium-226	4	4	100	0.60	0.80	0.71
Rubidium-83	10	1	10	3.00	6.00	4.1
Thallium-208	14	1	7	4.85	17.00	6.6
Thorium-228	12	1	8	0.25	4.50	2.5
Thorium-230	8	5	63	0.04	16.00	0.80
Thorium-232	12	3	25	0.03	1.70	0.22
Tin-113	10	1	10	1.50	3.00	1.9
Uranium-234	8	4	50	0.10	2.20	0.38
Uranium-235	12	2	17	8.30	20.00	16.30
Uranium-238	12	5	42	0.03	23.50	0.25
Uranium-Natural	4	1	25	0.10	1.50	0.7
Xenon-131M	10	2	20	75.00	400.00	166.32
Zirconium-89	10	1	10	2.00	500.00	17

Notes:

a. Only chemicals detected at least once in the source area well grouping are presented.

b. Method of calculation: (number of samples with detected concentrations/number of samples within this well grouping)

c. Minimum/Maximum detected concentration values (only two figures are significant).

d. Geometric mean of the median concentrations from all wells in this well grouping including ½ the detection limit for non-detects (only two figures are significant.)

Table 6-5
Summary of Chemical Concentration Data for Upgradient Monitoring Wells Outside of the Source Area

Chemical Name (a)	No. of Analyses	No. of Detects	Frequency (b) of Detects (%)	Minimum (c) Detected Concentration	Maximum (c) Detected Concentration	Average (d) Detect
			Organics(µg/l)			
1,1,1-Trichloroethane	33	4	12	4.00	5.00	3.33
1,1,-Dichloroethylene	33	1	3	1.00	1.00	2.10
2,3,4,6,7,8-Hexachlorodibenzofuran	4	1	25	0.000004	0.000004	0.0000045
2-Butanone (MEK)	24	1	4	7.50	7.50	5.30
4-Methyl-2-Pentanone (MIBK)	33	1	3	14.00	14.00	5.90
Acetone (2-Propanone)	33	7	21	1.00	1.00	6.96
Benzoic Acid	26	1	4	4.60	4.60	21.00
bis(2-Ethylhexyl)Phthalate	28	2	7	8.00	8.00	8.65
Di-N-Butylphthalate	28	3	11	3.60	3.60	6.70
Di-N-Octylphthalate	28	1	4	8.00	8.00	61.00
Hexachlorodibenzofurans	4	1	25	0.000004	0.000004	0.0000045
Methylene Chloride	33	11	33	1.60	1.60	7.68
Octachlorodibenzodioxins (Total)	4	1	25	0.00012	0.00012	0.000047
Octachlorodibenzofurans (Total)	4	1	25	0.00002	0.00002	0.000013
Phenol	28	2	7	2.20	2.20	4.27
Tetrachloroethylene	33	5	15	1.60	1.60	2.98
Toluene	33	6	18	1.10	1.10	2.20
Trichloroethylene	33	1	3	1.00	1.00	2.10
			Inorganics (µg/l)			
Aluminum	46	19	41	15.13	24600.00	176.41
Antimony	45	6	13	3.07	770.00	4.15
Arsenic	42	8	19	1.10	6.00	8.64
Barium	46	27	59	8.01	188.00	22.36
Beryllium	45	3	7	0.30	1.10	0.67
Boron	13	5	38	14.40	210.00	107.36
Cadmium	46	2	4	2.20	3.40	2.08
Chromium (Total)	46	6	13	3.40	210.00	6.17
Cobalt	46	6	13	2.10	27.90	1.85
Copper	46	10	22	3.90	90.90	10.87
Cyanide	41	1	2	5.00	5.00	3.00
Fluoride	2	1	50	670.00	670.00	230.00
Lead	42	4	10	4.00	34.60	1.90
Manganese	46	38	83	5.90	958.00	28.39
Mercury	46	4	9	0.31	1.00	0.29
Nickel	46	6	13	20.50	61.00	15.90
Selenium	38	25	66	1.30	372.00	36.10
Silver	46	2	4	3.30	3.50	2.19
Vanadium	46	5	11	1.30	65.00	9.18
Zinc	46	27	59	3.60	655000.00	66.37

Table 6-5
Summary of Chemical Concentration Data for Upgradient Monitoring Wells Outside of the Source Area

Chemical Name (a)	No. of Analyses	No. of Detects	Frequency (b) of Detects (%)	Minimum (c) Detected Concentration	Maximum (c) Detected Concentration	Average (d) Detect
Radionuclides (pCi/l)						
Americium-241 (Alpha)	2	1	50	0.10	1.30	0.40
Bismuth-214	15	5	33	3.50	74.00	8.42
Lead-212	4	1	25	2.75	30.00	9.30
Lead-214	15	3	20	5.00	55.00	12.60
Plutonium-239	4	1	25	0.05	0.59	0.10
Potassium-40	5	1	20	25.00	200.00	52.00
Radium-226	3	1	33	0.50	50.00	11.00
Thorium-232	4	2	50	0.02	12.00	0.34
Uranium-234	2	2	100	0.60	2.20	1.15
Uranium-235	5	1	20	12.50	20.00	16.00
Uranium-238	4	2	50	0.04	5.20	0.74
Uranium-Natural	2	1	50	1.50	19.00	5.30

Notes:

a. Only chemicals detected at least once in the source area well grouping are presented.

b. Method of calculation: (number of samples with detected concentrations/number of samples within this well grouping)

c. Minimum/Maximum detected concentration values (only two figures are significant).

d. Geometric mean of the median concentrations from all wells in this well grouping including ½ the detection limit for non-detects (only two figures are significant)>

Table 6-6

Summary of Chemicals Detected in Unsaturated Solids Within the Landfill Mass

Parameter Name	No. of Analyses	No. of Detects	Minimum Detect	Maximum Detect	Average Detect	Frequency of Detects (%)
			Organics (µg/kg)			
1,1-Dichloroethane	19	2	8	950	480	11
1,1,1-Trichloroethane	19	2	2	24,000	12,000	11
1,2-Dichlorobenzene	18	1	800	800	800	5.6
1,2-Dichloroethane	19	6	3	510	220	32
1,2,4-Trichlorobenzene	18	1	11,000	11,000	11,000	5.6
1,3-Dichlorobenzene	18	1	1,300	1,300	1,300	5.6
1,4-Dichlorobenzene	18	3	540	1,900	1,300	17
2-Butanone (MEK)	18	10	6.0	3,100	610	56
2-Hexanone	19	1	85	85	85	5.3
2-Methylnaphthalene	18	6	290	5,900	2,500	33
2-Methylphenol	18	1	2,000	2,000	2,000	5.6
4-Chloroaniline	18	1	680	680	680	5.6
4-Methylphenol	18	5	180	8,000	3,100	28
4-Methyl-2-pentanone (MIBK)	19	4	25	330	120	21
4,4'-DDD	19	5	1.9	400	150	26
4,4'-DDE	19	9	0.52	87	22	47
4,4'-DDT	19	6	1.1	1,700	290	32
Acenaphthene	18	1	220	220	220	5.6
Acetone (2-propanone)	19	11	110	8,200	1,700	58
Aldrin	19	4	1.1	3.2	1.7	21
Alpha Chlordane	19	6	1.9	390	71	32
Alpha-BHC	19	2	1.3	2.0	1.7	11
Benzene	19	4	2.0	16	8.0	21
Beta-BHC	19	3	4.1	17	9.2	16
Bis(2-ethylhexyl)phthalate	17	13	640	52,000	18,100	76
Butylbenzylphthalate	18	10	190	37,000	9,700	56
Carbon disulfide	19	1	2.0	2.0	2.0	5.3
Chlorobenzene	19	1	2.0	2.0	2.0	5.3
Chloroform	19	3	3.0	300	110	16
Delta-BHC	19	2	0.50	14	7.3	11
Dibenzofuran	18	1	140	140	1 40	5.6
Dieldrin	19	8	0.50	21	4.9	42
Diethylphthalate	18	7	100	8,200	2,200	39
Dimethylphthalate	18	1	510	510	510	5.6
Di-n-butylphthalate	18	12	280	19,000	4,700	67
Di-n-octylphlhalate	18	4	450	9,000	6,100	22
Endosulfan sulfate	19	6	0.19	640	110	32
Endosulfan II	19	5	0.25	790	160	26
Endosulfan I	19	5	0.36	6.2	2.5	26
Endrin ketone	19	4	0.90	95	28	21
Endrin	19	9	0.49	38	9.6	47
Endrin aldehyde	17	8	0.44	370	52	46
Ethylbenzene	19	12	4.0	5,300	580	63
Fluoranthene	18	1	500	500	500	5.6
Gamma chlordane	19	8	0.57	18	5.3	42
Gamma-BHC (Lindane)	19	3	1.5	13	5.7	16

Table 6-6

Summary of Chemicals Detected in Unsaturated Solids Within the Landfill Mass

Parameter Name	No. of Analyses	No. of Detects	Minimum Detect	Maximum Detect	Average Detect	Frequency of Detects (%)
Organics (µg/kg) (Continued)						
Heptachlor	19	4	0.60	10	3.3	21
Methoxychlor	19	5	0.41	36	14	26
Methylene chloride	18	12	13	13,000	1,300	67
N-nitroso-di-n-propylamine	18	1	23,000	23,000	23,000	5.6
N-nitrosodiphenylamine	18	3	800	1,500	1,100	17
Naphthalene	18	6	76	3,100	1,200	33
PCB-1260 (Aroclor 1260)	19	2	230	54,000	27,000	11
Pentachlorophenol	18	3	480	3,200	2,200	17
Phenanthrene	18	3	450	1,300	910	17
Phenol	18	11	120	7,000	2,400	61
Pyrene	18	1	560	560	560	5.7
Styreno	19	6	3.0	120	52	32
Tetrachloroethylene	19	9	6.0	4,800	650	47
Toluene	19	14	5.0	530,000	43,000	74
Total xylenes	19	14	7.0	61,000	8,500	74
Trichloroethylene	19	5	8.0	3,000	690	26
Inorganics (mg/kg)						
Aluminum	17	14	118	25,000	6,200	82
Arsenic	18	10	1.4	7.3	3.8	56
Barium	17	14	6.8	355	120	82
Beryllium	18	9	0.31	1.1	0.59	50
Cadmium	18	3	1.2	15.3	6.3	17
Chromium (Total)	17	13	2.7	46.7	17	76
Cobalt	18	10	4.3	10	6.9	56
Copper	17	14	3.6	2,500	230	82
Fluorene	18	1	260	260	260	5.6
Lead	17	14	0.77	1,400	150	82
Manganese	17	14	51	940	420	82
Mercury	18	5	0.22	0.87	0.49	28
Nickel	18	11	4.1	45	16	61
Selenium	18	1	1.6	1.6	1.6	5.6
Silver	18	1	4.1	4.1	4.1	5.6
Vanadium	17	11	5.2	65	19	64
Zinc	17	14	18	3,800	540	82
Radionuclides-pCi/g						
Alpha (Oross)	13	10	0	34	13	77
Americium-241 (Alpha)	13	10	0	1.6	0.20	77
Beta (Gross)	13	10	0.18	43	20	77
Bismuth-214	13	6	0.97	3.4	1.5	46
Iodine- 131	13	10	0	42	8. I	77
Iron-59	13	2	0.34	10	5.2	15
Lead-210	13	10	0.18	2.1	1.2	77
Lead-214	11	5	0.92	1.2	1.1	45

Table 6-6

Summary of Chemicals Detected in Unsaturated Solids Within the Landfill Mass

Parameter Name	No. of Analyses	No. of Detects	Minimum Detect	Maximum Detect	Average Detect	Frequency of Detects (%)
		Radionuclides-pCi/g (Continued)				
Phosphorus-32	13	1	5.0	5.0	5.0	7.7
Plutonium-239	13	10	0	2.0	0.33	77
Potassium-40	13	7	11	26	19	54
Radium-226	13	10	0.01	2.4	0.98	77
Radium-228	13	10	0	2.0	0.94	77
Strontium-90	13	10	0	0.30	0.13	77
Thorium-228	13	10	0	2.2	0.67	77
Thorium-232	13	10	0	1.4	0.65	77
Uranium-234	13	10	0	1.9	0.91	77
Uranium-235	13	10	0	0.1	0.01	77
Uranium-238	13	10	0	1.5	0.64	77

Source: CDM, 1993.

Table 6-7

**Summary of Chemicals Detected in Unsaturated Solids
Within the Former Tire Pile Area**

Parameter Name	No. of Analyses	No. of Detects	Frequency of Detects	Minimum Detect	Maximum Detect	Average Detect	
Organics (µg/kg)							
1,1-Dichlorethane	15	1	6.7	1,200	1,200	1,200	
1,1,1-Trichlorothane	15	2	13	3.9	1,700	840	
1,1,2,2-Tetrachlorethane	9	1	11	5,000	5,000	5,000	
1,2-Dichlorethane	15	1	6.7	3,900	3,900	3,900	
1,2-Dichlorethene (total)	13	2	15	3,900	34,000	19,000	
1,2-Dichloropropane	15	1	6.7	11,000	11,000	11,000	
1,2,3,4,6,7,8-Heptachlordibenzo-p-dioxin	3	3	100	0.68	1.3	1.0	
1,2,3,4,6,7,8-Heptachlordibenzofuran	3	3	100	0.13	0.28	0.18	
1,2,3,4,7,8-Hexachlordibenzofuran	3	3	100	0.0060	0.12	0.045	
1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin	3	1	33	0.0080	0.0080	0.0080	
1,2,3,4,7,8,9-Heptachlordibenzo-p-dioxin	3	2	67	0.0030	0.020	0.012	
1,2,3,4,7,8,9-Heptachlorodibenzofuran	3	3	100	0.0020	0.28	0.12	
1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin	3	3	100	0.030	0.070	0.040	
1,2,3,6,7,8 Hexachlorodibenzofuran	3	3	100	0.0020	0.050	0.020	
1,2,3,7,8-Pentachlorodibenzo-p-dioxin	3	1	33	0.0050	0.0050	0.0050	
1,2,3,7,8-Pentachiorodibenzofuran	3	3	100	0.0010	0.15	0.057	
1,2,3,7,8,9-Hexachlorodibenzofuran	3	1	33	0.040	0.040	0.040	
2-Butanone (MEK)	11	1	9.1	2,200	2,200	2,200	
2-Hexanone	15	1	6.7	6,900	6,900	6,900	
2-Methylnaphthalene	15	2	13	11,000	70,000	40,000	
2,3,4,6,7,8-Hexachlordibenzofuran	3	1	33	0.020	0.020	0.02	
2,3,4,7,8-Pentachlorodibenzofuran	3	3	100	0.0040	0.060	0.02	
2,3,7,8-Tetrachlordibenzofuran	3	3	100	0.0080	0.17	0.066	
3,3'-Dichlorobenzidine	14	1	7.1	420	420	420	--
4-Methyl-2-pentanone (MIBK)	15	3	20	2.7	54,000	22,000	
4,4'-DDE	15	3	20	96	25,000	9,000	
4,4'-DDT	15	2	13	30	63	47	
Acetone (2-propanone)	15	6	40	24	360,000	78,000	
Aldrin	15	2	13	3.7	55	29	
Alpha chlordane	13	1	7.7	0.16	0.16	0.16	
Benzene	15	3	20	1.0	5,500	2,600	
Beta-BHC	15	1	6.7	6.0	6.0	6.0	
Bis(2-ethylhexyl)phthalate	15	8	53	49	35,000	9,100	
Butylbenzylphthalate	14	1	7.1	48	48	48	
Chlorobenzene	15	2	13	2,800	16,000	9,300	
Delta-BHC	15	1	6.7	8.0	8.0	8.0	
Di-n-octylphthalate	14	1	7.1	43	43	43	
Dieldrin	15	1	6.7	9.5	9.5	9.5	
Ethylbenzene	15	3	20	900	170,000	80,000	
Gamma chlordane	13	1	7.7	51	51	51	
Heptachlor	15	1	6.7	83	83	83	
Heptachlorodibenzofurans	3	3	100	0.74	1.3	0.94	
Hexachlorodibenzofurans	3	3	100	0.12	0.44	0.23	
HXCDD (Dioxin)	3	3	100	0.08	0.43	0.20	

Table 6-7

Summary of Chemicals Detected in Unsaturated Solids Within the Former Tire Pile Area

Parameter Name	No. of Analyses	No. of Detects	Frequency of Detects	Minimum Detect	Maximum Detect	Average Detect
Organics (µg/kg) (Continued)						
Methoxychlor	15	1	6.7	0.61	0.61	0.61
Methylene chloride	15	2	13	7.0	9,600	4,800
Naphthalene	14	1	7.1	8,600	8,600	8,000
Octachlorodibenzodioxins (Total)	3	3	100	5.6	12	9.0
Octachlorodibenzofurans (Total)	3	3	100	1.10	2.1	1.5
PCB-1016 (Arclor 1016)	15	1	6.7	950	950	950
PCB-1254 (Aroclor 1254)	15	1	6.7	1,000	1,000	1,000
Pentachlorodibenzodioxins (Total)	3	2	67	0.0010	0.0040	0.0030
Pentachlorodibenzofurans (Total)	3	3	100	0.010	0.83	0.30
Phenanthrene	15	3	20	43	17,000	6,600
Phenol	15	1	6.7	47,000	47,000	47,000
Tetrachlorethylene	15	3	20	1.9	83,000	28,000
Tetrachlorodibenzofuran (dioxin)	3	3	100	0.020	1.0	0.38
Toluene	15	3	13	120,000	790,000	460,000
Total Heptachlorodibenzo-p-dioxin	3	3	100	1.9	2.1	2.0
Total Xylenes	15	3	20	2,600	2,500,000	1,000,000
Trichlorethylene	15	2	13	11,000	41,000	26,000
Inorganics (mg/kg)						
Aluminum	16	13	81	9,200	21,000	15,000
Antimony	8	2	25	1.0	30	16
Arsenic	13	8	62	0.86	18	7.3
Barium	16	16	100	24	1,200	270
Beryllium	16	14	88	0. 10	2.1	1.1
Boron	3	2	67	9.8	10	7.4
Cadmium	16	9	56	0.09	3.3	1.4
Chromium (Total)	16	16	100	6.6	240	32
Cobalt	16	16	100	4.1	15	8.7
Copper	16	16	100	13	40	22
Cyanide	13	2	15	0.94	1.6	1.3
Lead	16	15	94	8.3	250	35
Manganese	13	10	77	120	1,100	560
Mercury	16	4	25	0.070	20	5.0
Nickel	16	14	88	9.0	40	13
Silver	16	2	13	0.253	16	8.1
Thallium	16	3	19	0.030	0.22	0.15
Vanadium	16	16	100	12	170	44
Zinc	16	16	100	40	110	65
Radionuclides-pCi/g						
Actinium-228	3	3	100	0.77	NR	1.1
Alpha (Gross)	9	8	89	9.4	29	18
Americium-241 (Alpha)	9	6	67	0	1.5	0.27

Table 6-7

Summary of Chemicals Detected in Unsaturated Solids Within the Former Tire Pile Area

Parameter Name	No. of Analyses	No. of Detects	Frequency of Detects	Minimum Detect	Maximum Detect	Average Detect	
Radionuclides-pCi/g (Continued)							
Beta (Gross)	9	9	100	9.8	64	37	
Bismuth-214	9	5	56	0.69	2.7	1.5	
Fluorene	15	1	6.7	22,000	22,000	22,000	
Iodine-131	8	5	63	0	1.0	0.20	
Lead-210	6	4	67	1.2	1.8	1.6	
Lead-212-bismuth	3	1	33	0.27	0.27	0.27	
Lead-214	9	9	100	0.33	2.9	1.4	
Plutonium-239	9	8	89	0	0.40	0.12	
Potassium-40	9	9	100	4.8	36	22	
Radium-228 (Beta)	3	3	100	0.26	1.3	0.92	
Radium-226	6	6	100	1.2	2.9	1.8	i
Radium-228	9	9	100	0.2	3.0	1.4	
Strontium-90	9	6	67	0	0.20	0.030	
Thallium-208	3	3	100	0.40	1.2	0.85	
Thorium-228	9	9	100	0.27	2.2	1.4	
Thorium-230	6	6	100	1.2	2.1	1.6	
Thorium-232	9	9	100	0.15	1.7	1.1	
Tritium	3	1	33	0.27	0.27	0.27	
Uranium-234	9	9	100	0.12	2.9	1.1	
Uranium-235 (Alpha)	3	1	33	0.05	0.053	0.050	
Uranium-235	9	6	67	0	0.10	0.020	
Uranium-238	9	9	100	0.07	1.5	0.89	

NR = Not reported.

Table 6-8

Methane Concentrations in Perimeter Gas Monitoring Wells

Methane Concentrations (% by Volume)a

Gas Probe	8/91	9/91	10/91	11/91	12/91	1/92	2/92	3/92	4/92	5/92	6/92	7/92	8/92
GMP-1	0	NR	0	0	-	0	0	0.8	0	0	0	0	0
GMP-2	0	0	0	0	-	0	0	0	0	0	0	0	0
GMP-3	0.6	5	0	0.9	-	1.0	0	6	0.8	1.8	7	2.2	5.5
GMP-4A	0	0	0	0	-	0	0	0	0	0	0	0	0
GMP-5A	0	0	0	0	-	0	0	0	0	0	0	0	0
GMP-6A	30	4	0	0	-	1.5	44	50	47	45	36	38	49
GMP-7	10	16	0.3	10	-	19	7.5	30	16	25	16	13	21
GMP-8	0	0	0	0	-	0	0	0	0	0	0.4	0	0
GMP-9	0.7	30	0	1.6	-	25	0.2	0.2	1.1	0.3	0.2	0.1	0
GMP-10	0	0	0	0	-	0	0	0	0	0	0	0	0
GMP-11	0	NR	0	0	-	0	0	0	0	0	0	0	0
GMP-12	0	NR	0	0	-	0	0	0	0	0	0	0	0
GMP-13	0	NR	0	0	-	0	0	0	0	0	0	0	0
GMP-109	0	NR	NR	0	-	0	0	0	0	0	0	0	0
GMP-110	0	NR	NR	0	-	0	0	0	0	0	0	0	0

Methane Concentrations (% by Volume)a

Gas Probe	9/92	10/92	11/92	12/92	1/93	2/93	3/93	4/93	5/93	6/93	7/93	8/93	9/93
GMP-1	0	0	0	0	0	0	0.8	0	0	0	0	0	0
GMP-2	0	0	0	0	0	0.2	0	0	0	0	0	0	0
GMP-3	0.8	0.8	0.8	0	0	0.2	0	1.0	0.2	2.6	0.7	0.1	0
GMP-4A	0	0	0	0	0	0	0	0	0	0	0	0	0
GMP-5A	0	0	0	0	0	0	0	0	0	0	0	0	0
GMP-6A	15	30	30	1.8	0.3	3	0.2	45	24	35	1	35	32
GMP-7	1.7	20	15	7	14	0.2	10	0	4.4	30	10	25	0
GMP-8	0	0	0	0	0	0.2	0	0	0	0	0	0	1.3
GMP-9	6	0	0	0	0	0.2	0.1	14	0.6	20	2.5	0.1	0
GMP-10	0	0	0	0	0	0	0	0	0	0	0	0	0
GMP-11	0	0	0	0	0	0.1	0	0	0	0	0	0	0
GMP-12	0	0	0	0	0	0	0	0	0	0	0	0	0
GMP-13	0	0	0	0	0	0	0	0	0	0	0	0	0
GMP-109	0	0	0	0	0	0	0	0	0	0	0	0	0
GMP-110	0	0	0	0	0	0	0	0	0	0	0	0	0

aReadings taken with a direct reading instrument.

Note:

NR = No reading taken.

\- = No data collected.

Table 6-9

Landfill Gas Data Summary

Parameter Name	Total Observation	Detection Frequency	Minimum Detection (µg/m3)	Maximum Reported (µg/m3)
1,1,1-Trichloroethane	58	60	38	270,000
1,1,2-Trichloroethane	59	2.0	300	300
1,1-Dichloroethane	59	59	300	770,000
1,1-Dichloroethylene	38	50	170	18,000
1,2-Dichloroethane	38	16	110	68,000
1,2-Dichloroethylene (Total)	21	43	75	61,000
1,2-Dichloropropane	59	5.0	1,000	12,000
2-Butanone	62	24	1.0	38,000
4-Methyl-2-Pentanone	62	5.0	2,000	49,000
Acetone	61	41	43	85,000
Benzene	61	57	10	190,000
Bromomethane	59	3.0	62	230
Carbon disulfide	59	44	22	160,000
Carbon tetrachloride	62	2.0	86	86
Chlorobenzene	59	5.0	170	3,000
Chloroethane	59	56	21	780,000
Chloroform	59	20	19	4,000
Chloromethane	59	2.0	4,000	4,000
Ethylbenzene	61	56	30	80,000
Methylene chloride	62	63	42	840,000
Styrene	59	3.0	150	19,000
Tetrachloroethylene	59	64	14	160,000
Toluene	61	79	19	1,400,000
Total Xylenes	60	58	17	120,000
Trans-1,2-dichloroethylene	38	55	71	110,000
Trichloroethylene	59	53	64	24,000
Vinyl Acetate	62	2.0	98,000	98,000
Vinyl Chloride	58	57	77	680,000
cis-1,2-Dichloroethylene	21	33	300	670,000

Table 6-10

Sewage Sludge Application/Leachate Injection Area (Group 1) Soils Data Summary

Constituent	Total Observation	Detection Frequency (%)	Minimum Detected (µg/kg)	Maximum Reported (µg/kg)	Calculated (a) Mean (µg/kg)
1,1,1-Trichloroethane	15	20	0.5	3.0	0.9
2-Butanone	2	100	1.0	1.0	1.0
4,4'-DDE	11	9	0.90	3.7	1.2
4-Chloroaniline	27	48	44	2.000	380
4-Nitrophenol	1	100	530	530	530
Acetone	18	17	5.0	140	30
Benzene	29	10	0.50	16	2.7
Benzo(a)pyrene	1	100	52	52	52
Benzo(b)fluoranthene	3	100	33	120	75
Benzo(k)fluoranthene	1	100	72	72	72
Benzoic acid	2	100	60	76	68
beta-BHC	15	20	0.90	5.1	1.7
Bezno(g,h,i)perylene	1	100	64	64	64
bis(2-ethylhexyl)phthalate	30	67	35	2,200	380
Butylbenzylphthalate	12	17	100	390	200
Carbon disfulide	18	17	2.5	25	5.0
Chloroform	21	29	0.50	2.0	0.80
Chrysene	1	100	110	110	110
di-n-Butylphthalate	8	88	27	110	60
Dieldrin	15	13	1.6	12	2.9
Fluoranthene	3	67	25	98	58
gamma-Chlordane	11	9	1.6	6.6	2
Heptachlor	14	7	1.5	3.6	1.7
Heptachlor epoxide	3	33	1.6	3.2	2.1
Heptachlorodibenzodioxins	2	50	0.020	1.1	0.60
Heptachlorodibenzofurans (Total)	2	50	0.010	0.16	0.090
Hexachlorodibenzodioxins (Total)	2	50	0.010	0.030	0.020
Hexachlorodibenzofurans (Total)	2	50	0.010	0.020	0.010
Indeno(1,2,3-cd)pyrene	1	100	52	52	52
Methylene chloride	30	67	1.3	150	35
Octachlorodibenzodioxins (Total)	2	100	0.490	7.2	3.9
Octachlorodibenzofurans (Total)	2	50	0.010	0.090	0.050
PCB-1260	24	33	30	7600	520
Pentachlorodibenzodioxins	2	50	0.010	0.050	0.030
Pentachlorophenol	1	100	150	150	150
Phenanthrene	1	100	41	41	41
Phenol	3	67	39	80	57
Pyrene	4	75	25	91	55
Toluene	29	21	0.50	11	2.3
		Inorganics			
Aluminum	16	100	13,000,000	17,000,000	15,000,000
Arsenic	16	100	5,600	14,000	8,100
Barium	16	100	210,000	1,200,000	400,000

Table 6-10

Sewage Sludge Application/Leachate Injection Area (Group 1) Soils Data Summary

Constituent	Total Observation	Detection Frequency (%)	Minimum Detected (µg/kg)	Maximum Reported (µg/kg)	Calculated (a) Mean (µg/kg)
Beryllium	16	75	500	13,000	1,700
Cadmium	16	100	1,900	13,000	3,900
Chromium (total)	16	100	19,000	130,000	60,000
Cobalt	16	100	7,300	120,000	17,000
Copper	16	100	27,000	150,000	81,000
Cyanide	16	25	300	830,000	900
Lead	16	100	37,000	151,000	77,000
Manganese	16	100	420,000	830,000	600,000
Mercury	16	94	50	1,000	500
Nickel	16	100	17,000	130,000	33,000
Selenium	11	9.0	350	1,000	430
Silver	12	92	750	9,800	5,300
Tin	2	100	11,000	12,000	11,000
Vanadium	16	100	25,000	140,000	50,000
Zinc	16	100	70,000	290,000	
		Radionuclides			
Cesium-137	16	25	0.035	0.42	0.1
Radium-226	21	81	1.1	3.6	2.0
Uranium-234	2	100	1.3	1.6	1.4
Uranium-235	18	17	0.080	0.37	0.2
Uranium-238	2	100	1.2	1.6	1.4

a. Arithmetic mean using one-half the detection limit for non-detects.

Source: Table A-7, Baseline Risk Assessment (EPA, 1992).

Table 6-11

Sewage Sludge Applications Area (Group 2) Soils Data Summary

Constituent	Total Observation	Detection Frequency (%)	Minimum Detected (µg/kg)	Maximum Reported (µg/kg)	Calculated (a) Mean (µg/kg)
		Organics			
4,4'-DDD	8	13	2.2	38	12
4-Chloroaniline	8	63	55	520	200
Benzoic acid	1	100	210	210	210
bis(2-ethylhexyl)phthalate	8	63	93	510	240
Chloroform	3	33	0.50	3.0	1.3
di-n-Octylphthalate	1	100	190	190	190
Methylene chloride	8	25	1.7	30	15
Phenol	2	100	61	76	69
Toluene	8	13	0.5	3.0	2.3
		Inorganics			
Aluminum	6	100	11,000,000	20,000,000	16,000,000
Arsenic	6	83	1,300	7,300	5,100
Barium	6	100	140,000	240,000	210,000
Beryllium	6	83	550	1,500	1,100
Cadmium	6	100	1,400	3,000	2,300
Chromium (total)	6	100	23,000	62,000	45,000
Cobalt	6	100	8,800	12,000	10,000
Copper	6	100	33,000	83,000	60,000
Cyanide	6	33	300	1,800	650
Lead	6	100	44,000	81,000	63,000
Manganese	6	100	400,000	2,700,000	830,000
Mercury	6	50	50	500	225
Nickel	6	100	22,000	30,000	26,000
Vanadium	6	100	31,000	39,000	36,000
Zinc	6	100	77,000	160,000	120,000

a. Arithmetic mean using one-half the detection limit for non-detects.

Table 6-12

Leachate Spraying Area (Group 3) Soils Data Summary

Constituent	Total Observation	Detection Frequency (%)	Minimum Detected (µg/kg)	Maximum Reported (µg/kg)	Calculated (a) Mean (µg/kg)
		Organics			
Benzene	7	14	0.5	3.0	2.4
bis(2-ethylhexyl)phthalate	7	14	46	215	180
Chloroform	2	50	0.5	2.0	1.3
Methylene chloride	7	14	6.0	25	12
		Inorganics			
Aluminum	5	100	10,000,000	17,000,000	15,000,000
Arsenic	5	100	6,400	12,000	9,000
Barium	5	100	170,000	260,000	230,000
Beryllium	5	60	550	1,200	900
Cadmium	5	100	980	1,500	1,300
Chromium (total)	5	100	13,000	17,000	15,000
Cobalt	5	100	7,900	9,000	8,400
Copper	5	100	17,000	21,000	19,000
Lead	5	100	26,000	36,000	34,000
Manganese	5	100	370,000	640,000	460,000
Mercury	5	20	50	200	80
Nickel	5	100	12,000	16,000	15,000
Vanadium	5	100	25,000	34,000	30,000
Zinc	5	100	44,000	62,000	55,000

a. Arithmetic mean using one-half the detection limit for non-detects.

Table 6-13

Chemical Detected in Surface Soil Samples in the Tire Pile Area

Chemical	Detection Frequency Within the Tire Pile Area (%)	Total Number or Samples Collected in Tire Pile Area	Maximum Concentration (µg/kg)	Minimum Detected (µg/kg)	Calculated Mean (µg/kg)
		Organics			
1,1,1,-Trichloroethane	11	9	5	5	NC
2-Methylnaphthalene	11	9	4,600	4,600	NC
Alpha chlordane	56	9	0.25	0.07	NC
Acenaphthene	11	9	770	770	NC
Acetone	11	9	31	31	NC
Aldrin	11	9	0.75	0.75	NC
Anthracene	11	9	260	260	NC
Benzo(a)anthracene	11	9	1,100	1,100	NC
Benzo(a)pyreno	11	9	840	840	NC
Benzo(b)fluoranthene	11	9	740	740	NC
Alpha-BHC	11	9	0.96	0.96	NC
Beta-BHC	11	9	0.58	0.58	NC
Delta-BHC	11	9	2	2	NC
Gamma-BHC	11	9	8.7	8.7	NC
Benzo(k)fluoranthene	11	9	740	740	NC
bis(2-Ethylhexyl)phthalate	22	9	2,400	85	NC
Chrysene	11	9	2,000	2,000	NC
4,4'-DDE	11	9	2.1	2.1	NC
4,4'-DDT	22	9	0.58	0.32	NC
Dieldrin	22	9	0.24	0.08	NC
Endrin aldehyde	22	9	0.54	0.41	NC
Endosulfan I	11	9	2.2	2.2	NC
Endosulfan II	11	9	0.24	0.24	NC
Fluoranthene	11	9	900	900	NC
Fluorene	11	9	930	930	NC
Gamma chlordane	22	9	1.9	0.11	NC

Table 6-13

Chemicals Detected in Surface Soil Samples
in the Tire Pile Area

Chemical	Deletion Frequency With the Tire Pile Area (%)	Total Number of Samples Collected in Tire Pile Area	Maximum Concentration (µg/kg)	Minimum Detected (µg/kg)	Calculated Mean (µg/kg)
		Organics (Continued)			
Heptachlor	11	9	1.8	1.8	NC
Heptachlor epoxide	11	9	2.4	2.4	NC
Methoxychlor	22	9	1.4	0.5	NC
Naphthalene	11	9	890	890	NC
Phenanthrene	11	9	2,700	2,700	NC
PCB-1260 (Aroclor 1260)	11	9	100	100	NC
Tetrachloroethylene	11	9	18	18	NC
Pyrene	11	9	5,500	5,500	NC
		Inorganics			
Aluminum	100	8	25,100,000	7,860,000	21,000,000
Arsenic	100	8	5,250	1,400	3,000
Barium	100	8	331,000	124,000	220,000
Beryllium	100	8	1,300	720	1,100
Chromium	100	8	35,200	8,800	19,000
Cobalt	100	8	11,500	5,000	9,000
Copper	100	8	46,700	13,400	25,500
Lead	100	8	36,500	7,300	19,000
Manganese	100	8	1,880,000	206,000	830,000
Mercury	25	8	130	46	73
Nickel	100	8	20,500	7,100	14,000
Selenium	14	7	1,000	455	555
Vanadium	100	8	68,300	19,400	44,000
Zinc	100	8	95,500	44,500	74,000

NC - Not Calculated.

Table 6-14

Subsurface Soil Data Summary

Constituent	Total Observation	Detection Frequency (%)	Minimum Detected (µg/kg)	Maximum Reported (µg/kg)	Calculated Mean (µg/kg)
		Organics			
1,2-Dichloroethane	27	7.0	42	130	NC
1,1,1-Trichloroethane	61	2.0	3.9	3.9	NC
2-Butanone	16	12	44	120	NC
4,4'-DDD	58	3.0	0.26	1.2	NC
4,4'-DDE	58	2.0	0.11	0.11	NC
4,4'-DDT	26	15	0.34	30	NC
4-Chloroaniline	60	13	53	2,500	NC
4-Methyl-2-pentanone	45	4.0	2.7	170	NC
Acetone	45	20	15	160	NC
Aldrin	26	8.0	0.15	3.7	NC
Benzene	59	2.0	1.0	1.0	NC
Benzo(b)fluoroanthene	34	3.0	52	52	NC
Benzoic acid	46	7.0	81	210	NC
beta-BHC	58	3.0	1.1	6.0	NC
bis(2-ethylhexyl)phthalate	60	47	41	1,800	NC
Butylbenzyl phthalate	60	8.0	48	170	NC
Chloroform	61	10	2.0	4.0	NC
di-n-Butylphthalate	60	5.0	45	110	NC
di-n-Octylphthalate	60	2.0	43	43	NC
Dieldrin	58	2.0	9.5	9.5	NC
Endrin	26	12	0.11	0.15	NC
Endrin ketone	26	4.0	0.21	0.21	NC
Fluoranthene	34	3.0	69	69	NC
gamma Chlordane	56	2.0	0.13	0.13	NC
gamma-BHC (lindane)	26	4.0	0.11	0.11	NC
Methylene chloride	67	41	1.2	120	NC
PCB-1260	28	11	270	2,100	NC
Phenanthrene	34	3.0	46	46	NC
Phenol	34	9.0	40	95	NC
Pyrene	34	3.0	75	75	NC
Tetrachloroethene	27	4.0	1.9	1.9	NC
Toluene	59	5.0	1.0	4.0	NC
		Inorganics			
Aluminum	51	100	6400	25,000,000	NC
Antimony	11	9.0	30	30,000	NC
Arsenic	51	86	0.86	18,000	NC
Barium	51	100	43	1,200,000	NC
Beryllium	50	76	0.78	21,000	NC
Cadmium	51	69	0.82	3,900	NC
Chromium (total)	51	96	6.6	83,000	NC
Cobalt	51	100	5.8	17,000	NC
Copper	51	100	13	97,000	NC

Table 6-14

Subsurface Soil Data Summary

Constituent	Total Observation	Detection Frequency (%)	Minimum Detected (µg/kg)	Maximum Reported (µg/kg)	Calculated Mean (µg/kg)
		Inorganics (cont.)			
Cyanide	51	12	0.52	2,400	NC
Lead	51	100	8.3	100,000	NC
Manganese	47	100	120	1,800,000	NC
Mercury	51	43	0.10	1,100	NC
Nickel	51	92	7.7	29,000	NC
Silver	39	8.0	2.3	16,000	NC
Vanadium	51	96	20	85,000	NC
Zinc	51	100	43	180,000	NC
		Radionuclides			
Lead-210 (pCI/g)	4	75	1.2	1.8	1.5
Plutonium-239	3	100	0.10	0.40	0.20
Potassium-40	20	100	16	27	19
Strontium-90	1	100	0.20	0.20	0.20
Thorium-228	4	100	0.80	2.2	1.4
Thorium-230	4	100	1.3	2.1	1.7
Thorium-232	20	100	0.70	1.7	1.3
Uranium-234	4	100	0.90	2.9	1.7
Uranium-238	4	100	0.70	1.5	1.2

NC = not calculated.

Table 6-15

Surface Water Data Summary

Constituent	Total Observation	Detection Frequency (%)	Group 1 Minimum Detected (µg/kg)	Group 1 Maximum Reported (µg/kg)	Group 1 Calculated Mean (µg/kg)	Group 2 Minimum Detected (µg/kg)	Group 2 Maximum Reported (µg/kg)	Group 2 Calculated Mean (µg/kg)	Group 3 Minimum Detected (µg/kg)	Group 3 Maximum Reported (µg/kg)	Group 3 Calculated Mean (µg/kg)
Organics											
1,2-Dichloroethene	12	75	2.5	730	400	--			--		
1,1,1-Trichloroethane	60	62	0.80	31,000	4,400	2.5			0.80	6.3	2.8
1,1,2-Trichloroethane	51	4.0	2.0	3.0	2.5	0.5			--		
2-Butanone	46	59	2.1	51,000	12,000	4	4.9	4.5	3.1	52	9.1
Acetone	59	61	4.1	240,000	27,000	3.5	220	58	3.0	16	6.5
di-n-Butylphthalate	55	11	3.9	3.9	4.0	0.80	10	5.3	3.9	3.9	3.9
Methylene chloride	60	53	0.80	7,700	970	1.3	4.5	2.8	0.60	39	5.1
OCDD (total)	2	50	0	0.04	0.020	--			--		
PCDD (total)	2	0	0	0.01	0	--			--		
Pyrene	55	7.0	10	10	10	-			--		
Styrene	1	100	--			--			1.2	1.2	1.2
Inorganics											
Aluminum	66	80	13	260,000	15,000	62	7,200	1,700	32	6,500	1,200
Arsenic	59	58	4.2	42	19	0.55	6.0	4.0	4.0	5.0	4.9
Barium	65	86	54	1,500	300	50	110	80	50	290	170
Boron	2	100	120	240	180	--			--		
Chromium (total)	65	32	1.2	200	19	2.5	7.5	5.0	1.5	15	4.0
Copper	65	32	1.3	660	34	5.0	25	11	1.0	13	4.7
Cyanide	62	50	2.5	62	14	5.0	10	7.0	2.5	250	26
Fluoride	2	50	300	660	480	--			--		
Manganese	68	99	46	38,000	12,000	9.4	1,200	380	6.9	4,000	600
Mercury	58	33	0.050	1.5	0.46	0.10	2.7	0.60	0.10	3.6	0.6
Nickel	65	55	2.5	250	110	6.0	29	18	3.0	36	13
Selenium	11	64	--			--			2.0	23	9.1
Vanadium	65	42	0.50	630	50	2.5	21	11	1.0	19	8.5
Zinc	65	80	1.5	1,300	81	1.7	90	36	5.3	230	64

-- = Not analysed for or not reported.

Table 6-16

Summary of Chemicals Detected in Sediments in Section 6

Parameter Name	Total Observations	Number of Detects	Number of Non Detects	Detection Frequency	Minimum (µg/mg)	Maximum (µg/mg)
			Organics			
1,1,1-Trichloroethane	15	10	5	67	3.35	110,000.00
1,1,2-Trichloroethane	12	1	11	8	2.50	18.00
1,1-Dichloroethane	15	9	6	60	1.00	3,400.00
1,1-Dechloroethylene	15	6	9	40	2.00	1,800.00
1,2-Dichloroethane	4	2	2	50	2.00	6.00
1,2-Dichlorobenzene	15	3	12	20	100.00	900.00
1,2-Dichloroethlene (Total)	7	4	3	57	3.00	570.00
1,2-Dichloropropane	13	3	10	23	2.50	270.00
2,4-Dinitrophenol	10	0	10	0	800.00	1,200.00
2,4-Dimthylphenol	5	5	0	100	69.00	310.00
2-Butanone	5	5	0	100	33.00	15,000.00
2-Chlorophenol	1	1	0	100	50.00	50.00
2-Methylnaphthalene	15	5	10	33	54.00	24,000.00
2-Methylphenol	10	6	4	60	98.00	470.00
3,3'-Dichlorobenzidine	1	1	0	100	70.00	70.00
4-Methyl-2-pentanone	14	1	13	7	5.00	570.00
4-Methylphenol	4	2	2	50	165.00	390.00
Acenaphthene	15	1	14	7	165.00	2,400.00
Acetone	15	4	11	27	4.05	8,400.00
Aniline	1	1	0	100	330.00	330.00
Anthracene	15	2	13	13	59.00	1,200.00
Benzo(a)anthracene	15	2	13	13	87.00	2,400.00
Benzo(b)fluoranthene	15	1	14	7	165.00	3,400.00
Benzene	15	4	11	27	3.35	6,100.00
Gamma-BHC (Lindane)	15	1	14	7	4.00	300.00
Benzo(k)fluoranthene	15	1	14	7	165.00	3,400.00
bis(2-Ethylhexyl)phthalate	15	9	6	60	120.00	95,000.00
Chlorobenzene	14	1	13	7	2.50	710.00
Carbon disulfide	12	1	11	8	2.50	9.10
Chloroform	8	0	8	0	1.50	3.50
Chrysene	15	2	13	13	86.00	3,200.00
Dibenzofuran	15	1	14	7	165.00	1,400.00
Di-n-butylphthalate	15	2	13	13	145.00	2,700.00
2,4-Dichlorophenol	15	9	6	60	170.00	2,700.00
4,4'-DDT	14	1	13	7	8.00	280.00
Dieldrin	14	1	13	7	8.00	280.00
Di-n-octylphthalate	15	0	15	0	165.00	3,750.00
Ethylbenzene	15	8	7	53	1.00	95,000.00
Fluoranthene	15	4	11	27	69.00	7,700.00
Methylene chloride	14	1	13	7	4.95	710.00
Naphthalene	15	7	8	47	81.00	14,000.00
N-Nitrosodiphenylamine	1	1	0	100	75.00	75.00
Phenanthrene	15	5	10	33	62.00	6,200.00

Table 6-16

Summary of Chemicals Detected in Sediments in Section 6

Parameter Name	Total Observations	Number of Detects	Number of Non Detects	Detection Frequency	Minimum (µg/mg)	Maximum (µg/mg)	
PCB-1260 (Aroclor 1260)	13	3	10	23	105.00	2,400.00	
Tetrachloroethylene	15	9	6	60	3.00	48,000.00	
Phenol	1	1	0	100	130.00	130.00	
Pyrene	15	6	9	40	50.00	5,500.00	
trans-1,2-Dichloroethylene	8	6	2	75	3.35	3,100.00	
Trichloroethylene	15	9	6	60	3.35	41,000.00	
Toluene	15	11	4	73	3.35	280,000.00	
Total Xylenes	15	11	4	73	3.35	580,000.00	
Vinyl chloride	12	4	8	33	2.00	57.00	
			Inorganics				
Silver	12	1	11	8	800.00	3,300.00	
Aluminum	13	12	1	92	6,070,000.00	22,300,000.00	
Arsenic	10	7	3	70	3,550.00	21,000.00	
Barium	14	12	2	86	147,000.00	859,000.00	
Beryllium	9	1	8	11	355.00	1,800.00	
Cadmium	9	3	6	33	650.00	2,600.00	
Cyanide	14	2	12	14	145.00	1,910.00	
Cobalt	11	9	2	82	5,600.00	18,000.00	
Chromium (Total)	14	12	2	86	3,700.00	420,000.00	
Copper	14	12	2	86	11,000	159,000.00	---
Fluorene	15	1	14	7	165.00	1,800.00	
Mercury	14	5	9	36	50.00	1,900.00	
Manganese	9	7	2	78	476,000.00	1,860,000.00	
Nickel	14	11	3	79	9,100.00	22,000.00	
Lead	12	10	2	83	5,500.00	2,950,000.00	
Antimony	1	1	0	100	29,000.00	29,000.00	
Tin	1	1	0	100	13,000.00	13,000.00	
Vanadium	14	12	2	86	24,500.00	71,000.00	
Zinc	14	12	2	86	36,000.00	535,000.00	

Section 7.0
Summary of Site Risks

Baseline risk assessments (baseline RAs) were conducted for each environmental medium at the Lowry Site to evaluate the potential for adverse health and environmental effects caused by actual or potential releases of and exposure to site-related chemicals under current and hypothetical future conditions. A baseline risk assessment evaluates what types of risks could be present now and in the future if a site is not remediated or cleaned up. Under the baseline RA scenarios, EPA would not restrict the use of the Lowry Site and its resources and would take no action to prevent exposure of people or the environment to contaminants (the No-Action Alternative). This no-action scenario is used to assess the need for remedial action, to provide a basis for determining cleanup levels, and for comparing potential health effects of various remedial alternatives.

The baseline risk assessment for the Lowry Site consists of three volumes and will hereafter be referred to as the Baseline RA. A separate assessment was conducted for each group of OUs and for lead and radionuclides, as follows:

- Volume 1: OUs 1&6, which include shallow ground water and subsurface liquids and deep ground water.
- Volumes 2A and 2B3: OUs 2&3, which include landfill solids and landfill gas and OUs 4&5, which include soils, surface water and sediments.
- Volume 2C: sitewide issues relating to lead and radionuclides, and the relative risk contribution by media.

The Baseline RA for the Lowry Site assumed the following conditions:

- No further remedial actions would be implemented to address hazardous substances at the site.
- Interim remedial measures would be discontinued. Existing structures, such as fences and the ground-water barrier wall, would not be maintained and would eventually deteriorate. The Surface Water Removal Action (SWRA) would also not be maintained and would eventually deteriorate.
- Existing physical structures would not be maintained and would eventually deteriorate.
- Hypothetical future use of the Lowry Site would not be restricted and any type of land use could occur, including agricultural, industrial, recreational, or residential.

The results of the Baseline RA will be presented according to each medium and designated OU. The site risks presented by lead and radionuclides are presented separately. Key terms are defined in the ROD glossary.

7.1 Human Health Risks

A baseline risk assessment provides the basis for taking action and indicates the exposure pathways that need to be addressed by the remedial action. It serves as the baseline, indicating what risks could exist if no action were taken. This section of the ROD reports the results of the Baseline RA conducted for the Lowry Site.

Results are presented for each of the four basic components of the risk assessment: identification of chemicals of concern; exposure assessment; toxicity assessment; and risk characterization.

7.1.1 Chemicals of Concern

The chemicals of concern (COCs) for each OU were selected from all available Lowry Site data. Three primary criteria were used to select COCs:

- Comparing the chemical concentration to background levels to determine if the concentration in each sample was greater than the concentration expected under natural background conditions.
- Determining if the detection frequency of a chemical in a medium was greater than 10 percent.
- Toxicity-concentration screening to identify those chemicals, by media, that may contribute up to 99 percent of the risk.

Figure 7-1 presents the screening steps and selection criteria.

Table 7-1 presents the COCs selected for each medium and the minimum and maximum detected values for each. Forty-six chemicals were retained as COCs for the OUs 1&6 baseline risk assessment. Thirteen chemicals were selected as COCs for OU 3 and all 49 chemicals detected in subsurface soils were retained as COCs for OU 2. Thirty-six chemicals in surface water, 33 chemicals in sediments, and 23 chemicals in surface soil were retained as COCs for OUs 4&5. Radionuclides were detected in all media except landfill gas (no analyses were conducted for radionuclides in landfill gas) but they are not included in the COC counts above. Separate risk assessments for lead and radionuclides were conducted and are summarized in subsequent subsections (7.1.3, Summary of Lead Risks; 7.1.4, Summary of Radiological Risks).

7.1.2 Summary of Exposure Assessment

The exposure assessment identifies:

- Receptors (people) who could potentially be exposed to media containing COCs by looking at land use, both onsite and offsite (media may have migrated from the site) under current and hypothetical future conditions

- Pathways of exposure (such as ingestion, inhalation, dermal contact)

- Geographic locations where exposure could occur (exposure point)

- How much exposure could occur (exposure point concentrations, frequency, and duration of exposure, the amount of media contacted)

<u>7.1.2.1 Current Exposure</u>

Currently, the Lowry Site is zoned as agricultural and is only used for asbestos disposal. Figure 2-2 depicts major current land uses in the vicinity of the Lowry Site.

Currently, employees of WMC are onsite during the work week. There are no onsite residences and offsite receptors include farm residents near the Lowry Site, agricultural workers, and persons that may use the surrounding farmlands for recreation.

Under current conditions, no onsite or offsite exposures occur. WMC workers are subject to Federal and State regulations prescribing worker protection requirements to control exposure and, therefore, potential exposure pathways are not complete. Current offsite exposures do not occur because COCs have not been detected in media beyond the Section 6 boundaries to the south, east, and west, nor beyond Section 31 to the north.

<u>7.1.2.2 Hypothetical Future Exposure</u>

Development pressure for the area around the Lowry Site is influenced by projected population growth within Arapahoe County, economic growth of the City of Aurora, and the construction of the E-470 Beltway and interchanges. The U.S. Census Bureau projects a 50 percent increase in the population of Arapahoe County within the next 20 years. The City of Aurora anticipates mixed use for the area surrounding the Lowry Site, including industrial, commercial and residential. Following completion of the E-470 Beltway construction, it is expected that traffic will increase in the area. It may be assumed that increases in traffic may lead to increases in new businesses and eventually new residential development.

Given the potential for population growth and future land uses, three types of potentially exposed populations were identified: residential; commercial/industrial; and recreational.

Hypothetical future exposure settings were developed by integrating populations potentially exposed with the pathways through which exposure could occur. Settings identified include:

- Hypothetical future onsite and offsite residential (adults and children):

    - Ingestion of ground water

    - Incidental ingestion of surface soil, subsurface soils brought to the surface from excavation, sediment, and surface water

    - Inhalation of volatiles from surface water and sediment

    - Inhalation of suspended soil and/or dry sediments as particulates

  - Inhalation of landfill gas emissions

  - Dermal contact with surface soil, subsurface soil, surface water, sediment, and landfill gas

  - Encountering concentrated levels of methane

- Hypothetical future onsite commercial/industrial (worker):
  - Ingestion of ground water
  - Incidental ingestion of surface soil and subsurface soil
  - Inhalation of suspended surface soil as particulates
  - Inhalation of landfill gas emissions
  - Dermal contact with surface soil, subsurface soil, and landfill gas
  - Encountering concentrated levels of methane

- Hypothetical future onsite and offsite recreational:

  - Incidental ingestion of surface soft, surface water, and sediment
  - Inhalation of suspended soil and/or dry sediment as particulates
  - Inhalation of landfill gas emissions
  - Inhalation of volatiles from surface water and sediment
  - Dermal contact with surface soil, surface water, sediment, and landfill gas

The baseline risk assessments for the Lowry Site quantified exposure by estimating the highest exposure that could reasonably occur, the reasonable maximum exposure (RME), and for some media, the typical exposure-approximating conditions that are most likely to occur to provide a range of potential exposures. The RME is designed to be a conservative estimate of exposure that is within the range of possible exposures, but is higher than typical exposures. Exposure point concentrations and exposure parameter values are selected so the total exposure represents the upper 90th percentile estimate of possible exposures.

Exposure point concentrations were estimated from monitoring data, either directly or indirectly using simple models. In either case, monitoring data for each medium were summarized. Statistics used for the summary of each environmental medium vary because of the nature of the sample collection method (random or non-random), the distribution of the data in each medium, the variation in detection limits between various sampling events, and the number of values reported at the detection limit. For ground water, to control the bias introduced by multiple detection levels spanning several orders of magnitude, the median of the positively detected values (nondetects were ignored) from each well was used to generate a geometric mean and a 95th percentile upper confidence limit (95th UCL) on the geometric mean of the median for a specific grouping of wells (for example, waste-pit well points and shallow ground-water wells within the source area). If a well had no positive detects for a particular contaminant, one-half of the lowest detection limit was used to represent the median value.

For all other media, the data were log-transformed, and an arithmetic mean and a 95th UCL of the mean were calculated. A value of one-half the sample quantitation limit was used in the calculations for all nondetects.

Direct use of monitoring data utilized either the 95th UCL on the appropriate statistical parameter (mean or median) or the maximum concentration detected if the 95th UCL was greater than the maximum concentration detected in estimating the exposure point concentration for the RME. When typical exposure conditions were evaluated, average concentrations were used as the exposure point concentrations. Models used to estimate the exposure point concentration at a location where monitoring data were not available used the 95th UCL or maximum value as an input parameter for RME conditions and the average concentrations for typical conditions. A basic assumption of the risk assessments is that no physical, chemical, or biological processes reduce the chemical concentration over time, and therefore, exposure point concentrations are constant for the duration of exposure.

Exposure point concentrations for chemicals in ground water were developed for one onsite and seven offsite locations for different aquifers using various pumping rates (domestic at 15 gpm and municipal at greater than 200 gpm). Of these eight locations, the highest concentrations were obtained with the direct use of monitoring data from shallow ground-water wells in the weathered Dawson aquifer and waste-pit liquid well points within the source area (the landfill mass). These concentrations, presented in Table 7-2, were used to evaluate RME conditions for the future onsite residential setting.

The maximum detected concentration of chemicals in subsurface soil (see Table 74) were used as the exposure point concentrations for the future onsite residential setting and the future onsite worker setting. The assumption was made that subsurface soils could be excavated to 10 feet, spread over the surface, and regraded.

Human exposure to landfill gas in a future onsite residence was evaluated at two distinct locations onsite that corresponded to the origin of the gas: the landfill mass area with exposure to refuse gas; and the tire pile area with exposure to soil gas.

The assumption was made that subsurface gas would be transported into a home through a combination of convective and diffusive transport mechanisms. Exposure point concentrations inside an onsite residence were obtained by direct use of subsurface gas concentrations assuming equilibrium between the home and the subsurface gas and through modeling which varied the parameters governing gas migration. The highest concentrations were obtained with direct use of subsurface refuse gas data. These exposure point concentrations are reported in Table 7-3 and were used to evaluate RME conditions for the future onsite residential setting.

Inhalation of landfill gas was evaluated for the future offsite residential setting by estimating exposure point concentrations along the southwest perimeter of the Lowry Site. This location was selected because gas migration has occurred about 200 feet beyond the landfill mass in this area. Four different modeling scenarios were evaluated; the highest concentrations resulted from assuming a residence had a cracked structural slab. These were used as the exposure point concentrations for RME conditions in the future offsite residential settings and are reported in Table 7-3.

Exposure point concentrations for chemicals in surface soil were developed for four distinct areas onsite according to the chemical distribution. The chemical distributions corresponded with past onsite disposal activities. The four areas consist of:

- The sewage sludge application/leachate injection area (Group 1)
- The sewage sludge application area (Group 2)
- The leachate spraying area (Group 3)
- The tire pile area (Group 4)

It was assumed that future use at the Lowry Site could occur in each of the four areas. Exposure point concentrations used for RME conditions for the future onsite residential setting are reported in Table 7-4 for each area. The exposure point concentrations for Group 4 include only inorganic constituents. Data on organic constituents were evaluated separately for the Baseline RA. Exposure point concentrations for dust arising from these four distinct locations were derived with the use of an analytical mass-load model. Dust concentrations are also reported in Table 7-4.

Surface water data were grouped according to geographic location and creek flow for the derivation of exposure point concentrations. Three groups were formed:

- Group 1 included data taken within the unnamed creek, from the toe of the landfill to the area previously occupied by Pond 3.

- Group 2 included samples taken in Section 31, from the area previously occupied by Pond 3 to the confluence of unnamed creek and Murphy Creek.

- Group 3 included samples taken in Section 31 and 30, from the confluence of unnamed creek and Murphy Creek to the southern portion of Section 30.

It was assumed future onsite residents would use the unnamed creek for recreational purposes, from the toe of the landfill to the area previously occupied by Pond 3 (Group 1). For this group, exposure point concentrations used for RME conditions and the future onsite residential setting are reported in Table 7-5. Similar procedures were employed for the sediment data groupings and are reported in Table 7-5.

Exposure parameters used for the future onsite residential RME were obtained from risk assessment guidance and were not adjusted to account for site-specific conditions.

Typical exposure parameters approximated the 50th percentile of the parameter distribution and were then adjusted to account for local and regional conditions, such as:

- Number of days children would be expected to play out-of-doors considering school schedules and weather conditions

- Number of days when soil is expected to be frozen, which would limit ingestion and dust generation

- Number of days when precipitation exceeds 0.01 inch and dust generation would be suppressed

Table 7-6 presents RME parameter values for pathways quantified for the future residential, commercial/industrial, and recreational settings. Absorption of chemicals through dermal contact was not specifically quantified in any exposure setting because of the uncertainties associated with this pathway.

Combining exposure meters for each exposure route for a medium (for example, soil ingestion) with exposure point concentrations for each chemical in that medium results in the calculation of a chronic daily intake (CDI) of each chemical for the exposure route for a medium.

7.1.2.3 Summary of Toxicity Assessment

Chemical contaminants may be divided into two groups according to their effects on human health. Contaminants may have carcinogenic effects or noncarcinogenic/systemic effects. Exposure to some of the chemicals detected at the Lowry Site could potentially result in both types of effects.

Carcinogenic effects result in or are suspected to result in, the development of cancer. EPA assumes a non-threshold mechanism for carcinogens; that is, any amount of exposure to a carcinogenic chemical poses a potential for generating a carcinogenic response in the exposed organism. EPA has developed a carcinogen-classification system using weight-of-evidence to classify the likelihood that a chemical is a human carcinogen. Chemicals are classified by EPA as:

- A Human carcinogen
- B1 Probable human carcinogen; limited human data are available
- B2 Probable human carcinogen; sufficient evidence in animals and inadequate or no evidence in humans
- C Possible human carcinogen
- D Not classifiable as to human carcinogenicity
- E Evidence of noncarcinogenicity for humans

Noncarcinogenic or systemic effects include a variety of toxicological end points and may include effects on specific organs or systems, such as the kidney, liver, lungs, etc. EPA believes that thresholds exist for noncarcinogenic effects.

Slope factors (SFs) have been developed by EPA's Carcinogenic Assessment Group for estimating excess lifetime cancer risks associated with exposure to potentially carcinogenic COCs. SFs, which are expressed in units of (mg/kg-day)-1, are multiplied by the estimated intake of a potential carcinogen, in mg/kg-day, to provide an upper-bound estimate of the excess lifetime cancer risk associated with exposure at the intake level. The term "upper bound" reflects the conservative estimate of the risks calculated from the SF. Use of this approach makes underestimation of the actual cancer risk highly unlikely. Slope factors are derived from the results of human epidemiological studies or chronic animal bioassays to which animal-to-human extrapolation and uncertainty factors have been applied (for example, to account for the use of animal data to predict effects on humans).

Reference doses (RfDs) have been developed by EPA for indicating the potential for adverse health effects from exposure to COCs exhibiting noncarcinogenic effects. RfDs, which are expressed in units of mg/kg-day, are estimated threshold levels for daily exposure above which exposure is considered unsafe for humans, including sensitive individuals. Estimated intakes of COCs from environmental media (for example, the amount of a COC ingested from contaminated drinking water) can be compared to the RfD. RfDs are derived from human epidemiological studies or animal studies to which uncertainty factors have been applied (for example, to account for the use of animal data to predict effects on humans).

Toxicity values for COCs are presented in Table 7-7 for carcinogenic effects and in Table 7-8 for noncarcinogenic effects.

As suggested by the EPA Risk Assessment Forum, the Toxicity Equivalence Factor (TEF) approach was used for estimating risk from the dioxin-furan congeners without SFs. Currently, a SF is available for only 2,3,7,8-tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD). Where a specific congener was not given in the analytical data (that is, total hexachlorodibenzo-p-dioxins rather than a specific one such as 2,3,7,8-hexachloro-dibenzo-p-dioxin), the corresponding 2,3,7,8-congener TEF was used.

The chromium toxicity values presented in Tables 7-7 and 7-8 are for hexavalent chromium. In the absence of species-specific data, all chromium detected was assumed to be hexavalent chromium.

Slope factors and RfDs are specific to the route of exposure, for example, oral SFs are used to evaluate risk through ingestion of a carcinogenic COC. Oral SFs and RfDs are not available for all COCs identified at the Lowry Site. Table 7-9 identifies the chemicals, by medium, for which toxicity values were not available.

Lead, listed on Table 7-9, does not have an EPA-developed toxicity value for the ingestion or inhalation pathways. The toxic effects of lead exposure are correlated with blood lead levels rather than a daily intake. EPA has developed a model, the Uptake/Biokinetic Model (U/BK, version 0.5), to assess the potential effects of lead exposure in the most sensitive population, children ages 1 to 6 years. The use of the model and results are discussed separately in Section 7.1.3, Summary of Lead Risks.

Radionuclides, also listed on Table 7-9, were evaluated separately from other chemical contaminants and are discussed in Section 7.1.4, Summary of Radiological Risks.

7.1.2.4 Summary of Risk Characterization

For carcinogens, risks are estimated as the incremental probability of an individual developing cancer over a life-time as a result of exposure to the carcinogen. Excess lifetime cancer risk is calculated from the following equation:

$$\text{Risk} = \text{CDI} \times \text{SF}$$

where:

Risk = A unitless probability of an individual developing cancer (for example, one chance in 10,000 or 1 x 10-4)

CDI = Chronic daily intake averaged over 70 years (mg/kg-day)

SF = Slope factor (mg/kg-day)-1

Risks are probabilities that are generally expressed in exponential form (1 x 10-4). An excess lifetime cancer risk of 1 x 10-6 indicates that as a reasonable maximum estimate, an individual has a one-in-1 million additional chance of developing cancer as a result of site-related exposure to a carcinogen over a 70-year lifetime under specific exposure conditions at the Lowry Site.

EPA uses the general 1 x 10-4 to 1 x 10-6 risk range as a "target range" within which the EPA strives to manage risks as part of a Superfund cleanup. Although waste management strategies achieving reductions in site risks anywhere within the risk range may be deemed acceptable by the EPA risk manager, EPA has expressed a preference for cleanups achieving the more protective end of the range (for example, 1 x 10-6). Furthermore, although EPA generally uses 1 x 10-4 in making risk management decisions, the upper boundary of the risk range is not a discrete line at 1 x 10-4. A specific risk estimate less than 1 X 10-4 may be considered unacceptable based on site-specific conditions, including any remaining uncertainties about the nature and extent of contamination and associated risks.

The potential for noncarcinogenic effects is evaluated by comparing an exposure level over a specified time period (for example, a lifetime) with a reference dose (RID) derived for a similar exposure period. The ratio of exposure to toxicity is called a hazard quotient (HQ).

The HQ is calculated as follows:

$$\text{Noncancer HQ} = \frac{\text{CDI}}{\text{RfD}}$$

where:

CDI = Chronic daily intake averaged over the exposure period (mg/kg-day)

RfD = Reference dose (mg/kg-day)

The CDI and RfD are expressed in the same units and represent the same exposure period (that is, chronic, subchronic or short-term).

If the CDI (exposure) is greater than the Rfd, the HQ will be greater than one. An HQ greater than one indicates the potential for an adverse noncarcinogenic health effect from exposure to the chemical.

A Hazard Index (HI) is generated by adding the HQs for all COCs that affect the same target organ or system (for example, the liver or respiratory system) within a medium or across all media to which a given population may reasonably be exposed. If the HI for each toxic end point exceeds one, the potential for an adverse noncarcinogenic health effect from exposure to the medium is indicated.

To evaluate the potential for adverse effects from exposure to subsurface soil and landfill gas, the baseline risk assessment used risk-specific values as a screening tool. A risk-specific value is a concentration that will result in a 1 x 10-6 excess lifetime cancer risk for carcinogenic effects. A reference concentration is a concentration that will result in a hazard quotient of one for noncarcinogenic effects. Both risk-specific values and reference concentrations are calculated with the same media-specific intake parameters developed for the Lowry Site. Risk-specific values and reference concentrations were then compared to the exposure point concentrations calculated for subsurface soil and landfill gas.

The following discussion of OU groups presents the risks associated primarily with the onsite exposure scenario. In general, the onsite exposure scenario results in the greatest or most significant estimates of risks.

7.1.2.4.10Us 1&6: Shallow Ground Water, Subsurface Liquids, and Deep Ground Water. The highest excess lifetime cancer risk from ingesting water from a well within the source area, for a future onsite resident adult using RME conditions, is 1 x 10-2. Three COCs (arsenic at 23 percent; benzo(a)anthracene at 24 percent; and vinyl chloride at 22 percent) are responsible for about 70 percent of the total risk estimate. With 6 years of exposure, the HI for noncarcinogenic effects through ingestion could be as high as 47 for an adult and 46 for a child. Five COCs exceed their reference dose and contribute to the total HI. Table 7-10 presents the excess lifetime cancer risk and non-cancer HQ for the COCs with the greatest contribution to risk in subsurface liquids.

7.1.2.4.2 0U 2: Landfill Solids. (Landfill solids are evaluated as subsurface soil 1 to 10 feet below ground surface). The potential for adverse effects of landfill solids was evaluated on a screening level basis only. Concentrations of four chemicals exceed their carcinogenic risk-specific values for the ingestion or inhalation pathway in a future onsite residential setting. Concentrations of arsenic, beryllium and PCB-1260, in subsurface soil, exceed their risk-specific values for the ingestion pathway. Concentrations of arsenic, beryllium, and chromium (hexavalent), in subsurface soil, exceed their risk-specific values for the inhalation pathway. The chemical concentrations that exceed risk-specific values were detected through the Lowry Site and at many were co-located. The term co-located is explained as follows. Forty-four separate samples had concentrations of arsenic that exceeded its risk-specific value for ingestion of soil and inhalation of dust. Thirty-six separate samples had concentrations of beryllium that exceeded its risk-specific value for ingestion of soil and inhalation of dust. Concentrations of arsenic and beryllium were co-located in 30 samples. only one sample location contained concentrations of all four chemicals that exceeded their risk-specific values. At selected sample locations, exposure to these chemicals in subsurface soil would result in an excess lifetime cancer risk greater than 1 x 10-5 for each individual chemical.

None of the COCs evaluated in this manner exceed their noncarcinogenic reference concentration for ingestion or inhalation. Table 7-11 presents the comparison of subsurface soil concentrations to risk-specific values calculated at a 1 x 10-6 risk and to reference concentrations.

Concentrations of two chemicals exceed their carcinogenic risk-specific values for the ingestion or inhalation pathway in a future onsite occupational setting. The concentration of PCBs in one sample exceeds its risk-specific value for the ingestion pathway. The concentration of chromium in 37 samples exceed its risk-specific value for the inhalation pathway. Concentrations of PCBs and chromium are co-located at one sample location.

None of the COCs evaluated in this manner exceed their noncarcinogenic reference concentration for ingestion or inhalation in an occupational setting.

7.1.2.4.3 0U 3: Landfill Gas. The potential for adverse effects of landfill gas was evaluated on a screening level basis only. For the RME future onsite residential setting, exposure point concentrations of all carcinogenic VOCs from within the landfill mass exceed their carcinogenic risk-specific values for the inhalation pathway. Furthermore, exposure to these chemicals through inhalation could result in an excess lifetime cancer risk of one in one, due to the measured concentrations of vinyl chloride within the landfill mass. A cancer risk of one in one is exceedingly high. Concentrations of five VOCs with noncarcinogenic effects from within the landfill mass exceed their noncarcinogenic reference concentrations for inhalation (the HQ for each chemical is greater than one). Table 7-12 presents the comparison of exposure point concentrations of refuse gas within the landfill mass to risk-specific values and reference concentrations.

Methane is present within the landfill mass at concentrations above the lower explosive limit. Methane has been detected above the lower explosive limit outside of the landfill mass, but not offsite. It therefore presents an explosion hazard under a prescribed set of conditions (i.e., concentrations between 5 and 15 percent by volume and the presence of a spark source).

Modeled concentrations of 1,1-dichloroethene and vinyl chloride, within a future offsite residence with a cracked structural slab, exceed their carcinogenic risk-specific values for the inhalation pathway. Exposure to these chemicals through inhalation would result in an excess lifetime cancer risk greater than 1 x 10-6 for each individual chemical. Modeled concentrations of noncarcinogenic VOCs do not exceed their noncarcinogenic reference concentrations for inhalation. Table 7-13 presents the comparison of exposure point concentrations modeled from 95th UCL concentrations to risk-specific values and reference concentrations.

7.1.2.4.4 0U 4: Soil. The highest excess lifetime cancer risk, 4 x 10-5 (summation of cancer risks from arsenic, beryllium, 2,3,7,8-TCDD, and PCB-1260), was estimated for a future onsite resident child ingesting surface soil from the sewage sludge application/leachate injection area (Group 1, see Figure 6-6). Arsenic contributes 53 percent and beryllium contributes 28 percent to the cancer risk estimate for Group 1, regardless of the age of the receptor soils. Using the same receptor and exposure settings, all remaining soil groups (2 through 4) had estimated risks equal to or less than those calculated for Group 1 (Group 2 risk was estimated as 4 x 10-5; Group 3 as 3 x 10-5; and Group 4 as 1 x 10-5; the inclusion of organic data in risk estimates for Group 4 would increase the risk to 4 x 10-5). The pathway total HI for a future onsite resident child ingesting and inhaling soil from Group 2 is slightly higher at 1.2.

The estimated risks for an adult receptor are similar; ingestion of surface soil from Group 1 soil results in an estimated risk of 2 x 10-5; 2 x 10-5 for Group 2 soil; 1 x 10-5 for Group 3 soil; and 6 x 10-6 for Group 4 soil. The total pathway risk from ingestion of soil over a period of 30 years as an onsite resident (child and adult) is 6 x 10-5 for Group 1 soil; 6 x 10-5 for Group 2 soil; 4 x 10-5 for Group 3 soil; and 2 x 10-5 for Group 4 soil (without the inclusion of organic data).

The estimated excess lifetime cancer risk from inhalation of dust arising from the soil in Group 1 was 8 x 10-5 for an adult. Estimated cancer risks for a child for all remaining soil groups were less than those calculated for Group 1. The future onsite resident adult had the highest estimated risks through inhalation of dust arising from the remaining soil groups (2 through 4), although less than those calculated from Group 1 soil (Group 2 risk was estimated as 8 x 10-6; Group 3 as 3 x 10-6; and Group 4 as 4 x 10-6). The total pathway risk from inhalation of dust arising from Group 1 soil is 2 x 10-5 (adult of 1 x 10-5 plus the child of 8 x 10-6, for a total of 1.8 or 2 x 10-5). Chromium (assumed to be in the carcinogenic hexavalent form), is the primary contributor to the risk estimate for inhalation of dust. Table 7-10 presents the excess lifetime cancer risk for the COCs, within soil from the sewage sludge application/leachate injection area (Group 1), that contribute to the greatest risk estimates for the future onsite residential setting.

For the scenario in which a future onsite resident child ingests surface sod from the Group 1 soil, the pathway total HI for noncarcinogenic effects equals 1. The pathway total HI for a future onsite resident child ingesting and inhaling soil from Group 2 soil is slightly higher at 1.2. Other HIs for the ingestion and/or inhalation pathways using different soil groups or children or adult receptors are below one. Table 7-10 presents the noncancer HQs for adults and children using for COCs in Group 1 surface soil that have the greatest contribution to risk in the future onsite adult residential setting.

7.1.2.4.5 0U 5: Surface Water and Sediments. Using the onsite portion of unnamed creek for recreational purposes, a child in the future onsite residential setting could experience an excess lifetime cancer risk of 8 x 10-4 from ingestion (at the RME) of vinyl chloride (85 percent contribution) and 1,1-dichloroethene (14 percent contribution) in surface water. An excess lifetime cancer risk of 9 x 10-6 could result from ingestion of arsenic (77 percent contribution) in sediments from the same section of the creek. Table 7-10 presents the excess lifetime cancer risk for the COCs within the onsite section of the unnamed creek for surface water and sediment exposure that contribute the most to risk form a recreational use by a child in the future onsite residential setting.

The HI for noncarcinogenic effects was 2 for the future onsite resident child ingesting acetone and trans-1,2-dichloroethene (each contributes 30 percent of the total HI) in surface water and 0.4 for ingesting antimony and arsenic (75 percent contribution) in sediments from recreational use on the onsite section of the unnamed creek. Table 7-10 also presents the noncancer HQ for each COC quantified in surface water and sediments for exposure to a child in the future onsite residential setting. Table 7-10 also summarizes the potential maximum cumulative excess lifetime cancer risk for the future onsite resident.

Exposure to offsite surface water (Group 2 and 3) in a recreational setting resulted in estimated risks less than 10-6. Exposure to offsite sediments assumed that sediments had spread beyond the creek banks during periods of high flow. Therefore, sediment data were used in a residential setting. Childhood exposure to offsite sediments (Group 2) in a residential setting resulted in an estimated risk of 7 x 10-5 from ingestion of arsenic and dioxins and 4 x 10-6 from inhalation of chromium (IV) and arsenic. Ingestion of arsenic, manganese, and vanadium by a child in a residential setting resulted in a pathway HI for noncancer effects of 1. However, these chemicals affect different target organs. An HI should be calculated for each target organ which would result in an HI less than 1 for each target organ.

Childhood exposure to offsite sediments (Group 3) in a residential setting resulted in an estimated risk of 2 x 10-5 from ingestion of arsenic and beryllium and 6 x 10-6 from inhalation of chromium (IV) and arsenic. Ingestion of antimony, arsenic, and chromium by a child in a residential setting results in an HI for noncancer effects of 2. Antimony had an HQ of 1, while the remaining chemicals each had HQ significantly below 1. Antimony was detected once in one analysis. The uncertainty of the resulting HI from the contribution of antimony is high.

For Sections 30/31 sediments (offsite), a child could experience an excess cancer risk of 2 x 10-5 from ingestion (at RME) of sediments primarily from arsenic and beryllium. For noncancer effects, the HI of 2 is based on the ingestion of antimony and arsenic.

Table 7-14 summarizes the total risk for the future onsite residential setting for all pathways quantified. Cancer risks from all pathways quantified are added together to obtain a cumulative risk for the exposure setting. The cancer risks presented represent RME conditions, the full 30-year exposure duration (child and adult and the highest exposure point concentrations estimated for each onsite media. Noncancer HIs are added together to obtain a cumulative risk for each receptor (adult or child) within a pathway. Adult and child HI's are not additive. Landfill solids and landfill gas are not included in this summary table because risk from exposure to these media were evaluated on a screening level basis only and were not quantified.

7.1.2.5 Uncertainty in the Risk Assessment

Several significant sources of uncertainty impacted the baseline risk assessments. These have been described in detail in the Baseline RA. To summarize, the major sources of uncertainty and their effect on the risk assessments include:

- Use of data from investigations spanning 8 years. The resulting data base contained a wide variation in sample quantitation limits (SQLs) and a large number of nondetects. This adds uncertainty to the selection of COCs and could overestimate or underestimate exposure point concentrations.

- The prediction of human activities that lead to contact with media and exposure to chemicals is highly uncertain. Assumptions used to estimate RME conditions may lead to an overestimation of risk.

- Simplifying assumptions used to estimate exposure point concentrations may result in an overestimation of exposure. For example, it was assumed that: contaminant concentrations remain constant over time; all dust originates from soil contaminated at the 95th UCL concentration; and equilibration occurs between subsurface refuse gas concentrations and concentrations inside a home constructed on the landfill.

- Toxicity data and the assumptions made in using toxicity values (for example, all chromium was assumed to be present in the hexavalent form, and bioavailability was assumed to be 100 percent) could result in an overestimation of risk. On the other hand, the unavailability of toxicity values for all COCs could result in an underestimation of risk.

- Risk and doses within an exposure route are assumed to be additive when, in fact, synergisms and antagonisms occur. This could act to overestimate or underestimate risk.

- The prediction of risks associated with the dermal exposure pathway is difficult since mechanisms to quantify the contribution of dermal absorption are not well established and considerable uncertainty surround estimates of dermal exposure and risk. As a result, the uncertainty associated with the dermal route of exposure necessitates excluding the dermal contribution from the other routes of exposure.

7.1.3 Summary of Lead Risks

Exposure to lead cannot be evaluated through the same methodology used in the baseline risk assessments. Toxicity values cannot be determined because research has not identified a threshold below which no adverse health effects occur. Therefore reference doses, for evaluating the potential for noncancer effects, cannot be developed. Lead is also thought to be carcinogenic through prolonged low dose exposure; however, its noncarcinogenic effects on infants and children are more serious because they are manifested in a shorter time period than the onset of cancer.

Toxic effects of lead exposure are correlated with blood lead levels, and therefore, blood lead levels have been determined to be an appropriate benchmark for exposure. The Uptake/Biokinetic Model (U/BK, version 0.5) developed by EPA, allows the estimation of blood lead levels in infants and children (zero to 7 years of age) from exposure to lead in environmental media. This model was used to evaluate the potential for adverse health effects in infants and children exposed (current and potential future) to lead in environmental media at the Lowry Site by estimating the percent of children that would have a blood lead level greater than the "level of concern" of 10 µg/dl established by the EPA and Centers for Disease Control (CDC).

Lead was detected in ground water, soil, surface water, and sediments at the Lowry Site. The summary statistics for lead in each medium have been presented in Tables 7-2 through 7-5. Potential receptors and exposure pathways and, therefore, possible exposure settings, have also been described in Volume 2C of the Baseline RA. The most conservative setting involving children to 7 years in age is the future onsite residential setting. Because the U/BK model is specific to children, only the following pathways were considered in this evaluation:

- Ingestion of ground water
- Incidental ingestion of surface soil and subsurface soil from an excavation
- Ingestion of indoor dust derived from outdoor soil
- Inhalation of suspended soil as particulates

Incidental ingestion of surface water and sediments from the unnamed creek were not included in this evaluation because it was assumed that a child under the age of 7 would not leave the house to play in the creek. Dermal exposure was not evaluated because percutaneous absorption is not considered a significant route of exposure for inorganic forms of lead.

Exposure point concentrations of each medium were taken from the sitewide Baseline RA. The future onsite residential setting evaluates ground water using data from shallow ground-water wells in the weathered Dawson aquifer and waste-pit liquid well points within the source area (Table 7-2); soft from the sewage sludge application/leachate injection area (Table 7-4); and dust derived from soil in this area (also Table 7-4). The U/BK model default intake parameters reflect the central tendency of each parameter for the exposed population of zero to 7-year-olds. Table 7-15 presents the default parameters used in this evaluation. The U/BK model includes ingestion of lead in the diet and in lead-based paint. Lead-based paint was not included in the evaluation for the Lowry Site because of the assumption of new residential development. New developments do not contain lead-based paint. The U/BK model can be effectively employed without including ingestion of paint. Ingestion of lead in the diet was included using default intake and exposure point concentrations.

The U/BK model results in a frequency distribution that displays the probability density corresponding to the estimated mean blood lead level concentration for a given exposure setting. For the future onsite residential setting, 6 percent of the children ages zero to 7 years were estimated to have blood lead levels above 10 µg/dl. Uptake of lead from ground water had the greatest contribution to total lead uptake.

7.1.4 Summary of Radiological Risks

A radiological risk assessment was prepared separately from the assessment of chemical risk from the Lowry Site. Refer to Volume 2C of the Baseline RA for details on the assessment for radionuclides. While much of the data needed for a radiological risk assessment is similar to that required for a chemical risk assessment, the procedures used to characterize the radionuclide contaminants and estimate exposure are different.

7.1.4.1 Contaminated Media and Exposure

As previously stated, radionuclides were detected in all media except landfill gas. With the exception of gross alpha and gross beta, characterization of radionuclides in gas was not conducted. Because specific isotopes were not identified, exposure to radionuclides in landfill gas was not quantitatively evaluated in this ROD.

The following steps were used to select the radionuclides in each media to be carried through the risk assessment: an evaluation of the detection frequency; a comparison to background concentrations; a determination of parent radionuclides; and an elimination of radionuclides with short half-lives.

Table 7-16 lists the risk assessment radionu¢lides detected in each medium.

Potential receptors and exposure pathways, and therefore, possible exposure settings were described in the sitewide Baseline RA for chemical contaminants. Further, it was assumed that all future offsite settings would result in lower exposures than future onsite exposures. Consequently, future offsite exposures were not evaluated for radionuclide exposure.

Dermal contact with radionuclides was not included as an exposure pathway because percutaneous absorption is not considered a significant route of exposure for radionuclides. Therefore, dermal exposure was not evaluated in this Baseline RA.

However, radionuclides, unlike chemicals, can have deleterious effects on humans without being taken into, or brought in contact with, the body. This is because high energy beta particles and photons from radionuclides in contaminated air, water, or soil can travel long distances with only minimum attenuation in these media before depositing their energy in human tissue. Therefore, external radiation exposure was included as an exposure pathway for evaluation in this Baseline RA.

7.1.4.2 Summary of Toxicity Assessment

EPA classifies all radionuclides as human carcinogens (Group A) based on their property of emitting ionizing radiation and the extensive weight of evidence provided by epidemiological studies of radiogenic cancers in humans. EPA generally evaluates potential human health risks based on radiotoxicity, considering only the carcinogenic effects of radionuclides. One exception to this is uranium, which is a kidney toxin as well as a carcinogen. Given that kidney toxicity may occur prior to the onset of cancer from exposure to uranium concentrations in drinking water, EPA has developed a reference dose for chronic oral exposure to uranium.

7.1.4.3 Summary of Risk Characterization

Residential ingestion of ground water at the RME from a future onsite domestic well within the source area could result in an excess lifetime cancer risk of 5 x 10-4 from radionuclides. Three radionuclides are responsible for the majority of the risk: radium-226 contributes a risk of 1.9 x 10-4 (31 percent); lead-210 contributes a risk of 1.5 x 10-4 (25 percent); and potassium-40 contributes a risk of 1.1 x 10-4 (18 percent). Radium-226, lead-210, and potassium-40 are naturally occurring radionuclides and both radium-226 and potassium-40 were detected in upgradient (background) ground-water samples lead-210 data are not available). Concentrations of the two radionuclides in upgradient wells results in a total risk of 2 x 10-4 with radium-226 contributing a risk of 1.3 x 10-4 (86 percent) and potassium-40 contributing a risk of 2.2 x 10-5 (14 percent).

Risks from ingestion of radionuclides in upgradient ground water (for example, water with background or naturally-occurring concentrations) are approximately equivalent to those onsite. Table 7-17 presents a summary of radiological risks onsite and upgradient (or offsite).

The HQ resulting from ingestion of uranium at the RME, for a future onsite resident child, was estimated as 2.3 and as 1.0 for an adult. These HQ values indicate the potential for an adverse noncarcinogenic health effect. The HQs for children or adults ingesting uranium in upgradient (or offsite) wells was estimated to be below 1 (0.4 and 0.2, respectively).

The concentrations of four radionuclides in subsurface soil exceed their carcinogenic risk-specific values for the ingestion, inhalation, and external exposure pathways in the future onsite residential setting. The maximum concentrations of potassium-40, lead-210, thorium-228, and uranium-238 in subsurface soil exceed their risk-specific values, which were derived for soil ingestion, particulate inhalation, and external exposure assuming subsurface soil was excavated and spread on the surface. Exposure to these radionuclides in subsurface soil would result in an excess lifetime cancer risk greater than 1 x 10-6 for each individual radionuclide. Maximum concentrations of potassium-40 and thorium-228 in background subsurface soil also exceed their respective carcinogenic risk-specific values. Table 7-18 presents the comparison of onsite and background concentrations to risk-specific values corresponding to a 10-6 cancer risk.

An excess lifetime cancer risk of 4 x 10-7 was estimated for the future onsite residential setting from ingesting surface soil from the sewage sludge application/leachate injection area (Group 1). Inhalation of soil suspended as dust from this area resulted in a 7 x 10-7 excess lifetime cancer risk estimate. External exposure to these soils resulted in an estimated risk of 4 x 10-4 from radium-226 (97 percent of the total risk estimate). However, since radium-226 is a naturally occurring element, the background risk was also estimated. The excess lifetime cancer risk from external exposure to background concentrations of radium-226 is 5 x 10-4; and is basically the same risk that was calculated for onsite external exposure. If radium-226 is not considered in estimating the risk from external exposure to surface soil in the sewage sludge application/leachate injection area, the risk drops to 1 x 10-5. Table 7-19 presents a summary of onsite and background radiological risk from exposure to surface soil.

Although external exposure from contact with surface water is possible, only incidental ingestion of surface water was evaluated quantitatively. Two surface water sampling points were available for radionuclide analysis; one onsite and one offsite. The assumption was made that the concentrations of radionuclides at the two sampling points were representative of all surface water and, therefore, could be used as exposure point concentrations for the future onsite residential setting. Ingestion of surface water by a future onsite resident child (ages 7 to 18 years) using the unnamed creek for recreation could result in an excess lifetime cancer risk of 2 x 10-7.

For the future onsite residential setting, the only exposure to sediments for children or adults that results in an excess lifetime cancer risk greater than 1 x 10-6, is external exposure. Radium-226, potassium-40, and thorium-228 contribute to 98 percent of the estimated risk of 1 x 10-3. As all three radionuclides are naturally occurring, the excess lifetime cancer risk of background concentrations was also calculated. The background risk from external exposure was estimated as 9 x 10-4, indicating that onsite and background risks are approximately equal. Table 7-20 presents a summary of the onsite and background radiological risk.

Table 7-21 presents a summary of radiological risk from all exposure pathways. Total radiological risk estimated for background and onsite concentrations is the same, 2 x 10-3. Radionuclides present in media onsite do not appear to present an increased risk over background, using exposure conditions outlined in this assessment.

7.1.4.4 Uncertainties

Uncertainties in the data include the lack of a rigorous evaluation of data useability, due to the lack of laboratory documentation and the limited quantity of radionuclides data available. The representativeness of the data is questionable and affects the estimation of external dose and the risk from external exposure. External exposure assumes a uniform distribution of radionuclides in the environmental medium of interest. Uniformity in distribution is difficult to determine with limited data.

Shielding was not accounted for in the estimation of external exposure. Shielding can reduce the exposure by a factor of 0.5, thereby reducing the risk from exposure. The toxicological data base is limited for low-level environmental exposures; most available data on risk are from high-dose radiation exposures (such as survivors of the atomic bomb). Extrapolation to low-dose environmental exposures is subject to much scientific debate. Consequently, the degree of conservatism introduced into estimates of risk from incomplete toxicological data cannot be estimated.

7.1.5 Summary of Environmental Risks

The Lowry Site ecological assessment (EA) consisted of:

- An ecological site description
- Identification of ecological chemicals of concern (ECOCs)
- Identification of the actual and potential ecological receptors
- Characterization of ecological exposure pathways
- Identification of ECOC exposure levels considered to have no observable adverse effects from literature references
- Comparison of potential exposure levels to receptors with exposure levels considered to have no observable adverse effects
- A qualitative description of uncertainty

The ecological assessment, included in Volume 2B of the Baseline RA, focused on potential effects on terrestrial wildlife from ingestion of contaminated media.

7.1.5.1 Ecological Setting

The ecological setting of the Lowry Site has been described in other sections of this document. A list of threatened and endangered species that could be present in the vicinity of the Lowry Site is provided as Table 7-22. None of these species have been observed at the site and it is unlikely that these species would be found onsite. However, the area surrounding the Lowry Site could provide a habitat for these species, and therefore, they were considered potential ecological receptors.

