Final Five-Year Review Report

Five-Year Review Report
for
Rocky Mountain Arsenal
Commerce City
Adams County, Colorado

October 2000

PREPARED BY:

Department of the Army
Rocky Mountain Arsenal
Commerce City, Colorado

Approved by:

Bruce M Huenefeld

Bruce Huenefeld
RMA Committee Chairman
Rocky Mountain Arsenal

Date:

25 October 2000

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Acronyms

ACGIH	American Conference on Government Industrial Hygienists
ACM	Asbestos Containing Material
APA	Air Pathways Analysis
AR	Army Regulation
ARAR	Applicable or Relevant and Appropriate Requirement
A-TAT	Arsenal Transition and Analysis Team
ATSDR	U.S. Agency for Toxic Substances and Disease Registry
BANCS	Basin A Neck Containment System
BAS	Biological Advisory Subcommittee
bcy	Bank Cubic Yard
BMF	Biomagnification Factor
CAMU	Corrective Action Management Unit
CAB	Citizen Advisory Board
CBSG	Colorado Basic Standard for Groundwater
CBSSW	Colorado Basic Standard for Surface Water
CCD	CERCLA Compliance Document
CCR	Colorado Code of Regulations
CDPHE	Colorado Department of Public Health and Environment
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CFS	Confined Flow System
COC	Chemical of Concern
C/PIP	Cost/Productivity Improvement Program
CPMSO	4-Chlorophenylmethyl sulfoxide
$CPMSO_2$	4-Chlorophenylmethyl sulfone
CQAP	Chemical Quality Assurance Plan
CRL	Certified Reporting Limit
CSRG	Containment System Remediation Goal
CY	Calendar Year
DA	Department of Army
DA PAM	Department of Army Pamphlet
DBCP	Dibromochloropropane
DCPD	Dicyclopentadiene
DDE	2,2-bis (p-chlorophenyl)-1,1-dichloroethene
DDT	2,2-Bis (p-chlorophenyl)-1,1,1-trichloroethane
DIMP	Diisopropylmethyl Phosphonate
DMR	Discharge Monitoring Report
ELF	Enhanced Landfill
ESL	Existing (Sanitary) Landfills
EPA	U.S. Environmental Protection Agency
ESD	Explanation of Significant Differences
f/cc	Fibers Per Cubic Centimeter
FFA	Federal Facility Agreement
FS	Feasibility Study

FWQC	Federal Water Quality Criteria
FY	Fiscal Year
HCCPD	Hexachlorocyclopentadiene
HLA	Harding Lawson Associates
IC-APA	Interactive Comprehensive Air Pathways Analysis
ICS	Irondale Containment System
IEA/RC	Integrated Endangerment Assessment/Risk Characterization
IRA	Interim Response Actions
JARDF	Joint Administrative Record and Document Facility
LTMP	Long-Term Monitoring Plan
LWTS	Hazardous Waste Landfill Wastewater Treatment System
mg/m^3	Milligrams Per Cubic Centimeter
MMAG	Medical Monitoring Advisory Group
MRL	Method Reporting Limit
N/A	Not Applicable Appropriate
NBCS	North Boundary Containment System
NDMA	n-Nitrosodimethylamine
NEPA	National Environmental Policy Act
NWBCS	Northwest Boundary Containment System
NS	Not Specified
OCP	Organochlorine Pesticide
OGITS	Off-Post Groundwater Intercept and Treatment System
O&M	Operation and Maintenance
OSHA	Occupational Safety and Health Administration
OSWER	Office of Solid Waste and Emergency Response
OU	Operable Unit
PCB	Polychlorinated Biphenyl
PCE	Tetrachloroethylene
PL	Public Law
PMRMA	Program Manager for Rocky Mountain Arsenal
ppb	Parts Per Billion
ppm	Parts Per Million
ppt	Parts Per Trillion
PQL	Practical Quantitation Limit
RAB	Restoration Advisory Board
RCRA	Resource Conservation and Recovery Act
RDIS	Remediation Design and Implementation Schedule
RDX	Cyclonite
RMA	Rocky Mountain Arsenal
RMPDC	Rocky Mountain Poison and Drug Center
ROD	Record of Decision
RVO	Remediation Venture Office
RWMP	Remediation Waste Management Plan
SACWSD	South Adams County Water and Sanitation District
SAR	Study Area Report
SEO	State Engineer's Office

SFS	Supplemental Field Study
SQI	Submerged Quench Incinerator
SSAB	Site-Specific Advisory Board
SWAQMP	Site-Wide Air Quality Monitoring Program Plan
SWOMP	Site-Wide Odor Monitoring Program Plan
STEL	Short Term Exposure Limit
TBC	To-Be-Considered Criteria
TBD	To Be Determined
TCE	Trichloroethylene
TCHD	Tri-County Health Department
TCLP	Toxicity Characteristic Leaching Procedure
TLV	Threshold Limit Value
TNT	2,4,6-trinitrotoluene
TSCA	Toxic Substances Control Act
µg/g	Micrograms Per Gram
µg/L	Micrograms Per Liter
UFS	Unconfined Flow System
UV	Ultraviolet
FWS	U.S. Fish and Wildlife Service
UXO	Unexploded Ordnance
VHO	Volatile Halogenated Organic
WY	Water Year

Executive Summary

Background

The Army established Rocky Mountain Arsenal (RMA) in 1942 to produce chemical warfare agents and incendiary munitions used in World War II. Following the war and through the early 1980's, the Army continued to use these facilities. Beginning in 1946, some RMA facilities were leased to private companies to manufacture industrial and agricultural chemicals. Shell, the principal lessee, manufactured primarily pesticides at RMA from 1952 to 1982. Common industrial and waste disposal practices during these years resulted in significant levels of contamination. Approximately 70 chemicals have been the focus of remedial investigations for the On-Post Operable Unit (OU). Of these, the principal contaminants are organochlorine pesticides, heavy metals, agent-degradation products and manufacturing byproducts, and chlorinated and aromatic solvents. The remedial investigation and subsequent investigations have identified chemicals at over 180 sites contaminating soil, ditches, stream and lakebed sediments, sewers, groundwater, surface water, biota, and structures. Unexploded ordnance has been identified at several locations on-site. Contaminated areas include approximately 3,000 acres of soil, 15 groundwater plumes, and 798 remaining structures. Sites that posed potential immediate risks to human health and the environment were addressed through interim response actions (IRAs).

Groundwater contamination migrated off-post prior to the implementation of groundwater pump and treat systems resulting in the necessity for the Off-Post OU. Specifically, the Off-Post OU addressed groundwater contamination north and northwest of RMA. The risk assessment performed for the Off-Post OU indicated that only human exposure via contaminated groundwater needed to be assessed.