7.1.5.2 Ecological Chemicals of Concern

The EA was based on data collected during the RIs for OUs 2&3 and 4&5. Only data from surface soil (zero to 1 foot), surface water, and sediment were used in the assessment. Landfill gas was not addressed because of a lack of literature information on the toxicity of gas to ecological receptors. Landfill solids were not addressed because it was assumed that the most significant exposures for terrestrial organisms would result from the upper 1 foot of the soil column. Because of the transient nature of terrestrial receptors, it was assumed that potential receptors would have access to the entire site. Therefore, data were summarized by media.

Chemicals detected in surface soil, surface water, and sediments were initially screened on the basis of comparisons with background concentrations, frequency of detection, and relative toxicity for use in the EA. The first two screening steps follow the procedure outlined in the Baseline RA. The relative toxicity screening step eliminates inorganic constituents that are commonly found in the environment, act as macronutrients to living organisms, and/or are relatively nontoxic to environmental receptors. Table 7-23 lists the constituents eliminated from each medium because of their relative nontoxicity. Table 7-24 lists the COCs evaluated in each medium and their maximum detected concentration.

7.1.5.3 Exposure Assessment

No aquatic organisms were observed within the limited aquatic habitat onsite, therefore, aquatic organisms were not considered potential receptors to environmental contamination. Terrestrial wildlife are considered potential receptors as they can use the Lowry Site as habitat and become exposed to site-related contamination through daily activities. Other potential receptors include terrestrial and riparian vegetation growing in contaminated media.

Exposure pathways for terrestrial wildlife may include:

- Foraging and ingestion of vegetation or invertebates contaminated through biomagnification or bioaccumulation

- Ingestion of vegetation, which may result in the incidental ingestion of surface soil and the inhalation of surface soil as dust or volatile constituents in surface soil

- Ingestion of surface water and inhalation of volatile constituents volatilizing from surface water

- Incidental ingestion of sediments while drinking or searching for food in the unnamed creek

- Dermal contact with soil, surface water, and sediment while burrowing or grooming

Terrestrial wildlife currently use the Lowry Site and could continue to use the site in the future, regardless of planned land use. Therefore, this EA focused on direct exposures (ingestion of media) to terrestrial wildlife. Because the habitat in the area occupied by the former landfill is highly disturbed and of relatively poor quality, exposures resulting from biomagnification and bioaccumulation of contaminants were considered minor and therefore, not addressed. Other exposure routes affecting terrestrial wildlife including inhalation and dermal contact and effects to vegetation were also not addressed because of the lack of quantitative literature values for quantifying exposure.

7.1.5.4 Ecological Effects Assessment

The potential for adverse effects to terrestrial wildlife was assessed through comparison of potential intake through ingestion with an appropriate toxicity value. Toxicity values were obtained from the literature for all COCs in each media evaluated. The lowest observable adverse effect level (LOAEL), no observable adverse effect level (NOAEL), and the lethal dose that kills half of the population exposed (LD50) were obtained from toxicological investigations using laboratory or wild animal species. Data related to chronic oral exposure studies (garbage, drinking water, or diet) were used preferentially to data derived from intraperitoneal or intramuscular studies. Inhalation toxicity data were not included. Toxicity data are media- and species-specific and were not available for all COCs.

LOAELs were used in comparison to doses received from ingestion of soil and sediment for small mammals. Each constituent-specific LOAEL was divided by an uncertainty factor to adjust the value to account for the uncertainty involved with data comparisons. Small mammal soil ingestion rates, in mg soil/kg body weight/day, were available in the literature. Small mammals ingest soil during feeding, grooming, and burrowing activities whereas no data are available for soil ingestion in larger animals. Species specific (rats, mice, or rabbits) soil ingestion rates were multiplied by the maximum constituent concentration in surface soil or sediments. The adjusted LOAEL was then compared to the dose received through ingestion (using the species on which the LOAEL was developed). If the dose received exceeded the adjusted LOAEL, an adverse effect to ecological health may exist and further evaluation of ecological exposure would be appropriate.

For surface water, the preferred toxicity value is the NOAEL. If an NOAEL was not available, a LOAEL was used and then an LD5o. Water criteria were calculated using drinking water ingestion rates for laboratory animals to represent rates for small mammals in the wild. This will result in conservative criteria because most small mammals in the wild do not consume water on a regular basis. The NOAEL (or other toxicity value) was divided by both water intake rate for an appropriate species and an uncertainty factor to estimate a water concentration (termed water criteria) associated with the no adverse effects. The water criteria were then compared to the maximum detected concentration of the constituent. If the maximum concentration detected in surface water exceeded the water criteria, the potential for adverse effects to terrestrial receptors using surface water within the Lowry Site may be present.

For surface soil, the ingestion of aluminum, barium, cadmium, cobalt, iron, and octochlorodibenzodioxins exceeded their respective adjusted LOAEL value. In addition, because of the lack of toxicological information for acetone and ammonia, as they pertain to environmental receptors, these two chemicals could not be evaluated.

For sediments, ingestion of aluminum, barium, cobalt, iron, lead, and heptachlorodibenzo-p-dioxin exceeded their respective adjusted LOAEL value. Due to the lack of toxicological information for acetone, ammonia, aniline, and benzene, these chemicals could not be evaluated for their effects on environmental receptors.

For surface water, maximum concentrations of aluminum, antimony, barium, cobalt, iron, mercury, vanadium, benzene, 2-butanone, 1,2-dichloroethene (trans and total), 2,4-dichlorophenol, methylene chloride, 2-methylnaphthalene, 2-methyl phenol, 4-methylphenol, 4-methyl-2-pentanone, octochlorodibenzodioxins, phenol, tetrachloroethene, trichloroethene, toluene, and vinyl chloride exceeded calculated water criteria.

On the basis of comparisons in this assessment, maximum detected concentrations of select inorganic and organic chemicals in surface soil, surface water, and sediments may result in adverse effects to terrestrial wildlife.

7.1.5.5 Uncertainties

The EA has a high level of uncertainty as a result of the many assumptions made and issues addressed. The following assumptions contribute to the uncertainty:

- All soil and sediment consumed was from a contaminated source.
- All water ingested was from onsite contaminated surface water.
- The maximum detected concentration of each constituent in each medium represents the potential exposure concentration.

These assumptions act to overestimate intake, since terrestrial species are mobile and have access to multiple sources of food and drinking water. Not all terrestrial species would be contaminated at the maximum concentration, and not all would ingest food and water from the Lowry Site.

The assumption was made that all chemicals in each media were 100 percent bioavailable, which overestimates the true dose received. For example, chemicals bound to soil may not be readily digested and may pass through the gastrointestinal system; or, chemicals ingested may be metabolized and rendered nontoxic.

In addition, chemical interactions were not addressed. The true toxicity of an environmental medium cannot be known unless synergistic and/or antagonistic effects can be determined. The total hazard of each media has not been addressed because comparisons made in the EA were on a constituent-by-constituent basis.

Soil and sediment consumption and water ingestion were estimated using laboratory animals to represent small mammals. This may overestimate intake and the potential hazard since correlations between standard lab animals and actual receptor species are not known. Uncertainty factors were applied to account for this. However, there is no means to measure the magnitude of uncertainty involved.

The EA only quantified the ingestion route. Other routes, such as inhalation and dermal contact, may have a significant impact for small mammals that burrow in the ground. The potential hazard to small mammals may therefore have been underestimated.

7.2 Baseline Risk Assessment Summary

Actual or threatened releases of hazardous substances from the Lowry Site, if not addressed by implementing the response action selected in this ROD, may present an imminent and substantial endangerment to public health, welfare, or the environment. The most significant risks are summarized in Subsection 7.1.2.4.

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Table 7-1
Minimum/Maximum Concentrations of Contaminants of Concern

Chemical	OUs 1/6 Subsurface Liquids (µg/L)	OUs 2/3 Subsurface Soil (µg/kg)	Landfill Gas (µg/m2)	Surface Soil (µg/kg)	Surface Water (µg/L)	OUs 4/5 Sediment (µg/kg)	
		Organics					
1,1-Dichloroethane	2/1,100,000		300/770,000		1/150,000		
1,1-Dichloroethene	0.8/14,000		170/18,000		6.4/5,000	2/1,800	
1,2-Dichloroethane	3/1,800,000	42,/30	110/68,000				
1,2-Dichloroethene	1/160,000				2/730		
1,4-Dichlorobenzene							
1,1,1-Trichloroethane		3.9/3.9	38/270,000		4/31,000	6,110,000	
1,1,2-Trichloroethane	3/100						
1,2,4-Trichlorobenzene	8.5/1,700						
1,1,2,2-Tetrachloroethane	66/66						
2,4-Dichlorophenol	22/160				26/190	170/2,700	
2,4-Dimethylphenol					14/920		
2,4-Dinitrophenol	500/500						
2,3,7,8-TCDD	5 x 106/ 1.1 x 10-3			0.02/14a	0.04/0.04a	0.1/5.6a	
2-Butanone (MEK)	17/230,000	44/120	1/38,000	1/1	3.1/51,000	33/15,000	
2-Chlorophenol	8/8						
2-Hexanone	49/270				4/7,400		
2-Methylnaphthalene	3/44,000				4.7/10	54/24,000	
2-Methylphenol					87/4,100		
4,4'-DDD		0.26/1.2					
4,4'-DDE		0.11/0.11					
4,4'-DDT		0.34/30					
4-Chloroaniline		53/2,500					
4-Methylphenol					380/6,600		
4-Methyl-2-pentanone	4/960,000	2.7/170			3.7/27,000		
Acetone	4/3,000,000	15/160			3/240,000		
Aldrin		0.15/3.7					
Aniline						330/330	330/330
Benzene	1/970,000	1/1	10/190,000		1.5/180	2/6,100	
Benzo(a)anthracene	84/84						
Benzo(b)fluoranthene		52/52					
Benzoic acid		81/210					
Benzyl alcohol	7.2/1,900						
beta-BHC		1.1/6					
bis(2-chloroethyl)ether	3/3						
bis(2-Ethylhexyl)phthalate	1/22,000			46/2,200		49/95,000	
Butylbenzylphthalate		48/170					
Carbazole	7/12						
Carbon disulfide			22/160,000	9/25			
Carbon tetrachloride	15/26,000						

Table 7-1
Minimum/Maximum Concentrations of Contaminants of Concern

	OUs 1/6	OUs 2/3		OUs 4/5		
Chemical	Subsurface Liquids (µg/L)	Subsurface Soil (µg/kg)	Landfill Gas (µg/m2)	Surface Soil (µg/kg)	Surface Water (µg/L)	Sediment (µg/kg)
		Organics (continued)				
Chloroethane	2/260					
Chloroform	0.6/56,000	214				
d-n-Butylphthalate		45/110	19/4,000	1/3		
di-n-Octylphthalate	5.7/1,200	43/43				
Dibenzofuran	2.0x10-6/ 1.4x10-3					
Dieldrin		9.5/9.5				
Endrin		0.11/0.15				
Endrin ketone		0.21/0.21				
Ethylbenzene					1.1/340	4/95,000
Ethylene dibromide	0.12/0.28					
Fluoranthene	26/200	69/69				69/7,700
gamma Chlordane		0.13/0.13				
gamma-BHC		0.11/0.11				
Methylene chloride	3/440,000	1.2/120	42,840,000		1/7,700	
Naphthalene	2.0/110,000					
PCB-1260		270/2,100		200/7,600		170/2,400
Pentachlorophenol	4/4,100					
Phenanthrene	4.2/1,700	46/46				62/6,200
Phenol		40/95			73/4,100	
Pyrene		75/75				
Tetrachloroethylene	0.9/340,000	1.9/1.9			0.7/2,300	3/48,000
Toluene	0.9/11,000,000	1/4	19/1,400,000	2/11	1/28,800	3/280,000
Trans-1,2-Dichloroethene					5.7/56,000	
trans-1,3-Dechloropropane	2.2/3.0					
Trichloroethylene	4/7,700,000				0.6/2,500	
Vinyl chloride	2.6/1,800		77/680,000		27/9,600	2/57
Xylenes			17/120,000		1.3/9,700	4/580,000
			Inorganics (Metals)			
Aluminum		6,400/2.5x107		7,900/2.8x107	32/260,000	3.2x107
Antimony		30/30,000			26/82	29/32,000
Arsenic	2.2/1,600	0.86/18,000		1.4/14,000	4/82	2/21,000
Barium		43/1,200,000		120/1,200,000	54/1,500	79/860,000
Beryllium		0.78/2,100		0.72/13,000		0.79/2,700
Cadmium		0.823/3,900		0.98/13,000		1.5/3,900
Chromium (IV)						
Chromium (total)	0.71/1,700	6.6/83,000		8.8/130,000	3/200	2.5/42,000
Cobalt	5.4/330	5.81/17,000		5/120,000	6.7/210	
Copper		13/97,000		13/150,000	2.5/660	

Table 7-1
Minimum/Maximum Concentrations of Contaminants of Concern

Chemical	OUs 1/6 Subsurface Liquids (µg/L)	OUs 2/3 Subsurface Soil (µg/kg)	OUs 2/3 Landfill Gas (µg/m2)	OUs 4/5 Surface Soil (µg/kg)	OUs 4/5 Surface Water (µg/L)	OUs 4/5 Sediment (µg/kg)	Sm-fam Water	Sm-fam Sediment
Inorganics (Metals) (Continued)								
Cyanide		0.52/2,400		0.914,900	8/250	0.29/2,300		
Fluoride					0.66/66O			
Lead	1/510	8.3/100,000		7.3/150,000	5/290	6.7/2,950,000		
Manganese	180/70,000	120/1,800,000		200/2,700,000	6.9/38,000	380/1,900,000		
Mercury		0.1/1,100		0.13/1,000		0.1/1,900		
Nickel	13/2,000	7.7/29,000		7.1/130,000		2.8/42,000		
Silver		2.3/16,000		3.1/9,800				
Thallium	0.34/76O							
Vanadium		20/85,000		19/140,000	1.2/630	12/71,000		
Zinc		43/180,000		44/340,000		13/540,000		
Radionuclides								
Radionuclides	NA	NA		NA	NA	NA		

Table 7-2

Ground-Water Exposure Point Concentrations for the Hypothetical Future Onsite Residential Setting

Chemical	Onsite-Source Area Wells 95 UCL of Geometric Mean of the Median (µg/l)
1,1-Dichloroethane	520
1,1-Dichloroethene	83
1,2-Dichloroethane	590
1,2-Dichloroethane	140
1,4-Dichlorobenzene	21
1,1,2-Trichloroethane	29
1,2,4-Trichlorobenzene	18
1,1,2,2-Tetrachloroethane	31
2,4-Dichlorophenol	31
2,4-Dinitrophenol	220
2,3,7,8-TCDD	0.00053
2-Butanone (MEK)	980
2-Chlorophenol	8
2-Hexanone	45
2-Methylnaphthalene	58
4-Methyl-2-pentanone	520
Acetone	2,800
Benzene	270
Benzo(a)anthracene	17
Benzyl alcohol	53
bis(2-chlorethyl)ether	3 m
bis(2-ethylhexyl)phthalate	82
Carbazole	12
Carbon tetrachloride	40
Chloroethane	62
Chloroform	49
di-a-Octylphthalate	22
Dibenzofuran	4
Ethylene dibromide	49
Fluoranthene	18
Methylene chloride	270
Naphthalene	56

Table 7-2

Ground-Water Exposure Point Concentrations for the Hypothetical Future Onsite Residential Setting

Chemical	Onsite-Source Area Wells 95 UCL of Geometric Mean of the Median (µg/l)
Organics	
Pentachlorophenol	130
Phenanthrene	36
Tetrachloroethylene	190
Toluene	1,600
trans-1,3-Dichloropropene	3 m
Trichloroethylene	250
Vinyl chloride,	99
Inorganic (Metals)	
Arsenic	110
Chromium (IV)	40
Cobalt	45
Lead	61
Manganese	4,300
Nickel	230
Thallium	61

Note: An "m" after the value indicates it is the maximum concentration detected rather than a 95 UCL of the geometric mean of the median.

Table 7-3

Subsurface Soil and Landfill Gas Exposure Point Concentration

Chemical	Subsurface Soil RME Concentration (mg/kg)	Landfill Gas Onsite RME Concentration (µg/m3)	Landfill Gas Offsite Modeled RME Concentration (µg/m3)
	Organics		
1,1-Dichloroethane		129,571 m	
1,1-Dichloroethene		8,669	1.17
1,2-Dichloroethane	130 m	1,498 m	
1,1,1-Trichloroethane	3.9 m	37,061	3.65
2-Butanone (MEK)	120 m	38,282 m	
4,4,'-DDD	1.2 m		
4,4'-DDE	0.11 m		
4,4'-DDT	30 m		
4-Chloroaniline	2,500 m		
4-Methyl-2-pentanone	170 m		
Acetone	160 m		
Aldrin	3.7 m		
Benzene	1 m	12,541	
Benzo(b)fluoranthene	52 m		
Benzoic acid	210 m		
Beta-BHC	6 m		
bis(2-Exthylhexyl)phthalate	1,800 m		
Butylbenzylphthalate	170 m		
Carbon disulfule		22,066	
Chloroform	4 m	1,217 m	
di-n-Butylphthalate	110 m		
di-n-Octylphthalate	43 m		
Dieldrin	9.5 m		
Endrin	0.15 m		
Endrin ketone	0.21 m		
Ethylbenzene		4,133	
Fluoranthene	690 m		
gamma Chlordane	0.13 m		

Note: An "m" after the value indicates it is the maximum concentration detected rather than a 95 percent UCL.

Table 7-3

Subsurface Soil and Landfill Gas Exposure Point Concentrations

Chemical	Subsurface Soil RME Concentration (mg/kg)	Landfill Gas Onsite RME Concentration (µg/m3)	Landfill Gas Offsite Modeled RME Concentration (µg/m3)
Organics (continued)			
gamma-BHC	0.11 m		
Methylene chloride	120 m	441,718 m	
PCB-1260	2,100 m		
Phenanthrene	46 m		
Phenol	95 m		
Pyrene	75 m		
Tetrachloroethylene	1.9 m		22.26
Toluene	4 m	90,486	
Vinyl chloride		438,037 m	0.16
Xylenes		4,997	30.71
Inorganics (Metal)			
Aluminum	25,000,000 m		
Antimony	30,000 m		
Arsenic	18,000 m		
Barium	1,200,000 m		
Beryllium	2,100 m		
Cadmium	3,900 m		
Chromium (total)	89,000 m		
Cobalt	17,000 m		
Copper	97,000 m		
Cyanide	2,400 m		
Lead	100,000 m		
Manganese	18,000,000 m		
Mercury	1,100 m		
Nickel	29,000 m		
Silver	16,000 m		
Vanadium	85,000 m		
Zinc	180,000 m		

Note: An "m" after the value indicates it is the maximum concentration detected rather than a 95 percent UCL.

Table 7-4

Surface Soil Exposure Point Concentrations for the Hypothetical Future Onsite Residential Setting

Chemical	Group 1a: 95 UCL of the Mean Soil Concentration (µg/kg)	Group 1a: 95 UCL of the Mean Modeled Dust Concentration (µg/m3)	Group 2b: 95 UCL of the Mean Soil Concentration (µg/kg)	Group 2b: 95 UCL of the Mean Modeled Dust Concentration (µg/m3)	Group 3c: 95 UCL of the Mean Soil Concentration (µg/kg)	Group 3c: 95 UCL of the Mean Modeled Dust Concentration (µg/m3)	Group 4d: 95 UCL of the Mean Soil Concentration (µg/kg)	Group 4d: 95 UCL of the Mean Modeled Dust Concentration (µg/m3)
2,3,7,8-TCDD	0.057 e	0.000000009	0.11 e	0.0000000028				
2-Butanone	1 m	0.000000025						
bis(2-ethylhexyl)Phthalate	586.63	0.000015	424	0.000011	215 m	0.0000054		
Carbon disulfide	6.53	0.00000016						
Chloroform	1.05	0.0000000026	3 m	0.000000075	2 m	0.00000005		
PCB-1260	633.86	0.000016						
Toluene	3.84	0.000000098	3 m	0.000000075				
Aluminum	16,000,000	NC	19,000,000	NC	170,000,000	NC	25,000,000	NC
Arsenic	9,200	0.00023	7,300	0.00018	12,000	0.0003	4,800	0.00012
Barium	510,000	0.013	240,000	0.006	260,000	0.0064	330,000	0.0078
Beryllium	2,300	0.000057	1,500	0.000038	1,200	0.00003	1,200	0.00003
Cadmium	5,000	0.00012	3,000	0.000075	1,500	0.000038		
Chromium (total)	1,600	0.0021	62,000	0.0016	16,000	0.00041	27,000	0.00066
Cobalt	21,000	NC	11,000	NC	8,900	NC	11,000	NC
Copper	110,000	NC	83,000	NC	21,000	NC	36,000	NC
Cyanide	85,000	0.000039	1,800	0.000045				

aGroup 1 consists of data from the sewage sludge application/leachate injection area.
bGroup 2 consists of data from the sewage sludge application area.
cGroup 3 consists of data from the leachate spraying area.
dGroup 4 consists of data from the tire pile area.
e2,3,7,8 TCDD equivalents.

Notes: NC = Indicates a dust concentration was not calculated.
The notation "m" next to the concentration indicates a maximum value used for the RME. All other values reported are 95 UCL of the mean.
Blanks indicate chemical was not detested in the soil grouping.

Table 7-4
Surface Soil Exposure Point Concentrations for the
Hypothetical Future Onsite Residential Setting

Group 1a		Group 2b		Group 3c		Group 4d		
Chemical	95 UCL of the Mean Soil Concentration (µg/kg)	95 UCL of the Mean Modeled Dust Concentration (µg/m3)	95 UCL of the Mean Soil Concentration (µg/kg)	95 UCL of the Mean Modeled Dust Concentration (µg/m3)	95 UCL of the Mean Soil Concentration (µg/kg)	95 UCL of the Mean Modeled Dust Concentration (µg/m3)	95 UCL of the Mean Soil Concentration (µg/kg)	95 UCL of the Mean Modeled Dust Concentration (µg/m3)
Lead	670,000	0.0024	80,000	0.002	35,000	0.00086	30,000	0.00075
Manganese	97,000	0.017	2,300,000	0.057	580,000	0.015	1,900,000	0.045
Mercury	880	0.000022	500	0.000013	200	0.000005	100	0.0000026
Nickel	42,000	0.0011	29,000	0.00072	16,000	0.0004	19,000	0.00048
Silver	9,400	0.00023	5,000	0.00013				
Vanadium	6,3000	0.0016	39,000	0.00097	34,000	0.00084	62	0.0016
Zinc	200,000	0.005	160,000	0.0039	62,000	0.0016	87,000	0.0022

aGroup 1 consists of data from the sewage sludge application/leachate injection area.
bGroup 2 consists of data from the sewage sludge application area.
cGroup 3 consist of data from the leachate spraying area.
dGroup 4 consists of data from the tire pile area.
e2,3,7,8 TCDD equivalents.

Notes: NC = Indicates a dust concentration was not calculated.
The notation "m" next to the concentration indicates a maximum value used for the RME. All other values reported are 95 UCL of the mean.
Blanks indicate chemical was not detected in ths soil grouping.

Table 7-5

Surface Water and Sediment Exposure Point Concentrations for the Hypothetical Future Onsite Residential Setting

Chemical	95 UCL of the Mean Surface Water[a] Concentration (µg/l)	95 UCL of the Mean Sediment[b] Concentration (µg/kg)
	Organics	
1,1-Dichloroethane	15,000	
1,1-Dichloroethene	5,000	1,800
1,2-Dichloroethene	730	
1,1,1-Trichloroethane	31,000	110,000
2,4-Dichlorophenol	170	710
2,4-Dimethylphenol	920	
2-Butanone	51,000	15,000
2-Hexanone	7,400	
2-Methylnaphthalene	9.0	2,100
2-Methylphenol	2,700	
2,3,7,8-TCDD[c]	0.0033	
4-Methylphenol	6,600	
4-Methyl-2-pentanone	27,000	
Acetone	240,000	
Aniline		330
Benzene	180	4,700
bis(2-ethylhexyl)phthalate		11,000
Ethylbenzene	340	95,000
Fluoranthene		940
Methylene chloride	7,700	
PCB-1260		550
Phenanthrene	0.74	910
Phenol	4,100	
Tetrachloroethene	2,300	48,000
Toluene	28,000	280,000
trans-1,2-Dichloroethene	56,000	
Trichloroethene	2,500	

[a]Surface water data in unnamed creek from the toe of the landfill to Pond 3 in Section 6.
[b]Sediment data in unnamed creek from the toe of the landfill to Pond 3 in Section 6.

Note: The notation "m" next to the concentration indicates a maximum value used for the RME. All other values reported are 95 UCL of the mean.

Table 7-5

Surface Water and Sediment Exposure Point Concentrations for the Hypothetical Future Onsite Residential Setting

Chemical	95 UCL of the Mean Surface Water Concentration (µg/l)	95 UCL of the Mean Sediment Concentration (µg/kg)
	Organics (continued)	
Vinyl chloride	9,600	19
Xylenes	9,700	580,000
	Inorganics (Metals)	
Aluminum	110,000	15,000,000
Antimony	40	29,000
Arsenic	24	21,000
Barium	420	430,000
Beryllium		980
Cadmium		2,400
Chromium (total)	33	59,000
Cobalt	51	12,000
Copper	43	46,000
Cyanide	20	650
Fluoride	660	
Lead	59	700,000
Manganese	24,000	1,100,000
Mercury		1,000
Nickel		17,000
Vanadium	120	44,000
Zinc		130,000

aSurface water data in unnamed creek from the toe of the landfill to Pond 3 in Section 6.
bSediment data in unnamed creek from the toe of the landfill to Pond 3 in Section 6.

Note: The notation "m" next to the concentration indicates a maximum value used for the RME. All other values reported are 95 UCL of the mean.

Table 7-6
RME Exposure Parameters

Exposure Scenario	Exposure Route	Agea	Intake Rate	Units	Reference	Exposure Frequency	Units	Comments	Reference	Exposure Duration	Units	Reference	Body Weight	Units	Reference
Residential	Ground-water irrigation	A: 7-70	2	L/day	RAGS	350	days/yr			30	years	RAGS	70	kg	RAGS
		C: 1-6	1	L/day	OSWER	350	days/yr			6	years	OSWER	15	kg	OSWER
Residential	Surface or subsurface soil ingestion	A: 7-70	100	mg/day	OSWER	350	days/yr		OSWER	24	years	OSWER	70	kg	EPA VII
		C: 1-6	200	mg/day	OSWER	350	days/yr		OSWER	6	years	OSWER	15	kg	OSWER
Residential	Particulate inhalation (surface soil)	A: 19-70	20	m3/day	OSWERc	350	days/yr		OSWER	30	years	RAGS	70	kg	EPA VIII
		C: 1-18	14	m3/day	IPGDd	350	days/yr		OSWER	15	years	EPA VIII	33	kg	IPGDd
Residential	Surface water ingestion while wading	C: 7-18	50	mL/hr	RAGS	60	days/yr	4 days/wk at 12 wks/yr (summer) + 2 days/wk at 6 wks/yr (spring/fall)	SS	12	years	EPA VIII	38	kg	EPA VIII
Residential	Sediment ingestion (Receptor in Section 31)	A: 7-70	100	mg/day	OSWER	350	days/yr		OSWER	24	years	OSWER	70	kg	OSWER
OSWER															
		C: 7-18	100	mg/day	OSWER	60	days/yr		OSWER	12	years	EPA VIII	38	kg	EPA VII
Residential	Ambient air inhalalation (Gaseous emissions)	A: 19-70	20	m3/day	OSWERc	350	days/yr		OSWER	30	years	RAGS	70	kg	EPA VII
		C: 1-18	14	m3/day	IPGDd	350	days/yr		OSWER	15	years	EPA VIII	33	kg	IPGDd
Occupational	Surface or subsurface soil Ingestion	A: 19-70	50	mg/day	OSWER	250	days/yr		OSWER	25	years	OSWER	70	kg	OSWER
Occupational	Particular inhalation	A: 19-70	20	m3/work day	OSWERc	250	days/yr		OSWER	25	years	OSWER	70	kg	OSWER
Occupational	Ambient air inhalation (Gaseous emissions)	A: 19-70	20	m3/work day	OSWER	250	days/yr		OSWER	25	years	OSWER	70	kg	OSWER
OSWER															
Recreational	Surface soil ingestion	A: 7-70	100	mg/day	OSWERb	60	days/yr	4 days/wk at 12 wks/yr (summer) + 2 days/wk at 6 wks/yr (spring/fall)	SS	24	years	OSWERb	70	kg	OSWERb
		C: 1-6	200	mg/day	OSWERb	60	days/yr	4 days/wk at 12 wks/yr (summer) + 2 days/wk at 6 wks/yr (spring/fall)	SS	6	years	OSWERb	15	kg	OSWERb
Recreational	Particulate inhalation (suface soil)	A: 19-70	20	m3/day	OSWERb,c	60	days/yr	4 days/wk at 12 wks/yr (summer) + 2 days/wk at 6 wks/yr (spring/fall)	SS	30	years	RAGSb	70	kg	EPA VIII
		C: 1-18	14	m3/day	IPGDd	60	days/yr	4 days/wk at 12 wks/yr (summer) + 2 days/wk at 6 wks/yr (spring/fall)	SS	15	years	EPA VIIIb	33	kg	IPGD4
Recreational	Surface water ingestion while wading	C: 7-18	50	mL/hr	RAGSb	60	days/yr	4 days/wk at 12 wks/yr (summer) + 2 days/wk at 6 wks/yr (spring/fall)	SS	12	years	EPA VIII	38	kg	EPA VIII
Recreational	Sediment ingestion	A: 7-70	100	mg/day	OSWERb	60	days/yr	4 days/wk at 12 wks/yr (summer) +	SS	24	years	OSWERb	70	kg	OSWERb

Table 7-6
RME Exposure Parameters

Exposure Scenario	Exposure Route	Agea	Intake Rate	Units	Reference	Exposure Frequency	Units	Comments	Reference	Exposure Duration	Units	References	Body Weight	Units	Reference
	(Receptor in Section 31)	C: 1-6	200	mg/day	OSWERb	60	days/yr	4 days/wk at 12 wke/yr (summer) + 2 days/wk at 6 wks/yr (spring/fall)	SS	6	years	OSWERb	15	kg	OSWERb
	Ambient air inhalation (Gaseous emissions)	A: 19-70	20	mg3/day	OSWERc	60	days/yr	4 days/wk at 12 wks/yr (summer) + 2 days/wk at 6 wks/yr (spring/fall)	SS	30	years	RAGSb	70	kg	EPA VIIIb
		C: 1-18	14	m3/day	IPGDd	60	days/yr	4 days/wk at 12 wks/yr (summer) + 2 days/wk at 6 wks/yr (spring/fall)	SS	15	years	EPA VIIIb	33	kg	IPGDd

aA = Adult and C = child.
bThe residential exposure value was considered applicable to the corresponding Recreational or Occupational setting.
cReasonable upperbound value based on "conservative" activity and "average" inhalation rates.
dValues are average of three age groups defined by IPGD as follows:

Age Period	Inhalation Rate Average	(m3/day) Maximum	Average Body Weight (kg)	Exposure Duration (yrs)
1-4	5	5	14	4
5-11	10	12	29	7
12-18	17	26	57	7
Average value	11	14	33	6

Reference Cited:

- EFH = USEPA 1989. Exposure Factors Handbook, Final Report.
- EPA VIII = EPA Region VIII Draft intake Assumptions.
- IPGD = Clement Associates, Inc. 1988. Multipathway Health Risk Assessment Input Parameters Guidance Document.
- OSWER = USEPA 1991. Human Health Evaluation Manual, Supplemental Guidance; Standard Default Exposure Factors.
- RAGS = USEPA 1989. Risk assessment guidance for Superfund, Human health evaluation manual, Part A.
- SS = Exposure values are based on site-specific conditions and professional Judgement. See text for full explanation.
- EPA, 1986 = Draft Superfund Exposure Assessment Manual, regarding dust suppression when precipitation exceeds 0.01 inch.

Table 7-7

Toxicity Values for Chemicals with Carcinogenic Effectsa

Chemical	U.S. EPA Cancer Classification	Oral SFb (mg/kg-day)-1	Oral Ref	Inhalation SFb (mg/kg-day)-1	Inhalation Refc
Organics					
1,1-Dichloroethane	C		IRIS 12/7/89		
1,1-Dichloroethylene	C	0.6	IRIS 1/1/91	0.175	IRIS 1/1/91
1,2-Dichloroethane	B2	0.091	IRIS 1/1/91	0.091	IRIS 1/1/91
1,1,2-Trichloroethane	C	0.057	IRIS 1/1/91		
1,1,2,2-Tetrachloroethane	C	0.2	IRIS 1/1/91		
2,3,7,8-TCDD	B2	156,000 150,000d	HEAST 1/91 HEAST 1/92	150,000	HEAST 1/92 (oral)
2-Methylphenol	C		IRIS 8/1/91		
4,4'-DDD		0.24			
4,4'-DDE		0.034			
4,4'-DDT	B2	0.3395	IRIS 1/1/91	0.34	IRIS 1/1/91
Aldrin		17		17.15	
Aniline	B2	0.0057	IRIS 6/1/89		
Benzene	A	0.029	IRIS 1/1/91	0.029	IRIS 1/1/91
Benzo(a)anthracene	B2	11.5	HEAST 1/91		
Benzo(b)fluoranthene		7.3			
Beta-BHC		1.8		1.855	
bis(2-chloroethyl)ether	B2	1.1	HEAST 1/91		
bis(2-ethylhexyl)phthalate	B2	0.014	IRIS 5/1/90 IRIS 8/1/91d		
Carbon tetrachloride	B2	0.13	IRIS 1/1/91		
Chloroform	B2	0 0061	IRIS 1/1/91	0.0805	IRIS 1/1/91
Dieldrin		16		16.1	
Ethylene dibromide	B2	8585	IRIS 1/1/91		
Gamma-BHC		1.3			
Methylene chloride	B2	0.0075	IRIS 9/1/90	0.00165	IRIS 1/1/90
PCB-1260	B2	7.7	IRlS 1/9/90		
Pentachlorophenol	B2	0.12	IRIS 3/1/91		
Tetrachloroethylene	B2	0.051	IRIS 6/1/90 HEAST 1/91d	0.00182	HEAST 1/91
trans-1,3-Dichloropropene	B2		IRIS 1/1/91		
Trichloroethylene	B2	0.011	IRIS 6/1/90	0.006	HEAST 1/91
Vinyl chloride	A	1.9	HEAST 1/91	0.3	HEAST 1/92

aOnly those chemicals classified as A, B1, B2, or C carcinogen are listed on this table.
bSF = Slope factor.
cRef = Reference, citation and date of toxicity value.
dValue and date used for OUs 2&3 and 4&5 if different than that used for OUs 1&6.

Table 7-7

Toxicity Values for Chemicals with Carcinogenic Effects[a]

Chemical	U.S. EPA Cancer Classification	Oral SF[b] (mg/kg-day)-1	Oral Ref[c]	Inhalation SF (mg/kg-day)-1	Inhalation Ref[c]
Inorganic (Metals)					
Arsenic	A	1.75	IRIS 9/1/91	15.05	IRIS 1/13/88
Beryllium	B2	4.3	IRIS 1/1/91	8.4	IRIS 1/1/91
Cadmium	B1 (inhalation)			6.3	IRIS 1/1/91
Chromium (IV)	A (inhalation)		IRIS 3/1/91	42	IRIS 3/1/91
Lead	B2		IRIS 5/1/91		

[a]Only those chemicals classified as an A, B1, B2, or C carcinogen are listed on this table.
[b]SF = Slope factor.
[c]Ref = Reference, citation and date of toxicity value.
[d]Value and date used for OUs 2&3 and 4&5 if different than that mind for OUs 1&6.

Table 7-8

Toxicity Values for Chemicals with Noncarcinogenic Effectsa

Chemical	Oral Reference Dose (RfD) (mg/kg/day)	Oral Confidence/ U/M Factorsb	Oral Health Effects	Oral Referencec	Inhalation Reference Dose (RfD) (mg/kg/day)	Inhalation Confidence/ U/M Factorsb	Inhalation Health Effects	Inhalation Referencec
Organics								
1,1-Dichloroethane	0.1	--/1001--	None observed	HEAST 1/92	0.143	--/1000/-	Kidney damage	HEAST 1/92
1,1-Dichloroethylene	0.009	M/1000/1	Hepatic lesions	IRIS 1/1/91				
1,2-Dichloroethene	0.02	L/1000/1	Liver lesions	IRIS 1/1/89				
	0.009d	--1000d/--		HEAST 1/92d				
1,1-Trichloroethane	0.09	--/1000/--	Hepatotoxicity	HEAST 1/92	0.286	--/1000/--	Hepatotoxicity	HEAST 1/92
1,1,2-Trichloroethane	0.004	M/1000/1		IRIS 1/1/91				
1,2,4-Trichloroebenzene	0.0013	--/1000/--		HEAST 8/1/90				
2,4-Dichlorophenol	0.003	L/100/1	Decreased delayed hyper-sensitivity	IRIS 8/1/89				
2,4-Dimethylphenol	0.02	L/3000/1	Lethargy, heme	IRIS 11/1/90				
2,4-Dinitrophenol	0.002	L/1000/1		IRIS 3/1/90				
2-Butanone (MEK)	0.05e	--/1000/--e		IRIS 8/1/91	0.286	L/1000/3	Decreased fetal birth weight	IRIS 7/1/9
2-Chlorophenol	0.005	1/1000/1		IRIS 8/1/89				
2-Methylphenol	0.05	M/1000/1	Decreased body weight, neurotoxicity	IRIS 9/1/90				
4,4'-DDT	0.0005	M/100/1	Liver lesions	IRIS 9130187				
4-Chloroaniline	0.004							
4-Methylphenol	0.05	--/1000/--	Decreased body weight, neurotoxicity	HEAST 1/92				
4-Methyl-2-pentanone	0.05	--/1000/--	Liver and kidney	HEAST 1/92	0.0229	--/1000/--	Liver and kidney effects	HEAST 1/92

aOnly those chemicals with an RfD or a pending Rt-D are listed on this table.
bConfidence is the level of confidence in the RfD and is given as L for low, M for medium, and H for high. U/M is the uncertainty and modifying factors used to derived the RfD, the uncertainty factor is the middle value and the modifying factor is the last value given.
cRef = Reference, citation and date of toxicity value.
dValue and date used for OUs 2/3 and 4/5 if different than that used for OUs 1/6.
eNo toxicity value was used for OUs 2/3 and 4/5.
fRfD is pending.

Table 7-8

Toxicity Values for Chemicals with Noncarcinogenic Effects[a]

Chemical	Oral: Reference Dose (RfD) (mg/kg/day)	Oral: Confidence/ U/M Factors[a]	Oral: Health Effects	Oral: Reference[c]	Inhalation: Reference Dose (RfD) (mg/kg/day)	Inhalation: Confidence/ U/M Factors[b]	Inhalation: Health Effects	Inhalation: Reference[c]
Organics (continued)								
Acetone	0.1	L/1000/1	Neurotoxicity, increased liver and kidney weight	IRIS 12/1/90				
Aldrin	0.00003							
Aniline					0.000286	L/3000/1	Spleen toxicity	IRIS 11/1/91
Benzene					f			
Benzoic acid	4							
bis(2-ethylhexl)phthalate	0.02	M/1000/1	Increased liver	IRIS 5/1/91				
Butylbenzyl phthalate	0.2							
Carbon disulfide	0.1	M/100/1	Fetal toxicity, malformations	IRIS 9/1/90	f			
Carbon tetrachloride	0.0007	M/1000/1	IRIS 1/1/91					
Chloroform	0.01	M/1000/1		IRIS 1/1/91	f			
Di-n-butylphthalate	0.1							
Dieldrin	0.00005							
Endrin	0.0003	M/100/1	Mild liver lesions, occasional contusions	IRIS 4/1/91				
Gamma-BHC	0.0003							
Methylene chloride	0.06	M/100/1	Liver toxicity	IRIS 3/1/88	f			
Naphthalene	0.004	--/10000/--	--	IRIS 12/1/90				
Pentachlorophenol	0.03	M/100/1	--	IRIS 3/1/90				
Phenol	0.6	L/100/1	Decreased fetal	IRIS 2/1/90				

[a] Only those chemicals with an RfD or a pending Rt-D are listed on this table.
[b] Confidence is the level of confidence in the RfD and is given as L for low, M for medium, and H for high. U/M is the uncertainty and modifying factors used to derived the RfD, the uncertainty factor is the middle value and the modifying factor is the last value given.
[c] Ref = Reference, citation and date of toxicity value.
[d] Value and date used for OUs 2/3 nnd 4/5 if different than that used for OUs 1/6.
[e] No toxicity value was used for OUs 2/3 and 4/5.
[f] RfD is pending.

Table 7-8
Toxicity Values for Chemicals with Noncarcinogenic Effectsa

Chemical	Oral Reference Dose (R/D) (mg/kg/day)	Confidence/ U/M Factorsb	Health Effects	Reference	Inhalation Reference Dose (RfD) (mg/kg/day)	Confidence U/M Factorsb	Health Effects	Referencec
			(Organics (continued)					
Pyrene	0.03							
Tetrachloroelhylene	0.01	M/1000/1	Hepatotoxicity, weight gain	IRIS 6/1/90				
Toluene	0.2	M/1000/1	Changes in liver and kidney weight	IRIS 8/1/90	0.114	--/300/--	Neurological effects	HEAST 1/92
trans-1,2-Dichloroethene	0.02	L/1000/1	--	IRIS 1/1/89				
trans-1,3-Dichloropropene	0.0003	L/10000/1	--	IRIS 1/1/91				
Trichloroethylene			--		f			
Xylenes	2	M/100/1	HS peractivity, decreased body weight	IRIS 9/30/87	f			
			Inorganics (Metals)					
Antimony	0.0004	L/1000/1	Decreased longevity, increased blood cholesterol	IRIS 8/1/89				
Arsenic	0.0003	M/3/1	Hyperpigmentation, vascular complications	IRIS 9/1/9				
Barium	0.07	M/3/1	Increased blood pressure	IRIS 8/1/90	0.000143	--/1000/--	Fetotoxicity	
Beryllium	0.005	L/100/1	None observed	IRIS 9/1/90				
Cadmium	0.0005	H/10/1	Proteinuria	IRIS 10/1/89	f			
Chromium (IV)	0.005	L/500/1	None observed	IRIS 3/1/88	f			

aOnly those chemicals with an RfD or a pending Rt-D are listed on this table.
bConfidence is the level of confidence in the RfD and is given as L for low, M for medium, and H for high. U/M is the uncertainty and modifying factors used to derived the RfD, the uncertainty factor is the middle value and the modifying factor is the last value given.
cRef = Reference, citation and date of toxicity value.
dValue and date used for OUs 2/3 and 4/5 if different than that used for OUs 1/6.
eNo toxicity value was used for OUs 2/3 and 4/5.
fRfD is pending.

Table 7-8
Toxicity Values for Chemicals with Noncarcinogenic Effectsa

	Oral				Inhalation			
Chemical	Reference Dose(RfD) (mg/kg/day)	Confidence/ U/M Factorsb	Health Effects	Reference	Reference Dose (RfD) (mg/kg/day)	Confidence/ U/M Factorsb	Health Effects	Referencec
			Inorganics (Metals) (continued)					
Cyanide	0.02	M/100/5	Weight loss, thyroid effects, myelin degeneration	IRIS 3/1/91				
Manganese	0.14	M/1/1	CNS effects	IRIS 12/1/90	0.00014	M/300/3	Increased prevalence of respiratory symptoms, psychomotor disturbances	IRIS 12/1/90
Mercury	0.0003	--/1000/--	Kidney effects	HEAST 1/91	0.0000857	--1301--	Neurotoxicity	
Nickel	0.02	--/300/--	Decreased body wight/ organ weight	HEAST 1/92	f			
Silver	0.005	L/3/1	Argyria	IRIS 12/1/91				
Thallium	0.00007	--/3000/--	--	HEAST 1/91				
Vanadium	0.007	--/100/--	None observed	HEAST 1/92				
Zinc	0.2	--/10/--	Anemia	HEAST 9/30/87				

aOnly those chemicals with an RfD or a pending Rt-D are listed on this table.
bConfidence is the level of confidence in the RfD and is given as L for low, M for medium, and H for high. U/M is the uncertainty and modifying factors used to derived the RfD, the uncertainty factor is the middle value and the modifying factor is the last value given.
cRef = Reference, citation and date of toxicity value.
dValue end date used for OUs 2/3 and 4/5 if different than that used for OUs 1/6.
eNo toxicity value was used for OUs 2/3 and 4/5.
fRfD is pending.

Table 7-9

COCs Without Toxicity Values

Chemical	OUs 1/6	OUs 2/3		OUs 4/5		
	Subsurface Liquids[a]	Subsurface Soil	Landfill Gas	Surface Soil	Surface Water	Sediment
Organics						
1,1-Dichloroethane	X		X		X	
1,4-Dichlorobenzene	X					
2-Hexanone	X				X	
2-Methylnaphthalene	X				X	X
Benzyl alcohol	X					
Carbazole	X					
Chloroethane	X					
di-n-octylphthalate	X	X				
Dibenzofuran	X					
Endrin ketone		X				
Phenanthrene	X	X				X
Inorganics (Metals)						
Aluminum		X		X	X	X
Cobalt	X	X		X	X	X
Copper		X		X	X	X
Fluoride					X	
Lead	X	X		X	X	X

[a]Subsurface liquids consist of shallow ground water, waste-pit liquids, and deep ground water.

Note: An X indicates the medium the chemical was detected in.

Table 7-10

Summary of Quantified Site Risks Based on Hypothetical Future Onsite Residential Setting

		Reasonable Maximum Exposure	
Exposure Pathways[a]	Chemicals of Concern	Excess Lifetime Cancer Risk	Noncancer Hazard Quotient
	Organics		
Ingestion of subsurface liquids as a drinking water source[b]	Benzo(a)anthracene	2 x 10-3	NA
	Arsenic	2 x 10-3	10
	Vinyl chloride	2 x 10-3	NA
	2,3,7,8-TCDD[c]	1 X 10-3	NA
	1,2-Dichloroethane	6 x 10-4	NA
	1,1-Dichloroethene	6 x 10-4	0.25
	bis(2-chloroethyl)ether	3 x 10-4	NA
	Pentachlorophenol	2 x 10-4	0.12
	Tetrachloroethene	1 X 10-4	0.52
	Thallium	NC	24
	2,4-Dinitrophenol	NC	3.0
	Carbon tetrachloride	6 x 10-5	1.5
	Manganese	NC	1.2
Pathway Total[d]		1 x 10-2	47
Surface Soil Ingestion[e]	Arsenic	8 x 10-6	0.04
	Beryllium	5 x 10-6	<0.01

[a]Exposure pathways presented are for adults using reasonable maximum exposures (RMEs).
[b]Subsurface liquids consist of shallow ground-water, waste-pit liquids, and deep ground water from source area wells.
[c]Dioxin equivalents.
[d]Not all COCs that contribute to the total risk are listed, therefore, sum of risk (or HQs) for listed chemicals will not equal the total.
[e]Using Group 1 exposure point concentrations.
[f]Dust arising form Group 1 surface soil.
[g]As hexavalent chromium.

NC = Not carcinogenic through this pathway.
NA = Not applicable.

Table 7-10

Summary of Quantified Site Risks Based on Hypothetical Future Onsite Residential Setting

		Reasonable Maximum Exposure	
Exposure Pathways[a]	Chemicals of Concern	Excess Lifetime Cancer Risk	Noncancer Hazard Quotient
	Organics (continued)		
Surface Soil Ingestion[e]	2,3,7,8-TCDD	4 x 10-6	NA
	PCB-1260	2 x 10-6	NA
	Chromium	NC	0.02
Pathway Total[d]		2 x 10-5	0.1
Particulate Inhalation[f]	Chromium[g]	1 x 10-5	NA
	Manganese	NC	0.04
	Barium	NC	0.02
Pathway Total[d]		1 x 10-5	0.06
Surface Water Ingestion as a Child	Vinyl chloride	7 x 10-4	NA
	1,1-Dichloroethene	1 x 10-4	0.12
	2,3,7,8-TCDD[c]	2 x 10-5	NA
	trans-1,2-Dichloroethene	NC	0.61
	Acetone	NC	0.52
	4-Methyl-2-pentanone	NC	0.12

[a]Exposure pathways presented are for adults using reasonable maximum exposures (RMEs).
[b]Subsurface liquids consist of shallow ground-water, waste-pit liquids, and deep ground water from source area wells.
[c]Dioxin equivalents.
[d]Not all COCs that contribute to the total risk are listed, therefore, sum of risk (or HQs) for listed chemicals will not equal the total.
[e]Using Group 1 exposure point concentrations.
[f]Dust arising form Group 1 surface soil.
[g]As hexavalent chromium.

NC = Not carcinogenic through this pathway.
NA = Not applicable.

Table 7-10

Summary of Quantified Site Risks Based on Hypothetical Future Onsite Residential Setting

Exposure Pathwaysa	Chemicals of Concern	Reasonable Maximum Exposure: Excess Lifetime Cancer Risk	Reasonable Maximum Exposure: Noncancer Hazard Quotient
	Organics (continued)		
Surface Water Ingestion as a Child	1,1,1-trichloroethane	NC	0.075
	Manganese	NC	0.05
Pathway Totald		8 x 10-4	2
	Inorganics (Metals)		
Sediment Ingestion as a Child	Arsenic	7 x 10-6	0.15
	Antimony	NC	0.16
	Chromium	NC	0.03
	Manganese	NC	0.03
Pathway Totald		9 x 10-6	0.4
Maximum Cumulative Total		2 x 10-2	49

aExposure pathways presented are for adults using reasonable maximum exposures (RMEs).
bSubsurface liquids consist of shallow ground-water, waste-pit liquids, and deep ground water from source area wells.
cDioxin equivalents.
dNot all COCs that contribute to the total risk are listed, therefore, sum of risk (or HQs) for listed chemicals will not equal the total.
eUsing Group 1 exposure point concentrations.
fDust arising form Group 1 surface soil.
gAs hexavalent chromium.

NC = Not carcinogenic through this pathway.
NA = Not applicable.

Table 7-11

Comparison of Subsurface Soil Maximum Detected Concentrations to Carcinogenic Risk-Specific Values and Noncarcinogenic Reference Concentrations in the Future Onsite Residential Setting

Reasonable Maximum Exposure[a]

Chemical	Maximum Detected Concentration	Risk-Specific Value[b] (µg/kg)	Exceeds Risk-specific Value?	Reference Concentration (µg/kg)	Exceeds Reference Concentration
1,1,1-Trichloroethane	3.9	NA	-	7,029,702	No
1,2-Dichloroethane	130	6,986	No	NA	-
2-Butanone	6,700	NA	-	31,923,383,879	No
4,4'-DDD	1.2	2,654	No	NA	-
4,4'-DDE	0.11	1,873	No	NA	-
4,4'-DDT	30	1,870	No	39,063	No
4-Chloroaniline	2,500	NA	-	312,500	No
4-Methyl-2-pentanone	540	NA	-	3,900,284	No
Acetone	15,000	NA	-	7,821,500	No
Aldrin	3.7	37	No	2,344	No
Aluminum	124,700,000	NA	-	NA	-
Antimony	30,000	NA	-	31,250	No
Arsenic	18,000	358	Yes	23,438	No
Barium	1,190,000	NA	-	4,073,201	No
Benzene	1	21,922	No	NA	-
Benzo(b)fluoranthene	52	87	No	NA	-
Benzoic acid	210	NA	-	312,500,000	No
Beryllium	2,100	148	Yes	390,625	No
Beta-BHC	6	353	No	NA	-
Butylbenzylphthalate	170	NA	-	15,625,000	No
Cadmium	3,900	53,990	No	39,063	No
Chloroform	4	101,899	No	781,250	No
Chromium (Total)	83,000	8,098	Yes	390,625	No
Cobalt	17,000	NA	-	NA	-
Copper	97,000	NA	-	NA	-
Cyanide	2,400	NA	-	1,562,500	No
Di-n-butylphthalate	110	NA	-	7,812,500	No
Di-n-octylphthalate	62	NA	-	NA	No
Dieldrin	9.5	40	No	3,906	No
Endrin	0.15	NA	-	23,438	No
Endrin Ketone	0.21	NA	-	NA	-

[a]Reasonable maximum exposure parameters and maximum detected concentrations.
[b]Risk-specific values and reference concentrations assume ingestion of soil and inhalation of airborne contaminants adsorbed to dust.

Note: NA = No toxicity values with which to calculate a value.
- = Not applicable.

Table 7-11

Comparison of Subsurface Soil Maximum Detected Concentrations to Carcinogenic Risk-Specific Values and Noncarcinogenic Reference Concentration in the Future Onsite Residential Setting

Reasonable Maximum Exposure[a]

Chemical	Maximum Detected Concentration	Risk-Specific Value[b] (µg/kg)	Exceeds Risk-Specific Value?	Reference Concentration[b] (µg/kg)	Exceeds Reference Concentration	
Fluoranthene	69	NA	-	3,125,000	No	
Gamma chlordane	0.13	NA	-	NA	-	
Gamma-BHC (Lindane)	0.11	490	No	23,438	No	
Lead	101,000	NA	-	NA	-	
Manganese	1,770,000	NA	-	4,847,016	No	
Mercury	1,100	NA	-	23,380	No	
Methylene chloride	120	84,891	No	4,687,500	No	
Nickel	29,000	NA	-	1,562,500	No	
PCB-1260 (Aroclor 1260)	2,100	83	Yes	NA	-	
Phenanthrene	46	NA	-	NA	-	
Phenol	95	NA	-	46,875,000	No	
Pyrene	75	NA	-	2,343,750	No	
Silver	16,000	NA	-	390,625	No	
Tetrachloroethene	1.9	12,488	No	781,250	No	
Toluene	4	NA	-	15,605,904	No	-
Vanadium	85,000	NA	-	546,875	No	
Zinc	179,000	NA	-	15,625,000	No	
bis(2-Ethylhexyl)phthalate	1,800	45,496	No	1,562,500	No	

[a]Reasonable maximum exposure parameters and maximum detected concentrations.
[b]Risk-specific values and reference concentrations assume ingestion of soil and inhalation of airborne contaminants adsorbed to dust.

Note: NA = No toxicity values with which to calculate a value.
- = Not applicable.

Table 7-12

Comparison of Exposure Point Concentrations of Landfill Gas Within the Landfill Mass to Carcinogenic Risk-Specific Values and Noncarcinogenic Reference Concentrations in the Future Onsite Residential Setting

	Reasonable Maximum Exposurea				
Chemical	95 UCL Gas Concentration (µg/m3)	Risk-Specific Value (µg/m3)	Exceeds Risk-Specific Value?	Reference Concentration (µg/m3)	Reference Concentration?
1,1,1-Trichloroethane	3.7 x 104	NA	-	1,043	Yes
1,1-Dichloroethane	1.3 x 105 (M)	NA	-	521	Yes
1,1-Dichloroethene	8.7 x 103	0.05	Yes	NA	-
1,2-Dichloroethane	1.5 x 103 (M)	0.09	Yes	NA	-
2-Butanone	3.8 x 104 (M)	NA	-	1,043	Yes
Benzene	1.3 x 104	0.29	Yes	NA	-
Carbon disulfide	2.2 x 104	NA	-	NA	-
Chloroform	1.2 x 103 (M)	0.11	Yes	NA	-
Ethylbenzene	4.1 x 103	NA	-	1,043	Yes
Methylene chloride	4.4 x 105 (M)	5.18	Yes	NA	-
Toluene	9.0 x 104	NA	-	417	Yes
Xylenes	5.0 x 103	NA	-	NA	-
Vinyl chloride	4.4 x 105	0.03	Yes	NA	-

aRME uses reasonable maximum exposure parameters and 95 UCL concentrations.

Notes: (M) = Maximum concentration used; 95 UCL exceeds maximum concentration.
NA = No inhalation toxicity value with which to calculate a value.

Table 7-13

Comparison of Modeled Exposure Point Concentrations Assuming a Cracked Slab to Carcinogenic Risk-Specific Values and Noncarcinogenic Reference Concentrations in the Future Offsite Residential Setting

Reasonable Maximum Exposure

Chemical	Modeled Gas Concentration (µg/m3)	Risk-Specific Value (µg/m3)	Exceeds Risk-Specific Value?	Reference Concentration (µg/m3)	Exceeds Reference Concentration
1,1,1-Trichloroethane	3.6	NA	-	1,043	No
1,1-Dichloroethene	1.2	0.05	Yes	NA	-
Vinyl chloride	31.0	0.03	Yes	NA	-

aRME uses reasonable maximum exposure parameters and 95 UCL modeled gas concentrations.

Notes:

NA = No inhalation toxicity values with which to calculate value.
- = Not applicable.

Table 7-14

Cumulative Total Risk for the Hypothetical Future Onsite Residential Setting

	Reasonable Maximum Exposure	
Exposure Media/Exposure Pathway	Excess Lifetime Cancer Risk	Noncancer HI
Ground Water		
Ingestion	1 x 10-2	47
Surface Soil		
Ingestion	2 x 10-5	0.1
Inhalation	1 X 10-5	0.06
Surface Water		
Ingestion	8 x 10-4	2
Sediments		
Ingestion	9 X 10-6	0.4
Cumulative Total	2 x 10-2	49

Table 7-15

Default Parameters Used in Uptake/Biokinetic Model

Age Group (yrs)	Time Spent Outdoors (hr/day)	Verification Rate (µg/day)	Dietary Lead Uptake (µg/day)	Water Consumption (L/day)	Dust/Soil Ingestion Rate (mg/day)
0.5-1	1.0	2.0	5.88	0.20	100
1 - 2	2.0	3.0	5.92	0.50	100
2 - 3	3.0	5.0	6.79	0.52	100
3 - 4	4.0	5.0	6.57	0.53	100
4 - 5	4.0	5.0	6.36	0.55	100
5 - 6	4.0	7.0	6.75	0.58	100
6 - 7	4.0	7.0	7.48	0.59	100

Notes: Additional assumptions used for all age groups:

(1) Indoor air concentration of Pb = 30 percent of outdoor air concentration of Pb.
(2) Lung absorption: 32 percent of inhaled Pb is absorbed by respiratory tract.
(3) Nonlineal gastrointestinal tract absorption method was used for all model runs.
(4) Fraction of household dust derived from soil = 0.28 µgPb/g dust per µgPb/g soil.
(5) Concentration of Pb in indoor dust derived from air = 100 µgPb/g dust per µgPb/g air.
(6) Pb in indoor dust derived from soil and airborne particulates only.
(7) Percent of soil/dust that is soft = 45 percent.
(8) Mother's blood Pb level at birth of child = 7.50 µg/dL.

% = Percent
hr/day = hour(s) per day
m3/day = cubic meter(s) per day
µg/dL = microgram(s) per deciliter
L/day = liter(s) per day
Pb = Lead
yr(s) = year(s)
mg/day = milligrams per day
µg/day = microgram(s) per day

Table 7-16
Risk Assessment Radionuclides

	OUs 1/6	OUs 2/3		OUs 4/5		
Radionuclide	Subsurface Liquids[a]	Subsurface Soil	Landfill Gas	Surface Soil	Surface Water	Sediment
Americium-241	X					
Cadmium-109					X	
Cesium-137				X	X	
Europium-159						X
Lead-210	X	X				
Plutonium-239	X	X			X	
Potassium-40	X	X			X	X
Radium-226	X			X		X
Strontium-90	X	X			X	
Thorium-228	X	X				X
Thorium-230	X	X				
Thorium-232	X	X			X	X
Tritium	X				X	
Uranium-234	X	X		X	X	X
Uranium-235	X			X	X	X
Uranium-238	X	X		X	X	X

Table 7-17

Summary of Radiological Risk from Ingestion of Ground Water at the RME Future Onsite Residential Setting

Radionuclide	95 UCL Concentration Onsite[a] (pCi/L)	95 UCL Concentration Upgradient (pCi/L)	Excess Cancer Risk Onsite	Excess Cancer Risk Upgradient
Potassium-40	462	97	1.1 x 10-4	2.2 x 10-5
Lead-210	11 M	NA	1.5 x 10-4	-
Radium-226	75	50 (M)	1.9 x 10-4	1.3 x 10-4
Uranium-234	49 (M)	2.2 (M)	1.6 x 10-5	7.4 x 10-7
Uranium-235	18 (M)	20 (M)	6.0 x 10-6	6.6 x 10-6
Uranium-238	73 (M)	5.2 (M)	4.3 x 10-5	3.1 x 10-6
Total			5 x 10-4	2 x 10-4

[a]Shallow ground-water wells and waste pit liquids well point within the source area.

(M) = Maximum concentration used as 95 UCL exceeds maximum concentrations or insufficient data to calculate a 95 UCL.

NA = Not available.

Table 7-18
Comparison of Maximum Detected Subsurface Soil Concentrations to Carcinogenic Risk-Specific Values at the RME for the Future Onsite Residential Setting

Reasonable Maximum Exposure

Radionuclide	Risk-Specific Value2 (pCi/g)	Onsite Maximum Detected Concentration (pCi/g)	Exceeds Risk-Specific Value?	Background Maximum Detected Concentration (pCi/g)	Exceeds Risk-Specific Value?
Potassium-40	0.064	27	Yes	21	Yes
Lead-210	0.79	1.8	Yes	NA	--
Plutonium-239	1.6	0.4	No	NA	--
Strontium-90	14.6	0.2	No	NA	--
Thorium-230	5.6	2.1	No	NA	--
Thorium-232	5.9	1.7	No	NA	--
Thorium-228	0.0062	2.2	Yes	2.2	Yes
Uranium-234	5.9	2.9	No	NA	--
Uranium-238	0.73	1.5	Yes	NA	--

2Risk-specific values account for internal (ingestion and inhalation) and external exposure and correspond to a 10-6 excess cancer risk.

NA = Not available.

Table 7-19
Summary of Radiological Risk from Exposure to Surficial Soil2
at the RME Future Onsite Residential Setting

	95 UCL Concentration		Pathway Specific Excess Cancer Risk					
			Ingestion		Inhalation		External	
Radionuclide	Onsite (pCi/g)	Background (pCi/g)	Onsite	Background	Onsite	Background	Onsite	Background
Cesium-137	0.17	0.23	5.9 x 10-9	8.3 x 10-9	1.7 x 10-11	2.3 X 10-11	9.7 X 10-6	1.3 x 10-5
Radium-226	2.3	2.8	3.4 x 10-7	4.2 x 10-7	3.6 x 10-8	4.4 x 10-8	3.9 x 10-4	4.8 x 10-4
Uranium-234	1.6	1.2	3.2 x 10-8	2.4 x 10-8	2.2 x 10-7	1.6 x 10-7	1.4 x 10-9	1.0 x 10-9
Uranium-235	0.25	0.3	5.1 x 10-9	6.0 x 10-9	3.3 x 10-8	3.9 x 10-8	1.7 x 10-6	2.1 x 10-6
Uranium-238	1.6	1.3	5.6 x 10-8	4.6 x 10-8	4.4 x 10-7	3.5 x 10-7	1.7 x 10-6	1.3 x 10-6
Total			4 x 10-7	5 x 10-7	7 x 10-7	6 x 10-7	4 x 10-4	5 x 10-4

2Surface soil from the sewage sludge based application/leachate injection area (Group 1 soils).

Table 7-20
Summary of Radiological Risk from Exposure to Sediments[a]
at the RME Future Onsite Residential Setting

	95 UCL Concentration		Pathway Specific Excess Cancer Risk					
			Ingestion		Inhalation		External	
Radionuclide	Onsite (pCi/g)	Background (pCi/g)	Onsite	Background	Onsite	Background	Onsite	Background
Europium-154	0.20	NA	7.6 x 10-10	--	1.5 x 10-10	--	2.4 x 10-5	--
Potassium-40	23.0	19.0	3.2 x 10-7	2.7 x 10-7	9.3 x 10-10	7.7 x 10-10	3.6 x 10-4	3.0 x 10-4
Radium-226	2.7	2.1	4.0 x 10-7	3.2 x 10-7	4.2 x 10-8	3.4 x 10-8	4.6 x 10-4	3.7 x 10-4
Thorium-232	1.3	NA	2.0 x 10-8	--	2.0 x 10-7	--	9.9 x 10-10	--
Thorium-228	1.6	1.3	1.1 x 10-7	9.2 x 10-8	6.6 x 10-7	5.4 x 10-7	2.6 x 10-4	2.1 x 10-4
Uranium-234	1.5	1.8	3.0 x 10-8	3.6 x 10-8	2.0 x 10-7	2.5 x 10-7	1.3 x 10-9	1.6 x 10-9
Uranium-235	0.077	0.30	1.6 x 10-9	6.0 x 10-9	1.0 x 10-8	3.9 x 10-8	5.3 x 10-7	2.1 x 10-6
Uranium-238	1.5	1.2	5.3 x 10-8	4.2 x 10-8	4.1 x 10-7	3.3 x 10-7	1.6 x 10-6	1.2 x 10-6
Total			9 x 10-7	8 x 10-7	2 x 10-6	1 x 10-6	1 x 10-3	9 x 10-4

[a]Sediments from eight sample locations.

Table 7-21
Summary of Radiological Risk at the RME
Future Onsite Residential Setting

Exposure Media	Exposure Pathway	Excess Cancer Risk Onsite	Excess Cancer Risk Background
Ground Water	Ingestion	5 x 10-4	2 x 10-4
Surface Soil	Ingestion	4 x 10-7	5 x 10-7
	Inhalation	7 x 10-7	6 x 10-7
	External	4 x 10-4	5 x 10-4
Surface Water	Ingestion	2 x 10-7	NA
Sediments	Ingestion	9 x 10-7	8 x 10-7
	Inhalation	2 x 10-6	1 x 10-6
	External	1 x 10-3	9 x 10-4
Total Exposure		2 x 10-3	2 x 10-3

Table 7-22
Potentially Occurring Threatened and Endangered Species Within or Around the Lowry Site

	Birds
Peregrine falcon	Falco peregrinus
Bald Eagle	Haliaeetus leucocephalus
Black tern[a]	Chlidonia niger
Mountain plover[a]	Charadrius montanus
White-faced ibis[a]	Plegadis chihi
Baird's sparrow[a]	Ammodramus bairdii
Whooping crane	Grus americana
Long-billed curlew	Numenius americanus
Ferruginous hawk	Buteo regalis
	Amphibians
Westerhn boreal toad[a]	Bufo boreas boreas
	Insects
Regal fritillary butterfly[a]	Speyeria idalia
	Mammals
Preble's meadow jumping mouse	Zapus hudsonius preblei
Swift fox[a]	Vulpes velos
Black-footed ferret	Mustela nigripes
	Vegetation
Diluvium lady's tresses[b]	Spiranthes diluvialis
Colorado butterfly plant[c]	Gaura neomexicana ssp, Coloradensis

a Species that are candidates for official listing as threatened or endangered species (Federal Register, Vol. 54, No. 4, January 6, 1989; Vol 55, No. 35, February 21, 1990).
b Listed by USFWS as Category 2, under review for protective status, Final Remedial Investigation Report for the Shallow Ground Water and Subsurface Liquids and Deep Groundwater Operable Units, Lowry Landfill, Vol. VI of VIII. Lowry Coalition, Boulder, CO).
c Listed by USFWS as Category 1, under review for protective status with sufficient information to support proposing to list the taxa as Threatened and Endangered.

Table 7-23
Constituents Eliminated on the Basis of Relative Toxicity

Constituent	Surface Soil	Surface Water	Sediments
Bromide		X	
Calcium	X	X	X
Chloride	X	X	X
Magnesium	X	X	X
Nitrate	X	X	X
Nitrite		X	
Nitrogen		X	
Phosphorous	X	X	X
Potassium	X	X	
Sodium	X	X	X
Sulfate	X		
Sulfur	X	X	X

Table 7-24
Maximum Detected Concentrations of Ecological Chemicals of Concern

Chemical	Surface Soil (mg/mg soil)	Surface Water (µg/l)	Sediment (mg/mg sediment)
	Organics		
1,1-Dichloroethane		15,000	0.0000034
1,1-Dichloroethane		5,000	
1,2-Dichloroethane (total)		730	0.00000057
1,1,1-Trichloroethane		31,000	0.00011
2,4-Dichlorophenol		400	0.0000027
2,4-Dimethylphenol		920	0.0000038
2-Butanone	0.0000000065	51,000	0.000015
2-Hexanone		10,000	
2-Methylnaphthalene		400	0.000024
2-Methylphenol			0.0000038
4-Chloroaniline	0.0000025		
4-Methylphenol		66,000	
4-Methyl-2-pentanone		27,000	
Acetone	0.00000014	240,000	0.0000084
Aniline			0.00000033
Benzene		5,000	0.00000061
Benzoic acid		6,300	
bis(2-ethylhexyl)phthalate	0.0000022		0.000095
Carbon disulfide	0.000000025		
Chloroform	0.0000000035		
di-n-Butylpthalate	0.0000020	4,000	0.0000027
Ethylbenzene		5,000	0.000095
Fluoranthene			0.0000077
Heptachloroodibenzofurans	0.00000000030		
Heptachlorodibenzo-p-dioxins	0.0000000029		0.0000000056
Hexachlorodibenzodioxins	0.00000000030		0.00000000070
Hexachlorodibenzofurans	0.00000000010		
Methylene chloride	0.00000015	77,000	
Naphthalene		400	0.000014
octochlorodibenzodioxins	0.000000014	0.040	0.00000000060
Octochlorodibenzofurans	0.00000000020		
PCB-1260	0.0000076		0.0000024
Pentachlorodibenzodioxins	0.00000000010		

Note: Blanks indicate chemical not of concern in the medium.

Table 7-24
Maximum Detected Concentrations of
Ecological Chemicals of Concern

Chemical	Surface Soil (mg/mg soil)	Surface Water (µg/l)	Sediment (mg/mg sediment)
	Organics (continued)		
Phenanthrene			0.0000062
Phenol		4,100	
Pyrene			0.0000055
Toluene	0.000000011	28,000	0.00028
Tetrachloroethene		2,300	0.000048
trans-1,2-Dichloroethene		56,000	0.0000031
Trichloroethene		5,000	0.000041
Vinyl chloride		9,600	0.0000012
Xylenes		9,700	0.00058
	Inorganics (Metals)		
Aluminum	0.027	260,000	0.032
Ammonia	0.0000032	25,000	0.000051
Antimony		150	0.000032
Arsenic	0.000014	42	0.000021
Barium	0.0016	1,500	0.00086
Beryllium		130,000	0.0000027
Boron	240		
Cadmium	0.000013		0.0000042
Chromium (total)	0.00013	210	0.00042
Cobalt	0.00012	210	0.000018
Copper	0.00015	660	0.00016
Cyanide	0.0000049	250	0.0000023
Iron	0.039	360,000	0.042
Lead	0.00015	290	0.0030
Magnesium		38,000	0.0019
Mercury	0.0000010	3.6	0.0000019
Nickel	0.00013	250	0.000042
Silver	0.0000098		
Tin	0.000014	250	0.000018
Vanadium	0.00014	620	0.000071
Zinc	0.35	1,300	0.00054

Note: Blanks indicate chemical not of concern in the medium.

Section 8.0
Description of Remedial Alternatives

Feasibility Studies (FSs) were conducted to develop and evaluate remedial alternatives for ground water, subsurface liquids, landfill solids and gas, soils, surface water, and sediments at the Lowry Site. Several alternatives were assembled from the applicable remedial technology process options and were screened for their effectiveness, implementability and cost. The alternatives passing this screening were then evaluated in further detail based on the nine criteria required by the NCP. This section provides a description of each alternative that was retained for the detailed to provide a point of comparison for other alternatives.

The descriptions of alternatives in this section follow the groupings of OUs by media: shallow ground water and subsurface liquids (OU 1) and deep ground water (OU 6);landfill solids (OU 2) and landfill gas (OU 3); and soils (OU 4), surface water, and sediments (OU 5).

The descriptions of alternatives include the following components:

- Treatment components
  - Treatment technologies that will be used;
  - Type and volume of waste to be treated;
  - Process sizing; and
  - Primary treatment levels.
- Containment or storage components
  - Type of storage;
  - Type of closure that will be implemented;
  - Type and quantity of waste to be stored; and
  - Quantity of untreated waste and treatment residuals to be disposed offsite or managed onsite in a containment system and the degree of hazard remaining in such waste.
- General components and cost
  - Contaminated media addressed (and their physical location at the Lowry Site);
  - Risk reduction (including initial risk);
  - Whether treatability testing has been or will be conducted;
  - Implementation requirements;
  - Institutional controls;
  - Residual levels;
  - Assumptions, limitations, uncertainties;
  - Estimated implementation time frame; and
  - Estimated capital, operation and maintenance (O&M), and present worth costs.
- Major ARARs, risk-based levels, and TBCs being met/utilized for the specific components of the alternatives
  - How specific components of each alternative will comply with the major ARARs and why the standard is applicable, or relevant and appropriate.

In addition, for ground-water remedial alternatives, the following ground-water components are addressed, as appropriate:

- Ground-water classification;
- Performance standards;
- Estimated restoration timeframe; and
- Area of attainment.

8.1 Cost Estimating Procedures

Alternatives were evaluated in terms of capital costs, annual or operation and maintenance (O&M) costs, and present worth costs. Capital costs include the sum of the direct capital costs (materials, equipment, labor, land purchases) and indirect capital costs (engineering, licenses, or permits). Annual costs include the cost for labor, O&M, materials, energy, equipment replacement, disposal, and sampling to operate the treatment facilities. Present worth costs include capital costs and O&M costs calculated over a 30-year period.

The present worth analysis is used to evaluate expenditures that would occur over an assumed 30-year operation period by discounting all future costs to a common base year. This allows the cost of remedial action alternatives to be compared on the basis of a single figure representing the amount of money that, if invested in the base year and disbursed as scheduled, would be sufficient to cover the costs associated with the remedial alternative over its planned life.

Additional assumptions used in cost estimation include: a real discount rate of five percent (the difference between the nominal discount rate and inflation is five percent); and a constant value based on 1993 rates for materials, expenses, and services.

The accuracy of costs is subject to substantial variation since details about the specific design of each alternative (such as design details, the bidding element, changes during construction and operation, interest rates, labor and equipment rates, tax effects, and other similar items) will not be known until the time of actual implementation of the remedies.

Remedial Design efforts may also reveal that it is possible to reduce the original project cost estimates. Reductions in the estimated costs could be the result of value engineering conducted during Remedial Design. Through the value engineering process, modifications could be made to the functional specifications of the remedy to optimize performance and minimize costs. These changes would fall within the definition of "non-significant modifications," as defined by EPA's guidance for preparing Superfund decision documents. For example, it may be determined that a reduction in costs could be effected by non-significant changes to type, quantity, and/or cost of materials, equipment, facilities, services, and supplies used to implement the remedy. It should he noted that this type of design variance may have a noticeable impact on the estimated cost of the remedy, but will not affect the remedy's ability to comply with the performance standards.

8.1.1 Respondent's Cost Estimates

Standard cost data from the following sources were used in the OU RI/FSs prepared by the various Respondents: EPA guidance, construction industry guidance, remedial action contractors, vendors, and treatability studies. While the Respondents used these sources to develop their cost data, each group of Respondents used these sources assumptions in developing the costs. As a result, the cost estimates were not directly comparable across RI/FSs. EPA has revised the cost estimates as described below.

8.1.2 EPA's Revised Cost Estimates

Present worth cost calculations, as they appear in the ROD, differ slightly from those presented in the feasibility studies for all OUs. In order to allow for the consistent comparison of costs for the various alternatives, EPA recalculated the costs using a single set of assumptions. The following factors were standardized for all alternatives: interest rates and inflation rates.

8.2 Features Common to All Remedial Alternatives

All remedial alternatives, except for the No Action Alternative, have the following common features:

- Institutional Controls-Institutional controls are non-engineering methods by which Federal, State, local governments, or private parties can prevent or limit access to or use of a site. Institutional controls for the Lowry Site shall include, but not be limited to, deed notices and restrictions that run with the land; onsite-access restrictions including, but not limited to, fencing and warning signs; zoning controls; and well restrictions. Executive Order No. 97, as issued by City and County of Denver Mayor Federico Peña, currently provides some measure of control. Institutional controls at the Lowry Site must prohibit all activities and uses that EPA determines would interfere or be incompatible with, or that would in any way reduce or impair the effectiveness or protectiveness of, the sitewide remedy. These shall include, but not be limited to, prohibitions on all ground-water well construction and use not necessary for implementation and monitoring of the selected remedy; prohibitions on access; and prohibitions on activities and land use not connected with design, construction, and implementation and monitoring of the selected sitewide remedy. Offsite institutional controls shall serve as an additional measure of protection to enhance the effectiveness of the selected remedy and to act as preventative measures to preserve the implementability and effectiveness of any of the selected remedy contingency measures. Offsite institutional controls shall include, but not be limited to, deed notices and restrictions, zoning controls, and well restrictions. These controls must prohibit all offsite activities in the vicinity of the Lowry Site that would interfere or be incompatible with, or that would in any way reduce or impair the effectiveness or protectiveness of, the selected sitewide remedy.

All onsite and offsite institutional controls shall be adequately administered, maintained, and enforced.

The owner and operator of the Lowry Site shall be responsible for access restrictions, warning signs, and fences.

- Performance and Compliance Monitoring-To ensure that the performance standards are met for all components of the selected remedy for as long as contamination remains onsite, a long-term monitoring program shall be designed and implemented during the RD/RA and shall continue throughout the implementation of the selected sitewide remedy. The monitoring program shall assess compliance with the remediation levels in the ground-water system, monitor effluent chemical concentrations from the treatment plant, evaluate the horizontal and vertical migration of contamination, monitor the erosion of soils and sediments, and monitor the migration of landfill gases. Details of the monitoring program shall be determined by EPA, in consultation with CDH, during the RD. The monitoring program shall include, at a minimum, the following: analytical parameters and methods; indicator parameters; monitoring locations; monitoring frequency and duration; sampling methods; well installation, maintenance and abandonment procedures; statistical methods for evaluating data; reporting methods and procedures for tracking and maintaining sample records; and QA methods, including data validation methods. The FSs estimated that approximately 60 to 100 ground-water monitoring wells will be sampled semi-annually. Landfill gas shall be monitored quarterly, or more frequently if migration is detected, using approximately 40 to 60 monitoring wells. The ground-water monitoring component of the selected sitewide remedy includes an early-warning monitoring component; this will allow for a timely remedial response in the event that EPA determines that additional remedial actions are necessary. Soil and sediment erosion shall be monitored on a monthly basis using three surface-water samplers installed in drainages. The actual details of the monitoring program are subject to revisions and refinement during RD.

- Five-Year Review-As specified in Section 121(c) of CERCLA, as amended by SARA, and Section 300.430(f)(4)(ii) of the NCP, EPA will review the sitewide remedy no less often than each 5 years after the initiation of the remedial action to assure that human health and the environment are being protected by the implemented remedy (this review will ensure that the remedy is operating and functioning as designed and that institutional controls are in place and are protective). An additional purpose for the review is to evaluate whether the performance standards specified in this ROD remain protective of human health and the environment. EPA will continue the reviews until no hazardous substances, pollutants, or contaminants remain at the Lowry Site above levels that allow for unrestricted use and unlimited exposure.

8.3 Interim Remedial Measures

The following interim remedial measures, as described in Section 3.0 of this ROD, have already been constructed and are operational at the Lowry Site. These measures shall continue to operate in accordance with the existing design and operations criteria unless EPA determines that modifications are needed:

- Ground-Water Barrier Wall-The ground-water barrier wall system shall continue to be operated in accordance with the existing design and operations program. The existing barrier wall consists of a 30-foot-deep, 1,000-foot-long compacted clay wall with a central collection sump. The base of the barrier wall is anchored to the top of the unweathered bedrock (Dawson formation).

- Surface Water Removal Action (SWRA)-The Surface Water Removal Action shall be continued and the collection system along unnamed creek shall be maintained.

- Existing Ground-Water Treatment Plant (GWTP)-The existing groundwater treatment plant shall be upgraded and maintained on the basis of SWRA design criteria.

8.4 Description of Alternatives

8.4.1 Description of No Action Alternative for all Operable Units

Evaluation of the No Action Alternative is required under CERCLA (as amended by SARA) and is used as a baseline against which other alternatives are evaluated. Under this alternative, no remedial action would be undertaken to treat, contain, or remove contaminated media at the Lowry Site. All interim remeaial measures currently being taken at the Lowry Site would be discontinued. The SWRA collection system, existing GWTP, and barrier wall would no longer function and would be allowed to deteriorate. The landfill cap and existing fencing would be allowed to degrade and become nonfunctional. Landfill gas and ground-water monitoring would also cease and no action would be taken to prevent migration of contaminants offsite. No institutional or operational controls would be implemented to restrict access to the Lowry Site or to restrict exposure to contaminants.

There would be no reduction in the volume, toxicity, or mobility of the contaminants. The overall volume of contaminated water could increase from infiltration. Monitoring would not be a component of this alternative.

There would be no treatment or containment components associated with this alternative. Under the No Action Alternative, all waste would be left in place and there would be no reduction in risk. The remedial action objectives (RAOs) would not be met for this alternative because contaminants would migrate offsite, and protection of human health and the environment would not be achieved.

Because the interim remedial measures would be discontinued, chemical-, location-, and action-specific would not be met.

The total 30-year present worth cost of this alternative is $0 with no capital costs and no annual O&M costs. The No Action Alternative would be immediately implementable.

8.4.2 OUs 1&6-Shallow Ground Water and Subsurface Liquids, and Deep Ground Water

The following remedial alternatives were evaluated in detail during the FS for OUs 1&6:

- Alternative GW-1-No Further Action;
- Alternative GW-2-North Boundary (Downgradient) Containment, Collection, and Treatment,
- Alternative GW-3-North Boundary and Toe of landfill Containment, Collection, and Treatment;
- Alternative GW4-North Boundary, Toe of Landfill and Upgradient Containment, Collection, and Treatment, Plus Multilayered Cap in Landfill Area;
- Alternative GW-5-North Boundary, Toe of landfill and Lateral Containment, Collection, and Treatment;
- Alternative GW-6-North Boundary and Toe of Landfill Containment.

In addition, EPA added the following alternative to the list of alternatives to be evaluated:

- Modified Alternative GW-5 (North Boundary, Toe of Landfill and Lateral Containment, Collection and Treatment, and Southern Containment, Collection, and Diversion).

The alternatives for OUs 1&6 are described below. Major ARARs are identified for each alternative. Additional ARARs for OUs 1&6 alternatives are presented in Table 8-1.

<u>8.4.2.1 Alternative GW-1-No Further Action</u>

The No Further Action Alternative (GW-1) would entail the continued implementation of the existing interim remedial and monitoring measures at the Lowry Site. Under this alternative, the following activities and components would be maintained:

- The existing ground-water barrier wall/collection system and treatment facility would remain intact and functional. The existing ground-water barrier system consists of a 1,000-foot-long drain backed by a 30-foot-deep compacted clay barrier.
- The SWRA, which includes a collection system and an upgrade to the treatment facility, would remain intact and functional.
- The landfill cover would be maintained, and landfill gas monitoring would continue.
- Existing ground-water monitoring would continue.
- Surface-water and ground-water restrictions that are currently in place would continue.
- Existing onsite and offsite institutional controls would be enforced.

Treatment components associated with this alternative include removal of contaminants in ground water by air stripping and carbon adsorption. The existing treatment plant has an optional aerobic biological treatment unit available if phenols and ketones are detected in the early-warning monitoring well. Spent carbon is regenerated offsite and treated ground water is injected into the shallow subsurface beyond the barrier wall. It is estimated that 3.7 million gallons of ground water would be treated annually, resulting in approximately 60 pounds per year of contaminants being removed. The SWRA performance standards have been updated in this ROD to comply with current requirements. Although the existing plant capacity is 30 gpm, the plant is currently operating at about 15 gpm. The restoration time frame would be more than 30 years and because wastes would be left in place, treatment would continue in perpetuity.

The barrier wall intercepts the northward migration of contaminants flowing through the alluvium of unnamed creek as well as the seepage collected in the SWRA collection system. The SWRA collection system keeps the waste-pit seepage separated from precipitation runoff, thus preventing contaminated water from migrating offsite during storm events. The landfill cover minimizes production of leachate and limits migration into the underlying Dawson Aquifer.

The remedy is primarily containment-based; therefore, wastes would be left in place. The Baseline Risk Assessment for OUs 1&6 indicated that there are no current exposure pathways to ground water. However, if onsite residents used ground water as a drinking water source in the future, the estimated cancer risk would be 1x10-2. Onsite risks would remain and would be controlled through the use of institutional controls. Estimated risk for a residential setting using a hypothetical future offsite drinking water well in the direction of regional ground-water flow could be 2x10-5 within 30 years. This risk could increase to 1x10-3 after 150 years of contaminant migration. Under the No Further Action alternative, offsite migration of contaminants toward the north would be prevented. It is assumed that contaminant migration toward the west, east, and south would be controlled through monitoring and implementation of contingency measures. However, the exact nature of these measures has not been identified or costed out. In the absence of these contingency measures, contaminant migration toward the west, east, and south would continue, and offsite risks would not be eliminated.

Treatability studies were performed during the ground-water treatment plant design, and formed the basis for the original treatment train. Additional treatability studies were conducted prior to the implementation of the SWRA. Based on these additional studies, the treatment plant was upgraded to address a wider range of contaminants. Treatment residuals from this alternative consist of spent carbon (4,000 pounds/month), which is regenerated offsite approximately every 10 weeks. Other treatment residuals may include solids from bag filters and, in the future, sludge from the biotreatment unit. The alternative assumes that future treatment plant upgrades as described and mandated by the SWRA would be adequate to treat all chemicals that may be present in the contaminated ground water. The No Further Action Alternative would use current technologies.

The following major ARARs have been identified for this alternative:

- Colorado Water Quality Control Act (5 CCR 1002-8), Colorado Basic Standards for Ground Water, Classifications and Water Quality Standards for Ground Water: These regulations establish standards for both classified and unclassified ground water. The standards are applicable because ground water (within confined, unconfined, and alluvial aquifers) near the Lowry Site and ground water (within unconfined and alluvial aquifers) within the Lowry Site have been classified for domestic- and agricultural-quality use. Ground water within confined aquifers of the Lowry Site is not classified. However, regulatory standards that are pertinent to classified ground water also apply to unclassified ground water for the protection of offsite beneficial uses of the ground water. Under this alternative, ground water would be treated to meet these standards and then discharged to the shallow ground-water system. This alternative would comply with the requirements specified under these ARARs.

- Safe Drinking Water Act, National Primary Drinking Water Regulations (40 CFR Part 141) and the Colorado Primary Drinking Water Regulations (5 CCR 1003-1): These regulations establish health- and treatment-based standards for public drinking water systems. These regulations would be relevant and appropriate because the shallow and deep ground water in the vicinity of the Lowry Site is being used or may be used in the future as a source of water for a public water system or private supply wells. Under this alternative, treated ground water from the treatment plant Would be injected into the shallow ground-water system. This alternative would comply with the requirements specified under these ARARs.

- Safe Drinking Water Act, and National Secondary Drinking Water Regulations (40 CFR Part 143): These regulations establish welfare-based standards for public water supply systems and have been adopted by the State of Colorado under the basic standards for ground water. The regulations would be relevant and appropriate because the shallow and deep ground water in the vicinity of the Lowry Site is being used or may be used in the future as a source of water for a public water system or private supply wells. Under this alternative, ground water would be treated to meet these standards and then discharged to the shallow ground-water system. This alternative would comply with the requirements identified under these regulations.

- Colorado Air Quality Act/Colorado Air Pollution Regulations (5 CCR 1001): These regulations establish standards for air emissions from stationary sources. These regulations are applicable because the treatment plant is a source of air emissions. These regulations would be met for the air stripper/carbon-polishing treatment process.

This alternative includes contingency measures to ensure that RAOs and ARARs would be met at the compliance boundary.

The total 30-year present worth of this alternative is $31,970,000, with capital costs of $4,300,000, and annual O&M costs of $1,800,000. The implementation time is immediate.

<u>8.4.2.2 Alternative GW-2-North Boundary (Downgradient) Containment, Collection, and Treatment</u>

Under Alternative GW-2, all existing interim remedial measure identified in the No Further Action Alternative (GW-1) would continue. Additionally, a 2,200-foot groundwater barrier wall and collection system (referred to as an extraction trench in the Proposed Plan for OUs 1&6) would be constructed along the northern boundary of Section 6. The barrier wall would be an extension of the existing barrier wall or a separate barrier wall adjacent to the existing barrier wall. The effectiveness of the existing barrier wall in capturing the northward migration of the contaminated ground water would be evaluated to determine the necessary barrier wall configuration. Contaminated ground water, collected from the new extraction trench and/or the existing barrier wall, would be treated using the existing ground-water treatment plant.

The barrier wall would be constructed so that it would be anchored into the separation layer, which in this area averages about 65 feet in depth. Four ground-water collection sumps would be located along the collection system and connected to a header pipeline to the existing ground-water treatment plant.

Since the barrier wall and collection system would capture additional ground water, approximately 6.3 million gallons per year of contaminants ground water would be treated, and would result in the removal of approximately 100 pounds per year of contaminants. The restoration time frame would be more than 30 years, and since waste would be left in place, treatment would continue in perpetuity.

This alternative is primarily containment-based; therefore, waste would remain in place. Onsite risks would remain at unacceptable levels and would be controlled through institutional controls. Offsite migration of contaminants toward the north would be prevented. It is assumed that contaminant migration toward the west, east, and south would be controlled through monitoring and implementation of contingency measures. However, the exact nature of these measures has not been identified or costed out. In the absence of these contingency measures, contaminant migration toward the west, east, and south would continue, and offsite risks would not be eliminated.

Treatability testing has been performed in conjunction with the design of the existing ground-water treatment plant and the SWRA. This alternative assumes that the existing ground-water treatment plant would be adequate to treat all contaminants in ground-water and waste-pit liquids. The alternative is considered implementable since proven technologies are being proposed.

Major ARARs for this alternative are the same as the ARARs identified for the No Further Action alternative (GW-1) and would be met by this alternative using similar methods.

This alternative includes contingency measures to ensure that RAOs and ARARs would be met at the compliance boundary.

The total 30-year present worth cost of this alternative is $39,010,000, with capital cost of $9,800,000, and annual O&M cost of $1,900,00. The estimated implementation time is 2 years.

<u>8.4.2.3 Alternative GW-3-North Boundary and Toe of Landfill Containment, Collection, and Treatment</u>

Under Alternative GW-3, all existing interim remedial measures identified in the No Further Action Alternative (GW-1) would continue. The ground-water barrier wall and collection system on the northern boundary of Section 6, as identified in Alternative GW-2, would also be constructed. In addition, the other containment components discussed for Alternative GW-2 would apply as well. For Alternative GW-3, an additional ground-water extraction system, to extract highly contaminated ground water, would be constructed near the toe of the landfill mass. This system would be approximately 300 feet long and 50 feet deep, and would be constructed approximately 200 feet north of the downgradient edge of the landfill (termed "toe of the landfill").

The extraction system would consist of a subsurface drain, a line of extraction wells, or horizontally drilled wells. For the comparative analysis of alternatives, it was assumed that the ground-water extraction system would consist of 15 wells, 50 feet deep, and 20 feet apart. Ground water would be pumped to the surface and piped to the existing or a new ground-water treatment facility for highly contaminated liquids.

The cost for a new ground-water treatment plant have been incorporated into this alternative. The need for an additional ground-water treatment plant would be evaluated during Remedial Design. A new ground-water treatment plant would need to be designed and constructed unless it could be demonstrated through pilot-scale testing that the existing ground-water plant could effectively treat the more highly contaminated ground water to the performance standards.

The treatment technologies used for this alternative are part of the conceptual treatment model presented in the FS for OUs 1&6 and include: gravity phase separation for NAPLs; lime soda softening for metals, radionuclides, hardness, and solids; biological treatment (PACTTM) to remove organic compounds, BOD, COD, ammonia, and nitrate; and granular-activated carbon to remove volatile organics in offgas streams.

The extraction system at the toe of the landfill is expected to capture approximately 3.9 million gallons of contaminated ground water annually. The total annual amount of ground water to be treated from the toe of the landfill and the northern boundary would be approximately 6.3 million gallons. Approximately 700 pounds per year of contaminants would be removed and treated. Although the existing ground-water treatment capacity is 30 gpm, the ground-water treatment plant is currently operating at almost 15 gpm. If an additional ground-water treatment plant were required, it is expected that it would be sized for 20 gpm. The restoration time frame would be more than 30 years, and because waste would be left in place, treatment would continue in perpetuity.

The remedy is containment based; therefore waste would be left in place. Onsite risks would remain, and would be controlled through institutional controls. Offsite migration of contaminants toward the north would be prevented. It is assumed that contaminant migration toward the west, east, and south would be controlled through monitoring and implementation of contingency measures. However, the exact nature of these measures has not been identified or costed out. In the absence of these contingency measures, contaminant migration toward the west, east, and south would continue, and offsite risks would not be eliminated.

The treatment technologies, tested during OUs 1&6 treatability study stages 1 through 3, were selected on the basis of demonstrated effectiveness for removal. Residuals would include spent vapor-phase granular activated carbon, solids from lime-soda softening, and PACTTM solids. Carbon would be regenerated offsite and reused. Other solids (550 tons of lime-softening and 430 tons of sludge produced annually from the biological treatment) would be disposed in accordance with ARARs. The alternative would be implementable since proven technologies are being proposed.

Major ARARs for this alternative are the same as the ARARs identified for the No Further Action alternative (GW-1) and would be met by this alternative using similar methods.

This alternative includes contingency measures to ensure that RAOs and ARARs would be met at the compliance boundary.

The total 30-year present worth cost of this alternative is $61,420,000 with capital costs of $15,300,000, and annual O&M costs of $3,000,000. The estimated implementation time is 3 years.

8.4.2.4 Alternative GW-4-North Boundary, Toe of Landfill, and Upgradient Containment, Collection and Treatment, Plus Multilayered Cap in Landfill Area

Under Alternative GW-4, all provisions identified in Alternative GW-3 would be constructed, except the extraction system at the toe of the landfill would be 100 feet deep rather than 50. All existing remedial measures identified in the No Further Action alternative (GW-1) would continue. Containment components would include all those described in Alternatives GW-2 and GW-3.

In addition, a 50-foot-deep containment, collection, and diversion system would be constructed upgradient of (south of) the landfill mass. This ground-water extraction system (3,600-foot-long) would be located upgradient of the source area, approximately 50 feet deep (keyed to the unweathered Dawson aquifer).

Also, a multilayer cap would be placed over the existing landfill cover and over the waste pits in the former tire pile area. The multi-layered RCRA cap would cover 220 acres of the Site, including the landfill and waste pits, and the northern pits near the former tire pile area. Components of the cap would include a minimum of three feet compacted native clay soil, flexible membrane cap (60-mil) constructed of high density polyethylene, filler fabric to protect the drainage layer, and soil cover capable of supporting vegetation. A RCRA Subtitle C landfill closure would be implemented.

Treatment components are the same as those described for Alternative GW-3.

Approximately 6.8 million gallons per year of contaminated ground-water would be treated, resulting in removal of approximately 700 pounds per year of contaminants. The existing treatment plant were required, it is expected that it would be sized at 20 gpm. The upgradient system is expected to intercept 0.5 million gallons per year of clean water, thereby reducing the volume of clean ground water mixed with contaminated ground water. The restoration time frame would be 30+ years and because waste would be left in place, treatment would continue in perpetuity.

The costs for a new treatment plant have been incorporated into this alternative. The need for an additional treatment plant would be evaluated during Remedial Design. A new treatment plant would need to be designed and constructed unless it could be demonstrated through pilot-scale testing that the existing plant could effectively treat the more highly contaminated ground water to the performance standards.

This alternative is containment-based; therefore, waste would remain in place. Onsite risks would remain, and would be controlled through institutional controls. Offsite migration of contaminants toward the north and south would be prevented. It is assumed that contaminant migration toward the west and east would be controlled through monitoring and implementation of contingency measures. However, the exact nature of these measures has not been identified or costed out. In the absence of these contingency measures, contaminant migration toward the west and east would continue, and offsite risks would not be eliminated.

The treatment technologies, tested during OUs 1&6 treatability study stages 1 through 3, were selected on the basis of demonstrated effectiveness for removal. Residuals would include spent vapor-phase granular activated carbon, solids from lime-soda softening, and PACTTM solids. Spent carbon (approximately 4,000 pounds per month) would be regenerated offsite. Other solids would be disposed in accordance with ARARs. The alternative would be implementable since proven technologies are being proposed.

Major ARARs for this alternative are the same as the ARARs identified in GW-1 and would be met by this alternative using similar methods.

This alternative includes contingency measures to ensure that RAOs and ARARs would be met at the compliance boundary.

The total 30-year present worth cost of this alternative is $113,300,000, with capital costs of $64,100,000 and annual O&M costs of $3,200,000. The estimated implementation time is 3 years.

8.4.2.5 Alternative GW-5-North Boundary, Toe of Landfill, and Lateral Containment, Collection and Treatment

Under Alternative GW-5, all existing interim remedial measures identified in the No Further Action Alternative (GW-1) would continue. The ground-water collection system would be constructed at the toe of the former landfill, as with Alternative GW-3. Treatment components are also the same as those described for Alternative GW-3.

In addition, this alternative would provide for lateral containment of ground water on the eastern and western boundaries of the Lowry Site through underground barrier walls and collection systems. The lateral containment would consist of a barrier wall and collection system measuring approximately 2,000 feet in length along the eastern boundary and 1,000 feet in length along the southwest portion of the compliance boundary.

Ground water would be intercepted annually in the amount of 6.3 million gallons. Approximately 700 pounds of contaminants would be removed by the treatment system. Although the existing treatment capacity is 30 gpm, it is currently operating at almost 15 gpm. If an additional treatment plant were required, it is expected that it would be sized at 20 gpm. The restoration time frame would be 30+ years and because wastes would be left in place, treatment would continue in perpetuity.

The costs for a new treatment plant have been incorporated into this alternative. The need for an additional treatment plant would be evaluated during Remedial Design. A new treatment plant would need to be designed and constructed unless it could be demonstrated through pilot-scale testing that the existing plant could effectively treat the more highly contaminated ground water to the performance standards.

The remedy is containment based; therefore, waste would be left in place. Onsite risks would remain, and would be controlled through institutional controls. Offsite migration of contaminants toward the north, west, and east would be prevented. It is assumed that contaminant migration toward the south would be controlled through monitoring and implementation of contingency measures. However, the exact nature of these measures has not been identified or costed out. In the absence of these contingency measure, contaminant migration toward the south would continue, and offsite risks would not be eliminated.

Treatment technologies, tested during OUs, 1&6 treatability study stages 1 through 3, were selected on the basis of demonstrated effectiveness for removal. Treatment residuals include spent vapor-phase granular activated carbon, solids form lime-soda softening, and PACTTM solids. Spent carbon (approximately 4,000 pounds per month) would be regenerated offsite. Other solids would be disposed in accordance with ARARs. This alternative would be implementable because proven technologies are proposed.

Major ARARs for this alternative are the same as the ARARs identified for GW-1 and would be met by this alternative using similar methods.

This alternative includes contingency measures to ensure that RAOs and ARARs would be met at the compliance boundary.

The total 30-year present worth cost of this alternative is $68,820,000 with capital costs of $17,700,000 and annual O&M cost of $3,000,000. The estimated implementation time is 3 years.

8.4.2.6 Alternative GW-6-North Boundary and Toe of Landfill Containment, Collection and Treatment, and Waste-Pit Pumping

Under Alternative GW-6, all existing interim remedial measures identified in the No Further Action Alternative (GW-1) would continue. Ground-water collection systems as described in Alternative GW-3 would be constructed at the toe of the landfill mass. This alternative includes the same containment components as identified for Alternatives GW-2 and GW-3. In addition, waste-pit pumping wells would be installed, liquids would be extracted from waste pits, and the liquids would be treated.

Treatment components are the same as those described for Alternative GW-3. Treatment technologies would include: gravity-phase separation for NAPLs; lime soda softening for metals, radionuclides, hardness, and solids; biological treatment (PACTTM) to remove organic compounds, BOD, COD, ammonia, and nitrate; and granular activated carbon to remove volatile organics in offgas streams. Treatment residuals would be disposed in accordance with ARARs.

Approximately 52 waste-pit extraction wells (one for each waste pit) would be installed and pumped at 0.04 gpm per well, totaling about two gpm for all wells or 1.1 million gallons per year. A total of 7.4 million gallons of ground water and waste-pit liquids would be treated. Contaminant removal is estimated to total about 1,800 pounds per year. Although the existing treatment capacity is 30 gpm, it is currently operating at almost 15 gpm. If an additional treatment plant were required, it is expected that it would be sized at 20 gpm. The restoration time frame would be 30+ years and because wastes would be left in place, treatment would continue in perpetuity.

The cost for a new treatment plant have been incorporated into this alternative. The need for an additional treatment plant would be evaluated during Remedial Design. A new treatment plant would need to be designed and constructed unless it could be demonstrated that the existing plant could effectively treat the more highly contaminated ground water to the performance standards.

Although the remedy is primarily containment-based and waste would be left in place, waste-pit extraction wells would remove approximately 1.1 million gallons per year. Onsite risks would remain, and would be controlled through institutional controls. Offsite migration toward the west, east, and south would be controlled through monitoring and implementation of contingency measures. However, the exact nature of these measures has not been identified or costed out. In the absence of these contingency measures, contaminant migration toward the west, east, and south would continue, and offsite risks would not be eliminated.

Treatment technologies, tested during OUs 1&6 treatability study stages 1 through 3, were selected on the basis of demonstrated effectiveness for removal. Residuals from gravity-phase separation, lime-soda softening, and biological treatment would be thickened and dewatered. The dewatered solids are not expected to demonstrate RCRA-toxicity characteristics and would therefore be disposed in a Subtitle D-equivalent landfill. Spent granular activated carbon would be regenerated offsite. Residuals would include spent vapor-phase granular activated carbon, solids from lime-soda softening, and PACTTM solids. Spent carbon (approximately 4,000 pounds per month) would be regenerated offsite. Other solids would be disposed in accordance with ARARs. This alternative assumes sustained pumping from waste pits could be achieved. The implementability of this alternative could be affected by the technical feasibility of drilling and installing extraction waste-pit well points.

Major ARARs for this alternative are the same as the ARARs identified for GW-1 and would be met by this alternative using similar methods.

This alternative includes contingency measures to ensure that RAOs and ARARs would be met at the compliance boundary.

The total 30-year present worth cost of this alternative is $72,570,000 with capital costs of $20,300,000 and annual O&M cost of $3,400,000. The estimated implementation time is 3 years.

8.4.2.7 EPA's Preferred Alternative-Modified Alternative GW-5-North Boundary, Toe of Landfill, and, Lateral Containment, Collection, and Treatment plus Upgradient Containment, Collection, and/or Diversion

This alternative is similar to Alternative GW-5, but has been modified by the addition of an upgradient containment/collection and/or diversion system. Modified Alternative GW-5 would use barrier walls as the type of containment, collection, and diversion system. Due to the presence of subsurface sand lenses at the Site, barrier walls would be the most effective method to isolate site containments and restrict offsite migration of contaminated ground water. This alternative would contain and treat onsite shallow ground water. Modified Alternative GW-5 would include construction of underground barrier walls and collection systems to the east, west, north and south of the Lowry Site and installation of a ground-water extraction system at the toe of the landfill.

Collected liquids would be treated in the existing ground-water treatment facility, an upgraded facility, or a new ground-water treatment facility, if required. Operation of the existing ground-water barrier wall would continue. This alternative also includes additional measure to address the potential for offsite migration of contaminated ground water at the northern boundary. These measure include construction of a separate barrier wall adjacent to the existing barrier wall, or construction of an extension to the existing barrier wall.

Treatment components would be the same as those described for Alternative GW-3. The following treatment technologies are part of the conceptual treatment model presented in the FS for OUs 1&6: gravity phase separation for NAPLs; lime soda softening for metals, radionuclides, hardness, and solids; biological treatment (PACTTM) to remove organic compounds, BOD, COD, ammonia, and nitrate; and granular activated carbon to remove volatile organics in offgas streams. Treatment residuals would be disposed in accordance with ARARs.

Approximately 6.3 million gallons of ground water would be intercepted on an annual basis. Contaminant removal is estimated to total about 700 pounds per year. Although the existing treatment capacity is 30 gpm, it is currently at almost 15 gpm. If an additional treatment plant were required, it is expected that it would be sized at 20 gpm. The restoration time frame would be 30+ years and because waste would be left in place, treatment would continue in perpetuity.

The costs for a new treatment plant have been incorporated into this alternative. The need for an additional treatment plant would be evaluated during Remedial Design. A new treatment plant would need to be designed and constructed unless it could be demonstrated through pilot-scale testing that the existing plant could effectively treat the more highly contaminated ground water to the performance standards.

This alternative would effectively isolate onsite contaminated ground water from the offsite ground-water systems through containment on the southern, eastern, western, and northern boundaries. In addition, containment, collection, and treatment at the toe of the landfill mass would extract highly contaminated liquids closer to the source.

While this alternative does include a limited treatment component, the remedy would be primarily containment-based; therefore, waste would remain onsite. Because Modified Alternative GW-5 would effectively restrict offsite migration of contaminated ground water, this alternative would prevent offsite migration of contaminants and would eliminate offsite risks. Onsite risks would remain, and would be controlled through institutional controls.

Treatment technologies, tested during the OUs 1&6 treatability study stages 1 through 3, were selected on the basis of demonstrated effectiveness for removal. Residuals would include spent vapor-phase granular activated carbon, solids from lime-soda softening, and PACTTM solids. Spent Carbon would be regenerated offsite and other solids would be disposed in accordance with ARARs. This alternative would use current technology and therefore would be implementable.

Major ARARs for this alternative are the same as the ARARs identified for GW-1 and would be met by this alternative using similar methods.

RAOs relating to offsite migration would be met without the use of contingency measures.

The total 30-year present worth cost of this alternative is $65,030,000, with capital costs of $19,000,000 and annual O&M costs of $2,400,000. The estimated implementation time is 3 years.

8.4.3 OUs 2&3-Landfill Solids and Gas

The following alternatives were evaluated as part of the FS for OUs 2 and 3:

- Landfill Solids (OU 2)
  - Alternative LFS-2 (No Further Action);
  - Alternative LFS-3 (Clay Cap);
  - Alternative LFS-4 (Drum Removal and Offsite Disposal);
  - Alternative LFS-6 (Drum Removal/Low Temperature Thermal Desorption/Stabilization/Disposal); and
  - Alternative LFS-7 (Landfill Mass Regarding).

- Landfill Gas (OU 3)
  - Alternative LFG-2 (No Further Action);
  - Alternative LFG-3 (Gas Collection/Enclosed Flare); and
  - Alternative LFG-5 (Gas Collection with Heat Recovery).

In addition, EPA added the following two alternatives to the list of alternatives to be evaluated for consideration:

- Modified Alternative LFS-4 (Drum Removal/Offsite Disposal/North Face Cover); and

- Modified Alternative LFG-3 (Gas Collection/Enclosed Flare).

These modified alternatives were discussed in the Proposed Plan for OUs 2&3, 4&5, and the sitewide remedy.

Major ARARs for each alternative are identified below. Additional ARARs for OUs 2&3 alternatives are presented in Table 8-2.

8.4.3.1 Alternative LFS-2-No Further Action

Under Alternative LFS-2, the No Further Action Alternative for landfill solids, no additional remedial action would be undertaken to treat, contain, or remove contaminated landfill solids within the landfill mass and the former tire pile area. Existing sitewide operational measures pertinent to landfill solids such as cover maintenance, site access restrictions and security, and interim remedial measures would continue to be operated and maintained. Under these measures:

- The landfill in Section 6 would remain closed and the existing landfill cover would be maintained;

- The existing soft cover in the former tire pile area would be maintained; and

- Existing institutional controls and onsite access restrictions including fencing and warning signs, and land use restrictions including well drilling restrictions would be enforced.

There are no treatment components associated with this alternative.

Containment of the landfill mass solids would be achieved by proper maintenance of the existing cover on the landfill. Approximately 12 million cubic yards of landfill solids would be contained.

Because there are currently no residential or recreational uses at the Lowry Site, there is no current risk from ingestion, inhalation, or skin adsorption of landfill solids. The Baseline Risk Assessment indicated that if no remedial actions were taken, and if people lived or worked (without protective regulations) on the Lowry Site, the excess cancer risk could be 1 x 10-5 from ingestion or inhalation of contaminants.

There would be no reduction of toxicity, mobility or volume under the No Further Action Alternative. By maintaining the existing landfill cover, risks from exposure to the solids would be minimized.

The following major ARARs have been identified for this alternative:

- Criteria for Classification of Solid Waste Disposal Facilities and Practices (40 CFR Part 257): This requirement establishes criteria for use in determining which solid waste disposal facilities and practices pose a reasonable probability of adverse effects on health or the environment. This requirement would be relevant and appropriate to maintenance of the landfill cover and would be met through proper maintenance of the cap.

- Regulations Concerning Municipal Solid Waste Landfills (40 CFR Part 258): This requirement establishes the design and operational criteria for solid waste landfills. The operational criteria would applicable to closure and would be met through proper maintenance of the cap.

- Colorado Solid Wastes Disposal Sites and Facilities Act (6 CCR 1007-2): This requirement establishes standards for municipal solid waste disposal facilities. This requirement would be applicable to maintenance of the landfill cap and would be met through proper maintenance of the cap.

The total 30-year present worth cost of this alternative is $7,260,000, with capital costs of $36,000 and annual O&M costs of $470,000. The No Further Action Alternative could be implemented immediately.

<u>8.4.3.2 Alternative LFS-3-Clay Cap</u>

Under Alternative LFS-3, all existing interim measures identified in the No Further Action Alternative would continue. In addition to the existing soil cover for the landfill mass, a clay cap would be placed in the former tire pile area over areas where drums and waste pits have been identified. This cap would provide an additional physical barrier that would reduce the potential for contact with contaminated solids and reduce infiltration, thus reducing additional ground-water contamination. The drums at or near the surface (approximately 10 drums) would be removed for offsite disposal at a Subtitle C landfill. Additionally, approximately 600 tires from the unnamed creek area would be removed and placed against the north toe of the landfill mass area. This alternative would be simple to implement because it involves common earthwork.

There would be no treatment components associated with this alternative.

The containment component of this alternative would be the placement of a 24-inch clay cap in the former tire pile area (approximately 1.9 acres) where several metal anomalies and drums have been identified. The area would be revegetated after the cap was placed. Containment of the landfill mass solids would also be achieved by proper maintenance of the existing cover on the landfill.

Although waste would be left in place (approximately 12 million cubic yards of solids), risks would be reduced because use the potential for exposure to the contaminated solids in the landfill mass and the former tire pile area would be decreased due to the cap. No treatability testing was conducted during the RI/FS that relates specifically to this alternative.

Maintenance of the existing landfill mass cover would be performed in compliance with RCRA Subtitle D regulations. The former tire pile area clay cap would meet pertinent criteria for RCRA Subtitle D landfills. The drums at or near the surface would be removed offsite for disposal. These drums would be transported and disposed of at a RCRA Subtitle C facility which complies with the Superfund Offsite Policy.

The major ARARs for this alternative would be the same as those identified for Alternative LFS-2 and would be met by this alternative using similar methods.

The total 30-year present worth cost of this alternative is $6,970,000, with capital costs of $670,000 and annual O&M costs of $410,000. The estimated time to implement Alternative LFS-3 would be 1 year.

<u>8.4.3.3 Alternative LFS-4-Drum Removal/Off site Disposal</u>

Under Alternative LFS-4, all existing interim measures identified in the No Further Action Alternative would continue. The alternative consists of continued maintenance of the existing cover on the landfill mass; surface and subsurface drum removal from the former tire pile area (approximately 1,350 drums); offsite treatment and disposal of drums, drum contents, and contaminated soils from near the drums at an offsite RCRA Subtitle C facility. The excavated areas would be backed and revegetated.

Liquids in drums (estimated at 1,300 gallons) removed would be transported to an offsite RCRA Subtitle C facility for incineration and ash stabilization. Treatment by incineration is expected to result in a 99.99 percent reduction in contaminants.

Containment of the landfill mass solids would be achieved by proper maintenance of the existing cover on the landfill.

This alternative would result in the removal of approximately 1,350 drums and contaminated material surrounding drums in the former tire pile area. All solids in the landfill mass (approximately 12 million cubic yards) would be left in place. Risks in the former fire pile area from the unsaturated solids would be reduced by excavation and offsite treatment and disposal of these materials. Risks posed by the landfill mass would be reduced by decreasing the potential for exposure to the solids through maintenance of the cover.

This remedy would be implementable because it utilizes conventional equipment, construction techniques, and established treatment and disposal facilities. Institutional controls such as access controls and land use restrictions would be required to limit access to the Lowry Site.

Because solids in the landfill mass would not be treated or moved, residual levels would be the same as the initial levels; solids in the former tire pile area would be excavated, treated, and disposed to achieve the performance standards. This alternative assumes that solids in the former tire pile area would only be excavated down to the depth of ground water.

The major ARARs for this alternative would be the same as those for Alternative LFS-2 and would be met by this alternative using similar methods.

The total 30-year present worth cost of this alternative is $8,700,000, with capital costs of $2,400,000 and annual O&M costs of $410,000. The estimated time to implement Alternative LFS-4 would be 6 months.

8.4.3.4 Alternative LFS-6-Drum Removal/Low Temperature Thermal Desorption/Stabilization/Disposal

Under Alternative LFS-6, all existing interim measures identified in the No Further Action Alternative would continue. In addition, this alternative would consist of continued maintenance of the existing cover on the landfill mass area; surface and subsurface drum removal from the former tire pile area (approximately 1,350 drums); offsite treatment and disposal of the drums and drum contents; treatment of approximately 4,200 cubic yards of contaminated soil through desorption, stabilization, fixation and onsite disposal, and reclamation of the former tire pile area.

Containment of the landfill mass solids would be achieved by proper maintenance of the existing cover on the landfill.

All solids in the landfill mass (approximately 12 million cubic yards) would be left in place. Risks posed by the landfill mass would be reduced by reducing the potential for exposure to the solids through maintenance of the cover. Risks posed by the former tire pile area would be reduced by removing and treating the contaminated soil to the performance standards.

Results of treatability tests conduction during the RI/FS indicated that low temperature thermal desorption would meet cleanup levels. This alternative would be implementable because it would utilize conventional equipment and construction techniques, and established treatment and disposal facilities. Institutional controls such as access restrictions and land use restrictions would be required. This alternative might be difficult to implement if soils were encountered with different contaminants than those encountered for the treatability study. This alternative assumes that the soils used in the treatability study would be sufficiently similar to those in the former tire pile area to allow treatment levels to be met.

Because solids in the landfill mass would not be treated or moved, residual levels would be the same as the initial levels; solids in the former tire pile area would be excavated down to the depth of ground water to meet the performance standards.

Maintenance of the existing landfill mass cover would be performed in compliance with RCRA Subtitle D regulations. Overpacked drums and bulk liquids would be transported to an offsite RCRA Subtitle C facility for incineration and ash stabilization. Approximately 4,200 cubic yards of contaminated sod would be excavated and treated through low temperature thermal desorption to separate volatile and semivolatile organic compounds from soils. The treatment would be followed by stabilization of the soils to minimize leaching of inorganic compounds from the soils. The stabilization would result in an increase in volume to 6,000 cubic yards. The soils would be TCLP-tested and, if they were not found to be RCRA characteristic wastes, would be disposed in an onsite RCRA Subtitle D disposal cell.

Waste residuals produced by low temperature thermal desorption treatment technologies would include condensate and treated soils. The condensate would be transported to an offsite RCRA Subtitle C facility for incineration, and the treated soils would be stabilized ands disposed onsite. Vented gas produced through the operation of the low temperature thermal system would meet standards outlined in the Clean Air Act, and the Colorado Air Quality Act/Colorado Air Pollution Regulations.

The thermal desorption unit would be an existing unit on a trailer; retention time in the treatment unit would be 1 to 5 hours.

The major ARARs identified for Alternative LFS-2 also apply to this alternative and would be met by this alternative using similar methods. In addition, the following major ARARs have been identified:

- Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities (40 CFR Part 264 and 6 CCR 1007-3 Part 264): This requirement establishes standards for the design and operation of hazardous waste facilities and closure and post-closure care. This requirement would be applicable if solids (including the soils) are identified as a RCRA hazardous waste and relevant and appropriate if solids are sufficiently similar to RCRA hazardous waste. In either event, the low temperature thermal desorption unit would be constructed and operated to comply with these requirements.

- Land Disposal Restrictions (40 CFR Part 268 and 6 CCR 1007-3 Part 268): This requirement establishes prohibitions on land disposal unless treatment standards are met. If soils were determined to be a hazardous waste, these restrictions would be applicable for disposal of the soils following treatment. The soils would meet these requirements before disposal.

- Colorado Air Quality Act/Colorado Air Pollution Regulations (5 CCR 1001): These regulations establish standards for air emissions from stationary sources. These regulations are applicable because the low temperature thermal desorption system is a source of air emissions and would be met for the low temperature thermal treatment process.

The total 30-year present worth cost of this alternative is $11,500,000 with capital costs of $5,200,000 and annual O&M costs of $410,000. The estimated time to implement Alternative LFS-6 would be 1 year.

<u>8.4.3.5 Alternative LFS-7-Landfill Mass Regrading</u>

Under Alternative LFS-7, all existing interim measures identified in the No Further action Alternative would continue. In addition, under this alternative all existing wastepit liquid, gas, and ground-water monitoring wells would be abandoned. The soft cover in the former tire pile area would be maintained. The top layers of the existing landfill mass cover would be stripped and the clay stored temporarily. The landfill mass in Section 6 would be regraded by placing approximately 1.2 million cubic yards of additional municipal solid waste on top of the existing landfill and then the clay cover would be placed. An additional 2-foot clay layer would be placed on the north face of the landfill mass to minimize infiltration and erosion.

There are no treatment components associated with this alternative. Containment of the landfill mass solids would be achieved by proper maintenance of the new cover on the landfill. All waste would be left in place (approximately 12 million yards).

No treatability testing was conducted during the RI/FS that relates specifically to this alternative. This alternative is implementable because it would utilize conventional equipment and construction techniques, and established disposal facilities. Institutional controls such as access restrictions and land use restrictions would be required. Maintenance of the new landfill cover would continue.

The following major ARARs have been identified for this alternative:

- Criteria for Classification of Solid Waste Disposal Facilities and Practices (40 CFR Part 257) and Regulations Concerning Municipal Solid Waste Landfills (40 CFR Part 258): These requirements establish design and operational criteria for all new municipal solid waste landfills. These requirements would be applicable to future land filling actions at the Lowry Site. As proposed, this alternative would not meet these requirements because it would not include the necessary liner and leachate collection system.

- Colorado Solid Wastes Disposal Sites and Facilities Act (6 CCR 1007-2): This requirement establishes standards for municipal solid waste disposal facilities. This requirement would be applicable to future landfilling actions at the Lowry Site. As proposed, this alternative would not meet this requirement because the regulation requires that new municipal solid waste disposal facilities be constructed with engineering liners and leachate collection systems on a stable sub-base. This alternative does not include these components.

The total 30-year present worth cost of this alternative is $5,380,000, with capital costs of $0 and annual O&M costs of $350,000. The estimated time to implement Alternative LFS-7 would be 9 months.

<u>8.4.3.6 EPA's Preferred Alternative-Modified Alternative LFS-4-Drum Removal/Offsite Disposal/North Face Cover</u>

Under Modified Alternative LFS-4, all existing interim measures identified in the No Further Action Alternative would continue. Alternative LFS-4 was modified to increase the volume of soils excavated, treated, and disposed offsite by including excavation of contaminated materials associated with unsaturated waste pits in the former tire pile area. Excavation would include waste-pit solids and surrounding contaminated soil and would reduce contamination sources and thus, reduce adverse risks.

This alternative consists of continued maintenance of the existing soil cover on the landfill mass; excavation of approximately 10 surface and 1,350 subsurface drums, contaminated soils associated with the drums to a depth of 15 feet, and excavation of approximately 15,000 cubic yards of contaminated materials associated with waste pits to a depth of three feet beneath the bottom of each pit within the former tire pile area; offsite treatment and disposal of drums, drum contents, and contaminated soils; and reclamation of the former tire pile area.

This alternative also modifies Alternative LFS-4 to include an additional two feet of soil cover on the north slope of the landfill mass. This additional cover would further reduce risk from landfill solids by decreasing the potential for contact with contamination from landfill solids and by minimizing infiltration and erosion.

Liquids in drums removed (estimated at 1,300 gallons) would be transported to an offsite RCRA Subtitle C facility for incineration and ash stabilization. Treatment would be expected to result in a 99.99 percent reduction of contaminants.

Containment of the landfill mass solids would be achieved by proper maintenance of the existing cover on the landfill. Landfill solids in the landfill mass would remain in place. Approximately 15,00 cubic yards of contaminated material would be removed from the former tire pile area.

Risks would be reduced because of the diminished potential for exposure to contaminated solids. Risks in the former tire pile area from the unsaturated solids would be eliminated by excavation of these materials.

This alternative is implementable because it would utilize conventional equipment and construction techniques, and established treatment and disposal facilities. Institutional controls such as access restrictions and land use restrictions would be required.

Because solids in the landfill mass would not be treated or moved, residual levels would be the same as the initial levels; solids in the former tire pile area would be excavated to the performance standards and treated and disposed offsite.

The major ARARs identified for this alternative are the same as those identified for Alternative LFS-2 and would be met by this alternative using similar methods.

The total 30-year present worth cost of this alternative is $13,460,000 with capital costs of $8,600,000 and annual O&M costs of $316,000. The estimated time to implement Modified Alternative LFS-4 Alternative would be 1 year.

8.4.3.7 Alternative LFG-2-No Further Action

Under LFG-2, the No Further Action Alternative for landfill gas, no additional remedial action would be undertaken to treat, contain, or remove landfill gas. The perimeter gas monitoring program at existing gas probes would be continued. Existing sitewide operational measures such as cover maintenance, site access restrictions and security, and interim remedial measures would continue to be maintained.

There are no treatment or containment associated with this alternative. There would be no reduction of toxicity, mobility, or volume. This alternative would not be protective of human health and the environment because it would not prevent gas migration from occurring.

The Baseline Risk Assessment indicated that if people lived on the Lowry Site, there would be a probability that 100% of the population would contract cancer from exposure to vinyl chloride and other contaminants in landfill gas. In addition, there would be risks of injury due to explosion and adverse health effects to individuals exposed to landfill gas on or offsite.

The following major ARARs have been identified for this alternative:

- Criteria for Classification of Solid Waste Disposal Facilities and Practices (40 CFR Part 257) and Regulations Concerning Municipal Solid Waste Landfills (40 CFR Part 258): These requirements establish design and operational criteria for all new municipal solid waste landfills. These requirements are relevant and appropriate because the Lowry Site operated as a landfill and accepted municipal solid waste. These requirements might not be met because landfill gas might migrate offsite above the regulated limits in the future.

- Colorado Solid Wastes Disposal Sites and Facilities Act (6 CCR 1007-2): This requirement establishes standards for municipal solid waste disposal facilities. This requirement would be applicable to the closed landfill at the Lowry Site. The requirement might not be met because landfill gas might migrate offsite above the regulated limits in the future.

The total 30-year present worth cost of this alternative is $943,000, with capital costs of $36,000 and annual O&M costs of $59,000. The No Further Action Alternative could be implemented immediately.

8.4.3.8 Alternative LFG-3-Gas Collection/Enclosed Flare

Alternative LFG-3 for Landfill Gas involves the placement of gas collection wells in the interior and at the perimeter of the former landfill area and treatment of the gas by an enclosed flare. It also incorporates all elements of Alternative LFG-2. The main objective of this gas collection system is to prevent lateral migration of gas offsite. This alternative would be implemented in stages. The staged approach would be to add gas collection wells, as necessary, to control gas migration.

- Stage 1 would involve constructing approximately seven perimeter collection wells and two interior collection wells.

- Stage 2 would be implemented if gas monitoring indicates that gas is migrating beyond the perimeter of the landfill mass. Stage 2 would add approximately 14 perimeter collection wells.

- Stage 3 would add approximately 26 gas extraction wells in the interior if Stages 1 and 2 did not prevent gas migration at the perimeter.

To supplement the existing gas monitoring network, additional gas monitoring probes would be installed along the perimeter of the Lowry Site to improve the gas monitoring system (approximately 26 probes would be added to the existing 17 probes). The gas monitoring probes would be analyzed for methane and VOCs. The levels of methane and VOCs would be compared to performance standards to determine if the extraction system was effective in preventing offsite gas migration and if Stages 2 and 3 were necessary.

All existing gas, waste-pit liquid, and ground-water monitoring wells within the landfill mass would be abandoned to eliminate the potential for vertical gas migration from the wells.

The collected gas would be treated at approximately 750 standard cubic feet per minute (scfm) per day using an enclosed flare with an 8-foot-diameter stack approximately 40 feet high. It is estimated that treatment would result in approximately 98 percent destruction of VOCs. Condensate collected in the gas collection system would be treated in the existing ground-water treatment system.

Approximately 15 tons per year of VOCs would be treated using Stage 1 only and approximately 40 tons per year of VOCs would be treated using Stage 2. Treatability testing was conducted as part of the FS. This alternative would be implementable because the system would use established and reliable technologies. Institutional controls such as ms restrictions and land use restrictions would be required. Residual levels would achieve performance standards because extraction would continue until the standards were met. This alternative assumes that methane would continue to be generated in quantifies sufficient to operate the flare.

The potential for adverse offsite risk (health and explosion) would be significantly reduced through the collection and treatment of gas.

The following major ARARs have been identified for this alternative:

- Clean Air Act [including NAAQS (40 CFR Part 50), NESHAPS (40 CFR Part 61), and NSPS (40 CFR Part 60)]: These requirements establish emissions standards for air pollutants. NAAQS would be applicable, and NESHAPS and NSPS would be relevant and appropriate because gas would be flared under this alternative. These requirements would be met at the compliance boundary.

- Colorado Air Quality Control Act/Colorado Air Pollution Regulations (5 CCR 1001): These regulations establish standards for air emissions from stationary sources. These regulations would be applicable during construction and operations activities, and would be met by this alternative.

- Regulations Concerning Municipal Solid Waste Landfills (40 CFR Part 258): This requirement establishes design and operational criteria for all new municipal solid waste landfills. This requirement would be relevant and appropriate because the Lowry Site operated as a landfill and accepted municipal solid waste. The regulations include controls for explosive gas. The requirement would be met because landfill gas would be prevented from migrating offsite.

- Proposed Standards of Performance for New Stationary Sources and Guidelines for Control of Existing Sources-Municipal Solid Waste Landfills (40 CFR Part 60, Subpart WWW): This requirement establishes performance standards for new stationary sources. This requirement would be a to-be-considered (TBC) regulation because the standards are proposed. Landfill gas would be collected and flared, and would meet these proposed standards.

The total 30-year present worth cost of Stage 1 of Alternative LFG-3 is $7,970,000, with capital costs of $3,200,000 and annual O&M costs of $310,000. The estimated time to implement Stage 1 of the LFG-3 Alternative would be 6 months.

The total 30-year present worth cost of Stage 2 Alternative of LFG-3 is $8,830,000, with capital costs of $3,600,000 and annual O&M costs of $335,000. These costs include the costs for implementation of Stage 1. The estimated time to implement Stage 2 of the LFG-3 Alternative would be 6 months.

The total 30-year present worth cost of Stage 3 Alternative of LFG-3 is $12,930,000 with capital costs of $5,200,000 and annual O&M costs of $503,000. These costs include the costs for implementation of Stages 1 and 2. The estimated time to implement Stage 3 of the LFG-3 Alternative would be 6 months.

8.4.3.9 Alternative LFG-5-Gas Collection with Heat Recovery

Alternative LFG-5, for Landfill Gas, includes all of the components of Alternative LFG-3. This alternative would add a heat recovery system which would utilize heat from the enclosed flare for onsite use. At this time, a practical and economical use for this heat, such as healing offices or maintenance facilities, has not been identified. Approximately 15 tons per year of VOCs would be treated using Stage 1 only and approximately 40 tons per year of VOCs would be treated using Stage 2.

The major ARARs identified for this alternative are the same as those identified for Alternative LFG-3 and would be met by this alternative using similar methods.

The total 30-year present worth cost of Stage 1 of Alternative LFG-5 is $8,510,000, with capital costs of $3,700,000 and annual O&M costs of $313,000. The estimated time to implement Stage 1 of the LFG-5 Alternative would be 6 months.

The total 30-year present worth cost of Stage 2 of Alternative LFG-5 is $9,330,000, with capital costs of $4,100,000 and annual O&M costs of $340,000. These costs include the costs for implementation of Stage 1. The estimated time to implement Stage 2 of the LFG-5 Alternative would be 6 months.

The total 30-year present worth cost of Stage 3 of Alternative LFG-5 is $13,510,000, with capital costs of $5,700,000 and annual O&M costs of $508,000. These costs include the costs for implementation of Stages 1 and 2. The estimated time to implement Stage 3 of the LFG-5 Alternative would be 6 months.

8.4.3.10 EPA's Preferred Alternative-Modified Alternative LFG-3-Gas Collection/Enclosed Flare

EPA's preferred alternative, Modified Alternative LFG-3 for Landfill Gas, includes Stages 1 and 2 of Alternative LFG-3, to be implemented simultaneously. By combining these stages, the potential for gas migration would be decreased, minimizing exposure and thus reducing risks.

Rather than immediately removing existing wells as in Alternative LFG-3, EPA would evaluate existing gas, waste-pit liquid, and ground-water monitoring wells within the landfill for future use. Wells that are no longer effective would be abandoned.

Approximately 21 perimeter collection wells and two interior collection wells would be installed to intercept migrating gas, and the gas would be treated with an enclosed flare. Approximately 26 additional gas monitoring wells would be installed along the perimeter of the Lowry Site to improve the perimeter gas monitoring system (17 gas monitoring wells currently exist onsite). If EPA determines that the combined Stages 1 and 2 efforts are unsuccessful in preventing migration or meeting performance standards, Stage 3 would be activated and would involve installation of approximately 26 interior collection wells.

Approximately 40 tons per year of VOCs would be treated using Stage 2. The gas would be treated at a rate of approximately 2,000 scfm per day using an enclosed flare with an 8-foot-diameter stack approximately 40 feet in height. Condensate collected in the gas collection system would be treated in the existing ground-water treatment system. It is estimated that treatment would achieve approximately 98 percent destruction of VOCs.

There would be no containment components associated with this alternative.

Treatability testing was performed during the FS and showed that cleanup levels can be met. This alternative would be implementable because the systems would use established and reliable technologies. Institutional controls including access restrictions and land use restrictions would be required. Residual levels would achieve performance standards because extraction would continue until the standards were met. This alternative assumes that methane would continue to be generated in quantities sufficient to operate the flare.

The major ARARs identified for this alternative are the same as those identified for Alternative LFG-3 and would be met by this alternative using similar methods.

The total 30-year present worth cost of EPA's preferred alternative, Modified Alternative LFG-3, is $8,430,000 with capital costs of $3,200,000 and annual O&M costs of $340,000. The estimated time to implement Modified Alternative LFG-3 would be 6 months. If Stage 3 were required, it is estimated that capital costs would increase by $1,575,000. O&M costs would require an additional $168,000 per year and the total present worth would increase by $4,160,000.

8.4.4 OUs 4&5-Soils, Surface Water, and Sediments

The following alternatives were evaluated in detail during the FS for OUs 4&5, and were described in the Proposed Plan for OUs 2&3 and 4&5, issued in August 1993:

- Soils (OU 4)
    - Alternative SOIL-1, No Further Action;
    - Alternative SOIL-2, Access Restrictions and Dust Controls;
    - Alternative SOIL-4a, Option 1, Excavation (as needed) and Landfill (onsite);
    - Alternative SOIL-4a, Option 2, Excavation (one time) and Landfill (onsite);
    - Alternative SOIL-4b Option 1, Excavation (as needed) and Landfill (offsite); and
    - Alternative SOIL-4b Option 2, Excavation (one time) and Landfill (off site).
- Surface Water (OU 5)
    - No Further Action.
- Section 6 Sediments (OU 5)
    - Alternative SED6-1, No Further Action; and
    - Alternative SED6-2, Access Restrictions.
- Section 31 Sediments (OU 5)
    - Alternative SED31-1, No Further Action;
    - Alternative SED31-2, Access Restrictions and Capping; and
    - Alternative SED31-3, Excavation and Landfill.

These alternatives are described in the following paragraphs. Major ARARs are identified for each alternative. Additional ARARs for OUs 4&5 alternatives are presented in Table 8-3.

<u>8.4.4.1 EPA 's Preferred Alternative-Alternative SOIL-1-No Further Action</u>

Under Alternative SOIL-1, the No Further Action Alternative for soil, no additional remedial action would be undertaken to treat, contain, or remove contaminated soil. Contaminated soil consists of approximately 2.5 million cubic yards contaminated with low levels of arsenic, beryllium, polychlorinated biphenyls, and dioxins/furans.

This alternative would include maintenance of the SWRA, including the barrier wall, and existing institutional controls; performance and compliance monitoring associated with the collection system and treatment facility; and continued operation of the SWRA. The landfill in Section 6 would remain closed and the existing landfill mass cover would be maintained. The existing soil cover in the former tire pile area would be maintained.

Existing Lowry Site access and land use restrictions would continue; fencing and vegetative cover would be maintained. Visual monitoring of the soil areas would be carried out to identify areas of erosion. Periodic monitoring of the surface water runoff would be conducted to determined if any contaminated is migrating offsite. One automated surface water runoff sampler would be installed in the Section 31 drainage to monitor the runoff.

There would be no treatment components associated with this alternative. There would be a continuation of existing institutional controls including site fencing, signage, access and land use restrictions.

All of the soil (approximately 2.5 million cubic yards) would be left untreated on site. Contaminated soil spans approximately 103 acres in the northern half of Section 6. The area is divided into two portions, one east of the unnamed creek and the other west of the unnamed creek. Because the soil would not be treated or removed under this alternative, the residual contaminant levels would be the same as the initial levels.

The Baseline Risk Assessment calculated a combined maximum excess cancer risk of 3 x 10-5 for a future resident adult and a future resident child from the ingestion and inhalation of soil contaminated with arsenic, beryllium, polychlorinated biphenyls, and dioxins/furans within the sewage sludge application/leachate injection area (Group 1). The Baseline Risk Assessment estimated that the cancer risk posed to human health and the environment by soil at the Lowry Site were within EPA's acceptable risk range. A noncancer HI greater than 1 was estimated for a future resident child that ingest and inhales soil from the sewage sludge application/leachate injection area (Group 1) or the sewage sludge application area (Group 2). Although there would be no reduction in toxicity, mobility or volume through treatment, the No Further Action Alternative would be protective of human health and the environment because estimated cancer risk is within the acceptable range and noncancer risk would be controlled by land use restrictions.

No treatability testing was performed during the RI/FS for soil because the alternatives considered are proven technologies. This alternative would be fully implementable. The automated surface water sampler would be installed within the first year.

The following major ARARS have been identified for this alternative:

- Colorado Air Quality Control Act/Colorado Air Pollution Regulations (5 CCR 1001): These regulations establish standards for air emissions from stationary sources. These regulations would be applicable during maintenance activities for the vegetated soft cover and would be met by this alternative.

The RAOs would be achieved for this alternative through institutional controls which would reduce the disturbance of and exposure to the soil.

The total 30-year present worth cost of this alternative is $390,000 with capital costs of $22,000 and annual O&M costs of $24,000. The estimated time to implement the No Further Action alternative would be less than 1 year.

8.4.4.2 Alternative SOIL-2-Access Restrictions and Dust Control

Alternative SOIL-2 would include installation of 13,200 linear feet of 6-foot-high chain link fence topped with three strands of barbed wire to restrict access to the Site. In addition, the elements of Alternative SOIL-1, the No Further Action alternative would be included.

As a dust control and prevention measure, approximately 103 acres of the soil would be regraded, covered with six inches of topsoil, and vegetated with seed and mulch as a dust control and erosion prevention measure. Additionally, during revegetation and fence installation activities, water spraying would be used to minimize generation of fugitive dust. Existing site access land use restrictions regarding use of the site surface, surface water, and ground water would be continued.

Visual monitoring of the soil and vegetative cover would be performed on a monthly basis. Annual monitoring of the surface water runoff would be carried out to evaluate potential for contaminant migration. One automated surface water runoff sampler would be installed in the Section 31 drainage to monitor the runoff.

There would be no treatment components associated with this alternative.

This alternative would contain the soil via placement of the topsoil and vegetative cover. The potential for chemical migration through air-borne particulates and runoff erosion would be reduced because of the topsoil and vegetative cover over the soil. All of the soil (approximately 2.5 million cubic yards) would be left untreated onsite; but since the soil would be covered, the risks from inhalation and ingestion of soil would be eliminated.

The Baseline Risk Assessment estimated that the cancer risks posed to human health and the environment by soil at the Lowry Site were within EPA's acceptable risk range. The noncancer HI greater than 1 was estimated for a future resident child that ingests and inhales onsite soil. Under this alternative since the soil would be covered, the risks from inhalation and ingestion of soil would be eliminated.

Because the soil would not be treated under this alternative, the residual contaminant levels would be the same as the initial levels. However, exposure pathways would be incomplete and risk would not be present.

No treatability testing was performed for soil, because the alternatives considered are proven technologies. This alternative would be implementable because it uses proven methods of remediation. The automated surface water sampler would be installed within the first year.

The following major ARARs have been identified for this alternative:

- Colorado Air Quality Control Act/Colorado Air Pollution Regulations (5 CCR 1001): These regulations establish standards for air emissions from stationary sources. These regulations would be applicable during construction and operations activities and would be met by this alternative.

Although fence installation, soil grading and vegetation activities might increase the potential for short-term exposure and habitat disturbance, the RAOs would be achieved for this alternative through a reduced potential for long-term exposure to the soil. Toxicity, mobility, and volume of the contaminants would not be reduced by this alternative.

The total 30-year present worth cost of this alternative is $2,080,000 with capital costs of $1,400,000 and annual O&M costs of $44,000. The estimated time to implement Alternative SOIL-2 would be 1 year.

8.4.4.3 Alternative SOIL-4a Excavation and Landfill (onsite)

Alternative SOIL-4a for soil would include excavation of approximately 2.5 million cubic yards of contaminated soft to a depth of 15 feet. The excavated soils would then be used as a daily cover in the onsite landfilling operations. In addition, the elements of the Alternative SOIL-1, No-Further Action, would be included.

Contaminated soil consists of approximately 2.5 million cubic yards contaminated with low levels of arsenic, beryllium, polychlorinated biphenyls, and dioxins/furans. The soil spans approximately 103 acres in the northern half of Section 6. The area is divided into two portions, one east of the unnamed creek and the other west of the unnamed creek.

There are two options for excavation:

- Option 1-Excavate soft on an as needed basis for daily landfill cover; or

- Option 2-Excavate soft at one time and stockpile material for use as daily cover in landfill.

RCRA Subtitle D landfill cells would be constructed on Section 6 in which the excavated soil would be used as the daily cover. The new landfill would receive municipal solid waste. Excavation of the soil would be to a depth of 15 feet. The areal extent of the excavation would be 103 acres. Dust suppression techniques would be used to minimize fugitive dust.

Land use restrictions that are currently in place regarding use of the site surface, surface water, and ground water would be continued.

Annual monitoring of the surface water runoff would be carried out to evaluate potential for contaminant migration. One automated surface water runoff sampler would be installed in the Section 31 drainage to monitor the runoff. Installation of the sampler would be achieved within the first year.

Construction of additional landfill cells would be in compliance with the RCRA Subtitle D requirements. Landfill design would promote surface drainage, minimize erosion of the cover and reduce the potential for precipitation permeation and leachate generation. Disposal of soil, in the form of daily cover over the municipal solid waste, would result in the containment of the contaminants in the soil within the landfill.

There are no treatment components associated with this alternative.

All of the soil (approximately 2.5 million cubic yards) would be left untreated onsite. Because the soil would not be treated or moved offsite under this alternative, the residual contaminant levels would be the same as the initial levels. However, because the soils would be used as daily cover, exposure pathways would be incomplete.

The Baseline Risk Assessment estimated that the cancer risks posed to human health and the environment by soil at the Lowry Site were found to be already within EPA's acceptable risk range. Under this alternative, the long-term risk from the ingestion and inhalation of soil would be eliminated because of the containment of the soil; however, there would be an increased potential for short-tern risk from dust generation during excavation, stockpiling, and handling of the soil.

No treatability testing was carried out for soil, because the alternatives considered are proven technologies. Construction of the additional landfill cells and complete utilization of the excavated soil would be expected to take 10 years. In Option 2, onsite stockpiling would be difficult to implement because of limited area available in Section 6, as well as the potential interference with the daily landfilling activities.

Existing institutional controls would continue under this alternative.

The following major ARARs have been identified for this alternative:

- Regulations Concerning Municipal Solid Waste Landfills (40 CFR Part 258): This requirement establishes design and operational criteria for all new municipal solid waste landfills and would be applicable because new landfill cells would be constructed. This standard would be met through proper design and operation of the landfill cells.

- Regulations Pertaining to Solid Waste Disposal Sites and Facilities (6 CCR 1007-2, Section 1): This requirement establishes standards for new solid waste disposal facilities. Standards for design, construction and operation of landfill cells would be applicable because new landfill cells would be constructed and soils would be land filled. These standards would be met through proper design of the landfill cells.

- Colorado Air Quality Act/Colorado Air Pollution Regulations (5 CCR 1001): These regulations establish standards for air emissions from stationary sources. These regulations would be applicable during construction and operations activities, and would be met by this alternative.

Although soil excavation, stockpiling and movement activities would increase the potential for short-term exposure and habitat disturbance, the RAOs would be achieved for this alternative through a reduced potential for long-term exposure to the soil. Neither toxicity nor volume of the contaminants would be reduced by this alternative. Mobility would be significantly reduced because of the use of the soil as a daily cover in a RCRA Subtitle D landfill.

The total 30-year present worth cost for Option 1 of this alternative is $490,000 with capital costs of $43,000 and annual O&M costs of $29,000. The estimated time to implement Option 1 of Alternative SOIL4a would be 10 years, at which point all contaminated soil would have been used as daily cover.

The total 30-year present worth cost for Option 2 of this alternative is $3,280,000 with capital costs of $2,800,000 and annual O&M costs of $31,000. The estimated time to implement Option 2 of Alternative SOIL4a would be 10 years, at which point all stockpiled soil would have been used as daily cover.

<u>8.4.4.4 Alternative SOIL-4b, Excavation and Landfill (off site)</u>

Alternative SOIL-4b for soil includes excavation of approximately 2.5 million cubic yards of contaminated soil to a depth of 15 feet. In addition, all elements of Alternative SOIL-l, No-Further Action would be included in this alternative. The contaminated soil spans approximately 103 acres in the northern half of Section 6. The area is divided into two portions, one east of the unnamed creek and the other west of the unnamed creek. Under this alternative, excavated soil would be transported to the Section 31 RCRA Subtitle D landfill to be used as daily cover.

There are two options for excavation:

- Option 1-Excavate soil for daily landfill cover on an as needed basis; or

- Option 2-Excavate soil at one time and stockpile material for use in the landfill.

The areal extent of the excavation would be 103 acres. Dust suppression techniques would be used to minimize fugitive dust. Under Option 2, the soil stockpile would be vegetated to minimize contaminant migration, since the soil might be stockpiled up to 10 years.

Land use restrictions that are currently in place regarding use of the site surface, surface water, and ground water would be continued. Annual monitoring of the surface water runoff would be carried out to evaluate potential for contaminant migration. One automated surface water runoff sampler would be installed in the Section 31 drainage to monitor the runoff.

There would be no treatment components associated with this alternative.

Under Option 1, the soil would be used as a daily cover in the offsite landfilling operations in Section 31, on an as needed basis. Under Option 2, excavated soil would require intermediate stockpiling for the one-time excavation of all soil and would later be used as daily cover in the offsite landfilling operations in Section 31. Dust control measures would be applied to the stockpile in the latter case.

All of the soil (approximately 2.5 million cubic yards) would be removed from the Lowry Site and transported to Section 31 for use as daily cover. The existing contamination would be eliminated because the soil would be excavated and moved offsite.

The Baseline Risk Assessment estimated that the cancer risks posed to human health and the environment by soil at the Lowry Site were found to be already within EPA's acceptable risk range. Under this alternative, the long-term risk from ingestion and inhalation of soil would be eliminated; however, there would be a potential for short-term risk from dust generation during excavation, stockpiling and additional handling of the soil. No treatability testing was carried out for soil, because the alternatives considered are proven technologies.

Construction of the additional landfill cells as well as complete utilization of the excavated soil would be expected to take 10 years. Installation of the automated surface water sampler would be achieved within the first year. Existing institutional controls would continue under this alternative.

The following major ARARs have been identified for this alternative:

- Colorado Air Quality Act/Colorado Air Pollution Regulations (5 CCR 1001): These regulations establish standards for air emissions from stationary sources. These regulations would be applicable during construction and operations activities, and would be met by this alternative.

Although soil excavation and transport to Section 31 would increase the potential for short-term exposure and habitat disturbance, the RAOs would be achieved for this alternative through a reduced potential for long-term exposure to the soil.

The total 30-year present worth cost for Option 1 of this alternative is $1,880,000 with capital costs of $1,200,000 and annual O&M costs of $44,000. The estimated time to implement Option 1 of Alternative SOIL4b would be 10 years, at which point all contaminated soil would have been used as daily cover.

The total 30-year present worth cost for option 2 of this alternative is $4,800,000 with capital costs of $4,000,000 and annual O&M costs of $52,000. The estimated time to implement Option 2 of Alternative SOIL-4b would be 10 years, at which point all excavated soil would have been used as daily cover.

8.4.4.5 EPA's Preferred Alternative- Alternative SW-1-No Further Action

Alternatives for surface water were previously evaluated under the Surface Water Removal Action Engineering Evaluation and Cost Analysis. During the RI/FS process, the SWRA was evaluated for incorporation into the overall selected remedy. This evaluation included an assessment of the effectiveness, implementability, and cost of the SWRA, as well as the statutory considerations in CERCLA Section 121(b)(1). Upon the initial screening of the alternatives, it was determined that the SWRA met the evaluation criteria and should therefore be retained for detailed analysis as the No Further Action alternative.

This alternative includes the O&M of the barrier wall; the SWRA, including both the collection system and upgrades to the GWTP; and the enforcement of the existing institutional controls, such as fencing and signage, and restrictions on land uses, site access, well drilling, and residential development. Additional measures would include construction of wetlands in accordance with the SWRA Consent Order and implementation of a long-term monitoring program.

The ground-water barrier system and GWTP is an interim remedial measure implemented pursuant to Consent Order, EPA Docket No. CERCLA VIII-83-06 (signed January 10, 1984) and is designed to reduce the northern offsite migration of contaminated ground water via the unnamed creek alluvium and weathered bedrock. The barrier wall consists of a 1,000-foot-long drain backed by a 30-foot-deep compacted clay barrier located immediately north of the Section 6 northern boundary. The drain and barrier function as a subsurface collection system. Water collected in this system is pumped to the GWTP to treat volatile and semivolatile organic compounds. The treated effluent is released via an injection trench into the alluvium of unnamed creek north of the barrier wall. The GWTP was modified as part of the SWRA and may be further upgraded, based on pilot-scale testing, to remove iron, manganese, vanadium, or other contaminants, if these are detected above performance standards. These upgrades could include biological treatment or ion exchange.

The SWRA interim remedial measure includes a seepage collection system in the Section 6 portion of the unnamed creek drainageway, closure of Ponds 3 and 4, and modification of the existing GWTP. The SWRA was completed in 1992 and is currently operational.

The SWRA collection system consists of a subsurface drainage system wrapped in geotextile that was constructed within the unnamed creek channel in Section 6. The collection system is designed to keep the contaminated alluvial flows separate from the uncontaminated surface water runoff. The system collects the alluvial flows and directs them toward the barrier wall. The drainage system and the Section 6 sediments located within unnamed creek have been covered by a compacted, fine-grained soil layer, which has been graded into a broad, gently sloping drainage swale. This relatively low permeability soil layer keeps the precipitation primarily as surface runoff and prevents it from contacting the covered sediments or entering the drainage system. The uncontaminated surface water flows over the collection system and eventually empties into Murphy Creek via the unnamed creek segment in Section 31.

Placement of a compacted 4-foot soil cover over the landfill mass in Section 6 was initiated in 1987. The landfill mass cover was completed in 1992, vegetated, and graded to provide control of surface water runoff. The cover efficiently drains precipitation-derived runoff from the landfill, thereby significantly reducing the potential for infiltration of the runoff into the landfill mass.

Under the preferred alternative, annual monitoring of the surface water runoff into the unnamed creek drainage would be conducted to evaluate the potential for contaminant migration, although the exposure pathway to the Section 6 sediments has been eliminated as a result of the soil cover over the SWRA collection system. An automated surface water runoff sampler would be installed in the drainage in Section 6 for the purpose of monitoring offsite contaminant migration.

Before the SWRA was implemented, the natural storm water runoff and any underground seepage in the unnamed creek basin in Section 6 constituted the contaminated media. The contaminated surface water medium, as it existed before the construction of the SWRA collection system, has been eliminated. The SWRA collection system effectively limits the contaminated seepage as an underground flow, and keeps it from mixing with surface water. The SWRA collection system also isolates the sediments from the surface water and provides a control on the sediment contamination migration. The SWRA collection system covers an area of approximately 4.8 acres.

The treatment of water in the upgraded treatment plant includes aerobic biodegradation treatment to reduce the biological oxygen demand (BOD). Although the system is not specifically designed to remove particular organic compounds, significant degradation of phenols, ketones and other biodegradable organic compounds is expected in the system. The biodegradation system would be incorporated in the overall treatment train only if EPA determines that phenols and ketones are anticipated based on the early warning monitoring data from the access well. If iron, manganese, and vanadium are detected in the early warning monitoring system in quantities above the performance standards, they would be precipitated from the water by addition of potassium permanganate. The metals precipitation module has not been incorporated into the GWTP at the present time.

Next, the water is air-stripped to remove volatile organic compounds. The off-gases from the stripper are then passed through a vapor-phase activated carbon bed to adsorb stripped organics. Clean off-gas is vented to the atmosphere.

Stripper bottoms or residuals may contain organics that are not biodegradable or strippable to any significant extent; therefore, the stripper effluent is passed through a bed of liquid-phase carbon to adsorb these organics. The effluent from the liquid-phase carbon polishing step must meet the performance standards for injection downgradient of the barrier wall.

The chemical composition of the influent to the treatment plant is assumed. to be compounds detected in the seepage water, ground water, and in waste-pit liquids. These chemicals consist of volatile and semivolatile organics, iron, manganese, and vanadium. Existing data from the treatment plant show removal efficiencies of 95 percent or greater. Based on these measurements, approximately 80 pounds of contaminants would be removed annually (assuming operation at 13 gpm).

The treatment plant has been designed for a combined seepage/ground water inflow of 30 gallons per minute (gpm) with flexibility to handle flows from 10 to 50 gpm. The treatment process has been designed with flexibility to handle a wide range of chemicals and concentrations that might need to be treated in the future.

The SWRA has been designed and constructed to collect and treat contaminated seepage and ground water for at least 30 years. It is anticipated that this system will be in operation as long as there is contaminated seepage and/or ground water. If used, biodegradation and permanganate oxidation treatment would produce treatment residuals or sludge which would be periodically dewatered, and drummed. The sludge would be tested to determine the disposal options. If the sludge tests to be hazardous, it would be disposed of in a RCRA Subtitle C facility; otherwise, it would be disposed of in the Section 31 landfill.

Based on historic data from surface water in the unnamed creek onsite, risks were estimated as 8 x 10-4 for ingestion by a child in the future onsite residential setting. The SWRA collection system has eliminated the initial risk from the surface water because contaminated surface water does not exist anymore. Contaminated underground seepage is treated in the GWTP to meet the SWRA ARARs. Thus, the risk from surface water has been eliminated and would continue to be eliminated with this approach.

Treatability testing was performed to aid in the design of the original GWTP, modification to the GWTP for the SWRA, and to test the compatibility of SWRA collection system materials with the contaminated seepage.

Except for the automated runoff sampler and construction of new wetlands, there are no initial measures to implement in this alternative because the SWRA has already been implemented and is currently operational. The sampler would be installed within the first year. A location and schedule for constructing the new wetlands would be determined by EPA during the design phase.

Land use restrictions regarding use of the site surface, surface water, and ground water would be continued. The GWTP effluent would meet the ARARs for the SWRA as updated in this ROD; therefore, the residual levels would comply with performance standards.

The following major ARARs were identified for this alternative:

- Colorado Water Quality Control Act (5 CCR 1002-8), Colorado Basic Standards for Ground Water, Classifications and Water Quality Standards for Ground Water: These regulations establish standards for both classified and unclassified ground water. The standards would be applicable because ground water (within non-alluvial and alluvial aquifers) near the Lowry Site and ground water (within alluvial aquifers) within the Lowry Site have been classified for domestic and agricultural use-quality. Under this alternative, ground water would be treated to meet these standards and then discharged to the shallow ground-water system.

- Safe Drinking Water Act, National Primary Drinking Water Regulations (40 CFR Part 141) and the Colorado Primary Drinking Water Regulations (5 CCR 1003-1): These regulations would be relevant and appropriate because the shallow and deep ground water in the vicinity of the Lowry Site is being used or may be used in the future as a source of water for a public water system or private supply wells. Under this alternative, treated ground water from the treatment plant would be injected into the shallow ground-water system in compliance with these requirements.

- Safe Drinking Water Act, National Secondary Drinking Water Regulations (40 CFR Part 143): These regulations establish welfare-based standards for public water supply systems and have been adopted by the State of Colorado under the basic standards for ground water. The regulations would be relevant and appropriate because the shallow and deep ground water in the vicinity of the Lowry Site is being used or may be used in the future as a source of water for a public water system or private supply wells. Under this alternative, ground water would be treated to meet these standards and then discharged to the shallow ground-water system in compliance with these requirements.

- Colorado Air Quality Act/Colorado Air Pollution Regulations (5 CCR 1001): These regulations establish standards for air emissions from stationary sources. These regulations are applicable for treatment plant operations and would be met by this alternative.

- Executive Order 11990, Protection of Wetlands would be applicable because wetlands have been identified at the Lowry Site and were destroyed as part of construction of the SWRA. New wetlands would be constructed under this alternative to mitigate the loss of wetlands, thus meeting the requirements of this Executive Order.

Excavated sediments would be transported offsite for disposal in accordance with EPA's Offsite Policy (40 CFR Section 300.400).

The total 30-year present worth cost of this alternative is $12,190,000 with capital costs of $41,000 and annual O&M costs of $790,000. The estimated time to implement the No Further Action alternative is 1 year.

The SWRA, GWTP and landfill cover remedies were developed and implemented earlier, independent of the alternatives developed for OUs 4&5. Therefore, the capital expenditures associated with these remedies are not considered part of the surface water alternatives developed in conjunction with the sitewide remedy and presented here. However, because the upgrade and O&M of these facilities are consistent with the sitewide remedial strategy, their costs are included in the No Further Action alternative.

8.4.4.6 EPA's Preferred Alternative-Section 6 Sediments Alternative SED6-1-No Further Action

The major feature of Alternative SED6-1, the No Further Action alternative for Section 6 sediments, is the SWRA as described in Alternative SW-1.

Although the exposure pathway to the Section 6 sediments has been eliminated as a result of the soil cover over the SWRA collection system, annual monitoring of the surface water runoff into the unnamed creek drainage would be conducted to evaluate the potential for contaminant migration. For the purpose of monitoring offsite contaminant migration, one automated surface water runoff sampler would be installed in the drainage in Section 6 to monitor runoff.

Before implementation of the SWRA, sediments in the approximately 2,800-foot-long portion of the unnamed creek in Section 6 constituted the contaminated media: However, during the construction of the SWRA collection system, a polypropylene geotextile blanket and a 2-foot-thick low-permeability soil cap were placed over the sediments. As a result, the sediments are no longer exposed.

There would be no treatment components associated with this alternative.

The containment component for the Section 6 sediments includes a geotextile and a low-permeability soil cap in order to keep the surface water runoff from contacting the sediments or mixing with the contaminated leachate from the landfill mass. The type of storage utilized by this alternative is in-place containment under geotextile and soil cap. The areal extent of the sediments is conservatively estimated at 320,000 square feet. The volume of the sediments is unknown.

Based on the historic data on sediments, a maximum excess cancer risk of 9 x 10-6 was calculated for ingestion of sediments by a child. By covering the sediments with a geotextile and a soil cap, the risk has been eliminated. Geotechnical properties of the sediments were determined during the design of the SWRA collection system. No other treatability studies were carried out for the sediments. Existing institutional controls, including site fencing, signage, site access, and land use restrictions would be continued under this alternative. Because the sediments would not be treated under this alternative, the residual levels would be the same as the initial levels. However, exposure pathways would be incomplete.

There are no major action-, location-, or chemical-specific ARARs identified for this alternative.

The RAOs would be achieved for this alternative through elimination of exposure to the sediments. Neither toxicity nor volume of the contaminants would be reduced by this alternative. The potential for mobilization of the contaminants would still exist, since the underground seepage would flow through the sediments. However, the seepage would be treated in the GWTP to meet the performance standards.

The total 30-year present worth cost of this alternative is $250,000 with capital costs of $16,000 and annual O&M costs of $350,000. Except for the automated runoff sampler, there would be no initial measures to implement in this alternative. The sampler would be installed within the first year.

8.4.4.7 Section 6 Sediments Alternative SED6-2-Access Restrictions

Alternative SED6-2 for Section 6 sediments would include the installation of 6,145 linear feet of 6-foot-high chain link fence topped with three strands of barbed wire around the unnamed creek to restrict access to the SWRA collection system cover over the sediments. The SWRA collection system would also be an integral part of the alternative as described in Alternative SW-1.

Although the exposure pathway to the Section 6 sediments has been eliminated as a result of the soil cover over the SWRA collection system, annual monitoring of the surface water runoff into the unnamed creek drainage would be conducted to evaluate the potential for contaminant migration. For the purpose of monitoring offsite contaminant migration, one automated surface water runoff sampler would be installed in the drainage in Section 6 to monitor runoff.

The SWRA cover would be inspected after each significant rainfall or runoff. Surface water runoff would be monitored annually so that EPA could determine whether contaminants were migrating offsite.

Contaminated media include sediments in the approximately 2,800-foot-long portion of the unnamed creek in Section 6. During the construction of the SWRA collection system, a polypropylene geotextile blanket and a 2-foot-thick low permeability soil cap were placed over the sediments. As a result, the sediments are no longer exposed.

There would be no treatment components associated with this alternative.

The containment component for the Section 6 sediments would include a geotextile and a low permeability soil cap in order to keep surface water runoff from contacting contaminated sediments or mixing with the contaminated leachate from the landfill mass. Additionally, the fence around the Section 6 area would further restrict access and potential exposure to the sediments. The fence would cover an area conservatively estimated at 320,000 square feet. The exact area and volume of the sediments are unknown. The type of storage utilized by this alternative would be in-place containment under geotextile and soil cap.

Based on the historic data on sediments, a maximum excess cancer risk of 9 x 10-6 was calculated for ingestion of sediments by a child. By covering the sediments with a geotextile and a soil cap, the risk has been eliminated. Geotechnical properties of the sediments were determined during the design of the SWRA collection system to evaluate the use of sediments as a daily cover in the landfill. The sediments were deemed unsuitable for use as a daily cover. No other treatability studies were carried out for the sediments. Existing institutional controls including site fencing, signage, site access, and land use restrictions would be continued under this alternative. The additional fencing of 6,145 feet around the unnamed creek would further restrict access to the sediment area.

The residual levels would be the same as the initial levels, since the sediments would not be treated under this alternative. In any event, exposure pathways would be incomplete.

The following major ARARs have been identified for this alternative:

- Colorado Air Quality Act/Colorado Air Pollution Regulations (5 CCR 1001): These regulations establish standards for air emissions from stationary sources. These regulations would be applicable during construction activities and would be met by this alternative.

The RAOs would be achieved for this alternative through elimination of exposure to the sediments. Neither toxicity nor volume of the contaminants would be reduced by this alternative. The potential for mobilization of the contaminants would still exist, since the underground seepage would flow through the sediments. However, the seepage would be treated in the GWTP to performance standards.

The total 30-year present worth of this alternative is $450,000 with capital costs of $93,000 and annual O&M costs of $23,000. The estimated time to implement Alternative SED6-2 would be 1 year. Except for the automated runoff sampler and the fence, there are no initial measures to implement in this alternative. The sampler and the fence would be installed within the first year.

8.4.4.8 EPA's Preferred Alternative-Section 31 Sediments Alternative SED31-1-No Further Action

Alternative SED31-1, The No Further Action alternative, would include continuation of the existing site fencing, signage, site access, and land use restrictions. The contaminated media are the sediments in the approximately 2,660-foot-long portion of the unnamed creek in Section 31, from the southern boundary of Section 31 up to the confluence with Murphy Creek.

Annual monitoring of the surface water runoff into the unnamed creek drainage would be conducted to evaluate the potential for contaminant migration. For the purpose of monitoring offsite contaminant migration, one automated surface water runoff sampler would be installed in the drainage in Section 31.

There would be no treatment or containment components associated with this alternative. Approximately 23,700 cubic yards of the untreated sediments would be left in place under this alternative. The risk would remain unchanged, since no treatment or containment of the sediments would be involved.

The Baseline Risk Assessment assumed the SWRA was no longer operational and future residences were built in Section 31. An excess cancer risk of 7 x 10-5 was calculated for ingestion of sediments by a child. The risk would not be reduced by this alternative. However, the risks associated with potential sediment contaminant exposures is within the acceptable excess cancer risk range. A noncancer HI greater than 1 was estimated for a future resident child that ingests and inhales sediments from this portion of Section 31. The three chemicals that contribute to this HI have different target organs; therefore, the HI would be below 1 if the chemical-specific target organ was considered. In addition, land use restrictions would prevent residential development on this Section. Thus, the No Further Action alternative for Section 31 would be protective of human health and the environment.

No treatability testing was conducted during the RI/FS for the sediments, because the alternatives considered are proven technologies. The residual levels would be the same as the initial levels, because the sediments would not be treated under this alternative.

There are no action-, location-, or chemical-specific ARARs identified for this alternative.

The RAOs would be achieved for this alternative through the existing restrictions on access and land uses. Sediments would remain in place, but would be of concern only for a residential exposure (resident in Section 31). Toxicity, volume and mobility of the contaminants would not be reduced by this alternative.

The total 30-year present worth of this alternative is $300,000 with capital costs of $22,000 and annual O&M costs of $18,000. The estimated time to implement Alternative SED31-1 would be 1 year.

8.4.4.9 Section 31 Sediments Alternative SED31-2-Access Restrictions and Capping

Alternative SED 31-2 for Section 31 Sediments would include a cap over the sediments, and approximately 5,400 linear feet of fence around the unnamed creek to restrict access to the sediments. Sediments in the approximately 2,660-foot long portion of the unnamed creek in Section 31, from the southern boundary of Section 31 up to the confluence of Murphy Creek constitute the contaminated media.

The cap would consist of approximately 10,800 square yards of a single layer of synthetic liner (60-mil high-density polyethylene) over the unnamed creek drainageway in Section 31, overlain with a 6-inch layer of gravel (approximately 1,700 cubic yards) and a 9-inch layer of riprap (approximately 2,500 cubic yards). A total of 1.47 acres of the drainageway would be capped. Grading operations before the placement of the liner would create fugitive dust. The dust would be suppressed with water sprays.

Grading might require removal of some sediments. These sediments would be characterized to determine if they could be disposed of in a RCRA Subtitle D landfill. Capping of the sediments would claim approximately 1.27 acres of wetlands. New wetlands would be created in the Murphy Creek drainage or in an offsite area appropriate for wetland development. Approximately 5,400 linear feet of 6-foot-high chain link fence topped with three strands of barbed wire would be installed to restrict access to the sediments along the unnamed creek segment in Section 31 up to the confluence with Murphy Creek. The alternative would also include maintenance of the cap, wetlands, new site fencing, signage, site access, and land use restrictions.

Annual monitoring of the surface water runoff into the unnamed creek drainage would be conducted to evaluate the potential for contaminant migration, although the exposure pathway to the Section 31 sediments would have been eliminated as a result of the cap over the sediments. For the purpose of monitoring offsite contaminant migration, one automated surface water runoff sampler would be installed in the drainage in Section 31 to monitor runoff.

There would be no treatment components associated with this alternative.

The Section 31 sediments would be contained and covered with a liner in order to keep the surface water runoff from contacting the sediments. Additionally, the fence around the sediment area would restrict access to the sediments. Approximately 23,700 cubic yards of the untreated sediments would be left in place under this alternative. The risk prior to and following containment would remain unchanged, since no treatment of the sediments would be involved. Because the sediments would be covered, the exposure pathway would be incomplete. The long-term risks would be essentially eliminated due to capping of the sediments and access restrictions. However, there would be a potential for the short-term risk from fugitive dust generated during the installation of the fence and the cap. Treatability testing was not conducted during the RI/FS for the sediments, because the alternatives considered are proven technologies.

The initial measures to implement in this alternative are the new chain link fence, synthetic liner and gravel and riprap, creation of new wetlands, and the automated runoff sampler.

The following major ARARs have been identified for this alternative:

- Colorado Air Quality Act/Colorado Air Pollution Regulations (5 CCR 1001): These regulations establish standards for air emissions from stationary sources. These regulations would be applicable during construction activities and would be met by this alternative.

- Executive Order 11990, Protection of Wetlands: This requirement would be applicable to protection of designated wetlands. Wetlands have been identified at the Lowry Site and would be destroyed in capping the sediments. New wetlands would be constructed under this alternative to mitigate the loss of wetlands. Creation of new wetlands would comply with the requirements of this Executive Order.

- Clean Water Act (40 CFR Part 230): This requirement establishes standards for construction activities affecting waters of the United States. This Act is applicable because this alternative would involve disturbance of potential wetlands and placement of a cap in the unnamed creek. Any substantive permit requirements would have to be met.

The RAOs would be achieved for this alternative through a reduced potential for long-term exposure to the sediments due to the cap over the sediments as well as fencing off of the area.

Grading, potential removal of some sediments, and installation of the new fence would create a potential for occupational (short-term) exposure and habitat disturbance. Neither toxicity nor volume of the contaminants would be reduced by this alternative. The potential for mobilization of the contaminants would be greatly reduced due to the isolation of sediments from the surface water runoff.

The total 30-year present worth of this alternative is $1,215,000 with capital costs of $400,000 and annual O&M costs of $53,000. The estimated time to implement Alternative SED31-2 would be 1 year.

8.4.4.10 Section 31 Sediments Alternative SED31-3-Excavation and Landfill

Alternative SED31-3 would include excavation and landfilling of 23,700 cubic yards of the Section 31 sediments. The excavation would be carried out in the unnamed creek drainage in Section 31 up to the confluence with Murphy creek (approximately 2,660 feet) at an average width of 24 feet and down to the depth of the water table (average 10 feet). The sediments would be landfilled in the existing Section 31 landfill, which complies with the current RCRA Subtitle D requirements. An area of approximately 1.47 acres, and a volume of 23,700 cubic yards are calculated for the sediments.

Disposal in a RCRA Subtitle C landfill is not anticipated based on the available contaminant and concentration information for the sediments. However, the sediments would be tested for RCRA hazard characteristics prior to disposal. If determined necessary by EPA, excavated sediments would be transported offsite for disposal in accordance with EPA's Offsite Policy (40 CFR Section 300.400). Following excavation, the area would be backfilled with clean soil, compacted, graded and vegetated.

Excavation of the sediments would claim approximately 1.27 acres of wetlands. New wetlands would be created in the Murphy Creek drainage or in an offsite area appropriate for wetland development.

The existing institutional controls such as fencing, signage, site access and land use restrictions would be maintained under this alternative.

Annual monitoring of the surface water runoff into Murphy Creek would be conducted to evaluate the potential for contaminant migration, although the Section 31 sediments would have been excavated and landfilled. For the purpose of monitoring offsite contaminant migration, one automated surface water runoff sampler would be installed in the drainage in Section 31.

There would be no treatment components of this alternative.

Excavation and landfilling of the sediments would result in the containment of the contaminants in the RCRA Subtitle D facility in Section 31. The excavated material would be disposed of as solid waste rather than being used as a daily cover material because the sediments are not expected to be of a quality appropriate for use as daily cover.

Approximately 23,700 cubic yards of sediments would be excavated and landfilled in the RCRA Subtitle D facility in Section 31. No sediments would be left in place; therefore, risk would be eliminated.

The Baseline Risk Assessment estimated a maximum excess cancer risk of 7 x 10-5 from ingestion of sediments by a child in a residential setting. All long-term risk (cancer and noncancer) would be essentially eliminated due to excavation and land filling of the sediments. A short-term risk would be created from fugitive dust generation during the excavation and materials handling activities. Treatability testing was not conducted during the RI/FS for the sediments because the alternatives considered are proven technologies. Excavation and landfilling of the sediments would be completed in three to 6 months. Installation of the automated surface water sampler would be achieved within the first year. There would be no residual levels remaining from removal of the sediments.

Major ARARs for this alternative are the same as for Alternative SED31-2 and would be met by this alternative using similar methods.

Although excavation and transport of the sediments to the active landfill area in Section 31 would create a potential for occupational (short-term) exposure and habitat disturbance, the RAOs would be achieved for this alternative through elimination of potential for long-term exposure to the sediments. Neither toxicity nor volume of the contaminants would be reduced by this alternative. The potential for mobilization of the contaminants would be significantly reduced due to the disposal in a RCRA Subtitle D landfill.

The total 30-year present worth of this alternative is $1,235,000 with capital costs of $620,000 and annual O&M costs of $40,000. The estimated time to implement Alternative SED31-3 would be 1 year.

Table 8-1
ARARs for OUs 1&6

Citation	Description	Evaluation
	Chemical-Specific ARARs-Federal	
	Safe Drinking Water Act	
40 CFR Part 141 Subpart B	Establishes health-based standards for public drinking water systems (MCLs).	These regulations are relevant and appropriate because the shallow and deep ground water in the vicinity of the Lowry Site is being used or may be used in the future as a source of water for a public water system or private supply wells. Treated ground water from the treatment plant would be injected into the shallow ground-water system. The standards are pertinent to treatment plant effluent at the point of injection as well as within the ground water at the compliance boundary.
40 CFR Part 141 Subpart F	Establish drinking water quality goals set at levels of no known or anticipated adverse health effects, with an adequate margin of safer (MCLGs).	Non-zero MCLGs are relevant and appropriate since shallow and deep ground water in the vicinity of the Lowry Site is being used or may be used as a source of water for a public water system or private supply wells.
	Federal Water Pollution Control Act (amended by the Clean Water Act)	
40 CFR Part 129 Toxic Pollution Effluent Standards	Establishes toxic pollutant effluent standards for six groups of toxic pollutants from manufacturers, formulators, and applicators who develop or use these compounds and discharge to navigable waters.	Relevant and appropriate for treatment plant effluent because compound groups were detected in waste pit liquids and unnamed creek and Murphy Creek discharges to the South Platte River, which is a navigable water.
	Solid Waste Disposal Act-RCRA Subtitle C	
40 CFR Part 264 Subpart F	Sets groundwater protection standards for land disposal units.	The State of Colorado operates an approved delegated program for this portion of RCRA. See requirement under Colorado Hazardous Waste Act. Relevant and appropriate because the landfill operates like a hazardous waste management unit.
	Chemical-Specific ARARs-State	
	Colorado Hazardous Waste Act	
6 CCR 1007-3 Part 264.94 Colorado Rules and Regulations Pertaining to Hazardous Waste-Ground Water Protection Standard	Establishes concentration levels for 14 chemicals in ground water.	The concentration limits are relevant and appropriate to ground water at the compliance boundary for ground water and treatment plant effluent.

Colorado Water Quality Control Act

5 CCR 1002-3 Regulation on Effluent Limitation	Establishes specific limitations on point source discharges of wastewaters into state waters and from specified industry sources, specifies sampling and analytical requirements.	Relevant and appropriate for discharge from treatment plant.
5 CCR 1003-1 Colorado Primary Drinking Water Regulations.	Establishes health-based standards for public water systems.	These regulations are relevant and appropriate because the shallow and deep ground water in the vicinity of the Lowry Site is being used or may be used in the future as a source of water for a public water system or private supply wells. Treated ground water from the treatment plant would be injected into the shallow ground-water system.
5 CCR 1002-8 Section 3.11.0 Colorado Basic Standards for Ground Water and Section 3.12.0 Classifications and Water Quality Standards for Ground Water	Establishes a system for classifying ground water and sets water quality standards for such classifications.	These regulations establish standards for both classified and unclassified ground water. The standards are applicable because ground water (within non-alluvial and alluvial aquifers) near the Lowry Site and ground water (within alluvial aquifers) within the Lowry Site have been classified for domestic and agricultural use-quality. Ground water would be treated to meet these standards and then discharged to the shallow ground-water system.
5 CCR 1002-8 Section 3.1.0 basic Standards and Methodologies for Surface Water	Establishes basic standards and a system for classifying surface waters of the State, assigning standards, and granting temporary variances for the standard.	Murphy Creek and the unnamed creek are classified and regulated as tributaries of the South Platte River Basin (Stream Segment 16). Segment 16 is classified as Recreation Class 2, Warm Water Aquatic Life Class 2, and statewide interim organic pollutant standards for aquatic life segments (Section 3.1.11 and Table C) are applicable to the remedy. If surface-water discharge results from injection of the treated water, surface water standards will be established based on the more stringent surface water ARAR.
5 CCR 1002-8 Section 3.2.0 Classifications and Numeric Standards	Used in conjunction with Basic Standards and Methodologies Section 3.1.0. South Platte River Standards (Section 3.8) establish numeric standards for the South Platte River Basin based on use classifications for stream segments.	Murphy Creek and the unnamed creek are classified and regulated tributaries of the South Platte River Basin (Stream Segment 16). Segment 16 is classified as Recreation Class 2, Warm Water Aquatic Life Class 2, and Agricultural Supply. Based on the regulations, numeric standards for protection of these three classified uses are applicable. Chemical-specific standards established for Stream Segment 16 are applicable to the remedy. If surface-water discharge results from injection of the treated water, surface water standards will be established based on the most stringent surface water ARAR.

Colorado Air Quality Act/Air Pollution Regulations

5 CCR 1001-3 Regulation No. 1	Establishes standards for emissions of particulates, smoke, carbon monoxide, and sulfur oxides.	These regulations are applicable because air emissions will occur at the ground-water treatment plant and due to construction activities. These regulations would be met for the air stripper/carbon polishing treatment process and during construction. Regulations for opacity and offsite transport of visible fugitive emissions are applicable and must be attained during construction activities resulting in disturbance of 5 acres or more in attainment areas or one acre in nonattainment areas. The Lowry Site is in an attainment area for sulfur oxides and lead and in a nonattainment area for PM 10, ozone, and carbon monoxide.
5 CCR 1001-4 Regulation No. 2	Sets limits on odorous air contaminants and particulates.	These regulations are applicable because air emissions will occur at the site during all activities. Activities regulated include activities such as soil movement or treatment plant air emissions. These regulations would be met for all activities including the air stripper/carbon polishing treatment process and movement of soil for construction of barrier walls.
5 CCR 1001-10 Regulation No. 8	Sets emission control requirements for hazardous air pollutants.	These regulations are applicable because air emissions occur at the treatment plant. These regulations would be met for the air stripper/carbon polishing treatment process. The lead standards are applicable because they are ambient standards that apply to all sources. The beryllium provisions set out emission limitations for stationary sources that are applicable for all sources. The hydrogen sulfide standards are applicable to any actions emitting hydrogen sulfide. The mercury standards are applicable if wastewater treatment plant sludge is dried or incinerated.
5 CCR 1001-14 Ambient Standards	Establishes ambient standards for SO2, TSP, NO2, CO, ozone, and PM 10.	These regulations are applicable because air emissions occur at the treatment plant. These regulations would be met because these parameters are not expected to be present. If these parameters are detected above the regulated levels, action will be taken to correct the problem.

Table 8-1
ARARs for OUs l&6

Citation	Description	Evaluation
	Action-Specific ARARs-Federal	
	Solid Waste Disposal Act-RCRA Subtitle C Regulations	
Massachusetts Allowable Ambient Levels (AALs) and Threshold Effects Exposure Limits (TELs)	Establishes health-based air standards.	TBCs. These standards were used to design the SWRA when considering air pollution controls for the water treatment plant. The plant will continue to meet these standards.
40 CFR Part 260-261 Identification and Listing of Hazardous Waste	Defines those solid wastes that are subject to regulation as hazardous wastes under 40 CFR Parts 262-265 and Parts 124, 270, 271.	The State of Colorado has an approved delegated program for this portion of RCRA. The regulations are applicable for purposes of determining whether any of the materials being treated or disposed are hazardous wastes. Materials may also be compared to the waste listings to determine whether any of the materials are sufficiently similar such that RCRA regulations are relevant and appropriate.
40 CFR Part 262 Standards Applicable to Generators of Hazardous Waste	Establishes standards for RCRA generators.	Because remediation activities will generate waste that will be sufficiently similar to RCRA hazardous waste such that use of this requirement is well suited to the situation, the requirement is relevant and appropriate to the ground-water treatment plant residuals, and waste generated during construction activities for the barrier walls. Therefore, waste generated must meet these standards which include testing per 40 CFR Part 261, temporary tanks or containers, inspection and leak detection, and accumulation time. The State of Colorado has an approved, delegated program under RCRA.
40 CFR Part 264 Subparts B, C, and D Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities	Establishes minimum standards that define the acceptable management of hazardous waste for owners and operators of facilities which treat, store, or dispose of hazardous waste.	Because remediation activities constitute treatment and storage activities (ground-water treatment plant and residuals management), and because the water to be treated is sufficiently similar to RCRA hazardous waste such that use of the requirement is well suited to the situation, the requirement is relevant and appropriate to the ground-water treatment component of the remedy (including residuals management). Thus, treatment of the ground water must meet these standards, which include waste analysis, site security, emergency control and response equipment, personnel training, contingency planning and implementation.

Table 8-1
ARARs for OUs 1&6

Citation	Description	Evaluation
	Action-Specific ARARs-Federal (continued)	
40 CFR Part 264 Subpart F	Sets ground-water protection standards for land disposal units.	The State of Colorado operates an approved delegated program for this portion of RCRA. See the requirements under Part 264.94 of the Colorado Hazardous Waste Act. Relevant and appropriate to ground water under the site because the landfill operates like a solid waste management unit. Therefore, ground-water programs must meet these standards, which include a monitoring and response program that includes detection monitoring to identify the presence of hazardous constituents in ground water; compliance monitoring to determine whether the agency-specified ground-water protection standard is being met at the identified compliance point; and corrective action that prevents hazardous constituents from exceeding the established concentration limits beyond the point of compliance.
40 CFR Part 264 Subpart G	Closure and post-closure care.	Because ground-water treatment constitutes treatment of a waste that is sufficiently similar to RCRA hazardous waste such that use of the requirement is well suited to the situation, the requirement is relevant and appropriate to the ground-water treatment component of the remedy. Therefore, closure and post-closure care for this treatment system must meet these standards which include removal of waste, waste residues, contaminated system components, and contaminated subsoils; or closure with wastes and/or contamination in place with containment systems and post-closure care to include ground-water monitoring and inspection and maintenance on containments and monitoring systems.
40 CFR Part 264 Subpart I	Sets operating and performance standards for container storage of hazardous waste.	Because ground-water treatment includes storage in containers of a waste that is sufficiently similar to RCRA hazardous waste such that use of the requirement is well suited to the situation, the requirement is relevant and appropriate to the ground-water treatment component of the remedy. Therefore, container storage at the ground-water treatment plant must meet these standards, which include maintaining wastes in containers that are in good condition and comparable with the wastes they contain, providing a containment system, managing ignitable and reactive wastes away from the property line, keeping incompatible wastes in separate containers and containment systems, and at closure removing all wastes and decontaminating structures and equipment.