Current and future land use for the On-Post OU has been restricted based on the fact that the area is ecologically unique and based on the land use restrictions established by the Federal Facility Agreement. Surrounded by development, the On-Post OU provides a refuge for an abundant diversity of flora and fauna. For this reason the site has been designated as a future National Wildlife Refuge in accordance with the Rocky Mountain Arsenal National Wildlife Refuge Act of 1992 (PL 102-402). As components of the remedy are completed, jurisdiction will be transferred to the U.S. Fish and Wildlife Service except for the property and facilities continuing to be used for response actions. This transfer may occur in total at one point in time or in portions over an extended period. In addition, the site will be subject to restrictions prohibiting residential or industrial use; use of water on the site as a source of potable water; hunting and fishing for consumptive use; and agricultural use. Current and future land use of the Off-Post OU has not been restricted, though groundwater use has been restricted through a series of institutional controls identified in the Off-Post Record of Decision (ROD) which was signed on 19 December 1995.

Requirement

Section 121(c) of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) as amended by the Superfund Amendments and Reauthorization Act of 1986, together with the implementing regulation in the National Oil and Hazardous Substance Pollution Contingency Plan, requires that remedial actions resulting in any hazardous substances, pollutants, or contamination remaining at the site above levels that allow for unlimited use and unrestricted exposure be reviewed every five years to assure protection of human health and the environment. This requirement applies to RMA and consequently this report is RMA's first Five-Year Review.

RMA's Five-Year Review was conducted by the Army in accordance with Paragraph 36.3 of the Federal Facility Agreement (FFA)(US EPA et al 1989) and CERCLA, Section 121(c).

This Five-Year Review primarily consisted of a thorough review of relevant documents. Appropriate documents were referenced in this review to substantiate conclusions reached. Interviews were conducted, as appropriate, with on-site personnel. Notices in local newspapers provided public notification of this review in April and September 2000. The purpose of the Five-Year Review is to determine whether the remedy for RMA selected in the RODs remains protective of human health and the environment; is functioning as designed; and necessary operations and maintenance is being performed.

Conclusions

Protectiveness Statements:

The protection of human health and the environment of the remedial actions at both the On-Post and Off-Post OUs is discussed below. All controls are in place to adequately minimize risks. Because the remedial actions at both the On-Post and Off-Post OUs are expected to be protective of human health and the environment upon completion, the remedy for the entire site is expected to be protective of both human health and the environment.

On-Post Operable Unit

The remedy at the On-Post OU is expected to be protective of human health and the environment upon completion. All immediate threats have been adequately addressed in the form of IRAs and their continued effectiveness has been assured by transferring them administratively into specific, related remedial projects under the On-Post ROD, as appropriate. The Hazardous Waste Landfill, which is central to the effective implementation of the remedy, has been expeditiously constructed and is operational. All other implementation projects are on schedule and in compliance with all elements of the On-Post ROD. Air, water, and biota monitoring programs are comprehensive in their design and effective in their implementation. Contaminant migration is being adequately controlled. Risks to human health and the environment are also being controlled by a comprehensive worker protection and access control program, institutional controls, and the past implementation of IRAs.

Off-Post Operable Unit

The remedy at the Off-Post OU is expected to be protective of human health and the environment upon completion. All immediate threats have been adequately addressed in the form of IRAs and their continued effectiveness has been assured by transferring them administratively into specific, related remedial projects under the Off-Post ROD, as appropriate. Administrative controls to protect the public have been effective in their implementation. Groundwater contamination is being treated to ROD remediation goals both at the RMA boundary as well as at the Off-Post Groundwater Intercept and Treatment System.

Deficiencies:

Basin F Wastepile - The Basin F Wastepile is not operating as designed. Very little leachate is being collected in the primary system while larger volumes are being collected by the secondary sump system.

Off-Post Institutional Controls – The requirement to include a distinctive notice on each well permit application correspondence, well permit, and drilling permit was not followed for 10 of the 26 well applications received in the area north of RMA specified by the Off-Post ROD.

Recommendations and Follow-up Actions:

Basin F Wastepile – All evidence indicates that this deficiency is not impacting the groundwater. It should be noted that the leachate volume currently being generated (24,650 gallons in calendar year [CY] 1999) is dramatically less than it has been in the past (81,336 gallons in CY1990) due to the gradual dewatering of the waste. Although no new action is recommended to address the deficiency noted above, the collection system and the leachate levels should continue to be carefully monitored on a daily basis until the wastepile is addressed as directed in the On-Post ROD. The On-Post ROD requires the Basin F Wastepile to be re-excavated and placed in a new triple-lined landfill currently scheduled to begin operation in September 2004.

Off-Post Institutional Controls - The following are recommendations and follow-up actions for improving the well notification program. They should be implemented no later than three months after the issuance of this report.

- The State Engineer's Office (SEO) has the responsibility of providing notification to well permit applicants. RMA will set up periodic meetings (e.g., annually) with the SEO staff to review the status of well applications from the potentially affected area. The purpose of the meeting will be to determine if correspondence associated with the applications includes the proper notification.
- The SEO will provide the Army and the Tri-County Health Department (TCHD) copies of all well applications for the potentially affected area.
- When warranted, RMA will request TCHD to make individual contact with well applicants to provide detailed explanation of the nature and extent of groundwater contamination in the off-post area.

Quantitation Limits – To ensure a more effective implementation of the remedy, the new procedure identified in the Five-Year Review Report to ensure new quantitation limits for Containment System Remediation Goals (CSRGs) are implemented in a timely and consistent manner should be immediately implemented. This new procedure provides a mechanism for reviewing and changing the Method Reporting Limits (MRL) and the Practical Quantitation Limits (PQL) originally listed in the RODs on a five-year cycle. The next MRL/PQL review is therefore scheduled for 2005. In addition to defining a procedure for adopting new quantitation limits, new quantitation limits should be adopted as identified in the Five-Year Review Report.

Endrin Applicable or Relevant and Appropriate Requirement (ARAR) – The endrin ARAR (applicable as a CSRG) should be changed from 0.2 µg/L (micrograms per liter) to 2.0 µg/L to reflect the relaxation in the Colorado Basic Standard for Groundwater for endrin. This change should be effected via an Explanation of Significant Differences (ESD) to be completed no later than six months after the issuance of this report. This change is recommended as an optimization step.