40 CFR Part 264 Subpart J	Sets operating and performance standards for tank storage of hazardous waste.	Because ground-water treatment includes storage in tanks of a waste that is sufficiently similar to RCRA hazardous waste such that use of the requirement is well suited to the situation, the requirement is relevant and appropriate to the ground-water treatment component of the remedy. Therefore, tank storage at the ground-water treatment plant must meet the standards, which include secondary containment; spill and overflow controls; removal from service if there is a leak, spill, or the tank is unfit for use; and at closure have all wastes removed and also remove or decontaminate waste residues, containment systems, soils, structures, and equipment.
40 CFR 265.17	Sets standards for mixing and treatment of soils or the mixing and treatment of potentially incompatible, reactive, or ignitable hazardous wastes.	Because the ground-water treatment plant will mix and treat potentially incompatible, reactive, or ignitable wastes which may be similar to hazardous wastes, the requirement is relevant and appropriate to the ground-water treatment plant. Therefore, the wastes must be analyzed to determine compatibility, reactivity, and ignitability before treatment in the treatment plant.
40 CFR Part 268 Land Disposal Restrictions	Establishes prohibitions on land disposal unless treatment standards are met or a "no migration exemption" is granted.	Because residuals from the ground-water barrier walls construction and residuals from the ground-water treatment plant operations will be land disposed, the requirement is applicable. The materials must be tested to determine if they are a characteristic hazardous waste (per 40 CFR Part 262) and then must meet treatment requirements for land disposal as required in the standards if they are hazardous waste for which a treatment standard has been established. For land disposal of residuals, other than soils, which are not characteristic hazardous wastes, these requirements are relevant and appropriate because the residuals are sufficiently similar to listed hazardous waste such that use of the requirements is well suited to the situation.
	Federal Water Pollution Control Act (amended by the Clean Water Act)	
40 CFR Part 122 NPDES Stormwater Regulations	Establishes requirements for stormwater discharges related to industrial activity. Stormwater runoff, snow melt runoff, and surface runoff and drainage associated with industrial activity from remedial actions which discharge to surface waters shall be conducted in compliance with RCRA, FWQC, CWA technology based standards, Colorado surface water quality standards, monitoring requirements, and best management practices.	Because stormwater discharges will occur from any treatment process areas constructed (such as the ground-water treatment plant), this requirement is applicable to stormwater discharges. Therefore, stormwater discharges must meet these standards which include sampling, analysis and treatment requirements. Implementation and enforcement has been delegated to the State of Colorado, see the Colorado Water Quality Control Act.

40 CFR, Part 440 Effluent Guidelines and Standards for Ore Mining and Dressing Point Source Categories	Establishes radionuclide concentration limits for liquid effluents from facilities that extract and process uranium, radium, and vanadium ores.	Because the effluent from the ground-water treatment plant could have radionuclides sufficiently similar to those regulated such that the requirement is well suited to the situation, the requirement is relevant and appropriate to the ground-water treatment plant effluent. Therefore, contingencies have been made for the early detection of radionuclides and for a treatment process to be added to treat radionuclides at the ground-water treatment plant.
	Clean Air Act	
40 CFR 61 National Emission Standards for Hazardous Air Pollutants (NESHAPs)	Establishes emission standards for hazardous air pollutants from specific sources.	Because the ground-water treatment plant has an air stripper that is a source of air emissions, and this source is sufficiently similar to source types in the regulations such that use of the requirement is well suited to the situation, the requirement is relevant and appropriate to the ground-water treatment plant. Therefore, the air stripper must meet these standards which include treatment levels for arsenic, beryllium, benzene, vinyl chloride and radionuclide emissions.
40 CFR Parts 144-147 Underground Injection Control Regulations	Establishes standards for construction and operation of injection wells. Provides for protection of underground sources of drinking water.	Applicable to injection of water from treatment plant. The requirements include constructing, operating, and maintaining a well in a manner that does not result in contamination of an underground source of drinking water at levels that violate MCLs or otherwise affect the health of persons. These requirements will be met by ensuring the effluent from the ground-water treatment plant meets standards that are protective of human health (based on MCLs and risk-based concentrations).
	Action-Specific ARARs-State	
	Colorado Hazardous Waste Act	
6 CCR 1007-3 Part 260-261 Identification and Listing of Hazardous Waste	Defines solid wastes subject to hazardous waste regulations.	The State of Colorado has an approved delegated program for this portion of RCRA. Applicable to determining whether substances are hazardous wastes under RCRA.
6 CCR 1007-3 Part 262 Standards Applicable to Generators of Hazardous Waste	Establishes standards for RCRA generators.	Because remediation activities will generate waste that will be sufficiently similar to RCRA hazardous waste such that use of this requirement is well suited to the situation, the requirement is relevant and appropriate to the ground-water treatment plant residuals and waste generated during construction of the barrier walls. Therefore, waste generated must meet these standards which include testing per 40 CFR Part 261, temporary tanks or containers, inspection and leak detection, offsite shipping procedures, and accumulation time. The State of Colorado has an approved, delegated program under RCRA.

6 CCR 1007-3 Part 264 Subparts B, C, and D Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities	Establishes minimum standards that define the acceptable management of hazardous waste for owners and operators of facilities which treat, store, or dispose of hazardous waste.	Because remediation activities constitute treatment and storage activities (ground-water treatment plant and residuals management), and because the water to be treated is sufficiently similar to RCRA hazardous waste such that use of the requirement is well suited to the situation, the requirement is relevant and appropriate to the ground-water treatment component of the remedy (including residuals management). Thus, treatment of the ground water must meet these standards, which include waste analysis, site security, emergency control and response equipment, personnel training, contingency planning and implementation.
6 CCR 1007-3 Part 264 Subpart F	Sets ground-water protection standards for land disposal units.	The State of Colorado operates an approved delegated program for this portion of RCRA. See the requirements under Part 264.94 of the Colorado Hazardous Waste Act. Relevant and appropriate to ground water under the site because the landfill operates like a solid waste management unit. Therefore, ground-water programs must meet these standards, which include a monitoring and response program that includes detection monitoring to identify the presence of hazardous constituents in ground water; compliance monitoring to determine whether the agency-specified ground-water protection standard is being met at the identified compliance point; and corrective action that prevents hazardous constituents from exceeding the established concentration limits beyond the point of compliance.
6 CCR 1007-3 Part 264 Subpart G	Closure and post-closure care.	Because ground-water treatment constitutes treatment of waste that is sufficiently similar to RCRA hazardous waste such that use of the requirement is well suited to the situation, the requirement is relevant and appropriate to the ground-water treatment component of the remedy. Therefore, closure and post-closure care for these treatment systems must meet these standards which include removal of waste, waste residues, contaminated system components, and contaminated subsoils; or closure with wastes and/or contamination in place with containment systems and post-closure care to include ground-water monitoring and inspection and maintenance on containments and monitoring systems.

6 CCR 1007-3 Part 264 Subpart I	Sets operating and performance standards for container storage of hazardous waste.	Because ground-water treatment includes storage in containers of a waste that is sufficiently similar to RCRA hazardous waste such that use of the requirement is well suited to the situation, the requirement is relevant and appropriate to the ground-water treatment component of the remedy. Therefore, container storage at the ground-water treatment plant must meet these standards, which include maintaining wastes in containers that are in good condition and compatible with the wastes they contain, providing a containment system, managing ignitable and reactive wastes away from the property line, keeping incompatible wastes in separate containers and containment systems, and at closure removing all wastes and decontaminating structures and equipment.
6 CCR 1007-3 Part 264 Subpart J	Sets operating and performance standards for tank storage of hazardous waste.	Because ground-water treatment includes storage in tanks of a waste that is sufficiently similar to RCRA hazardous waste such that use of the requirement is well suited to the situation, the requirement is relevant and appropriate to the ground-water treatment component of the remedy. Therefore, tank storage at the ground-water treatment plant must meet these standards, which include secondary containment, spill and overflow controls, removal from service if there is a leak, spill, or the tank is unfit for use, and at closure have all wastes removed and also remove or decontaminate waste residues, containment system, soils, structures, and equipment.
6 CCR 1007-3 Part 265.17	Sets standards for mixing and treatment of contaminated soils or the mixing and treatment of potentially incompatible, reactive, or ignitable hazardous wastes.	Because the ground-water treatment plant will mix and treat potentially incompatible, reactive, or ignitable wastes which may be similar to hazardous wastes, the requirement is relevant and appropriate to the ground-water treatment plant. Therefore, the wastes must be analyzed to determine compatibility, reactivity, and ignitability before treatment in the treatment plant.
6 CCR 1007-3 Part 268 Land Disposal Restrictions	Establishes prohibitions on land disposal unless treatment standards are met or a "no migration exemption" is granted.	Because the construction residuals from the ground-water barrier walls will be land disposed, the requirement is applicable. The materials must be tested to determine if they are a characteristic hazardous waste (per 6 CCR 1007-3 Part 262) and then must meet treatment requirements for land disposal as required in the standards if they are hazardous waste for which a treatment standard has been established. For land disposal of residuals, other than soils which are not characteristic hazardous wastes, these requirements are relevant and appropriate because the residuals are sufficiently similar to listed hazardous waste such that use of the requirements is well suited to the situation.

	Colorado Air Quality Act/Air Pollution Regulations	
5 CCR 1001-5 Regulation No. 3	Requires filing of Air Pollution Emission Notice (APEN) including estimation of emission rates.	These regulations are applicable because air emissions will occur at the treatment plant. The air stripper/carbon polishing treatment process must meet any substantive provisions of these requirements.
5 CCR 1001-8 Regulation No. 6	Establishes standards for new stationary sources including incinerators. Sets discharge and performance rates and opacity requirements.	These regulations are applicable because air emissions will occur at the treatment plant. The air stripper/carbon polishing treatment process must meet these requirements which include discharge and performance rates and opacity requirements.
5 CCR 1001-9 Section II.C.2, Section V Regulation No. 7	Establishes standards for disposal or spillage of VOCs.	These regulations are applicable because air emissions will occur at the treatment plant. The air stripper/carbon polishing treatment process must meet these requirements which include controls representing reasonably available control technology (RACT).
	Colorado Noise Abatement Statute	
Colorado Revised Statute Section 25-12-103	Provides limits for noise based on time periods and zones.	Applicable for all construction activities associated with the remedy.
	Water Well Pump Installation Contractors Act	
2 CCR 402-4	Establishes standards for installation of water wells and pumping equipment.	Applicable because wells will be installed.
	Well Construction/Abandonment Requirements	
2 CCR 402-2 State of Colorado Division of Water Resources, 1988, as revised-Colorado State Engineers Office	Well construction/abandonment requirements	Applicable for new wells and abandonment of existing wells. Additional requirements may be added to ensure that a migration pathway is not created.
	Location-Specific ARARs-Federal	
	Federal Water Pollution Control Act (Clean Water Act)	
40 CFR Part 230	Discharge of dredged or fill material into wetlands prohibited without a permit.	For areas of the site that have designated wetlands, a permit will not be required pursuant to Section 121(c) of CERCLA, but the substantive requirements of Part 230 will be applicable if wetlands that have been identified at the Lowry Site are dredged or filled during implementation of the remedial activity.

5 CCR 1002-18	Discharge of dredge and fill material into wetlands prohibited without a State certification.	For areas of the site that have designated wetlands, a permit will not be required pursuant to Section 121 (c) of CERCLA, but the substantive requirements will be applicable if wetlands that have been identified at the Lowry Site are dredged or filled during implementation of the remedial activity.

Table 8-2
ARARs for OUs 2&3

Citation	Description	Evaluation
	Chemical-Specific ARARs-State	
	Colorado Air Quality Act/Air Pollution Regulations	
5 CCR 1001-3 Regulation No. 1	Establishes standards for emissions of particulates, smoke, carbon monoxide, and sulfur oxides.	These regulations are applicable because air emissions will occur at the gas treatment system and due to construction activities. These regulations would be met for the gas flaring system and during construction. Regulations for opacity and offsite transport of visible fugitive emissions are applicable and must be attained during construction activities resulting in disturbance of 5 acres or more in attainment areas or one acre in nonattainment areas. The Lowry Site is in an attainment area for sulfur oxides and lead and in a nonattainment area for PM 10, ozone, and carbon monoxide.
5 CCR 1001-4 Regulation No. 2	Sets limits on odorous air contaminants and particulates.	These regulations are applicable because air emissions will occur at the site during all activities. Activities regulated include activities such as soil movement. These regulations would be met for all activities including the excavation of soil in the former tire pile area, and movement of soil for construction of the gas collection and treatment system.
5 CCR 1001-10 Regulation No. 8	Sets emission control requirements for hazardous air pollutants.	These regulations are applicable because air emissions will occur at the gas treatment system. These regulations would be met for the gas flare. The lead standards are applicable because they are ambient standards that apply to all sources. The beryllium provisions set out emission limitations for stationary sources that are applicable for all sources. The hydrogen sulfide standards are applicable to any actions emitting hydrogen sulfide. The mercury standards are applicable if wastewater treatment plant sludge is dried or incinerated.
	Action-Specific ARARs-Federal	
	Solid Waste Disposal Act-RCRA Subtitle D Requirements	
40 CFR Part 241 Guidelines for the Land Disposal of Solid Wastes	Establishes minimum levels of performance required of any solid waste land disposal site operation. Part 241.205-2(b) states "decomposition gases should not be allowed to concentrate in a manner that will pose an explosion or toxicity hazard."	Because the Lowry Site is a landfill and because decomposition gases have been detected, this requirement is well suited to the situation and is relevant and appropriate to the gas collection and treatment system. Therefore, the gas collection and treatment must meet these standards, which include maintaining methane below explosive limits.

40 CFR Part 257 Criteria for Classification of Solid Waste Disposal Facilities & Practices	Establishes criteria for use in determining which solid waste disposal facilities and practices pose a reasonable probability of adverse effects on health or the environment and thereby constitute prohibited open dumps.	Applicable for existing MSW landfills. The Section 6 MSW landfill is a closed landfill. Landfill cover requirements are relevant and appropriate.
40 CFR Part 258 Regulations Concerning Municipal Solid Waste Landfills	Establishes design and operational criteria for all new municipal solid waste landfills or expansions of existing facilities. The requirements vary depending on the time frame that the land disposal unit is used. Includes closure and post closure care. ! If the landfill stopped receiving waste prior to 10/9/91 it is not regulated ! If the landfill stopped receiving waste prior to 10/9/93 the facility must comply with final cover requirements. ! If the landfill receives waste on or after 10/9/93 the facility must comply with all requirements of 40 CFR 258	Explosive gas requirements (Part 258.23) are relevant and appropriate since waste was not received after October 9, 1993, but the use of the requirement is well suited to the situation. Therefore, methane monitoring within onsite structures and at the facility property boundary is required. Landfill cover requirements are relevant and appropriate since waste was not received after October 9, 1991, but the use of the requirement is well suited to the situation. Therefore, landfill cover maintenance is required.
	Solid Waste Disposal Act-RCRA Subtitle C Regulations	
40 CFR Part 260-261 Identification and Listing of Hazardous Waste	Defines those solid wastes that are subject to regulation as hazardous wastes under 40 CFR Parts 262-265 and Parts 124, 270, 271.	The State of Colorado has an approved delegated program for this portion of RCRA. The regulations are applicable for purposes of determining whether any of the materials being treated or disposed are hazardous wastes. Materials may also be compared to the waste listings to determine whether any of the materials are sufficiently similar such that RCRA regulations are relevant and appropriate.
40 CFR Part 262 Standards Applicable to Generators of Hazardous Waste	Establishes standards for RCRA generators.	Because remediation activities will generate waste that will be sufficiently similar to RCRA hazardous waste such that use of this requirement is well suited to the situation, the requirement is relevant and appropriate to solids excavated from the former tire pile area, gas that is collected and treated, and waste generated during construction activities for the gas extraction system. Therefore, waste generated must meet these standards which include testing per 40 CFR Part 261, temporary tanks or containers, inspection and leak detection, and accumulation time. The State of Colorado has an approved, delegated program under RCRA.

40 CFR Part 264 Subparts B, C, and D Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities	Establishes minimum standards that define the acceptable management of hazardous waste for owners and operators of facilities which treat, store, or dispose of hazardous waste.	Because remediation activities constitute treatment and storage activities (gas treatment and residuals management) and because the gas to be treated is sufficiently similar to RCRA hazardous waste such that use of the requirement is well suited to the situation, the requirement is relevant and appropriate to the gas treatment component of the remedy (including residuals management). Thus, flaring of the gas must meet these standards, which include waste analysis, site security, emergency control and response equipment, personnel training, contingency planning and implementation.
40 CFR Part 264 Subpart G	Closure and post-closure care.	Because gas treatment constitutes treatment of a waste that is sufficiently similar to RCRA hazardous waste such that use of the requirement is well suited to the situation, the requirement is relevant and appropriate to the gas treatment components of the remedy. Therefore, closure and post-closure care for this treatment system must meet these standards which include removal of waste, waste residues, contaminated system components, and contaminated subsoils; or closure with wastes and/or contamination in place with containment systems and post-closure care to include ground-water monitoring and inspection and maintenance on containments and monitoring systems.
40 CFR Part 264 Subpart O	Sets standards for destruction and removal efficiency, HCl emissions, and particulate emissions from incinerators or thermal treatment.	Because gas treatment constitutes thermal treatment, and because the gas to be treated is sufficiently similar to RCRA hazardous waste such that use of the requirement is well suited to the situation, the requirement is relevant and appropriate to the gas flaring component of the remedy. Thus, flaring of the gas must meet these standards, which include emissions standards and operating constraints as needed to ensure emissions standards are met.
40 CFR Part 264 Subpart AA	Sets operation and performance standards for air emissions from process vents.	Because the gas treatment has process vents from thermal treatment and because the gas to be treated is sufficiently similar to RCRA hazardous waste such that the use of the requirement is well suited to the situation, the requirement is relevant and appropriate to the gas flaring component of the remedy. Thus, the gas treatment system must meet these standards, which include standards for process vents and test methods and procedures.
40 CFR 265 Subpart P Interim Standards for Owners and Operators Hazardous Waste Treatment, Storage, and Disposal Facilities	Standards for thermal treatment.	Because gas flaring constitutes thermal treatment and because the gas to be treated is sufficiently similar to RCRA hazardous waste such that use of the requirement is well suited to the situation, the requirement is relevant and appropriate to the gas treatment component of the remedy. Therefore, the gas treatment system must meet the standards, which include general operating requirements, waste analysis, monitoring and inspection, and closure.

40 CFR Part 265 Subpart AA	Sets operating and performance standards for air emissions from process vents.	Because the gas treatment has process vents from thermal treatment and because the gas to be treated is sufficiently similar to RCRA hazardous waste such that the use of the requirement is well suited to the situation, the requirement is relevant and appropriate to the gas flaring component of the remedy. Thus, the gas treatment system must meet these standards, which include standards for process vents and test methods and procedures.
40 CFR Part 268 Land Disposal Restrictions	Establishes prohibitions on land disposal unless treatment standards are met or a "no migration exception" is granted.	Because the solids excavation in the former tire pile area and residuals from the gas extraction system construction and residuals from the gas extraction system operations will be land disposed, the requirement is applicable. The materials must be tested to determine if they are a characteristic hazardous waste (per 40 CFR Part 262) and then must meet treatment requirements for land disposal as required in the standards if they are hazardous waste for which a treatment standard has been established. For land disposal of residuals, other than soils, which are not characteristic hazardous wastes, these requirements are relevant and appropriate because the residuals are sufficiently similar to listed hazardous waste such that use of the requirements is well suited to the situation.
58 FR 48091 (9/14/93) 40 CFR Part 268 Universal Treatment Standards	Establishes a concentration limit for over 200 regulated constituents in soil regardless of waste type, which must be met before land disposal.	TBC for soil and sediments because it is a proposed regulation. Excavated soils from the tire pile area must meet these requirements.
	Federal Water Pollution Control Act (amended by the Clean Water Act)	
40 CFR Part 122 NPDES Stormwater Regulations	Establishes requirements for stormwater discharges related to industrial activity. Stormwater runoff, snow melt runoff, and surface runoff and drainage associated with industrial activity from remedial actions which discharge to surface waters shall be conducted in compliance with RCRA, FWQC, CWA technology-based standards, Colorado surface water quality standards, monitoring requirements, and best management practices.	Because stormwater discharges will occur from the landfill and from any treatment process areas constructed (such as the gas treatment system), this requirement is applicable to stormwater discharges. Therefore, stormwater discharges must meet these standards which include sampling, analysis, and treatment requirements. Implementation and enforcement has been delegated to the State of Colorado, see Colorado Water Quality Control Act.
	Clean Air Act	
40 CFR Part 60 New Source Performance Standards	Establishes performance standards for new stationary sources of air pollutants.	Relevant and appropriate for gas treatment. Proposed NSPS for municipal solid waste facilities (Subpart WWW) is a TBC (56 FR 24468 [5/30/91]).

40 CFR Part. 61 National Emission Standards for Hazardous Air Pollutants (NESHAPs)	Establishes emission standards for hazardous air pollution from specific sources.	Because the gas treatment system will have a flare, this source is sufficiently similar to source types in the regulations such that use of the requirement is well suited to the situation, the requirement is relevant and appropriate to the gas treatment system. Therefore, the gas flare must meet these standards which include treatment levels for arsenic, beryllium, benzene, vinyl chloride and radionuclide emissions.

Action-Specific ARARs-State

Colorado Solid Wastes Disposal sites and Facilities Act

6 CCR 1007-2 Section 1 Regulations Pertaining to Solids Waste Disposal Sites and Facilities relevant and	Establishes standards for new solid waste disposal facilities and defines those solid wastes.	Explosive gas requirements and landfill cover requirements are relevant and appropriate because waste was not received after October 9, 1993, but the use of the requirement is well suited to the situation so the requirement is appropriate to the existing landfill mass. Therefore, the gas concentrations need to be maintained below the explosive limits and maintenance of the landfill cover is required.
6 CCR 1007-2 Section 2.3	Establishes minimum standards for landfill gas collection and treatment systems.	These requirements are applicable for the landfill gas collection and treatment system and include monitoring requirements in structures and at the landfill boundary, notification of gas excursions, and remediation activities if explosive gas limits are exceeded.
6 CCR 1007-2 Sections 2.6 and 3.6	Post closure maintenance and care.	Substantive requirements are applicable to the gas extraction system and landfill cover. Requirements include maintaining the cover for 30 years, ground-water monitoring, describing uses of land during post closure care, and certification at the completion of post closure care.

Colorado Hazardous Waste Act

6 CCR 1007-3 Part 260-261 Identification and Listing of Hazardous Waste	Defines those solid wastes subject to hazardous waste regulations.	The State of Colorado has an approved delegated program for this portion of RCRA. Applicable to determining whether substances are hazardous wastes under RCRA.
6 CCR 1007-3 Part 262 Standards Applicable to Generators of Hazardous Waste	Establishes standards for RCRA generators.	Because remediation activities will generate waste that will be sufficiently similar to RCRA hazardous waste such that use of this requirement is well suited to the situation, the requirement is relevant and appropriate to the solids excavated from the former tire pile area, gas that is treated, and waste generated during construction of the gas extraction system. Therefore, waste generated must meet these standards which include testing per 40 CFR Part 261, temporary tanks or containers, inspection and leak detection,

		offsite shipping procedures, and accumulation time. The State of Colorado has an approved, delegated program under RCRA.
6 CCR 1007-3 Part 264 Subparts B, C, and D Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities	Establishes minimum standards that define the acceptable management of hazardous waste for owners and operators of facilities which treat, store, or dispose of hazardous waste.	Because remediation activities constitute treatment and storage activities (gas treatment and residuals management), and because the gas to be treated is sufficiently similar to RCRA hazardous waste such that use of this requirement is well suited to the situation, the requirement is relevant and appropriate to the gas treatment components of the remedy (including residuals management). Thus, flaring of the gas must meet these standards, which include waste analysis, site security, emergency control and response equipment, personnel training, contingency planning and implementation.
6 CCR 1007-3 Part 264 Subpart G	Closure and post-closure care.	Because gas treatment constitutes treatment of a waste that is sufficiently similar to RCRA hazardous waste such that use of the requirement is well suited to the situation, the requirement is relevant and appropriate to the gas treatment components of the remedy. Therefore, closure and post-closure care for this treatment system must meet these standards which include removal of waste, waste residues, contaminated system components, and contaminated sub-soils; or closure with wastes and/or contamination in place with containment systems and post-closure care to include ground-water monitoring and inspection and maintenance on containments and monitoring systems.
6 CCR 1007-3 Part 264 Subpart O Standards for Owners and Operators of Hazardous Waste TSD Facilities	Sets standards for destruction and removal efficiency HCl emissions and particulate matter in excess of the stated standard.	Because gas treatment constitutes thermal treatment, and because the gas to be treated is sufficiently similar to RCRA hazardous waste such that use of the requirement is well suited to the situation, the requirement is relevant and appropriate to the gas flaring component of the remedy. Thus, flaring of the gas must meet these standards, which include standards for process vents and test methods and procedures.
6 CCR 1007-3 Part 264 Subpart AA	Sets operating and performance standards for air emissions from process vents.	Because the gas treatment has process vents from thermal treatment and because the gas to be treated is sufficiently similar to RCRA hazardous waste such that the use of the requirement is well suited to the situation, the requirement is relevant and appropriate to the gas flaring component of the remedy. Thus, the gas treatment system must meet these standards, which include general operating requirements, waste analysis, monitoring and inspections, and closure.
6 CCR 1007-3 Part 265 Subpart P	Standards for thermal treatment.	Because gas flaring constitutes thermal treatment and because the gas to be treated is sufficiently similar to RCRA hazardous waste such that use of the requirement is well

		suited to the situation, the requirement is relevant and appropriate to the gas treatment component of the remedy. Therefore, the gas treatment system must meet these standards, which include standards for process vents and test methods and procedures.
6 CCR 1007-3 Part 265 Subpart AA	Sets operation and performance standards for air emissions from process vents.	Because the gas treatment has process vents from thermal treatment and because the gas to be treated is sufficiently similar to RCRA hazardous waste such that the use of the requirement is well suited to the situation, the requirement is relevant and appropriate to the gas flaring component of the remedy. Thus, the gas treatment system must meet these standards, which include general operating requirements, waste analysis, monitoring and inspections, and closure.
6 CCR 1007-3 Part 268 Land Disposal Restrictions	Establishes prohibitions on land disposal unless treatment standards are met or a "no migration exemption" is granted.	Because the solids excavation in the former tire pile area and construction residuals from the ground-water barrier walls and gas extraction system will be land disposed, the requirement is applicable. The materials must be tested to determine if they are a characteristic hazardous waste (per 6 CCR 1007-3 Part 262) and then must meet treatment requirements for land disposal as required in the standards if they are hazardous waste for which treatment standard has been established. For land disposal of residuals, other than soils, which are not characteristic hazardous wastes, these requirements are relevant and appropriate because the residuals are sufficiently similar to listed hazardous waste such that use of the requirements is well suited to the situation.
	Colorado Air Quality Act/Air Pollution Regulations	
5 CCR 1001-5 Regulation No. 3	Requires filing of Air Pollution Emission Notice (APEN) including estimation of emission rates.	These regulations are applicable because air emissions will occur at the gas treatment system. The gas flaring process must meet any substantive provisions of these requirements.
5 CCR 1001-8 Regulation No. 6	Establishes standards for new stationary sources including incinerators. Sets discharge and performance rates and opacity requirements.	These regulations are applicable because air emissions will occur at the gas treatment system. The gas flaring process must meet these requirements which include discharge and performance rates and opacity requirements.
5 CCR 1001-9 Section II.C.2, Section V Regulation No. 7	Establishes standards for disposal or spillage of VOCs.	These regulations are applicable because air emissions will occur at the gas treatment system. The gas flaring process must meet the requirements which include controls representing reasonably available control technology (RACT).

	Colorado Noise Abatement Statute	
Colorado Revised Statute Section 25-12-103	Provides limits for noise based on time periods and zones.	Applicable for all construction activities associated with the remedy.
	Water Well Pump Installation Contractors Act	
2 CCR 402-4	Establishes standards for installation of water wells and pumping equipment.	Applicable because wells will be installed.
	Well Construction/Abandonment Requirements	
2 CCR 402-2 State of Colorado Division of Water Resources, 1988, as revised-Colorado State Engineers Office	Well construction/abandonment requirements	Applicable for new wells and abandonment of existing wells. Additional requirements may be added to ensure that a migration pathway is not created.
	Location-Specific ARARs-Federal	
	Federal Water Pollution Control Act (Clean Water Act)	
40 CFR Part 230	Discharge of dredged or fill material into wetlands prohibited without a permit.	For areas of the site that have designated wetlands, a permit will not be required pursuant to Section 121(c) of CERCLA, but the substantive requirements of Part 230 will be applicable if wetlands that have been identified at the Lowry Site are dredged or filled during implementation of the remedial activity.
	Location-Specific ARARs-State	
	Certification of Federal Licenses and Permits	
5 CCR 1002-18	Discharge of dredged or fill material into wetlands prohibited without a State certification.	For areas of the site that have designated wetlands, a permit will not be required pursuant to Section 121 (c) of CERCLA, but the substantive requirements of Part 230 will be applicable if wetlands that have been identified at the Lowry Site are dredged or filled during implementation of the remedial activity.

Table 8-3
ARARs for OUs 4&5

Citation	Description	Evaluation
	Chemical-Specific ARARs-Federal	
	Safe Drinking Water Act	
40 CFR Part 141 Subpart B	Establishes health-based standards for public drinking water systems (MCLs).	These regulations are relevant and appropriate because the shallow and deep ground water in the vicinity of the Lowry Site is being used or may be used in the future as a source of water for a public water system or private supply wells. Treated ground water from the treatment plant would be injected into the shallow ground-water system. The are pertinent to treatment plant effluent at the point of injection as well as within the ground water at the compliance boundary.
40 CFR Part 141 Subpart F	Establishes drinking water quality goals set at levels of no known or anticipated adverse health effects, with an adequate margin of safety (MCLGs).	Non-zero MCLGs are relevant and appropriate since shallow and deep ground water in the vicinity of the Lowry Site is being used or may be used as a source of water for a public water system or private supply wells.
	Federal Water Pollution Control Act (amended by the Clean Water Act)	
40 CFR Part 129 Toxic Pollutant Effluent Standards	Establishes toxic pollutant effluent standards for six groups of toxic pollutants from manufacturers, formulators, and applicators who develop or use these compounds and discharge to navigable waters.	Relevant and appropriate for treatment plant effluent because compound groups were detected in waste pit liquids and unnamed creek and Murphy Creek discharges to the South Platte River, which is a navigable water.
	Chemical-Specific ARARs-State	
	Colorado Hazardous Waste Act	
6 CCR 1007-3 Part 264.94 Colorado Rules and Regulations Pertaining to Hazardous Waste-Ground Water Protection Standard	Establishes concentration levels for 14 chemicals in ground water.	The concentration limits are relevant and appropriate to treatment plant effluent.
	Colorado Water Quality Control Act	
5 CCR 1002-3 Regulation on Effluent Limitation	Establishes specific limit on point source discharges of wastewaters into state waters and from specified industry sources, specifies sampling and analytical requirements.	Relevant and appropriate for discharge from treatment plant.

5 CCR 1003-1 Colorado Primary Drinking Water Regulation	Establishes health-based standards for public drinking water systems.	These regulations are relevant and appropriate because the shallow and deep ground water in the vicinity of the Lowry Site is being used or may be used in the future as a source of water for a public water system or private supply wells. Treated ground water from the treatment plant would be injected into the shallow ground-water system.
5 CCR 1002-8 Section 3.11.0 Colorado Basic Standards for Ground Water and Section 3.12.0 Classifications and Water Quality Standards for Ground Water	Establishes a system for classifying ground water and sets water quality standards for such classifications.	These regulations establish standards for both classified and unclassified ground water. The standards are applicable because ground water (within non-alluvial and alluvial aquifers) near the Lowry Site and ground water (within alluvial aquifers) within the Lowry Site have been classified for domestic and agricultural use-quality. Ground water would be treated to meet these standards and then discharged to the shallow ground-water system.
5 CCR 1002-8 Section 3.1.0 Basic Standards and Methodologies for Surface Water	Establishes basic standards and a system for classifying surface waters of the State, assigning standards, and granting temporary variances for the standard.	Murphy Creek and the unnamed creek are classified and regulated as tributaries of the South Platte River Basin (Stream Segment 16). Segment 16 is classified as Recreation Class 2, Warm Water Aquatic Life Class 2, and Agricultural Supply. Because of this classification, statewide interim organic pollutant standards for aquatic life segments (Section 3.1.11 and Table C) are applicable to the remedy. If surface-water discharge results from injection of the treated water, surface water standards will be established based on the most stringent surface water ARAR.
5 CCR 1002-8 Section 3.2.0 Classifications and Numeric Standards	Used in conjunction with Basic Standards and Methodologies Section 3.1.0. South Platte River Standards (Section 3.8) establish numeric standards for the South Platte River Basin based on use classifications for stream segments.	Murphy Creek and the unnamed creek are classified and regulated as tributaries of the South Platte River Rasin (Stream Segment 16). Segment 16 is classified as Recreation Class 2, Warm Water Aquatic Life Class 2, and Agricultural Supply. Based on the regulations, numeric standards for protection of these three classified uses are applicable. Chemical-specific standards established for Stream Segment 16 are applicable to the remedy. If surface-water discharge results from injection of the treated water, surface water standards will be established based on the most stringent surface water ARAR.
	Colorado Air Quality Act/Air Pollution Regulations	
5 CCR 1001-3 Regulation No. 1	Establishes standards for emissions of particulates, smoke, carbon monoxide, and sulfur oxides.	These regulations are applicable because air emissions will occur at the ground-water treatment plant. These regulations would be met for the air stripper/carbon polishing treatment process. Regulations for opacity and offsite transport of visible fugitive emissions are applicable and must be attained during construction activities resulting in disturbance of 5 acres or more in attainment areas or one acre in nonattainment areas. The Lowry Site is in an attainment area for sulfur oxides and lead and in a nonattainment area for PM 10, ozone, and carbon monoxide.

5 CCR 1001-4 Regulation No. 2	Sets limits on odorous air contaminants and particulates.	These regulations are applicable because air emissions will occur at the site during all activities. Activities regulated include activities such as treatment plant air emissions. These regulations would be met for all activities including the air stripper/carbon polishing treatment process.
5 CCR 1001-10 Regulation No. 8	Sets emission control requirements for hazardous air pollutants.	These regulations are applicable because air emissions occur at the treatment plant. These regulations would be met for the air stripper/carbon polishing treatment process. The lead standards are applicable because they are ambient standards that apply to all sources. The beryllium provisions set out emission limitations for stationary sources that are applicable for all sources. The hydrogen sulfide standards are applicable to any actions emitting hydrogen sulfide. The mercury standards are applicable if wastewater from treatment plant sludge is dried or incinerated.
5 CCR 1001-14 Ambient Standards	Establishes ambient standards for SO2, TSP, NO2, CO, ozone, and PM 10.	These regulations are applicable because air emissions occur at the treatment plant. These regulations would be met because these parameters are not expected to be present. If these parameters are detected above the regulated levels, action will be taken to correct the problem.
Massachusetts Allowable Ambient Levels (AALs) and Threshold Effects Exposure Limits (TELs)	Establishes health-based air standards.	TBCs. These standards were used to design the SWRA when considering air pollution controls for the water treatment plant. The plant will continue to meet these standards.

Action-Specific ARARs-Federal

Solid Waste Disposal Act-RCRA Subtitle C Regulations

40 CFR Part 260-261 Identification and Listing of Hazardous Waste	Defines those solid wastes that are subject to regulation as hazardous wastes under 40 CFR Parts 262-265 and Parts 124, 270, 271.	The State of Colorado has an approved delegated program for this portion of RCRA. The regulations are applicable for purposes of determining whether any of the materials being treated or disposed are hazardous wastes. Materials may also be compared to the waste listings to determine whether any of the materials are sufficiently similar such that RCRA regulations are relevant and appropriate.
40 CFR Part 262 Standards Applicable to Generators of Hazardous Waste	Establishes standards for RCRA generators.	Because remediation activities will generate waste that will be sufficiently similar to RCRA hazardous waste such that use of this requirement is well suited to the situation, the requirement is relevant and appropriate to the ground-water treatment plant residuals. Therefore, waste generated must meet these standards which include testing per 40 CFR Part 261, temporary tanks or containers, inspection and leak detection, and accumulation time. The State of Colorado has an approved, delegated program under RCRA.

40 CFR Part 264 Subparts B, C, and D Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities	Establishes minimum standards that define acceptable management of hazardous waste for owners and operators of facilities which treat, store, or dispose of hazardous waste.	Because remediation activities constitute treatment and storage activities (ground-water treatment plant and residuals management), and because the water to be treated is sufficiently similar to RCRA hazardous waste such that use of this requirement is well suited to the situation, the requirement is relevant and appropriate to the ground-water treatment component of the remedy (including residuals management). Thus, treatment of the groundwater must meet these standards, which include waste analysis, site security, emergency control and response equipment, personnel training, contingency planning and implementation.
40 CFR Part 264 Subpart G	Closure and post-closure care.	Because ground-water treatment constitutes treatment of a waste that is sufficiently similar to RCRA hazardous waste such that use of the requirement is well suited to the situation, the requirement is relevant and appropriate to the ground-water treatment component of the remedy. Therefore, closure and post-closure care for this treatment system must meet these standards which include removal of waste, waste residues, contaminated system components, and contaminated subsoils; or closure with wastes and/or contamination in place with containment systems and post-closure care to include ground-water monitoring and installation and maintenance on containments and monitoring systems.
40 CFR Part 264 Subpart I	Sets operating and performance standards for container storage of hazardous waste.	Because ground-water treatment includes storage in containers of a waste that is sufficiently similar to RCRA hazardous waste such that use of the requirement is well suited to the situation, the requirement is relevant and appropriate to the ground-water treatment component of the remedy. Therefore, container storage at the ground-water treatment plant must meet these standards, which include maintaining wastes in containers that are in good condition and compatible with the wastes they contain, providing a containment system, managing ignitable and reactive wastes away from the property line, keeping incompatible wastes in separate containers and containment systems, and at closure removing all wastes and decontaminating structures and equipment.
40 CFR Part 264 Subpart J	Sets operating and performance standards for tank storage of hazardous waste.	Because ground-water treatment includes storage in tanks of a waste that is sufficiently similar to RCRA hazardous waste such that use of the requirement is well suited to the situation, the requirement is relevant and appropriate to the ground-water treatment component of the remedy. Therefore, tank storage at the ground-water treatment plant must meet the standards, which include secondary containment; spill and overflow controls; removal from service if there is a leak, spill, or the tank is unfit for use; and at closure have all wastes removed and also remove or decontaminate waste

		residues, containment systems, soils, structures, and equipment.
40 CFR 265.17	Sets standards for mixing and treatment of contaminated soils or the mixing and treatment of potentially incompatible, reactive, or ignitable hazardous wastes.	Because the ground-water treatment plant will mix and treat potentially incompatible, reactive, or ignitable wastes which may be similar to hazardous wastes, the requirement is relevant and appropriate to the ground-water treatment plant. Therefore, the wastes must be analyzed to determine compatibility, reactivity, and ignitability before treatment in the treatment plant.
40 CFR Part 268 Land Disposal Restrictions	Establishes prohibitions on land disposal unless treatment standards are met or a "no migration exemption" is granted.	Because the residuals from the ground-water treatment plant operations will be land disposed, the requirement is applicable. The materials must be tested to determine if they are a characteristic hazardous waste (per 40 CFR Part 262) and then must meet treatment requirements for land disposal as required in the standards if they are hazardous waste for which a treatment standard has been established. For land disposal of residuals, other than soils, which are not characteristic hazardous wastes, these requirements are relevant and appropriate because the residuals are sufficiently similar to listed hazardous waste such that use of the requirement is well suited to the situation.
	Federal Water Pollution Control Act (amended by the Clean Water Act)	
40 CFR, Part 230/231 Guidelines for Specification of Disposal Sites for Dredged or Fill Materials	The discharge of dredged or fill material into the waters of the U.S. is prohibited without a permit.	Wetlands were destroyed during construction of the SWRA and must be mitigated during implementation of the selected remedy by constructing new wetlands.
40 CFR, Part 440 Effluent Guidelines and Standards for Ore Mining and Dressing Point Source Categories	Establishes radionuclide concentration limits for liquid effluents from facilities that extract and process uranium, radium, and vanadium ores.	Because the effluent from the ground-water treatment plant could have radionuclides sufficiently similar to those regulated such that the requirement is well suited to the situation, the requirement is relevant and appropriate to the ground-water treatment plant effluent. Therefore, contingencies have been made for the early detection of radionuclides and for a treatment process to be added to treat radionuclides at the ground-water treatment plant.
	Clean Air Act	
40 CFR Part 61 National Emission Standards for Hazardous Air Pollutants (NESHAPs)	Establishes emission standards for hazardous air pollutants from specific sources.	Because the ground-water treatment plant has an air stripper that is a source of air emissions, and this source is sufficiently similar to source types in the regulations such that use of the requirement is well suited to the situation, the requirement is relevant and appropriate to the ground-water treatment plant. Therefore, the air stripper must meet these standards which include treatment levels for arsenic,

		beryllium, benzene, vinyl chloride and radionuclide emissions.

Safe Drinking Water Act

40 CFR Part 144-147 Underground Injection Control Regulations	Establishes standards for construction and operation of injection wells. Provides for protection of underground source of drinking water.	Applicable to injection of water from treatment plant. The requirements include constructing, operating, and maintaining a well in a manner that does not result in contamination of an underground source of drinking water at levels that violate MCLs or otherwise affect the health of persons. These requirements will be met by ensuring the effluent from the groundwater treatment plant meets standards that are protective of human health (based on MCLs and risk-based concentrations).

Action-Specific ARARs-State

Colorado Hazardous Waste Act

6 CCR 1007-3 Part 260-261 Identification and Listing of Hazardous Waste	Defines those solid wastes subject to hazardous waste regulations.	The State of Colorado has an approved delegated program for this portion of RCRA. Applicable to determining whether substances are hazardous wastes under RCRA.
6 CCR 1007-3 Part 262 Standards Applicable to Generators of Hazardous Waste	Establishes standards for RCRA generators.	Because remediation will generate waste that will be sufficiently similar to RCRA hazardous waste such that use of this requirement is well suited to the situation, the requirement is relevant and appropriate to the ground-water treatment plant residuals. Therefore, waste generated must meet these standards which include testing per 40 CFR Part 261, temporary tanks or containers, inspection and leak detection, offsite shipping procedures, and accumulation time. The State of Colorado has an approved, delegated program under RCRA.
6 CCR 1007-3 Part 264 Subparts B, C, and D Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities	Establishes minimum standards that define the acceptable management of hazardous waste for owners and operators of facilities which treat, store, or dispose of hazardous waste.	Because remediation activities constitute treatment and storage activities (ground-water treatment plant and residuals management), and because the water to be treated is sufficiently similar to RCRA hazardous waste such that use of the requirement is well suited to the situation, the requirement is relevant and appropriate to the ground-water treatment component of the remedy (including residuals management). Thus, treatment of the groundwater must meet these standards, which include waste analysis, site security, emergency control and response equipment, personnel training, contingency planning and implementation.
6 CCR 1007-3 Part 264 Subpart G	Closure and post-closure care.	Because ground-water treatment constitutes treatment of a waste that is sufficiently similar to RCRA hazardous waste such that use of the requirement is well suited to the

		situation, the requirement is relevant and appropriate to the ground-water treatment component of the remedy. Therefore, closure and post-closure care for this treatment system must meet these standards which include removal of waste, waste residues, contaminated system components, and contaminated subsoils; or closure with wastes and/or contamination in place with containment systems and post-closure care to include ground-water monitoring and inspection and maintenance on containments and monitoring systems.
6 CCR 1007-3 Part 264 -' Subpart I	Sets operating and performance standards for container storage of hazardous wastes.	Because ground-water treatment includes storage in containers of a waste that is sufficiently similar to RCRA hazardous waste such that use of the requirement is well suited to the situation, the requirement is relevant and appropriate to the ground-water treatment component of the remedy. Therefore, container storage at the ground-water treatment plant must meet these standards, which include maintaining wastes in containers that are in good condition and compatible with the wastes they contain, providing a containment system, managing ignitable and reactive wastes away from the property line, keeping incompatible wastes in separate containers and containment systems, and at closure removing all wastes and decontaminating structures and equipment.
6 CCR 1007-3 Part 264 Subpart J	Sets operating and performance standards for tank storage of hazardous waste.	Because ground-water treatment includes storage in tanks of a waste that is sufficiently similar to RCRA hazardous waste such that use of the requirement is well suited to the situation, the requirement is relevant and appropriate to the ground-water treatment component of the remedy. Therefore, tank storage at the ground-water treatment plant must meet these standards, which include secondary containment, spill, and overflow controls, removal from service if there is a leak, spill, or the tank is unfit for use, and at closure have all wastes removed and also remove or decontaminate waste residues, containment system, soils, structures, and equipment.
6 CCR 1007-3 Part 265.17	Sets standards for mixing and treatment of contaminated soils or the mixing and treatment of potentially incompatible, reactive, or ignitable hazardous wastes.	Because the ground-water treatment plant will mix and treat potentially incompatible, reactive, or ignitable wastes which may be similar to hazardous wastes, the requirement is relevant and appropriate to the ground-water treatment plant. Therefore, the wastes must be analyzed to determine compatibility, reactivity, and ignitability before treatment in the treatment plant.
6 CCR 1007-3 Part 268 Land Disposal Restrictions	Establishes prohibitions on land disposal unless treatment standards are met or a "no migration exemption" is	Because the residuals from the ground-water treatment plant will be land disposed, the requirement is applicable. The materials must be tested to determine if they are a

	granted.	characteristic hazardous waste (per 6 CCR 1007-3 Part 262) and then must meet treatment requirements for land disposal as required in the standards if they are hazardous waste for which a treatment standard has been established. For land disposal of residuals, other than soils, which are not characteristic hazardous wastes, these requirements are relevant and appropriate because the residuals are sufficiently similar to hazardous waste such that use of the requirements is well suited to the situation.

Colorado Air Quality Act/Air Pollution Requirements

5 CCR 1001-5 Regulation No. 3	Requires filing of Air Pollution Emission Notice (APEN) including estimation of emission rates.	These regulations are applicable because air emissions will occur at the treatment plant. The air stripper/carbon polishing treatment process must meet any substantive provisions of these requirements.
5 CCR 1001-8 Regulation No. 6	Establishes standards for new stationary sources including incinerators. Sets discharge and performance rates and opacity requirements.	These regulations are applicable because air emissions will occur at the treatment plant. The air stripper/carbon polishing treatment process must meet these requirements which include discharge and performance rates and opacity requirements.
5 CCR 1001-9 Section II.C.2, Section V Regulation No. 7	Established standards for disposal or spillage of VOCs.	These regulations are applicable because air emissions will occur at the treatment plant. The air stripper/carbon polishing treatment process must meet these requirements which include controls representing reasonable available control technology (RACT).

Colorado Noise Abatement Statute

Colorado Revised Statute Section 25-12-103	Provides limits for noise based on time periods and zones.	Applicable for all construction activities associated with the remedy.

Location-Specific ARARs-Federal

Executive Order 11990, Protection of Wetlands

CFR Part 6, Appendix A	Action to avoid adverse effects, minimize potential harm, and preserve and enhance wetlands, to the extent possible. Requires action to minimize the destruction, loss, or degradation of wetlands.	Applicable because wetlands have been identified and destroyed at the Lowry Site during the SWRA. New wetlands will be constructed as part of the remedy.

Federal Water Pollution Control Act (Clean Water Act)

40 CFR Part 230	Discharge of dredged or fill material into wetlands prohibited without a permit.	For areas of the site that have designated wetlands, a permit will not be required pursuant to Section 121(c) of CERCLA, but the substantive requirements of Part 230 will be applicable if wetlands that have been identified at the Lowry Site are dredged or filled during implementation of the remedial activity.

Location-Specific ARARs-State

Certification of Federal Licenses and Permits

5 CCR 1002-18	Discharge of dredge and fill material into wetlands prohibited without a State certification.	For areas of the site that have designated wetlands, a permit will not be required pursuant to Section 121(c) of CERCLA, but the substantive requirements will be applicable if wetlands that have been identified at the Lowry Site are dredged or filled during implementation of the remedial activity.

Section 9.0
Summary of the Comparative Analysis of Alternatives

This section compares the remedial alternatives described in Section 8.0. The comparative analysis provides the basis for determining which alternative presents the best balance between the EPA's nine evaluation criteria listed below. The first two cleanup evaluation criteria are considered threshold criteria that must be met by the selected remedial action. The five primary balancing criteria are balanced to achieve the best overall solution. The final two modifying criteria that are considered in remedy selection are State acceptance and community acceptance.

- Threshold Criteria

  1. Overall Protection of Human Health and the Environment addresses whether a remedy provides adequate protection and describes how risks posed through each pathway are eliminated, reduced, or controlled.

  2. Compliance with Applicable or Relevant and Appropriate Requirements addresses whether a remedy will meet all Federal and State environmental laws and/or provide grounds for a waiver.

- Primary Balancing Criteria

  3. Long-Term Effectiveness and Permanence refers to the ability of a remedy to provide reliable protection of human health and the environment over time.

  4. Reduction of Toxicity, Mobility, or Volume Through Treatment refers to the preference for a remedy that reduces health hazards of contaminants, the movement of contaminants, or the quantity of contaminants at the Lowry Site through treatment.

  5. Short-Term Effectiveness addresses the period of time needed to complete the remedy, and any adverse effects to human health and the environment that may be caused during the construction and implementation of the remedy.

  6. Implementability refers to the technical and administrative feasibility of an alternative or a remedy. This includes the availability of materials and services needed to carry out a remedy. It also includes coordination of Federal, State, and local government efforts.

  7. Cost evaluates the estimated capital, operation, and maintenance (O&M) costs of each alternative in comparison to other equally protective alternatives.

- Modifying Criteria

  8. State Acceptance indicates whether the State agrees with, opposes, or has no comment on the preferred alternative.

  9. Community Acceptance includes determining which components of the alternatives interested persons in the community support, have reservations about, or oppose.

The strengths and weaknesses of the alternatives were weighed to identify the alternative providing the best balance among the nine evaluation criteria. The comparative analysis of alternatives for OUs l&6, 2&3, and 4&5 is provided in the following discussion.

9.1 0U 1: Shallow Ground Water and Subsurface Liquids and OU 6: Deep Ground Water

9.1.1 Threshold Criteria

<u>9.1.1.1 Overall Protection of Human Health and the Environment</u>

The NCP requires that all alternatives be assessed to determine whether they can adequately protect human health and the environment, in both the short- and long-term, from unacceptable risks posed by hazardous substances, pollutants, or contaminants present at the site by eliminating, reducing, or controlling exposures to such hazardous substances, pollutants, or contaminants. Overall protection of human health and the environment draws on the assessments of other evaluation criteria, especially long-term effectiveness and permanence, short-term effectiveness, and compliance with ARARs.

All of the alternatives would be protective of human health and the environment, with the exception of the No Action alternative. The No Action alternative would not be protective because contamination above ARARs and other performance standards would migrate offsite and downward into the major water supply aquifers. Therefore, the No Action alternative will not be considered further in this evaluation. All other alternatives would be protective because they would: prevent migration of contaminants above performance standards beyond the compliance boundary through containment and collection and/or through monitoring and implementation of contingencies; meet ARARs; prevent exposure to contaminants within the compliance boundary through the use of institutional controls; monitor for vertical migration of contaminants and implement contingencies to contain such vertical migration; monitor the effectiveness of remedial measures.

The following analysis is structured such that the alternatives are discussed in order of relative protectiveness. The comparison of alternatives shows that for overall protectiveness, Modified Alternative Groundwater No. 5 (GW-5) (the North Boundary, Toe of Landfill and Lateral Barrier Walls Collection and Treatment System, plus Upgradient Containment Collection and Treatment alternative) is superior to all other alternatives. This is because it is the only alternative which does not rely on contingencies to prevent lateral migration of contaminated ground water from the Lowry Site. Instead, Modified Alternative GW-5 includes barrier walls and collection systems on all boundaries of the Lowry Site. All other alternatives rely to one degree or another on monitoring at the boundaries and would require further action if monitoring revealed offsite migration of contaminants above performance standards.

This distinction between Modified Alternative GW-5 and the other alternatives is important because contaminants have been detected at the western and southern portions of the Lowry Site near the compliance boundary, and ground-water modeling performed for the risk assessment and feasibility studies indicates that offsite migration will occur. By requiring the immediate design and installation of barrier walls on the eastern, western and southern boundaries, and upgrading of the existing barrier wall or construction of an additional barrier wall on the northern boundary of the Lowry Site, Modified Alternative GW-5 provides the greatest assurance that performance standards will be achieved at the compliance boundary.

Like Modified Alternative GW-5, Alternative GW-5 (the North Boundary, Toe of Landfill plus Lateral Containment, Collection and Treatment alternative) includes containment systems on the eastern and western boundaries. However, Alternative GW-5 lacks Modified Alternative GW-5's upgradient containment feature on the southern boundary of the Lowry Site and would require further action if monitoring revealed migration of contaminants at the southern boundary.

Modified Alternative GW-5's upgradient system would result in the following benefits to human health and the environment:

- Prevention of migration of contaminants southward from the landfill mass resulting from localized ground-water flow to the south. As noted above, contaminants have been detected near the southern compliance boundary. Local southward flow could be caused by mounding from the landfill, unidentified sand stringers/sand channels, and other geologic heterogeneities, chemical diffusion, dispersion, and possible unidentified localized seasonal changes in ground-water flow direction.

- Reduction of ground-water inflow from the south entering the contaminated Site. This would reduce the volume of clean water that is mixed with contaminated water and thereby reduce the ground-water treatment cost.

Like Modified Alternative GW-5, Alternative GW-4 (the North Boundary, Toe of Landfill, Upgradient Containment, Collection, and Treatment, plus Multilayer Cap alternative) includes installation of the upgradient ground-water containment, collection, and diversion system. However, Alternative GW-4 lacks the barrier walls on the eastern and western boundaries and would require further action if monitoring revealed migration of contaminants at the eastern and western compliance boundaries.

Unlike Modified Alternative GW-5, Alternative GW-4 requires installation of a multilayer cap. However, the existing clay cap is effective in preventing infiltration from precipitation into the landfill mass and waste-pit liquids. Modeling results show that placement of the multilayer cap in Alternative GW-4 would not reduce the infiltration rate any more than the current clay cap. Therefore, the multilayer cap in Alternative GW-4 would not provide any additional protection of human health and the environment than the existing clay cap.

Unlike the other alternatives, Alternative GW-6 (the North Boundary and Toe of Landfill Containment, Collection and Treatment plus Waste-Pit Pumping alternative) includes pumping and treatment of waste pit liquids. However, only a small portion of the waste pit liquids could be extracted and the waste pit liquids would continue to act as a source for ground water contamination. Alternative GW-6 does not include containment systems on the eastern, western, and southern boundaries, and thus, is not considered to be as protective as the alternatives which include such systems.

Like Alternatives GW-4, GW-5, GW-6 and Modified Alternative GW-5, Alternative GW-3 (the North Boundary and Toe of Landfill Containment, Collection, and Treatment alternative) includes a toe of the landfill collection system. This system provides an additional measure of protectiveness over alternatives which don't include the system by preventing the most highly contaminated liquids from migrating northward and further degrading ground water between the landfill mass and the northern compliance boundary. This system is an extra safety measure which, among other things, would limit the negative impacts if there were ever a breakthrough of contaminated ground water at the northern barrier wall. Alternative GW-3 does not include containment systems on the eastern, western, and southern boundaries, and thus, is not considered to be as protective as the alternatives which include such systems.

Like Modified Alternative GW-5 and some of the other alternatives, Alternative GW-2 (the North Boundary Containment Collection and Treatment alternative) would extend the existing barrier wall on the northern boundary or build a new longer barrier wall adjacent to the existing one. This feature would provide an additional measure of protectiveness over Alternative GW-1 (the No Further Action alternative) by providing greater assurance that contaminants would be captured at the northern compliance boundary and would not move around the edges of the barrier wall. Neither Alternative GW-2 nor Alternative GW-1 include containment systems on the eastern, western, and southern boundaries or toe of the landfill collection. Thus, they are not considered to be as protective as the alternatives which include such systems.

9.1.1.2 Compliance with ARARs

Applicable requirements are those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under Federal or State law that specifically address a hazardous substance, pollutant, contaminant, remedial action, or location at a CERCLA site. Relevant and appropriate requirements are similar requirements that, while not applicable, clearly address problems or situations sufficiently similar to those encountered at a CERCLA site such that their use is well suited to the particular site.

The alternatives were assessed to determine whether they would attain applicable or relevant and appropriate requirements under Federal environmental laws and State environmental or facility siting laws or provide grounds for invoking an ARARs waiver.

The ARARs for OUs 1&6 alternatives are discussed in Section 8.0.

All of the alternatives would meet ARARs. Modified Alternative GW-5 and Alternative GW-5 are the only alternatives that would include control of lateral migration as a principal component to achieve compliance with ARARs at the eastern and western compliance boundaries. These alternatives would also be superior in meeting the intent of the closure provisions for RCRA hazardous waste landfills, which are considered relevant and appropriate at the Lowry Site.

The conclusion that each alternative can meet the ARARs is based on treatability study results. Contingencies would be implemented if performance data showed that the selected remedy was not achieving ARARs. Contingencies would include any or all of the following:

- If, during implementation or operation of the ground-water remedy, it was determined that contaminant levels exceeded the performance standards at the point of action boundary, the remedy would be re-evaluated and modifications made to prevent contaminant migration beyond the compliance boundary. Modifications might include any or all of the following, at EPA's discretion:

    - Alternating pumping at wells to eliminate stagnation points

    - Pulse pumping to allow aquifer equilibration and to allow adsorbed contaminants to partition into ground water

    - Installation of extraction wells to facilitate containment of the contaminant plume and to address possible vertical migration of contaminants and alternate pumping at these wells to eliminate ground water stagnation points

  To ensure that performance standards would continue to be maintained, the aquifer would be monitored at appropriate locations and frequencies, as determined by EPA.

- If it were determined by EPA, on the basis of the system performance data, that contaminants had migrated vertically downward to the lignite layer, contingency measures would be implemented to ensure that the beneficial use of the underlying aquifer would not be impaired. The following measures involving long-term management might be required, at EPA's discretion, for an indefinite period of time, as a modification of the existing system:

- Additional engineering controls such as underground barriers, or long-term gradient control provided by low level pumping, as containment measures

- Continued monitoring of specified wells

- Periodic re-evaluation of remedial technologies for ground-water restoration

- Additional institutional controls on water extraction and use

• Contingencies for the SWRA, which are relevant to the operation of the GWTP, were developed as part of the SWRA design and are discussed in Subsection 11.5.2. These contingencies would be reviewed during the selected remedy design and, if necessary, modified or upgraded.

Contingency plans would be developed in detail during the RD. These plans would address measures to be taken if ARARs are not met.

9.1.2 Primary Balancing Criteria

9.1.2.1 Long-Term Effectiveness and Permanence

The alternatives were assessed for the long-term effectiveness and permanence they afford, along with the degree of certainty that the alternative would prove successful. Factors that were considered include the following:

1. The magnitude of residual risk remaining from untreated waste or treatment residuals remaining at the conclusion of the remedial activities; and

2. The adequacy and reliability of controls such as containment systems and institutional controls that are necessary to manage untreated waste and treatment residuals.

All of the alternatives would offer long-term effectiveness and permanence and address the movement of contaminants to the north (the primary migration pathway) through treatment of ground water collected at the existing barrier wall system. However, Modified Alternative GW-5 would best address long-term effectiveness and permanence through up-front construction of containment and collection systems on all sides of the Lowry Site.

Modified Alternative GW-5 and Alternative GW-5 are the only alternatives that would immediately prevent potential offsite migration of contaminants to the east and west. In addition, Modified Alternative GW-5 and Alternative GW-5 provide additional long-term effectiveness and permanence above Alternatives GW-1, 2, 3, and 4, because they extract waste from the east and west sides of the landfill mass.

Alternative GW-6 would extract more subsurface liquids from the landfill; however, because only a small fraction of the waste pits would be extracted, the waste pit liquids would still act as a continual source for ground-water contamination. Therefore, Alternative GW-6, although better at extraction, would not offer any significant additional long-term effectiveness and permanence over Modified Alternative GW-5 or Alternative GW-5.

Like Alternatives GW-5 and GW-6 and Modified Alternative GW-5, Alternatives GW-3 and GW-4 would reduce risk through treatment of the highly contaminated ground water collected at the toe of the landfill. Collection of the contaminated ground water at the toe of the landfill would capture contamination closer to the source and avoid further contamination of the aquifer downgradient of the landfill mass.

Alternative GW-4 and Modified Alternative GW-5 offer upgradient containment, collection, and diversion, which reduces the inflow of clean water mixing with contaminated water and also prevents southern offsite migration. Alternative GW-4 adds a multilayer cap, but this has not been shown to be any more effective in inhibiting infiltration of surface water into the Lowry Site than the existing clay cap.

Alternatives GW-1 (the No Further Action alternative) and GW-2 (the North Boundary Containment, Collection, and Treatment alternative) would be the least effective alternatives because they rely on contingency measures for eastern, western, and southern compliance boundary exceedances and would not capture and treat contamination as close to the source area as the remaining alternatives which use toe of the landfill ground-water extraction and treatment. Modified Alternative GW-5 is the only alternative that fully contains migration to the north, east, west, and south, as well as effectively reduces the long-term potential for contaminated ground-water migration.

9.1.2.2 Reduction of Toxicity, Mobility, or Volume Through Treatment

The degree to which alternatives employ recycling or treatment to reduce toxicity, mobility, or volume was assessed, including how treatment would be used to address the principal threats posed by the site. Factors that were considered include the following:

1. The treatment or recycling processes the alternatives employ and materials they will treat;

2. The amount of hazardous substances, pollutants, or contaminants that will be destroyed, treated, or recycled;

3. The degree of expected reduction in toxicity, mobility, or volume of the waste from treatment or recycling and the specification of which reduction(s) axe occurring;

4. The degree to which the treatment is irreversible;

5. The type and quantity of residuals that will remain following treatment, considering the persistence, toxicity, mobility, and propensity to bioaccumulate of such hazardous substances and their constituents; and

6. The degree to which treatment reduces the inherent hazards posed by principal threats at the site.

All of the alternatives would reduce the toxicity, mobility, or volume of contaminated ground water migrating to the north through extraction and treatment at the existing barrier wall. The alternative that would best achieve this criterion is Alternative GW-6, because it includes extraction and treatment of waste-pit liquids and extraction and treatment of highly contaminated ground water in the alluvium at the toe of the landfill.

Alternatives GW-3, GW-4, GW-5, and Modified Alternative GW-5 would be next best at reducing toxicity, mobility, or volume through treatment, because they would provide for extraction of highly contaminated ground water in the alluvium at the toe of the landfill. Alternative GW-1 (the No Further Action alternative) and Alternative GW-2 (the North Boundary Containment, Collection, and Treatment alternative) have the least reduction of mobility, toxicity, or volume through treatment because contamination is allowed to migrate beyond the toe of the landfill until it is captured at the northern site boundary.

9.1.2.3 Short-Term Effectiveness

The NCP considers the following four features as components of short-term effectiveness:

- Short-term risks to the community during implementation
- Potential impacts to workers during implementation
- Potential environmental impacts during remediation
- Time until protection is achieved

All of the alternatives would have reasonable short-term effectiveness. Alternative GW-1 (the No Further Action alternative) and Alternative GW-2 (the North Boundary Containment, Collection, and Treatment alternative) would have no adverse short-term effects. The remaining Alternatives, GW-3, GW-4, GW-5, Modified Alternative GW-5, and GW-6, would include a ground-water extraction system at the toe of the landfill for highly contaminated ground water. During construction of this system, construction workers would be exposed to higher risks from the potential presence of volatile organic compounds in the soil. However, these risks are not anticipated to be significant during the 3-year design and construction period.

With the exception of measures that may be required during construction of the trench at the toe of the landfill, the use of unusual or special construction techniques is not anticipated. It has been demonstrated that workers at the Lowry Site can be adequately protected during construction through routine application of accepted Occupational Safety and Health Administration (OSHA) health and safety practices. The majority of the construction would not require special health protective measures.

None of the alternatives would pose short-term risks to the community during implementation or cause adverse environmental impacts during remediation.

While potential impacts to workers might be greater with Modified Alternative GW-5 than with Alternatives GW-1 and GW-2, Modified Alternative GW-5 would achieve overall protection in a shorter time frame than these alternatives because containment systems would be immediately designed and installed on the eastern, western, and southern sides of the Lowry Site. Thus, from an overall perspective, Modified Alternative GW-5 is as effective in the short-term as Alternatives GW-1 and GW-2. Likewise, Alternatives GW-5 and GW-4, which both include lateral containment on the west and east or the south, offer advantages over Alternatives GW-1 and

GW-2 in terms of the amount of time required until protection is achieved.

9.1.2.4 Implementability

The ease or difficulty of implementing the alternatives was assessed by considering the following types of factors:

1. Technical feasibility, including technical difficulties and unknowns associated with the construction and operation of a technology, the reliability of the technology, ease of undertaking additional remedial actions, and the ability to monitor the effectiveness of the remedy.

2. Administrative feasibility, including activities needed to coordinate with other offices and agencies and the ability and time required to obtain any necessary approvals and permits from other agencies (for offsite actions);

3. Availability of services and materials, including the availability of adequate off-site treatment, storage capacity, and disposal capacity and services; the availability of necessary equipment and specialists, and provisions to ensure any necessary additional resources; the availability of services and materials; and availability of prospective technologies.

All of the alternatives are considered to be administratively and technically implementable. In addition, the services and materials required to implement all of the alternatives would be readily available. Alternative GW-1 (the No Further Action alternative) and Alternative GW-2 (the North Boundary Containment, Collection, and Treatment alternative) would be the easiest to implement. Alternatives GW-3, GW-5, and Modified Alternative GW-5 would all use current technology and would be the next easiest to implement.

The construction of containment barrier walls that act to collect or divert are considered routine construction and can be performed by local contractors. The effectiveness of the ground-water treatment system is proven by the success of the existing treatment facility located onsite.

Alternative GW-4 (the North Boundary, Toe of Landfill, Upgradient and Multilayer Cap alternative) and Alternative GW-6 (the North Boundary, Toe of Landfill Containment, and Waste-Pit Pumping alternative) are considered to be the least implementable alternatives. This is because Alternative GW-4 proposes 100-foot-deep extraction trenches that may be difficult to construct, and Alternative GW-6 includes drilling 52 waste-pit extraction wells that may be difficult to drill through landfill refuse.

9.1.2.5 Cost

The types of costs that were assessed include the following:

1. Capital costs, including both direct and indirect costs;
2. Annual operation and maintenance costs; and
3. Net present value of capital and O&M costs.

A description of cost estimating procedures is provided in Section 8.1.

The No Further Action alternative would be the least costly, while Alternative GW-4 (North Boundary, Toe of Landfill, Upgradient Containment, Collection and Treatment Plus Multilayer Cap alternative) would be the most costly. Modified Alternative GW-5 is significantly less expensive than Alternative GW-6 and is more expensive than Alternative GW-3. Modified Alternative GW-5 is comparable in costs to Alternative GW-5, but includes physical barriers and an additional upgradient ground-water collection, containment, and diversion system. Modified Alternative GW-5 is more expensive than Alternatives GW-1 and GW-2 because Alternatives GW-1 and GW-2 do not immediately address offsite contaminant migration to the eastern, western, and southern site boundaries.

Costs for OUs 1&6 alternatives are ranked below from least to most expensive based on the following present worth estimates:

- Alternative GW-1: No Further Action

  - Capital Costs: $4,300,000
  - Annual O&M Costs: $1,800,000
  - Total (30-year Present Worth): $31,970,000

- Alternative GW-2: North Boundary (Downgradient) Containment, Collection, and Treatment

  - Capital Costs: $9,800,000
  - Annual O&M Costs: $1,900,000
  - Total (30-year Present Worth): $39,010,000

- Alternative GW-3: North Boundary and Toe of Landfill Containment, Collection, and Treatment

  - Capital Costs: $15,300,000
  - Annual O&M Costs: $3,000,000
  - Total (30-year Present Worth): $61,420,000

- Alternative GW-5: North Boundary, Toe of Landfill, and Lateral Containment, Collection, and Treatment

  - Capital Costs: $17,700,000
  - Annual O&M Costs: $3,000,000
  - Total (30-year Present Worth): $63,820,000

- Modified Alternative GW-5: North Boundary, Toe of Landfill, and Lateral Containment, Collection and Treatment plus Upgradient Containment, Collection, and Diversion

  - Capital Costs: $19,000,000
  - Annual O&M Costs $2,400,000
  - Total (30-year Present Worth): $65,030,000

- Alternative GW-6: North Boundary and Toe of Landfill Containment, Collection and Treatment, and Waste Pit Pumping

  - Capital Costs: $20,300,000
  - Annual O&M Costs: $3,400,000
  - Total (30-year Present Worth): $72,570,000

- Alternative GW-4: North Boundary, Toe of Landfill, and Upgradient Containment, Collection and Treatment, plus Multilayered Cap in Landfill Area

  - Capital Costs: $64,100,000
  - Annual O&M Costs: $3,200,000
  - Total (30-year Present Worth): $113,300,000

It should be noted that the cost figures for alternatives which rely on contingency measures to address potential contaminant migration to the east, west, and/or south (all alternatives other than Modified Alternative GW-5) do not include cost figures for such contingency measures. If such contingency measures had to be initiated, the costs could increase significantly for those alternatives.

9.1.3 Modifying Criteria

9.1.3.1 State/Support Agency Acceptance (August 1993)

The State of Colorado concurs with the EPA on the selection of Modified Alternative GW-5 for OUs 1&6. The State of Colorado also concurs with the selected ARARs.

9.1.3.2 Community Acceptance

Community input on the alternatives for remedial action for OUs 1&6 was solicited by EPA and CDH during the public comment period for the OUs 1&6 Proposed Plan from November 23, 1992 to March 2, 1993. Comments from the public were supportive of the preferred remedy. Several of the commenters recommended that EPA consider additional efforts to pump waste pits and several commenters were opposed to any use of offsite institutional controls as a substitute for cleanup actions or which would prohibit use of the surrounding lands. Responses to community comments are found in the Responsiveness Summary for OUs 1&6 in Section 13.0 of this ROD. The PRPs were generally supportive of the selected remedy. One set of PRPs was in favor of the upgradient containment, collection and diversion system, while the other set of PRPs asked for additional justification on the upgradient system. Responses to PRP comments are found in the Responsiveness Summary for OUs 1&6 in Section 13.0 of this ROD.

9.2 OU 2: Landfill Solids and OU 3: Landfill Gas

9.2.1 Threshold Criteria

9.2.1.1 Overall Protection of Human Health and the Environment

Under the No Action alternative, Landfill Solids Alternative 1 (LFS-1), all of the potential risks to human health and the environment associated with the landfill solids and gas would remain. These include the excess risk of getting cancer from exposure to gas migrating offsite, risks associated with the potential buildup and explosion of methane gas, and risks associated with potential exposure to contaminated drums at or near the land surface in the former tire pile area.

In addition, the existing clay cap would deteriorate without maintenance, which could lead to infiltration of surface water into the landfill mass and a resultant increase in the potential for migration of contaminants. EPA has determined that these risks are unacceptable. Because the No Action alternative is not protective for either landfill solids or landfill gas, it will not be considered further in this evaluation.

9.2.1.1.1 Landfill Solids (LFS). All of the alternatives would be protective of human health and the environment because they would prevent exposure to contaminants in landfill solids. This would be accomplished through the use of various combinations of cover over, and excavation and treatment of, landfill solids, in conjunction with institutional controls.

Modified Alternative LFS-4 (the Drum Removal/Offsite Disposal/North Face Cover alternative) would be the most protective of human health and the environment. This is because Modified Alternative LSF-4 requires the removal of the greatest volume of contaminated materials in the former tire pile area, thereby providing the greatest risk reduction and overall protection of human health and the environment. Moreover, Modified Alternative LSF-4 would provide additional protection by including an additional 2 feet of soil cover on the north slope of the former landfill. This cover would further reduce potential exposure from landfill solids, thus reducing risks to human health and the environment.

Alternative LFS-6 (the Drum Removal/Low-Temperature Thermal Desorption/Stabilization and Disposal alternative) would be the second most protective of human health and the environment because this alternative requires the removal and treatment of the second greatest volume of contaminated materials (approximately 1,350 drums and 4,200 cubic yards of contaminated soil) in the former tire pile area. Like Modified Alternative LFS-4, Alternative LFS-6 would include reclamation of excavated areas and maintenance of soil cover in the former tire pile area. The existing cap over the landfill mass would be maintained. However, this alternative does not include the additional 2 feet of soil cover on the north slope of the landfill.

Alternative LFS-4 (the Drum Removal/Offsite Disposal alternative) would be the third most protective of human health and the environment because this alternative requires the removal and treatment of the third greatest volume of contaminated materials (approximately 1,350 drums and contaminated soils adjacent to the drums) in the former tire pile area. Thus, risks would be reduced in the former tire pile area, but not as much as Alternative LFS-6 and Modified Alternative LSF-4. Alternative LSF-4 would include the same cover elements as Alternative LFS-6 in the former tire pile area and the landfill mass.

Alternative LFS-3 (Clay Cap alternative) would be slightly less protective than Alternative LSF-4 because it would remove a lesser volume of contaminated materials (approximately ten drums) in the former tire pile area and would not result in treatment of those materials (instead they would be disposed of at an offsite RCRA Subtitle C facility.) However, Alternative LFS-3 would include a clay cap in the former tire pile area rather than a soil cover. This would provide a more substantial physical barrier to contaminated landfill solids in this area and thus reduce the potential for exposure.

The No Further Action (LFS-2) and Landfill Regrading (LFS-7) alternatives are considered to be least protective of human health and the environment because neither alternative requires removal or treatment of contaminated materials. Alternative LFS-7 would include an additional 2 feet of clay on the north face of the landfill mass after landfilling was completed.

9.2.1.1.2 Landfill Gas (LFG). Alternatives LFG-3, LFG-5, and Modified Alternative LFG-3 would each be protective of human health and the environment. These alternatives would ensure protectiveness by extracting gas from the landfill, thereby preventing gas migration beyond the Lowry Site boundaries, and treating the gas. Potentially dangerous buildups of methane would be prevented and migrating VOCs would be captured and treated.

Modified Alternative LFG-3 (Gas Collection/Enclosed Flare) is the most protective of human health and the environment. This is because Modified Alternative LFG-3 provides greater short- and long-term risk reduction than other alternatives involving gas collection because of the initial installation of a more comprehensive extraction system (Stage 1 and Stage 2). Alternatives LFG-3 (Stage 1) and LFG-5 (Stage 1) would provide initial gas extraction in localized areas in the western and southwestern portions of the landfill mass. If gas continued to migrate from the landfill mass, Stage 2 of these alternatives would be implemented.

Stage 2 includes the addition of gas extraction wells around the perimeter of the landfill mass. If Stage 2 of Alternative LFG-3 and Stage 2 of Alternative LFG-5 were implemented, Alternatives LFG-3 and LFG-5 would be as protective of human health and the environment as Modified Alternative LFG-3. The No Further Action alternative (LFG-2) would not be protective of human health and the environment because it would not prevent gas migration from occurring.

9.2.1.2 Compliance with ARARs

The ARARs for OUs 2&3 alternatives are discussed in Section 8.0.

9.2.1.2.1 Landfill Solids. All alternatives would meet ARARs except Alternative LFS-7 (Landfill Regrading). Alternative LFS-7 would not meet RCRA Subtitle D Solid Waste Disposal Regulations (40 CFR Parts 257 and 258) and Regulations Pertaining to Solid Waste Disposal Sites and Facilities (6CCR 1007-2) because standards for design and construction would not be met.

9.2.1.2.2 Landfill Gas. All alternatives except the No Further Action alternative would meet ARARs. The No Further Action alternative would not meet RCRA Solid Waste Disposal Regulations (40 CFR Parts 241) because gas would migrate offsite above the regulated limits.

9.2.2 Primary Balancing Criteria

9.2.2.1 Long-Term Effectiveness and Permanence

9.2.2.1.1 Landfill Solids. Modified Alternative LFS-4 would provide the greatest long-term effectiveness and permanence because the former tire pile area would be excavated and the largest volume of contaminated material would be removed relative to the remaining alternatives. This would permanently remove contaminated material from the Lowry Site. In addition, Modified Alternative LFS-4 would provide 2 feet of additional cover on the north face of the landfill mass, thus providing greater containment and long-term effectiveness and permanence in the landfill area.

Alternatives LFS-3, LFS-4, and LFS-6 would each provide a lesser level of effectiveness in the landfill mass and the former tire pile area because these alternatives would remove a smaller volume of contaminated material from the former tire pile area and would not provide 2 feet of additional cover on the north face of the landfill mass. The alternatives that would least meet this criterion are the No Further Action alternative (LFS-2) and Alternative LFS-7 (Landfill Regrading) because they would remove no contaminated material from the former tire pile area. Alternative LFS-7 would provide an additional 2 feet of cover on the north face of the landfill mass.

9.2.2.1.2 Landfill Gas. Modified Alternative LFG-3 would provide the greatest long-term effectiveness and permanence because it would provide a more extensive gas extraction system throughout the landfill mass, and it would be less dependent on gas monitoring activities than other alternatives.

Alternatives LFG-3 and LFG-5 would be as effective in the long-term as Modified Alternative LFG-3 if Stage 2 of Alternative LFG-3 and Stage 2 of Alternative LFG-5 were implemented. The No Further Action alternative (LFG-2) does not remove and treat gas from the landfill and is therefore considered the least effective alternative. Over time, gas would migrate offsite and pose a risk to human health and the environment.

9.2.2.2 Reduction of Toxicity, Mobility, or Volume Through Treatment

9.2.2.2.1 Landfill Solids. Modified Alternative LFS-4 (the Drum Removal/Offsite Disposal/North Face Cover alternative) would require excavation and treatment of the greatest volume of contaminated solid material, and would thus provide the greatest reduction of toxicity, mobility, and volume of contaminants through treatment. The toxicity, mobility, and volume of liquids in drums would be reduced through incineration and the mobility of other excavated materials would be reduced through stabilization.

Alternative LFS-6 (the Drum Removal/Low-Temperature Thermal Desorption/Stabilization/Disposal alternative) requires the excavation and treatment of the next greatest volume of contaminated solid material and would thus provide the next greatest reduction of toxicity, mobility, and volume of contaminants through treatment. This alternative would incinerate the same volume of liquids from drums as Modified Alternative LFS-4, but would treat a lesser volume of soils (4,200 cubic yards versus 15,000 cubic yards.) Treatment for the soils would consist of low temperature thermal desorption.

Alternative LFS-4 (the Drum Removal/Offsite Disposal/North Face Cover alternative) would provide the next greatest reduction in toxicity, mobility, and volume through excavation and offsite treatment. The same volume of liquids in drums would be incinerated, but a lesser volume of soils would be treated than with either Modified Alternative LFS-4 or Alternative LFS-6.

Alternative LFS-3 (Clay Cap alternative), Alternative LFS-2 (No Further Action alternative), and Alternative LFS-7 (Landfill Regrading alternative) would provide no reduction of toxicity, mobility, or volume through treatment.

9.2.2.2.2 Landfill Gas. Modified Alternative LFG-3 would provide a greater reduction of toxicity, mobility, and volume through treatment than other alternatives by extracting and treating more gas from the eastern, western, and southern portions of the landfill mass than the remaining alternatives. Alternatives LFG-3 (Stage 1) and LFG-5 (Stage 1) would provide for the next greatest reduction in toxicity, mobility, and volume through the treatment of landfill gas in the western and southwestern portions of the landfill mass. Alternatives LFG-3 and LFG-5 would provide the same reductions of toxicity, mobility, or volume through treatment as Modified Alternative LFG-3 if Stage 2 of Alternative LFG-3 and Stage 2 of Alternative LFG-5 were implemented. Alternative LFG-2 (No Further Action) would provide no reduction in toxicity, mobility, or volume through treatment.

9.2.2.3 Short-Term Effectiveness

9.2.2.3.1 Landfill Solids. The No Further Action alternative (LFS-2) would provide the greatest short-term effectiveness because it poses no adverse short-term effects to workers, the community, or the environment. Construction and implementation risks associated with placing the additional 2 feet of cover on the north face in Modified Alternative LFS-4 and regrading in Alternative LFS-7 would be similar to typical landfill grading activities. These portions of the alternatives are considered to have a high level of short-term effectiveness because they have very few adverse effects. There would be a limited potential for construction workers or the community to be exposed to volatile organic compounds through the excavation activities associated with Alternatives LFS-3, LFS-4, and LFS-6, and for the general public to be exposed during offsite transport of the excavated materials. Modified Alternative LFS-4 would pose a slightly higher risk to construction workers because of the more extensive level of excavation and thus is considered to have slightly less short-term effectiveness.

9.2.2.3.2 Landfill Gas. Modified Alternative LFG-3 and Alternative LFG-3 (Stage 1) would be most effective in the short-term. These alternatives would achieve protectiveness in a short time frame and would pose minimal short-term risks to workers, the community, or the environment during construction. Modified Alternative LFG-5 (Stage 1) would be slightly less effective in the short-term because it would pose slightly greater risks to workers during the installation and operation of heat recovery equipment. Although the No Further Action alternative (LFG-2) would pose no adverse short-term risks to workers, the community, or the environment from construction activities (because there would be none), this alternative would not eliminate potential short-term risks from gas buildup and migration.

9.2.2.4 Implementability

9.2.2.4.1 Landfill Solids. All of the Landfill Solids alternatives are considered relatively equal in terms of technical and administrative implementability. This is because all alternatives would use proven technologies that have been successfully implemented at many other sites. Alternatives LFS-4 and LFS-6 would include the excavation of drums, drum contents, and contaminated soils using readily available construction equipment. Modified Alternative LFS-4 would consist of excavation as described in Alternatives LFS-4 and LFS-6, and would also include excavation of waste pits within the unsaturated zone. This type of excavation is considered routine construction, could be conducted by local contractors, and has been implemented at other Superfund sites. Construction of the north face cover in Modified Alternative LFS-4 and regrading in Alternative LFS-7 would involve routine landfill construction procedures, and cover material is readily available onsite.

9.2.2.4.2 Landfill Gas. All of the landfill Gas Alternatives would be technically and administratively implementable. Next to Alternative LFG-2, Modified Alternative LFG-3 is considered to be the most implementable alternative because this alternative would use proven technology, and the construction of gas extraction wells would be a routine activity that could be conducted by many local contractors. In addition, constructing Stages 1 and 2 extraction wells together in Modified Alternative LFG-3 would be easier to implement than constructing them separately in Alternative LFG-3 (Stage 2) and Alternative LFG-5 (Stage 2) since there would be only one mobilization expense and less monitoring to determine rates and directions of gas migration.

Alternative LFG-5, which includes heat recovery, would be the most technically difficult to implement because heat recovery from an enclosed flare is not commonly practiced.

9.2.2.5 Cost

9.2.2.5.1 Landfill Solids. Modified Alternative LFS-4 (the Drum Removal/Offsite Disposal alternative) and Alternative LFS-6 (the Drum Removal/Low-Temperature Thermal Desorption/Stabilization/Disposal alternative) have the highest present-worth costs. However, Modified Alternative LFS-4 would remove a larger volume of contaminated material than Alternatives LFS-4 or LFS-6. In addition, Modified Alternative LFS-4 includes the cover on the northern slope of the landfill mass. Alternative LFS-4 (the Drum Removal/Offsite Disposal alternative) is the next most costly alternative, followed by Alternative LFS-2 (the No Further Action alternative), Alternative LFS-3 (the Clay Cap alternative), and Alternative LFS-7 (the Landfill Mass Regrading alternative). The costs for each of the landfill solids alternatives are listed below:

- Alternative LFS-7: Landfill Mass Regrading
  - Capital Costs: $0
  - Annual O&M Costs: $350,000
  - Total 30-year Present Worth): $5,380,000
- Alternative LFS-3: Clay Cap
  - Capital Costs: $670,000
  - Annual O&M Costs: $410,000
  - Total (30-year Present Worth $6,970,000
- Alternative LFS-2: No Further Action
  - Capital Costs: $36,000
  - Annual O&M Costs: $470,000
  - Total (30-year Present Worth): $7,260,000
- Alternative LFS-4: Drum Removal/Offsite Disposal
  - Capital Costs: $2,400,000
  - Annual O&M Costs: $410,000
  - Total (30-year Present Worth): $8,700,000
- Alternative LFS-6: Drum Removal/Low Temperature Thermal Desorption/Stabilization/Disposal
  - Capital Costs: $5,200,000
  - Annual O&M Costs: $410,000
  - Total (30-year Present Worth): $11,500,000
- Modified Alternative LFS-4: Drum Removal/Offsite Disposal/North Face Cover
  - Capital Costs: $8,600,000
  - Annual O&M Costs: $316,000
  - Total (30-year Present Worth): $13,460,000

9.2.2.5.2 Landfill Gas. The estimated present-worth costs for Modified Alternative LFG-3 are slightly greater than present-worth estimates for Alternative LFG-3 (Stage 1). These are the least costly alternatives that meet the threshold criteria. Alternative LFG-5 would be the next most costly based on present worth estimates. It is slightly less than Alternative LFG-3 (Stages 1 & 2). The most expensive alternative is Stage 3 of Alternative LFG-3. The present-worth costs for the OU3 alternatives are ranked below. These costs also include estimated capital and O&M costs.

- Alternative LFG-2: No Further Action
  - Capital Costs: $36,000
  - Annual O&M Costs: $59,000
  - Total (30-year Present Worth): $943,000
- Alternative LFG-3: Gas Collection/Enclosed Flare (Stage 1)
  - Capital Costs: $3,200,000
  - Annual O&M Costs: $310,000
  - Total (30-year Present Worth): $7,970,000

- Modified Alternative LFG-3: Gas Collection/Enclosed Flare
  - Capital Costs: $3,200,000
  - Annual O&M Costs: $340,000
  - Total (30-year Present Worth): $8,430,000
- Alternative LFG-5: Gas Collection with Heat Recovery (Stage 1)
  - Capital Costs: $3,700,000
  - Annual O&M Costs: $313,000
  - Total (30-year Present Worth): $8,510,000
- Alternative LFG-3: Gas Collection/Enclosed Flare (Stages 1 and 2)
  - Capital Costs: $3,600,000
  - Annual O&M Costs: $340,000
  - Total (30-year Present Worth): $8,830,000
- Alternative LFG-3: Gas Collection/Enclosed Flare (Stages 1, 2, and 3)
  - Capital Costs: $5,200,000
  - Annual O&M Costs: $503,000
  - Total (30-year Present Worth): $12,930,000

The above-referenced cost breakdowns suggest that capital costs for Modified Alternative LFG-3 are similar to capital costs for Alternative LFG-3, Stage 1. Although Modified Alternative LFG-3 involves an additional stage of well construction (Stage 2) compared to Alternative LFG-3, Stage 1, it does not include costs associated with a well abandonment program. Estimated capital costs for Stage 2 construction are approximately equal to estimated costs for the well abandonment program. Consequently, Modified Alternative LFG-3 and Alternative LFG-3, Stage 1 have similar capital costs.

9.2.3 Modifying Criteria

9.2.3.1 State/Support Agency Acceptance

The State of Colorado concurs with EPA on the selection of Modified Alternative LFS-4 and Modified Alternative LFG-3 for OUs 2&3.

9.2.3.2 Community Acceptance

Community input on the alternatives for remedial action for OUs 2&3 were solicited by EPA and CDH during the public comment period from September 1, 1993 to November 29, 1993. Comments received from the community were strongly supportive of the excavation and treatment of contaminated solids in the former tire pile area. The community was also generally supportive of the simultaneous implementation of the Stage 1 and 2 gas extraction measures as a means of controlling gas migration offsite. However, one commenter encouraged EPA to consider the focus of the gas extraction to be extraction and removal rather than control of offsite gas migration. The commenter felt that the additional installation of Stage 3 would yield a significant increase in the annual volume of contaminants removed for a relatively small incremental increase in the overall cost. The community was also adamantly opposed to the addition of 1.2 million cubic yards of municipal solid waste over the former waste pits (Alternative LFS-7, Landfill Regrading). Commentors were very supportive of EPA's proposal to reject this alternative.

Comments from the PRPs opposed EPA's preferred alternative and proposed a remedy consisting of land acquisition and land use restrictions 0.5 mile around the perimeter of the Lowry Site, the enhancement of the landfill cover through the addition of 1.2 million cubic yards of municipal solid waste, and the installation of Stage 1 of the gas extraction system. The PRPs comments also focused on the short-term effectiveness of the excavation in the former tire pile area and the potential exposure to workers during the excavation.

Responses to the community and the PRP comments are found in the Responsiveness Summary for OUs 2&3 in Section 14.0 of this ROD.

9.3 OU 4: Soil and OU 5: Surface Water and Sediments

9.3.1 Threshold Criteria

9.3.1.1 Overall Protection of Human Health and the Environment

9.3.1.1.1 OU 4: Soils. All of the alternatives for soils are protective of human health and the environment. This is because the risks to human health and the environment posed by soil at the Lowry Site are estimated to be minimal and in the range of background risks. Background risks were found to already be within EPA's acceptable risk range. The No Further Action alternative (SOIL-1) would be the most protective because it would not entail any disturbance of soils, thereby minimizing the potential for exposure. The remaining alternatives (SOIL-2, SOIL-4a, and SOIL-4b) would involve soil disturbance during construction or excavation which could potentially uncover material of greater risk. Moreover, the disturbance of the soil would result in an exposure pathway to construction workers.

9.3.1.1.2 OU 5: Surface Water. The No Further Action alternative (SW-1) is protective of human health and the environment because the Surface Water Removal Action (SWRA) isolates and treats, to protective levels, contaminated seepage that previously existed as surface water flow in the unnamed creek. No other alternatives were evaluated for surface water because the SWRA can be fully integrated into the sitewide remedy.

9.3.1.1.3 OU 5: Sediments. All alternatives considered for sediments in both Sections 6 and 31 would be protective of human health and the environment.

Sediments in Section 6 have already been covered by a geotextile and low-permeability soft cap as part of the SWRA. Therefore, there is no exposure to Section 6 sediments and no current or future risk to human health and the environment. Alternative SED6-2 would be slightly more protective of human health and the environment because the exposure pathway posed by sediments in Section 6 would be further limited through a physical barrier (fence).

For Section 31 sediments, the Baseline Risk Assessment found that risks associated with potential sediment contaminant exposures were within the acceptable excess cancer risk range. Therefore, Alternative SED31-1 (the No Further Action alternative) would be protective of human health and environment. Alternatives SED31-2 and SED31-3 are considered to be the most protective because they would eliminate exposure, although there would be an increased potential for short-term exposure to sediments from the disturbance of sediments.

9.3.1.2 Compliance with ARARs

The ARARs for OUs 4&5 alternatives are discussed in Section 8.0.

9.3.1.2.1 OU 4: Soils. All alternatives would meet ARARs. The requirements primarily deal with landfilling and maintenance actions and would be met by following the requirements of the regulations.

9.3.1.2.2 OU 5: Surface Water. The only alternative evaluated, No Further Action, would meet ARARs.

9.3.1.2.3 OU 5: Sediments. All alternatives for both Section 6 and Section 31 sediments would meet ARARs. The ARARs primarily deal with construction, excavation, and landfilling actions and would be met by satisfying the requirements of each regulation.

9.3.2 Primary Balancing Criteria

9.3.2.1 Long-Term Effectiveness and Permanence

9.3.2.1.1 OU 4: Soils. Alternatives SOIL-4a, and SOIL-4b (Excavation and Landfill) would provide the greatest long-term effectiveness and permanence because these alternatives would require excavation and landfilling of contaminated materials.

Alternative SOIL-2 (Access Restrictions and Dust Control) would provide the next greatest long-term effectiveness and permanence because the soil would be covered by vegetation and exposure to the soil would be further restricted by a fence. The No Further Action alternative would provide the next level of long-term effectiveness and permanence through institutional controls. The risks associated with the No Further Action alternative are within EPA's acceptable risk range. Therefore, the No Further Action alternative would offer acceptable long-term effectiveness and permanence.

9.3.2.1.2 OU 5: Surface Water. The SWRA has been constructed, has operated reliably, and has met performance standards. The SWRA has been designed for long-term operation and will be monitored and maintained such that it continues to achieve performance standards. Thus, the SWRA will provide long-term effectiveness and permanence.

9.3.2.1.3 OU 5: Sediments. In Section 6, the sediments have already been covered as part of the SWRA. Alternative SED6-2 (Access Restrictions) would provide the greatest long-term effectiveness and permanence by fencing the cover over the sediments to restrict access and by maintaining the cover. Alternative SED6-1 (No Further Action) would provide nearly as great long-term effectiveness and permanence through continued maintenance of the cover.

Alternative SED31-3 (the Excavation and Landfill alternative) would provide the greatest long-term effectiveness and permanence through removal and landfilling of the sediments. Alternative SED31-2 (the Access Restriction/Capping alternative) would provide the next level of long-term effectiveness and permanence by minimizing the exposure to the sediments through physical barriers (a cap and fence). Alternative SED31-1 (No Further Action) would provide acceptable long-term effectiveness and permanence because the risks associated with the sediments are within EPA's acceptable risk range.

9.3.2.2 Reduction of Toxicity, Mobility, or Volume Through Treatment

9.3.2.2.1 OU 4: Soils. None of the soils alternatives involve treatment. Therefore, these alternatives would not result in a reduction of toxicity, mobility, or volume through treatment.

9.3.2.2.2 OU 5: Surface Water. Under the No Further Action alternative, the SWRA would reduce the volume of contaminants through collection and treatment of the alluvial seepage. In the absence of the SWRA, this seepage would have become contaminated surface water by emerging in the unnamed creek drainage. There would be no apparent reduction in the toxicity or mobility of the contaminants since the treatment would not induce any changes in the chemical forms; however, the contaminants would be immobilized/adsorbed using granular activated carbon during treatment.

9.3.2.2.3 OU 5: Sediments. None of the sediments alternatives for Section 6 or 31 would involve treatment. Therefore, these alternatives would not result in a reduction of toxicity, mobility, or volume through treatment. However, the mobility of the contaminants would be reduced in Alternatives SED31-2 and SED31-3 through engineering controls.

9.3.2.3 Short-Term Effectiveness

9.3.2.3.1 OU 4: Soils. The No Further Action alternative (SOIL-1) would not involve soil disturbance and, therefore, would provide maximum short-term protection to workers and the community. The risk from soils are already within EPA's acceptable risk range and therefore the time until protection is achieved is immediate.

Alternative SOIL-2 would provide the next greatest short-term protection to workers, the environment, and the community because it involves only access restrictions and dust control activities.

Alternatives SOIL-4a and SOIL-4b would involve disturbance in the short-term through excavation of soils. This would result in a potential for exposure to workers and disturbance of existing habitats.

9.3.2.3.2 OU 5: Surface Water. Construction and startup of SWRA facilities have been completed and were conducted in a manner without accidents or adverse environmental impacts. Therefore, the SWRA satisfies the short-term effectiveness criterion.

9.3.2.3.3 OU 5: Sediments. Alternatives SED6-1 (No Further Action) and SED31-1 (No Further Action) provide the greatest short-term effectiveness for workers, the community, and the environment because these alternatives require no disturbance of sediments. Alternative SED6-2 requires installation of fencing, which would involve minimal exposure to workers and habitat disturbance. Alternatives SED31-2 and SED31-3 would involve sediment disturbance through capping and/or excavation activities. Therefore, these alternatives would be the least effective in providing short-term protection.

9.3.2.4 Implementability

9.3.2.4.1 OU 4: Soils. All alternatives are considered to be technically and administratively implementable. Alternatives SOIL-2, SOIL-4a (Option 1), SOIL-4b (Option 1), and the No Further Action alternative would be equally implementable. Option 2 of Alternatives SOIL-4a and SOIL-4b would be harder to implement because of technical difficulties associated with the one-time excavation of approximately 2.5 million cubic yards of soil, uncertainties about availability of land for stockpiling, and difficulties associated with maintenance of the stockpile.

9.3.2.4.2 OU 5: Surface Water. The SWRA has been constructed and is operational, and is therefore implementable.

9.3.2.4.3 OU 5: Sediments. Implementation of Alternative SED6-1 (No Further Action alternative) and Alternative SED6-2 (Access Restrictions) would be technically feasible because of the availability of materials for access control and for fugitive dust and noise control. Except for additional fencing, Alternative SED6-2 (Access Restrictions) is already an integral part of the SWRA.

Alternative SED31-1 (No Further Action) and Alternative SED31-2 (Access Restrictions and Capping) would both be technically implementable. Alternative SED31-3 (Excavation and Landfill) would also be implementable; however, some seasonal delays could be encountered when implementing this alternative because of a potential need for wetlands construction.

9.3.2.5 Cost

9.3.2.5.1 OU 4: Soils. Excavation alternatives generally have the highest present-worth costs. Alternative SOIL-4b (Option 2) is the most expensive because of the magnitude of excavation, materials movement, and offsite stockpiling. The No Further Action alternative and Alternative SOIL-4a (Option 1) would be the least expensive alternatives. Present-worth costs for OU 4 are ranked below. These costs include estimated capital and O&M costs.

- Alternative SOIL-1: No Further Action

  - Capital Costs: $22,000
  - Annual O&M Costs: $24,000
  - Total (30-year Present Worth): $390,000

- Alternative SOIL-4a, Option 1: Excavation (as-needed) and Landfill (onsite)

  - Capital Costs: $43,000
  - Annual O&M Costs: $29,000
  - Total (30-year Present Worth): $490,000

- Alternative SOIL-4b, Option 1: Excavation (as-needed) and Landfill (offsite)

  - Capital Costs: $1,200,000
  - Annual O&M Costs: $44,000
  - Total (30-year Present Worth): $1,880,000

- Alternative SOIL-2: Access Restrictions and Dust Control

  - Capital Costs: $1,400,000
  - Annual O&M Costs: $44,000
  - Total (30-year Present Worth): $2,080,000

- Alternative SOIL-4a, Option 2: Excavation (one-time) and Landfill (onsite)

  - Capital Costs: $2,800,000
  - Annual O&M Costs: $31,000
  - Total (30-year Present Worth): $3,280,000

- Alternative SOIL-4b, Option 2: Excavation (one-time) and Landfill (offsite)

  - Capital Costs: $4,000,000
  - Annual O&M Costs: $52,000
  - Total (30-year Present Worth): $4,800,000

9.3.2.5.2 OU 5: Surface Water. Capital costs for construction of the SWRA have already been incurred and are not included in the cost estimate. Other costs associated with the No Further Action alternative (SW-1) would include O&M for the SWRA and the construction of wetlands. These costs are as follows:

- Alternative SW-1, No Further Action

  - Capital Costs: $41,000
  - Annual O&M Costs: $790,000
  - Total (30-year Present Worth): $12,190,000

9.3.2.5.3 OU 5: Sediments. Access Restrictions/Capping (Alternative SED31-2) and Excavation and Landfill (Alternative SED31-3) would be the most costly alternatives. The No Further Action alternatives (SED6-1 and SED31-1) would be the least expensive alternatives. Present-worth costs for sediments alternatives are ranked below. These costs include estimated capital and O&M costs.

- Section 6 Sediments Alternative SED6-1: No Further Action
  - Capital Costs: $16,000
  - Annual O&M Costs: $15,000
  - Total (30-year Present Worth): $250,000
- Section 6 Sediments Alternative SED6-2: Access Restrictions
  - Capital Costs: $93,000
  - Annual O&M Costs: $23,000
  - Total (30-year Present Worth): $450,000
- Section 31 Sediments Alternative SED31-1: No Further Action
  - Capital Costs: $22,000
  - Annual O&M Costs: $18,000
  - Total (30-year Present Worth): $300,000
- Section 31 Sediments Alternative SED31-2: Access Restrictions and Capping
  - Capital Costs: $400,000
  - Annual O&M Costs: $53,000
  - Total (30-year Present Worth): $1,215,000
- Section 31 Sediments Alternative SED31-3: Excavation and Landfill
  - Capital Costs: $620,000
  - Annual O&M Costs: $40,000
  - Total (30-year Present Worth): $1,235,000

9.3.3 Modifying Criteria

9.3.3.1 State/Support Agency Acceptance

The State of Colorado concurs with the EPA on the selection of the No Further Action alternative for OUs 4&5.

9.3.3.2 Community Acceptance

Community input on the alternatives for remedial action for OUs 4&5 was solicited by EPA and CDH during the public comment period from September 1, 1993, to November 29, 1993. Comments received from the community and the PRPs indicate no opposition to the preferred alternative for each media under OUs 4&5. Responses to community comments are found in the Responsiveness Summary in this ROD.

Section 10.0
Documentation of Significant Changes

Two separate Proposed Plans were published by EPA and released for the Lowry Site. One Proposed Plan was for the Shallow Ground Water and Subsurface Liquids/Deep Ground Water Operable Units (OUs 1&6), and that document was released for public comment in November 1992. The second Proposed Plan for the Landfill Solids/Gas Operable Units and for the Soils/Surface Water and Sediments Operable Units (OUs 2&3 and 4&5) was released for public comment in August 1993. The second Proposed Plan also included a description of the proposed sitewide remedy that addressed all six OUs.

The Proposed Plan for OUs 1&6 identified Modified Alternative GW-5 (the North Boundary/Toe of Landfill/Lateral and Upgradient Containment, Collection, and Treatment alternative) as the preferred alternative for ground-water and subsurface liquids remediation. EPA reviewed all written and verbal comments submitted during the public comment period, and issued a preliminary response in August 1993.

The OUs 2&3 and 4&5 Proposed Plan identified Modified Alternative LFS-4 (the Drum Removal/Offsite Disposal/North Face Cover alternative) as the preferred alternative for landfill solids and Modified Alternative LFG-3 (the Gas Collection/Enclosed Flare alternative) as the preferred alternative for landfill gas. For soils, surface water, and sediments, the OUs 2&3 and 4&5 Proposed Plan identified the No Further Action alternative as the preferred alternative. The OUs 2&3 and 4&5 Proposed Plan also described how all of the preferred alternatives would be integrated into a sitewide remedy. The sitewide remedy is the combination of the preferred alternatives for each OU.

There are no significant changes from the proposed plans. However, the present worth cost calculations, as they appear in the ROD, differ slightly from those presented in the proposed plans. In order to allow for the consistent comparison of costs for the various alternatives, EPA recalculated the costs using a single set of assumptions. The following factors were standardized for all components of the selected sitewide remedy: indirect costs; capital costs contingencies; interest rates; and inflation rates.

Section 11.0
Selected Sitewide Remedy

After considering CERCLA's statutory requirements, the detailed analysis of the alternatives using the nine criteria, and public comments, EPA, in consultation with CDH, has determined that the most appropriate sitewide remedy for the Lowry Site includes the following OU components, described in greater detail in Subsections 11.2 through 11.5 of this ROD:

- OUs 1&6-Shallow Ground Water and Subsurface Liquids and Deep Ground Water-Modified Alternative GW-5 (the North Boundary, Toe of Landfill, and Lateral [Eastern and Western] Containment, Collection and Treatment plus Upgradient Containment, Collection and Diversion alternative).

- OU 2-Landfill Solids-Modified Alternative LFS4 (the Drum Removal/Offsite Disposal/North Face Cover alternative).

- OU 3-Landfill Gas-Modified Alternative LFG-3 (the Gas Collection/Enclosed Flare alternative).

- OU 4&5-Soils, Surface Water, and Sediments-No Further Action alternative.

The selected sitewide remedy also includes the general components described in Subsection 11.1 of this ROD. The selected sitewide remedy addresses all contaminated media at the Lowry Site and provides the best balance of tradeoffs among the nine criteria. EPA has also determined that the selected sitewide remedy is protective of human health and the environment. Although the selected sitewide remedy includes containment elements, the selected sitewide remedy also includes significant collection and treatment elements. Figure 11-1 is a graphical representation of the selected sitewide remedy. Table 11-1 presents the ARARs for the selected sitewide remedy. Additional performance standards for the selected remedy are described in the following subsections.

11.1 General Components of the Selected Sitewide Remedy

The selected sitewide remedy includes the following general components:

- Institutional Controls-Institutional controls are nonengineering methods by which Federal, State, local governments, or private parties can prevent or limit access to or use of a site. Institutional controls for the Lowry Site shall include, but not be limited to, deed notices and restrictions that run with the land; onsite access restrictions including, but not limited to, fencing and warning signs; zoning controls; and well restrictions. Executive Order No. 97, as issued by City and County of Denver Mayor Federico Peña, currently provides some measure of control. Institutional controls at the Lowry Site must prohibit all activities and uses that EPA determines would interfere or be incompatible with, or that would in any way reduce or impair the effectiveness or protectiveness of, the sitewide remedy. These shall include, but are not limited to, prohibitions on all ground-water well construction and use not necessary for implementation and monitoring of the selected remedy; prohibitions on access; and prohibitions on activities and land use not connected with design, construction, and implementation and monitoring of the selected sitewide remedy.

- Offsite institutional controls shall serve as an additional measure of protection to enhance the effectiveness of the selected remedy and to act as preventative measures to preserve the implementability and effectiveness of any of the selected remedy contingency measures. Offsite institutional controls shall include, but not be limited to, deed notices and restrictions, zoning controls, and well restrictions. These controls must prohibit all offsite activities in the vicinity of the Lowry Site that would interfere or be incompatible with, or that would in any way reduce or impair the effectiveness or protectiveness of, the selected sitewide remedy.

  All onsite and offsite institutional controls shall be adequately administered, maintained, and enforced.

  The owner and operator of the Lowry Site shall be responsible for access restrictions, warning signs, and fences.

- Performance and Compliance Monitoring-To ensure that the performance standards are met for all components of the selected remedy for as long as contamination remains onsite, a long-term monitoring program shall be designed and implemented during the RD/RA and shall continue throughout the implementation of the selected sitewide remedy. The monitoring program shall assess compliance with the remediation levels in the ground-water system, monitor effluent chemical concentrations from the treatment plant, evaluate the horizontal and vertical migration of contamination, monitor the erosion of soils and sediments, and monitor the migration of landfill gases. Details of the monitoring program shall be determined by EPA, in consultation with CDH, during the RD. The monitoring program shall include, at a minimum, the following: analytical parameters and methods; indicator parameters; monitoring locations; monitoring frequency and duration; sampling methods; well installation, maintenance and abandonment procedures; statistical methods for evaluating data; reporting methods and procedures for tracking and maintaining sample records; and QA methods, including data validation methods. It is estimated that approximately 60 to 100 ground-water monitoring wells will be sampled semi-annually. Landfill gas shall be monitored quarterly, or more frequently if migration is detected, using approximately 40 to 60 monitoring wells. The ground-water monitoring component of the selected sitewide remedy includes an early-warning monitoring component; this will allow for a timely remedial response in the event that EPA determines that additional remedial actions are necessary. Soil and sediment erosion shall be monitored on a monthly basis using three surface-water samplers installed in drainages. The actual details of the monitoring program are subject to revisions and refinement during RD.

- Five-Year Review-As specified in Section 121(c) of CERCLA, as amended by SARA, and Section 300.430(f)(4)(ii) of the NCP, EPA will review the sitewide remedy no less often than each 5 years after the initiation of the remedial action to assure that human health and the environment are being protected by the implemented remedy (this review will ensure that the remedy is operating and functioning as designed and that institutional controls are in place and are protective). An additional purpose for the review is to evaluate whether the performance standards specified this ROD remain protective of human health and the environment. EPA will continue the reviews until no hazardous substances, pollutants, or contaminants remain at the Lowry Site above levels that allow for unrestricted use and unlimited exposure.

11.2 Remedy for Shallow Ground Water and Subsurface Liquids and Deep Ground Water

The selected remedy for shallow ground water and subsurface liquids and deep ground water (ground-water remedy) shall contain, collect, and treat contaminated shallow ground water at the Lowry Site. This shall be achieved through the construction and operation of barrier walls, collection and diversion systems, and a treatment system to be upgraded as necessary, and continued operation of the existing barrier wall and collection system, thereby reducing the mobility of potential contamination from the main source and reducing the level of toxicity and volume of contamination. Specifically, the groundwater remedy shall include the following containment and treatment components:

- Evaluation of the effectiveness of, and upgrading as necessary, the barrier wall system at the northern boundary of the Lowry Site to restrict offsite migration of contaminated ground water.

- Installation and operation of a ground-water extraction system at the toe of the former landfill. This ground water will be pumped to the ground-water treatment plant. The treatment plant will be upgraded as necessary to meet performance standards, as described below.

- Construction and operation of underground barrier walls and ground-water collection systems on the west and east sides of the Lowry Site.

- Construction and operation of an approximately 50-foot-deep upgradient ground-water containment, collection, and diversion system along the southern perimeter of the Lowry Site.

- Design and construction of a new ground-water treatment plant unless it can be demonstrated through pilot-scale testing during the RD that the existing ground-water treatment plant can effectively treat the more highly contaminated ground water to the performance standards.

- Annual interception and treatment of approximately 6.4 million gallons of contaminated ground water from the barrier walls and collection systems.

- Implementation of a long-term ground-water monitoring program for assessing compliance with performance standards and protectiveness of the remedy for the shallow ground-water system and potential impacts on deep ground water.

- Implementation of a contingency measure (see Subsection 11.2.1.2) if contaminant migration (including NAPLs movement) into deep ground water occurs in the future. EPA's decision regarding the contingency measure will be based on an evaluation of monitoring data and comparison with performance standards as described in Table 11-2.

The ground-water remedy also includes components of the selected remedies for OUS 2&3 and OUS 4&5. Applicable components include:

- Maintenance of the existing cover on the landfill mass (described in Subsection 11.3).

- As modified by this ROD, continued operation of the Surface Water Removal Action (SWRA), including the upgraded treatment plant and collection system within unnamed creek. The Surface Water Removal Action also includes continued operation, maintenance, and monitoring of the existing ground-water barrier wall at the northern boundary of the Lowry Site. Transition from the SWRA performance standards to the ground-water remedy performance standards is described in Subsection 11.2.2.1.

The ground-water remedy shall achieve the Remedial Action Objectives (RAOs) for the protection of human health and the environment. The RAOs for the ground-water remedy are:

- Prevention of exposure to humans and the environment (through ingestion, inhalation, or dermal absorption) from liquids (either ground water or waste-pit liquids) containing contaminants in excess of the performance standards

- Prevention of migration of contaminants beyond the compliance boundary in excess of the performance standards

- Prevention of horizontal migration of dissolved ground-water contaminants offsite and to surface waters

- Prevention of vertical migration of dissolved ground-water contaminants beyond the lignite layer

- Prevention of movement of nonaqueous phase liquids (NAPLs) beyond the compliance boundary and minimization of movement of NAPLs

- Minimization of infiltration and leachate production in the waste-pit source

11.2.1 Containment Components (Barrier Walls and Collection Systems)

The containment components of the ground-water remedy shall effectively isolate the contamination at the Lowry Site from the surrounding areas by controlling horizontal migration of contaminated ground water through the construction of containment and diversion systems. The construction and operation of these systems shall comply fully with all ARARs as described in Table 11-1. The requirements of the Colorado Hazardous Waste Act and Land Disposal Restrictions of the Solid Waste Act shall be met through testing and proper disposal if RCRA hazardous waste, hazardous waste sufficiently similar to RCRA hazardous waste, or solid waste is generated during construction. Air emissions shall be monitored to ensure compliance with the Colorado Air Quality Act/Air Pollution Regulations. All monitoring wells shall be constructed and abandoned according to the requirements of the Well Construction and Abandonment Procedures of the State Engineer's Office to ensure that a migration pathway is not created.

The following discussion provides a detailed description of each containment component. Figure 11-1 illustrates the approximate locations and relative length of each containment component.

Northern Boundary. Containment shall be accomplished using the existing barrier wall, elongating the existing barrier wall, or constructing a barrier wall immediately upgradient or downgradient of the existing barrier wall that may be deeper and longer than the existing barrier wall. The effectiveness of the existing barrier wall and the need for a modified barrier wall or new barrier wall shall be evaluated during the RD. EPA shall determine whether a modified or new barrier wall is needed, based on an evaluation of whether the existing system is able to meet performance standards. The protectiveness of this component of the selected remedy shall be ensured on the northern boundary by the implementation of monitoring systems at the compliance boundary and at the Point of Action boundary (installation of an early warning monitoring well network).

Toe of the Landfill. A ground-water extraction system shall be installed and operated at the toe of the landfill to capture contaminated shallow ground water migrating from the landfill mass at the Lowry Site and prevent further contamination of the aquifer downgradient of the landfill mass. The dimensions of the subsurface drain shall be such that the drain will intercept and collect the contaminated ground water within the shallow ground-water system at the toe of the landfill mass. Approximate dimensions are 300 feet long and 50 feet deep, but actual dimensions shall be determined by EPA, in consultation with CDH, during RD.

Eastern and Western Boundaries. Underground barrier walls and ground-water collection systems shall be constructed and operated on the east and west sides of the Lowry Site so as to prevent potential offsite migration of contaminated shallow ground water. The dimensions of the systems shall be such that the collection systems will intercept and collect the contaminated ground water within the sand channels within the shallow ground-water aquifer. Approximate dimensions are 2,000 feet long by 50 feet deep on the eastern boundary and 1,000 feet long by 50 feet deep on the western boundary. Actual dimensions shall be determined by EPA, in consultation with CDH, during RD. The protectiveness of these components of the selected remedy shall be ensured on the eastern and western boundaries by the implementation of monitoring systems at the compliance boundary and at the Point of Action boundary (installation of an early warning monitoring well network).

Southern Perimeter. An approximately 50-foot-deep upgradient ground-water containment, collection, and diversion system (barrier wall) shall be constructed and operated along the southern perimeter of the Lowry Site so as to prevent offsite contaminant migration to the south and recharge of ground water from the south. The barrier wall shall be installed in the saturated portion of the weathered zone. The approximate dimensions of the barrier wall are 1,500 feet long, 50 feet deep, and 3 feet wide. Upgradient extraction wells shall also be installed to collect uncontaminated upgradient ground water for diversion around the Lowry Site. The actual dimensions of the barrier wall system and configuration of the upgradient extraction wells shall be determined by EPA, in consultation with CDH, during RD. The protectiveness of this component of the selected remedy shall be ensured on the southern boundary by the implementation of monitoring systems at the compliance boundary and at the Point of Action boundary (installation of an early warning monitoring well network).

11.2.1.1 Performance Standards and Points of Compliance

The containment components of the ground-water remedy shall meet the performance standards, which are presented in Tables 11-1 and 11-2. Table 11-1 includes all ARARs for the selected remedy, including the ground-water portion of the remedy. Table 11-2 presents chemical-specific numeric standards for the ground-water remedy, some of which are based on ARARs. Table 11-2 performance standards shall be met at the ground-water compliance boundary.

The compliance boundary is depicted in Figure 11-2. The compliance boundary for vertical ground-water migration is the lignite layer. The ground water within the compliance boundary is not expected to be restored to meet the performance standards because the sitewide remedy consists of containment and the source areas will remain in place.

In locating the point of compliance for ground-water performance standards, EPA has determined that performance standards shall be attained at and beyond the edge of the waste management area when waste is left in place. At the Lowry Site, the plume of ground-water contamination is caused by releases from several distinct sources that are in close geographical proximity. In addition to the delineated locations of the waste pits and landfill mass, historical evidence indicates that the northwestern, northern, northeastern, and eastern areas of the Lowry Site received waste via sludge application, leachate injection, and leachate spraying. Consequently, the most feasible and effective groundwater cleanup strategy is to draw the point of compliance to encompass the sources of release and thereby address ground-water contamination as a whole. In establishing the ground-water compliance boundary, EPA considered the proximity of the sources, the technical practicability of ground-water remediation, the vulnerability of the ground water and its possible uses, and the likelihood of exposure.

The selected ground-water remedy also includes a Point of Action (POA) boundary (Figure 11-2). Table 11-3 identifies numeric standards for the POA boundary which are based on the Colorado Basic Standards for Ground Water [5 CCR-1002-8 (3.11.5c)]. The POA boundary encompasses the highly concentrated waste-pit liquids and ground water within the main source area and unnamed creek. Ground-water monitoring shall be conducted at the POA boundary and additional measures, as described in the next section, shall be taken if Table 11-3 standards are exceeded at the POA boundary. The POA boundary has been established to provide sufficient warning such that response actions can be taken to prevent violation of performance standards at the compliance boundary. The physical/surveyed location of the compliance boundary and the POA boundary shall be determined by EPA during RD.

To ensure compliance of the ground-water containment components with the RAOs and performance standards, the barrier walls and collection systems shall be monitored. The monitoring systems shall consist of wells upgradient, downgradient, and adjacent to the barrier walls. The well placement shall be such that the hydraulic gradient information from the wells demonstrates the containment systems' effectiveness. Additionally, contaminant concentrations shall be measured to determine whether the containment systems capture the ground water and prevent contamination downgradient and adjacent to the systems. Details of the monitoring program shall be determined by EPA, in consultation with CDH, during the RD.

11.2.1.2 Contingency Measures

If, during implementation or operation of the ground-water remedy, contaminant levels exceed the performance standards at the POA or compliance boundaries, appropriate measures shall be taken to prevent and remediate contaminant migration beyond the compliance boundary. Such measures may include but are not limited to any or all of the following, subject to approval by EPA:

- Alternating pumping at wells to eliminate stagnation points
- Pulse pumping to allow aquifer equilibration and to allow adsorbed contaminants to partition into ground water
- Installation of additional extraction wells to facilitate containment of the contaminant plume, to address possible vertical migration of contaminants, and if necessary to remediate the ground water to performance standards.

To ensure that performance standards continue to be met and maintained, the aquifer shall be monitored at appropriate locations and frequencies, as determined by EPA.

If EPA determines, on the basis of monitoring data, that contaminants have migrated vertically downward to the lignite layer, contingency measures shall be implemented to ensure that performance standards are achieved and maintained and to ensure that the beneficial use of the underlying aquifer is not impaired. Contingency measures may include any or all of the following, at EPA's discretion, for an indefinite period of time, as a modification of the existing system:

- Additional engineering controls such as underground barriers, or long-term gradient control provided by low level pumping, as containment measures
- Continued monitoring of specified wells
- Periodic re-evaluation of remedial technologies for ground-water restoration
- Additional institutional controls on water extraction and use

11.2.2 Treatment Component

The ground-water remedy shall treat approximately 6.4 million gallons of contaminated ground water annually, collected from the new and existing collection systems and barrier walls. A new onsite treatment plant shall be designed and constructed unless it can be demonstrated through pilot-testing that the existing plant can be upgraded to effectively treat the more highly contaminated ground water from the toe of the landfill to performance standards. Based on treatability studies of the influent from the toe of the landfill conducted during the OUS 1&6 RI, the following treatment technologies have been determined to be effective in treating highly contaminated ground water and may be used to treat the contaminated ground water collected from the Lowry Site: gravity-phase separation for nonaqueous phase liquids (NAPLs); lime soda softening for metals, radionuclides, hardness, and solids; and biological treatment (PACT) to remove organic compounds, BOD, COD, ammonia, and nitrate. Treatment technologies shall be evaluated further during RD; actual selection of treatment technologies shall be subject to EPA approval, in consultation with CDH.

Air emissions from the treatment plant shall be treated using vapor-phase activated carbon and monitored to ensure that performance standards, including the Colorado Air Quality Act/Air Pollution Regulations are met. During construction and operation, noise levels will be monitored to ensure that the Colorado Noise Abatement Statute will be met.

11.2.2.1 Performance Standards and Points of Compliance

The ground-water treatment plant shall meet water and air quality performance standards presented in Tables 11-2 and 11-5 of this ROD, respectively, no later than 60 days after the startup of a new or upgraded ground-water treatment plant, or no later than 60 days after a determination by EPA that the existing treatment plant may be used without an upgrade. These performance standards shall supersede the performance standards identified in the SWRA Consent Order. However, until that time, the performance standards identified in the SWRA Consent Order shall remain in effect. The point of compliance for the ground-water treatment plant effluent shall be existing Port 13 of the treatment plant or its equivalent in the upgraded or new treatment plant.

Table 11-4 identifies performance standards for surface water. While a surface water discharge from the ground-water treatment plant is not anticipated, there is a possibility that the ground-water injection trench could malfunction and allow water to surface. Any such surface water discharge shall meet the performance standards in Table 11-4.

Construction, operation, and maintenance of the ground-water treatment plant shall comply with the performance standards (ARARs) specified in Table 11-1.

Residuals from the treatment process will include spent vapor-phase granular activated carbon, solids from lime-soda softening, and PACTTM solids. Spent carbon shall be transported and regenerated offsite in accordance with the performance standards (ARARs) identified in Table 11-1 and in compliance with EPA's offsite policy. Other residuals shall be transported and disposed in accordance with the performance standards (ARARs) identified in Table 11-1 and EPA's offsite policy.

Monitoring pursuant to a plan approved by EPA shall be conducted to ensure that performance standards are met.

11.2.2.2 Contingency Measures

The treatability studies conducted during the OUS 1&6 RI indicated that there may be difficulty in achieving the performance standards for certain metals and methylene chloride and other similar organics. If performance standards for metals cannot be met by the existing ground-water treatment plant, additional metal treatment processes shall be installed to ensure compliance with the performance standards. Additionally, if performance standards for any organics, including, but not limited to, methylene chloride, cannot be met by the treatment plant, additional treatment technologies shall be installed to ensure compliance with the performance standards.

11.3 Remedy for Landfill Solids

The selected remedy for landfill solids is containment for the landfill mass and removal of accessible in the former tire pile area and shall be achieved through the following activities:

- Maintenance of the existing cover on the landfill mass
- Placement of an additional 2-foot cover on the north face of the landfill
- Excavation, removal, and treatment, within the former fire pile area, of surface and subsurface drums, contaminated softs, and waste pits and reclamation of the former tire pile area

The solids remedy shall achieve the following landfill solids RAOs:

- Protection of human health and the environment from direct contact or ingestion of landfill solids or softs intermingled with landfill solids containing contaminants
- Protection of humans from inhalation of volatilized contaminants from landfill solids or soils intermingled with landfill solids, and inhalation of contaminated airborne particulate matter from soils or landfill solids that exceed performance standards
- Minimization of the production and migration of leachate, from landfill solids or soils intermingled with landfill solids, to the saturated zone and ground water
- Minimization of the migration of soils intermingled with solids, caused by erosion or entrainment by wind or water
- Prevention of offsite migration of landfill solids and soils intermingled with solids into other media
- Protection of human health and the environment from direct contact with or ingestion of leachate that exceeds the performance standards for shallow ground water and subsurface liquids
- Prevention of offsite migration of leachate or infiltration into other media

Maintenance of the existing cover on the landfill mass and the addition of a 2-foot cover on the north face of the landfill mass shall reduce risk by minimizing (1) the potential for contact with contamination from landfill solids, and (2) infiltration, thus reducing additional ground-water contamination. Details of operation and maintenance measures for the existing cover and the new north face cover shall be refined during RD and shall be subject to EPA approval, in consultation with CDH.

11.3.1 Performance Standards and Points of Compliance

Excavation activities in the former tire pile area shall remove surface and subsurface drums, associated free liquids, and other visible contamination to the extent practicable. This shall include excavation of contaminated materials and softs in waste pits in the former tire pile area. It is estimated there are approximately 10 surface and 1,350 buried drums containing approximately 1,300 gallons of liquid waste, and that there are approximately 15,000 cubic yards of contaminated sod and debris in the area. The actual numbers may be different. "Visible" contamination shall include stained or discolored materials such as soft, construction debris, woody materials, and refuse; excavation "to the extent practicable" shall include the removal of visible contamination until undisturbed, competent, native bedrock is encountered. These terms, as well as the overall areal extent of contamination and approach to excavation within the former tire pile area, will be further defined by EPA, in consultation with CDH, during RD.

Contaminated materials in the former tire pile area shall be excavated and characterized for offsite treatment and disposal to meet RCRA Subtitle C and D requirements of the Solid Waste Disposal Act and the Colorado Hazardous Waste Act. In addition, maintenance of the landfill cap shall comply with the above ARARs. Liquids shall be treated offsite at a RCRA Subtitle C facility using incineration and ash stabilization, or other treatment method capable of similar performance approved by EPA, in consultation with CDH. It is anticipated that solids and soils shall be treated using stabilization before disposal, but actual treatment methods shall be determined by EPA, in consultation with CDH, during RD.

The excavations shall be backfilled with clean softs. To meet the existing grade, a 2-foot-thick layer of clay soil shall be placed on top of the excavated areas as a cap. The purpose of the cap shall be to minimize infiltration. The clay shall be placed in lifts not exceeding 6 inches and compacted to a minimum of 95 percent relative density according to Standard Proctor (ASTM D698). A minimum 6-inch top soil layer shall be placed on top of the cap and shall be vegetated with a dryland pasture mix similar to that used on the main landfill mass to stabilize the cap surface and minimize soil and wind erosion.

The remedy for landfill solids shall comply with all other performance standards (ARARs) identified in Table 11-1.

11.4 Remedy for Landfill Gas

The selected remedy for landfill gas shall contain, collect, and treat landfill gas to prevent offsite migration of, and explosion due to, landfill gas. Containment, collection, and treatment of landfill gas shall be achieved through the construction and installation of perimeter and interior gas extraction wells and treatment of the gas using an enclosed flare. Specifically, the selected remedy shall include the following components:

- Installation of gas collection and monitoring wells on the western, eastern, and southern perimeter and in the interior of the former landfill

- Treatment of landfill gas using an enclosed flare

The landfill gas remedy shall achieve the following RAOs for landfill gas:

- Protection of human health from inhalation of landfill gases in excess of the performance standards

- Protection of human health and the environment from explosion hazards associated with landfill gases

- Prevention of offsite migration of landfill gas or migration to other media

The installation of gas collection wells on the western, eastern, and southern boundaries, and in the interior of the former landfill, shall control gas migration. Approximately 21 perimeter collection wells and two interior collection wells shall be installed to intercept migrating gas. The gas shall be treated at a rate of approximately 2,000 scfm per day using an enclosed flare with an 8-foot-diameter stack approximately 40 feet in height. Condensate collected in the gas collection system shall be treated in the groundwater treatment plant. The actual number and location of wells, rate of treatment, and size of the enclosed flare, may change as a result of RD, subject to EPA approval, in consultation with CDH.

Approximately 26 gas monitoring probes shall also be installed along the perimeter of the Lowry Site to improve the perimeter gas monitoring system. The actual number may change as a result of RD, subject to EPA approval, in consultation with CDH. Samples collected from the gas monitoring probes shall be analyzed for methane and VOCs, which shall act as indicators for the effectiveness of the collection system. EPA will evaluate existing gas, waste-pit liquid, and ground-water monitoring wells within the former landfill for the potential for vertical migration of gas from these wells. Wells that are likely to cause vertical migration of gas shall be properly plugged and abandoned. The requirements of the Well Construction and Abandonment Procedures of the State Engineer's Office shall be met during any installation or abandonment of wells.

The selected remedy for landfill gas shall comply fully with all pertinent ARARs as described in Table 11-1. The requirements of RCRA Subtitles C and D, the Clean Air Act, and the Colorado Air Quality Act/Colorado Air Pollution Regulations shall be met through the use of an enclosed flare. (The enclosed flare is not considered a "totally enclosed treatment facility" for purposes of RCRA's use/reuse exemption.) The requirements of the Colorado Hazardous Waste Act shall be met through proper disposal if RCRA hazardous wastes or wastes sufficiently similar to hazardous wastes are generated during the installation of gas monitoring or extraction wells.

11.4.1 Performance Standards and Point of Compliance

The landfill gas remedy shall meet the performance standards presented in Tables 11-1 and 11-7. Table 11-1 includes all ARARs for the selected remedy, including the landfill gas portion of the remedy. Table 11-7 presents chemical-specific numeric standards for the landfill gas remedy, some of which are based on ARARs. Table 11-7 performance standards shall be met at the landfill gas compliance boundary, which is depicted in Figure 11-3.

The landfill gas remedy also includes a Point of Action (POA) boundary (Figure 11-3). The POA boundary for landfill gas borders the toe of the landfill mass. Table 11-6 identifies numeric standards for the POA boundary which are based on a concentration which corresponds to a 1 x 10-4 risk level. Monitoring shall be conducted at the POA boundary to allow landfill gas to be addressed before it reaches the compliance boundary, thus preventing exceedances of the performance standards at the compliance boundary. If Table 11-6 standards are exceeded at the POA boundary, additional measures shall be required as described in the next section.

Monitoring shall also be conducted at the compliance boundary. If Table 11-7 performance standards are exceeded at the compliance boundary, contingency measures shall be required as described in the next section.

Flare emissions shall be measured at the enclosed flare stack and shall attain Table 11-7 performance standards. The flare shall meet the New Source Performance Standards (40 CFR Section 60.18); compliance shall be determined by testing for volatile organic compounds using procedures approved by EPA.

The physical/surveyed location of the POA boundary and compliance boundary is preliminary and shall be refined during the RD and subject to EPA approval.

11.4.2 Contingency Measures

If Table 11-6 standards are exceeded at the POA boundary, or if Table 11-7 performance standards are exceeded at the compliance boundary, contingency measures shall be implemented which may, at EPA's discretion, include the implementation of increased extraction rates and/or the installation of approximately 26 additional extraction wells within the landfill (Stage 3). The additional extraction wells would increase the total amount of gas extracted, thereby reducing landfill gas pressures. In addition, EPA may, at its discretion, require implementation of other technologies to further control landfill gas migration. Use of these other treatment technologies and operation and maintenance parameters shall be subject to EPA approval, in consultation with CDH.

11.5 Remedy for Soils and Surface Water and Sediments

The selected remedy for soils, surface water, and sediments is No Further Action. Specifically, the selected remedy for soils, surface water, and sediments includes the following components:

- Continued maintenance of the existing cover on the landfill mass
- Continued maintenance of other covered areas, including the unnamed creek drainage, vegetated areas, and the former tire pile area (after it is reclaimed), including visual monitoring for soil and sediment erosion
- As modified by this ROD, continued operation and maintenance of the SWRA and all its components, as set forth in the Consent Order (Docket No. CERCLA VII-91-12) and Modified Consent Decree (Civil Action 84-F-1507), including the existing ground-water barrier wall
- Mitigation of 0.87 acres of wetlands loss through construction of 0.87 acres of new wetlands

- Periodic monitoring of surface water runoff

The selected remedy for soils, surface water, and sediments shall achieve the following RAOs for soils, surface water, and sediments:

- Protection of human health and the environment from direct contact or ingestion of soils, surface water, and sediments containing contaminants that exceed the performance standards

- Protection of human health from inhalation of volatilized contaminants from the soils, surface water, or sediments; and inhalation of contaminated airborne particulate matter from soils or sediments that exceeds performance standards

- Minimization of the production and migration of contaminated surface water to the saturated zone and ground water

- Minimization of the migration of soils and sediments by erosion or entrainment by wind or water

- Minimization of migration of contaminated surface water offsite and into other media

11.5.1 Performance Standards and Points of Compliance

The selected remedy for soils, surface water, and sediments shall comply fully with the performance standards (ARARs) described in Table 11-1.

The selected remedy shall include the continued operation and maintenance of the SWRA. The components of the SWRA include a seepage collection system in the Section 6 segment of unnamed creek, a soil cover over the seepage collection system, the closure of Ponds 3 and 4, and the upgraded treatment plant. The SWRA is currently being and maintained in accordance with the requirements of the Final SWRA Performance and Compliance Monitoring Plan, dated June 1992. The SWRA shall continue to be operated and maintained in accordance with such plan unless otherwise required by this ROD or by EPA. EPA may require modifications to the plan to ensure that the requirements of this ROD are met.

The ground-water treatment plant shall meet water and air quality performance standards presented in Tables 11-2 and 11-5 of this ROD, respectively, no later than 60 days after the startup of a new or upgraded ground-water treatment plant, or no later than 60 days after a determination by EPA that the existing treatment plant may be used without an upgrade. These performance standards shall supersede the performance standards identified in the SWRA Consent Order. However, until that time, the performance standards identified in the SWRA Consent Order shall remain in effect. The point of compliance for the ground-water treatment plant effluent shall be existing Port 13 of the treatment plant or its equivalent in the upgraded or new treatment plant.

The selected remedy for surface water and sediments shall also include the construction of 0.87 acres of wetlands to replace those destroyed during installation of the SWRA. The composition of the vegetation of the created wetlands shall be equal to the types and percentages that were destroyed by the SWRA. The mitigation of wetlands shall fully comply with the Executive Order on Protection of Wetlands.

Mitigation shall consist of in-kind replacement of destroyed wetlands, except for the mud flats, which shall be replaced by vegetated wetlands. To account for mud flats replacement, the area of each of the three identified species shall be increased in proportion to the ratio of species extent to total extent of vegetated wetlands. As such, based on 1:1 replacement, 0.31 acres of Cattail Marsh, 0.01 acres of Three-Square Marsh, and 0.55 acres of Foxtail Barley Meadow shall be created.

The constructed wetlands shall be created in a location unaffected by Section 6 landfill closure, the SWRA, current Section 31 landfill operations, or future Section 31 landfill operations. Wetlands mitigation may occur offsite at a location more conducive to habitat enhancement. The final location of created wetlands shall be specified during the RD and shall be subject to EPA approval, in consultation with CDH.

Wetlands mitigation, which is conducted offsite and in connection with CERCLA activities, shall be regulated by EPA. EPA shall provide the necessary coordination among pertinent regulatory agencies such as the U.S. Army Corps of Engineers, U.S. Division of Fish and Wildlife, and Colorado Department of Health.

A 5-year maintenance program shall be started on the date that construction of the created wetlands is completed. This program shall establish successional trends and overall viability of the created wetlands. Four aspects shall be monitored: surface water, ground water, soils, and vegetation. The first year of monitoring shall determine if corrective actions are necessary and the approximate acreage in which the wetlands community has been established. Monitoring during years 2 through 5 shall document functional equivalency.

Annual monitoring of the surface water runoff into the unnamed creek drainage basin shall be conducted to evaluate the incidence of and potential for contaminant migration. Potential or actual migration shall be evaluated with the installation of approximately three automated surface water samplers. These samplers shall be installed on the western edge of the former landfill mass, in the unnamed creek drainage, and near the confluence of unnamed creek and Murphy Creek in Section 31. The specific parameters for annual monitoring shall be evaluated during RD and shall be subject to EPA approval.

11.5.2 Contingency Measures

Contingencies for the SWRA were developed as part of the SWRA design effort (the SWRA Contingency Plan dated May 1992; the Final SWRA Performance and Compliance Monitoring Plan dated June 1992; and the Final O&M Manual dated June 1993), are included as part of the selected remedy, and shall be implemented if (1) chemicals incompatible with treatment processes are detected in the treatment plant influent; (2) a collection system, barrier wall, and/or injection trench malfunctions or is inadequate to meet performance standards; (3) noncompliance with performance standards occurs; (4) surface ponding of seepage water occurs; or (5) new seeps develop above the engineered drain system. These contingency measures may be modified by EPA during RD to ensure the requirements of this ROD are met.

11.6 Cost of the Selected Sitewide Remedy

The selected sitewide remedy was evaluated for cost in terms of capital costs, annual or operation and maintenance costs (O&M), and present worth cost. Capital costs include the sum of the direct capital costs (materials, equipment, labor, land purchases) and indirect capital costs (engineering, licenses, or permits). Annual costs include the cost for labor, operation and maintenance, materials, energy, equipment replacement and disposal, and sampling to operate the treatment facilities. Present worth costs include capital costs and O&M costs calculated over a 30-year period. Table 11-8 summarizes the capital, annual operations and maintenance, and present worth costs for the selected sitewide remedy.

EPA integrated the OUS into a sitewide remedy to eliminate the duplication of costs between different OUS. In addition, EPA incorporated modifications to the alternatives in the selected sitewide remedy. The direct capital costs were revised to reflect the integration of the OUS and modifications to the alternatives.

The present worth analysis is used to evaluate expenditures that would occur over an assumed 30-year operation period by discounting all future costs to a common base year. This allows the cost of remedial action alternatives to be compared on the basis of a single figure representing the amount of money that, if invested in the base year and disbursed as scheduled, would be sufficient to cover all costs associated with the remedial action over its planned life.

Remedial design efforts may reveal that it is possible to reduce the original project cost estimates. Reductions in the estimated costs could be the result of value engineering conducted during the remedial design. Through the value engineering process, modifications could be made to functional specifications of the remedy to optimize performance and minimize costs. These changes would fall within the definition of "non-significant modifications," as defined by EPA guidance for preparing Superfund decision documents.

For example, it may be determined that a reduction in costs could be effected by non-significant changes to the type, quantity and/or cost of materials, equipment, facilities, services, or supplies used to implement the remedy. It should be noted that this type of design variance may have a noticeable impact on the estimated cost of the remedy, but will not affect the remedy's ability to comply with performance standards.

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Table 11-1
Selected Sitewide Remedy ARARs

Citation	Description	Evaluation
	Chemical-Specific ARARs-Federal	
	Safe Drinking Water Act	
40 CFR Part 141 Subpart B	Establishes health-based standards for public drinking water systems (MCLs).	These regulations are relevant and appropriate because the shallow and deep ground water in the vicinity of the Lowry Site is being used or may be used in the future as a source of water for a public water system or private supply wells. Treated ground water from the treatment plant would be injected into the shallow ground-water system. The standards are pertinent to treatment plant effluent at the point of injection as well as within the ground water at the compliance boundary.
40 CFR Part 141	Establishes drinking water quality goals set at levels of no known or anticipated adverse health effects, with an adequate margin of safety (MCLGs).	Non-zero MCLGs are relevant and appropriate since shallow and deep ground water in the vicinity of the Lowry Site is being used or may be used as a source of water for a public water system or private supply wells.
	Federal Water Pollution Control Act (amended by the Clean Water Act)	
40 CFR Part 129	Establishes toxic pollutant effluent standards for six groups of toxic pollutants from manufacturers, formulators, and applicators who develop or use these compounds and discharge to navigable waters.	Relevant and appropriate for treatment plant effluent because compound groups were detected in waste pit liquids and unnamed creek and Murphy Creek discharges to the South Platte River, which is a navigable water.
	Solid Waste Disposal Act-RCRA Subtitle C	
40 CFR Part 264 Subpart F	Sets ground water protection standards for land disposal units.	The State of Colorado operates an approved delegated program for this portion of RCRA. See requirements under Colorado Hazardous Waste Act. Relevant and appropriate because the landfill operates like a hazardous waste management unit.
	Chemical-Specific ARARs-State	
	Colorado Hazardous Waste Act	
6 CCR 1007-3 Part 264.94 Colorado Rules and Regulations Pertaining to Hazardous Waste-Ground Water Protection Standard	Establishes concentration levels for 14 chemicals in ground water.	The concentration limits are relevant and appropriate to ground water at the compliance boundary for ground water and treatment plant effluent.

Citation	Description	Evaluation
	Chemical-Specific ARARs-State (continued)	
	Colorado Water Quality Control Act	
5 CCR 1002-3 Regulation on Effluent Limitation	Establishes specific limitations on point source discharges of wastewaters into state waters and from specified industry sources, specifies sampling and analytical requirements.	Relevant and appropriate for discharge from treatment plant.
5 CCR 1003-1 Colorado Primary Drinking Water Regulations	Establishes health-based standards for public water systems.	These regulations are relevant and appropriate because the shallow and deep ground water in the vicinity of the Lowry Site is being used or may be used in the future as a source of water for a public water system or private supply wells. Treated ground water from the treatment plant would be injected into the shallow ground-water system.
5 CCR 1002-8 Section 3.11.0 Colorado Basic Standards for Ground Water and Section 3.12.0 Classifications and Water Quality Standards for Ground Water	Establishes a system for classifying ground water and sets water quality for such classifications.	These regulations establish standards for both classified and unclassified ground water. The standards are applicable because ground water (with non-alluvial and alluvial aquifers) near the Lowry Site and ground water (within alluvial aquifers) within the Lowry Site have been classified for domestic and agricultural use-quality. Ground water would be treated to meet these standards and then discharge to the shallow ground-water system.
5 CCR 1002-8 Section 3.1.0 Basic Standards and Methodologies for Surface Water	Establishes basic standards and a system for classifying surface waters of the State, assigning standards, and granting temporary variances for the standard.	Murphy Creek and the unnamed creek are classified and regulated as tributaries of the South Platte River Basin (Stream Segment 16). Segment 16 is classified as Recreation Class 2, Warm Water Aquatic Life Class 2, and Agricultural Supply. Because of this classification, statewide interim organic pollutant standards for aquatic life segments (Section 3.1.11 and Table C) are applicable to the remedy. If surface-water discharge results from injection of the treated water, surface water standards will be established based on the most stringent surface water ARAR.

Citation	Description	Evaluation
	Chemical-Specific ARARs-State (continued)	
5 CCR 1002-8 Section 3.2.0 Classifications and Numeric Standards	Used in conjunction with Basic Standards and Methodologies Section 3.1.0. South Platte River Standards (Section 3.8) establish numeric standards for the South Platte River Basin based on use classifications for stream segments.	Murphy Creek and the unnamed creek are classified and regulated as tributaries of the South Platte River Basin (Stream Segment 16). Segment is classified as Recreation Class 2, Warm Water Aquatic Life Class 2, and Agricultural Supply. Based on the regulations, numeric standards for protection of these three classified uses are applicable. Chemical-specific standards established for Stream Segment 16 are applicable to the remedy. If surface-water discharge results from injection of the treated water, surface water standards will be established based on the most stringent surface water ARAR.
	Colorado Air Quality Act/Air Pollution Regulations	
5 CCR 1001-3 Regulations No. 1	Establishes standards for emissions of particulates, smoke, carbon monoxide, and sulfur oxides.	These regulations are applicable because air emissions will occur at the ground water treatment plant, the gas treatment system, and due to construction activities. These regulations would be met for the air stripper/carbon polishing treatment process, gas flaring system, and during construction. Regulations for opacity and offsite transport of visible fugitive emissions are applicable and must be attained during construction activities resulting in disturbance of 5 acres or more in attainment areas or one acre in nonattainment areas. The Lowry Site is in an attainment area for sulfur oxides and lead and in a nonattainment area for PM 10, ozone, and carbon monoxide.
5 CCR 1001-4 Regulations No. 2	Sets limits on odorous air containments and particulates.	These regulations are applicable because air emissions will occur at the site during all activities. Activities regulated include activities such as soil movement or treatment plant air emissions. These regulations would be met for all activities including the air stripper/carbon polishing treatment process, excavation of soil in the former tire pile area, and movement of soil for construction of barrier walls and gas collection and treatment system.

Citation	Description	Evaluation
	Chemical-Specific ARARs-State (continued)	
5 CCR 1001-10 Regulation No. 8	Sets emission control requirements for hazardous air pollutants.	These regulations are applicable because air emissions will occur at the treatment plant and at the gas treatment system. These regulations would be met for the air stripper/carbon polishing treatment process and for the fas flare. The lead standards are applicable because they are ambient standards that apply to all sources. The beryllium provisions set out emission limitations for stationary sources that are applicable for all sources. The hydrogen sulfide standards are applicable to any actions emitting hydrogen sulfide. The mercury standards are applicable if wastewater treatment plant sludge is dried or incinerated.
5 CCR 1001-14 Ambient Standards	Establishes ambient standards for SO2, TSP, NO2, CO, ozone, and PM 10.	These regulations are applicable because air emissions occur at the treatment plant. These regulations would be met because these parameters are not expected to be present. If these parameters are detected above the regulated levels, action will be taken to correct the problem.
Massachusetts Allowable Ambient Levels (AALs) and Threshold Effects Exposure Limits (TELs)	Establishes health-based air standards.	TBCs. These standards were used to design the SWRA when considering air pollution controls for the water treatment plant. The plant will continue to meet these standards.
	Action-Specific ARARa-Federal Solid Waste Disposal Act-RCRA Subtitle D Requirements	
40 CFR Part 241 Guidelines for the Land Disposal of Solid Wastes	Establishes minimum levels of performance required of any solid waste land disposal site operation. Part 241.205-2(b) states "decomposition gases should not be allowed to concentrate in a manner that will pose an explosion or toxicity hazard."	Because the Lowry Site is a landfill and because decomposition gases have been detected, this requirement is well suited to the situation and is relevant and appropriate to the gas collection and treatment system. Therefore, the gas collection and treatment must meet these standards, which include maintaining methane below explosive limits.
40 CFR Part 257 Criteria for Classification of Solid Waste Disposal Facilities & Practices	Establishes criteria for use in determining which solid waste disposal facilities and practices pose a reasonable probability of adverse effects on health or the environment and thereby constitute prohibited open dumps.	Applicable for existing MSW landfills. The Section 6 MSW landfill is a closed landfill. Landfill cover requirements are relevant and appropriate.

Citation	Description	Evaluation
	Action-Specific ARARs-Federal (continued)	
40 CFR Part 258 Regulations Concerning Municipal Solid Waste landfills Landfills	Establishes design and operational criteria for all new municipal solid or expansions of existing facilities. The requirements vary depending on the time frame that the land disposal unit is used. Includes closure and post closure care. **!**If the landfill stopped receiving waste prior to 10/9/91 it is not regulated **!**If the landfill stopped receiving waste prior to 10/9/93 the facility must comply with final cover requirements **!**If the landfill receives waste on or after 10/9/93 the facility must comply with all requirements of 40 CFR 258	Explosive gas requirements (Part 258.23) are relevant and appropriate since waste was not received after October 9, 1993, but the use of the requirements is well suited to the situation. Therefore, methane monitoring within onsite structures and at the facility property boundary is required. Landfill cover requirements are relevant and appropriate since waste was not received after October 9, 1991, but the use of the requirement is well suited to the situation. Therefore, landfill cover maintenance is required.
	Solid Waste Disposal Act-RCRA Subtitle C Regulations	
40 CFR Part 260-261 Identification and Listing of Hazardous Waste	Defines those solid wastes that are subject to regulation as hazardous wastes under 40 CFR Parts 262-265 and Parts 124, 270, 271.	The State of Colorado has an approved delegated program for this portion of RCRA. The regulations are applicable for purposes of determining whether any of the materials being treated or disposed are hazardous wastes. Materials may also be compared to the waste listings to determine whether any of the materials are sufficiently similar such that RCRA regulations are relevant and appropriate.
40 CFR Part 262 Standards Applicable to Generators of Hazardous Waste	Establishes standards for RCRA generators.	Because remediation activities will generate waste that will be sufficiently similar to RCRA hazardous waste such that use of this requirements is well suited to the situation, the requirement is relevant and appropriate to the ground water treatment plant residuals, solids excavated from the former tire pile area, gas that is collected and treated, and waste generated during construction activities for the barrier walls or the gas extraction system. Therefore, waste generated must meet these standards which include testing per 40 CFR Part 261, temporary tanks or containers, inspection and leak detection, and accumulation time. The State of Colorado has an approved, delegated program under RCRA.

Citation	Description	Evaluation
	Action-Specific ARARs-Federal (continued)	
40 CFR Part 264 Subparts B, C, and D Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities	Establishes minimum standards that define the acceptable management of hazardous waste for owners and operators of facilities which treat, store, or dispose of hazardous waste.	Because remediation activities constitute treatment and storage activities (ground water treatment plant, gas treatment, and residuals management), and because the gas and water to be treated is sufficiently similar to RCRA hazardous waste such that use of the requirements is well suited to the situation, the requirement is relevant and appropriate to the ground water treatment and gas treatment components of the remedy (including residuals management). Thus, flaring of the gas and treatment of the groundwater must meet these standards, which include waste analysis, site security, emergency control and response equipment, personnel training, contingency planning and implementation.
40 CFR Part 264 Subpart F	Sets ground-water protection standards for land disposal units.	The State of Colorado operates and approved delegated program for this portion of RCRA. See the requirements under Part 264.94 of the Colorado Hazardous Waste Act. Relevant and appropriate to ground water under the site because the landfill operates like a solid waste management unit. Therefore, ground water programs must meet these standards, which include a monitoring and response program that includes detection monitoring to identify the presence of hazardous constituents in ground water; compliance monitoring to determine whether the agency-specified ground water protection standard is being met at the identified compliance point; and corrective action that prevents hazardous constituents from exceeding the established concentration limits beyond the point of compliance.
40 CFR Part 264 Subpart G	Closure and post-closure care.	Because ground treatment and gas treatment constitute treatment of a waste that is sufficiently similar to RCRA hazardous waste such that use of the requirements is well suited to the situation, the requirement is relevant and appropriate to the ground water treatment and gas treatment components of the remedy. Therefore, closure post-closure care for these treatment systems must meet these standards which include removal of waste, waste residues, contaminated system components, and contaminated subsoils; or closure with wastes and/or contamination in place with containment systems and post-closure care to include ground water monitoring and inspection and maintenance on containments and monitoring systems.

Citation	Description	Evaluation
	Action-Specific ARARs-Federal (continued)	
40 CFR Part 264 Subpart I	Sets operating and performance standards for container storage of hazardous waste.	Because ground water treatment includes storage in containers of a waste that is sufficiently similar to RCRA hazardous waste such that use of the requirement is well suited to the situation, the requirement is relevant and appropriate to the ground water treatment component of the remedy. Therefore, container storage at the ground water treatment plant must meet these standards, which include maintaining wastes in containers that are in good condition and compatible with the wastes they contain, providing a containment system, managing ignitable and reactive wastes away from the property line, keeping incompatible wastes in separate containers and containment systems, and at closure removing all wastes and decontaminating structures and equipment.
40 CFR Part 264 Subpart J .	Sets operating and performance standards for tank storage of hazardous	Because ground water treatment includes storage in tanks of a waste that is sufficiently similar to RCRA hazardous waste such that use of the requirement is well suited to the situation, the requirement is relevant and appropriate to the ground water treatment component of the remedy. Therefore, tank storage at the ground water treatment plant must meet these standards, which include secondary containment; spill and overflow controls; removal from service if there is a leak, spill, or the tank is unfit for use; and at closure have all wastes removed and also remove or decontaminate waste residues, containment system, soils, structures, and equipment.
40 CFR Part 264 Subpart O	Sets standards for destruction and removal efficiency, HCI emissions, and particulate emissions from incinerators or thermal treatment.	Because gas treatment constitutes thermal treatment, and because the gas to be treated is sufficiently similar to RCRA hazardous waste such that use of the requirement is well suited to the situation, the requirement is relevant and appropriate to the gas flaring component of the remedy. Thus, flaring of the gas must meet these standards, which include emissions standards and operating constraints as needed to ensure emissions standards are met.
40 CFR Part 264 Subpart AA	Sets operation and performance standards for air emissions from process vents.	Because the gas treatment has process vents from thermal treatment and because the gas to be treated is sufficiently similar to RCRA hazardous waste such that the use of the requirement is well suited to situation, the requirement is relevant and appropriate to the gas flaring component of the remedy. Thus, the gas treatment system must meet these standards, which include standards for process vents and test methods and procedures.

Citation	Description	Evaluation
	Action-Specific ARARs-Federal (continued)	
40 CFR 265 Subpart P Interim Standards Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities	Standards for thermal treatment.	Because gas flaring constitutes thermal treatment and because the gas to be treated is sufficiently similar to RCRA hazardous waste such that use of the requirement is well suited to the situation, the requirement is relevant and appropriate to the gas treatment component of the remedy. Therefore, the gas treatment system must meet these standards, which include general operating requirements, waste analysis, monitoring and inspection, and closure.
40 CFR Part 265 Subpart AA	Sets operating and performance standards for air emissions from process vents.	Because the gas treatment has process vents from thermal treatment and because the gas to be treated is sufficiently similar to RCRA hazardous waste such that the use of the requirement is well suited to the situation, the requirement is relevant and appropriate to the gas flaring component of the remedy. Thus, the gas treatment system must meet these standards, which include standards for process vents and test methods and procedures.
40 CFR 265.17	Sets standards for mixing and treatment of contaminated soils or the mixing and treatment of potentially incompatible, reactive, or ignitable hazardous wastes.	Because the ground water treatment plant will mix and treat potentially incompatible, reactive, or ignitable wastes which may be similar to hazardous wastes, the requirement is relevant and appropriate to the ground water treatment plant. Therefore, the wastes must be analyzed to determine compatibility, reactivity, and ignitability before treatment in the treatment plant.
40 CFR Part 268 Land Disposal Restrictions	Establishes prohibitions on land disposal unless treatment standards are met or a "no migration exemption" is granted.	Because the solids excavation in the former tire pile area and residuals from the ground water barrier walls and gas extraction system construction and residuals from the ground water treatment plant and gas extraction system operations will be land disposed, the requirement is applicable. The materials must be tested to determine if they are a characteristic hazardous waste (per 4 CFR Part 262) and then must meet treatment requirements for land disposal as required in the standards if they are hazardous waste for which a treatment standard has been established. For land disposal of residuals, other than soils, which are not characteristic hazardous wastes, these requirements are relevant and appropriate because the residuals are sufficiently similar to listed hazardous waste such that use of the requirements is well suited to the situation.

Citation	Description	Evaluation
	Action-Specific ARARs-Federal (continued)	
58 FR 48091 (9/14/93) 40 CFR Part 268 Universal Treatment Standards	Establishes a concentration limit for over 200 regulated constituents in soil, regardless of waste type, which must be met before land disposal.	TBC for soil and sediments because it is a proposed regulation. Excavated soils from the tire pile area must meet these requirements.
	Federal Water Pollution Control Act (amended by the Clean Water Act)	
40 CFR Part 122 NPDES Stormwater Regulations	Establishes requirements for discharges related to industrial activity. Stormwater runoff, snow melt runoff, and surface runoff and drainage associated with industrial activity from remedial actions which discharge to surface waters shall be conducted in compliance with RCRA, FWQC, CWA technology-based standards, Colorado surface water quality standards, monitoring requirements, and best management practices.	Because stormwater discharges will occur from the landfill and from any treatment process areas constructed (such as the ground water treatment plant and the gas treatment system), this requirement is applicable to stormwater discharges. Therefore, stormwater discharges must meet these standards which include sampling, analysis, and treatment requirements. Implementation and enforcement has been delegated to the State of Colorado, see the Colorado Water Quality Control Act.
40 CFR, Part 230/231 Guidelines for Specification of Disposal Sites for Dredged or Fill Materials.	The discharge of dredged or fill material into the waters of the U.S. is prohibited without a permit.	Wetlands were destroyed during construction of the SWRA and must be mitigated during implementation of the selected remedy by constructing new wetlands.
40 CFR, Part 440 Effluent Guidelines and Standards for Ore Mining and Dressing Point Source Categories	Establishes radionuclide concentration limits for liquid effluents from facilities that extract and process uranium, radium, and vanadium ores.	Because the effluent from the ground water treatment plant could have radionuclides sufficiently similar to those regulated such that the requirement is well suited to the situation, the requirement is relevant and appropriate to the ground water treatment plant effluent. Therefore, contingencies have been made for the early detection of radionuclides and for a treatment process to be added to treat radionuclides at the ground water treatment plant.
	Clean Air Act	
40 CFR Part 60 New Source Performance Standards	Establishes performance standards for new stationary sources of air pollutants.	Relevant and appropriate for gas treatment. Proposed NSPS for municipal solid waste facilities (Subpart WWW) is a TBC (56 FR 24468 [5/30/91]).

Citation	Description	Evaluation
	Action-Specific ARARs-Federal (continued)	
40 CFR Part 61 National Emission Standards for Hazardous Air Pollutants (NESHAPAs)	Establishes emission standards for hazardous air pollutants from specific sources.	Because the ground water treatment plant has an air stripper that is a source of air emissions and the gas treatment system will have a flare, these two sources are sufficiently similar to source types in the regulations such that use of the requirement is well suited to the situation, the requirement is relevant and appropriate to the ground water treatment plant and the gas treatment system. Therefore, the air stripper and gas flare must meet these standards which include treatment levels for arsenic, beryllium, benzene, vinyl chloride and radionuclide emissions.
	Safe Drinking Water Act	
40 CFR Part 144-147 Underground Injection Control Regulations	Establishes standards for construction and operation of injection wells. Provides for protection of underground sources of drinking water.	Applicable to injection of water from treatment plant. The requirements include constructing, operating, and maintaining a well in a manner that does no result in contamination of an underground source of drinking water at levels that violate MCLs or otherwise affect the health of persons. These requirements will be met by ensuring the effluent from the groundwater treatment plant meets standards that are protective of human health (based on MCLs and risk-based concentrations).
	Action-Specific ARARs-State	
	Colorado Solid Wastes Disposal Sites and Facilities Act	
6 CCR 1007-2 Section 1 Regulations Pertaining to Solids Waste Disposal Sites and Facilities	Establishes standards for new solid waste disposal facilities and defines those solid wastes.	Explosive gas requirements and landfill cover requirements are relevant and appropriate because waste was not received after October 9, 1993, but the use of the requirement is well suited to the situation so the requirement is relevant and appropriate to the existing landfill mass. Therefore, the gas concentrations need to be maintained below the explosive limits and maintenance of the landfill cover is required.
6 CCR 1007-2 Section 2.3	Establishes minimum standards for landfill gas collection and treatment systems.	These requirements are applicable for the landfill gas collection and treatment system and include monitoring requirements in structures and at the landfill boundary, notification of gas excursions, and remediation activities if explosive gas limits are exceeded.

Table 11-1
Selected Sitewide Remedy ARARs

Citation	Description	Evaluation
	Action-Specific ARARs-State	
6 CCR 1007-2 Section 2.6 and 3.6	Post closure maintenance and care.	Substantive requirements are applicable to the gas extraction system and landfill cover. Requirements include maintaining the cover for 30 years, ground water monitoring, describing uses of land during post closure care, and certification at the completion of post closure care.
	Colorado Hazardous Waste Act	
6 CCR 1007-3 Part 260-261 Identification and Listing of Hazardous Waste	Defines those solid wastes subject to hazardous waste regulations.	The State Colorado has an approved delegated program for this portion of RCRA. Applicable to determining whether substance are hazardous waste under RCRA.
6 CCR 1007-3 Part 262 Standards Applicable to Generators of Hazardous Waste	Establishes standards for RCRA generators.	Because remediation activities will generate waste that will be sufficiently similar to RCRA hazardous waste such that use of this requirement is well suited to the situation, the requirement is relevant and appropriate to the ground water treatment plant residuals, solids excavated from the former tire pile area, gas that is treated, and waste generated during construction of the barrier walls or gas extraction system. Therefore, waste generated must meet these standards which include testing per 40 CFR Part 261, temporary tanks or containers, inspection and leak detection, offsite shipping procedures, and accumulation time. The State of Colorado has an approved, delegated program under RCRA.
6 CCR 1007-3 Part 264 Subparts B, C, and D Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities	Establishes minimum standards that define that acceptable management of hazardous waste for owners and operators of facilities which treat, store, or dispose of hazardous waste.	Because remediation activities constitute treatment and storage activities (ground water treatment plant, gas treatment, and residuals management), and because the gas and water to be treated is sufficiently similar to RCRA hazardous waste such that use of the requirement is well suited to the situation, the requirement is relevant and appropriate to the ground water treatment and gas treatment components of the remedy (including residuals management). Thus, flaring of the gas and treatment of the groundwater must meet these standards, which include waste analysis, site security, emergency control and response equipment, personnel training, contingency planning and implementation.

Citation	Description	Evaluation
	Action-Specific ARARs-State (continued)	
6 CCR 1007-3 Part 264 Subpart F	Sets ground-water protection standards for land disposal units.	The State of Colorado operates an approved delegated program for this portion of RCRA. See the requirements under Part 264.94 of the Colorado Hazardous Waste Act. Relevant and appropriate to ground water under the site because the landfill operates like a solid waste management unit. Therefore, ground water programs must meet these standards, which include a monitoring a response program that includes detection monitoring to identify the presence of hazardous constituents in ground water; compliance monitoring to determine whether the agency-specified ground water protection standard is being met at the identified compliance point; and corrective action that prevents hazardous constituents from exceeding the established concentration limits beyond the point of compliance.
6 CCR 1007-3 Part 264 Subpart G	Closure and post-closure care.	Because ground water treatment and gas treatment constitute treatment of a waste that is sufficiently similar to RCRA hazardous waste such that use of the requirement is well suited to the situation, the requirement is relevant and appropriate to the ground water treatment and gas treatment compounds of the remedy. Therefore, closure and post-closure care for these treatment systems must meet these standards which include removal of waste, waste residues, contaminated system components, and contaminated subsoils; or closure with wastes and/or contamination in place with containment systems and post-closure care to include ground water monitoring and inspection and maintenance on containments and monitoring systems.
6 CCR 1007-3 Part 264 Subpart I	Sets operating and performance standards for container storage of hazardous waste.	Because ground water treatment includes storage in container of a waste that is sufficiently similar to RCRA hazardous waste such that use of the requirement is well suited to the situation, the requirement is relevant and appropriate to the ground water treatment component of the remedy. Therefore, container storage at the ground water treatment plant must meet these standards, which include maintaining wastes in containers that are in good condition and compatible with the wastes they contain, providing a containment system, managing ignitable and reactive wastes away from the property line, keeping incompatible wastes in separate containers and containment systems, and at closure removing all wastes and decontaminating structures and equipment.

Citation	Description	Evaluation
	Action-Specific ARARs-State (continued)	
6 CCR 1007-3 Part 264 Subpart J	Sets operating and performance standards for tank storage of hazardous	Because ground water treatment includes storage in tanks of a waste that is sufficiently similar to RCRA hazardous waste such that use of the requirement is well suited to the situation, the requirement is relevant and appropriate to the ground water treatment component of the remedy. Therefore, tank storage at the ground water treatment plant must meet these standards, which include secondary containment, spill and overflow controls, removal from service if there is a leak, spill, or the tank is unit for use, and at closure have all wastes removed and also remove or decontaminate waste residues, containment system, soils, structures, and equipment.
6 CCR 1007-3 Part 264 Subpart O Standards for Owners and Operators of Hazardous Waste TSD Facilities	Sets standards for destruction and removal efficiency, HC1 emissions and particulate matter in excess of the stated standard.	Because gas treatment constitutes thermal treatment, and because the gas to be treated is sufficiently similar to RCRA hazardous waste such that use of the requirement is well suited to the situation, the requirement is relevant and appropriate to the gas flaring component of the remedy. Thus, flaring of the gas must meet these standards, which include standards for process vents and test methods and procedures.
6 CCR 1007-3 Part 264 Subpart AA	Sets operating and performance standards for air emissions from process vents.	Because the gas treatment has process vents from thermal treatment and because the gas to be treated is sufficiently similar to RCRA hazardous waste such that the use of the requirement is well suited to the situation, the requirement is relevant and appropriate to the gas flaring component of the remedy. Thus, the gas treatment system must meet these standards, which include general operating requirements, waste analysis, monitoring and inspections, and closure.
6 CCR 1007-3 Part 265 Subpart P	Standards for thermal treatment.	Because gas flaring constituents thermal treatment and because the gas to be treated is sufficiently similar to RCRA hazardous waste such that use of the requirement is well suited to the situation, the requirement is relevant and appropriate to the gas treatment component of the remedy. Therefore, the gas treatment system must meet these standards, which include standards for process vents and test methods and procedures.

Citation	Description	Evaluation
	Action-Specific ARARs-State (continued)	
6 CCR 1007-3 Part 265 Subpart AA	Sets operation and performance standards for air emissions from process vents.	Because the gas treatment has process vents from thermal treatment and because the gas to be treated is sufficiently similar to RCRA hazardous waste such that the use of the requirement is well suited to the situation, the requirement is relevant and appropriate to the gas flaring component of the remedy. Thus, the gas treatment system must meet these standards, which include general operating requirements, waste analysis, monitoring and inspections, and closure.
6 CCR 1007-3 Part 265.17	Sets standards for mixing and treatment of contaminated soils or the mixing and treatment of potentially incompatible, reactive, or ignitable hazardous wastes.	Because the ground water treatment plant will mix and treat potentially incompatible, reactive, or ignitable wastes which may be similar to hazardous wastes, the requirement is relevant and appropriate to the ground water treatment plant. Therefore, the wastes must be analyzed to determine compatibility, reactivity, and ignitability before treatment in the treatment plant.
6 CCR 1007-3 Part 268 Land Disposal Restrictions	Establishes prohibitions on land disposal unless treatment standards are met or a "not migration exemption" is granted.	Because the solids excavation in the former tire pile area and construction residuals from the ground water barrier walls and gas extraction system will be land disposed, the requirements is applicable so the materials must be tested to determine if they are a characteristic hazardous waste (per 6 CCR 1007-3 Part 262) and then must meet treatment requirements for land disposal as required in the standards if they are hazardous waste for which a treatment standard has been established.
	Colorado Air Quality Act/Air Pollution Regulations	
5 CCR 1001-5 Regulations No. 3	Requires filing of Air Pollution Emission Notice (APEN) including estimation of emission rates.	These regulations are applicable because air emissions will occur at the treatment plant and at the gas treatment system. The air stripper/carbon polishing treatment process and the gas flaring process must meet any substantive provisions of these requirements.
5 CCR 1001-8 Regulation No. 6	Establishes standards for new stationary sources including incinerators. Sets discharge and performance rates and opacity requirements.	These regulations are applicable because air emissions will occur at the treatment plant and at the gas treatment system. The air stripper/carbon polishing treatment process and the gas flaring process must meet these requirements which include discharge and performance rates and opacity requirements.

Citation	Description	Evaluation
	Action-Specific ARARs-State (continued)	
5 CCR 1001-9 Section II.C.2, Section V Regulation No. 7	Establishes standards for disposal or spillage of VOCs.	These regulations are applicable because air emissions will occur at the treatment plant and at the gas treatment system. The air stripper/carbon polishing treatment process and the gas flaring process must meet these requirements which include controls representing reasonably available control technology (RACT).
	Colorado Noise Abatement Statute	
Colorado Revised Statute Section 25-12-103	Provides limits for noise based on time periods and zones.	Applicable for all construction activities associated with the remedy.
	Water Well Pump Installation Contractors Act	
2 CCR 402-4	Establishes standards for installation of water wells and pumping equipment.	Applicable because wells will be installed.
	Well Construction/Abandonment Requirements	
2 CCR 402-2 State of Colorado Division of Water Resources, 1988, as revised-Colorado State Engineers Office	Well construction/abandonment requirements	Applicable for new wells and abandonment of existing wells. Additional requirements may be added to ensure that a migration is not created.
	Location-Specific ARARs-Federal Executive Order 11990, Protection of Wetlands	
40 CFR Part 6, Appendix A	Action to avoid adverse effects, minimize potential harm, and preserve and enhance wetlands, to the extent possible. Requires action to minimize the destruction, loss, or degradation of wetlands.	Applicable because wetlands have been identified and destroyed at the Lowry Site during the SWRA. New wetlands will be constructed as part of the remedy.
	Federal Water Pollution Control Act (Clean Water Act)	
40 CFR Part 230	Discharge of dredged or fill material into wetlands prohibited without a permit.	For areas of the site that have designated wetlands, a permit will not be required pursuant to Section 121(c) of CERCLA, but the substantive requirements of Part 230 will be applicable if wetlands that have been identified at the Lowry Site are dredged or filled during implementation of the remedial activity.

Citation	Description	Evaluation
	Location-Specific ARARs-State Certification of Federal Licenses and Permits	
5 CCR 1002-18	Discharge of dredged and fill material into wetlands prohibited without a State certification.	For areas of the site that have designated wetlands, a permit will not be required pursuant to Section 121(c) of CERCLA, but the substantive requirements will be applicable if wetlands that have been identified at the Lowry Site are dredged or filled during implementation of the remedial activity.

Table 11-2
Ground-Water Compliance Boundary Performance Standards
Sitewide Remedy

Chemical	Performance Standard ($\mu g/l$)	Basis
Organics		
1,1-Dichloroethane	-	-
1,1-Dichloroethylene	0.068	B
1,2-Dichloroethylene(cis)	70	D
1,2-Dichlorethylene(trans)	100	D
1,1,1-Trichloroethane	200	D
1,1,2-Trichloroethane	0.32	B
1,1,2,2-Tetrachlorethane	0.089	B
1,2-Dibromo-3-Chloropropane	0.2	D
1,2-Dichlorobenzene	600	D
1,2-Dichloroethane	0.2	B
1,2-Dichloropropane	0.56	D
1,2-Diphenylhydrazine	0.05	D
1,2,4-Trichlorobenzene	20	C
1,2,4,5-Tetrachlorobenzene	2	D
1,3-Dichlorobenzene	620	D
1,4-Dichlorobenzene	75	A
2-Butanone	780	C
2-Chlorophenol	0.1	A
2-Hexanone	-	-
2-Methylnaphthalene	0.0031 (total PAHs)	A
2,3,7,8-TCDD (dioxin equivalence	.00000022	A
2,4-D(dichlorophenoxyacetic acid)	70	D
2,4-Dichlorophenol	21	A
2,4-Dinitrophenol	14	A
2,4,5 TP(trichlorophenoxypropionic acid)	10	D
2,4,6-Trichlorophenol	2	D
4-Methyl-2-pentanone	780	C
Acetone	1,600	C
Alachlor	2.0	D
Aldicarb	3.0	D
Aldicarb Sulfone	2.0	D
Aldicarb Sulfoxide	4.0	D
Aldrin	0.002	D
Altrazine	3.0	D
Benzene	0.62	B
Benzidine	0.0002	D

Notes: A = ARAR/TBC.
B = Carcinogenic (1 x 10-6) target risk for adult.
C = Noncarcinogenic target concentration for child.
D = Colorado Basic Standards for Ground Water for chemicals that are not COCs.

Table 11-2
Ground-Water Compliance Boundary Performance Standards
Sitewide Remedy

Chemical	Performance Standard (µg/l)	Basis
Benzo(a)anthracene	0.0031 (total PAHs)	A
Benzo(a)pyrene (PAH)	0.2	D
Benzyl Alcohol	-	-
Bis(2-chloroethyl)ether	0.016	B
Bis(2-ethylhexyl)phthalate	6.1	B
Bromodichloromethane	0.3	D
Bromoform	4.0	D
Carbazole	-	-
Carbofuran	36	D
Carbon tetrachloride	0.026	B
Chlordane	0.004	D
Chlorobenzene	100	D
Chloroethane	-	-
Chloroform	0.19	A
Chlorophenol	1	D
Dalapon	200	D
DDT Metabolite (DDE)	0.1	D
DDT	0.1	D
Di(2-ethylhexyl)adipate	400	D
Di(2-ethylhexyl)phthalate	6	D
Di-n-Octylphthalate	-	-
Dibenzofuran	-	-
Dibromochloromethane	14	D
Dichloromethane	5	D
Dieldrin	0.002	D
Dinoseb	7	D
Diquat	20	D
Ethylbenzene	680	D
Endothall	100	D
Endrin	0.2	D
Endrin Aldehyde	0.2	D
Ethylenedibromide	0.05	A
Fluoranthene	188	A
Glyphosate	700	D
Heptachlor	0.008	D
Heptachlor Epoxide	0.09	D
Hexachlorobenzene	1	D
Hexachlorobutadiene	1	D

Notes: A = ARAR/TBC.
B = Carcinogenic (1 x 10-6) target risk for adult.
C = Noncarcinogenic target concentration for child.
D = Colorado Basic Standards for Ground Water for chemicals that are not COCs.

Table 11-2
Ground-Water Compliance Boundary Performance Standards
Statewide Remedy

Chemical	Performance Standard (µg/l)	Basis
Hexachlorocyclohexane,Alpha	0.2	D
Hexachlorocyclohexane,Gamma (Lindane)	0.004	D
Hexachlorocyclopentadiene	50	D
Isophorone	1,050	D
Malathion	2,500	D*
Methoxychlor	40	D
Methylene chloride	0.19	A
Monohydric phenol	1	D
Nephthalene	-	-
Nitrobenzene	3.5	D
Oxamyl (vydate)	200	D
PCBs	0.005	D
Pentachlorobenzene	6	D
Pentachlorophenol	0.71	B
Phenanthrene	0.0031 (total PAHs)	A
Phenol	1	D
Picloram	500	D
Simazine	4	D
Styrene	100	D
Tetrachloroethylene	1.5	B
Toluene	1,000	A
Toxaphene	0.03	D
Trans-1,3-dichloropropene	3.0	C
Trichloroethylene	2.6	B
Vinyl chloride	0.037	B
Xylenes (total)	10,000	D
Inorganics and Miscellaneous		
Aluminum	5,000	D
Antimony	6	D
Arsenic	0.049	B
Asbestos (fibers/l)	30,000	D
Barium	1,000	D
Beryllium	4	D
Boron	750	D
Cadamium	5	D
Chloride	250,000	D

Notes: A = ARAR/TBC.
B = Carcinogenic (1 x 10-6) target risk for adult.
C = Noncarcinogenic target concentration for child.
D = Colorado Basic Standards for Ground Water for chemicals that are not COCs.
D* = Must be met at the western compliance boundary, based on classifications and Water Quality Standards for Ground Water.
- = No information available.

Table 11-2
Ground-Water Compliance Boundary Performance Standards
Sitewide Remedy

Chemical	Performance Standard (µg/l)	Basis
Cobalt	50	A
Coliform (total) per 100 ml	<1	D
Color, color units	15	D
Corrosivity	noncorrosive	D
Copper	200	D
Chromium (as Cr[VI])	50	A
Chromium (total)	50	D
Cyanide	200	D
Flouride	2,000	D
Foaming Agents	500	D
Iron	300	D
Lead	15	A
Manganese	50	A
Mercury	2	D
Nickel	2	A
Nirate as N	10,000	D
Nirate and Nitrite as N	10,000	D
Nitrite as N	1,000	D
pH	6.5 to 8.5	D
Selenium	10	D
Silver	50	D
Sulfate	250,000	D
Thallium	1.1	C
Vanadium	100	D
Zinc	2,000	D
Radionuclides		
Americium-241	1.3 pCi/l	C
Beta and photon emitters, mrem/yr	4	D
Cesium-134	80 pCi/l	D
Gross Alpha	15 pCi/l	D
Lead-210	0.072 pCi/l	B
Plutonium-238,-239,and -240	15 pCi/l	A
Potassium-40	76 pCi/l	C
Radium-226 and -228	5	A
Strontium-90	1.3 pCi/l	B
Thorium-228	0.87 pCi/l	B
Thorium-230	3.7 pCi/l	B
Thorium-232	12 pCi/l	C

Notes: A = ARAR/TBC.
B = Carcinogenic (1 x 10-6) target risk for adult.
C = Noncarcinogenic target concentration for child.
D = Colorado Basic Standards for Ground Water for Chemicals that are not COCs.
- = No information available.

Table 11-2
Ground-Water Compliance Boundary Performance Standards
Sitewide Remedy

Chemical	Performance Standard (µg/l)	Basis
Tritium	880 pCi/l	B
Tritium	20,000 pCi/l	D
Uranium-234	3.0 pCi/l	B
Uranium-235	20 pCi/l	C
Uranium-238	5.2 pCi/l	C
Xylenes (total)	10,000	D

Notes: A = ARAR/TBC.
B = Carcinogenic (1 x 10-6) target risk for adult.
C = Noncarcinogenic target concentration for child.
D = Colorado Basic Standards for Ground Water for chemicals that are not COCs.
\- = No information available.

Table 11-3
Ground-Water Point of Action Boundary Standards

Parameter Name	Basic Standards for Ground Water µg/L
1,1,1-Trichloroethane	200
1,1,2-Trichloroethane	3
1,1-Dichloroethylene	7
1,2,4,5-Tetrachlorobenzene	2
1,2,4-Trichlorobenzene	70
1,2-Dibromo-3-chloropane	0.2
1,2-Dichlorobenzene	600
1,2-Dichloroethane	0.4
1,2-Dichloroethylene (cis)	70
1,2-Dichloroethylene (trans)	100
1,2-Dichloropropane	0.56
1,2-Diphenylhydrazine	0.05
1,3-Dichlorobenzene	620
1,4-Dichlorobenzene	75
2,4,6-Trichlorophenol	2
2,4-Dichlorophenol	21
2,4-Dinitrophenol	14
Alachlor	2.0
Aldicarb	3.0
Aldicarb sulfone	2.0
Aldicarb sulfoxide	4.0
Aldrin	0.002
Atrazine	3.0
Benzene	5.0
Benzidine	0.0002
Benzo(a)pyrene (PAH)	0.2
Bis(2-chloroethyl)ether	0.03
Bromodichloromethane (HM)	0.3
Bromoform (HM)	4.0
Carbofuran	36
Carbon Tetrachloride	0.3
Chlorodane	0.03
Chlorobenzene	100
Chloroform (HM)	6.0

Table 11-3
Ground-Water Point of Action Boundary Standards

Parameter Name	Basic Standards for Ground Water µg/L
Dalapon	200
DDT	0.1
DDT Metabolite (DDE)	0.1
Di(2-ethylexyl)adipate	4OO
Di(2-ethylhexyl)phthalate	6
Dibromochloromethane (HM)	14
Dichloromethane	5
Dichlorophenoxyacetic Acid (2,4-D)	70
Dieldrin	0.002
Dionseb	7
Dioxen (2,3,7,8-TCDD)	2.2x10 -7
Diquat	20
Endothall	100
Endrin	2.0
Endrin Aldehyde	0.2
Enthylbenzene	680.0
Ethylene Dibromide	0.05
Glyphosate	700
Heptachlor	0.008
Heptachlor Epoxide	0.09
Hexachlorobenzene	1
Hexachlorobutadiene	1.O
Hexachloroclohexane, Alpha	0.006
Hexachloroclohexane, Gamma (Lindane)	0.2
Hexachlorocyclopentadiene	5O
Isophorone	1050
Methoxychlor	40
Nitrobenzene	3.5
Oxamyl (vydate)	200
PCBs	0.005
Pentachlorobenzene	6
Pentachlorophenol	1.0
Picloram	500
Simazine	4
Styrene	100
Tetrachloroethylene	5.0
Toluene	1000
Toxaphene	0.03
Trichloroethylene	5
Trichlorophenoxypropionic Acid (2,4,5-TP)	50
Vinyl Chloride	2
Xylenes (total)	10,000

Notes: The Standard is based on Colorado Basic Standards for Ground Water-Statewide Standards (Table A).