CERCLA Compliance Document (CCD) for the Hazardous Waste Landfill Wastewater Treatment System - During the next annual review of the CCD the revised Federal Water Quality Criteria detailed in the Five-Year Review Report should be taken into consideration and changes, as appropriate, should be incorporated.

Changes in Polychlorinated Biphenyl Decontamination Standards – The updated provisions of the Code of Federal Regulations, Title 40, Section 761.79 should be adopted within three months of the issuance date of this report. This is recommended to better ensure the protective implementation of the remedy in the future.

Private Well Network - The number of off-post confined flow system wells monitored as part of the Private Well Network project should be reduced based on evidence presented in the Five-Year Review Report. The following wells should be monitored for diisopropylmethyl phosphonate; 1070B, 343A, 359A, 486C, 588A, 589A, 848A, and 914B. Wells 1070B and 914B should also be monitored for chloroform. This sampling should continue annually until contaminant concentrations fall below analytical reporting limits, or until the well has been sampled at least five times and the mean concentration plus two standard deviations is less than the CSRG. These new criteria for evaluating wells in the Private Well Network should be implemented via an ESD or a Fact Sheet. This ESD or Fact Sheet should be submitted for approval within three months of the issuance date of this report.

Five-Year Review Summary Form

SITE IDENTIFICATION		
Site Name: Rocky Mountain Arsenal		
EPA ID: CO5210020769		
Region: VIII	**State:** CO	**City/County:** Commerce City/Adams County

SITE STATUS		
NPL Status: ☒ **Final** ☐ **Deleted** ☐ **Other (specify)**_____		
Remediation Status: ☒ **Under Construction** ☒ **Operating** ☒ **Complete**		
Multiple OUs? ☒ **Yes** ☐ **No**	**Construction Completion Date:** April 21, 2011	
Has site been put into reuse? ☐ **Yes** ☒ **No**		

REVIEW STATUS	
Reviewing Agency: ☐ **EPA** ☐ **State** ☐ **Tribe** ☒ **Other Federal Agency:** Army	
Author Name: Bruce Huenefeld	
Author Title: RMA Committee Chairman	**Author Affiliation:** Army
Review Period: December 19, 1995 – July 6, 2000	
Date(s) of Site Inspection: October 1, 1999 – July 6, 2000	
Type of review: ☒ **Statutory** ☐ **Policy (Post-SARA)**	
Review Number: ☒ **First** ☐ **Second** ☐ **Third** ☐ **Other (specify)**_____	
Triggering Action: ☐ **Actual RA Onsite Construction at OU** ☐ **Actual RA Start at OU** ☐ **Construction Completion** ☐ **Previous Five-Year Review Report** ☒ **Other (specify):** Issuance date of Off-Post ROD	
Triggering Action Date: December 19, 1995	
Due Date: December 19, 2000	

Five-Year Review Summary Form

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1.0 INTRODUCTION

1.1 General

Section 121(c) of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) as amended by the Superfund Amendments and Reauthorization Act of 1986, together with the implementing regulation in the National Oil and Hazardous Substance Pollution Contingency Plan, requires that remedial actions resulting in any hazardous substances, pollutants, or contamination remaining at the site above levels that allow for unlimited use and unrestricted exposure be reviewed every five years to assure protection of human health and the environment. This requirement applies to Rocky Mountain Arsenal (RMA) and consequently this report is RMA's first Five-Year Review.

RMA's Five-Year Review was conducted by the Army in accordance with Paragraph 36.3 of the Federal Facility Agreement (FFA)(US EPA et al 1989) and CERCLA, Section 121(c).

The U.S. Department of the Army (Army) has conducted the first Five-Year Review of the CERCLA remedial actions implemented at the Rocky Mountain Arsenal (RMA) site in Commerce City, Colorado. This review was conducted from October 1999 through July 2000. This report documents the results of the review. The purpose of a Five-Year Review is to determine whether the implementation of the remedy at a site is protective of human health and the environment and that it will remain protective when complete. For elements of the remedy that are under construction, or have not yet begun, the purpose of the review is to confirm that immediate threats have been addressed. U.S. Environmental Protection Agency (EPA) guidance states "the main purpose of the Five-Year Review is not to reconsider decisions made during the selection of the remedy, but to evaluate the implementation and performance of the selected remedy" (EPA 1999). This Report provides a detailed discussion of the conclusions reached and recommendations made.

EPA guidance requires Five-Year Reviews to be conducted on a site-wide basis. For the RMA, this includes the On-Post Operable Unit (OU), the Off-Post OU, and all Interim Response Actions (IRAs) implemented prior to the signing of the Records of Decision (ROD). The review of the IRAs, the On-Post OU, and the Off-Post OU is required by statute. The schedule for conducting this Five-Year Review is based upon the signature of the Off-Post ROD (HLA 1995) on December 19, 1995.

Due to the size and complexity of the RMA site, and to keep this report as clear and readable as possible, other documents are routinely referenced as sources for more detailed information.

1.2 Structure of Report

The general structure of this report was based on guidance provided by the EPA (EPA 1999). To enable the reader to better understand this report the following breakdown of the report is provided.

Section 1.0, Introduction – Provides the legal basis and the objectives for the review as well as description of the report's structure.

Section 2.0, Site Chronology – Provides a chronology of past events at RMA.

Section 3.0, Background – Provides historical information on RMA to include a description of past operations, a listing of chemicals of concern, and information on current and future land use.

Section 4.0, Remedial Actions – Provides a listing of components of the remedy in the Off-Post and On-Post OUs as provided in the On-Post and Off-Post RODs, a listing of IRAs, and a table listing individual projects that make up the remedy. This listing of projects was developed solely for the purpose of the Five-Year Review to provide a clear structure by which to evaluate the remedy.

Section 5.0, Five-Year Review Process – Provides a list of participants in the Five-Year Review process as well as detailing the approach taken in performing this review.

Section 6.0, Five-Year Review Findings – Details the findings of the Five-Year Review. This includes a section evaluating changes to regulations and standards that apply to the remedy, a section reviewing data collected in the groundwater, surface water, biota, and air monitoring programs, and a section summarizing remedy costs.

Section 7.0, Assessment – Uses information provided in Section 6.0 as well as additional information gathered in the review process to answer two key questions.

> **Section 7.1** – Answers the question "is the remedy functioning as intended by the decision documents?" This includes a review of steps taken to control risk on-site and a review of all completed, ongoing, operations and maintenance, and operational projects. Definitions of these terms are included in this section. This section also includes information on remedy optimization and an evaluation of potential remedy failure.
>
> **Section 7.2** – Answers the question "are the assumptions used at the time of the remedy selection still valid?" This includes a review of risk assessment assumptions as well as a discussion of the impact of changes to regulations and standards detailed in Section 6.0.
>
> **Section 7.3** – States that there is no other new information relevant to the review that was not discussed in Sections 7.1 and 7.2.

Section 8.0, Conclusions – Provides a succinct statement of the conclusions drawn in Section 7.0 based on information detailed in both Sections 6.0 and 7.0.

Section 9.0, Recommendations and Follow-up Actions – Details follow-up actions necessary to address the conclusions stated in Section 8.0.

Section 10.0, Protectiveness Statements – Provides protectiveness statements for both the On-Post and Off-Post OUs.

Section 11.0, Next Review – Details when the next Five-Year Review is scheduled to take place.

2.0 SITE CHRONOLOGY

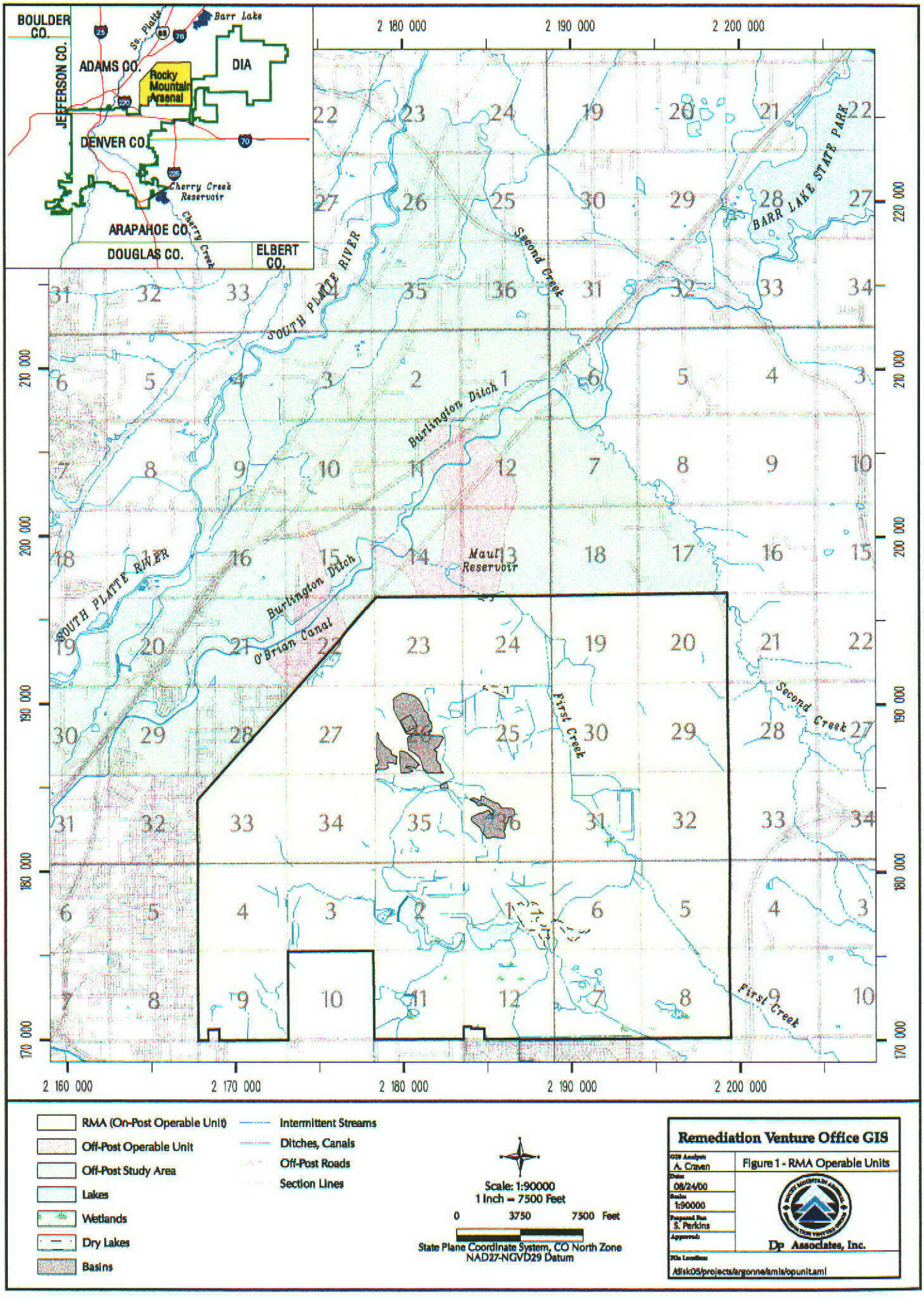
Table 1 lists the chronology of events for the RMA site.

Table 1 - Chronology of Events

Date	Event
1942	Establishment of RMA
Late 1950's	Off-post groundwater contamination first suspected
1974	Army establishes the RMA Contamination Control Program
Apr. 1975	Colorado Department of Health issues a Cease and Desist Cleanup and Monitoring Order to RMA in connection with the alleged pollution of ground and surface waters north of RMA
1977	Army installs pilot groundwater containment system at the north boundary
1978-1984	Army and Shell install three boundary groundwater containment systems
1984	Site proposed for addition to the National Priorities List
1984	Army completes a Preliminary Assessment and Site Inspection that identifies 179 potentially contaminated sites
1985	First Interim Response Action completed
Aug. 1987	Rocky Mountain Arsenal added to the National Priorities List
Feb. 1989	**FEDERAL FACILITY AGREEMENT SIGNED**
Jan. 1992	Remedial Investigation completed
Dec. 1992	Development and Screening of Alternatives completed
Oct. 1995	Detailed Analysis of Alternatives completed
Dec. 1995	Record of Decision signed for Off-Post Operable Unit
Jun. 1996	Record of Decision signed for On-Post Operable Unit

3.0 BACKGROUND

The RMA site is comprised of two OUs: On-Post and Off-Post. Figure 1 provides the location of both OUs. The On-Post OU consists of all of RMA and occupies approximately 27 square miles in southern Adams County, approximately 10 miles northeast of downtown Denver. The Off-Post OU encompasses a groundwater plume which underlies rural, agricultural, commercial, residential, and industrial zoned areas north and northwest of RMA as well as property