Table 11-4
Surface Water Standards
Basic Standards and Methodologies for Surface Water
Site-Specific Standards for Use Classification
Recreation Class 2, Aquatic Life Warm Water Class 2, Agricultural

	Agricultural Standard (µg/L)	Water Supply Segments (µg/L)	Aquatic Life (Acute)	Aquatic Life (Chronic)	PQL (µg/L)
		Organics			
Acenaphthene	--	--	1,700	520	10
Acrolein	--	--	68	21	10
Acrylonitrile	--	--	7,500	2,600	5
Aldicarb	--	10	--	--	10
Aldrin	--	0.002	1.5	--	0.1
Benzene	--	1	5,300	--	1.0
Benzidine	--	0.0002	2,500	--	10
Beryllium	100 (30 day)	0.007	--	--	--
BHC Hexachlorocyclohexane	--	--	100	--	0.05
Bromodichlormethane (HM)	--	0.3	--	--	1.0
Bromoform (HM)	--	4	--	--	1.0
Carbofuran	--	36	--	--	--
Carbon Tetrachloride	--	0.3	35,200	--	1.0
Chlorobenzene	--	100	--	--	1.0
Chlordane	--	0.03	1.2	0.0043	1.0
Chloroethyl Ether (bis-2-)	--	0.03	--	--	10
Chloroform (HM)	--	6	28,900	1240	1.0
Chloro-4 Methyl-3 Phenol	--	--	30	--	50
2-Chlorophenol	--	--	4,380	2000	50
Chlorhyrifos	--	--	0.083	0.041	0.1
DDT	--	0.1	0.55	0.001	0.1
DDT Metabolite (DDE)	--	0.1	1,050	--	0.1
DDT Metabolite (DDD)	--	--	0.6	--	0.1
Demton	--	--	--	0.1	1.0
Dibromochloromethane (HM)	--	14	--	--	1.0
1,2-Dichlorobenzene	--	620	--	--	1.0
1,3-Dichlorobenzene	--	620	--	--	1.0
1,4-Dichlorobenzene	--	75	--	--	1.0

Table 11-4
Surface Water Standards
Basic Standards and Methodologies for Surface Water
Site-Specific Standards for Use Classification
Recreation Class 2, Aquatic Life Warm Water Class 2, Agricultural

	Agricultural Standard (µg/L)	Water Supply Segments (µg/L)	Aquatic Life (Acute)	Aquatic Life (Chronic)	PQL (µg/L)
1,2-Dichloroethane	--	0.4	118,000	20,000	1.0
1,1-Dichlorethylene	--	7	--	--	1.0
1,2-cis-Dichlorethylene	--	70	--	--	1.0
1,2-trans-Dichlorethylene	--	100	--	--	1.0
2,4-Dichlorophenol	--	21	2,020	365	50
Dichlorophenoxyacetic Acid (2,4-D)	--	70	--	--	2.02
1,4-Dichlorobenzene	--	75	--	--	1.0
1,2-Dichloroethane	--	0.4	118,000	20,000	1.0
1,1-Dichlorethylene	--	7	--	--	1.0
1,2-cis-Dichlorethylene	--	70	--	--	1.0
1,2-trans-Dichlorethylene	--	100	--	--	1.0
2,4-Dichlorophenol	--	21	2,020	365	50
Dichlorophenoxyacetic Acid (2,4-D)	--	70	--	--	2.02
1,2-Dichloropropane	--	0.56	23000	5700	1.0
1,3-Dichloropropylene	--	--	6,060	244	1.0
Dieldrin	--	0.002	1.3	0.0019	0.1
2,4-Dimethylphenol	--	--	2,120	--	50
2,4-Dinitrophenol	--	14	--	--	50
2,6-Dinitrotoluene	--	--	330	230	10
Dioxin (2,3,7,8-TCDD)	--	2.2 x 10-7	0.01	0.00001	0.02
1,2-Diphenylhydrazine	--	0.05	270	--	
Endosulfan	--	--	0.22	0.056	0.1
Endrin	--	0.2	0.09	0.0023	0.1
Endrin Aldehyde	--	0.2	--	--	0.1
Ethylbenzene	--	680	32,000	--	1.0
Fluoranthene (PAH)	--	--	3,980	--	10
Guthion	--	--	--	0.01	1.5
Heptachlor	--	0.008	0.26	0.0038	0.05
Heptachlor Epoxide	--	0.09	0.26	0.0038	0.05

Table 11-4
Surface Water Standards
Basic Standards and Methodologies for Surface Water
Site-Specific Standards for Use Classification
Recreation Class 2, Aquatic Life Warm Water Class 2, Agricultural

	Agricultural Standard (µg/L)	Water Supply Segments (µg/L)	Aquatic Life (Acute)	Aquatic Life (Chronic)	PQL (µg/L)
Hexachlorobenzene	--	6	--	--	10
Hexachlorobutadiene	--	1.0	90	9.3	10
Hexachlorocyclohexane, Alpha	--	0.006	0.0039	--	0.05
Hexachlorocyclohexane, Gamma (Lindane)	--	0.2	1.0	0.080	0.05
Hexachloroethane	--	--	980	540	10
Hexachlorocyclopentadiene	--	--	7	5	10
Indeno(1,2,30cd)pyrene (PAH)	--	--	--	--	10
Isophorone	--	1050	117,000	--	10
Malathion	--	--	--	0.1	0.2
Methoxychlor	--	40	--	0.03	0.5
Mirex	--	--	--	0.001	0.1
Naphthalene (PAH)	--	--	2,300	620	10
Nitrobenzene	--	3.5	27,000	--	10
Parathion	--	--	0.065	0.013	
PCBs	--	0.005	2.0	0.014	1.0
Pentachlorobenzene	--	6	--	--	10
Pentachlorophenol	--	200	9	5.7	50
Phenol	--	--	10,200	2,560	50
1,2,4,5-Tetrachlorobenzene	--	2	--	--	10
1,1,2,2-Tetrachlorethane	--	--	--	2,400	1.0
Tetrachloroethylene	--	5.0	5,280	840	1.0
Toluene	--	1000	17,500	--	1.0
Toxaphene	--	0.03	0.73	0.0002	5.0
1,1,1-Trichlorethane	--	200	--	--	1.0
1,1,2-Trichlorethane	--	3	9,400	--	1.0
Trichlorethylene	--	5	45,000	21,900	1.0
2,4,6-Trichlorophenol	--	2.0	--	970	50
Trichlorophenoxypropionic Acid (2,4,5-TP)	–	50	--	--	0.5
Vinyl Chloride	--	2	--	--	2

Table 11-4
Surface Water Standards
Basic Standards and Methodologies for Surface Water
Site-Specific Standards for Use Classification
Recreation Class 2, Aquatic Life Warm Water Class 2, Agricultural

	Agricultural Standard (µg/L)	Water Supply Segments (µg/L)	Aquatic Life (Acute)	Aquatic Life (Chronic)	PQL (µg/L)
		Ingorganics			
Antimony	--	14	--	--	
Aluminum	--	--	750	87	
Ammonia (un-ionized as N)	--	500	site specific	60--100	
Arsenic	100 (30 day)	50	360	150	
Asbestos, fibers/l	--	30000	--	--	
Barium	--	1000	--	--	
Boron	750 (30 day)	--	--	--	--
Cadmium	10 (30 day)	10 (1 day)	hardness dep.	hardness dep.	--
Chloride	--	250,000	--	--	
Chromium (hexavalent)	100 (30 day)	50 (1 day)	16	11	
Chromium (trivalent)	100 (30 day)	50 (1 day)	hardness dep.	hardness dep.	
Copper	200 (30 day)	1,000 (30 day)	hardness dep.	hardness dep.	
Cyanide (free)	200 (1 day)	200 (1 day)	--	--	
Dissolved Oxygen	3000	3,000	--	--	
Fecal Coliform	--	2,000/100ml	--	--	
Flouride	--	2,000	--	--	
Iron	--	300 (30 day) a	--	1,000 (tot rec)	
Lead	100 (30 day)	50 (1 day)	hardness dep	hardness dep	
Manganese	200 (30 day)	50 (dis)(30 day)	--	1,000	
Mercury	--	2.0 (1 day)	2.4	0.1	
Nickel	200 (30 day)	--	hardness dep.	hardness dep.	
Nirate as N	100,000	10,000 (1 day)	--	--	
Nitrite as N (NO2-N)	10,000	1,000 (1 day)	--	--	
pH	--	5.0--9.0	--	--	
Selenium	20 (30 day)	10 (1 day)	135	17	
Silver	--	50	hardness dep.	hardness dep.	
Sulfide as H2S	--	50	--	–	

Table 11-4
Surface Water Standards
Basic Standards and Methodologies for Surface Water
Site-Specific Standards for Use Classification
Recreation Class 2, Aquatic Life Warm Water Class 2, Agricultural

	Agricultural Standard (µg/L)	Water Supply Segments (µg/L)	Aquatic Life (Acute)	Aquatic Life (Chronic)	PQL (µg/L)
Sulfate	--	250,000	--	--	
Thallium	--	--	--	15	
Uranium	--	--	hardness dep.	hardness dep.	
Zinc	2,000 (30 day)	5,000 (30 day)	hardness dep.	hardness dep.	
Radionuclides					
Cesium 134,pCi/l	--	80th	--	--	--
Plutonium 238,239, and 240, pCi/l	--	15th	--	--	
Radium 226 and 228, pCi/l	--	5th	--	--	
Strontium 90, pCi/l	--	8th	--	--	
Thorium 230 and 232 pCi/l	--	60th	--	--	
Tritium, pCi/l	--	20,000th	--	–	

Table 11-5
Air Quality Performance Standards
Sitewide Remedy

Chemical/Element	Concentration (µg/m3) Annual Average (AAL)	24-Hour Average (TEL)	Other	Source
		Organics		
1,1,1-Trichloroethane	1038.37	1038.37	--	Massachusetts Guidance
1,1,2-Trichloroethaae	0.06	14.84	--	Massachusetts Guidance
1,1-Dichloroethane	--	--	521	Noncarcinogenic Risk
1,1,2,2-Tetrachloroethane	0.02	18.67	--	Massachusetts Guidance
1,2,4 Trichlorobenzene	--	--	11	Based on RfC
1,2-Dichloroethylene (total)	107.81	215.62	--	Massachusetts Guidance
1,1-Dichloroethylene	--	--	0.049	Carcinogenic Risk
1,2-Dichlorobenzene (ortho)	81.74	81.74	--	Massschusetts Guidance
1,2-Dichloroethane	0.04	11.01	--	Massachusetts Guidance
1,2-Dichloroethylene	107.81	215.62	--	Massachusetts Guidance
1,2-Dichloropropane	0.05	94.23	--	Massachusetts Guidance
1,4-Dichlorobenzene	0.18	122.61	--	Massachusetts Guidance
2,3,7,8-TCDD (dioxin equivalence)	--	--	--	
2,4-Dichlorophenol	--	--	--	
2,4-Dimethylphenol	--	--	--	
2,4--Dinitrophenol	--	--	--	
2-Butanone	--	--	--	
2-Chlorophenol	--	--	--	
2-Hexanone	10.88	10.88	--	Massachusetts Guidance
2-Methylphenol	--	--	--	
2-Methylnaphthalene	14.25a	14.25a	--	Massachusetts Guidance
4,4-DDT	--	--	0.0103	Base on Slope factor
4-Methylpheaol	--	--	--	
4-Methyl-2-pentanone	--	--	--	
Acetone	160.54	160.54	--	Massachusetts Guidance
Acrylonitrile	0.01	1.18	--	Massachusetts Guidance
Aniline	0.14	2.07	--	Massachusetts Guidance
Benzene	0.12	1.74	--	Massachusetts Guidance
Benzo(a)anthracene	--	--	--	
Benzyl alcohol	--	--	--	
Bis(2-chloroethyl)ether	--	--	--	

aValue is for sum of naphthalene and 2-methyl naphthalene.

Table 11-5
Air Quality Performance Standards
Sitewide Remedy

Chemical/Element	Annual Average (AAL)	24-Hour Average (TEL)	Other	Source
	Concentration (µg/m3)			
Bis(2-ethylhexyl)phthalate	--	--	--	
Carbazole	--	--	--	
Carbon disulfide	0.27	0.27	--	Massachusetts Guidance
Carbon tetrachloride	0.07	85.52	--	Massachusetts Guidance
Chlorobenzene	6.26	93.88	--	Massachusetts Guidance
Chloroethane	358.78	717.55	--	Massachusetts Guidance
Chloroform	0.04	132.76	--	Massachusetts Guidance
Chloromethane (methyl chloride)	--	--	0.56	Based on Slope Factor
Dibenzofurab	--	--	--	
Dieldrin	--	--	0.000219	Based on Slope Factor
Di-n-Octylphthalate	--	--	--	
Ethylbenzene	118.04	118.04	--	Massachusetts Guidance
Ethylenedibromide	--	--	--	
Fluoranthene	--	--	--	
Gamma BHC (lindane)	0.003	0.14	--	Massachusetts Guidance
Heptachlor	0.001	0.14	--	Massachusetts Guidance
Methylene chloride	0.24	9.45	--	Massachusetts Guidance
Naphthalene	14.25a	14.25a	--	Massachusetts Guidance
NDMA	--	--	0.0001	Based on Slope Factor
PCBs	0.0005	0.003	--	Massachusetts Guidance
Pentachlorophenol	0.01	0.01	--	Massachusetts Guidance
Phenanthrene	--	--	--	
Phenol	52.33	52.33	--	Massachusetts Guidance
Styrene	1.75	115.81	--	Massachusetts Guidance
Tetrachloroethylene	0.02	922.18	--	Massachusetts Guidance
Toluene	10.24	10.24	--	Massachusetts Guidance
trans-1,3-Dichloropropene	--	--	--	
Trichloroethylene	0.61	36.52	--	Massachusetts Guidance
Vinyl chloride	--	--	0.028	Carcinogenic Risk
Xylenes (total)	11.8	11.8	--	Massachusetts Guidance
	Inorganics			
Ammonia	4.73	4.73	--	Massachusetts Guidance
Arsenic	--	--	0.0007	Based on Slope Factor
Barium	--	--	0.5	Based on Unit Risk
Beryllium	0.0004	0.001	--	Massachusetts Guidance
Cadmium	0.001	0.003	--	Massachusetts Guidance
Chromium	--	--	0.000085	Based on Slope Factor
Lead	0.07	0.14	--	Massachusetts Guidance
Manganese	--	--	1	Based on RfC
Mercury	--	--	0.3	Based on Unit Risk
Nickel	0.18	0.27	--	Massachusetts Guidance
Selenium	0.54	0.54	--	Massachusetts Guidance
Vanadium	0.27	0.27	--	Massachusetts Guidance

aValue is for sum of naphthalene and 2-methyl naphthalene.

Table 11-6
Landfill Gas Point of Action Boundary Standards

Chemical	Standards (µg/m3)
1,1-Dichloroethylene	4.9
1,2-Dichloroethane	9.4
Benzene	29
Chloroform	11
Methylene chloride	520
Vinyl chloride	2.8

aStandard based on 10-4 excess cancer risk.

Table 11-7
Landfill Gas Compliance Boundary Performance Standards Sitewide Remedy

Chemical	Performance Standard (µg/m3)	Basis
1,1,1-Trichloroethane	700	C
1,1-Dichloroethane	400	C
1,1-Dichloroethylene	0.033	B
1,2-Dichloroethane	0.040	A
2-Butanone	700	C
Benzene	O.12	A
Carbon disulfide	0.27	A
Chloroform	0.04	A
Ethylbenzene	118.04	A
Methylene chloride	0.24	A
Methane	5% LEL	D
Toluene	10.24	A
Total Xylenes	11.8	A
Vinyl chloride	0.020	B

Notes: A = ARAR/TBC (based on the Massachusetts AALs).
B = Carcinogenic (1 x 10-6) target risk (adult).
C = Noncarcinogenic target calculation (Hazard Index = 1).
D = 40 CFR, Part 241.
LEL = Lower Explosive Limit.

Table 11-8
Cost Estimate Summary
Selected Sitewide Remedy

OU	Remedial Actions/Components	(1) Capital	Annual O&M	(2) Present Worth O&M (i=5%, n=30 years)	(3) = (1) + (2) Present Worth Total
2/3	Gas Collection/Flare				
	Stage 1 (minus abandonment of wells) (630 scfm)	$1,543,000	$237,000	$3,643,000	$5,186,000
	Stage 2 (630 scfm)	226,000	21,000	323,000	549,000
	Drum Removal (includes cover maintenance)	4,054,000	243,000	3,736,000	7,790,000
	North Slope Cover	736,000	0	0	736,000
	Indirects @ 80% Capital & 30% O&M	5,247,000	150,000	2,306,000	7,553,000
	Subtotals	11,806,000	651,000	10,008,000	21,814,000
4/5	Section 6 Soil Monitoring	16,000	18,000	277,000	293,000
	Surface Water Removal Action	41,000	789,000	12,129,000	12,170,000
	Section 6 Sediment Monitoring	16,000	15,000	231,000	247,000
	Section 31 Sediment Monitoring	16,000	15,000	231,000	247,000
	Indirects @ 80% Capital & 30% O&M	71,000	251,000	3,858,000	3,929,000
	Subtotals	160,000	1,088,000	16,726,000	16,886,000
1/6	Slurry Walls	2,841,000	83,000	1,276,000	4,117,000
	Extraction Wells and Piezometers	261,000	11,000	169,000	430,000
	Mobilization	100,000	0	0	100,000
	Treatment System (20 gpm)	4,357,000	618,000	9,500,000	13,857,000
	Onsite Subtitle D Landfill	966,000	218,000	3,351,000	4,317,000
	Reinjection Trench	60,000	10,000	154,000	214,000
	Long-term GW Monitoring	508,000	840,000	12,913,000	13,421,000
	Infrastracture	278,000	30,000	461,000	739,000
	Well Abandonment	97,000	0	0	97,000
	Command Post Demolition	700,000	0	0	700,000
	Decommissioning	375,000	0	0	375,000
	Indirects @ 80% Capital & 30% O&M	8,434,000	543,000	8,347,000	16,781,000
	Subtotals	18,977,000	2,353,000	36,171,000	55,148,000
Totals		$31,000,000	$4,100,000	$63,000,000	$94,000,000

Note: Indirects include a 25 percent for contingency on capital costs and a 20 percent for contingency on O&M costs.

Section 12.0
Statutory Determinations

Under CERCLA Section 121, EPA must select remedies at Superfund sites that are protective of human health and the environment. CERCLA Section 121 specifies that when complete, the selected remedial action for a site must comply with applicable or relevant and appropriate environmental standards established under federal and state environmental laws unless a statutory waiver is justified. The selected remedy must also be cost effective and utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable. Finally, CERCLA Section 121 includes a preference for remedies that employ treatment that permanently and significantly reduce the volume, toxicity, or mobility of hazardous wastes as their principal element.

12.1 Protection of Human Health and the Environment

The following discussion describes how the risks posed through each pathway will be eliminated, reduced, or controlled by the components of the selected sitewide remedy and in doing so protect both human health and the environment. The selected remedy protects human health and the environment by achieving performance standards that will reduce the risk levels for individual contaminants at the Lowry Site to 1 x 10-6, and cumulative risk for all exposures and contaminants to between 1 x 10-6 and 1 x 10-6.

The selected remedy protects human health through: containment of contaminated ground water and collection and treatment of that ground water in an upgraded or new onsite treatment facility; maintenance of a complete cover over the landfill mass and the addition of cover material on the north face of the landfill; containment and collection of landfill gases, treatment and destruction of those gases in an enclosed flare, and treatment of gas condensate in the onsite treatment facility; excavation, treatment, and offsite disposal of drums and associated contamination in the former tire pile area; construction and operation of an adequate ground water/liquids treatment facility onsite; re-engineering of the drainage in unnamed creek to intercept and contain contaminated seepage and eliminate the release of contamination into sediments and surface water; implementation of a comprehensive monitoring program for all media; and, establishment of institutional controls to limit access, prohibit onsite construction, prohibit use of water beneath the Lowry Site, and prohibit all incompatible offsite land uses and activities.

The selected remedy is protective of the environment because it addresses all concerns identified by the ecological risk assessment for surface water, sediments, and surficial soils. Environmental risks posed by contaminated surface water and sediments in Section 6 are addressed by remedial actions, while surface water and sediments in Section 31 are addressed through limiting exposure and continued monitoring.

The landfill gas collection and treatment systems will minimize landfill gas migration into the offsite subsurface environment, thus reducing the mobility and volume of toxic substances through their treatment. The selected sitewide remedy will also remove contaminants from the gas through operation of an enclosed flare. The selected remedy eliminates the risk of fire or explosion from the accumulation of methane by reducing methane concentrations to less than 5 percent of the lower explosive limit at the boundary of the landfill mass. These reductions will also minimize the potential threat of inhalation of contaminants in landfill gas by future receptors.

According to the Baseline Risk Assessment, the estimated concentration of each carcinogenic contaminant in landfill gas within a potential future onsite residence would exceed a 1 x 10-6 cancer risk level for each carcinogenic contaminant. This also would be true for a hypothetical future offsite (200 feet west) residence if the structural slab of the residence were cracked and gas diffused in. Installation of the gas collection and flare systems will reduce the offsite risk of cancer from these pathways. Collection of landfill gas will also reduce the potential for gas to contaminate ground water.

The ground-water barrier walls and collection systems will minimize the potential for any future offsite migration of contaminated ground water. The upgradient containment, collection and diversion system will also inhibit offsite ground water from flowing into the Lowry Site's subsurface environment.

Containment and treatment of contaminated ground water will, over time, reduce the contaminant concentration in ground water onsite. Shallow ground water beneath the Lowry Site is not currently used. Deep ground water beneath the Lowry Site is used for industrial supply. Shallow and deep ground water downgradient of the Lowry Site is of domestic- and agricultural-quality and is used by nearby residents and farmers. The baseline cancer risk associated with the potential future ingestion of onsite shallow ground water within the waste-pit source area is estimated as 1 x 10-^{2}. The baseline noncancer hazard index is estimated as 47 for this potential future pathway. These risks are expected to decrease over time as existing ground water within the shallow aquifer is treated and flow through the Lowry Site is reduced. Residual risk after implementation of the selected remedy cannot be quantitatively estimated.

Operation of the SWRA will eliminate the potential future threat of exposure from direct contact and incidental ingestion of contaminated surface water and sediments. The baseline cancer risks associated with the potential future ingestion of onsite surface water and sediments (as they existed before the SWRA) are estimated as 8 x 10-4 and 9 x 10-6, respectively. The baseline noncancer hazard index for ingestion of surface water is estimated as 2, and the baseline noncancer hazard index for the ingestion of sediments is below 1. Baseline cancer and noncancer risks have been reduced to acceptable levels as a result of the SWRA. The hydraulic connection between ground water and surface water within the unnamed creek has been eliminated and thus, surface water is no longer contaminated above performance standards. Sediments within unnamed creek have been covered as a result of the SWRA, and thus, potential exposure to Section 6 sediments has been eliminated. These measures will be operated and maintained as part of the selected remedy. Institutional controls and access restrictions will eliminate the potential for exposure to surface water and contaminated sediments in Section 31. Monitoring will provide a mechanism to detect contaminant migration.

Excavation of contaminated solids from the former tire pile area will eliminate the potential for future direct contact, incidental ingestion, and inhalation. The baseline carcinogenic risks estimated for a hypothetical future onsite resident within the former tire pile area are 2 x 10-5 for ingestion and inhalation (inorganics and organic chemicals). These risks will be eliminated with excavation of the contaminated solids. In addition, excavation of contaminated solids will eliminate them as a potential source of further ground-water contamination.

Cap improvements on the north slope and containment of the landfill mass will eliminate the possible exposure of rectors to physical and chemical hazards associated with contaminated solids and landfill waste. In addition, the north slope cover will prevent infiltration of precipitation and thus reduce the potential for leachate generation.

Institutional controls will prohibit future land uses that are incompatible with or that could inhibit or impair the effectiveness of the on- and potential future offsite remedial actions.

Monitoring of ground water, gas, the SWRA, soil, sediments, ground-water treatment plant effluent, and surface water will assure that there is early warning of any failure of the selected sitewide remedy. These requirements include, but are not limited to: performance and compliance monitoring of the existing ground-water barrier wall, injection trench, SWRA collection system, and existing ground-water treatment facility; soil and sediment erosion monitoring; surface water runoff monitoring; monitoring of gas migration; and ground-water monitoring for detection of potential vertical and/or horizontal contaminant migration.

There will be no unacceptable short-term risks or cross-media impacts. Short-term effectiveness is discussed in detail in Section 12.4.3. Cross-media impacts were evaluated in terms of contaminant transfer to air, soil, ground water, surface water, and gas.

12.2 Compliance with ARARs

Under Section 121(d)(1) of CERCLA, remedial actions must attain standards, requirements, limitations, or criteria that are "applicable or relevant and appropriate" under the circumstances of the release at a site. All ARARs would be met upon completion of the selected sitewide remedy at the Lowry Site.

The selected sitewide remedy of additional capping, excavation of contaminated solids in the former tire pile area, ground-water containment and treatment, active landfill gas collection and treatment, operation and maintenance of the SWRA, and institutional controls will comply with all Federal and State applicable or relevant and appropriate chemical-, action-, and location-specific requirements (ARARs). Federal and State statutes and regulations pertinent to the selected remedy are discussed in Section 11.0.

The specific ARARs and TBCs for the selected sitewide remedy are presented in Table 11-1.

12.3 Cost Effectiveness

EPA has determined that the selected sitewide remedy will provide overall effectiveness proportional to its costs and is, therefore, cost effective. In order to make this determination, EPA compared the costs of components of the selected remedy to the alternatives evaluated during the FSs, as described below. A description of cost estimating procedures is provided in Subsection 8.1.

12.3.1 Shallow Ground Water and Subsurface Liquids (OU 1) and Deep Ground Water (OU 6)

For ground water alternatives (OUS 1&6), Section 9.0 of this ROD provides the capital costs, annual operation and maintenance costs, and the present worth of each alternative. The selected ground-water remedy, Modified Alternative GW-5 (the North Boundary and Toe of Landfill and Lateral Barrier Wall, Collection and Treatment System, Plus Upgradient Containment, Collection and Treatment alternative), is comparable in cost to

Alternatives GW-3 (the North Boundary, Toe of Landfill Containment, Collection and Treatment alternative), GW-5 (The North Boundary, Toe of Landfill, Lateral Containment, Collection and Treatment alternative), and GW-6 (the North Boundary, Toe of Landfill, and Waste-Pit Pumping alternative), but will be more effective than these alternatives at preventing offsite migration of contaminants. Unlike these other alternatives, the selected ground-water remedy includes the immediate design and construction of containment and collection systems on all sides of the Lowry Site.

Alternative GW-6 results in a slightly greater reduction of volume of contaminants than the selected remedy; however, this alternative would not eliminate the source and the potential for offsite migration of contaminants would still exist. Thus, the additional cost of this alternative would not be warranted.

The selected ground-water remedy is more expensive than Alternatives GW-1 (the No Further Action alternative) and GW-2 (the North Boundary Containment alternative), but it is also more effective at containing and treating contaminants than these alternatives. Alternative GW-4 (the North Boundary, Upgradient Containment Plus Multilayered Cap alternative) is more expensive than the selected remedy, but would be less effective because it would not include lateral containment.

12.3.2 Landfill Solids (OU 2)

Section 9.0 of this ROD provides capital costs, annual operation and maintenance costs, and present worth costs for Landfill Solids (OU 2). Although the selected landfill solids remedy, Modified LFS-4 (the Drum Removal/Offsite Disposal/North Face Cover alternative), is the most expensive of the alternatives evaluated, it offers greater long-term effectiveness and permanence and a significantly greater reduction of toxicity, mobility, or volume through treatment than any of the other alternatives. This is because the selected remedy will excavate, treat, and dispose offsite a much larger volume of contaminated solids from the former tire pile area than any of the other alternatives. The effectiveness of the selected remedy is also greater because it includes 2 feet of additional cover on the north slope of the landfill mass, which will reduce the potential for exposure to landfill solids and for infiltration of water into the landfill mass.

12.3.3 Landfill Gas (OU 3)

Section 9.0 of this ROD provides cost information for remedial alternatives evaluated for Landfill Gas (OU 3). The selected landfill gas remedy, Modified LFG-3 (the Gas Collection/Enclosed Flare alternative), is slightly more expensive than Stage 1 of Alternative LFG-3 (the Gas Collection/Enclosed Flare alternative) and slightly less expensive than Stage 1 of Alternative LFG-5 (Gas Collection/Enclosed Flare and Heat Recovery), but includes significantly more extraction wells than either alternative, and thus, will be more effective at preventing offsite migration of landfill gas and dangerous buildup of gases onsite. The selected remedy will also result in a greater reduction of toxicity, mobility, and volume of contaminants through treatment.

Stage 2 of Alternative LFG-3 would be as effective and offer the same reduction in toxicity, mobility, and volume through treatment as the selected remedy, but would be more expensive because it would involve the immediate abandonment of existing wells and would involve remobilization for Stage 2 construction.

Stage 2 of Alternative LFG-5 would be as effective and offer the same reduction in toxicity, mobility, and volume through treatment as the selected remedy, but would be more expensive because it would involve: installation of heat recovery equipment; the immediate abandonment of existing wells; and would involve remobilization for Stage 2 construction. Alternative LFG-5 would offer the benefit of heat recovery, but an economical use for the heat has not been identified.

The selected remedy is more expensive than Alternative LFG-2 (the No Further Action alternative), but Alternative LFG-2 will not prevent the migration of landfill gas offsite or reduce the toxicity, mobility, or volume of contaminants through treatment. Alternative LFG-2 is not an effective remedy.

12.3.4 Soil (OU 4)

For soil (OU 4), Section 9.0 of this ROD summarizes cost data for each alternative. The selected remedial alternative for soil, Alternative SOIL-1 (No Further Action), is the least costly option. The remaining alternatives are more expensive without providing significant additional short-term or long-term effectiveness. Contaminant concentrations in soils are already at protective levels, and therefore, excavation or dust control provide no added benefit. None of the alternatives reduces toxicity, mobility, or volume through treatment, because no alternative involves treatment.

12.3.5 Surface Water (OU 5)

For surface water (OU 5), the SWRA was evaluated for its effectiveness and integration into the sitewide remedy. Because the SWRA was deemed effective in eliminating surface water exposures at the Lowry Site and could be fully integrated into the sitewide remedy, it was the only alternative retained. The design life of the SWRA was investigated to ensure full integration with the components of the sitewide remedy. The costs for the SWRA are provided below:

Alternative SW-1, No Further Action

Capital Costs-$41,000
Annual O&M Costs-$790,000
Present Worth-$12,100,000

12.3.6 Sediments (OU 5)

For sediments that are part of OU 5, the remedial alternatives are discussed by location, in either Section 6 or Section 31. For Section 6 sediments, Section 9.3 of this ROD summarizes costs for each alternative. The selected remedy, SED6-1 (the No Further Action alternative), is the least expensive alternative, will be virtually as effective as Alternative SED6-2 in the long term, and will be as or more effective than Alternative SED6-2 in the short term because no construction is required. Neither alternative includes treatment.

For Section 31 sediments (OU 5), Section 9.3 of this ROD summarizes costs for each alternative. The selected remedial alternative for Section 31 sediments, Alternative SED31-1 (No Further Action), is the least costly option. The remaining alternatives are more expensive without providing additional short-term or long-term effectiveness. Contaminant concentrations in sediments are already at protective levels, and therefore, capping, excavation, or access restrictions provide no added benefit. None of the alternatives reduces toxicity, mobility, or volume through treatment, because no alternative involves treatment.

12.3.7 Selected Sitewide Remedy

The net present-worth value for the selected sitewide remedy is $94,000,000 (see Table 11-8 for equated cost summaries for the selected sitewide remedy). Because there are no significant cross-media impacts, and since each of the selected components has been demonstrated to be cost effective, the sum of the components is also cost effective. Therefore, EPA has determined that the sitewide remedy is cost effective in accordance with Sections 300.430(f)(1)(i)(B) and 300.430(f)(1)(ii)(D) of the NCP.

12.4 Utilization of Permanent Solutions and Alternative Treatment Technologies (or Resource Recovery Technologies) to the Maximum Extent Practicable

EPA has determined that the selected sitewide remedy utilizes permanent solutions and alternative treatment technologies, or resource recovery technologies, to the maximum extent practicable because it uses state-of-the-art treatment technologies for landfill gas and ground water. In addition, the removal, treatment, and disposal of wastes in the former tire pile area will achieve a permanent solution for those wastes. Although the selected sitewide remedy is in large part a containment remedy, the remedy offers the best balance of tradeoffs among the five primary balancing criteria and further use of treatment as evaluated in the RI/FSs is not practicable. State and community acceptance were also considered in making this determination.

Since the selected sitewide remedy is in large part a containment-based remedy, it is consistent with Directive No. 9355.0-49FS Presumptive Remedy for CERCLA Municipal Landfill Sites; however, every effort has been made to treat the landfill gas and ground water within the containment system. The selected remedy will ensure the containment of ground water on the northern, eastern, western, and southern boundaries, and will collect ground water for treatment at each of these locations. In addition, ground water will be collected for treatment at the toe of the landfill. Gas will be collected at the eastern, western, and southern boundaries of the landfill mass and within the landfill mass and treated. In addition, the removal and offsite treatment of accessible waste within the former tire pile area (the principal threat in the former tire pile area) is consistent with the statutory requirement.

Of the alternatives that meet EPA's two threshold criteria of overall protection of human health and the environment and compliance with ARARs, EPA has determined that the selected sitewide remedy best balances the tradeoffs of the alternatives as they relate to: long-term effectiveness and permanence; reduction in toxicity, mobility, or volume achieved through treatment; short-term effectiveness; implementability; and cost.

The following discussion of tradeoffs among alternatives is based on a comparison to the five primary balancing criteria listed above, and the two modifying criteria of State and community acceptance.

12.4.1 Long-Term Effectiveness and Permanence

Ground Water

Of the alternatives evaluated, the selected ground-water remedy would offer the greatest long-term effectiveness and permanence because it addresses the movement of contaminants from all sides of the Lowry Site. The selected remedy will immediately prevent potential offsite migration of contaminants to the south, east, and west, using barrier walls and collection systems. Barrier walls are a permanent form of containment and have been proven effective over the long term at the Lowry Site. The selected ground-water remedy also includes treatment of contaminated ground water and is the only alternative that fully contains and collects contaminants migrating to the north, east, west, and south. In addition, the selected remedy will provide for collection of contaminated ground water at the toe of the landfill mass. Contamination will be captured closer to the source, thereby avoiding further contamination of the aquifer downgradient of the landfill mass. The selected remedy effectively reduces the long-term potential for contaminated ground-water migration.

Landfill Solids

The selected remedy would provide the greatest long-term effectiveness and permanence because portions of the former tire pile area will be excavated and the largest volume of contaminated material will be removed relative to the remaining alternatives. This remedy will permanently remove contaminated material from the Lowry Site. In addition, the selected remedy will provide 2 feet of additional cover on the north face of the landfill mass, thus providing greater containment and long-term effectiveness and permanence in the landfill area than the other alternatives.

Landfill Gas

The selected remedy will provide the greatest long-term effectiveness and permanence because it will provide a more extensive gas extraction system throughout the landfill mass, and will be less dependent on gas monitoring activities than other alternatives.

Soils

The selected remedy will provide long-term effectiveness and permanence through institutional controls. The risks associated with the soils are within EPA's acceptable risk range. Therefore, the selected remedy would offer acceptable long-term effectiveness and permanence.

Surface Water

The SWRA has been constructed, has operated reliably, and has met performance standards. The SWRA has been designed for long-term operation and will be monitored and maintained such that it continues to achieve performance standards. Thus, the SWRA will achieve long-term effectiveness and permanence.

Sediments

In Section 6, the sediments have already been covered as part of the SWRA. The selected remedy will provide long-term effectiveness and permanence through continued maintenance of the cover. The selected remedy for Section 31 sediments would provide acceptable long-term effectiveness and permanence because the risks associated with the sediments are within EPA's acceptable risk range.

12.4.2 Reduction of Toxicity, Mobility, or Volume Through Treatment

Ground Water

The selected remedy will provide substantial reduction of toxicity, mobility, and volume through treatment by extracting highly contaminated ground water from the alluvium at the toe of the former landfill. In addition, the selected remedy will provide for extraction and treatment of contaminated ground water from the northern, eastern, western, and southern boundaries of the Lowry Site. Because it would extract and treat waste-pit liquids, Alternative GW-6 would be the only alternative which would treat a greater volume of material than the selected remedy. However, Alternative GW-6 does not compare favorably to the selected remedy with respect to other criteria.

Landfill Solids

The selected remedy will provide the greatest level of excavation and treatment of contaminated solid material, thereby providing the most effective reduction of toxicity, mobility, and volume through treatment.

Landfill Gas

The selected remedy will provide the greatest reduction of toxicity, mobility, and volume by extracting and treating more gas from the eastern, western, and southern portions of the landfall mass than any of the other alternatives.

Soils and Sediments

None of the alternatives, including the soils and sediments selected remedies, result in a reduction of toxicity, mobility, or volume through treatment.

Surface Water

Under the selected remedy, the SWRA would reduce the volume of contaminants through collection and treatment of contaminated alluvial seepage.

12.4.3 Short-Term Effectiveness

Ground Water

All of the alternatives would have reasonable short-term effectiveness. The selected remedy would include a ground-water extraction system, at the toe of the landfill, for collection of highly contaminated ground water. During construction of this system, workers and the community would potentially be exposed to higher risks from the presence of volatile organic compounds in the soil. However, these risks are not anticipated to be significant during the 3-year design and construction period. It has also been demonstrated that workers at the Lowry Site, as well as the community, can be adequately protected during construction through the routine application of accepted health and safety practices. The selected remedy will achieve overall protection in a shorter time frame than any other alternative because containment systems would be immediately designed and installed on the eastern, western, and southern sides of the Lowry Site.

Landfill Solids

The selected remedy is not the best alternative considered under this criterion. The No Further Action alternative (LFS-2) would have the greatest short-term effectiveness because it would pose no adverse short-term effects to workers, the community, or the environment and would take the least amount of time until protection was achieved. However, potential short-term risks to construction workers associated with excavation of contaminated materials from the former tire pile area can and will be controlled through the use of appropriate health and safety measures.

Landfill Gas

The selected remedy poses minimal short-term risks in connection with the required construction activities. These risks would apply primarily to onsite workers during construction. Protectiveness will be achieved after construction is complete. Alternative LFG-2 (the No Further Action alternative) would pose no adverse short-term risks to workers because there would be no construction activities, but this alternative would not eliminate potential short-term risks from gas buildup and migration, and thus, would not be effective in the short-term.

Soils

The selected remedy would not involve soil disturbance and, therefore, would provide maximum short-term protection to workers, the environment, and the community. The risk from soils are already within EPA's acceptable risk range and therefore the time until protection is achieved is immediate.

Surface Water

Construction and startup of SWRA facilities have been completed and were conducted in a manner without accidents or adverse environmental impacts. Therefore, the SWRA satisfies the short-term effectiveness criterion.

Sediments

The selected remedies for sediments in Section 6 and Section 31 provide the greatest short-term effectiveness for workers, the community, and the environment because these alternatives require no disturbance of sediments. The risks from sediments in Section 6 have been addressed through construction of the SWRA and the risks from sediments in Section 31 are within EPA's acceptable risk range. Therefore, the selected remedies achieve protection immediately.

12.4.4 Implementability

Ground Water

The selected remedy is considered to be administratively and technically implementable. The services and materials required to implement this remedy are readily available and use current technologies. Construction of containment barrier walls is considered routine and can be performed by local contractors. The effectiveness of the ground-water treatment system has been proven by the success of the existing onsite treatment facility. Alternatives GW-4 and GW-6 would be more difficult to implement than the selected remedy because Alternative GW-4 would include 100-foot deep extraction trenches that might be difficult to construct, and Alternative GW-6 would include drilling 52 waste-pit extraction wells that might be difficult to drill through landfill refuse.

Landfill Solids

Like the ground-water selected remedy, the landfill solids selected remedy is considered to be administratively and technically implementable. The services and materials required to implement this remedy are readily available and use current technologies. The selected remedy will include excavation of drums, drum contents, and contaminated soils using readily available construction equipment. This type of excavation is considered routine construction, could be conducted by local contractors, and has been implemented at other Superfund sites. Construction of the north face cover would involve routine landfill construction procedures, and cover material is readily available onsite.

Landfill Gas

The selected remedy is technically and administratively implementable. The selected remedy will use current proven technology, and the construction of gas extraction wells would be a routine activity that could be conducted by local contractors. In the long term, the selected remedy would be more easily implemented than Alternatives LFG-3 and LFG-5 because construction activities would be limited to one mobilization event.

Soils and Sediments

All of the alternatives, including the selected remedies for soils and sediments, are considered to be technically and administratively implementable.

Surface Water

The SWRA has been constructed and is operational, and has therefore been demonstrated to be implementable.

12.4.5 Cost

Ground Water

While the selected remedy is not the least costly of the alternatives considered, it has significant advantages over less costly alternatives. In particular, unlike those alternatives which are significantly less expensive (Alternatives GW-1 and GW-2), the selected remedy includes the immediate design and installation of permanent containment and collection systems on all boundaries of the Lowry Site to prevent offsite migration of contaminants. It would thus offer greater long-term effectiveness and permanence. The selected remedy also includes toe of the landfill collection and treatment and will thus provide greater reduction in toxicity, mobility, and volume through treatment than Alternatives GW-1 or GW-2.

Other alternatives which are only slightly less expensive than the selected remedy (Alternatives GW-3 and GW-5) would also not include containment and collection systems on all boundaries of the Lowry Site. The same is true of more expensive alternatives (Alternative GW-4 and GW-6.) The addition of a multilayer cap in

Alternative GW-4 would not provide any significant advantages over the existing cap over the landfill mass. Alternative GW-6's extraction and treatment of waste-pit liquids would only be able to extract a small percentage of waste-pit liquids, and thus, the source of ground-water contamination would remain.

Landfill Solids

The selected remedy is the most costly of the alternatives evaluated, but it is considered to offer significant advantages over the other alternatives with respect to reduction of toxicity, mobility, and volume through treatment and long-term effectiveness and permanence because it would remove and treat the greatest volume of contaminated materials in the former tire pile area, including accessible waste pits which are considered hot spots, and would place an additional two feet of cover on the north face of the landfill mass.

Landfill Gas

The selected remedy is more costly than the No Further Action alternative, but the No Further Action alternative would not be effective in either the long or the short-term and would not achieve a reduction in toxicity, mobility, or volume through treatment. The selected remedy is only slightly more costly than Alternative LFG-3, Stage 1, but will include the installation of a more extensive array of extraction wells around and within the landfill and thus offers significant advantages with respect to long-term effectiveness and permanence and reduction of toxicity, mobility, or volume through treatment. Other landfill gas alternatives which are more expensive than the selected remedy offer no advantages over the selected remedy.

Soils and Sediments

The selected remedy for soils and sediments is the least costly of the alternatives considered and will also be effective in both the short and the long-term. None of the alternatives considered included treatment.

Surface Water

The selected remedy was the only alternative considered.

12.4.6 State Acceptance

The State of Colorado concurs with the selected remedy for the Lowry Site and concurs with the selected ARARs.

12.4.7 Community Acceptance

Based on comments to the Proposed Plan for OUS 1&6, the community and the PRPs support the selected remedy. The community has reservations about leaving the bulk of waste-pit liquids in place; however, it is technically infeasible to remove the waste-pit liquids. Comments received from the community on the Proposed Plan for OUS 2&3 and 4&5 were strongly supportive of the excavation and treatment of contaminated solids in the former tire pile area. The community was also generally supportive of the simultaneous implementation of Stage 1 and Stage 2 gas extraction as a means of controlling offsite landfill gas migration. However, one commenter encouraged EPA to consider the focus of the gas extraction to be extraction and removal rather than control of offsite landfill gas migration. The commenter felt that the additional installation of Stage 3 would yield a significant increase in the annual volume of contaminants removed for a relatively small incremental increase in the overall cost. The community was also adamantly opposed to the addition of 1.2 million cubic yards of municipal solid waste over the former waste pits. Commenters were very supportive of EPA's decision to reject this alternative.

Comments from the PRPs opposed EPA's preferred alternative for landfill gas and landfill solids and proposed a remedy consisting of land acquisition and land use restrictions of 0.5 miles around the perimeter of the Lowry Site, enhancement of the landfill cover through the addition of 1.2 million cubic yards of municipal solid waste, and the installation of only Stage 1 of the gas extraction system. The PRPs' comments also focused on the short-term effectiveness of the excavation in the former tire pile area and the potential exposure to workers during the excavation.

12.5 Preference for Treatment as a Principal Element

The selected sitewide remedy includes: treatment of contaminated ground water collected from the northern, western, eastern, and southern boundaries of the Lowry Site; treatment of contaminated ground water collected from the toe of the landfill mass; treatment of landfill gas collected from the perimeter of the landfill mass; and excavation and offsite treatment of "hot spots" from the former tire pile area. The hot spots in the former tire pile area constitute a principal threat at the Lowry Site. Also, the SWRA utilizes treatment to control the principal threat of contaminated seepage. The statutory preference for remedies that employ treatment as a principal element is thus at least partially satisfied by the selected sitewide remedy.

The statutory preference for treatment will not be met for the landfill mass and associated waste pits. Treatment is not practicable for the following reasons:

- The large volume of waste within the landfill mass.
- The lack of discrete, accessible hot spots that represent major sources of contamination.

- The impracticability of excavating and treating the entire volume of waste.

- The prohibitive cost. Preliminary estimates during early FS studies indicated that costs would be in excess of $4.5 billion.

It should be noted that the selection of a remedy based in large measure on containment for the Lowry Site with excavation of accessible hot spots is consistent with the NCP and EPA's guidance regarding presumptive remedies for CERCLA municipal landfill sites. Because this remedy will result in hazardous substances remaining on the Lowry Site above health-based levels, a review will be conducted at least every 5 years after commencement of remedial action to ensure that the remedy continues to provide adequate protection of human health and the environment.

Section 13.0
Responsiveness Summary for Operable Units 1 & 6

This section presents the oral and written responses to comments from EPA to individuals, concerned citizen groups, and public entities who have commented on the Proposed Plan for OUS 1 & 6. Comments are presented in italics; their responses in plain text. Each individual or public group's comments and responses are presented as individual subsections.

13.1 Response to Oral Comments on the Proposed Plan for Operable Units 1 & 6 Shallow Ground-Water and Subsurface Liquids and Deep Ground-Water Operable Units Lowry Landfill Public Meeting December 9, 1992

The following subsection is a legal transcript of the comments and responses recorded during the public meeting held in December 1992.

PUBLIC MEETING
LOWRY LANDFILL SUPERFUND SITE
Proposed Plan for Operable Unites 1 & 6:
Shallow Groundwater and Subsurface Liquids
and Deep Groundwater
December 9, 1992
7:15 p.m.

Eaglecrest High School
5100 S. Picadilly Street
Aurora, Colorado

PAMELA MEADE COURT REPORTERS
(303) 494-2141

MARC HERMAN: I'd like to welcome everyone to the proposed planning meeting for Lowry shallow groundwater and subsurface liquids and deep groundwater operable units. The purpose of the meeting is to present to you, the public, EPA's preferred alternative for remediating the groundwater operable units at Lowry Landfill.

I'd like to start, first of all, by providing some introductions. My name is Marc Herman, and I am a remedial project manager on the Lowry Landfill Superfund Site Project -- not a supreme commander of allied forces.

We have Robert Duprey, the director of the Hazardous Waste Management Division; Barry Levene, Chief of the North Dakota/Colorado Section of the Superfund Remedial Branch; Gwen Hooten, Remedial Project Manager for the Lowry Landfill Operable Units 1 and 6; Jesse Goldfarb, Assistant Regional Counsel; Rob Henneke, Community Relations Coordinator; and representing in this corner the State of Colorado, Colorado Department of Health, Angus Campbell, State Project Coordinator for Lowry Landfill Superfund Site, Joe Vranka; State Project Officer; Jane Mitchell, Toxicologist, Colorado Department of Health; and Bob True, Community Relations Specialist.

We also have some other folks without

whose participation this would not be possible. Representing EPA's technical contractor CH2M Hill, Phil Burke, and operating the slide projector; and Andrea Garcia, Community Relations Coordinator; and representing the Lowry Condition, Paul Rosasco.

I have a few announcements to make before we get into the presentation. The last day for written comments is December 30, 1992. However, we have received a request to extend the public comment period and it will be extended to January 30, 1993.

Everyone on the mailing list will receive a notice and both major newspapers in the Denver metropolitan area will receive notices that they will publish announcing the extension for the public comment period.

I would request that you hold all questions or comments until the end when we have a designated question and answer period.

Can everyone hear me okay? I would ask that all commentors when you get up to ask a question or make a comment, that you identify yourself and also identify your affiliation.

I would ask that you please limit your questions or comments to five minutes, and if you have more than one question or comment, perhaps you could make the initial one and give someone else a chance and then follow that.

I would remind you if you do not want to make verbal comments, you can make the comments in writing, and I would remind everyone that all pertinent documents that were used for making this decision are available for review at the Aurora Public Library and EPA Superfund Records Center.

With that, I would like to introduce Angus Campbell who will provide you -- oh, I'll go over the outline first. We've already done the introduction. Angus is going to provide a history of the site. Gwen will handle the summary of site studies, and she will discuss the evaluation of cleanup alternatives, and then we'll talk about public comments and open up the meeting to questions and answers.

Angus, go ahead.

ANGUS: CAMPBELL: Good evening. I'm here to talk a little bit about the location and history of the Lowry Landfill and some of the actions that have taken place to date.

The landfill is located here (indicating) at the corner of Gun Club Road and Quincy Avenue. It's about 15 miles to the southeast of downtown (Denver). It is about two miles east of the city of Aurora city limits. It's northwest of the Arapahoe Race Track and northwest of the Aurora Reservoir, which is just off the map here (indicating).

Communities in the area, there is Murphy Creek Ranch two miles to the north, and Dove Hill which is two miles to the south. Eaglecrest High School is about 2-1/2 miles to the southwest. The proposed E-470 alignment goes, depending on which proposal you look at, either east or west of the site.

A little more detail on the site is here, again, Gun Club Road and East Quincy Avenue to the south (indicating). The site consists -- well, the site is actually part of the Denver Arapahoe Disposal Site, which is five sections of land that was deeded to the City and County of Denver for waste disposal practices. I'll go into that a little more later. The Superfund site is on Section 6 area (indicating).

Section 31 is the current landfill. If you go down Gun Club Road, that's where you see all the trash. The waste pits are in the south here (indicating). Unnamed Creek is a small stream in the middle of the site. The tire fill area is here (indicating).

The command post where a lot of the activities for the Superfund studies are headed out of is here (indicating), the groundwater barrier wall and the treatment plant (indicating).

Here is a slide showing the site prior to landfilling (indicating). This is from 1956. Here we can see a good footprint of the Unnamed Creek drainage system. The actual site, again here is Gun Club Road and Quincy here to the south, and you see the section line here for Section 6. This is Unnamed Creek here (indicating). This is Murphy Creek, which is the major tributary that Unnamed Creek flows into.

History of the Site. Again, as I indicated, the landfill area was part of the Lowry bombing range during World War II. In 1964 that land was deeded to the City and County of Denver for waste disposal practices. Those practices went from '66 to 1980, and the practices were known as codisposal, which was the acceptable method at the time for disposing liquid industrial waste along with municipal solid waste.

EPA has calculated 142 million gallons of liquid waste was disposed of into unlined trenches. We'll have some pictures of those later. Again, this is called codisposal.

That practice ended in 1980. Since 1980, the landfill was used for municipal solid waste only. EPA listed the site on the NPL, National Priorities List, which is a list of the most dangerous hazardous waste sites in the nation, and that's where the Superfund Site funds come from.

In 1984 the first work began on site with the negotiations on work for the groundwater barrier wall and groundwater treatment facility. In '84, '85 the EPA began Phase I and II remedial investigations of the site.

In 1988 the EPA under SARA divided the site up into six operable units. Those are Operable Units 1 and 6 is what we're here for tonight, the shallow groundwater surface liquids and deep groundwaters. That work was conducted by the Lowry Coalition for the RI/FS process. Operable Units 2 and 3 are being conducted by the City and County of Denver, Waste Management of Colorado and Chemical Waste Management. Operable Units 4 and 5, again the work is being conducted for the City and County of Denver and Metro Waste Water Reclamation District.

In December 1988 under the new Operable Unit Plan, the EPA and CDH negotiated an agreement for Operable Unit 1. In 1989 -- we'll see later there is a lot of tires disposed of at the site. Denver contracted with Waste Management of Colorado to shred 6 to 7 million tires on site.

In September of '89, the negotiations and agreement to perform Operable Units 2 and 3 and also OU NO. 1, and there was an administrative amendment to include OU6 in December of that year.

In August of 1990 Section 6, the old landfill, was closed to municipal solid waste land-filling, and the cap was subsequently put on the site. And in March 1991, OUS 4 and 5 were negotiated, and in August of that year, the Surface Water Removal Action was negotiated. In October of that year, the design for the Surface Water Removal Action began.

Tire shredding was completed 16 months less than the contracted period, in April of this year, and Surface Water Removal Action construction began in August and, as you can see, was completed in November. As we are here tonight the RI/FS for Operable Units 1 and 6 was completed also last month.

There is a series of slides showing sort of the progression of the landfill and waste pit construction and filling. This is the site in 1965 (indicating). You can see a few waste pits. They're fairly long. Some of these waste pits get rather large, 800 feet long and up to 300 feet wide and 30 feet deep in spots.

This slide is from August of 1969, and you can see additional waste pits being constructed. Some are up in the northern part.

And in '72, again, you can see some rather large features here, which are all waste disposal pits for codisposal.

In 1977 we began to see tires being disposed of here. As you'll see later those are now gone, and still we have the waste pits being constructed and filled into the south into the tire area.

This is a picture of what codisposal is and why it is listed as a Superfund site. We have drums of liquid waste disposed of in unlined pits. These drums of liquid waste were disposed of in these unlined pits. Drums prior to 1966 were not punctured according to the State records, and they were just disposed of in the pits. Post-1966 they were punctured and drained.

Also they came in tanker trucks and opened up the valves of the tankers and let them go into the ground into these unlined pits. And, again, here we can see the tire piles here (indicating) and all the landfill and waste pit areas here, and this is how it was done.

This is a good picture of what codisposal is. Again, we have a pit here, 30 feet deep, fairly large, about two-thirds full of liquid. It was backed up -- trucks and waste haulers backed up and just dumped their solid wastes into the liquid waste.

The theory behind it was that the solid waste would act as an absorbent and sop up -- similar to what a sponge does -- sop up the liquids. Just to give you an idea, 77 pits have been identified on site, and 53 of those pits have known liquid in them.

To give you a scope of what these are, generally a Superfund site would be one of these pits, and here we have 50 of them, if it was elsewhere in the nation.

Contents of the waste pits, again it's 142 million gallons, give or take a few, of industrial and municipal liquid and solid waste, including sewage sludge, metal plating wastes, petroleum derived products and waste products, pesticides, industrial solvents.

These unlined pits over time leaked, and to address that shallow contamination, several interim remedial actions were put in place. We have the underground barrier wall -- I'll show you a slide of that later -- the groundwater treatment facility, the Surface Water Removal Action, and other actions, the shredding of the tires on site that allowed for access to the other RI/FS activities.

Here's a cross-section of the existing groundwater barrier wall (indicating). It was built, again, in 1984. It's about 960 feet long, 30 feet wide and 35 feet deep, and that's made of compacted clay, and on the upgrading side is a French drain or gravel drain that -- there is a pump in it which collects the contaminated groundwater and pumps it to the treatment plant.

Here's a picture of the treatment plant -- or what it used to look like (indicating). It's been updated tremendously since then. The process used for treating the contaminated groundwater is essentially filtration, air-stripping -- this is the old airstripper (indicating), a carbon unit, which takes up a lot of the volatile and semivolatile organic compounds, and then that clean water which meets standard is injected downgradient of the barrier wall in what is known as the injection trench. I believe the volume is on the order of 10 gallons a minute on the average.

Here's a picture of the Unnamed Creek as it used to look several years ago. Again we have contaminated seepage and groundwater flowing to the north. Here are tire piles. This was the problem that the Surface Water Removal Action was trying to address. What happened is that when it would rain, precipitation would go into this Unnamed Creek and flow offsite, this contaminated surface water.

The Surface Water Removal Action is here in green (indicating) and essentially is a drainage blanket that collects the contaminated seepage and keeps it separate from the rain water and precipitation. Again, we have a cartoon of the waste pits, the old tire pile areas and command post and groundwater treatment facilities here.

Tire piles. This is an old slide of what the tire piles used to look like. I believe it was 35 acres were shredded over a period of 16 months, I believe, and they are put into -- this is the shredding operation -- put into a monofill of 3 acres. The size of shreds are about 2 inches square, thereabouts.

This is a lined monofill and contains nothing but tire shreds. These shreds have been used as some of the drainage material for the Surface Water Removal Action. In addition the Colorado Department of Highways has used it as a low density fill over some ironically other landfills they're building a highway over, and in addition about 20 percent of the shreds have ended up as a fuel supplement used in cement kilns.

And with that I'll allow Gwen to discuss 0Us 1 and 6.

GWEN HOOTEN: I'm not as loud as Angus. I'll have to use a microphone. I'd like to extend a special welcome to our students in the back. We're glad to see you here.

As part of the site summary, Angus has discussed with you the first portion. What I'd like to do is place special emphasis on what we're here to discuss tonight which is OUS 1 and 6.

About 1989 we looked into -- previous to that we were doing an EPA fund project, which means that we financed the studies. Between 1989 and 1990, we moved into what we refer to as an enforcement, which means that the potentially responsible parties, or otherwise known as the polluters, paid for the expense of the studies.

These studies, which we will refer to as additional site characterization, the treatability studies and feasibility studies, were done simultaneously so that the work could be completed expeditiously.

We are at the end of the feasibility study, and we're here tonight to discuss the proposed plan. In addition to that, we have other studies going on simultaneously. We have OUS 2 and 3 on which the remedial investigation feasibility studies are being conducted. We expect that to be completed -- well, it was August. It has been accelerated up until April or May of this year.

In addition we have OUS 4 and 5. We

expect that to be completed in March of '93. We're looking at proposed plans coming out shortly after those feasibility studies are completed, and then we expect to write a site-wide Record of Decision.

As far as the results of the studies, what we found is that the groundwater predominantly flows to the north. However, there is a component to the east and to the west.

This right here (indicating) is a cross-section of the site, and what we're showing here is what our definition of shallow groundwater is versus deep groundwater. What we have here is -- this is south and this is north, and this is the groundwater containment system that Angus Campbell talked about, and we have refuse to the south, here we have alluvial soils and more refuse with lesser waste pits to the north.

Operable Unit 1, which is shallow groundwater, is defined by the weathered and unweathered Dawson. This right here is termed as the separation layer, and below that is considered the deep groundwater. So the deep groundwater includes the lower Dawson, the Denver and all other aquifers underneath there.

For the horizontal extent of contamination, what we found is that the waste pits seep out into the groundwater surrounding them and the extent of the contamination really flows around where the majority of the waste pits are, and, again, the flow is to the north so we see a migration pathway.

For the vertical extent of contamination, primarily that is driven into the deep groundwater by a well that we refer to as B-504. We've also placed C-702 in here because we do have one hit of benzene.

With this what we wanted to demonstrate to you is what the extent of contamination is thus far. This well is located about 150 feet from surface. This one here is about 170 feet. Again, there is the barrier wall (indicating).

What we believe is of most concern to you and to us is the protection of human health and the environment. In order to determine that, we have to determine what the risk is. We believe that this graphic demonstrates that.

First of 211, we have to have a contaminant source. By the sampling that we've done, we know we have contaminants out there. Then you have to have a transport, a point of exposure, a way that exposure has a route to a receptor, and then what you are drinking or inhaling or touching has to have a toxicity value.

We have to have all of these components before we can say there is risk. A baseline risk assessment is a study that describes the potential risks posed to human health if nothing is done to remediate the risk.

Angus Campbell has talked to you about the interim remedial actions that we've had done in coopera- tion with the PRPs to ensure that the contaminants have not migrated off site.

If we were to do a baseline risk assessment, we would allow those to deteriorate. We would essentially walk away from the site. Then we're trying to determine what the risk is to those remaining if we were to walk away from the site.

So for the results of our groundwater, we supplied to you an aerial photo of the site. This right here is Section 6 (indicating). As you can see, there is little to no development at this present time around the site. Therefore, we do not believe there is a receptor, so there is no current risk.

Right here is one of the nearest developments, as well as Murphy Ranch, and then also Dove Hill.

What we're finding is that if you built a residence on the site and you did drink water there, you would have a 1 in 100 chance of getting cancer above what you are normally exposed to, and this graphic shows that you would then be a receptor.

Now, we'll go into the evaluation of the cleanup alternative itself. In order to do this, we ended up having to look at very many technologies that would address the type of contaminants that we found. Since we found volatiles, semi-volatiles, metals, pesticides, we looked at a number of different ways to treat them. We then screened those into treatment options and set up treatment trains to do the complexity of the contaminants that we found.

We further honed those down to remedial action alternatives. I should tell you right now at this point in the presentation that the remedial action alternatives that we looked at are primarily containment; that is because the Lowry Landfill is about 400 acres. A large portion of that has been landfilled. We have about 70 to 100 foot of depth of refuge.

We at one time did consider taking 85 percent of the landfill and incinerating it, excavating the refuge and then incinerating. The cost of doing that particular remediation ran to $4.5 billion, and that is the estimate that most of you probably read in the papers. We have discounted that remedy for practicability.

So today what we'll be discussing is all the alternatives as well as the EPA preferred alternative.

In order to evaluate these alternatives, we looked at what we refer to as nine criteria. The last two criteria, state acceptance and community acceptance, will not be determined until after the comment period for the proposed plan. Based upon the comments that you supply to us, we will be able to gauge community acceptance of the alternatives.

The first two criteria are ones that have to be met for all the alternatives before we are able to select one. These are overall protection of human health and environment in compliance with applicable or relevant and appropriate requirements.

The next five are referred to as balancing criteria. In this we have the short-term effectiveness, which may be the risks that we may expose workers to during the implementation of the remedy; the long-term effectiveness and permanence, the ability we're able to reduce the risk irreversibly; reduction of toxicity mobility and volume through treatment; the implementability; and then finally the cost.

Now, again, our baseline risk assessment is based upon no action, we walk away from the site. If we were to do that, what we found is that there would be contaminants moving off site to the north, and there would be the component to both the east and the west.

We also looked at the vertical movement of contaminated groundwater in 200 years. These migration pathways are primarily coming from the feasibility study, a groundwater model that we completed.

In this, if the barrier wall was allowed to deteriorate, we would see groundwater migrating to the north. In addition, we would see some migration vertically.

In Alternative 1, we had referred to this one as the no further action alternative, meaning that we allow the interim remedial measures we had taken previously to be the remedy. This is the existing groundwater barrier wall and the associated treatment plant, the Surface Water Removal Action.

In addition to that, we would incorporate Waste Management's soil cover, which is a 4-foot clay, which is 2 feet above and beyond what the Colorado Department of Health regulations for landfill closures requires, and then we would monitor to ensure the contaminants did not leave the site.

So these are the common features. In

addition to that, there would be a contingency plan for vertical migration. We wouldn't allow the model solely to be our prediction of whether or not contaminants would migrate vertically. We would monitor to ensure that it did not reach the lignite bed.

Alternative 2, we have again the common features, the barrier wall, Surface Water Removal Action, the landfill cover, and in addition to that, we would put a 2,200-foot groundwater extraction trench. This would be at a cost of $36 million.

Alternative No. 3 would again have the common components, but in addition to this we would put what we refer to as a toe drain, a groundwater extraction system that would be closer to the majority of the waste pits on the south side. With this we are assuming that the groundwater -- and have studies that demonstrate this -- is more contaminated than the groundwater that flows to this wall. So, therefore, we would be constructing a new plant that would take care of the contaminants.

Alternative No. 4 has again the common elements with a toe drain and an up-gradient containment collection and/or diversion water that would divert clean water from the south away from the site so it would not mix with the contaminated water. This barrier wall would be at a depth of approximately 100 feet and is included in this cost.

In addition to that we would put a multi-layer cap to increase -- decrease the infiltration. This overall cost is $101 million.

Alternative 5, we have the common components, a toe drain, again with its associated treatment plant, and we have a barrier wall to take care of those components of flow on both the east and the west. This would be at a cost of $59 million.

And our final alternative is Alternative 6. It has the common components again, a toe drain, and then here we would place extraction wells. The graphic shows it as symmetrical, but we would try to put these extraction wells in the waste pits that we believe were pumpable. This would be done at a cost of $66 million.

After looking at these alternatives, the EPA determined that Alternative 5 was one that we wished to modify. Alternative 5 is one of the only alternatives that does take care of the east and west components of groundwater flow.

So the way that we modified is that we looked at adding a barrier wall to the south so that we could divert clean groundwater from the south away and thereby reduce the volume that would have to be treated. This is the alternative that we are introducing to you as our preferred alternative.

The reason that we're recommending this is because it meets all of the EPA cleanup criteria. It provides control of off-site migration to both the east and the west. It reduces toxicity, mobility, and volume of the contaminated water through collection, treatment, and diversion. Water is collected at both the north, at the toe of this landfill, and also on the east and west. In addition, it would be diverted from the south, thereby reducing the overall volume.

We believe it's more protective of the human health and environment through long-term effectiveness and permanence. Once we do treat it, we believe there is a permanent reduction of risk. In addition to that, we believe we are taking care of the east and west groundwater flow patterns.

We know that it's using proven technology that is implementable and that it can be easily constructed. And the cost is relatively similar to or less than other alternatives.

In addition to the criteria, we also looked at CERCLA statutory requirements. We felt that we are meeting our preference for treatment, that we are reducing the volume and the toxicity and the mobility of the constituents. We also believe that we are treating and that we have not looked at the least favorable alternative, which is to take the contaminants off site.

We also believe that we are using a permanent solution on the east and west as opposed to allowing it to migrate there and then doing something.

With this, Marc Herman is going to be our moderator for the questions and answers, and I'm going to go ahead and turn it over to him.

MARC HERMAN: After the public comment period and responding to comments to this proposed plan, the EPA, in consultation with the Colorado Department of Health and in cooperation with potential responsible parties, will be conducting remedial investigation studies and will finalize feasibility studies for both the landfill solids and gas operable units and for the soils and surface water and sediment operable units, and we will then issue proposed plans for OU's 2 and 3 and 4 and 5, and finally we will issue a site-wide Record of Decision that will take into account all public comments from all the proposed plans.

Following a record of decision, remedial design negotiations will begin and hopefully conclude in our lifetimes, and we will hopefully then be able to design -- actually design the final remedies for the site clean-up and get around to constructing those remedies.

For your written comments, you are requested to send those comments to Gwen at the address on the screen, U.S. Environmental Protection Agency, Mail 8 HWM-SR, that stands for Hazardous Waste Management Superfund Remedial, 999 - 18th Street, Suite 2500, Denver, Colorado 80202-2466.

Again, I would request that when you have a question or comment, please identify yourself and your affiliation and to limit your comment or question to five minutes, please.

SPEAKER: I'm a high school teacher in Littleton. I have students who are kind of interested in this whole public process.

You mentioned the possibility of vertical migration further down than might be expected for these barriers. What sort of contingency plans do you have for that vertical migration?

MARC HERMAN: The question is: What are the contingency plans for potential vertical migration of contaminated groundwater?

GWEN HOOTEN: What we have is a groundwater model that was performed, and we looked at periods up to 200 years. And what our groundwater model shows -- which we don't consider the groundwater model the answer but it's a relative answer -- it showed that we have vertical migration but it does not reach the lignite bed, which is approximately 350 feet below the surface. So we do have a vertical migration component.

We will monitor and assess some actions to be taken should we see vertical migration to that lignite bed, but at this time we feel fairly confident that the migration is fairly slow, and we're hoping that we can take care of contamination while it's in the shallower part of the aquifer.

MARC HERMAN: We forgot to point out that along the wall are cartoons of all the alternatives that were evaluated in case you want to take a look at them a little closer.

SPEAKER: I'm from Thunderbird Home Association across the street at Gunclub Road and Alameda. We're on wells there.

How far north have your test sites gone and how deep? We draw on wells anywhere from 700 to 1000 feet in that area.

MARC HERMAN: Your question is: How far north has the groundwater contamination been identified or how far have our studies gone?

SPEAKER: I've seen you test wells around your area. But how far north have the test wells gone?

GWEN HOOTEN: Perhaps we misled you a little bit. Our baseline risk assessment is based upon the interim remedial measures not working. What we found is that we have tested all the wells in the local area, including the area that you're talking about, and we have not found contamination to the north.

Phil, did you want to say anything more about that?

PHIL BURKE: In 1985 we conducted tests of selected holes in the north area there, and there was no contamination found in any of those wells. To date, no groundwater contamination has migrated past the barrier wall that you saw, the red line.

SPEAKER: I realize the groundwater -- and we're talking about the aquifer which is, I think, a little faster flowing. I know in '85 one well was tested because his water was getting funny looking and brown. Nobody ever contacted any of the homeowners associations. Has anything been done since '85?

PHIL BURKE: Since '85 numerous wells have been sampled on the site to the north. We have been monitoring those wells for almost eight years now, deep wells and shallow wells both, and to date there is no contamination migration on site. Even though your home-owner wells to the north haven't been sampled, plenty of wells have on site, both shallow and deep.

SPEAKER: If you want a sample, you can use mine.

SPEAKER: Rick Shalene associated with Lowry Landfill.

Gwen, can you give us some detail of what sort of actions you might request under this alternative if, in fact, you find some contamination in your monitoring down the road?

GWEN HOOTEN: Well, Rick, we're talking horizontal contamination, and we believe Alternative 5, our modified 5, takes care of any migration to both the east and west today if it was implemented.

If you're talking about a vertical migration, then we would have to institute some actions, and right now we don't know what those actions will be. But if I was to speculate, I would say that we would probably use extraction of the contaminants, if they started to get down near that lignite bed.

SPEAKER: The alternative doesn't go into any of that detail.

GWEN HOOTEN: No. We were at one time looking at horizontal wells placed at 100-foot spacings throughout the length of the landfill, and what we're finding on Lowry is that we have what is termed as dense aqueous phased liquids.

We don't believe that we will have much success in pulling those out, and we also believe that the vertical migration will be somewhat limited due to the tight formation.

So with those in mind, we have not come up with a vertical migration remedy. We would look to try to do as much as we can using the horizontal collection of groundwater and hope that that does it.

SPEAKER: Do you have any financial contingency in this plan should you detect contamination in some of the monitoring wells?

GWEN HOOTEN: Although the cost estimates you saw did not have amounts -- and, Paul, I'll need you on this one. The estimates that you saw tonight do not have a financial amount for the vertical contingency plan. However, we will be writing it into our Record of Decision, and we will hold the potentially responsible parties responsible for any migration to that lignite bed.

Is there anything you want to add to that, Paul?

PAUL ROSASCO: We did a lot of analysis, and because, as Gwen indicated, we have very low permeability, we have very low rates of flow. The estimate was it was going to take over 300 years for it to get to the first unit that we could pump the water out. That's the lignite bed. Coal type bed about 8 feet thick down about 300, 350 feet.

When you look at what it would cost 300 years from now to build a system and you bring it back to today's dollars and say, "Okay, let's put some money in for financial insurance," it's a minimal amount of money. It takes very little money to, say, put in 50 extraction wells 350 years from now.

So we did analyze that and look at that from a financial impact, but the estimates say it's going to take 300 to 600 years for the groundwater to reach that depth, and that's the first level at which we could pump any of the liquids out.

SPEAKER: My name is Bob Falcon. I'm an officer in a recycling company and also I'm an engineer. I'm not sure I like at all any sort of containment, much less the modified containment, because I think all you're going to be doing is delaying the problem, and you're feeding the public possibly being assured that you're going to be properly monitoring for 200 years.

I have noticed that the EPA has funded grants and research into soil washing, and it seems to me that at least some portion of the surface, say, 10 feet to 30 feet, could be soiled washed and at least some of the organics taken out and disposed of properly by the same technology that made them in the first place.

And so that's -- my first question is: Have you done anything with soil washing, and if so, does it apply to the Lowry site as part of -- at least part of the modified plan?

Also under your modified plan, what is your intention for the use of the surface for, say, the next 200 years? Would you make it a park or wildlife refuge, or is it just to sit there as a great big containment facility waiting for whatever might or might not happen?

Have you considered purchase of the surrounding land to make it part of an overall use, and are the polluters paying for whatever these millions of dollars are? Who pays for these modified plans?

MARC HERMAN: Those are all excellent questions. First of all, let me remind you that this proposed plan is for the shallow groundwater subsurface liquids and deep groundwater operable units. I don't know that specifically soil washing is being investigated under the other operable units, but that -- it is being investigated under the soil surface water and sediment's operable units along with other technologies, and there are also technologies being looked at, potentially digging up some of the contaminated soil in the landfill solids operable units remedies possibilities.

So those are being investigated and a similar sort of meeting will be held to propose to you what we think are reasonable alternatives for those environmental media.

SPEAKER: So they could retroactively apply for this plan?

MARC HERMAN: There are six environmental media broken up into six operable units, and what we strived to do is to take alternatives from each of the operable units and have them blend together to be one cohesive remedy for the site.

So in addition to controlling and treating groundwater, we will be looking at treating or digging up whatever soils and sediments there are, and we will be looking at landfill gas and landfill solids in terms of what technologies are available and meet the nine criteria to clean up the site.

You asked about land use, and we could spend an entire evening talking about land use, but I will tell you there is a Southeast Area Planning Initiative going on right now, and that is a group of local governmental entities that have been meeting now for a while -- about four months. We're talking about the City of Aurora and Arapahoe County and City and County of Denver and many other landowners, large landowners, both state and local within the area.

And what they're doing is, they're making a plan for land use for that entire eastern portion of the Denver Metro area, and Lowry Landfill Superfund site is one part of that. So the possible land uses and land use restrictions for the area are being investigated right now. And EPA intends to incorporate the recommendations and decisions of the Southeast Area Planning Initiative group into our final proposed site-wide remedy.

And then there was another question.

SPEAKER: Cost. Who's paying?

MARC HERMAN: That's an excellent question, and that's what I wanted to emphasize. The remedial investigation and feasibility studies that are going on are being paid by private entities, potentially responsible parties, who have been identified as being responsible for either transporting or generating the waste or operating the site, and they perform the studies under the watchful eye of the EPA and the Colorado Department of Health.

SPEAKER: Do those who are paying the cost weigh into the decision for any one of these plans? Do they have input to say, "Well, we like 31 million better than we like 61 million?

MARC HERMAN: In that respect they are the public just like you are. They are allowed to provide their comments to the proposed plans.

SPEAKER: So how much comment was in the choice?

MARC HERMAN: We'll find out. We're in the public comment period right now.

And that will be public information. EPA will collect all the comments, either from a private company or an individual, and we will summarize the comments, respond to them, and provide those to everyone who is interested.

SPEAKER: I was just wondering if Alternative 5, how long would it take to complete the whole process?

MARC HERMAN: That's a good question. The question is: How long would it take to implement this proposed remedy?

GWEN HOOTEN: We're talking about approximately three years to implement. That includes design time. But let me talk to you a little about the process.

Once the EPA writes a Record of Decision, then we enter into negotiations for the remedial design and the remedial action of that Record of Decision. That normally can take about six months to do that.

Then after that the PRPs, or those that signed up to do the remedial design and remedial action, we have an estimate that it will take approximately three years to complete the design and start implementation of the action itself.

SPEAKER: I'm from Littleton High School and I was wondering -- you stated that one of the nine criteria was short-term, and I was wondering what that risk would be to the workers in Alternative 5?

GWEN HOOTEN: We were cueing our toxicologists down here to see if they wanted to respond.

But we believe that OSHA will Protect the workers from any short-term effects. OSHA has regulations that talk about protection levels that the workers must be in -- masks so they don't inhale, suits so they don't have any dermal contact, those kind of things.

We believe they can be protected during construction if they comply with the OSHA standards.

SPEAKER: Rebecca Wild of Lowry Landfill.

What about the people off site, the people who live and work around the Lowry Landfill during the cleanup proceedings and decontamination?

MARC HERMAN: The question is: What sort of health risks are posed in the short-term to individuals or the public living off site away from the cleanup activities?

GWEN HOOTEN: We, again, believe that the -- any disturbance of the soil, any inhalation factors, the dermal factors will be pretty much confined to the site construction. We're not looking at any kind of alternative or the components of the remedy that we believe would enhance either the inhalation exposure or the dermal exposure for anybody off site.

SPEAKER: Mary Lake. You mentioned a 4-foot clay cover for the landfill mass. I've been here since '77 and was part of CALL when it began. My question is: How much clay was protecting when it broke open one summer where it rained and it was dry and rained and it was dry, and it broke open and it smelled to high heaven all over this area. Was there 4 foot of clay then?

ANGUS CAMPBELL: When was it? That was early '80?

SPEAKER: I can't tell you the year.

ANGUS CAMPBELL: There was 1-foot cover over the landfill at that time. If it was prior to 1980, they would have daily cover, so it was less than that 1 foot. So the answer is no, there was not that 4-foot cover as there is on site now.

SPEAKER: You started breaking into this. We get a day like today when we have high pollution and high winds. Who is going to tell the people living in the near subdivisions that what they're breathing is okay? Who's going to monitor that? OSHA is not.

ANGUS CAMPBELL: The State Health Department Air Program will be monitoring. They will have to have a monitoring plan that will be part of the remedy to ensure that the standards that are in place for the metro area are met at the site boundary.

SPEAKER: Where would those testing stations be?

ANGUS CAMPBELL: They will probably be at the corners of the landfill mass and at the construction site too, because they have to have monitoring -- air monitoring on site for health and safety purposes.

So there will be probably two stages of monitoring, the worker monitoring and ambient air monitoring.

MARC HERMAN: We have some experts in the crowd who can corroborate. As part of the Surface Water Removal Action, construction of the collection system in Unnamed Creek, the entities, Waste Management of Colorado, who constructed the collection system, took great pains to make sure there was monitoring programs both around the construction and on the boundaries of the landfill site to do what you're asking, to monitor potential impacts-- or a potential impact on air contamination.

So that's sort of like a small glimpse of what we may look at down the line in the larger scheme of things.

Rick?

SPEAKER: What kind of standards are we looking at for that type of monitoring? What are the existing standards that have to be met?

ANGUS CAMPBELL: The process will be that we will go through and look at the contaminants of concern that have been identified in the risk assessment and to set standards. They will use the State standards and go through a State standard setting procedure on a site by site basis.

This will emulate a state permitting issue. It won't get a State permit just because it's a Superfund site, but it will have to meet all the requirements. And if I'm in charge, then I will make sure that will happen.

MARC HERMAN: You want to know specific air regulations?

SPEAKER: Yeah.

ANGUS CAMPBELL: It will be Regulation 7 and 8 and 3.

SPEAKER: The reason I'm asking, it's been some time since I looked, but the last time I looked at the Colorado standards, they were pretty lax and almost nonexistent.

ANGUS CAMPBELL: I don't know when the last time was you looked at it, but with the new Clean Air Act that was passed in Congress last fall, I believe, all those will come down to the State as well.

The Denver area is fairly stringent in what they allow to be permitted from a stationary source, and that's what the landfill will be.

SPEAKER: Well, with regard to particulates. What about volatiles?

ANGUS CAMPBELL: The State of Massachusetts has set ambient air limits that will be used for our initial evaluation for safe levels at the site boundary.

The nonattainment area has been extended over the metropolitan area. That means that there is no allowable release of volatile or organic compounds within that nonattainment area.

If you care to know more, feel free to give me a call, and I can help you when I have the appropriate documents in front of me, or I can direct you to somebody who has a little more expertise in our air program.

SPEAKER: My question now is regarding liability. Can you name specifically by name who are the polluters who paid for the studies?

MARC HERMAN: Remedial investigation studies?

SPEAKER: Yes. In other words, who gave the EPA money? Do they still have the liability when the EPA is done here, or does the Colorado Department of Health have the liability if the monitoring system goes awry? Where is the liability located for 200 years?

GWEN HOOTEN: I'm going to ask some of the coalition members to help me out here. But the folks that are paying for the studies for the shallow groundwater and the deep groundwater were at one time 14 companies. I'm going to attempt to name the 14 companies: Adolph Coors, Conoco, Syntex Chemical, Gates Rubber Company, Littleton/Englewood Bi-City Treatment

Plant, the City of Lakewood, Metro Waste Water Reclamation District, IBM, Shattock, Honeywell and Sunstrand and Hewlett Packard -- and we got Amax.

Is that 147 And Asamera Oil.

Is that 14?

SPEAKER: The City and County of Denver escaped?

GWEN HOOTEN: No. Let me complete the answer. That was for the study on the shallow groundwater and deep water that you're seeing and we're discussing tonight. In addition to that, we have four other operable units being studied under two different orders.

Under the OU's 2 and 3 order, we have City and County of Denver, Waste Management of Colorado, and Chemical Waste Management, and they are paying for that study.

Then for the last two operable units, Operable Units 4 and 5, we have again the City and County of Denver and Metro Waste Water Reclamation District financing those studies.

Now at the end of this process, we have identified over 275 potentially responsible parties. EPA considers their liability joint and severable, so we could bill any one of those 275 parties for the total bill. So they're all liable.

SPEAKER: If the plan is approved and implemented, they still retain liability?

MARC HERMAN: Correct.

I was just going to say if anybody was wondering why we call it a toe drain, it's because it's at the base or the foot of the landfill mass, and what do you have at the end of a foot -- toes. In this case just one.

SPEAKER: Could you explain a little bit more exactly what a toe drain is?

MARC HERMAN: It will be a -- well, you guys did the work on it. Paul, do you want to explain this one?

The question is exactly what is a toe drain or what is a groundwater collection drain?

PAUL ROSASCO: It will either be a series of extraction wells will be installed at close spacing at the foot of the landfill, at the toe, to collect all of the water that otherwise would flow out into the creek or north through the site, or it might be a trench that is dug and filled with a pipe and gravel and a pump that's put into that to pump the water out of the trench.

Either one of the those options were looked at and considered valid for future construction.

SPEAKER: What if it gets clogged up like the barrier wall in the past?

PAUL ROSASCO: I'm not aware that the barrier wall got clogged up, but the wall itself. That may have been some issues involving the treatment plant.

SPEAKER: But the internal --

PAUL ROSASCO: The wells would have to be replaced, and that was included in the cost of the remedy, the cost for either rehabilitating the wells using standard well techniques to remove iron or actually replace the wells. But those costs were included in the remedy. The same with the drain, come in and rehabilitate it, remove iron or replace portions of it.

SPEAKER: I'm Ellen Fulton, a senior at Littleton High School. After your plan is implemented, would any of the three of you feel safe buying a home there and raising a family next to the site?

MARC HERMAN: Excellent question. I'm going to let Gwen answer that.

GWEN HOOTEN: I live about two miles to the west of the site, and I do have a family and I'm trying to raise her.

SPEAKER: This is for Angus. I'm saying this with a smile on my face, but 10 or 11 years ago Chemical Waste, the County, everybody, called this a sanitary landfill, harmless. When did it become a codisposal?

ANGUS CAMPBELL: I think since it began. A sanitary landfill refers to the covering of trash on a periodic basis. And it may not have been daily, however, it was covered up unlike an open dump. It was prior to a sanitary landfill, you had a dump and you go out there in the back 40.

SPEAKER: This was referred to at the Governor's Monitoring Committee meetings, and every meeting I attended it was always the sanitary landfill. I notice in actuality you were calling it --

ANGUS CAMPBELL: Codisposal.

SPEAKER: It was never called that.

ANGUS CAMPBELL: Codisposal was the process employed. It was a process employed at the sanitary landfill. Does that help?

SPEAKER: That helps.

SPEAKER: I have concerns with the environment. I'm wondering with the environment in 100 years who is to say you're going to be around to clean it up again? This project seems to be incomplete, if you have to do more work in 300 years on it. Do you see what I'm saying?

MARC HERMAN: Yes, I do. The question

is: Are any of us going to be around 300 years or whatever from now to make sure that the remedy is implemented properly?

I know I won't be around.

GWEN HOOTEN: That is a good question, and that's the reason that we think Modified 5 is the best one, because it takes care of the east and west components now even though from a modeling effort we don't believe it's contaminated -- the contaminants have not migrated that far.

As far as the vertical contaminants, we have discussed with you the technical and practicability we have today, but the EPA as a general practice will revisit Superfund sites every five years. In that five-year review, we go through all the standards that are looked at, we look for any changes in the state of the art on the sampling techniques, and we look for any changes in the techniques we have available for clean-up.

So even though we don't have the technology today, perhaps we will have it in the future. But we don't have the answers today.

MARC HERMAN: I want to just point out and remind everybody while the private companies or the municipalities that are involved in this project bear the burden of liability, as everybody might suspect, it eventually gets passed on to either the consumer or the taxpayer. So we all share in the liability eventually.

SPEAKER: You didn't answer my question of the role of the Colorado Department of Health. You monitor every five years, but the Department of Health at least has some control or jurisdiction over that site on a daily basis for the next 300 years, if the State is here.

MARC HERMAN: On a daily basis?

SPEAKER: Isn't the Colorado Department of Health ultimately responsible for the safety and health of the citizens, and, therefore, ultimately responsible for the control of this site?

MARC HERMAN: That's why --

SPEAKER: So when you're gone and come back in five years and test, during that time doesn't the Department of Health do something?

MARC HERMAN: That's why they're a partner with the EPA on this site, but I'll let Angus answer.

SPEAKER: What is their role?

ANGUS CAMPBELL: What is our role? In the Superfund we are management assistants. Now, on the site itself it has to comply with State solid waste rules and regulations as well as with the air pollution rules and regulations as I mentioned earlier.

It will be an ongoing process. We have standards that have to be met at the site, and we will ensure that those are met by the owner and operator.

PHIL BURKE: It probably should be made clear that the testing isn't every five years. In fact, the testing may be many times in a single year. It's every five years that the EPA comes back and evaluates the site as a whole, but all throughout the remediation the site is tested and monitored.

MARC HERMAN: We won't make a decision and walk away and come back in five years.

SPEAKER: My question is: How much, approximately, of the waste do you plan to treat?

GWEN HOOTEN: And we have Paul Rosasco here to answer that question.

PAUL ROSASCO: Modified Alternative 5 treats approximately 7 -- it will take out, our estimate was, 700 pounds of the actual chemicals on an annual basis over the life of the remedy. It takes out a lot of groundwater but the actual concentration in the groundwater is very low. It's on the order of parts per million. So you treat a lot of groundwater to get a pound out, but we will take about 700 pounds of the chemicals out a year.

SPEAKER: What's the rate?

PAUL ROSASCO: The flow rates for the system were -- we have approximately 12 gallons a minute currently on the existing groundwater barrier treatment system. There is an additional several gallons a minute from the approximately 10 gallons from the landfill toe drain and approximately there is an adjustment of a few gallons per minute on the east and west, so the total flow estimated is 20 gallons a minute we would be taking out of the site.

SPEAKER: What's the total amount that is being taken out, how many gallons?

PAUL ROSASCO: It's 20 gallons a minute.

SPEAKER: How many in the entire landfill?

PAUL ROSASCO: Several hundred million gallons in the landfill.

SPEAKER: What is the regional flow across the landfill in terms of gallons?

PAUL ROSASC0: The regional flow across the site is approximately -- essentially the 20 gallons a minute. We're taking out everything that would flow to the north of the site that would have the contamination, collecting all of that.

MARC HERMAN: I don't know how many of those 142 million gallons is waste. I understand each gallon has a different part per million, but the bottom line is how many of the 142 million gallons of waste are actually going to be clean?

GWEN HOOTEN: If we're treating 20 gallons a minute on an eight-hour-a-day basis -- I'll speculate on eight. Paul is telling me that we want to get into 24 hours a day. Okay, let's go with 24 hours.

If we're going to treat 20 gallons per minute, 60 minutes in an hour, 24 hours a day, 365 days a year, whatever that number comes out with is the amount of gallons that we're going to treat in a year. We expect to be out there at a minimum of 30 years. Our cost estimates have all the estimates based upon 30 years.

So I don't have a number for you. We could punch it out real quick and find out what it would be. Does that answer your question?

SPEAKER: It clarifies it at least.

ANGUS CAMPBELL: Your question was with regards to the liquids disposed of in the waste pits. Those liquids are in the waste pits and are seeping into the groundwater, so you're having a dramatic increase in the volume of water that's contaminated. Does that help too?

And this diluted contaminated groundwater is what is being collected and treated.

SPEAKER: I don't know if this is answered. What is the stuff that's been treated? Where does it go?

MARC HERMAN: Good question. Right now contaminated groundwater is treated at the City and County of Denver's water treatment plant which is on site and all the contaminants are removed, and the water is discharged back into the ground north of the treatment plant and north of Lowry Landfill.

SPEAKER: What will be the stuff that's used to decontaminate? Is that waste too?

MARC HERMAN: The carbon absorption units that Angus Campbell talked about collects the contaminants. They can be taken and cleaned. They never go away is the problem. We just move it from one place to another presumably. The carbon units can be thermally regenerated. The contaminants are burned off.

SPEAKER: My name is Eric Knight, and I go to Littleton High School. I was wondering why has this been discussed recently rather than years or months ago, if it's such a threat to the community?

MARC HERMAN: It has been. There are people here in the crowd who remember back in the late '7Os.

SPEAKER: I'd like to tell you that we have a number of people here tonight who have been working on this issue for almost 13 years.

MARC HERMAN: It's a great question. Let me mention to you that we have copies of proposed plans, and we have copies of progress updates down in the front to keep abreast of what's going on with the progress, and you can get on the mailing list, and we'll mail you all the updates and the proposed plans that we issue so you can keep more informed on this.

SPEAKER: Two-part question. I'm Terry Horn with the Citizens for the Responsible Development of E-470. Has the E-470 Authority asked for your input environmentally on which would be the better route for the routes they have out there; and No. 2, is the EPA in agreement with the E-470 Authority that there should be no need for an environmental impact statement to be produced along this area, a couple hundred feet of your landfill east or west?

MARC HERMAN: Well, first of all, I think that -- Carol, can you help out? Is part of the southeast area issue part of the E-470 been involved?

CAROL MCLENNAN: We haven't gotten specific comments from the Authority in response to that question. The Authority certainly has access to all the information, and I'm sure they will be commenting.

GWEN HOOTEN: The Environmental Protection Agency does not advise government groups as to their land plan. What we try and do is protect human health and the environment on Superfund sites. So we would not be in the position to instruct the E-470 Authority.

However, they have contacted both EPA and the Colorado Department of Health. They have been interested in what is happening on Section 6, the Superfund site.

Does that help answer your question?

SPEAKER: Yes. Thank you.

SPEAKER: I was just wondering, on TV you see other states bring in waste to this landfill, or are we the only ones in Colorado. Is this like a major landfill or whatever -- or that's what I heard.

MARC HERMAN: This was a regional landfill when it was in operation during the periods '66 to '80.