BOULDER CO.
JEFFERSON CO.
ADAMS CO.
Rocky Mountain Arsenal
DIA
DENVER CO.
ARAPAHOE CO.
DOUGLAS CO.
ELBERT CO.
So. Platte
Barr Lake
Cherry Creek Reservoir
Cherry Creek
2 180 000
2 190 000
2 200 000
2 160 000
2 170 000
220 000
210 000
200 000
190 000
180 000
170 000
SOUTH PLATTE RIVER
Second Creek
BARR LAKE STATE PARK
Burlington Ditch
Maul Reservoir
O'Brian Canal
First Creek
RMA (On-Post Operable Unit)
Off-Post Operable Unit
Off-Post Study Area
Lakes
Wetlands
Dry Lakes
Basins
Intermittent Streams
Ditches, Canals
Off-Post Roads
Section Lines
Scale: 1:90000
1 Inch = 7500 Feet
0
3750
7500 Feet
State Plane Coordinate System, CO North Zone
NAD27-NGVD29 Datum
Remediation Venture Office GIS
GIS Analysts: A. Craven
Figure 1 - RMA Operable Units
Date: 08/24/00
Scale: 1:90000
Prepared For: S. Perkins
Approved:
DP Associates, Inc.
File Location: /disk05/projects/argonne/ams/opunit.aml

purchased by Shell where the Off-Post Groundwater Intercept and Treatment System (OGITS) is located.

The Army established RMA in 1942 to produce chemical warfare agents and incendiary munitions used in World War II. Following the war and through the early 1980's, the Army continued to use these facilities. Beginning in 1946, some RMA facilities were leased to private companies to manufacture industrial and agricultural chemicals. Shell Oil Corporation (Shell), the principal lessee, manufactured primarily pesticides at RMA from 1952 to 1982. Common industrial and waste disposal practices during these years resulted in significant levels of contamination. Approximately 70 chemicals have been the focus of remedial investigations for the On-Post OU. Of these, the principal contaminants are organochlorine pesticides, heavy metals, agent-degradation products and manufacturing byproducts, and chlorinated and aromatic solvents. Specific chemicals of concern (COC) that have been identified are listed in Table 2. The remedial investigation and subsequent investigations have identified chemicals at over 180 sites with contaminated soil, ditches, stream and lakebed sediments, sewers, groundwater, surface water, biota, and structures. These contaminated areas include approximately 3,000 acres of soil, 15 groundwater plumes, and 798 remaining structures. Sites that posed potential immediate risks to human health and the environment were addressed through IRAs (see Table 3).

Groundwater contamination migrated off-post prior to the implementation of groundwater pump and treatment systems resulting in the necessity for the Off-Post OU. Specifically, the Off-Post OU addressed groundwater contamination north and northwest of RMA. The risk assessment performed for the Off-Post OU indicated that the only exposure pathway to address was human exposure via contaminated groundwater.

IRAs were determined to be necessary to mitigate the impact of contamination at several sites prior to selection of a final remedy. These interim actions are described in the IRA Summary Reports (EPA et al. 1997, 1997a, 1997b, 1999, 1999a, 1999b, 1999c, 2000, 2000a, 2000b, 2000c, 2000d, 2000e, 2000f, 2000g, 2000h, 2000i, 2000j, 2000k, 2000l, 2000m, 2000n, 2000o). Most of these actions were completed before the RODs were issued though some are ongoing in nature (i.e., groundwater treatment systems) and have been incorporated into the RODs. An assessment of these IRAs is included in Section 7.0. All interim actions necessary to mitigate immediate risks have been implemented and those that are ongoing have been incorporated into ROD-mandated projects and are evaluated as such.

Table 2 – Chemicals of Concern

On-Post OU Soil COCs[1]	Off-Post OU Soil COCs[2]	Off-Post OU Sediment COCs[3]	Off-Post OU Groundwater COCs[4]	Off-Post OU Surface Water COCs[5]
ALDRIN	Aldrin	Aldrin	Aldrin	Arsenic
Arsenic	Chlordane	Dibromochloropropane	Arsenic	Chlordane
Benzene	Dieldrin	Dieldrin	Atrazine	Chloride
Cadmium	Endrin	Endrin	Benzene	Dicyclopenta-diene
Carbon Tetrachloride	DDE	DDE	Carbon tetrachloride	DDE
Chlordane	DDT	DDT	Chlordane	DDT
Chloroacetic Acid			Chloride	Dieldrin
Chlorobenzene			Chlorobenzene	DIMP
Chloroform			Chloroform	Fluoride
Chromium			CPMSO	Sulfate
DBCP			$CPMSO_2$	
DCPD			Dibromochloro-propane	
DDE			1,2-Dichloro-ethane	
DDT			Dicyclopenta-diene	
1,2-Dichloro-ethane			DDE	
1,1-Dichloroethylene			DDT	
Dieldrin			Dichlorobenzene	
Endrin			DIMP	
HCCPD			Dieldrin	
Isodrin			Dithiane	
Lead			Endrin	
Mercury			Ethylbenzene	
Methylene Chloride			Fluoride	
1,1,2,2-Tetrachloroethane			HCCPD	
Tetrachloro-ethylene			Isodrin	
Toluene			Malathion	
Trichloroethene			Manganese	
			Oxathiane	
			Sulfate	

On-Post OU Soil COCs[1]	Off-Post OU Soil COCs[2]	Off-Post OU Sediment COCs[3]	Off-Post OU Groundwater COCs[4]	Off-Post OU Surface Water COCs[5]
			Tetrachloro-ethene	
			Toluene	
			Trichloroethene	
			Xylene	

[1] = From Table 6.1-1, On-Post ROD
[2] = From Table 6.4, Off-Post ROD
[3] = From Table 6.3, Off-Post ROD
[4] = From Table 6.1, Off-Post ROD
[5] = From Table 6.2, Off-Post ROD

CPMSO	4-Chlorophenylmethyl sulfoxide
$CPMSO_2$	4-Chlorophenylmethyl sulfone
DBCP	Dibromochloropropane
DDE	2,2-bis(p-chlorophenyl)-1,1-dichloroethene
DDT	2,2-Bis(p-chlorophenyl)-1,1,1-trichloroethane
DIMP	Diisopropylmethyl phosphonate
HCCPD	Hexachlorocyclopentadiene

Note: No risk assessment was conducted for on-post groundwater, in accordance with the FFA, which prohibits potable use of groundwater and surface water along with agricultural activities and consumption of fish and game. Risk assessments were conducted for soil and off-post groundwater for which COCs were identified. During the investigation leading up to the ROD, groundwater monitoring was conducted for the analyte lists identified through the Comprehensive Monitoring Program and Groundwater Monitoring Program. Modifications to these programs were made during the course of the investigation in response to requests from all parties. The Containment System Remediation Goal (CSRG) lists that apply to effluents for the different on-post containment/treatment systems were derived from the Groundwater Monitoring Program analyte list, but it should be noted that these are different for the different systems.