ANGUS CAMPBELL: You may be thinking of the Highway 36 Hazardous Waste Landfill out of Last Chance. That's a regionwide Subtitle C landfill.

MARC HERMAN: Under the Resource Conservation Recovery Act, which is a different law that EPA administers, that law applies to active hazardous waste sites. The Comprehensive Environmental Response

Compensation and Liability Act, CERCLA, or Superfund, takes care of abandoned or old hazardous waste sites.

SPEAKER: This would be a basic political question. You mentioned all the companies that were paying for some of the studies that were done, and I assume paying the salaries for some of the people who did these studies and came up with this particular plan.

It also seemed like in today's paper or the other day's paper there was an article on the total cost and who pays for it, and they had listed again Hewlett Packard, Honeywell, Gates, Adolf Coors, Littleton/Englewood Treatment, et cetera.

I guess my question is: If that's the bill, 120 million, they paid their portion, are they then finished with this deal, their responsibility?

ANGUS CAMPBELL: I gave that quote to the paper. The reporter asked me what was a ballpark figure. I went through the analysis that the groundwater is probably the most expensive remedy at the site, and I said, "Well, go ahead and just double it. It's probably in the ballpark." That's where that came from.

Now, with respect to the rest of that, I'll have to let Gwen answer that.

GWEN HOOTEN: We haven't publically released an overall ballpark figure so that's why the facts are misquoted in the paper as EPA saying that.

SPEAKER: It's a headline.

GWEN HOOTEN: Yes, I'm aware of that.

As far as your question -- and I'm going to repeat it back to you so I heard it right. You're saying that politically are the potentially responsible parties paying for both the RI/FS and the remedial design and the remedial action, and did I hear also perhaps our oversite cost -- the EPA and the Colorado Department of Health?

SPEAKER: Is there a political motivation to choosing this solution -- perhaps of its cost and ease of implementation? And once it's done, does it get those organizations who are paying for it off the hook?

GWEN HOOTEN: Well, Superfund liability, as many of the PRPs can attest to, it's very difficult to get off the hook. Even when we implement the remedy of which the PRPs would pay for, our five-year reviews really extend their liability to anything that we would find.

So their liability is pretty much until the site is delisted or until the site is removed from the National Priorities List and we no longer feel that there is a risk.

I think the second part of your question

-- was there a second part? The political motivation for picking one alternative over another?

SPEAKER: Yes. I'm trying to see if there is a tie-in between the groups who paid for the studies, the groups that will have to pay for the clean-up, and perhaps the people paying the salaries of the people coming for the five-year review?

GWEN HOOTEN: We are going to invite our divisional director to answer this question.

BOB DUPREY: I'm not political. Let me try to answer that. I think it's a good question. Because since some of the responsible parties produced the technical work, what I'm hearing is then who influenced us on selecting a particular remedy because we have less trouble with the cost and so on.

And the answer is no, in my view, that we were looking for -- and, frankly, I think some of the larger responsible parties are looking for -- as permanent a solution as they can get. Because they don't want to come back and face the continuing liability that remains there if other costs or problems arise in the future. It's like they would like to pay their costs and get out.

So in our view we picked the one that was actually towards the higher end of the cost range with additional measures of protection. Even where it didn't show much migration, we decided to go ahead with some measures to fully contain the site to not allow moisture to get into it as much as we could prevent moisture from getting in and to draw down the water and contamination level as much as we can with the treatment system and the draw-down system that has been proposed.

So if we could have done more than that and if people have ideas how to increase the effectiveness of that, we certainly welcome that. We haven't made a final decision. This is a proposed plan, so we want to take more comment where we can be more effective and more permanent on the answer.

On the liability question, I want to answer that a little bit because there is major litigation currently going on this issue in Federal District Court before Judge Finesilver, and the very issue you've raised is the subject of that lawsuit; that is, who will pay what share of these costs ultimately.

I believe that ultimately this will either get decided in the course of that litigation or through settlement talks that are taking place among the different parties.

The assurance I can give you is that the Federal Government and the State Government are looking to have all the costs paid by the responsible parties and all the continuing costs that might occur be paid by the responsible parties.

SPEAKER: First of all, who owns this part of the land that we're talking about? Second, the liable companies, what are they doing with their current waste? They must be recycling or putting it into a standard center to have it looked after. And, third, the large companies are playing politics because they have been dumping their stuff all over the United States and half the time around the world. They don't want the other sites found, so they're going to comply to bury this and hide instead of looking into technical recycling to clean the mess up that they caused.

MARC HERMAN: To answer your first question, ownership of the land, the City and County of Denver owns the land. The answer to your second question, where does the hazardous waste that was dumped into Lowry Landfill go or similar sort of waste go now, and they go to authorized hazardous waste disposal sites.

SPEAKER: I have just two comments. I'm Chuck Barrett, a private consultant.

Number one, a question about the liability. If everything that was dumped out at this site was done according to the rules and regulations at the time, the cost associated with the dumping of the waste at that time, and the Federal Government came back in hindsight and said, "You did something wrong in today's standards from 20 years ago."

So I foresee the federal regulations will always say that if they have to come back and clean up the site 20 years from now, the potentially responsible parties will be the ones to talk with, but ultimately it will be the taxpayers and consumers that are going to pay for it. If you buy Coors beer, they will roll the cost of that onto it.

SPEAKER: Your observation is a lie.

SPEAKER: The other issue is that I think there was a question whether they were actually cleaning up this 142 million gallons, and my understanding is you're not cleaning up any of the 142 million gallons except that which seeps into the rain water that falls on the site and comes down to the collection basin. And the reason why you'll be there for several hundred years is the fact that the amount that will be dissolved in any given time is a relatively minute amount.

So if you take your 20 gallons a minute and multiple it out by the hours per year by the 30 years and you come up with a number in excess of 142 million, but you still have got some of the contamination still entrenched in the soil.

MARC HERMAN: Actually the liquid hazardous waste has commingled with the groundwater on site and that's under the ground, and the purpose of this proposed plan is to collect that contaminated groundwater. There is an action going on right now that's designed to effectively -- while we study the site, to effectively collect the contaminated groundwater and to treat it.

And that's also the purpose -- to address your question of rain water, that's the purpose of the landfill cap, to prevent more moisture from entering the site and seeping down and mixing with the hazardous waste.

SPEAKER: After your proposed plan, your No. 5 -- in 1984 you said we were the most hazardous site. After your plan, where will we be on this scale.

MARC HERMAN: We were not the most but one of the many. That's a good question. Is that a political question? Maybe Bob will answer that.

BOB DUPREY: Well, it's one of the 1200 same -- 1250 or something like that on the National Priorities List sites across the nation. There is some 15 of those here in Colorado. We didn't give it a relative priority, and I can't remember quite where it is. I think somewhere in the middle.

Basically we will go through a process after we have done at least one of the five-year reviews to see how effective this remedy is after it's been selected to ultimately delist it from that priorities list if the dangers are adequately taken care of.

There is a process that's gone through to actually remove it from the priorities list. That doesn't mean that the work won't continue to go on. All that still will be mandated what we'll put into effect and that will be a court ordered remedy. It's required to be entered before a Federal District Court, and it will be enforceable then and the Federal District Court will have continuing jurisdiction over that.

SPEAKER: How does your plan solve your need -- toxic waste?

GWEN HOOTEN: Are you talking about the nine criteria? How does our plan solve the environmental issue of cleaning up the site?

We believe that our remedy is a containment remedy, but we are also collecting and treating groundwater as both the existing barrier wall, the toe drain, and the east and west components. So we believe that we are treating groundwater and that we are reducing the overall risk.

But we don't have a time frame when there will be no risk. We don't know when that will be. We expect to be out there a long time treating the waste.

MARC HERMAN: Do you mean how will that accomplish our goal, the EPA mission, to protect human health and the environment?

GWEN HOOTEN: Did we answer your question?

SPEAKER: I guess.

SPEAKER: I'm a student. I was wondering, all this stuff is fine and good, but what are you going to do with the other landfills to keep this problem from happening again? How do we make it so we don't have to clean it up?

BOB DUPREY: It covers other programs other than the Superfund programs. That is the most important question, I thank, because we don't know how to fully solve this problem. If we knew how to do it in a way in which we could get rid all of what was put in there and the haphazardous way it was done. It's mixed in with soils and garbage. We can't extract effectively all those contaminants in a way that's quick and efficient and cost effective.

Back in 1980 Congress authorized what is called the Resource Conservation and Recovery Act. Rules were put in effect that would not allow practices to take place, and since that date those practices have not taken place.

There was an attempt out at this very landfill to put in a hazardous waste site during that period and it was done early without all the safeguards. And, frankly, through the action of Paul, I remember the activity, they had that stopped and we made Chemical Waste Management remove that soil and send all that waste out of this area. It was all sent to approved facilities that met the standards.

Those facilities now require, first of all, that the waste be treated to meet certain treatment standards and also requires that no liquid waste be put in the ground. It has to be all solidified. And there are liners required, a double lined system, where you have leach checks which monitor those constantly. If you have a problem, to correct it.

So we have in place today, and have for a number of years, requirements that prevent this kind of situation from happening again. If it happens, it happens because it's an illegal practice. We go in and use our enforcement authority to correct it.

MARC HERMAN: I just want to mention again that Gwen and I and Angus are very interested in hearing anybody's concerns and comments, and if you don't get your questions answered tonight, I want to volunteer our phone numbers. Please feel free to call us and ask us questions. We can provide you with information.

Angus' phone number is 692-2385. Gwen's phone number is 293-1533. And my phone number is 293-1625.

SPEAKER: I'm wondering about the environment and the animals, like the animals around the landfill. On this paper here there is two landfills probably not three miles apart from each other. Is this pushing the animals away from there?

MARC HERMAN: Part of our duty is to protect human health and the environment. Included in the environment are the wildlife. And as part of the feasibility studies and the remedial investigations for Superfund sites, we look not only at the threats to human health, but we also look at the impact to vegetation and also wildlife.

So I guess what I'm recommending is that if you would like to, you could probably get more detail on how we address the issues of wildlife or the environment in some of the documents we produced.

You can get those, again, at the Aurora

Public Library or the EPA Superfund Center.

GWEN HOOTEN: We do have our toxicologist here from CH2M Hill, Beth Hudson, and as part of the studies for the operable units, we have done an ecological study.

Beth, if you would come up and discuss a little bit the results of that.

BETH HUDSON: As part of the risk assessment for Operable Units 4, 5, and 2 and 3, that's the surface water sediment, surface soils, landfill gas, and landfill solids, EPA looked at the aquatic and terrestial habitat at the facility within Section 6, looked for evidence for the presence of threatened or endangered species, also looked at information about the indigenous wildlife in the area, for example, the prong-horned mule deer, some of the smaller animals, mice. Also it looked at some of the vegetation patterns.

The ecological risk assessments are quite a bit different than human health in that it's a new science and that it's very difficult to quantify the impacts in terms of risk to those receptors. The overall ecological assessment indicates that there could be adverse impacts to receptors impacted by surface water sediment and surface soil. But beyond identifying the chemicals that could cause impact, it's difficult to characterize exactly what those impacts are.

I hope that answers your question.

SPEAKER: Summarizing all the various alternatives that exist on site land and use restrictions that will continue, can you tell us what those restrictions are and what the EPA and the State foresee happening during the clean-up period and after, off site?

GWEN HOOTEN: The existing institutional controls that we are talking about are -- the landfill is an operating landfill, and as such they have restricted access through the use of fences, and they have a gate that is monitored for any access. So that's one form of institutional control.

In addition to that, the Mayor of Denver has an Executive Order No. 97 that restricts the land use of Section 6.

We will look towards the Southeast Plan Initiative Group to tell us any additional institutional controls that they may institute. But those are the ones we're referring to in our document.

SPEAKER: So you don't foresee any active land use, industrial use, or anything like that on that site in the future?

GWEN HOOTEN: Not in the near future. When we did our baseline risk assessment, we did assume that a residence will be built on the site. So we have not defined what future or just how soon that will happen.

But our risk assessment is based upon a residence, but we don't expect any residences to be built during the term that it's going to be cleaned up.

ANGUS CAMPBELL: I would like to add something just as an example. In any institutional controls measure taken on any Superfund site, permanence is something that we evaluate very strongly -- how that control is in place and how permanent is that control. And when you're talking land use plans, over tile those change.

BOB DUPREY: Could I add to also since this was also a garbage landfill, the idea of actually putting residents there or structures is not advisable because the gases will build up from the decomposition of the garbage, and as a general rule there will be permanent restrictions I believe that Aurora, Denver will want to see in terms of actually having structures on a garbage landfill. That's not from the hazardous waste. That's from the ordinary paper and solid wastes in there.

So from a practical standpoint, we are going to look and see some very strong restrictions on development on the site itself, and those will need to be built into the final decision and become enforceable but will be there for the future so people won't -- they won't forget over time this is there and they accidentally build on top, which in the past where people have done it in other places, it has created major problems.

SPEAKER: I was wondering after the contaminants are extracted from the groundwater, where will they be disposed of and what provisions will be made?

MR. HERMAN: If the contaminants are removed from the groundwater through use of carbon absorption units, the granulated carbon pulls the contaminants out. I indicated earlier that the carbon can be thermally regenerated and burn the contaminants off.

In other cases the contaminants, if they're accumulated, will have to be disposed of in compliance with the Resource Conservation and Recovery Act, which is the set of laws and regulations that dictate how hazardous wastes currently can be disposed of properly.

BOB DUPREY: I can clear that a little bit more. There are companies in the United States -- there are several of them, one is Calgon, who have as part of their business the destruction of these chemicals that are collected in their activated carbon cells -- just one of the companies.

But whoever is selected ultimately to do this work, and that's yet to be done, we will make sure that there is a process to monitor where that collected waste goes, how it's disposed of, and to ensure it's not released at a future date back into the environment. That will be a part of this process.

But the best method in my view is activated carbon, because there you're going to get destruction of the chemical, and that carbon can then be brought back to the site and reused over and over again.

So that has special advantage. It really depends on the particular technique. Sometimes you end up with a bunch of sludge so that you have no other choice but to go back to another landfill with that. In that instance it has to be an approved hazardous waste facility that is properly designed and monitored.

SPEAKER: In burning those toxics off of the carbon, when you release that into the air, does that impact the environment?

BOB DUPREY: That' s not the way it works. It has an extremely high performance efficiency and only volatiles are collected in an activated carbon system. Those are combustible. It's done at very high temperatures and under strict conditions.

The air standards that apply to that are very strict so only a tiny, tiny amount of what was originally in there could possibly be released back into the environment.

SPEAKER: If any of the waste was to leak out north of your site, who or what would be effected by it, and what would the effect be?

MARC HERMAN: Another great question.

GWEN HOOTEN: We would place monitoring in strategic places looking for that kind of event. And if that happened, then we would have to take additional actions than what has been discussed tonight. But our monitoring would be set up just for that purpose.

SPEAKER: What effects would it have on anyone downstream?

GWEN HOOTEN: We believe that it would have the same effect that we described to you. If the contaminants do go beyond that barrier wall, we would have one in one hundred chance, additional chance, of getting cancer beyond what you normally are exposed to.

So anybody who would drink that contaminated water coming off the site, we believe that it would be that additional chance of contracting cancer.

MARC HERMAN: The national overall average for anybody to contract cancer is one in four. So Gwen was saying above and beyond the national average.

SPEAKER: But to drink it for whatever period -- not just a cup of water.

GWEN HOOTEN: This is based upon on a lot of assumptions, the body weight of the person, how much they're drinking a day, how many days in a year they're drinking it, how many years they're drinking it.

It's based upon a lot of assumptions, and EPA makes what we determine as a reasonable maximum exposure. So we look at the upper limits of all those to determine what the risk would be. So we feel it's fairly conservative.

SPEAKER: What would that risk decrease to after this project is finished? What would be the difference?

GWEN HOOTEN: We would try for that risk to go down to zero. Whether or not that's technically practical, we're saying right now that we can't achieve that at this time. That's why it's a containment type remedy.

BOB DUPREY: I would like to add one thing. There are three or four questions that I'm sensing you're not really getting clear.

On the first point, I've been here in the area since 1979, and I've been involved with the site, particularly early on, very extensively with some of the difficult problems. But one of the things that was done quite early was to put in that barrier wall and treatment system on flow to the north. And since that time there has been no detection of any off-site contamination from this site, and we've gone a long tame, approximately a decade, now.

And part of the reason it's taken so long to get to this point where we decided some of the ultimate things to do is because we made a commitment to Aurora and a number of people to look at as much treatment as we could do at this site and not simply just putting a cap on. We tried to put in as much as we can.

But also because there were a lot of unanswered questions. There has been an enormous amount of studies and monitoring, and that's taken a lot of time, but what it does give us is a great deal of assurance that there is no off-site movement of contamination, and that under this remedy there will be no off-site movement of contamination.

And if we're wrong -- and I think some of the best minds in the state are working on this from the companies involved as well as from the governmental agencies and the consultants that are here -- we'll have to go back and fix that.

And if you have some ideas -- as I say, this meeting in large part is to try and find out if there is something that's been missed. And if there is something we can improve on and how we can do that, what further things could be done?

We're very open to changes. This isn't the answer. We are required by law to respond to the public's input and the technical input we receive. So if there are things we can do better, let us know and we'll try to do them.

SPEAKER: You indicated the three-year period for implementation of the plan. Is that three years from the beginning of construction or end of construction and actually in operation?

MARC HERMAN: That's a great question.

PAUL ROSASCO: That was the period for doing all the design and the actual construction of the remedy. So it would be fully operable at that point, including initial testing and shake down and so forth.

SPEAKER: Are you saying that the EPA or the hazardous waste technology does not exist to pump one or more of the existing ponds of what's in there now and take it to a hazardous waste site and have it processed of these 142 million gallons? Does that not exist?

GWEN HOOTEN: I'm going to let Paul follow up on my answer.

In short, we're not saying that. We're saying that anything is pumpable. I mean if we apply as many dollars as possible, anything is possible for pumpability. But we're not convinced that we'll be able to pull out all the contaminants. The dense aqueous phased liquids we do believe will probably still be confined to that area.

We're saying that given the pumping rates that we have experienced at that landfill due to its tight formation, that we will gain as much by having it gradually migrate to these points of collection as we would gain from spending money to pump it.

Paul, is there anything you want to add to that?

PAUL ROSASCO: Earlier on in the process we looked at alternatives that would try to accomplish exactly what you're asking. One of them looked at an alternative where we had 800 wells out there pumping. It still took 200 years to get even a significant amount of the contamination out of the site, because we put in a number of wells into these pits to try and pump the liquids, and we only get very, very small amounts.

If you think back to the photos that they showed, we had all kinds of materials, a lot of sludges in there with the wells you just can't get a lot of liquid out of there.

SPEAKER: The pond and groundwaters down below and the big ion exchange column, once you get all the way down to the bottom, it may be benzene or thiozene or some aromatic, which then you process. But in each strata there may be PCBs or something else that you're just keeping. You're using the ground as just a great big ion exchange.

PAUL ROSASCO: We did tests to try and look and see if we could get to different fractions, if there were fractions present. We tried all of those things. We set treatment plants out at the site to do exactly what you're asking. We still cannot get a lot of liquid out of the site. The garbage did absorb a lot. The soils are very tight. And what we get out is not those separate cases. It's mixed with leaching from the refuse and other things, so we have to treat all of that.

We looked at biological treatment systems that totally destroy the chemicals, totally break them down, running them on site and still we were looking at hundreds of years to even make a dent in this.

So that's why we made the conclusion to look at these types of remedies.

SPEAKER: The 142 million gallons doesn't exist except in a mix, soil mix and garbage?

BOB DUPREY: I think some of your questions are some of the same ones I asked and went to this analysis of all these alternatives. If you look at Alternative 6 over here on the wall, you see all the well points. That's one of the ones that was to do part of what you're talking about, even though there were others that were more extensive.

The difference in the amount pulled out was inconsequential in my view. But the other point that was persuasive to me, and it's one if you have some ideas which you think we should sift through, was those well points are all going to create potential vents to the atmosphere. And what was said way back in '79, '80 and '81 when we had some problems with the odorous nature of this material, it's vile, because I smelled it too. I remember it well.

We were concerned that this would create a pathway to the air that might create more problems than this small amount of additional treatment that we would get out of it versus the toe system that would be put in.

But it is a complex technical question. We were seeking exactly what you're stating we ought to do, and we just simply felt that remedy was not as good as the other one and would offer some additional risk.

SPEAKER: Thank goodness you didn't try pond creek.

BOB DUPREY: I'm familiar with that too.

SPEAKER: You had mentioned some radioactivity material, right, on the 142 million gallons?

GWEN HOOTEN: Yes. We are finding some radionuclides out there. For the most part we believe that they're naturally occurring. We have not looked at the radionuclides specifically because we're looking at all media.

We plan to release a risk assessment for the radionuclides' portion.

SPEAKER: But that can't be cleaned up by carbon?

GWEN HOOTEN: In the treatability studies that were conducted, we didn't really have that many radionuclides. There wasn't that much in the residue. So the treatment studies didn't bear out some of the sampling that we found.

SPEAKER: What will go downstream of the pond could be found anywhere in Colorado or anywhere in the world by parts per million?

GWEN HOOTEN: Yes, that' s what we're finding.

SPEAKER: On your map you have the groundwater extraction trench. What is that exactly? I know what your toe barrier is because I've seen that.

MARC HERMAN: The barrier wall?

SPEAKER: Yes. What is that extraction trench?

MARC HERMAN: The barrier wall is like an underground dam.

SPEAKER: I know what that is. On some of your maps you have the new wall which is quite large.

PAUL ROSASCO: If you remember the slide that Angus showed that showed what the groundwater barrier wall looks like. There is a gravel drain on one side and clay. The extraction trench would be either the gravel portion or be a series of wells running along that alignment to collect the liquids.

SPEAKER: I thought the concern with putting that along the south end was that by digging the trench you create a pathway for more water to come in really than you would be taking out.

When did the decision -- how did that come about that you decided to add that to Alternative 5?

MARC HERMAN: The barrier wall on the south?

SPEAKER: Yes.

GWEN HOOTEN: Charlie, I'm unaware of what you're talking about.

SPEAKER: If you look at 5, you don't have an intercept. I heard where the concern was. If you try to dig down on the south end, because the soil was so tight and there was very little seepage coming in that you could break that up and actually allow additional seepage to come in by putting in that kind of a facility.

GWEN HOOTEN: Perhaps you're talking about the toe drain.

SPEAKER: That's why it wasn't included in the original 5 I thought.

PAUL ROSASCO: Charlie, I think there was a discussion earlier on about the toe drain being a lot deeper and a lot more extensive. And what that was, when we looked at the chemical data, we would be taking a lot of clean water at depth and with this other water than we would be taking out in the process.

What we do is make the gradient, that is the pressure that's driving the groundwater, make it stronger to drive it down deeper.

So we decided not to build the deeper drain at the landfill but to build the shallower one so we did not aggravate the problem.

BOB DUPREY: One of the concerns I had was to try to prevent as much moisture from getting into the system as possible and then drain it as much as possible over time so you draw down the level and you take away the drainage for any vertical movement.

Even though it was a small flow in, we thought with a modified, not the original, plan that would actually create that conduit that we're talking about. We could divert some water, and that any water that could be diverted out of the system would in the long term, over hundreds of years, be a benefit. That was the reason for the addition.

If there are other concerns that -- or problems created here where we shouldn't do that, obviously we reduce the cost somewhat, and it would be that much easier to implement. That's something we would want to know from the community.

The intent was to create as much as possible the situation where the cell out there would be contained fully on all sides, and that the drainage site would be a full collection treatment.

SPEAKER: What were the comparisons of contaminated radionuclides to uncontaminated ground during construction and the rupturing of any of these wells having more seepage in the water?

GWEN HOOTEN: I'm going to answer your second question first. There is always the potential for a well to become environmentally unsound for some reason. It could be the seasonal changes or what-not. And we would look during the operation and maintenance to ensure the soundness of all the wells. That is something we would look at.

And once we found that a well was possibly environmentally unsound or that it was causing cross contamination, we would abandon the well.

With respect to your first question which had to do with radionuclides, would you repeat that.

SPEAKER: If you were to take a sample of the radionuclides in the contaminated ground and compare that to uncontaminated ground off site, what would the comparison be?

GWEN HOOTEN: We're finding that the comparison would be quite similar, that the radionuclides that we're experiencing on site are comparable to the background radionuclides.

There was some question as to whether or

not we had transuranic radionuclides, which is man-made
nuclides, and we're finding for the most part that the
data that we've collected is inconclusive, and we really
cannot say whether it's there or it's not there.
SPEAKER: One of the questions that I do
recall coming up when we were discussing the containment
system concerns whether or not there was actually space
to install without getting into private land.
Could you elaborate on the proposed
location of the harrier wall.
GWEN HOOTEN: The alternatives where there
was some practicability problem was Alternative 4. That
south barrier wall was at a depth of 100 feet.

Alternative 5 the barrier wall is at a depth of 50 feet.
We believe it's totally impracticable. We
don't believe there is the need to access land that's not
presently owned by the City and County of Denver to
implement that.

MARC HERMAN: Any other questions? This
is not the only opportunity. I think I mentioned it
before.
GWEN HOOTEN: Just a wrap-up. We do have
extra copies of the proposed plan. If you wish to be a
part of our mailing list, we ask that you come down and
sign up with us. We will be issuing in both The Denver

Post and the Rocky Mountain News the notification that the comment period has been extended.

If there are no other questions we can answer tonight, then we'll formally close this meeting.

Thank you to the teacher at Littleton. Your students had excellent questions.

(The hearing was concluded at the hour of 9:30 p.m.)

13.2 Response to Written Comments on the Proposed Plan for Operable Units 1 & 6 Shallow Ground-Water and Subsurface Liquids and Deep Ground-Water Operable Units August 1993

13.2.1 EPA's Response to Comments from Citizens Against Lowry Landfill Richard Schelin, Chairman

Comment

None of the proposed alternatives meets the legal requirements in the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) because the alternatives fail to treat any meaningful percentage of the 142 million gallons of hazardous waste dumped in Section 6 of the landfill. The alternatives are indefinite containment strategies, not cleanup strategies.

Response

Section 121(a) of CERCLA mandates that EPA select appropriate remedial actions that are in accordance with Section 121 and, to the extent practicable, the National Contingency Plan (NCP), and which provide for cost-effective response. Each of the remedial alternatives described in the Proposed Plan for Operable Units (OUS) 1 & 6 meets these legal requirements. Consistent with Section 300.430(a)(iii)(c) of the NCP, in developing appropriate remedial alternatives for the Site, EPA considered a combination of methods to achieve protection of human health and the environment. EPA considered the expectation described in the NCP that in appropriate site situations, treatment of the principal threats posed by a site (with priority placed on treating waste that is liquid, highly toxic or highly mobile) will be combined with engineering controls and institutional controls, as appropriate, for treatment residuals and untreated waste. In addition, EPA also considered the expectation described in the NCP that engineering controls, such as containment, will be used for waste that poses a relatively low long-term threat or where treatment is impracticable. Containment was chosen at the Lowry Site because of the low level offsite risks and because it is impracticable to remove the waste. The NCP recognizes that containment should be used to remediate waste present in low levels, waste that is technically infeasible to treat, and large volumes of waste.

Treatment of contaminated ground water is a principal component of EPA's selected remedy for OUS 1 & 6. Treatment of ground water beyond that included in that remedy would be impracticable, given the prohibitively high costs and adverse short-term effects to onsite workers associated with such treatment.

The selected remedy for OUS 1 & 6 is expected to immediately treat 23,652,000 gallons of water per year extracted from the Shallow Ground Water and Subsurface Liquids at the Site. The selected remedy components for OUS 2 & 3 and 4 & 5 include, in part, treatment to address Landfill Solids and Gas, Surface Water and Sediments at the Site.

Comment

EPA should establish a new-technologies escrow fund of $75 million for ultimate cleanup of the Site. The interest-bearing escrow fund would be available on a competitive basis to vendors of technologies that detoxify the hazardous waste in Section 6. Payments would be based on the number of gallons of chemicals of concern (COC) that are removed.

Potentially responsible parties (PRPs) would be required to place in escrow $75 million in an interest bearing account. At each 5-year review interval, EPA would issue a Request for Proposals for vendors to apply new technologies to treat the remaining millions of gallons of hazardous waste at Section 6. Pursuant to a public process, EPA would review the proposals to identify the proposal(s) that results in the greatest treatment of hazardous waste at the lowest cost. Any qualifying proposal would have to meet community protection standards and be subject to bonding to assure performance.

The winning vendor would be paid according to the number of gallons (or pounds) of hazardous waste treated. EPA's administrative costs would be strictly limited to 5 percent of the amount paid the vendor. Funds not paid to the vendor would remain in the escrow account to be available at the next review in 5 years. EPA would have to assure all interested vendors access to the Site and preclude the Site owner/operator from barring competition, as Waste Management has tried to do during the Remedial Investigation/Feasibility Study (RI/FS).

Response

CALL's proposal raises a number of legal and policy concerns, including the fact that it does not specify a remedy which can be evaluated against the NCP criteria for remedy selection.

EPA has determined that the selected remedy for OUS 1 & 6 will be protective of human health and the environment, and will use the 5-year review process under Section 121(c) of CERCLA to ensure that the selected remedy remains so protective. If the Agency determines during a 5-year review that the remedy is no longer protective, it may review new technologies and evaluate whether they are appropriate for implementation at the Site.

Comment

If EPA abandons the cleanup objective at the Lowry Site, the agency will send a clear signal to all PRPs that the most effective method of avoiding cleanup of a Superfund site is to make it inaccessible by burying it under tons of municipal solid waste.

Response

EPA has not abandoned the cleanup objective at the Lowry Site. The primary remedial action objectives for OUS 1 and 6 are the following:

- Prevent human exposure (through ingestion, inhalation, and dermal absorption) to liquids containing contaminants in excess of the remediation goal

- Prevent migration of contaminants that would result in ground-water concentrations in excess of the remediation goal

The selected remedy for OUS 1 & 6 meets these objectives. As discussed above, the NCP recognizes that containment should be used to remediate waste present in low levels, waste that is technically infeasible to treat, and large volumes of waste. In addition, EPA guidance on Conducting Remedial Investigations/Feasibility Studies for CERCLA Municipal Landfill Sites recognizes that "[c]ontainment has been identified as the most likely response action at these sites because (1) CERCLA municipal landfills are primarily composed of municipal, and to a lesser extent hazardous wastes; therefore, they often pose a low-level threat rather than a principal threat; and (2) the volume and heterogeneity of waste within CERCLA municipal landfills will often make treatment impractical."

Comment

The alternatives give insufficient attention to the maximum extraction and treatment of hazardous constituents at the landfill because approximately 96 percent of the hazardous material in the waste pits will remain after 30 years of treatment.

Response

Although EPA does not agree with the specific analysis presented, the Agency does agree that a large portion of wastes will remain in the waste pits. The FS evaluated waste pit pumping and treatment and found that a significant reduction in volume cannot be achieved because of residual contamination. Because removal of wastes from the waste pits is technically infeasible and not cost-effective, EPA did not include waste pit pumping as a component of the selected sitewide remedy. Excavation and disposal of the contents of the shallow waste pits in the former tile pile area is, however, part of the selected remedy for OUS 2 & 3.

Comment

In the near term, EPA should assume full development of all lands up to the boundaries of Sections 6 and 31. In the long term, EPA should assume full development of all lands, including Sections 6 and 31. The buffer zone ordinance adopted by the City of Aurora was intended to protect citizens from the dangers from the landfill prior to and during cleanup. In convoluted logic, the PRPs argue, however, that they should not have to conduct extensive cleanup at the Site because EPA should assume institutional controls to prevent use of Sections 6 and 31 and adjacent land and related ground water now and in perpetuity.

CALL urges EPA to assume no institutional controls and ultimate full use of Sections 6 and 31 and order a cleanup accordingly.

Response

The risk assessment was based on ultimate residential use of both Sections 6 and 31. However, the lack of technologies to detoxify the waste pits has lead EPA to consider containment-based remedial alternatives with onsite institutional controls. EPA has determined that the selected remedy for OUS 1 & 6 is the most appropriate and technically feasible remedy to address Shallow Ground Water and Subsurface Liquids at the Site. During the 5-year review, if EPA finds the remedy is not protective, EPA may review new technologies and evaluate if they are appropriate for implementation at the Site.

Offsite institutional controls will serve as an additional measure of protection to enhance the effectiveness of the selected remedy and to act as preventative measures to preserve the implementability and effectiveness of any of the selected remedy contingency measures.

Comment

By limiting the remedial alternatives to containment strategies and not advancing options involving significant cleanup, EPA is rewarding PRPs for systematically making cleanup of a Superfund site more expensive and difficult. It is unconscionable that PRPs would now be able to claim cleaning up Section 6 is too costly after one such PRP consciously and systematically piled years worth of trash on the Site after the Site was placed on the National Priorities List (NPL). This type of chicanery for private profit at the expense of the public interest cannot be tolerated. EPA's sanctioning of this behavior by PRPs will send a signal to PRPs at other sites that it is profitable to make cleaning up their Superfund sites as costly as possible, because EPA will let them off the hook. By sanctioning such behavior, EPA will emasculate the central feature of CERCLA, which is that the polluter must pay.

Response

EPA does not believe that it is rewarding PRPs, who will ultimately pay the costs of cleanup, for piling trash on the Site over the years. The Lowry Site was permitted as a landfill for municipal and industrial disposal prior to becoming a Superfund site. In 1984, when the Site was placed on the NPL, the Site already had a significant amount of municipal waste as well as industrial waste. The Lowry Landfill was the prime recipient of municipal waste from the Denver metropolitan area. Rather than close the landfill without a viable alternative municipal landfill, a decision was made to continue landfilling operations until another facility could be opened.

Comment

CALL proposes that EPA adopt an innovative strategy for the long-term cleanup of the Lowry Landfill, which will also send a signal to PRPs that they cannot escape cleanup responsibilities. The strategy involves two elements:

1. Adopt and implement modified Alternative 5, which will contain the hazardous waste on Section 6, but only treat a small portion of the 142 million gallons of hazardous waste in the ground.

2. Place $75 million in an interest-bearing escrow account for applying new technologies to treat the millions of gallons of hazardous waste remaining at the Site after implementation of EPA's preferred alternative.

To meet the requirements of CERCLA, waste at sites on the NPL is to be treated, not merely contained. All the alternatives being considered by EPA now amount to containment strategies. None of the strategies treats a significant amount of the waste at the Site. The PRPs and EPA are apparently convinced that current technologies are insufficient to meet the treatment requirements of CERCLA.

Response

EPA acknowledges support of the preferred remedial alternative for OUS 1 & 6 as expressed in the Proposed Plan. EPA disagrees with the statement that "[t]o meet the requirements of CERCLA, waste at sites on the NPL is to be treated, not merely contained." (See response to CALL's first and second comments.)

Comment

Under CERLA, EPA is required to review cleanup sites no less often than every 5 years. However, CALL is unaware of any circumstances where EPA has conducted the required review and taken additional cleanup action following that review. Failure to take additional action may be for a number of reasons:

- Few sites have reached the 5-year review period
- No new cleanup technologies have become available prior to the review
- It is too difficult to acquire money to institute new cleanup actions
- Bureaucratic inertia, which seeks to close the door on sites that the agency says it has cleaned up

CALL's proposal would overcome these problems while instilling competition in a cleanup process characterized by a lack of competition. Competition will necessitate developing an aggressive program that will implement new technology and, ultimately, lower costs. The program will be applicable to the Lowry Landfill and similar sites.

Response

EPA agrees with the first two bullets, but disagrees with the remaining items. PRPs are liable for the costs of new cleanup actions. Furthermore, EPA does not "close the door" on any site so long as any wastes remain there.

13.2.2 EPA's Response to Comments from City of Aurora

Comment

Remove the element of the Plan that suggests that Aurora will maintain indefinitely its current restrictions on land and water development in the City around the Superfund site. The City Council enacted the ordinances as temporary protection at a time when it was not known if contamination had migrated off the Site or if the potential for exposure would be heightened during the Site investigation and stabilization.

Institutional controls should not be used as a substitute for cleanup actions, and site contaminants should be controlled so as to avoid offsite impacts.

Since the site studies have confirmed that contaminants are currently contained onsite and that it is technically and economically feasible to prevent migration beyond the compliance boundaries, we do not see the need for offsite institutional controls as a component of the ground-water remedy.

Response

The Proposed Plan cites Aurora's ordinance as an example of an existing institutional control. The risk assessment recognizes that existing institutional controls may be withdrawn or repealed. The selected sitewide remedy is a containment-based remedy. Therefore, permanent, enforceable, onsite institutional controls are required. Offsite institutional controls will serve as an additional measure of protection to enhance the effectiveness of the selected remedy and to act as preventative measures to preserve the implementability and effectiveness of any of the selected remedy contingency measures.

Comment

Provide additional information on the efficacy and cost-effectiveness of the upgradient system to control the flow of ground water into the Site. Would the system reverse the ground-water gradient to the south?

Response

The upgradient system proposed to control the flow of ground water into the Site will intercept clean ground water flowing from the south into the Site. The purpose of the system is also to prevent contaminant migration to the south, so that a hydraulic gradient reversal to the south will not occur.

The additional cost associated with the upgradient system is anticipated to be approximately $2 million. This cost will be offset by the benefits derived from the upgradient system. The following benefits have been identified:

Enhanced isolation of site contaminants.

- Prevention of offsite contamination migration, which may occur through the unidentified sand stringers/sand channels and other geologic heterogeneities.
- Mitigation of contaminant migration on the south that may result from localized ground-water flow to the south, chemical diffusion, dispersion, or possible unidentified, localized seasonal changes in ground-water flow direction.
- Prevention of most clean ground water from entering the contaminated site, thus reducing the treatment cost.

Comment

The EPA should make a commitment to further evaluate the pumpability of selected waste pits. Specifically, would it be possible to pump any of the waste pits downgradient of the toe drain or further north where the pits are relatively close to the surface? Such actions could contribute to overall reduction of toxicity at the Site and could reduce long-term problems, particularly as they relate to significant vertical contaminant migration. Aurora requests this additional assessment in furtherance of Superfund's directive to choose permanent reduction of volume, toxicity, or mobility of wastes wherever practicable.

Response

EPA evaluated this option in the FS. EPA also evaluated the option of excavating and removing the shallow pits downgradient of the toe drain. Excavation and disposal of the contents of shallow waste pits in the former tire pile area is part of the selected remedy for OUS 2 & 3.

Comment

The following policy guidelines were adopted by Aurora City Council May 18, 1992, to guide EPA and the parties conducting the site investigation in their development of the following potential remedies:

Development Rights

1. The site remedy shall not preclude either private development or the exercise of water use rights around the Lowry Superfund site.

2. The Record of Decision (ROD) shall not allow for migration of hazardous wastes beyond the Superfund site boundaries as defined during the remedial investigation.

Land Use Planning Around the Landfill

1. Remediation options shall not presume that local government institutional controls (e.g., the City of Aurora's 1-mile perimeter development restriction) will be used in lieu of cleanup actions.

2. Cleanup strategies identified by EPA should conform to duly adopted and approved local land use plans and programs of the City of Aurora and Arapahoe County.

Cleanup Implementation

1. The site remedy shall meet the CERCLA criteria of reducing contaminant toxicity, mobility, and volume through treatment; providing effectiveness over the long term; and permanence.

2. Reaching an ROD within the shortest reasonable time should be the priority of all parties with an interest in the Site. Considerations regarding the apportionment of liability must not be allowed to interfere with the process of identifying the site remedy. EPA should take whatever action is necessary to implement the selected remedy once the ROD is issued.

Funding

1. Funds collected through the de minimis settlement process should be immediately and solely dedicated to Lowry Superfund site cleanup actions. Cleanup actions are those that involve treatment of the contaminants. They specifically exclude transaction and administrative costs, including EPA oversight activities.

2. Additional technical resources beyond the Technical Assistance Grant awarded to Citizens Against Lowry Landfill should be made available to assist the community in understanding and reviewing the cleanup alternatives being proposed for the Site.

The above guidelines will be used by the Aurora Task Force as community standards against which to evaluate proposed EPA cleanup alternatives.

Response

EPA acknowledges the policy guidelines adopted by Aurora City Council on May 18, 1992. EPA believes that the selected remedy for OUS 1 & 6 will meet the guidelines described under Development Rights, Land Use Planning Around the Landfill, and Item 1 under the Cleanup Implementation criteria. With respect to Item 2 under Cleanup Implementation, EPA believes that selecting a remedy within the shortest reasonable time is a priority and will ensure that the selected remedy is implemented as soon as possible after the ROD is issued. With respect to Item 1 under funding, the funds collected through the De Minimis settlement have been dedicated to the Fund to reimburse EPA's past costs.

A Technical Assistance Grant (TAG), once issued, can be increased to a cap of $100,000 upon petition to EPA. In accordance with CERCLA Section 117(e), only one TAG is issued per site. There are no other existing funding mechanisms for this type of assistance. However, the current community relations program provides for two-way communication between EPA and the members of the community. EPA has imparted to the community considerable information regarding the Superfund process and the Site. To date, EPA has committed funds, personnel, and other resources to assist the community in understanding the cleanup alternatives for the

Site.

Comment

We wish to point out two inaccuracies in the FS report and Proposed Plan with respect to Aurora's ordinances and land use planning efforts.

The first relates to references in both documents that Aurora's ordinances 87-165 and 87-166 currently prohibit development of structures within 1 mile of the Site and well development within ½ mile of the Site. This is not true. Aurora's code does not prohibit development within the referenced area because the property within a mile of the Superfund site is not within Aurora's municipal boundaries. Property within a 1-mile radius of Section 6 is in unincorporated Arapahoe County, which does not expressly prohibit development in the vicinity.

EPA is aware that the Aurora City Council enacted its two ordinances restricting development with City limits around the Superfund site because of technical uncertainty about the potential for offsite health risks. The Council stated that they would reevaluate the restrictions at such time as significant new data became available. With the near completion of the site investigation and baseline risk assessment, the City Council has begun to evaluate the continuing need for the ordinances. The Council will assess whether the technical data support reducing or removing the restrictions.

The second inaccuracy is on page 7-5 of the Final Draft Feasibility Study, which states in a discussion of the Southeast Area Planning Initiative that the joint planning task force has recommended that a nonresidential or open space buffer of at least ½ mile remain around the landfill. While the concept of buffers around the Superfund site has been discussed by the task force, no specific recommendation has been made by the group, which is strictly advisory to the Aurora City Council and Arapahoe County Board of County Commissioners.

The Lowry Landfill Environs element of the Southeast Area Planning Initiative was undertaken by Arapahoe County and Aurora, with participation by the City and County of Denver, to provide EPA a conceptual land use plan for the Superfund site and immediately surrounding area to facilitate the evaluation of site remedies. As an invited participant in the planning effort, EPA will receive prompt notice of any land use decisions that are made by the jurisdictions.

Response

EPA appreciates the information provided. As described in the ROD, offsite institutional controls will serve as an additional measure of protection to enhance the effectiveness of the selected remedy and to act as preventative measures to preserve the implementability and effectiveness of any of the selected remedy contingency measures.

Comment

We believe it is critical that the selected remedy rely first on physical barriers to contain the site wastes, and that the performance of these physical containment systems be evaluated by a comprehensive and carefully designed monitoring program.

Because of the potential for contaminants to migrate to the east and west of the source area, the proposed physical barrier systems along these boundaries should both be installed immediately. The City particularly urges EPA to resist any efforts to delay the installation of the western boundary system, since development activity to the west of the site has been steadily increasing.

Response

The selected remedy for OUS 1 & 6 includes lateral containment on the eastern and western portions of the Site. EPA considers containment to be the key concept that may be implemented by several specific technologies. EPA has determined that physical barriers (such as installing a barrier wall) are more protective of human health and the environment because of the existence of sand lenses at the Site.

Comment

To the extent possible, contaminants should be kept from spreading beyond the compliance boundaries, even if the concentrations of those contaminants would meet current Applicable or Relevant and Appropriate Requirements (ARARs). EPA may avoid the need for upgrading the cleanup plan in the future by conservatively setting remediation goals and remedial action objectives close to background levels now.

Response

The threshold criteria for selection of a remedy is protection of human health and the environment and attainment of ARARs. The NCP states that the acceptable site risk range for human health is 10-4 to 10-4 for Superfund sites. EPA does not agree that cleanup should be to background levels for this Site. Based on the nine criteria and the risk range specified in the NCP, EPA cannot justify cleaning up to background levels for all contaminants at Lowry.

Comment

Long-term maintenance of the surface water removal action, the landfill cap, and the existing monitoring system is essential to a successful remedy. Also, since the majority of the ground-water contaminants will probably remain untreated in Section 6 indefinitely, the institutional controls outlined in Denver's Executive Order 97 will need to be enforced to prevent potential exposure on the Site.

Response

EPA agrees with this comment. As to Executive Order 97, EPA agrees that it will need to be enforced and that additional restrictions on the use of the Site will need to be implemented.

Comment

An effective containment and collection system, as described in Alternative 5, will be used to control further horizontal migration of contaminants in the shallow ground-water system. However, we strongly concur with EPA that, in addition, an effective long-term monitoring system must be developed to confirm aquifer characteristics and ground-water migration over time. References in the FS to uncharacterized heterogeneities, such as high permeability sands or fractures and uncertainties in site data, underscore the importance of an adequate monitoring system, particularly to assess vertical migration. We understand that the conceptual model will be used only for planning and not for management purposes, and we fully support this decision.

Response

EPA agrees with this comment.

Comment

If the conceptual site model is accurate, contaminant migration to the compliance boundaries is not expected to occur until after the 30-year estimated life of the cleanup remedies. At that time, there will likely be far more development around the Superfund site than there is today. This raises concerns for Aurora, despite EPA and PRP assurances that because of Superfund-mandated 5-year reviews, remedial activities at the Site will continue as long as they are necessary. It is critical that EPA accurately estimates cleanup costs and contingencies and is diligent in efforts to legally secure these resources at the time the remedy is negotiated. Any number of circumstances at the Site could significantly increase future risks. Unforeseen operation and maintenance problems, for example, could compromise the effectiveness of the remedy if there is a funding shortfall at the critical period.

Significant funds have already been paid to both EPA and Waste Management through the settlement process at the Site. A small portion of these funds dedicated now could grow to a substantial resource to finance future contingencies. The City requests that EPA investigate this and other potential options for ensuring that we are not faced with a shortage of funds to properly manage the Site at a time in the future when it may be most needed.

Response

EPA agrees that ground-water containment and treatment will continue in perpetuity since wastes will remain on the Site. EPA will seek to obtain financial assurance from any PRPs performing the remedy to ensure continued O&M of the remedy.

Section 107 of CERCLA provides EPA with the mechanism to obtain cleanup funding in the event that the PRP performing the RD/RA is no longer viable.

Comment

South Barrier System-We have some questions regarding the relative benefit of the proposed barrier and/or diversion system upgradient of the Site along the southern compliance boundary. Is there any potential for the barrier to cause a reversal of the ground-water gradient to the south? Could the existence of the barrier impede potentially beneficial downgradient flushing of the contaminants? Before endorsing installation of an upgradient barrier, the City requests that EPA provide additional information on the effectiveness of the concept. We raise this question particularly in light of the conclusion that migration of ground water onto the Site from the south is responsible for only a very small portion of the total annual infiltration.

Response

The relative benefits of the upgradient system were discussed previously (see response to City of Aurora's second comment). Migration of ground water onto the Site from the south is responsible for only a small portion of the total annual infiltration and would not result in beneficial flushing. However, intercepting this flow is one of the secondary benefits of the upgradient system. The primary benefit is isolating and preventing site contaminant migration to the south, as discussed earlier.

The Activity Report for Oversight of Compliance Boundary Sampling, dated May 1993, shows exceedances of the Preliminary Remediation Goals (PRGs) to the south or the upgradient portion of the Site. In addition, the Ground-Water Use Evaluation (Lowry Coalition, Draft Addenda 2 and 3 to the Ground-Water Well Inventory Technical Memorandum, dated July 24 and October 25, 1991, describes the effects of an operating municipal or industrial well in Section 7. The modeling results show that a reversal in the gradient flow will be induced by pumping. The function of the barrier wall will be to prevent contaminants from flowing with the reversed gradient and migrating offsite.

<u>13.2.3 EPA's Response to Comments from Colorado Department of Health</u>

Comment

The proposed point of compliance does not meet certain ARARs and to be considered (TBC) values. The state would be willing to consider a waiver of the Resource Conservation and Recovery Act (RCRA) ARAR if sufficient justification exists, and pursuant to the basic standards for ground-water requirements, if two points of compliance are established. The first boundary would be called a Point of Action (POA) and would be set at the current extent of contamination. The second boundary would be called a Point of Compliance and would be set at the property boundary as shown in the Proposed Plan.

The purpose of the POA boundary would be to trigger corrective measures to address migrating contamination beyond the areal extent of the existing plume. This will allow for additional time to correct a problem before offsite migration. The POA need only be set as a concept at this time, with the actual identification of the POA boundary to be made when sampling takes place during remedial design of the selected remedy.

Response

EPA has included POA and compliance boundaries in the ROD for the Site. Monitoring at the POA allows contamination to be addressed (via the planning and implementation of appropriate response actions) before it reaches the compliance boundary, thus preventing exeeedances of performance standards at the compliance boundary.

Consistent with the NCP, the compliance boundary has been established at the edge of the waste management area because the waste has been left in place. In this context, the waste management area encompasses the following waste management units: waste pits, sewage sludge application areas; leachate injection areas; command post; subsurface barrier wall and treatment facility; and leachate sprayback areas. In establishing the compliance boundary, EPA considered the proximity of the sources, the technical practicability of ground-water remediation, the vulnerability of the ground water and its possible uses, and the likelihood of exposure. Under this approach, there will be no need to waive the ARARs because ARARs will be met.

The actual surveyed location of the POA and compliance boundaries will be determined by EPA during RD.

<u>13.2.4 EPA's Response to Comments from East Cherry Creek Valley Water and Sanitation District</u>

Comment

The East Cherry Creek Valley Water and Sanitation District (the District) was established in 1962, before Denver's acquisition of Section 6 from the Army. The District presently serves over 5,000 accounts including homes, schools, churches, and commercial properties. Presently comprising a population of over 15,000, the District is poised to grow within its service area to serve as many as 90,000 people. Ground water in the Dawson, Denver, Arapahoe, and Laramie-Fox Hills aquifers is the primary source of water for the District and will continue to be a vital component of the District's water supply as it develops. Through its irrigation return flow recapture programs, the District is also using water from the shallow alluvial aquifer systems within its boundaries. Considering its reliance on ground-water resources, the District cannot tolerate any migration of hazardous waste off of the Lowry Landfill site. We have reviewed EPA's recommended alternative for remediation of the ground-water OUS on the basis of this standard.

The District believes very strongly that an immediate and active approach to cleaning up and containing the wastes is crucial to the protection of its water supplies. It further believes that the remediation program should include, at a minimum, the construction of the perimeter barriers and collection facilities as depicted in the recommended alternative. Although it generally supports the concepts outlined in the recommended alternative, the District remains concerned with the effectiveness of the cleanup and the impact it may have. Specifically, the District has the following general concerns:

1. It is opposed to using any offsite institutional controls which will in any way reduce, or restrict our access to ground water within the service area of the District.

2. It believes that it is critically important that the monitoring program developed be designed and operated in a fashion that will allow for the effective identification of any vertical migration of the plume, or migration of the contamination off of the Site.

3. There is currently no quantification of the impact the dewatering and cleanup would have on the District's water supplies. The District requests that such an analysis be undertaken, and that a means for replacing water impacted by the cleanup be developed.

4. It is concerned that the cleanup, as presented, may allow contamination to move beyond the western site boundary and onto the District. It understands the well system will be in place to help mitigate offsite contamination. However, if these wells are not operated until PRG (Preliminary Remediation Goals) levels of contamination arrive at the boundary, considerable contamination may migrate onto the District. It strongly recommends that the "trigger" level for starring the operation of the westside containment well system be set at some agreed upon background level rather than the PRGs. The water it currently delivers to customers is well within mandatory Safe Drinking Water Act (SDWA) standards, and it does not want a portion of its water supply to deteriorate to a marginal level of acceptance.

5. It requests that some additional effort be made to reduce toxicity onsite through the pumping of selected waste pits.

Our detailed comments are incorporated in the following document. Please include this cover letter into the formal record with, and as part of, our comments.

Response

EPA notes that the cover letter is included as part of the District's comments. All have been placed into the Administrative Record for the Site. EPA has responded to the five general concerns in the District's detailed comments below. The selected remedy for OUS 1 & 6 is, in part, a containment remedy that will halt offsite migration of contamination.

Comment

Institutional Controls-The District is strongly opposed to incorporating any offsite institutional controls that would in any way restrict its access to, or use of water within its boundaries.

The District does not have surplus water to attribute to a "buffer zone." All water within its boundaries is committed in the District's water supply planning to meet future demands. It cannot donate water to the cleanup effort either to provide an additional margin of safety in the event that the ground-water modeling is inaccurate, or to facilitate the operation of the ground-water collection system. The proposal does not include any detailed analysis of what impact offsite institutional controls would have on District adjudicated water rights and/or nondecreed water within its boundaries.

Response

As described in the ROD, offsite institutional controls shall serve as an additional measure of protection to enhance the effectiveness of the selected remedy and to act as preventative measures to preserve the implementability and effectiveness of any of the selected remedy contingency measures. Offsite institutional controls shall include, but not be limited to, deed notices and restrictions, zoning controls, and well restrictions. These controls must prohibit all offsite activities in the vicinity of the Lowry Site that would interfere or be incompatible with, or that would in any way reduce or impair the effectiveness or protectiveness of, the selected sitewide remedy.

Comment

Ground-Water Modeling-What is the potential for future impacts to the deep aquifers beneath and adjacent to the Site if this plan is implemented? At the Aurora Ordinance Review Meeting on February 21, 1993, representatives of t he City of Denver concluded that the deep aquifers, including the Arapahoe Aquifer, may not be protected and may become contaminated if nearby wells are allowed to pump. This is fully contrary to our understanding of the conclusions reached by EPA and the Coalition. We request that the modeling be reviewed and rerun, if appropriate, to resolve these questions.

Response

To address concerns that dissolved contaminants may migrate vertically downward under pumping conditions, EPA completed several scenario runs for potential receptors in the Denver and Arapahoe Formations using the FS model. The purpose of the simulations was to evaluate the impact of pumping near the Site on the Denver and Arapahoe aquifers. The simulations considered municipal wells pumping in a dewatered aquifer that reached water table conditions because of an assumed high level of ground-water development. These are conservative conditions because the existing confining conditions within the Denver and Arapahoe aquifers help reduce the rate of downward migration. Under water table conditions, the hydraulic head in the aquifer is lower than the head under confined conditions, resulting in an increase in the downward hydraulic gradient, which promotes downward vertical contaminant migration. This scenario simulates greater pumping than the total consumptive use currently allowed by the Denver Basin Rules. The results of the simulations indicated that no detectable dissolved contamination was predicted to reach the Denver or the Arapahoe Formations within the 200-year simulation period. It should be noted that to date, EPA has no reliable mechanism to predict migration of dense nonaqueous phase liquids. However, EPA will implement a vertical migration contingency plan to monitor and remediate, if necessary, migration of dense nonaqueous phase liquids.

Comment

Ground-Water Monitoring-What are the primary components of the monitoring system and how will they be designed? Since the modeling suggests that there will be little vertical migration of contaminants, engineered facilities to control vertical flow were abandoned in favor of monitoring of the deep ground-water system. This places a great deal of importance on the placement and design of the monitoring facilities. It is particularly important to the District that deep aquifer monitoring facilities be effective, and yet constructed in a manner to assure that the wells themselves will not, in the future provide a preferential pathway for contaminant migration vertically downward.

Response

The design and placement of the monitoring well network will occur during RD. However, EPA understands the District's concern that the monitoring wells should not provide a conduit for vertical migration. Monitoring wells that must be drilled through waste disposal areas will be installed with appropriate precautions. EPA would welcome any additional information and/or comments from the District pertaining to well monitoring and design.

Comment

Is there a vertical compliance boundary? Clearly, if contamination was identified offsite in excess of ARAR standards, some sort of remedial activity would be dictated. However, it is not clear what actions would be taken if monitoring confirmed that the plumes were migrating vertically downward into clean ground-water systems within the area of the compliance boundary.

Response

The top of the lignite layer is selected as a vertical compliance boundary and response action will be taken if contaminants migrate to this layer. The response action to be taken will be determined by the magnitude and speed of the migration event, the contaminants involved, contaminant concentration, and other physical parameters.

Comment

Who will be responsible for the Site in the long term (30+ years); and specifically, where is this responsibility described?

Response

Pursuant to Section 107 of CERCLA, the PRPs remain liable for all response costs associated with the Site, regardless of when incurred. Response costs were estimated for the 30-year present worth to provide a basis for comparing remedial alternatives. The 30-year period was not intended to signify the length of the remedial action. Under the selected remedy for OUS 1 & 6, the collection and treatment of contaminated ground water will continue in perpetuity. EPA, through the 5-year review process, will assure that human health and the environment are being protected by the remedial action selected for the Site.

Comment

What impact will the perimeter collection systems have on water availability and water rights, and how will these impacts be mitigated? We have seen no analysis of how the proposed dewatering systems might impact water beneath adjacent parcels within the District, and how replacement water might be made available to the District to compensate for any adverse impacts.

Response

The impact that the cleanup would have on the District's water rights is negligible for the following reasons:

- The remedial activities include extraction of contaminated ground water at the Site, ground-water treatment, and reinjection of the treated ground water at the Site; therefore, what is extracted from the ground water will be returned. This results in a net balance of zero; therefore, the amount of available ground water has not changed.

- The cleanup effort will target the Dawson Formation, which is not a major water producer in the area.

Comment

Ground-Water Quality-It is not clear exactly where the compliance boundary is currently proposed to lie. We would like better definition of this boundary.

Response

The proposed compliance boundary as shown in Figure 3 of the Proposed Plan is a conceptual boundary. Conceptually, the boundary consists of a southern boundary at East Quincy Avenue; a western boundary at Gun Club Road; an eastern boundary at the current fence running north/south in Section 6; and a northern boundary that is an extension of East Hampden Avenue with the exception of protrusions into Section 31 to encompass the barrier wall and command post. The actual surveyed location of the compliance boundary will be determined by EPA during RD.

Comment

Will the concentration of contaminants within plumes inside the compliance boundary be allowed to increase from current levels as long as compliance is attained at the boundaries?

Response

The concentration of contaminants could theoretically increase inside the compliance boundary. However, performance standards, including ARARs, must be met at and beyond the compliance boundary. Monitoring will be required within the plume of contaminated water, but action will not be taken unless contamination above the standards described in Section 11 of this ROD crosses the POA boundary.

Comment

Will contaminants be allowed to spread beyond the compliance boundary as long as ARARs and PRGs are met? For example, if the PRG for lead is set at 50 micrograms per liter (Table 2.1 in the FS), and the natural background lead is less than 5 micrograms per liter, will lead contamination be allowed to spread beyond the compliance boundary as long as it does not exceed 50 micrograms per liter? Although this is a concern with regard to all parameters, lead is a particularly good example. While the maximum contaminant level (MCL) for lead remains at 50 parts per billion (ppb), the new EPA notification and treatment level for lead in drinking water lies at only 15 ppb. We recommend bringing the PRG for lead into conformance with the new EPA lead-copper rule.

Response

The threshold criteria for selection of a remedy is protection of human health and the environment and attainment of ARARs. The NCP states that the acceptable risk range for human health is 10-4 to 10-6 for Superfund sites. Based on the nine criteria and the risk range specified in the NCP, EPA cannot justify cleaning up to background levels for all contaminants at Lowry.

Performance standards listed in the ROD, including ARARs and TBC values, use the most current information available at the time the ROD is issued.

Comment

Will there be provisions for alteration of the PRGs in the future as SDWA regulations become more comprehensive and stringent?

Response

CERCLA mandates EPA review of the remedy no less often than every 5 years as long as any wastes remain at the Site, allowing the remedy to be modified if it is not protective of human health and the environment.

Comment

Will any offsite ground-water degradation be allowed to occur before pumping from the barrier system is initiated? The EPA monitoring, as well as the District's own monitoring, indicate that the ground water underlying the District has not yet been impacted by the Lowry facility. The District's wells produce water containing some natural mineralization, but no organic or other induced contaminants. The District feels very strongly that the contaminant plume should be contained on Section 6, and should not be allowed to migrate off the Site onto the District at any levels. The District feels this is particularly important since the recommended alternative is not an effective cleanup proposal, but is in truth a containment program. The District recommends that a "trigger" level for starting the operation of the containment well system on the west boundary be set at some agreed upon background level rather than the PRGs. The water the District currently delivers to customers is well within mandatory SDWA standards, and the District does not want a portion of its water supply to deteriorate to a marginal level of acceptance.

Response

Offsite migration of contaminated ground water, as measured by the performance standards, including ARARs, will not be allowed to occur beyond the compliance boundary. Monitoring at the POA will allow quick response action to ensure that contaminants above performance standards, including ARARs, are not allowed to migrate beyond the compliance boundary.

Based on the nine criteria and the risk range specified in the NCP, EPA cannot justify cleaning up to background levels for all contaminants at Lowry.

Comment

Removal of Waste-Can any of the pits be effectively pumped to help reduce the volume of waste on the Site? The recommended alternative removes only relatively small amounts of waste from the Site. Instead, it relies upon containing the Site throughout the foreseeable future. If it appears that the pits as a whole cannot be effectively pumped, the District would like to know if there are select pits that could be pumped efficiently to help reduce the overall toxicity of the Site and diminish the long-term threat to the ground water.

Response

EPA evaluated the effectiveness of waste pit pumping and found that only a small portion of wastes can be removed through pumping. Residual contamination of liquids that are sorbed onto various waste materials will provide a continuous source of ground-water contamination. Excavation and disposal of the contents of shallow waste pits in the former tire pile area is part of the selected remedy for OUS 2 & 3.

13.2.5 EPA's Response to Comments from William G. Kennedy

Comment

Page 8, Table 1 of the Proposed Plan for OUS 1 & 6, last column-shows costs of Alternative 5 to be $59 million and Modified Alternative 5 to be $61 million. Page 6 shows costs of Alternative 5 and Modified Alternative 5 to be $17,680,000 and $21,100,000 respectively. What is the reason for this discrepancy?

Response

The $17,680,000 for Alternative 5 and $21,100,000 for Modified Alternative 5 represent the funds needed to design and construct the components of the project in a period of 3 years. These costs are referred to as the capital costs. In addition to the capital costs, EPA has estimated the cost to operate and maintain the project, typically referred to as O&M costs. The present worth is the amount of money you would need to have today, assuming that this money would collect 5 percent interest per year, to construct and operate the remedy for 30 years. The $59 million for Alternative 5 and $61 million for Modified Alternative represent the 30-year present worth values for both capital and O&M costs.

Comment

Present worth cost figures are estimated for all alternatives, but no mention is made of the interest rate used to amortize present worth over 30 years. There is no indication that the cost figures are estimates.

Response

EPA assumed a 5-percent discount rate. The FS report provides detailed information on cost estimates. EPA agrees that the costs are estimates. The accuracy of the estimate is subject to substantial variation since very little detail is known about the specific design of each alternative. Typically, the cost estimates are expected to be no more accurate than -30 percent to +50 percent.

Comment

Figures 1, 2, and 3 indicate a "current landfilling area" in Section 36 to the north, just outside the compliance boundary of the Proposed Plan. Is this an imminent future Superfund site?

Response

No. Superfund was established to provide funding and enforcement authority for past hazardous waste activities. The current landfill area in Section 31 deals with solid, not hazardous waste and is permitted under Colorado Hazardous Waste Management Regulations (CHWMR), which is a "cradle-to-grave" regulatory program for active landfilling facilities.

Comment

The Proposed Plan mentions OUS 2, 3, 4, and 5, but does not delineate their location on Figures 1, 3, or 4. Perhaps the above-mentioned "current landfill area" is actually OU 2, 3, 4, or 5. Could the Proposed Plan be edited to clarify this confusion?

Response

Operable Units (OUS) 2, 3, 4, and 5 refer to media addressed at the Lowry Landfill Superfund Site located in Section 6. The OUS refer to the following media:

- Landfill Solids, OU 2
- Landfill Gas, OU 3
- Soils, OU 4
- Surface Water and Sediments, OU 5

Their location is shown in the attached figures. The current landfill area is located in Section 31, immediately north of Section 6.

Comment

The word "Permanence" in conjunction with Long-Term Effectiveness appearing at the top of page 8 is defined on page 9 as "...the ability of a remedy to provide reliable protection of human health and environment over time." The phrase "over time" is meaningless. Could the word "permanence" appearing in the Proposed Plan be quantified in number of years?

Response

The phrase "over time" was used because EPA is required to determine the magnitude of residual risk remaining at the Lowry Landfill site after the remedy is implemented and to determine the adequacy and reliability of the remedial measures and onsite institutional controls to manage remaining wastes. In this way, the long-term effectiveness and permanence of the selected remedy can be demonstrated over time.

The word "permanence" cannot be quantified in years because the selected remedy is a containment type of remedy. Since wastes will remain on the Site, containment and treatment will continue in perpetuity.

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Comment

Page 10, Short-Term Effectiveness. The text that follows this heading addresses risk to construction workers, 3-year construction period, and special health protective measures. This text has no bearing on the word "Effectiveness" and vice versa. This is a nonsequitur. If Short-Term Effectiveness were changed to "Short-Term Adverse Effects," readers would be less confused. Could either the heading or the text be changed to make sense (in English)?

Response

The NCP defines short-term effectiveness as the short-term impacts of the alternatives. EPA agrees that the short-term effectiveness is measured by the magnitude of the short-term adverse effects of implementing a remedy.

Comment

Short-Term Adverse Effects that may be unavoidable during construction include increased dust, noise, traffic, and perturbance of toxic leachate. Does EPA intend to address these adverse effects to human health and environment in the final Proposed Plan?

Response

Dust, noise, and traffic will be addressed in the final design of the remedy. Other short-term adverse effects will be covered by the Occupational Safety and Health Act, which addresses hazardous exposures in the work place, and the Emergency Planning and Community Right-to-Know Act, which addresses unanticipated environmental releases.

Comment

Page 9, Implementability. The Proposed Plan does not acknowledge the differential dumping by the PRPs, that large companies were the major contributors, and that lawsuits are likely to be the greatest obstruction to implementability.

Response

The items listed in the comment relate to cost recovery. Selection of the remedy and cost recovery are two distinct phases of the Superfund process. In general, EPA addresses cost recovery issues after the remedy is selected.

Comment

Please regard these comments as honest inquiry and not as criticism. Everyone at EPA that 1 talked to on the telephone, relative to Lowry or any other environmental concerns, have been outstandingly courteous, helpful, and prompt. Despite comments herein, please count me as one in favor of the Proposed Plan as written.

Response

EPA acknowledges support of the selected remedy for OUS 1 & 6 as expressed in the Proposed Plan.

<u>13.2.6 EPA's Response to Comments from the Lowry Coalition</u>

Comment

The Lowry Coalition agrees that Alternative 5, as modified, meets the criteria that EPA must consider in evaluating remedial actions at CERCLA sites, and, in particular, meets ARARs and achieves overall protection of human health and the environment. The Lowry Coalition supports EPA's Proposed Plan.

Response

EPA acknowledges support of the preferred remedial alternative for OUS 1 & 6 as expressed in the Proposed Plan.

<u>13.2.7 EPA's Response to Comments from Robert Velton, Pemex, Inc.</u>

Comment

My proposal for a Proposed Plan modification and/or Revision of Closure Plan for the Sussquehanna Hazardous

Waste Site in Pueblo, Colorado, should be reviewed because it has some different approaches, some technical data, and some private sector thinking that may interest you at the Lowry site.

Response

The alternative methodology proposed for the Sussquehanna site is recycling. Based on Table 1 of your proposal, you have concluded that no reasonable alternative to containment exists for the Lowry Landfill site. Containment is part of the selected remedy for OUS 1 & 6. Your entire proposal is being retained as part of the Administrative Record for those OUS.

13.2.8 EPA's Response to Comments from United States Department of Interior, Fish and Wildlife Service

Comment

The U.S. Fish and Wildlife Service (USFWS) wishes to convey its concern for potential adverse impacts to natural resources by encouraging EPA to conduct an ecological risk assessment for OUS 1 & 6 if one has not already been completed. Decisions for interim actions and final remedy should be based on valid ecological risk assessments. We also encourage EPA to consider the Endangered Species Act, Fish and Wildlife Coordination Act, Migratory Bird Treaty Act, and the Bald Eagle Protection Act in planning for interim actions and final remedies.

Response

EPA prepared an ecological risk assessment as part of the Baseline Risk Assessment for Lowry OUS 2 & 3 and 4 & 5. Other ecological evaluations appear in the Preliminary Endangerment Assessment and the Remedial Investigation Report for the Shallow Ground-Water and Subsurface Liquids and Deep Ground-Water Operable Units. The Lowry Coalition conducted an Evaluation of Potentially Protected Resources for the Lowry Landfill site and adjacent areas. This evaluation included an evaluation of threatened and endangered species. The Lowry Coalition also conducted an investigation of the distribution of wetlands in the area. This evaluation includes a description and mapping of wetlands and a qualitative delineation of specific wetlands vegetation.

A list of the potentially endangered and threatened species thought to occur in the area of the Lowry Landfill site is included in the Baseline Risk Assessment for OUS 2 & 3 and 4 & 5. Among the species listed, there are several species of raptor and terrestrial carnivore that may be subject to bioaccumulation processes. These species include the Peregrine Falcon, the Bald Eagle, and the Swift Fox. While none of these species have been observed at the Lowry Landfill Site, the USFWS considers the area a possible habitat for these organisms.

The Lowry Coalition identified several endangered species that may be present in the vicinity of the Lowry Landfill site, including the Bald Eagle, Peregrine Falcon, Whooping Crane, and Black-footed Ferret. Threatened species that may be present include the Ferruginous Hawk, Mountain Plover, Long-billed Curlew, Preble's Jumping Mouse, Swift Fox, Colorado Butterfly Plant, and Diluvium Lady's Tresses.

EPA will use information from the ecological risk assessments in making decisions for the final remedy for the Lowry Landfill site.

13.2.9 EPA's Response to Comments from Waste Management of Colorado, Inc., Chemical Waste Management, Inc., and the City and County of Denver

Comment

In general, Waste Management of Colorado, Inc., Chemical Waste Management, Inc., and the City and County of Denver (WMC/CWM/Denver) agree with the remedial alternative that EPA has selected for the shallow and deep ground-water and subsurface liquids OUS. The concept of containing and treating ground-water contamination at Lowry is supported by WMC/CWM/Denver based upon:

1. The significant short-term health risk that would be posed by removing all contaminated materials at the Site, its technical impracticability, and cost/benefit;

2. The proven inability at the Site to remove all of the contaminated liquids from the landfill mass and underlying and surrounding subsurface by pumping and treating due to low permeability; and

3. EPA's Baseline Risk Assessment, which showed that ground water at Lowry poses no current health risk, and only future risk if a number of very conservative assumptions are made about the hydrogeology of the area, and future land and water use.

Response

EPA acknowledges support of the preferred remedial alternative for OUS 1 & 6 as expressed in the Proposed Plan.

Comment

In describing the practice of co-disposal, EPA states on page 3 of the Proposed Plan that "it was thought that the municipal refuse would act as an absorbent for the liquid wastes." While not 100 percent effective, municipal refuse did, in fact, absorb or retain much of the industrial liquid disposed of at the Site. This is evidenced by the presence of "perched" waste pits in the western portion of the Site, the presence of 95 million gallons of contaminated liquids still within waste pits, 14 million gallons of contaminated liquids in saturated refuse, and the proven increase in contaminant levels within the unsaturated refuse within the zone formerly containing waste pits.

Response

EPA discussed the procedure of co-disposal in the Proposed Plan to describe what was an accepted disposal practice in the past. This practice is no longer acceptable. EPA agrees that the refuse acts as an absorbent for the liquid industrial waste, but notes that refuse does nothing to address contamination from that waste. Unfortunately, a large volume of waste pit liquids migrated beyond the boundary of the pits and as a result, has contaminated every media at the Site.

In addition, it is also the presence of the refuse that makes liquid recovery difficult, if not impossible, and not cost-effective. EPA disagrees that waste pits in the western portion of the Site are "perched." The Lowry Coalition for OUS 1 & 6, dated March 1992, concluded that the waste pits are in direct hydraulic connection with ground water. EPA agrees with this conclusion.

Comment

EPA states on page 4 of the Proposed Plan that "the COCs identified in OUS 1 & 6 are the result of liquids from the buried waste pits and leachate from the buried refuse." There is absolutely no evidence that refuse at the Site contributed to contamination of media in OUS 1 & 6, nor is there any evidence that any liquids were generated or infiltrated through municipal waste at Lowry.

Response

There is evidence that refuse may have contributed and could continue to contribute to contamination of media in OUS 1 & 6. As stated in the draft RI report for OUS 2 & 3, up to 2,700 cubic feet of water per year could be percolating through the landfill. On the basis of the results of the column leachate study, the flux from the landfill mass based on this flow is estimated at 34,980 mg/day of toluene. These estimates are based on the current condition where the landfill has a clay cap covering it. In the past, before the cap was placed, even more liquid would have percolated through the landfill.

There is also evidence that liquids were generated, or infiltrated, through municipal waste at the Lowry Landfill site since small quantities of leachate have been noted to exist within the unsaturated landfill mass during site investigations.

Comment

In the first bullet in the discussion of the Baseline Risk Assessment, EPA discusses future onsite residents and future use of onsite ground water. Denver, as owner of the Site, regards future onsite residents or residential ground-water use as extremely unlikely. In 1991, Denver's mayor issued Executive Order No. 97, which placed restrictions on the use of land, surface water, and ground water at the Site. These restrictions included the following:

- No direct use or reuse shall be made of the ground water in the Denver or Dawson aquifers underlying the Site that could cause exposure of humans or animals to contaminants in said water.

- No direct use or reuse shall be made of ground water in the Arapahoe and Laramie-Fox Hills aquifers underlying the Site for domestic, residential, or municipal water supply purposes.

- The Site shall not be used for agriculture, residential development, or commercial development.

Executive Order No. 97 officially states the policy of Denver regarding use of its property. This policy has been followed since the adoption of the executive order by both the Pena and Webb administrations. In view of the identified health risks at the Site and Denver's commitment as a governmental entity to the protection of human health and the environment, this policy is not expected to change.

To further address concerns over the permanence of these controls, Denver Mayor Webb recently committed to formalizing these controls such that they were permanently enforceable by a responsible third party. Denver has recently proposed language to EPA and CDH for a declaration of covenants to run with the land. In the proposed covenants, EPA and CDH, as well as Denver, have enforcement authority to restrict land and ground-water use at the Site.

Response

Denver appears to be suggesting that EPA should not have used a residential-use scenario in the Baseline Risk Assessment because of Executive Order No. 97. It is EPA's policy not to consider institutional controls when conducting Baseline Risk Assessments. Furthermore, EPA has made a risk management decision to retain the residential scenario when evaluating remedial alternatives because there is residential development in the area and the ground water will potentially be used for residential consumption. For this and other reasons, EPA has determined that it is reasonable to assume that the Site could be used for residential purposes in the future.

As stated in the risk assessment for OUS 1 & 6, Executive Orders may be overturned by this or any future administration, and therefore do not qualify as permanent enforceable institutional controls. EPA acknowledges Denver's recent proposal for covenants to run with the land and agrees that this type of institutional control may meet some of EPA's concerns about permanent enforceability. As described in the ROD, offsite institutional controls shall serve as an additional measure of protection to enhance the effectiveness of the selected remedy and to act as preventative measures to preserve the implementability and effectiveness of any of the selected remedy contingency measures. Offsite institutional controls shall include, but not be limited to, deed notices and restrictions, zoning controls, and well restrictions. These controls must prohibit all offsite activities in the vicinity of the Lowry Site that would interfere or be incompatible with, or that would in any way reduce or impair the effectiveness or protectiveness of, the selected sitewide remedy.

Comment

In the second bullet discussing the Baseline Risk Assessment, it should be noted that contaminants in offsite ground water posing an unacceptable health risk are not anticipated for at least 50 years.

Response

The 50-year estimate is solely an estimate. Given the uncertainty associated with numerical models, EPA believes is prudent to assume a wide margin of error with respect to numerical predictions.

Comment

EPA, on page 4, states that "Executive Order No. 97, as issued by the City and County of Denver, would be enforced." Who does EPA anticipate will enforce these land-use restrictions? Have these enforcement costs been included in the total remedial costs?

Response

Since Executive Order No. 97 was written and signed by the Mayor of Denver, EPA expects that Denver would use its enforcement authorities to ensure that the components of the Order are followed. Furthermore, the land is owned by Denver. Enforcement costs for implementing this Executive Order have not been included in the cost of remedy. EPA does not know if the City of Denver has an enforcement budget to enforce this Executive Order.

Comment

EPA should explain the discrepancies between its Modified Alternative No. 5 described in the Proposed Plan, and Alternative No. 5 as described in the OUS 1 & 6 FS.

In the FS, east and west boundary containment is composed of 100-foot-deep wells, while in the Proposed Plan, east and west containment is composed of 50-foot-deep wells or collection systems. Also, the extent of the southern portion of the west boundary system is dissimilar.

EPA should clarify if the Lowry Coalition's assumptions about the use of wells is included in Modified Alternative No. 5. If not, and the lateral control systems consist of barrier walls, collection trenches, or other engineering control, then the cost quoted for the lateral control systems are not correct. At a minimum, if EPA intends to delay the decision about the proper engineering control until remedial design, then a sensitivity analysis of cost impacts of differing designs would be appropriate.

EPA apparently has used the Lowry Coalition's present value cost estimate for Alternative No. 5 as the basis for its present cost for Modified Alternative No. 5. It is important to note that Alternative No. 5, as priced in the OUS 1 & 6 FS, had lateral control systems that solely consisted of wells that are monitored over time, with no money ever allocated for electricity, well maintenance or replacement, or treatment of the collected ground water. WMC/CWM/Denver support the idea of monitoring the east and west boundaries for contamination, without implementing remedial action prior to arrival of contaminants, particularly given the OUS 1 & 6 ground-water modeling results, showing that contamination is not expected at the east or west boundary for at least 50 years. Any premature pumping of these systems may exacerbate the potential for lateral ground-water contamination.

Response

EPA has modified Alternative 5 from the FS and has renamed it Modified Alternative 5. The modifications consist of an additional upgradient containment/collection and/or diversion system on the southern boundary of Section 6 of the Lowry Landfill Superfund Site.

In Appendix C of the FS Report dated October 1992, the Lowry Coalition provided cost estimates for depths of 50, 65, and 100 feet for extraction trenches. EPA has determined that 50-foot depths will fulfill the functions of the barrier wall and/or collection system, in that the weathered Dawson is believed to be the primary pathway of contaminant migration. The weathered Dawson's depth does not exceed 50 feet.

EPA modified the southern portion of the western boundary to be closer to the source area and thus captures the migration of contamination closer to the source.

EPA used the assumptions outlined in Table 5.14 in the FS Report dated October 1992. EPA developed a cost estimate for Modified Alternative 5 based upon a 50-foot depth barrier wall and the same length as shown in Figure 5.51 in the FS Report. EPA requires that cost estimates for the final FS should be in the range of +50 percent/-30 percent range. The Modified Alternative 5 has been completed within this range.

Table 5.14 of the FS Report shows costs for electrical power, well replacement, well maintenance and well cleaning with acid. Tables C3 and C5 show start-up costs and operation and maintenance costs for the treatment plant. Based upon the January 1993 Compliance Boundary Sampling event, there is confirmed contamination in B301A and B216A at the western boundary of the Site. Therefore contaminants have migrated to the compliance boundary and remediation is required. EPA agrees that if extraction wells were used, pumping could cause lateral contaminant migration. This supports the selection of barrier walls over extraction wells.

Comment

EPA should explain why the southern boundary in the Proposed Plan is designed to a 50-foot depth, while in HLA's response to EPA comments on the FS, the southern boundary is designed to a 60-foot depth.

Response

See response to the above comment.

Comment

EPA should explain the technical basis for the upgradient containment, collection, and/or diversion system. The design and cost for the system described in the Proposed Plan is dissimilar to that contained in the Responsiveness Summary to EPA comments on the draft FS report.

Response

The upgradient system proposed to control the flow of ground water into the Site is conceptualized to intercept clean ground water flowing from the south into the Site. It is anticipated that the system will be composed of a barrier wall and an extraction system. A barrier wall will limit the impact of the extraction system on the ground-water hydraulic gradients inside the Site.

The additional cost associated with the upgradient system is anticipated to be approximately $2 million. This cost will be offset by the benefits derived from the upgradient system. The following benefits have been identified:

- Enhanced isolation of site contaminants. January 1993 sample results along the southern boundary confirmed contamination that exceeds the preliminary remediation goals.

- Prevention of offsite contamination migration, which may occur through the unidentified sand stringers/sand channels and other geologic heterogeneities.

- Mitigation of contaminant migration on the south, resulting from localized ground-water flow to the south, chemical diffusion, dispersion, or possible unidentified, localized seasonal changes in ground-water flow direction.

- Prevention of most clean ground water from entering the contaminated site, thus reducing the treatment cost associated with other onsite collection systems.

Modified Alternative 5 costs are different from those for Alternative 7B in the responsiveness summary because Modified Alternative 5's cost estimate was developed by EPA.

Comment

EPA should state that the present value costs calculated for the preferred alternative are greatly influenced by the financial assumptions made. EPA has assumed in its costing, as did the OUS 1 & 6 FS documents upon which EPA relies, a "real interest rate" of 5 percent over the next 30+ years (real interest meaning the difference between the discount rate and inflation).

EPA should carefully consider the aggressiveness of its financial estimates. It is unlikely that one could invest monies today and earn, after taxes, a 5 percent greater return than inflation. This point is readily apparent today, when inflation is running at approximately 4 percent per annum. EPA's financial assumptions would mean that one would have to generate a 9 percent return on investment, after taxes. If a PRP were paying 38 percent taxes, then EPA's financial assumptions would be that a PRP would have to make about a 14.5 percent pretax return on investment. Given that commercial paper in today's market is yielding only approximately 3.5 percent, EPA's aggressive financial assumptions must be questioned.

Response

EPA agrees that the present worth analysis is influenced by the assumed discount rate and timing of expenditures. However, the purpose of the present worth analysis is to compare the alternatives on a relative basis, not to determine the total PRGs cost of any remedy with a high degree of accuracy. The accuracy of the estimate for each individual remedy is subject to substantial variation since little detail is known about the specific design of each alternative. Typically, such "order-of-magnitude" estimates are expected to be no more accurate than roughly -30 to +50 percent.

In reviewing this comment, EPA performed an approximate check to assess whether or not the chosen present worth discount rate would affect the relative ranking of the alternatives on a cost basis. The method was only an approximation and used the following procedure:

1. Capital costs, annual O&M costs, and implementation times were taken from the Proposed Plan.

2. Capital costs were assumed to occur in two or three equal mounts at the end of each of two or three implementation years as given in the Proposed Plan. For example, for Alternative 2 (capital cost = $9,819,000; time to implement = 2 years), an expenditure of $4,905,500 was assumed at the end of year 1 and year 2.

3. O&M costs were assumed to occur at the end of each of 30 years succeeding the final year of implementation. For example, for Alternative 2 an expenditure of $1,816,000 was assumed to occur for 30 years, beginning at the end of year 3.

4. The present worth of the capital and O&M expenses were calculated at the beginning of year 1, then summed.

The results are presented in the attached table.

Since the flows for capital costs projected by the PRPs' consultants, HLA, were more detailed than the simple equal annual amounts used in the above procedure, the calculated present worth for 5-percent discount rates are not identical. However, they are all within 8 percent, which is well within the expected accuracy of the estimates.

A comparison of the calculated present worth for each discount rate shows that, in all cases, the relative ranking of the alternative costs remains the same.

The selection of a discount rate for present worth analysis is not intended to predict future interest rates, tax effects, or other financial factors. A present worth analysis is simply a technique to permit relative comparison of options on a cost basis. The actual cost of the selected remedy may vary depending on many factors, including design details, bidding climate, changes during construction and operation, interest rates, labor and equipment rates, inflation, tax effects, and similar items that neither EPA nor the PRPs can control.

Comment

The OUS 1 & 6 FS cost estimates are only for a duration of 30 years. It is highly unlikely that remedial action at the Site will terminate in 30 years. As EPA stated in its comments on the OUS 1 & 6 draft FS report, "the ground-water model indicates that dissolved contaminants will increase risks up to 800 years." EPA should address the length of the remedial action necessary, and state its long-term impact upon the cost.

Response

The treatment of contaminated ground water is likely to continue in perpetuity. The impact to the cost can be estimated using the same O&M and discount rate for the length of time desired. The Lowry Coalition has provided tables in Appendix H of the FS Phase 3 Report that describe how the present worth costs are derived. The PRP would need to invest less than $5,000 today to be able to fund $107,000 of O&M 63 years from now using a 5 percent discount rate. The amount needed to be invested today for O&M needed 800 years from today is negligible.

Table 13-1

Lowry Landfill, Arapahoe County, CO, Operable Units 1 and 6, Proposed Plan, Effect of Discount Rate on Cost Estimates

		PW in proposed Plan	Present Worth of Capital + O&M Costs ($000) Discount Rate (percent/annum)							
Alternative	Time to Implement (yrs)	($000)	2	4	5	6	8	10	12	14
No Action	0	0	0	0	0	0	0	0	0	0
1	0	31,000	45,976	36,706	33,220	30,301	25,748	22,423	19,932	18,021
2	2	36,000	49,959	39,284	35,314	32,008	26,881	23,152	20,357	18,203
3	3	56,000	77,916	60,188	53,653	48,237	39,898	33,883	29,409	25,984
4	3	101,000	129,512	108,969	101,205	94,652	84,260	76,420	70,296	65,362
5	3	59,000	80,859	62,872	56,232	50,725	42,231	36,088	31,505	27,985
Modified 5	3	61,000	85,074	66,712	59,921	54,281	45,562	39,235	34,495	30,840
6	3	66,000	91,181	70,988	63,533	57,347	47,803	40,898	35,744	31,782

PW = Present worth costs
O&M = Operation and maintenance

Comment

EPA's preferred alternative requires constructing collection systems at the east and west boundaries. The design life of these collection systems using extraction wells is assumed to be 4 years in the FS. If contamination requiring remediation is not anticipated at the east and west boundaries for at least 50 years, the extraction wells will need to be replaced 12.5 times before they are needed. Construction of the collection systems at this time is certainly not cost-effective.

Response

The FS assumes 25 percent of the wells would be replaced every 4 years, therefore the design life of any one well could be as little as 4 years and as much as 16 years. Most current wells at the Site are about 10 years old and do not require abandonment and replacement. Based upon the January 1993 Compliance Boundary Sampling event, there is confirmed contamination in B301A and B216A at the western boundary of the Site. Therefore containments have migrated to the compliance boundary and remediation is required.

Comment

EPA's preferred alternative shows a new ground-water treatment facility, the purpose of which is to treat high-concentration fluids extracted from the ground-water collection system at the northern toe of the existing Section 6 landfill mass. While treatment of fluids from this extraction system will be necessary, it may be possible to adequately treat these fluids at the existing upgraded treatment plant, or to modify the plant. EPA should not require a new treatment plant, but rather should allow the need for a new treatment plant versus the existing plant (or modification thereof) to be fully evaluated during remedial design.

Response

The selected sitewide remedy must meet the performance standards, including ARARs. Whether this is achievable via modification of the existing plant, or whether a new plant must be constructed, will be determined by EPA during RD.

Comment

EPA has chosen modified Alternative No. 5, in part, because of its increased reduction of contaminants over other alternatives. However, modified Alternative No. 5 represents a doubling of the 30-year present worth costs over the No Further Action Alternative. The cost/benefit of this doubling should be weighted against the fact that nearly 80 percent of the contaminants of concern will remain in the subsurface after 30 years (calculated by multiplying the mean concentration of COC in the weathered system, as reported in the OUS 1 & 6 final RI report, by the volume of contaminated ground water, then dividing by the anticipated rate of COC removal rate of 700 pounds per year).

Response

EPA's selection of Modified Alternative No. 5 shows EPA's commitment to prevent migration offsite while simultaneously treating to the maximum extent practicable and still be cost-effective.

Comment

In its Responsiveness Summary on the draft FS report, HLA indicated that the south boundary system will intercept about 21,000 gallons of ground water per year. HLA also calculated in the RI report that the Site contains in excess of 900 million gallons of contaminated liquids. Preventing 0.002 percent of the contaminated ground-water volume to flow into the Site seems insignificant when compared to the total volume of contaminated ground water at the Site. EPA should provide a cost/benefit analysis of the southern barrier.

Response

EPA believes that the estimated 21,000 gallons of ground water per year expected to be intercepted by the south boundary system will constitute substantially more than 0.002 percent of the contaminated water at the Site since the 900 million gallons of contaminated liquids will not all be extracted within a year. As discussed earlier, south boundary water interception is one of many benefits of the south boundary system.

The benefits derived from the upgradient system at an additional estimated cost of $2 million are as follows:

- Enhanced isolation of site contaminants. January 1993 sample results along the southern boundary confirmed contamination that exceeds the preliminary remediation goals.

- Prevention of offsite contamination migration, which may occur through the unidentified sand stringers/sand channels and other geologic heterogeneities.

- Mitigation of contaminant migration on the south, resulting from localized ground-water flow to the south, chemical diffusion, dispersion, or possible unidentified, localized seasonal changes in ground-water flow direction.

- Prevention of most clean ground water from entering the contaminated site, thus reducing the treatment cost associated with other onsite collection systems.

13.2.10 EPA Response to Comments from Wilbur A. Young

Comment

The commentor expressed a concern over the PRPs' commitment to protecting the environment.