Current and future land use for the On-Post OU has been restricted based on the fact that the area is ecologically unique and based on the land use restrictions established by the FFA. Surrounded by development, it provides a refuge for an abundant diversity of flora and fauna. For this reason the site has been designated as a future national wildlife refuge by the Rocky Mountain Arsenal National Wildlife Refuge Act of 1992 (PL 102-402) (Refuge Act). As components of the remedy are completed, jurisdiction over the site will be transferred to the U.S. Fish and Wildlife Service (FWS) except for the property and facilities continuing to be used for response actions (e.g., landfills and groundwater treatment systems). This transfer may occur in total at one point in time or in portions over an extended period. In addition, the site will be subject to restrictions prohibiting residential or industrial use; use of waster on the site as a source of

potable water; hunting and fishing for consumptive use; and agricultural use in accordance with the On-Post ROD (Foster Wheeler 1996), the Refuge Act, and the FFA. Current and future land use of the Off-Post OU has not been restricted, though groundwater use through new wells has been restricted through a series of institutional controls identified in the Off-Post ROD and assessed in Section 7.1.3.2 of this report.

4.0 REMEDIAL ACTIONS

This section lists the elements of the remedy that are presented in the On- and Off-Post RODs. For the purposes of this review, the remedy has been divided into 98 specific projects. When viewed in total, these projects encompass all aspects of the remedy set forth in the RODs.

4.1 Remedy Selection – On-Post OU

The On-Post ROD specified that the remedy address four essential components (water, structures, soil, and other). These are described below. A more detailed description of these components is available in the On-Post ROD. These components were reconfigured into a design/construction-oriented approach as detailed in the Remediation Design and Implementation Schedule (RDIS) (PMRMA 1999f). The "implementation projects" specifically identified by the RDIS are identified in Figure 2.

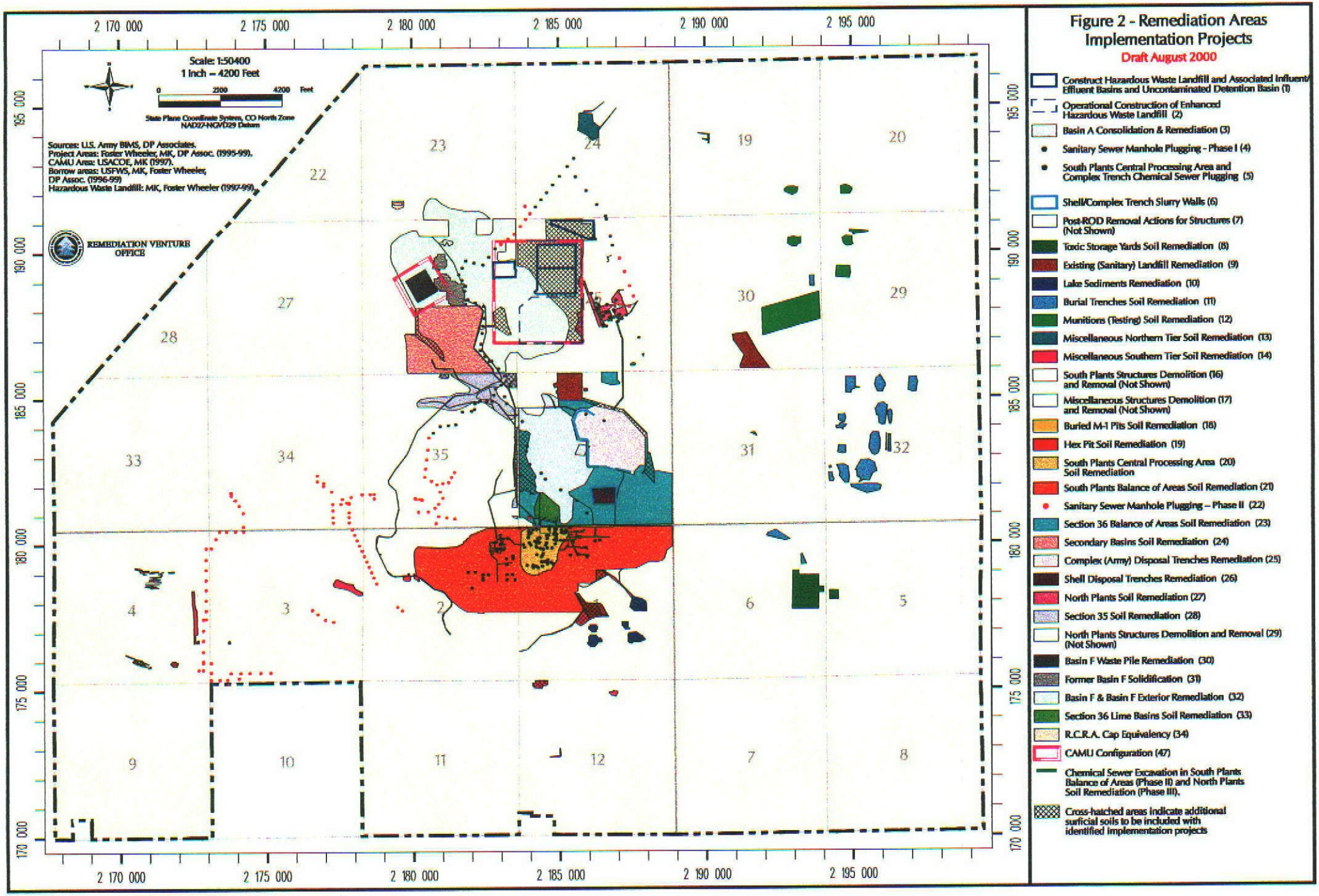
The On-Post ROD includes the following remedial action components:

Water

- Operation of the three boundary systems, the North Boundary Containment System (NBCS), Northwest Boundary Containment System (NWBCS), and Irondale Containment System (ICS), continues. These systems include extraction and recharge systems, slurry walls (NBCS and NWBCS) for hydraulic controls, and carbon adsorption for removal of organics. The systems will be operated until shut-off criteria, as described in the On-Post ROD, are met.

- Operation of existing on-post groundwater IRA systems continues. The Motor Pool and Rail Yard IRA systems, which pipe water to the ICS for treatment, will be shut down when shut-off criteria, as described in the On-Post ROD, are met. The Basin F extraction system continues to extract water that is treated at the Basin A Neck system and the Basin A Neck system continues to extract and treat water from Basin A until shut-off criteria are met.

- A new extraction system will be installed in the Section 36 Bedrock Ridge area. Extracted water will be piped to the Basin A Neck system for treatment (e.g., by air stripping or carbon adsorption).



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- Water levels in Lake Ladora, Lake Mary, and Lower Derby Lake will be maintained to support aquatic ecosystems. The biological health of the ecosystems will continue to be monitored.

  Lake-level maintenance or other means of hydraulic containment or plume control will be used to prevent South Plants plumes from migrating into the lakes at concentrations exceeding Colorado Basic Standards for Groundwater (CBSG) in groundwater at the point of discharge. Groundwater monitoring will be used to demonstrate compliance.

- Confined aquifer wells are monitored in the South Plants, Basin A, and Basin F areas. Specific monitoring wells will be selected during remedial design.

- Those monitoring wells installed in the confined aquifer that may represent pathways for migration from the unconfined aquifer (approximately 30-40 wells) are closed and sealed; replacement wells will be installed if the Parties jointly determine that specific wells to be closed are necessary for future monitoring.

- Chloride and sulfate are expected to attenuate naturally to the CSRGs.

- Monitoring and assessment of n-Nitrosodimethylamine (NDMA) contamination will be performed in support of design refinement/design characterization to achieve remediation goals specified for the boundary groundwater treatment systems.

Structures

- All No Future Use structures will be demolished.

- Agent History structures will be monitored for the presence of Army chemical agent, and treated by caustic washing as necessary prior to disposal.

- Both Agent History and Significant Contamination History Group structural debris will be disposed in the on-site Hazardous Waste Landfill (HWL).

- Other Contamination History Group structural debris will be used as grade fill in Basin A, which will subsequently be covered as part of the soil remediation.

- Structural assessments and review of asbestos containment material (ACM) and polychlorinated biphenyl (PCB) contamination status and disposition of ACM or PCB-contaminated materials will be performed as described in the On-Post ROD .

- Process-related equipment not remediated as part of the Chemical Process-Related Activities IRA will be disposed in the on-post HWL.

Soil

- On-Post HWL - Construction of a Resource Conservation and Recovery Act (RCRA)- and Toxic Substances Control Act (TSCA)-compliant HWL on-post.

- Former Basin F - Treatment of approximately 180,000 bcy of principal threat soil in the Former Basin F to a depth of 10 feet (measured from below the base of the overburden) using in situ solidification/stabilization to reduce the mobility of the contaminants and minimize further contamination of groundwater. The mixture of solidification agents will be determined during remedial design by treatability testing. This treatability testing will be used to verify the effectiveness of the treatment process and establish operating parameters for the design of the full-scale operation. The entire site is capped (including the Basin F Wastepile footprint) with a RCRA-equivalent cap that includes a biota barrier.

- Basin F Wastepile - Excavation of approximately 600,000 bcy of principal threat soil and liner materials from the wastepile and containment in dedicated triple-lined landfill cells at the on-post HWL facility. Excavation is conducted using vapor- and odor-suppression measures as necessary. If the wastepile soil fails EPA's paint filter test, the moisture content of the soil will be reduced to acceptable levels by using a dryer in an enclosed structure. Any volatile organics (and possibly some semivolatile organics) released from the soil during the drying process are captured and treated; however, the main objective of this process is drying. Prior to excavation of the wastepile, overburden from the existing cover is removed and set aside. The excavation area is backfilled with on-post borrow material and stockpiled overburden.

- Basin A - Construction of a soil cover consisting of a 6-inch-thick layer of concrete and a 4-feet-thick soil/vegetation layer over the principal threat and human health exceedance soil and soil posing a potential risk to biota, and consolidation of debris and soil posing a potential risk to biota and structural debris from other sites. No RCRA-listed or RCRA-characteristic waste from outside the Area of Contamination will be placed in Basin A. Any unexploded ordnance (UXO) encountered will be removed and transported off-post for detonation (unless the UXO is unstable and must be detonated on-post) or other demilitarization process.

- South Plants Central Processing Area - Excavation and landfill of principal threat and human health exceedance soil to a depth of five feet and caustic washing and landfill of any agent-contaminated soil found during monitoring. Backfill excavation and placement of a soil cover consisting of a one-foot-thick biota barrier and a four-feet-thick soil/vegetation layer over the entire site to contain the remaining human health exceedance soil and soil posing a potential risk to biota. Soil posing a potential risk to biota from other portions of South Plants may be used as backfill and/or gradefill prior to placement of the soil cover.

- South Plants Ditches - Excavation and landfill of principal threat and human health exceedance soil. Excavation of soil posing a potential risk to biota and consolidation

under the South Plants Central Processing Area soil cover. Backfill excavated area with on-post borrow material. These sites are contained under the South Plants Balance of Areas soil cover.

- South Plants Balance of Areas - Excavation (maximum depth of 10 feet) and landfill of principal threat and human health exceedance soil and caustic washing and landfill of any agent-contaminated soil found during monitoring. Any UXO encountered will be excavated and transported off-post for detonation (unless the UXO is unstable and must be detonated on-post) or other demilitarization process. Excavation of soil posing a potential risk to biota and consolidation as backfill and/or gradefill under the South Plants Central Processing Area soil cover and/or for use as backfill for excavated areas within this medium group. The former human health exceedance area is covered with a three-feet-thick soil cover and the former potential risk to biota area is covered with a one-foot-thick soil cover. Prior to placing this cover, two composite samples per acre will be collected to verify that the soil under the one-foot-thick soil cover does not exceed human health or principal threat criteria. If the residual soil is found to exceed these levels, the three-feet-thick cover will be extended over these areas or the exceedance soil will be excavated and landfilled. The top one foot of the entire soil cover area will be constructed using soil from the on-post borrow areas.

- Section 36 Balance of Areas - Excavation and landfill of human health exceedance soil and UXO debris and excavation and consolidation to Basin A of soil posing a potential risk to biota. The consolidated material is contained under the Basin A cover and the human health excavation area is backfilled with on-post borrow material. Prior to excavation, a geophysical survey is conducted to locate potential UXO. Any UXO encountered will be excavated and transported off-post for detonation (unless the UXO is unstable and must be detonated on-post) or other demilitarization process. Caustic washing and landfill of any agent-contaminated soil found during monitoring. The former human health exceedance area is covered with a two-feet-thick soil cover and the former potential risk to biota area is covered with a one-foot-thick soil cover.

- Secondary Basins - Excavation and landfill of human health exceedance soil. The excavated area is backfilled with on-post borrow material. A two-feet-thick soil cover is placed over the entire area of Basins B, C, and D, including the potential biota risk area.