Response

Many PRPs at the Lowry site have been responsive in answering questions regarding the types and amount of waste materials deposited at the Lowry Site in their 104(e) responses. In addition, certain PRPs have performed RI/FSs at the Site, and have implemented interim remedial measures such as the installation of the barrier wall and construction of a ground-water treatment facility to stop northward migration of contaminants.

Comment

The commentor also expressed a concern over the potential risks to human health and the environment posed by the Site.

Response

A risk assessment was performed to assess potential human health problems, and an ecological risk assessment was conducted to assess potential adverse effects on wildlife and plants. The cleanup strategy is protective of human health and the environment. The remedial investigation describes the fate and transport of chemicals at the Site, including degradation products. The risk assessment, which is based on results of the Remedial Investigation, addressed both cancer risks and adverse chronic health effects from chemicals at the Lowry Site.

Comment

The commentor expressed concern over the PRPs' commitment to environmental regulations and laws.

Response

See response to first comment, above.

Comment

The commentor was concerned about individuals coming forth to provide the government additional information about dumping at Lowry.

Response

EPA has received information, both official (as in the 104(e) responses) and unofficial (such as anonymous reports of dumping).

Comment

The commentor stated that Modified Alternative 5 is the best alternative based on cost.

Response

EPA acknowledges support of the preferred remedial alternative for OUS 1 & 6 as expressed in the Proposed Plan.

Section 14.0
Responsiveness Summary for Operable Units 2 & 3 and 4 & 5

This section presents the oral and written responses to comments from EPA to individuals, concerned citizen groups, and public entities who have commented on the Proposed Plan for OUS 2, 3, 4, and 5. Comments are expressed in italics; their responses in plain text.

14.1 Response to Oral Comments Proposed Plan Public Meeting Lowry Landfill Solids/Gas Operable Units (OUs 2&3) and Soils/Surface Water and Sediments Operable Units (OUS 4&5) September 21, 1993

The following is a summary of citizens' comments received at the September 21, 1993 Proposed Plan Public Meeting for OUS 2, 3, 4, and 5. The responses given at the public meeting are also listed, and in some circumstances have been expanded for a more detailed explanation.

1. Comment

How much of the capital costs for cleanup have already been incurred for such items as the Surface Water Removal Action?

Response

The costs of the interim measures including the Surface Water Removal Action, the ground-water barrier wall and treatment facility, and the tire shredding operation, have already been expended and are not included in the total capital costs for the various remedial alternatives.

The approximate cost of the Surface Water Removal Action was 1.5 million dollars. The approximate cost of the shredding operation was 2.3 million dollars.

2. Comment

Who is in charge of maintenance for the first 30 years and what happens after 30 years? Does EPA walk away ?

Response

Maintenance of the site for the first thirty years, and thereafter, is the responsibility of the Potentially Responsible Parties (PRPs) that sign up to implement the remedies under the supervision of EPA and the Colorado Department of Health. EPA often uses a standard period of 30 years to estimate operation and maintenance costs, so that comparisons can be made between alternatives and between all Superfund sites. For Lowry Landfill, the lifespan of the sitewide remedy may very well exceed 30 years.

3. Comment

Why aren't all the responsible parties being held accountable for the cost of paying for cleanup at Lowry? Who will pay for the cleanup?

Response

Under Section 107 of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended (CERCLA), current owners and operators, past owners or operators, transporters and/or generators are liable for cleanup costs incurred by the United States or a State at a Superfund site. EPA considers each of these Potentially Responsible Parties (PRPs) to be jointly and severally liable for the costs of cleanup at the Lowry Landfill site.

The City and County of Denver (Denver), Waste Management of Colorado, Inc. (WMC), and Chemical Waste Management, Inc. (CWM) have negotiated private settlement agreements with many of the other PRPs at the site. Although the terms of those settlements have not yet been made available to EPA, Denver and WMC/CWM have indicated that they intend to perform the cleanup of the site and use monies collected under the private settlement agreements to reimburse the United States for past and future response costs incurred at the site.

4. Comment

How much of an excavational alternative was considered? Does the excavation alternative include all six operable units? The reason it wasn't financially viable in part was because Waste Management put six years of trash on top of the Superfund site?

Response

Excavation of the Lowry Landfill was evaluated in a Technical Memorandum, Preliminary Identification of Remedial Alternatives, dated April 15, 1988. At that time, it was determined that it was not financially viable or practical to excavate the entire site. In addition to ground-water treatment, the excavation alternative included excavating the entire site, incinerating the solids and soils onsite, and disposing of the incinerated ash offsite. Estimated total capital and operation and maintenance costs for the excavation alternative would exceed $4.5 billion. Additionally, the volume of ash would be on the order of 40 percent of the incinerated material. Disposal of the ash would take over 19 years with a dump truck full of ash leaving every half hour, every day of the year. Onsite worker exposure to hazardous materials was also determined to be a high safety risk. The excavation analysis that was performed applies to the entire site, and therefore to all six operable units in combination.

The proposed excavation for the former tire pile area does not address all six operable units; it only addresses a portion of operable unit 2 (landfill solids).

The additional trash placed on the landfill from the time that it became a Superfund site (September 1984) to the last time trash was placed on the site (August 1990) was taken into consideration during EPA's evaluation of cleanup proposals. EPA does not endorse the proposal to place an additional 1.2 million cubic yards of municipal solid waste on the Lowry Site, as has been proposed by Waste Management of Colorado, Inc.

5. Comment

How does the ground-water treatment system work?

Response

Contaminated ground water is collected at the barrier wall and pumped to the onsite treatment facility. At this facility, ground water is first processed through an airstripper. As the contaminated ground water passes through the airstripper, contaminants volatilize (turn into a gaseous phase) and are removed from the water. These volatilized contaminants are then collected on granular activated carbon. The liquid that flows out of the airstripper is sent through a series of granular activated carbon units for additional treatment. The treated water is injected into the shallow ground-water system downgradient of the barrier wall.

If the collected ground water is observed to exceed concentrations above federal and state standards, a contingency plan for ground-water treatment will be implemented. The contingency plan includes a bioreactor and an ion exchange unit to remove ketones and metals/radionuclides, respectively, from the collected ground water.

6. Comment

Will new wetlands be constructed?

Response

During the Remedial Investigation for Operable Units 1 and 6, wetlands were identified in the former Unnamed Creek drainage. As a result of the construction of the Surface Water Removal Action, these wetlands were eliminated. New wetland habitats (0.87 acres) will be constructed to replace the wetlands that were lost. The final location of the wetlands will be specified during the Remedial Design phase.

7. Comment

What types of contaminants were found in the water?

Response

For this response, it is assumed that the commentor was referring to ground water at the site. A list of chemicals found in ground water, and their reported concentrations in the ground water at the site, is provided in Table 14-1.

8. Comment

Would vitrification be a viable cleanup alternative for the Lowry Site?

Response

No. Vitrification is a process in which electric probes are inserted into contaminated soils. The targeted material is electrified to the point that it melts and then solidifies as a "glass," rendering the contaminants immobile. Because of the presence of methane and other gases in the Lowry Landfill, the electric current used in the vitrification process could result in explosions or fires. Also, the composition of the landfill mass varies significantly (trash, garbage, liquids, etc.) and makes it unsuitable for heating, melting, and solidification.

9. Comment

In the cancer risk assessment for sediments, it appears that the risk is higher north in Murphy Creek than in Section 6. Why?

Response

First, it should be noted that the area identified as "north in Murphy Creek" is in fact within Section 31. Two factors contribute to the higher future risk estimates identified for the sediments in Section 31. First, the land use scenarios employed for Section 6 were different than for Section 31. To assess the potential risks, a combined residential/recreational scenario was used for Section 31, while a recreational only scenario was used for Section 6. This approach was based on the assumption that there would likely be restrictions on residential land use for Section 6.

For Section 31 sediments, ingestion and inhalation exposures were calculated for both future offsite residents (children and adults) and offsite recreational users. Risk assessment calculations for the sediments in Section 6 were estimated based on ingestion exposures to future onsite recreational users (children and adults) only. In estimating potential health risks, exposure periods and contact times are typically higher for residential scenarios than for recreational scenarios. Consequently, calculated health risks may be expected to be higher for calculations in which a residential scenario is used.

Second, the contaminants identified in Section 6 sediments differed, in some cases, from those identified in Section 31 sediments. The contaminants that contributed the highest proportion of the estimated risk (from ingestion) for Section 6 sediments included arsenic, beryllium, and antimony. For Section 31 sediments, the contaminants that contributed the greatest proportion of estimated risk (from ingestion and inhalation) included arsenic, dioxins, chromium, beryllium, manganese, and vanadium. Several of the contaminants in Section 31 sediments possess relatively greater chronic toxicity characteristics than those contaminants found in Section 6 sediments. As a result, the calculations resulted in a higher relative risk estimate. The observed concentrations, and resulting risk calculations, were similar to those for background (naturally occurring) sample concentrations.

10. Comment

Are any of the pollutants in the landfill recyclable, like the methane ?

Response

Heat recovery from flaring of methane gas in the landfill was analyzed in the Feasibility Study for OUS 2&3. However, it was determined that since the landfill is physically distanced from any potential heat users, it would not be financially viable to extract the gas at this time. Additionally, there are individual contaminants such as vinyl chloride in the methane which would have to be removed before the methane could be used for beneficial purposes. At this time, no other pollutants in the landfill are believed to be recyclable.

11. Comment

It seems that a combination of land use restrictions/acquisitions and excavation of the landfill in the areas where it would be effective, would be the best possible solution.

Response

The comment is noted by EPA. While EPA's preference is to implement a cleanup approach that does not rely on offsite institutional controls such as land use restrictions, restricting landuse around the site would add an extra measure of protection to the general public.

12. Comment

What is done with the asbestos?

Response

Asbestos is disposed of in the asbestos pit, which is located in the northwest portion of Section 6. Asbestos must enter the landfill in sealed containers or double bags, and is buried and covered on a daily basis. This asbestos disposal operation is regulated by the Colorado Department of Health.

13. Comment

What are the costs in addition to the $ 97 million?

Response

The Present Worth Cost estimate of $97,510,000 is for design, construction, and implementation of the Selected Sitewide Remedy. In performing calculations for engineering cost estimates, factors of -30 percent and +50 percent are typically included to account for unforeseen aspects of a project. Therefore the total cost of cleanup may range from $68,257,000 to $146,265,000.

The additional costs that have been incurred in connection with the site are approximately $60 to $70 million (this range represents a further refinement from that which was provided at the public meeting). These costs include, but are not limited to: EPA past costs (including Phase I & II studies, the Baseline Risk Assessment, oversight); and costs incurred by potentially responsible parties (PRPs) during implementation of interim remedial measures and the remedial investigations and feasibility studies. In many cases, because PRPs were not legally required to supply EPA with records of their expenditures, costs incurred by those parties could only be estimated.

14. Comment

What are the discount rates and inflation rates used to determine the present worth on the cleanup costs?

Response

The real net discount rate used for cost estimating purposes is 5 percent. This rate assumes the difference between the discount rate and inflation is 5 percent. This is the standard rate recommended by EPA for estimating present worth remediation costs.

15. Comment

Who was the largest polluter at the Lowry Site ?

Response

The Adolph Coors Company is estimated to have disposed of the largest volume of waste, approximately 32 million gallons. The Lowry Landfill Waste-In List (dated April 17, 1992), which is a listing of generators, transporters, owners, and operators for the Lowry Landfill Superfund Site, may be obtained from the EPA Superfund Records Center.

16. Comment

What happens at the 5-year review? Has EPA ever ordered additional remediation at a site as a result of the 5-year review?

Response

CERCLA Section 121(c) mandates that EPA review remedial actions which result in any hazardous substances, pollutants, or contaminants remaining at a Superfund site, no less often that each five years after the initiation of the remedial action. This requirement assures that human health and the environment are being protected by the remedial action being implemented. EPA will continue the reviews until no hazardous substances, pollutants, or contaminants remain at the Lowry Site above the remediation levels that allow for unrestricted use and unlimited exposure. Since protectiveness at the Lowry Site will be assured through containment and onsite institutional controls, the review will focus on the effectiveness of these measures. In addition, because the sitewide remedy contains a long-term remedial action, the review will also evaluate the effectiveness and performance of the technologies used in the remedy. The review will examine information such as monitoring data, applicable or relevant and appropriate requirements, remediation levels, and new information or considerations relevant to an assessment of protectiveness.

To date, there have been two 5-year reviews conducted for sites in EPA Region VIII: Chemical Sales Company Superfund Site; and Rose Park Sludge Pit Superfund Site. Both of these reviews concluded that human health and the environment are being protected by the remedial actions being implemented. However one of the reviews recommended that additional institutional controls, in the form of deed restrictions, be implemented.

For further information on 5-year reviews conducted in other EPA regions, please contact:

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Response to Specific Oral Comments from The City and County of Denver (Denver), Waste Management of Colorado, Inc. (WMC), and Chemical Waste Management, Inc. (CWM)

Landfill Solids

1. Comment

The Feasibility Study (FS) fully evaluated waste pit removal and did not recommend it because of health and safety concerns. Specifically, this remedy would create potential for high level risk to workers during excavation and removal of those materials.

Response

The Feasibility Study (FS) for the landfill solids operable unit (OU2) did not identify health and safety concerns as a major issue for waste pit removal. The FS for OU2 did discuss short-term effectiveness for worker protection. The FS also presented air modeling results, which were used to quantify worst-case potential and actual risk scenarios. These scenarios modeled volatile organic compound (VOC) releases resulting from excavation work in the former tire pile area. Under the assumption that all of the emissions were pure vinyl chloride and that a worker was exposed continually without protective wear, the lifetime excess cancer risk was estimated to be 2 x 10-5. This value is within the acceptable cancer risk range established for Superfund sites.

For further discussion on this issue, the reader is referred to the response to Written Comment 20 from Denver/WMC/CWM.

2. Comment

The only existing exposure pathways are through direct contact. The direct contact at this time is precluded because these materials are separated from the surface by an engineered drainage system.

Response

For a discussion on this issue, the reader is referred to the response to Written Comment 23 from Denver/WMC/CWM.

3. Comment

Any hopes of recovering drums of liquids to be shipped offsite and of finding perched liquids in old waste pits are probably misplaced.

Response

For a discussion on this issue, the reader is referred to the response to Written Comment 21 from Denver/WMC/CWM.

4. Comment

A remedy to collect and treat any releases from these drums and waste pits is now in place and has been operating for the last 10 years.

Response

To the extent that the commentor was referring to the barrier wall and treatment plant, it must first be noted that these facilities have been in operation for less than ten years. It is true that the these facilities, combined with the Surface Water Removal Action collection system, are intended to prevent offsite migration of contaminated ground water. These systems by themselves do not provide the degree of protection that is afforded by addressing source areas or that is warranted by the site risks. The intent of the preferred alternative for OU2 is to eliminate or reduce the source of the contamination by excavating drums, drum contents, and contaminated soils.

For further discussion on this issue, the reader is referred to the response to Written Comment 22 from Denver/WMC/CWM.

5. Comment

WMC/Denver are concerned during construction about the potential for a significant ground water recharge event from ponding that may occur during excavation that would carry any contaminants that might be found down into ground water.

Response

For a discussion on this issue, the reader is referred to the response to Written Comment 24 from Denver/WMC/CWM.

6. Comment

WMC/Denver are concerned that this selected remedy does not comply with EPA's Landfill Guidance.

Response

For a discussion on this issue, the reader is referred to the response to Written Comment 25 from Denver/WMC/CWM

7. Comment

The capping alternative fully complies with all laws and guidance and would create no short-term or long-term health risk. The FS recommended improving the cover over the landfill by adding more municipal solid waste (MSW) to increase the slope of the cover. The additional solid waste will add a very small increment of mass to the waste now in place.

Response

For a discussion on this issue, the refer is referred to the response to Written Comment 33 from Denver/WMC/CWM.

In addition, the community and local governmental entities oppose Alternative 7 for OU2. Community acceptance is one of the nine evaluation criteria to be evaluated in the alternative selection process.

The proposed volume of additional MSW (1.2 million cubic yards) represents approximately 10 percent of the waste in place. To the extent that the landfill cap requires repairs, there are a variety of other engineering options that will be evaluated during RD, for example, to minimize any existing surface drainage problems.

Landfill Gas

8. Comment

WMC/Denver strongly believe the staged approach is the most protective of human health and the environment.

Response

For a discussion on this issue, the reader is referred to the response to Written Comment 34 from Denver/WMC/CWM.

9. Comment

Denver/WMC/CWM are concerned about the specificity in the Proposed Plan for OUS 2, 3, 4, and 5 (i.e., number of wells).

Response

For a discussion on this issue, the reader is referred to the response to Written Comment 35 from Denver/WMC/CWM.

10. Comment

WMC/Denver believe that the preferred alternative for OU3 would cause undue delay in the collection and treatment of gas at the site.

Response

For a discussion on this issue, the reader is referred to the response to Written Comment 34 from Denver/WMC/CWM.

11. Comment

The Proposed Plan for OUS 2, 3, 4, and 5 unnecessarily modifies Landfill Gas Alternative 3, as presented in the FS for OU3.

Response

For a discussion on this issue, the reader is referred to the response to Written Comment 34 from Denver/WMC/CWM.

12. Comment

The Proposed Plan for OUS 2, 3, 4, and 5 unfairly compares the preferred alternative for OU3 to Stage 1 of the Landfill Gas Alternative 3, as presented in the FS for OU3.

Response

For a discussion on this issue, the reader is referred to the response to Written Comment 34 from Denver/WMC/CWM.

13. Comment

The landfill Gas Alternative 3 and proposed permanent land use restrictions provide a superior remedy.

Response

For a discussion on this issue, the reader is referred to the response to Written Comment 36 from Denver/WMC/CWM.

14.2 Response to Written Comments Proposed Plan Lowry Landfill Solids/Gas Operable Units (OUS 2&3) and Soils/Surface Water and Sediments Operable Units (OUS 4&5)

The following comments were offered in relation to the Proposed Plan for Operable Units (OUS) 2&3 and 4&5. EPA has taken into consideration that the comments may pertain equally or in greater degree to the selected remedy or to the Proposed Plan for OUS 1&6, although the comments were not specifically offered in connection with the Proposed Plan for OUS 1&6.

14.2.1 Response to Written Comments Hadden and Bonnie Robinson

1. Comment

The commentors expressed concern that the contents of the Lowry Landfill are unknown.

Response

Characterization of the waste types disposed at Lowry Landfill was performed during the remedial investigations of all six operable units. These investigations included the evaluation of landfill operator and other waste disposal records, as well as the performance of field studies. Over 2,000 samples of ground and surface water, soils, air, and gas were collected and analyzed. The lists of the chemicals detected at the site may be found in the remedial investigation reports for each of the operable units.

In general, the types of wastes disposed of at the Lowry Site prior to 1980 include such materials as acid and alkaline sludges, caustics, brines, oils, greases, solvents, laboratory wastes, construction debris, and municipal solid waste. Although it is true that a landfill such as Lowry can contain substances not yet identified, the cleanup plan is designed to keep all contaminants onsite.

2. Comment

The commentors would like the Lowry Site to be cleaned up soon.

Response

EPA supports the commmenters' recommendation for expeditious cleanup. EPA has recognized for several years the slow pace of Superfund cleanups and has taken actions to expedite the process, including early actions to achieve stabilization of immediate problems.

Initial efforts to clean up the Lowry Site began in 1983 with the construction of the ground-water barrier wall and treatment plant. These facilities prevent offsite migration of contaminated shallow ground water within the alluvium of unnamed creek. Most recently, contaminated seeps in unnamed creek were removed through the construction of the Surface Water Removal Action (SWRA) collection system. The selection of the cleanup remedy for the Lowry site has now been completed by the issuance of this Record of Decision (ROD). Following the ROD, Remedial Design (RD) activities for the overall sitewide remedy may proceed. It is anticipated that design of the cleanup will begin in the summer of 1994 and that construction of the remedy may commence as early as the fall of 1995.

3. Comment

The commentors would like to see legislation that would prohibit expensive hazards like the Lowry Site from ever occurring again.

Response

In 1976, Congress enacted the Resource Conservation and Recovery Act (RCRA). This law became effective in 1980 and requires hazardous waste to be treated, stored, and disposed of in such a manner as to minimize the present and future threat to human health and the environment. Hazardous waste disposal was discontinued at the Lowry Site in response to this law. RCRA was significantly amended by the Hazardous and Solid Waste Amendments of 1984 (HSWA). To date, there are over 500,000 companies and individuals that must comply with RCRA. If the RCRA program is effectively implemented, there should be no new Lowry Landfill-type problems.

<u>14.2.2 Response to Written Comments Wilbur Young, November 1, 1993 Letter</u>

1. Comment

The commentor is concerned that the responsible parties have not been held liable for the cleanup of the Lowry Site.

Response

Under Section 107 of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended (CERCLA), current owners and operators, past owners or operators, transporters and/or generators are liable for cleanup costs incurred by the United States or a State at a Superfund site. EPA considers each of these Potentially Responsible Parties (PRPs) to be jointly and severally liable for the costs of cleanup at the Lowry Site. For a more detailed discussion of cost recovery efforts involving liable parties, please see the Record of Decision.

The City and County of Denver (Denver), Waste Management of Colorado, Inc. (WMC), and Chemical Waste Management, Inc. (CWM) have indicated that they intend to perform the cleanup of the site and use monies collected under private settlement agreements to reimburse the United States for past and future response costs incurred at the Lowry Site.

2. Comment

The commentor is concerned that too much time has been spent on studies and that action needs to be taken soon.

Response

EPA acknowledges that the studies have taken a considerable amount of time to complete. Initial site studies began in the early 1980s and were completed in early 1993. Studies at the Lowry Site have involved the collection of over 2,000 samples of environmental media. Adequate characterization of the nature and extent of contamination is an essential step in a process that concludes with selection of the most appropriate cleanup approach. Initial actions have been implemented, concurrent with these characterization activities, to prevent offsite releases.

3. Comment

The commentor expressed the belief that complete excavation and disposal should be considered.

Response

Excavation of the Lowry Site was evaluated in 1988 and it was determined that it was not financially viable or practical to excavate the entire site. The costs for excavation, incineration, and ash disposal were estimated to exceed $4.5 billion. Additionally, the volume of ash would be about 40 percent of the incinerated material. Disposal of the ash would take over 19 years with a dump track full of ash leaving every half hour, every day of the year (refer to Final Draft Technical Memorandum, Preliminary Identification of Remedial Alternatives, Lowry Landfill Phase II RI/FS).

4. Comment

The commentor expressed the belief that the problems should first be stopped at the Lowry Site, then studied.

Response

The most immediate threats to human health and the environment at the Lowry Site have already been addressed through implementation of interim cleanup actions. These interim cleanup actions are described in the proposed plans and ROD. Such actions allow EPA to address the more immediate dangers that might affect human health and the environment while studies are being performed.

5. Comment

The commentor would like to see that the best possible plan is achieved for the taxpayers.

Response

To obtain the best possible plan, EPA uses the following nine evaluation criteria: overall protection of human health and the environment; compliance with applicable or relevant and appropriate requirements (ARARs); long-term effectiveness and permanence; reduction of toxicity, mobility, or volume through treatment; short-term effectiveness; cost; implementability; state acceptance; and community acceptance.

The selected remedy will protect human health and the environment, meet ARARs, and offers the best balance of tradeoffs among all nine evaluation criteria. This includes the cost-effectiveness criterion because the selected sitewide remedy provides long-term effectiveness and permanence through: collection/treatment of landfill gas; removal/treatment of contaminated material from the former tire pile area; and containment, collection, and treatment of contaminated ground water.

14.2.3 Response to Written Comments East Cherry Creek Valley Water and Sanitation District (ECCV)

1. Comment

The commentor believes that there are interactions between media, and that cleanup actions for the landfill solids and gas can have a positive impact on ground-water quality. Furthermore, the commentor stated that gas migration from the Lowry Site has the potential of impacting offsite wells, pipelines, pump stations, and other infrastructures owned and maintained by the ECCV.

Response

EPA agrees that interactions may occur between different contaminated media at the Lowry Site and that cleanup actions for one medium may improve the quality of other media. Prevention of offsite gas migration will eliminate the potential contamination of offsite subsurface soils and may reduce the potential adverse impacts to ground water. In addition, the removal and treatment of an estimated 80,000 pounds of volatile organic compounds (VOCs) per year through the gas extraction/treatment system will further benefit the ground-water system through contaminant source reduction.

The uncontrolled migration of gas has the potential to impact infrastructures in the vicinity of the Lowry Site. Modified Alternative 3 (Gas Collection/Enclosure Flare) was specifically selected to address this problem through containment, collection, and treatment. This alternative will prevent the offsite migration of gas.

2. Comment

Although the commentor would prefer to see more of the contaminated landfill solids treated and/or removed, the commentor understands the difficulties in accessing much of this material. The commentor feels that the removal of the accessible drums and contaminated soils in the tire pile area will significantly assist in achieving the National Contingency Plan (NCP) cleanup criteria that call for long-term effectiveness of the measures taken, and for reduction of toxicity and volume of waste. The commentor ardently supports this component of the proposed plan.

Response

EPA acknowledges ECCV's support for the OU2 (landfill solids) selected remedy. The selected remedy achieves long-term effectiveness and permanence, as stated. The selected remedy is also consistent with EPA's Guidance for Conducting Remedial Investigations/Feasibility Studies for CERCLA Municipal Landfill Sites. This guidance recognizes that containment is generally the most appropriate response action because of the large volume and heterogeneity of the waste typically found within a landfill mass.

This guidance also supports "hot-spot" removal where wastes are accessible, to achieve a decrease in the risk posed to human health or the environment.

3. Comment

The commentor is opposed to adding municipal solid waste on top of the former landfill as a means of drainage control.

Response

EPA and CDH agree that municipal solid waste (MSW) should not be added to the former landfill mass. CDH considers the former landfill to be closed and adding additional MSW to a closed MSW landfill would not be consistent with the intent of the new Subtitle D requirements. In addition, there are other engineering options that would be equally effective in ensuring acceptable drainage control and that would not also add additional solid waste mass to the Site.

4. Comment

The commentor noted that Waste Management of Colorado, Inc. (WMC) and the City and County of Denver (Denver) are currently in the process of optioning, or purchasing, all of the land and water rights within a ½ mile buffer around the Lowry Site. The commentor asked that EPA conduct an evaluation of the impact of this type of institutional control (land acquisition) since it may be undertaken as part of a potential cleanup strategy by WMC and Denver.

Response

At the public meeting on September 21, 1993, and in written comments on the proposed plan for OUS 2, 3, 4, and 5, Denver and WMC indicated that they are considering the purchase of property surrounding the Lowry Site. However, EPA has not been included in any negotiations regarding options or purchase of land and water rights by Denver and WMC. Offsite land use restrictions will provide an additional measure of protection against exposure of human populations to contamination, would be important in the future if additional measures are determined to be necessary under a contingency plan, and may be necessary to ensure the integrity of the remedy.

5. Comment

The commentor believes that no contamination should be allowed to migrate offsite. Furthermore, the commentor believes that offsite standards should include the non-degradation of the ground water and soil, rather than allowing contamination to migrate offsite until Applicable or Relevant and Appropriate Requirements (ARARs) are reached.

Response

The selected sitewide remedy is designed to prevent the offsite migration of contaminants and thus offsite aquifer degradation. The selected sitewide remedy must ensure that ARARs and other risk-based cleanup levels are achieved at the compliance boundaries. CERCLA does not require clean up to zero levels or to below background concentrations where MCLs and other ARARs provide numerical cleanup concentrations that are based on acceptable risk. However, each component of the selected sitewide remedy includes contingency measures to address offsite migration of contaminants.

In selecting a remedy, there are two threshold criteria: protection of human health and the environment; and attainment of ARARs. EPA has set the acceptable risk range for cancer incidents at Superfund sites at 1 x 10-4 (1 in 10,000) to 1 x 10-6 (1 in 1,000,000).

However, at the Lowry Site, there may be cumulative risks posed by the potential additivity of multiple contaminants or multiple pathways of exposure. Therefore, circumstances at the Lowry Site require that the 1 x 10-6 risk level be applied for evaluating individual contaminants to ensure that the cumulative risk does not exceed 1 x 10-4, thereby ensuring the protectiveness of the remedy.

6. Comment

The commentor asked what actions will be taken if chemical standards for ground water change at some future date, and if the contamination spreads beyond the current site boundaries.

Response

Chemical cleanup standards, or ARARs, are "frozen" at the time of the ROD. If new information is obtained or if a regulation changes such that EPA determines the remedy is no longer protective, the ROD would be amended to incorporate the new standard.

The performance standards will be re-evaluated at a minimum of every 5 years to ensure that the remedy remains protective of human health and the environment. However, if at any time contamination is detected above the ARARs (and other performance standards) selected in the Record of Decision, appropriate action will be taken to achieve the ARAR and to prevent the spread of contamination.

Appropriate action would include implementation of contingency measures that are included in the selected sitewide remedy. These contingency measures would not only prevent further contamination from occurring, but would also treat the contamination until ARARs and risk-based concentration limits are achieved and maintained at and beyond the Compliance Boundaries.

Offsite institutional controls would further facilitate implementation of additional measures if standards change in the future or if contingency plans must be implemented.

7. Comment

The commentor believes that the creation of a ½-mile buffer will allow the spread of low-level contamination.

Response

EPA agrees that creation of a ½-mile "buffer zone", as proposed by Denver and WMC/CWM, without the treatment and containment components of the selected sitewide remedy, would allow offsite migration of contaminants to occur prior to initiation of active measures to address the contamination problems.

On the other hand, EPA's selected sitewide remedy is designed to prevent offsite contaminant migration and will not allow the spread of low-level contamination. The selected remedy does not rely on offsite land acquisition and does not place primary reliance on other offsite institutional controls to accomplish its objectives. While the selected remedy is not dependent on offsite institutional controls as a primary element, offsite land use restrictions will provide an additional measure of protection and would allow for contingency plans to be implemented should they become necessary. Performance standards will not be exceeded beyond the ground-water compliance boundary.

See responses to Comments 4, 5, and 6 for additional information. Also see responses to Comments 2 and 5 through 11 under Denver and WMC/CWM.

8. Comment

The commentor believes that the extraction component of the gas extraction system is significant, and that the focus of OU3 should not be placed strictly on the control of gas but also on the extraction of contaminants and removal of wastes through the gas extraction system. By adding Stage 3 now, the commentor feels that for an additional 5 percent increase in the cost of sitewide remedy there would be a significant increase in the annual volume of contaminants removed at the Lowry Site. The commentor believes this is a good return on a relatively small increase in cleanup costs.

Response

For the selected remedy, Stage 3 is considered to be a contingency measure. EPA agrees that Stage 3 (interior well network) gas extraction would remove more volatile organic compounds (VOCs). However, at this time, it is not considered necessary for achieving the performance standards. Stage 3 will be implemented if the perimeter gas extraction system (Stage 2) does not meet the performance standards.

EPA's overall objectives for Operable Unit 3 (landfill gas) are to:

- Prevent offsite migration of landfill gas; and

- Protect human health and the environment from inhalation of landfill gas and explosion hazards;

The selected remedy will achieve these objectives because it contains, collects, and treats a significant amount of landfill gas. Also, the selected sitewide remedy is consistent with EPA's Guidance for Conducting Remedial Investigations/Feasibility Studies for CERCLA Municipal Landfill Sites.

9. Comment

The commentor supports the implementation of contaminant removal activities through the removal of drums and contaminated soil in the former tire pile area.

Response

EPA acknowledges the support for the removal, treatment, and disposal of drums, drum contents, and contaminated soils.

<u>14.2.4 Response to Written Comments Wilbur Young, November 5, 1993 Letter</u>

1. Comment

The commentor asked whether reverse osmosis technology could be used as a treatment technology at the Lowry Site, and if it might be less expensive.

Response

Reverse osmosis has been used in many applications for removing contaminants from liquids, including ground water and industrial wastes. In general, reverse osmosis is most effective for removing inorganic materials including metals, and least effective for removing organic contaminants such as pesticides and industrial chemicals. In fact, there are some organic chemicals that are capable of destroying reverse osmosis membranes. It is for this reason that reverse osmosis was not chosen as a possible cleanup alternative for the Lowry Site. In addition to the incompatibility of organic chemicals with membrane material, reverse osmosis is subject to two additional disadvantages. First, capital and operating costs are typically higher for reverse osmosis systems than for other technologies. Second, reverse osmosis produces a leftover or "dirty water" stream that must be properly disposed of. This stream contains all of the contaminants that do not pass through the membrane and will be 25 to 50 percent of the original untreated volume. Reverse osmosis does not result in a resin or other solid waste that may be disposed of or processed for reclaiming.

2. Comment

The commentor believes the general health of society would improve and industry would benefit from cleaning up waterways.

Response

The selected sitewide remedy, which includes the Surface Water Removal Action, will be protective of human health and the environment. All aspects of the sitewide remedy will be monitored for effectiveness to ensure that cleanup standards are met.

<u>14.2.5 Response to Written Comments City of Aurora</u>

1. Comment

The commentor endorses EPA's Proposed Plan for OUS 2, 3, 4, and 5 and accepts the need for a containment-based remedy. The commentor supports the proposal to concurrently install Stages 1 and 2 of the gas collection system, and endorses the plan to excavate the buried drums, unsaturated waste pits, and contaminated soils in the former tire pile area. The commentor feels that these aspects of the sitewide remedy are a reasonable attempt to address long term risk by reducing the source of contamination. The commentor is opposed to additional municipal solid waste being placed over the former disposal areas in

Section 6. Finally, the commentor is in favor of retaining for continued use, any monitoring wells that may have future utility.

Response

EPA acknowledges the commentor's support of the selected remedies for landfill solids and gas. EPA and CDH agree that additional municipal solid waste should not be added to the former landfill mass. A more complete discussion of the proposal by Denver and WMC/CWM and EPA's analysis may be found in the response to Comments 12 and 33 for Denver and WMC/CWM.

EPA also agrees that many of the monitoring wells may have future utility and may be necessary to monitor the effectiveness of the sitewide remedy. These wells will not be abandoned without a detailed evaluation of their potential use.

14.2.6 Response to Written Comments City and County of Denver (Denver) Waste Management of Colorado, Inc. (WMC) Chemical Waste Management, Inc. (CWM)

The following comments were offered in relation to the Proposed Plan for Operable Units (OUS) 2&3 and 4&5. EPA has taken into consideration that the comments may pertain equally or in greater degree to the selected sitewide remedy or to the Proposed Plan for OUS l&6, although the comments were not specifically offered in connection with the Proposed Plan for OUS 1&6.

On- and Offsite Land Use and Access Controls

1. Comment

The commentors asserted that the comments represent the collective views of over 140 generator, transporter, operator, and owner potentially responsible parties (PRPs) at the Lowry Site.

Response

Due to the lack of documentation regarding the private settlements between PRPs, EPA is unable to verify the accuracy of this statement. Nevertheless, EPA has given the comments due consideration.

2. Comment

The commentors stated that through or on behalf of the Lowry Landfill Superfund Trusts,[1] the commentors are prepared to acquire property and water rights surrounding Section 6 of the Lowry Site, to at least ½ mile of the Lowry Site, and to then place permanent land and ground-water use and access controls on these properties in order to augment the protectiveness of the remedy. (Also refer to similar comments submitted by the commentors, as documented in the summary of oral comments submitted by the commentors during a meeting with EPA, held on October 22, 1993; and oral comments by the same commentors, as presented in the Transcript of the Public Meeting on OUS 2&3 and 4&5, held on September 21, 1993.)

In the offsite areas, the commentors proposed controls that would restrict ground-water use in the Dawson and Denver aquifers for remediation purposes only. Residential and municipal uses of ground water from these aquifers, in these areas, would be prohibited. Additionally, the commentors stated that their proposed controls would not prohibit ground water use in offsite areas in the Arapahoe and Laramie-Fox Hills aquifers.

Response

First, as the commentors acknowledge, some institutional controls have already been established for Section 6 of the Lowry Site. These include Executive Order No. 97, issued by former Denver Mayor Federico Pena. Executive Order No. 97 places certain restrictions on development of the property, use of the ground water and surface water onsite, and excavation or well drilling onsite.

[1] EPA believes that these Trusts are privately established instruments holding funds generated through settlement of third party contribution suits initiated by Denver and WMC/CWM against other potentially responsible parties at the Site. The trusts are not controlled by, or connected in any way with the Federal government, and EPA has no independent knowledge concerning the provision of the agreements.

The selected sitewide remedy shall include, at a minimum, those controls contained in Executive Order No. 97.

The selected sitewide remedy includes institutional controls to prohibit future land use developments that would allow unacceptable human exposure to landfill solids, gas, or ground water. At a minimum, the institutional controls include a prohibition on land use that would damage the landfill cap and a prohibition against installation of ground-water supply wells on the Lowry Site or in the immediate vicinity of the Lowry Site. These institutional controls will be effective indefinitely.

Institutional controls required by the selected sitewide remedy are at least as broad and as stringent as those established by Executive order No. 97. EPA agrees with the commentor that such onsite institutional controls must be adopted in the form of either restrictive covenants or restrictive easements, which would be duly recorded instruments attached to or included in the chain of title for the Sections 6 and 31 parcels presently owned by Denver. These institutional controls would run with the land.

EPA, as evidenced by the selected sitewide remedy, also agrees with the commentors that such restrictive covenants or easements will be made enforceable by EPA or a neutral party other than EPA. EPA, in consultation with the Colorado Department of Health (CDH), will make the necessary determinations as to which land use and access controls are appropriate.

EPA is adopting the commentors' proposal that land use and access control measures be instituted in the areas immediately surrounding the Lowry Site. EPA agrees that the selected sitewide remedy should contain offsite institutional controls to enhance the protectiveness of the remedy, to allow expeditious and effective actions should contingency plans be invoked or risk-based performance standards change, and to ensure continued effectiveness of onsite controls. The size of the area to be addressed by the offsite controls should be based on the expected area needed to meet these criteria.

EPA agrees with the commentors that controls on construction of new residences immediately adjacent to the Lowry Site, restrictions on access to areas adjacent to the Lowry Site, and limitations on ground-water well construction and operation near the Lowry Site are appropriate types of controls. In addition, it is clear that the likelihood of such controls being included in the chain of title would be enhanced if the land is owned by parties, such as Denver and WMC/CWM, willing to impose the suggested restrictions.

3. Comment

The commentors stated that they fully support the preferred alternatives presented in the Proposed Plan for the soils, surface water, and sediments OUS at the Lowry Site, but indicated that this endorsement was conditioned on EPA's adoption of the commentors' proposal to institute and rely on on- and offsite land use and access controls.

Response

EPA acknowledges the conditional support for its preferred alternative(s) for OUS 4&5. As the commentors point out, the selected remedy includes active response measures to separate clean surface water from potentially contaminated ground water and to collect and treat contaminated ground water prior to its leaving the Lowry Site. The selected remedy also includes as a minimal level the onsite institutional (land use and access) controls described by the commentors, as well as offsite controls.

4. Comment

The commentors indicated they believed that EPA's preferred alternatives for OUS 2&3 ignore the studies and engineering evaluations done at the Lowry Site during the Remedial Investigation/Feasibility Studies (RI/FSs). The commentors recommend that EPA re-evaluate its determination of the preferred alternative for OUS 2&3 and select the remedial actions recommended by Denver and WMC/CWM in the FS for OUS 2&3.

Response

EPA recognizes that, based on the information presented in the RI/FSs for OUS 2&3, Denver and WMC/CWM recommended different remedial alternatives in the FS than those identified by EPA as the preferred alternatives in the Proposed Plan. However, EPA carefully evaluated the information in the RI/FSs in identifying the preferred alternatives for OUS 2&3 and fully evaluated the proposed remedies recommended by Denver and WMC/CWM in the FS for those OUS. EPA has determined that its selected remedies for these OUS represent the best balance of the nine evaluation criteria and are more protective, in both the short and long term, of human health and the environment.

5. Comment

The commentors propose that EPA rely on the land use controls proposed by Denver in the draft Declaratory Statement of Covenants running with the land submitted with Theresa Donahue's January 21, 1993 letter to Mr. Robert Duprey. Those proposed controls would apply to Sections 6 (Township 5 South, Range 65 West) and 31

(Township 4 South, Range 65 West) that are part of the Lowry Site. The commentors proposed that either the State, EPA, or an independent Colorado non-profit organization be authorized to enforce such covenants.

Response

EPA agrees that controls such as the covenants that run with the land, as proposed in Denver's January 21, 1993 letter, should be adopted for the Lowry Site. The selected sitewide remedy incorporates such controls as a minimum level of control for land and ground-water use and onsite excavation activities. However, EPA believes that the draft covenants, as presented in Denver's January 21, 1993, letter, must be more definitive concerning the restrictions on further landfilling at the Lowry Site. The covenants must be consistent with the selected sitewide remedy and must not allow additional disposal of solid waste in the former landfill area, but also in disallowing other incompatible uses or activities.

The covenants must permit additional ground-water well installation and operation, as may be necessary, to monitor and remediate the aquifers beneath the Lowry Site. However, the covenants must also provide restrictions on such wells for purposes related to human or other uses. Finally, while EPA has not determined the appropriate enforcement mechanism for such covenants, the selected sitewide remedy provides that proper and adequate enforcement of such covenants must be assured. EPA, in consultation with the State, will determine whether the instrument, in this instance the covenants that run with the land, effectively provides for the controls included in the selected sitewide remedy.

6. Comment

The commentors make several arguments in support of their proposal that the sitewide remedy should include the above-described offsite land use restrictions. First, the commentors assert that "although EPA guidance uniformly indicates that residential use scenarios are inappropriate," EPA has identified the residential development scenario as the basis for the primary site risks both on- and offsite. The commentors maintain that their proposed controls will address that risk by controlling and limiting land development on- and offsite and by assuring that development inconsistent with the selected sitewide remedy does not occur. The commentors propose that the land will be maintained as "open space" through the deed restrictions and covenants that run with the land.

Response

EPA disagrees with the commentors regarding the use of the residential development scenario in assessing risk at the Lowry Site. The baseline risk assessment is not the proper place to take institutional controls into account (55 FR 55 8710). EPA guidance entitled Risk Assessment Guidance for Superfund, Volume I Human Health Evaluation Manual (Part A), Interim Final provides that a residential use scenario be employed in the risk assessment process when available information suggests that future residential land use seems possible. In the case of the Lowry Site, ground water in the area is currently used, and is expected to be used in the future, as a source of drinking water. Furthermore, the Lowry Site is currently located near residential areas. Consequently, future residential land use is a reasonable possibility.

Moreover, EPA has identified other risks at the site upon which remedial action is based. Thus, EPA's selection of remedial action at the Lowry Site is not based solely on the residential use scenario, but on a variety of risks identified at the Lowry Site.

The commentors proposal runs counter to EPA's procedures for assessing risk at a Superfund site. As provided in EPA guidance and the NCP (55 FR 8709), one specific objective of the risk assessment is to provide an analysis of baseline risk (i.e., the risks that exist if no remediation or institutional controls are applied to a site). In other words, a baseline risk assessment is to be performed as if no institutional controls exist in the on- or offsite areas. The commentors' proposal would require that EPA consider the existence of institutional controls prior to, and as a presumption for, development of the baseline risk assessment. EPA has determined that the procedures set forth in the NCP and in EPA guidance produce the most reliable estimates of baseline risks at a site.

In essence, the commentors' proposal would require that EPA base its risk assessment on institutional measures that are not yet in existence and were not in existence at the time the risk assessment was performed. The approach suggested requires that EPA revise its definition of baseline risks which is intended to represent the risks at a site in the absence of any controls or active remedial measures. Such an approach does not provide a framework to accurately assess site risks because it requires that EPA speculate on the breadth and stringency of the proposed controls and project their effectiveness.

Finally, while the selected sitewide remedy imposes a complete prohibition on residential development at the Lowry Site, EPA does not believe that its selected sitewide remedy would necessarily require the offsite areas to be used as open space and that it is premature to make such a determination. The remedy requires that offsite controls be established to allow the unimpeded implementation of contingency plans should they become necessary and to ensure the integrity and effectiveness of engineering controls. Although EPA considers community acceptance in selecting a remedy, EPA received no other comments urging that the areas surrounding the Lowry Site be maintained as open space.

7. Comment

The commentors state that the proposed restrictions will control and limit construction and use of ground-water wells on- and offsite. The commentors also state that the proposed restrictions will allow for monitoring at offsite locations. The commentors further suggest that the proposed offsite restrictions will allow, as necessary, the construction of containment measures.

Response

EPA does agree that offsite ground-water well construction and extraction, particularly high capacity wells, must be prohibited to the extent these wells interfere with or diminish the protectiveness or effectiveness of the selected sitewide remedy. EPA also agrees that it would be desirable to ensure in perpetuity that no wells will be constructed, close to the Lowry Site, in aquifers that could potentially affect the movement of contaminants off site, or adversely affect the engineered components of the selected sitewide remedy. However, EPA does not agree that institutional controls such as those proposed by the commentors are the only means to accomplish these goals in offsite areas.

EPA does not believe that direct and blanket prohibitions on offsite ground-water wells must be incorporated in the selected sitewide remedy at the present time. EPA has not made a determination that all offsite well construction will necessarily affect the movement of contaminants offsite or adversely affect the engineered components of the selected sitewide remedy. Based on present information on the potential effects of such wells, EPA believes that this determination is best made on a case-by-case basis as applications for such wells are made.

EPA disagrees that there is presently very little evidence that contaminants at the Lowry Site could move offsite. In fact, recent monitoring data has shown evidence of contaminants in ground-water wells at the western and southern boundaries of the Lowry Site. EPA expects that such contamination, if confirmed, will be fully addressed by installation of the barrier wall and collection systems at the western and southern perimeters of the Lowry Site.

Nevertheless, the presence of detectable contamination in these areas underscores the need for engineered containment structures and systems in those areas. EPA has included such containment systems in the selected sitewide remedy. Thus, EPA does not agree that imposing institutional controls that merely prohibit future ground-water extraction is the most prudent way to address the contamination presently detected at the landfill perimeter.

The selected sitewide remedy includes monitoring of the containment systems to ensure the sitewide remedy is effective. EPA agrees with the commentors that monitoring in offsite locations may be necessary in the future to verify that contaminants are not moving offsite, to ensure the effectiveness of the barrier wall containment systems, or to monitor actual offsite contaminant migration in case it does occur. However, EPA disagrees that ownership by Denver and WMC/CWM is necessary to implement monitoring activities.

Finally, EPA agrees that offsite institutional controls are necessary at this time because they would allow for future construction of additional containment systems. EPA's selected sitewide remedy includes engineered containment components, such as the barrier walls at the south, west, and north perimeters of the Lowry Site, the cap, and the ground water pump and treatment system. The selected sitewide remedy also includes contingency measures that would address the failure of constructed barrier walls and other containment features and any resulting offsite movement of contamination. Even though such failure is not expected to occur, EPA would consider the need to locate additional containment structures and systems in offsite areas. Offsite institutional controls will facilitate and protect these aspects of the selected remedy. EPA does not favor a remedy that would include the acquisition of land surrounding the Lowry Site for the purpose of constructing containment structures farther out from the present extent of the Lowry Site.

8. Comment

The commentors state that the proposed restrictions will control and limit access to the Lowry Site and adjacent areas.

Response

EPA agrees with, and the selected sitewide remedy includes, restrictions on access to onsite areas. The selected sitewide remedy does not include access restrictions to offsite areas. EPA does not believe controls on access to offsite areas is necessary at this time to ensure protectiveness of the remedy.

However, such controls may become necessary if additional containment or monitoring systems are constructed in offsite areas due to implementation of contingency plans that are part of the selected sitewide remedy, or in the case of remedy failure.

9. Comment

The commentors state that while appropriate zoning and well construction and land use restrictions are possible with the cooperation of local governments that have jurisdiction, cooperative efforts have not borne fruit to date. The commentors recommend that land and water right acquisition are the only reliable means of ensuring that only compatible uses are made of land adjacent to the Lowry Site.

Response

EPA disagrees that the only reliable means of ensuring compatible offsite land use is through the commentors' purchase of the land. First, no determination of what uses are compatible has yet been made, nor has the selected sitewide remedy, including its engineered active components, yet been constructed.

EPA agrees in general that some forms of institutional controls, land ownership and water rights acquisition can enhance the reliability of institutional controls. However, as discussed above, land ownership is not essential for adequate implementation of necessary controls. Further, because of the inherent unreliability and impermanence of all institutional controls in comparison to engineered and/or active treatment remedial actions, reliance on offsite institutional controls as a major remedial component is not consistent with EPA's remedy selection requirements. EPA disagrees with the commentors that purchase of surrounding land and imposition of the suggested controls will "eliminate" future risks. EPA's selected sitewide remedy places more emphasis overall on active remedial measures. EPA believes that this approach is the best means to manage and eliminate unacceptable risks posed by the Lowry Site. Offsite controls are only necessary to support the integrity of the remedy by ensuring that onsite engineering controls remain effective; such controls are also required to effectively implement future monitoring systems and to allow the expeditious implementation of contingency plans.

EPA does not believe that voluntary cooperative efforts to secure desirable land use restrictions have been exhausted. The efforts of the Joint Southeast Area Planning Initiative are ongoing. It is EPA's understanding that local governments with jurisdiction over the areas adjacent to the Lowry Site have the same mandate as does Denver to protect the health and welfare of their citizens. EPA expects that the presence of a Superfund site, and the inherent risks presented by the contamination at the Lowry Site, as well as the remedial measures that are and will be implemented, will be considered by such local governments in future zoning and planning decisions. EPA believes that the local governments share the concern that the Lowry Site remain safe.

10. Comment

The commentors state that they believe their proposed remedy, including on- and offsite ground-water, land use, and access controls, combined with the active aspects of the remedial alternatives recommended by Denver and WMC/CWM in the FS for OUS 2&3, provide a remedy that is a better balance of the nine CERCLA evaluation criteria, and specifically, is more protective than, the preferred alternatives as presented in the Proposed Plans for all of the OUS.

Response

EPA disagrees that the suggested onsite and additional offsite land use and access controls in combination with the response action alternatives recommended by Denver and WMC/CWM in the FS for OUS 2&3 would represent a better balance of the nine CERCLA remedy selection criteria, or that such a combination would be more protective than the remedy selected by EPA. The Proposed Plan for OUS 2&3 and 4&5 highlights the comparative analysis of remedial alternatives presented in the FS for OUS 2&3. The active remedial measures included in the selected remedy, such as the barrier walls, drums and contaminated soils removal, and gas collection/treatment make the selected remedy more protective and more able to meet ARARs than the alternative recommended by Denver and WMC/CWM in the FS.

11. Comment

The commentors propose that offsite land use and access controls be instituted in addition to those presented by EPA in its preferred alternative for Section 6 at the Lowry Site, and not in lieu of active response measures.

Response

EPA agrees that institutional controls should not be selected as a remedial component in lieu of active response measures (55 FR 8846). In addition however, EPA believes that the commentors' proposed remedy does in fact significantly reduce the active engineering response measures from those included in EPA's selected sitewide remedy.

EPA can not determine at this time whether the long-term risks to human health would be reduced to any degree if the commentors' proposed remedy were implemented and believes that they could actually increase. EPA believes that the approach suggested by the commentors, that is, reliance on institutional controls and the existence of a monitoring or buffer zone, could ultimately lead to a situation similar to that existing presently at the site (with potential residential development immediately adjacent to the Lowry Site), but with a greatly expanded area of contamination.

Also, the remedy proposed by the commentors has less assurance of meeting ARARs than EPA's selected sitewide remedy, in particular for offsite areas. The selected sitewide remedy includes barrier walls constructed at the waste management area boundary. These barrier walls are designed and intended to prevent any offsite migration of contaminants. Any "breakthrough" will be immediately addressed by the contingency measures included in the selected sitewide remedy. ARARs for the surrounding ground water will thus be achieved. In the commentors' proposed remedy, action to install barrier walls will be delayed until after "breakthrough" to offsite areas has occurred. If barrier walls are constructed in the surrounding land and not at the waste management area boundary, ARARs will be exceeded in those areas. ARARs must be met at all areas outside the waste management area boundary when waste is left in place (55 FR 8753).

Detailed Comments on the Proposed Plan

12. Comment

The commentors stated that Section 6 is not closed to municipal solid waste disposal.

Response

EPA and CDH disagree that the landfill in Section 6 is not closed. In accordance with the Regulations Pertaining to Solid Waste Disposal Sites and Facilities (6CCR1007-2) and 40 CFR Part 258-Criteria for Municipal Solid Waste Landfills, the Solid Waste Section of the Hazardous Materials and Waste Management Division, Colorado Department of Health, considers the former solid waste management unit in Section 6 to be closed to municipal solid waste disposal.

Furthermore, adding waste to a Superfund site contradicts EPA's preference for a reduction in waste volume. The addition of a significant quantity of municipal solid waste to the existing landfill mass would also inhibit implementation of remedial activities that might be deemed necessary in the future.

13. Comment

The commentors stated that the dates of operation, provided in the OUS 2, 3, 4, and 5 Proposed Plan, for the barrier wall and the Ground Water Treatment Plant are incorrect. The commentors noted that the barrier wall has been in operation since June 1984 and that the Ground Water Treatment Plant has operated since October 1984.

Response

Information available to EPA suggests that the barrier wall was completed in the summer of 1984. EPA disagrees that the treatment plant began operations in October 1984. Based on the existing record, it is EPA's determination that the first interim remedial measure (combined operation of both the barrier wall and treatment plant) began in 1985.

14. Comment

The commentors stated that to be consistent with the No Further Action alternatives for the soils, surface water, and sediments operable units (OUS 4&5), the No Action and No Further Action alternatives for landfill solids and gas, as well as alternatives 3 and 7 for landfill solids, should also have a "high level of compliance" with the short-term effectiveness criterion.

Response

The commentors are correct in noting that the No Action and No Further Action alternatives for the landfill solids and gas operable units (OUS 2&3) should be identified as having a high level of compliance with the short-term effectiveness criterion.

EPA disagrees that Landfill Solids (OU2) Alternatives 3 and 7 would have a high level of compliance with the short-term effectiveness criterion. Landfill Solids Alternative 3 (Clay Cap) and Alternative 7 (Landfill Mass Regrading) would not have a high level of compliance with the short-term effectiveness criterion for the following reasons. Both alternatives involve disturbance of soils, which could precipitate impacts on workers or pose risks to the community, during remedial action implementation. For example, Alternative 3 includes placement of a clay cap over portions of the former tire pile area, and Alternative 7 includes removing the top layers of the existing landfill mass cover and regrading additional municipal solid waste on top of the landfill mass.

15. Comment

The commentors noted that the description for the preferred alternative for OUS l&6 should be consistent throughout the Proposed Plan for OUS 2&3 and 4&5.

Response

EPA agrees that the description of this alternative should be consistent throughout the Proposed Plan for OUS 2&3 and 4&5. The selected sitewide remedy includes underground barrier walls and collection systems, and an upgradient containment, collection, and diversion system.

16. Comment

The commentors stated that there is no evidence that an upgraded ground-water treatment facility will be necessary.

Response

EPA does not agree with the commentors' statement. The OUS 1&6 Feasibility Study (FS) concluded that a second treatment plant or a modification to the existing groundwater treatment plant may be necessary to treat highly contaminated ground water collected at the base of the northern slope of the landfill mass. The sitewide remedy must meet all performance standards and ARARs. During remedial design, the existing treatment plant will be evaluated to determine whether or not it is capable of treating: higher volumes of contaminated ground water; higher contaminant concentrations in the ground water; contaminants present at the site but not currently found within the treatment plant influent. If it is determined that the existing plant is not able to meet performance standards, the plant will be upgraded accordingly.

17. Comment

The commentors asked for an explanation of the difference between the costs in the OUS 1&6 Proposed Plan and those summarized for OUS 1&6 in the Proposed Plan for OUS 2&3 and 4&5. In addition, the commentors asked EPA to provide costs for the preferred alternatives to explain the differences between those alternatives and the recommended FS alternatives.

Response

The costs for the OUS 1&6 alternatives in the OUS 1&6 Proposed Plan included costs that had already been incurred; specifically the capital costs associated with the SWRA. For the OUS 2&3 and 4&5 Proposed Plan, EPA chose to exclude the capital costs previously incurred through implementation of the SWRA. Where components of the different OU alternatives overlapped, EPA removed the duplicated cost estimates. This included, for example, deletion of the SWRA operating and maintenance (O&M) costs from the cost estimate for the preferred alternative for OUS 1&6. O&M costs for the SWRA are accounted for in the cost estimate for the preferred alternative for OUS 4&5. Also, the costs associated with the OUS 1&6 preferred alternative, as presented in the OUS 2&3 and 4&5 Proposed Plan, include estimates for underground barrier walls and associated well extraction systems.

The cost estimates for each pair of OUS (1&6, 2&3, and 4&5) were developed using slightly different cost-estimating methodologies. This is due to the fact that a separate feasibility study was prepared for each set of OUS. Each study estimated indirect costs by assuming different percentages of direct costs.

Indirect capital costs include items that are incidental to direct capital costs such as engineering and design, legal fees, permitting requirements, EPA review and oversight, and a contingency for unexpected costs. Indirect O&M costs represent the estimated costs for administrating the O&M work and a contingency for unexpected costs. For the preferred alternatives, indirect capital costs ranged from 70 to 80 percent of direct capital costs, while O&M indirect costs ranged from 17 to 30 percent of O&M direct costs. To maintain consistency, EPA used the same percentages (80 percent for capital costs and 30 percent for O&M costs) for each OU.

18. Comment

The commentors are concerned that the use of specific numbers in the Proposed Plan will constrain the Remedial Design effort.

Response

EPA disagrees that the Remedial Design will be constrained. EPA's focus is to ensure that the performance standards, specified in the selected remedy, are achieved.

The Proposed Plan for OUS 2&3 and 4&5 provides estimates of such quantities as volume of material to be excavated and number of wells to be installed. Approximation is appropriate at this stage of the process and is necessary for cost estimating purposes. EPA acknowledges that it may be necessary to review these estimates during the remedial design. However, both the excavation and well-installation components are included as key components of the selected remedy and both activities must be implemented such that the performance standards specified in the selected remedy are achieved and maintained.

19. Comment

The commentors stated that the Proposed Plan fails to incorporate existing remedy elements and those proposed for OUS 1&6. As an example, the commentors suggested that the existing ground-water treatment plant does not appear to have been factored into the preferred alternative for landfill solids. The commentors also stated that the costs of certain IRMs do not appear to be factored into the selected alternatives.

Response

EPA disagrees that the Proposed Plan fails to incorporate existing or proposed remedy elements. The Proposed Plan for OUS 2&3 and 4&5 incorporates both existing remedial elements and the preferred alternative for OUS 1&6. In fact, the existing interim remedial measures (IRMs) and the preferred alternative for OUS 1&6 are an integral part of the selected sitewide remedy and are discussed in the Proposed Plan for OUS 2&3 and 4&5.

The benefits and treatment aspects of existing IRMs and the preferred alternative for OUS 1&6 were not specifically mentioned in the separate analyses of each alternative for each operable unit. However, the remedial benefits, treatment, and costs of existing IRMs and the preferred alternative for OUS 1&6 were factored into the sitewide remedy discussion and comparative analysis.

The existing ground-water treatment plant and barrier wall address contaminated ground water that is flowing from the landfill mass and the former tire pile area. While the treatment plant and barrier wall do not provide for source reduction, the preferred alternative for landfill solids does. The preference for removal of accessible hot spots is consistent with EPA's guidance Conducting Remedial Investigations/Feasibility Studies for CERCLA Municipal Landfill Sites.

20. Comment

The commentors stated that excavation in the former tire pile area could create short-term exposure to workers as well as become a risk to the public during offsite transportation.

Response

The Proposed Plan for OUS 2&3 and 4&5 acknowledges that excavation in the former tire pile area may create short-term exposure risks for workers. EPA recognizes that offsite transport of wastes has the potential to create short-term exposure risks for the general public.

The Feasibility Study (FS) for OUS 2&3 notes that it is anticipated that an increase in organic emissions, and possibly inorganic emissions, would be incurred as a result of excavation of the buried drums and contaminated soils. Emissions would be controlled using appropriate dust suppression methods that may include the use of water, foam, or cover materials such as PVC sheeting. The FS also evaluated the worst-case potential risks from increases of VOCs, as a result of excavation activities in the former tire pile area. Modeling results indicated that if a worker were continually exposed without protective equipment, the lifetime cancer risk would be 2 x 10-5. This calculation is based on conservative assumptions. Even with these assumptions, the potential risk is within EPA's acceptable range of 1 x 10-4 to 1 x 10-4. Using more realistic assumptions (such as the use of protective equipment), the risks would be much lower than 1x10-4.

In terms of offsite transportation and short-term risks to the general public, EPA believes that current waste transporting technologies are reliable and have proven to be successful. The loading and transport of materials would comply with all applicable regulations and would be performed in accordance with a health and safety plan, thereby minimizing any adverse short-term impacts.

There are numerous examples of situations in which excavation and offsite disposal have been successfully implemented with minimal risk to either onsite workers or the general public. At the Denver-Arapahoe Chemical Waste Processing Facility, located adjacent to the Lowry Site, the following materials were safely excavated with no adverse health impacts to human health: 34,569 55-gallon drums; 4,300 cubic yards of solid wastes; and 3,516 gallons of liquids in miscellaneous containers ranging from 1 gallon to 25 gallons in size. Excavation of drums, drum contents, and contaminated materials in the former tire pile area is believed to be no more complex.

Given the estimated low-level risks, the safety measures that may be taken, the existing regulations for waste transport and disposal, and the demonstrated success of a similar excavation adjacent to the Lowry Site, EPA believes that the short-term risks to workers and the general public are low and may be controlled through proven health and safety measures. In addition, short-term risks are only a part of one criterion, short-term effectiveness. The selected remedy provides the best balance of all nine evaluation criteria.

21. Comment

The commentors stated that it is not likely that intact drums will be found in the former tire pile area.

Response

EPA disagrees with the commentors. Subsection 4.3 of Appendix E (Former Tire Pile Area Geophysical Investigation) of the Feasibility Study, Volume 2, Lowry Landfill: drill Solids and Landfill Gas Operable Units (OUS 2&3), Remedial Investigation and Feasibility Study, Arapahoe County, Colorado estimates that approximately 19 percent (257 drums) of the total estimate of buried drums (1,350) may be intact and contain liquids. Based on treatability study results, the feasibility study further suggests that, on the average, about five gallons of liquid may be present in each of the estimated 257 liquid-filled drums. This would yield a total liquid volume of no less than 1,300 gallons of waste. Estimates show that a significant amount of source material may be removed through limited excavation of the hot spots in the former tire pile area.

The contaminant sources discussed in the Proposed Plan for OUS 2&3 and 4&5 include contaminated solids and liquid-filled drums that provide a source of contamination to other media such as ground water. The intent of the preferred alternative for OU2 is to remove higher concentration contaminated solids that are accessible. The excavation will include not only drums, but also contaminated soils and other material surrounding the drums.

22. Comment

The commentors stated that liquids leached from the former tire pile area will be captured at the barrier wall and through the SWRA, indicating that additional measures will not be necessary in the former tire pile area.

Response

EPA does not agree that additional measures will not be necessary in the former tire pile area. The SWRA collection system and barrier wall intercept some of the contaminated liquids which have migrated laterally from waste pits within the former tire pile area. These liquids are treated at the existing ground-water treatment facility. It is undesirable to allow perpetual seepage out of the waste pits in the former tire pile area. Elimination of this source of contamination, through excavation, reduces the potential for additional contamination of ground water. The excavation option has the following advantages:

- It further reduces a principle source of risk to human health and the environment;
- It removes accessible hot spots;
- It complements the source-control component (for the landfill mass) of the preferred alternative for OU2; and
- It complies with the statutory requirements of CERCLA.

23. Comment

The commentors believe that the risks are minimal in the former tire pile area and claim that the drums, soils, and waste pits are separated from the surface by an engineered drainage system. The commentors also stated that land use and access controls would eliminate public exposure to subsurface solids.

Response

Contaminated solids in the former tire pile area, within the SWRA collection system boundary, are separated from the surface by an engineered drainage system. The remainder of the former tire pile area does not have an engineered drainage system. Institutional controls such as access and land use restrictions will be implemented but only to supplement, and not replace, such engineering controls as excavation of the contaminated solids.

24. Comment

The commentors are concerned that excavation of the former tire pile area will involve the potential for ground-water recharge in disturbed areas.

Response

EPA believes that ground-water recharge can be prevented or limited through the following means:

- Excavation can be sequenced to minimize the open excavation areas;
- Engineering controls (such as berms) can be used to divert ponded water;
- The time period that the excavation area is kept open can be limited; and
- Storm water that may accumulate in the excavation area can be removed and treated onsite.

25. Comment

It is the commentors' opinion that removal of the drums, soils, and waste pits in the former tire pile area is not consistent with EPA guidance Presumptive Remedy for CERCLA Municipal Landfill Sites, OSWER Directive 9355.0-49FS, September 1993. The commentors identify four questions to be answered in evaluating the reasonableness of excavation as a cleanup alternative. The first question is whether or not evidence exists to indicate the presence and location of waste. The commentors stated that there is no evidence of intact drums or perched waste.

Response

EPA disagrees that the removal of the drums, soils, and waste pits is not consistent with EPA guidance. The proposed excavation, removal, treatment, and disposal of drums, drum contents, contaminated soils, and contaminated debris fully complies with EPA's guidance entitled Presumptive Remedy for CERCLA Municipal Landfill Sites [OSWER Directive 9355.0-49FS, September 1993]. This guidance indicates that the primary response action objectives for municipal landfill sites should include preventing direct contact with contaminated solids and minimizing contaminant infiltration to ground water. The preferred alternative for OU2 fulfills this requirement and is based on a determination that: evidence exists to indicate the presence and approximate location of waste; the hot spot is known to be a principal threat waste; the waste is in a discrete, accessible area of the site; and the hot spot is known to be large enough that its remediation will reduce the threat posed by the overall site but small enough that it is reasonable to consider removal.

EPA's fast response addresses the commentors' belief that there is no evidence of intact drums or perched waste. Sufficient evidence exists to indicate the presence and approximate location of waste in the former tire pile area. This evidence includes: aerial photographs; results from soil gas surveys, borings, and waste pit well points; geophysical studies; test pits analyses; and visual Observation of contaminated liquid seeps in the former unnamed creek. Specifically, the Feasibility Study, Volume 2, Lowry Landfill: Landfill Solids and Landfill Gas Operable Units (OUS 2&3), Remedial Investigation and Feasibility Study, Arapahoe County, Colorado estimates that, at a minimum, approximately 257 buffed drums may contain liquids and that there may be, at a minimum, 1,300 gallons of liquid waste in these drums. Thus, substantial evidence exists that perched liquids are present in the former tire pile area.

26. Comment

The second question posed by the commentors is whether or not the hot spot is known to be a principal threat waste. The commentors stated that the wastes are not unique.

Response

The concept of a principal threat waste is to be applied on a site-specific basis when characterizing source material. A Guide to Principal Threat and Low Level Threat Wastes [OSWER Directive 9380.3-06FS, November 1991] defines source material as material that includes or contains hazardous substances, pollutants or contaminants that act as a reservoir for migration of contamination to ground water, or acts as a source for direct exposure. Source materials may include drummed wastes, contaminated soft and debris, or dense non-aqueous phase liquids (DNAPLs).

As established in the NCP [40 CFR 300.430(a)(1)(iii)], EPA expects, at a minimum, to:

1. Use treatment to address the principal threats posed by a site, wherever practicable. The EPA guidance document entitled A Guide to Principal Threat and Low Level Threat Wastes [OSWER Directive 9380.3-06FS, November 1991], states that principal threat wastes are those source materials considered to be highly toxic or highly mobile that cannot be reliably contained or would present a significant risk to human health or the environment should exposure occur.

2. Use engineering controls, such as containment, for wastes that pose a relatively low long-term threat or where treatment is impracticable.

3. Use a combination of methods to achieve protection of human health and the environment. Treatment of principal threats will be combined with engineering controls and institutional controls for treatment residuals and untreated waste.

The source materials discussed in the Proposed Plan for OUS 2&3 and 4&5 include, at a minimum, contaminated soft and debris and drummed waste that provide a continuous source of contamination to the ground water. These source materials would present a significant risk to human health or the environment if exposure were to occur and comprise the hot spots identified in the former tire pile area at the Lowry Site. The hot spots are principal threat wastes and are in a discrete, accessible area of the site.

For additional discussion concerning documented evidence of buried liquid-filled drums in the former tire pile area, please see the response to Comment 21.

27. Comment

The third question posed by the commentors is whether or not the waste is in a discrete accessible part of the landfill. The commentors stated that the drums are not easily accessible.

Response

EPA disagrees that the wastes are not easily accessible. The hot spots that are targeted for excavation and treatment are located in an area that is physically separate from the main body of the landfill mass. EPA guidance does in fact suggest that it would be difficult to excavate and/or treat a landfill mass, but allows for circumstances in which source materials are located in separate or discrete and accessible areas.

The contaminated material to be excavated and treated is located in a discrete, accessible area, separate from the landfill mass. The waste is accessible through conventional excavation and construction techniques. The proposed construction process is provided in detail in Subsection 4.2.1.4 of the OUS 2&3 Feasibility Study. While many of the drums to be recovered may be deteriorated and construction debris over the waste pits may add some level of complexity to the excavation, neither of these issues are believed to be significant, and both can be addressed through proven technology. The commentors may also refer to the response to Comment 21 for additional discussion of a similar excavation project conducted at the Denver-Arapahoe Chemical Waste Processing Facility adjacent to the Lowry Site.

28. Comment

The fourth question posed by the commentors is whether or not the hot spot is large enough to reduce risk but small enough to consider removal. The commentors stated that the area is not large enough to reduce the threat posed by the overall site.

Response

EPA disagrees that the area(s) to be excavated are not large enough. The preferred alternative for OU2 is a combination of excavation in the former tire pile area and containment of wastes within the landfill mass. These components of the sitewide remedy would be implemented simultaneously.

In evaluating overall site risk reduction, EPA believes it is appropriate to separately consider the containment portion (southern portion of the Lowry Site) and the non-containment portion (northern portion including the former tire pile area of the Lowry Site). In doing so, risks from principal threats within the main landfill mass are effectively contained in the southern portion of the Lowry Site. Principal threats in the former tire pile area would be significantly addressed through excavation. Excavation in the former tire pile are is large enough to significantly reduce the majority of risk in the former tire pile area and is small enough that it is reasonable and practical to consider.

29. Comment

The commentors stated that the preferred alternative for landfill solids does not meet the requirements of the NCP. The commentors also claimed that the preferred alternative is not cost effective and EPA's Proposed Plan did not evaluate long-term effectiveness, treatment, and short-term effectiveness. Finally, the commentors stated that EPA's Proposed Plan focused on offsite treatment, did not consider existing onsite treatment, and short-term risks to onsite workers were hardly mentioned.

Response

The preferred alternative does meet the requirements of the NCP. EPA, in consultation with CDH, performed a detailed analysis of all the alternatives, including Modified Alternative 4 (Drum Removal/Offsite Disposal/North Face Cover). This analysis consisted of two parts: an assessment of individual alternatives against each of the nine evaluation criteria; and a comparative analysis that focused upon the relative performance of each alternative against the nine criteria.

With regard to the preferred alternative and the requirements of the NCP, the results of EPA's detailed analysis demonstrate that Modified Alternative 4 (Drum Removal/Offsite Disposal/North Face Cover) offers: the greatest protection of human health and the environment by removing contamination in the former tire pile area; the greatest long-term effectiveness and permanence through removal of contaminated material; and the greatest reduction of toxicity, mobility, and volume of contaminated solids through treatment.

The analysis also affirmed that the preferred alternative: is comprised of proven technologies; is implementable; complies with applicable or relevant and appropriate requirements; is fully supported by the State of Colorado; and has a high degree of acceptability to the community.

The commentors are correct in noting that cost effectiveness is determined by evaluating the following items: long-term effectiveness and permanence; reduction of toxicity, mobility, or volume through treatment; and short-term effectiveness. Modified Alternative 4 (Drum Removal/Offsite Disposal/North Face Cover) is cost effective for the reasons discussed below.

EPA disagrees that it did not consider, or that it gave less than due consideration to, the following criteria: long-term effectiveness; short-term effectiveness; and onsite treatment. First, EPA considered that Modified Alternative 4 (Drum Removal/Offsite Disposal/North Face Cover) provides long-term effectiveness and permanence through removal of contaminated drums, debris, and soils from the former tire pile area. There is a high degree of certainty that this alternative will prove successful and implementation of this alternative eliminates the need to consider either the magnitude of residual risk remaining from untreated waste or the adequacy and reliability of controls such as containment systems to manage the untreated waste.

Second, EPA considered that Modified Alternative 4 (Drum Removal/Offsite Disposal/North Face Cover) does in fact address treatment of drum contents and contaminated soils. This alternative provides for a significant reduction in toxicity, mobility, and volume of drum contents and contaminated soils through excavation and treatment at an offsite facility. Treatment would include, at a minimum, incineration and ash stabilization.

Third, the following potential short-term impacts of Modified Alternative 4 (Drum Removal/Offsite Disposal/North Face Cover) were also evaluated: short-term risks that might be posed to the community during implementation of the alternative; potential impacts on workers during remedial action and the effectiveness and reliability of protective measures; potential environmental impacts of the remedial action and the effectiveness and reliability of mitigative measures during implementation; and time until protection is achieved.

Excavation projects, similar in nature to the preferred alternative, have been successfully and safely implemented both onsite and offsite with minimal short-term risks. Onsite excavation of soils and potentially contaminated material was performed as part of the construction of the Surface Water Removal Action collection system within Unnamed Creek. Drum excavation and removal activities were also successfully completed in Section 32, in connection with the corrective action at the Denver-Arapahoe Chemical Waste Processing Facility.

Experience from these projects indicates that implementation of the preferred alternative would pose minimal short-term risk to the community. Furthermore, the preferred alternative can be implemented using effective and reliable protective measures for the cleanup workers. Also, mitigative measures employed during the implementation of the above-referenced excavation projects have proven to be effective in minimizing adverse impacts to the environment during remedial action.

In responding to the commentors' suggestions that EPA only focused on offsite treatment and that existing onsite treatment was not considered, the following points can be made. First, of the seven alternatives evaluated for remediation of the landfill solids, two alternatives involve no excavation, one alternative involves excavation and disposal either on- or offsite, three alternatives involve excavation and offsite treatment and disposal, and one alternative includes excavation and both onsite and offsite treatment and disposal.

Second, regarding the commentors' suggestion that the existing ground-water collection and treatment systems were not considered during the comparative evaluation of the alternatives for the landfill solids, please see the responses to Comment 19 and Comment 22.

30. Comment

The commentors are opposed to excavation in the former tire pile area for the following reasons: ground water treatment is already in place; there is a potential risk to onsite workers; long distance transport of excavated materials would be necessary; there would be congressional disapproval for offsite transport; and excavation in the former tire pile area does not meet the short-term effectiveness criteria.

Response

EPA acknowledges that a ground-water collection/treatment system is in place and is designed to capture dissolved contaminants in the ground water. However, source reduction through excavation in the former tire pile area will address a principal threat at the Lowry Site (see the response to Comment 22). The potential risks to onsite workers and associated with offsite disposal are discussed in Comments 19 and 20.

31. Comment

The commentors believe that Modified Alternative 4 (Drum Removal/Offsite Disposal/North Face Cover) is not cost-effective and is not eligible for selection as the remedy.

Response

Please see the response to Comment 29 and the Record of Decision for a discussion of the cost-effectiveness of Modified Alternative 4 (Drum Removal/Offsite Disposal/North Face Cover).

32. Comment

The commentors noted that the Feasibility Study for OUS 2&3 contained an alternative that included the following components: the placement of additional cover materials over those areas of the former tire pile area that potentially contain drums and waste; and permanent land use and access controls on the property. The commentors also provided an analysis of this alternative within the context of the nine evaluation criteria.

Response

In preparing the Proposed Plan for OUS 2&3 and 4&5, EPA evaluated the alternative cited by the commentors. The results of EPA's comparative analysis indicated that other alternatives more fully complied with the nine evaluation criteria.

33. Comment

The commentors stated that the existing cap on the former landfill should be enhanced and regraded using municipal solid waste.

Response

EPA disagrees that the existing cap needs to be enhanced by the means suggested by the commentor. The commentors' proposed approach is part of landfill Solids Alternative 7, which was evaluated as part of the FS for OUS 2&3. EPA performed a comparative analysis of this alternative in accordance with the nine evaluation criteria established in the NCP. Justification for not selecting this alternative may be found in the Record of Decision. The regulatory history of the Section 6 municipal solid waste (MSW) landfill, and its relationship to EPA's and CDH's analysis of Landfill Solids Alternative 7, is discussed below.

CWM initially submitted a closure plan to CDH for the Section 6 MSW landfill in November 1980. The Closure Plan was approved for the complete filling of Section 6 (from Quincy Avenue to Hampden Avenue) to a maximum final cover altitude of 5,862.5 feet. This plan was modified in 1985 to accommodate Superfund activities; however, the modification only stopped the northward growth of the MSW landfill while the final altitude remained the same. On August 3, 1990, WMC ceased MSW landfilling in Section 6 and began to utilize the engineered MSW landfill that was constructed in Section 31 of the Denver/Arapahoe Disposal Site (DADS) facility. WMC submitted the Quality Assurance report for the final cover of the Section 6 MSW landfill of the DADS facility in 1992. The report stated that the final cover installed over the MSW landfill in Section 6 met all minimum engineering requirements specified in the regulations under which the Section 6 MSW landfill had operated.

EPA, in consultation with CDH, has determined that ARARs regarding the Landfill Solids Alternative include the requirements specified in the State of Colorado's Regulations Pertaining to Solid Waste Disposal Sites and Facilities (6CCR1007-2) (SWA) and the Federal regulations titled Solid Waste Disposal Facility Criteria (40CFR Part 258) (Subtitle D).

In addition, RCRA Subtitle D regulations, 40 CFR Part 258.2, define an existing municipal solid waste landfill (MSWLF) unit to be a MSW landfill that received MSW as of October 9,1993. The Section 6 MSWLF unit did not receive MSW as of that date. Thus the MSW landfill in Section 6 is not an existing unit. All units not existing are considered to be closed. Based on this determination, Landfill Solids Alternative 7 could only attain ARARs if Alternative 7 could meet criteria specified in the SWA. Section 3 of the SWA requires that all new MSW units be constructed with engineering liners and leachate collection systems on a stable sub-base. Consequently, EPA and CDH do not believe that Alternative 7, as proposed, could meet these requirements. This conclusion conflicts with the results of the initial ARARs evaluation, which was presented in the Proposed Plan for OUS 2&3 and 4&5. As presented in the proposed plan, EPA and CDH initially concluded that the Landfill Solids Alternative 7 would comply with ARARs. However, based on the additional analysis presented above, Landfill Solids Alternative 7 would not comply with ARARs.

The commentors assert that the additional cover proposed for installation to the closed MSW landfill in Section 6 will meet the new Subtitle D requirements by increasing the slope of the final cover to a steeper grade. This type of approach to closed MSW landfills is not within the intent of the State and Federal Subtitle D requirements.

EPA and CDH consider the solid waste management unit within Section 6 to be closed to additional MSW disposal.

In addition, the placement of an additional 1.2 million cubic yards of MSW onto the existing landfill mass would serve to further limit access in the event that, in the future, it was determined that excavation was necessary.

34. Comment

The commentors disagree with the simultaneous installation of the first two stages of the gas collection system. The commentors also believe that the Proposed Plan for OUS 2&3 and 4&5 has been manipulated to improperly compare Modified Alternative 3 (Gas Collection/Enclosed Flare) to Stage 1 of Alternative 3 (Gas Collection/Enclosed Flare).

Response

EPA disagrees that the simultaneous installation of the first two stages of the gas collection system is unjustified. The preferred alternative for landfill gas, Modified Alternative 3 (Gas Collection/Enclosed Flare), includes a phased installation of gas collection wells in the landfill mass. The first phase is a combined source reduction and perimeter gas collection system (Stages 1 and 2 in the OUS 2&3 Feasibility Study). Installing the perimeter gas collection component is warranted for the following reasons:

- Shallow subsurface geologic uncertainties at the perimeter of the landfill mass indicate that targeting the few known areas of gas migration (as is proposed under Stage 1) may not comprehensively address all pathways for migration (monitoring points at some locations are as far as a 1/4 mile apart).

- The cost difference in targeting a few areas (Stage 1-$8.4 million) versus the entire perimeter (Stages 1 and 2-$9.2 million) is minimal when compared to the increased level of protection.

- By installing the perimeter gas collection system, there will be less reliance on monitoring and significant removal and treatment of contaminants.
- The level of protectiveness achieved by combined Stages 1 and 2 is higher than for Stage 1 only.

- Perimeter gas collection systems have proven effective at other landfills in Colorado.

Installing a full-perimeter gas collection system would not delay the start of remedial action as implied by the commentors.

EPA does not agree that the Proposed Plan for OUS 2&3 and 4&5 improperly manipulated the comparative analysis of Modified Alternative 3 (Gas Collection/Enclosed Flare) and Stage 1 of Alternative 3 (Gas Collection/Enclosed Flare). EPA's analysis is justified because the comparison between the two alternatives was made based on the implementation of engineered technology without contingencies. EPA believes it has fairly evaluated these two alternatives in the Record of Decision.

35. Comment

The commentors believe that the specificity contained in the Proposed Plan for OUS 2&3 and 4&5 (i.e., the exact number of collection and monitoring wells) cannot be justified and should be evaluated during the remedial design phase.

Response

A detailed technical justification for the estimated number of collection and monitoring wells identified in the alternatives may be found in the Feasibility Study for OUS 2&3. As mentioned in the response to Comment 18, the Proposed Plan for OUS 2&3 and 4&5 must, for conceptual and cost estimating purposes, provide estimates of such quantities as the number of wells to be installed. EPA acknowledges that it may be necessary to review and revise these estimates during the remedial design. However, the specific numbers must be sufficient to fully meet all performance standards identified in the selected sitewide remedy.

Comparison of Remedies in the Proposed Plan
with those in the Feasibility Study in
Combination with Land Use and Access Controls

36. Comment

The commentors summarize the analysis of alternatives, as presented in the Feasibility Study for OUS 2&3 (Denver/WMC/CWM, April 1993), and supplement this analysis with an additional discussion of possible onsite and offsite institutional controls.

Response

This comment serves as a summary of the set of specific comments received from the commentors. Therefore, the reader is asked to review the Responsiveness Summary for individual responses.

Table 14-1
Chemical Concentration Data Summary

95th Percentile Upper Confidence Limit on the Geometric Mean of the Median Well Concentrations

(ug/l)

Chemical Name	Shallow Ground-water Monitoring Wells Completed in Weathered Dawson and Waste Pit Liquids Well Points Within the Source Area	Ground-water Monitoring Wells Completed in Weathered Dawson Aquifer Outside of the Source Area	Ground-water Monitoring Wells Completed in Unweathered Dawson Aquifer Outside of the Source Area	Deep Ground-water Monitoring Wells	Upgradient Ground-water Monitoring Wells Outside the Source Area
1,1,1-Trichloroethane	250	120	4.3	15	4.3
1,1,2,2-Tetrachloroethane	31	ND	ND	ND	ND
1,1,2-Trichloroethane	29	5.9	ND	2.6	ND
1,1-Dichloroethane	520	47	3.2	13	ND
1,1-Dichloroethylene	83	41	2.7	11	2.9
1,2,4-Trichlorobenzene	18	7.3	ND	ND	ND
1,2-Dichlorobenzene	18	ND	ND	ND	ND
1,2-Dichloroethane	590	13	4.3	ND	ND
1,2-Dichloroethene (total)	140	31	ND	3.5	ND
1,2-Dichloropropane	29	8.7	ND	2.6	ND
cis-1,3-Dichloropropene	27	ND	ND	ND	ND
trans-1,3-dichloropropene	26	ND	ND	ND	ND
1,4-Dichlorobenzene	21	7.9	ND	ND	ND
2,3,7,8-TCDD (dioxin)a	0.00053	0.000020	0.000024	0.0002	ND
2,4,5-T	3.9	ND	0.27	ND	ND
2,4,5-TP	5.3	ND	ND	ND	ND
2,4,5-Trichlorophenol	90	ND	ND	ND	ND
2,4,6-Trichlorophenol	24	ND	ND	ND	ND
2,4-D	23	1.4	ND	ND	ND
2,4-Dichlorophenol	31	6.4	ND	ND	ND
2,4-Dimethylphenol	80	7.1	ND	ND	ND
2,4-Dinitrophenol	220	ND	ND	ND	ND
2-Butanone (MEK)	980	7.1	5.5	ND	6.1
2-Chloronaphthalene	18	ND	ND	ND	ND
2-Chlorophenol	25	ND	ND	ND	ND
2-Hexanone	45	9.8	5.1	ND	ND
2-Methylnaphthalene	58	ND	ND	ND	ND

Table 14-1
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(ug/l)

Chemical Name	Shallow Ground-water Monitoring Wells Completed in Weathered Dawson and Waste Pit Liquids Well Points Within the Source Area	Ground-water Monitoring Wells Completed in Weathered Dawson Aquifer Outside of the Source Area	Ground-water Monitoring Wells Completed in Unweathered Dawson Aquifer Outside of the Source Area	Deep Ground-water Monitoring Wells	Upgradient Ground-water Monitoring Wells Outside the Source Area
2-Methylphenol	54	6.6	ND	ND	ND
4,4'-DDD	0.19	ND	ND	ND	ND
4,4'-DDE	0.17	ND	ND	ND	ND
4,4'-DDT	0.18	ND	ND	ND	ND
4-Bromophenyl-phenylether	ND	7.9	ND	ND	ND
4-Methyl-2-pentanone(MIBK)	520	10	5.1	6.6	8.4
4-Methylphenol	140	7.1	ND	ND	ND
4-Nitroaniline	ND	40	ND	ND	ND
Acenaphthene	17	7.3	ND	ND	ND
Acetone (2-propanone)	2,800	23	16	35	10
Aldicarb	4	ND	ND	ND	ND
Aldicarb sulfoxide	3	0.71	ND	ND	ND
Alpha chlordane	0.28	ND	ND	ND	ND
Alpha-BHC	0.10	ND	ND	ND	ND
Aluminum	5,200	97	120	340	560
Aniline	94	ND	ND	ND	ND
Anthracene	21	ND	ND	ND	ND
Antimony	52	18	20	3.5	10
Arsenic	110	9.5	2.6	ND	15
Barium	620	53	44	87	48
Benzene	270	6.7	3.0	5.6	ND
Benzo(a)anthracene	17	ND	ND	ND	ND
Benzo(g,h,i)perylene	ND	7.9	ND	ND	ND
Benzoic acid	820	35	ND	ND	41
Benzyl alcohol	53	ND	ND	ND	ND
Beryllium	5	ND	0.97	1.7	1.3
bis(2-chloroethy)ether	22	ND	ND	ND	7.1

Table 14-1
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bis(2-ethylhexyl)phthalate	82	7.3	5.4	9.3	23
Boron	2,700	400	220	310	130
Bromodichloromethane	22	5.1	ND	ND	ND
Bromoform	30	6.1	ND	ND	ND
Butylbenzylphthalate	25	ND	ND	ND	ND
Cadmium	27	ND	2.2	ND	2.6
Carbaryl	5	ND	ND	ND	ND
Carbazole	20	ND	ND	ND	ND
Carbofuran	5	ND	ND	ND	ND
Carbon disulfide	87	7.4	ND	5.1	ND
Carbon tetrachloride	40	ND	ND	ND	ND
Chlorobenzene	32	ND	ND	ND	ND
Chloroethane	62	ND	ND	ND	ND
Chloroform	49	6.6	2.7	2.6	ND
Chloromethane	36	ND	ND	ND	ND
Chromium(total)	40	3.5	5.0	12	13
Chrysene	17	ND	ND	ND	ND
Cobalt	45	11	2.0	20	4.7
Copper	120	10	9.5	15	20
Cyanide	75	ND	13	8.7	3.6
Delta-BHC	0	0.026	ND	ND	ND
DI-n-butylphthalate	20	7.3	5.7	5.5	10
DI-n-octylphthalate	22	ND	ND	8.3	7.8
Dibenzofuran	15	ND	ND	ND	ND
Dibromochloromethane	27	5.5	ND	ND	ND
Dicamba	4	ND	ND	ND	ND
Dieldrin	0.19	ND	ND	ND	ND

Table 14-1
Chemical Concentration Data Summary

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(ug/l)

Chemical Name	Shallow Ground-water Monitoring Wells Completed in Weathered Dawson and Waste Pit Liquids Well Points Within the Source Area	Ground-water Monitoring Wells Completed in Weathered Dawson Aquifer Outside of the Source Area	Ground-water Monitoring Wells Completed in Unweathered Dawson Aquifer Outside of the Source Area	Deep Ground-water Monitoring Wells	Upgradient Ground-water Monitoring Wells Outside the Source Area
Nickel	230	25	9.5	33	30
PCB-1242(Aroclor 1242)	2.03	ND	ND	ND	ND
PCB-1248(Aroclor 1248)	ND	ND	ND	ND	ND
PCB-1260(Aroclor 1260)	2.3	ND	ND	ND	ND
Pentachlorophenol	130	ND	ND	ND	ND
Phenanthrene	36	ND	ND	ND	ND
Phenol	120	7.3	5.7	6.2	6.9
Propoxur	ND	ND	0.92	ND	ND
Pyrene	20	7.3	ND	ND	ND
Selenium	170	29	5.1	2.4	100
Silver	11	3.5	3.8	ND	2.8
Styrene	38	ND	ND	ND	ND
Tetrachloroethylene	190	37	3.4	18	3.5
Thallium	61	6.5	1.6	2.8	ND
Tin	480	40	28	ND	ND
Toluene	1,600	4.9	2.3	13	2.6
Total xylenes	930	15	ND	9.2	ND
Trichloroethylene	250	27	2.9	7.4	2.9
Vanadium	130	15	6.1	15	26
Vinyl chloride	99	8.5	ND	ND	ND
Zinc	410	37	24	40	110

Note: ND = Not detected.

a2,3,7,8-Dioxin equivalent concentration.

Section 15.0
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