- Complex Trenches - Construction of a RCRA-equivalent cap, including a six-inch-thick layer of concrete, over the entire site. Installation of a slurry wall into competent bedrock around the disposal trenches. Dewatering within the slurry wall is assumed for purposes of conceptual design and will be reevaluated during remedial design. Soil excavated for the slurry wall trench is graded over the surface of the site and is contained under the cap. Prior to installing the slurry wall and cap, a geophysical survey is conducted to locate potential UXO within construction areas. Any UXO encountered will be removed and transported off-post for detonation (unless the UXO is unstable and must be detonated on-post) or other demilitarization process.

- Shell Trenches - Modification of the existing soil cover to be a RCRA-equivalent cap with a biota barrier. Expansion of the existing slurry wall around the trenches. Dewatering within the slurry wall is assumed for purposes of conceptual design and will be re-evaluated during remedial design. Soil excavated for the slurry wall trench is graded over the surface of the site and is contained under the cap.

- Hex Pit - Treatment of approximately 1,000 bcy of principal threat material using an innovative thermal technology. The remaining 2,300 bcy are excavated and disposed in the on-post HWL. Remediation activities are conducted using vapor- and odor-suppression measures as required. Treatability testing will be performed during remedial design to verify the effectiveness of the innovative thermal process and establish operating parameters for the design of the full-scale operation. The innovative thermal technology must meet the treatability study technology evaluation criteria described in the dispute resolution agreement (PMRMA 1996b). Solidification/stabilization will become the selected remedy if all evaluation criteria for the innovative thermal technology are not met. Treatability testing for solidification will be performed to verify the effectiveness of the solidification process and determine appropriate solidification/stabilization agents.

- Section 36 Lime Basins - Excavation and containment of principal threat and human health exceedance soil in a triple-lined landfill cell at the on-post HWL facility. Prior to excavation of exceedance soil, overburden from the existing cover is removed and set aside. The excavated area is backfilled with clean borrow and the soil cover is repaired. Caustic washing and landfill of any agent-contaminated soil found during monitoring.

- Buried M-1 Pits - Approximately 26,000 bcy of principal threat and human health exceedance soil is treated by solidification/stabilization and then landfilled. The mixture of solidification/stabilization agents will be determined during remedial design by treatability testing. This treatability testing will be used to verify the effectiveness of the treatment process and establish operating parameters for the design of the full-scale operation. Excavation is conducted using vapor- and odor-suppression measures. Caustic washing and landfill of any agent-contaminated soil found during monitoring. The excavated area is backfilled with clean borrow.

- Burial Trenches -UXO in these sites is located using a geophysical survey, excavated, and transported off-post for detonation (unless the UXO is unstable and must be detonated on-post) or other demilitarization process. Excavation and landfill of human health exceedance soil and backfill with on-post borrow material. Caustic washing and landfill of any agent-contaminated soil found during monitoring. Removal and landfill of munitions debris and nearby soil in excess of the Toxicity Characteristic Leaching Procedure (TCLP).

- Chemical Sewers - For sewers located within the South Plants Central Processing Area and Complex Trenches area, the sewer void space is plugged with a concrete mixture to prohibit access to these lines and eliminate them as a potential migration pathway for contaminated groundwater. The plugged sewers are contained beneath the soil cover or

cap in their respective sites. For sewers located outside the South Plants Central Processing Area and Complex Trenches areas, sewer lines and principal threat and human health exceedance soil are excavated and landfilled. Any agent-contaminated soil found during monitoring is caustic washed and landfilled. Prior to excavation of exceedance soil, overburden is removed and set aside. The excavated area is backfilled with on-post borrow material and the overburden replaced.

- Sanitary/Process Water Sewers - Void space inside sewer manholes is plugged with a concrete mixture to prohibit access and eliminate the manholes as a potential migration pathway for contaminated groundwater. Aboveground warning signs are posted every 1,000 feet along the sewer lines to indicate their location underground.

- North Plants - Excavation and landfill of human health exceedance soil. Any agent-contaminated soil found during monitoring is caustic washed and landfilled. The excavated area is backfilled with on-post borrow material. A two-feet-thick soil cover is placed over the soil posing a potential risk to biota and the footprint of the North Plants processing area.

- Toxic Storage Yards - Excavation and landfill of human health exceedance soil. Any agent-contaminated soil found during monitoring is caustic washed and landfilled. The excavated area is backfilled with on-post borrow material. The New Toxic Storage Yards are used as a borrow area for both low-permeability soil and structural fill.

- Munitions Testing - UXO in these sites is located using a geophysical survey, excavated, and transported off-post for detonation (unless the UX0 is unstable and must be detonated on-post) or other demilitarization process. Removal and landfill of munitions debris and nearby soil in excess of TCLP.

- Lake Sediments - Excavation and landfill of human health exceedance soil and excavation and consolidation of soil posing risk to biota from Upper Derby Lake to Basin A. The excavated human health exceedance area is backfilled with on-post borrow material and the consolidated material is contained under the Basin A cover. Aquatic sediments are left in place and the area is monitored to ensure that the sediments continue to pose no unacceptable risk to aquatic biota.

- Ditches/Drainage Areas - Excavation and consolidation to Basin A of soil posing a potential risk to biota. The consolidated material is contained under the Basin A cover. The excavated area is backfilled with on-post borrow material.

- Sanitary Landfills - Excavation and landfill of human health exceedance soil and excavation and consolidation to Basin A of landfill debris and soil posing a potential risk to biota. The consolidated material is contained under the Basin A cover. The excavated area is backfilled with on-post borrow material.

- Buried Sediments - Excavation and landfill of human health exceedance soil. The excavated area is backfilled with on-post borrow material.

- Sand Creek Lateral - Excavation and landfill of human health exceedance soil and excavation and consolidation to Basin A of soil posing a potential risk to biota. The consolidated material is contained under the Basin A cover. The excavated area is backfilled with on-post borrow material.

- Surficial Soil - Excavation and landfill of human health exceedance soil and excavation and consolidation to Basin A or Former Basin F of soil posing a potential risk to biota from this medium group and excavation and landfill of soil from the pistol and rifle ranges. The consolidated material is contained under the Basin A cover or Basin F cap, and the human health exceedance area is backfilled.

- Excavation and disposal in the on-post TSCA-compliant landfill of PCB-contaminated soil (three areas identified by the PCB IRA with concentrations of 250 ppm or greater). Soil identified with concentrations ranging from 50 to 250 ppm will be covered with at least three feet of soil (five areas identified by the PCB IRA).

- Contingent Volume - Excavation and landfill of up to 150,000 bcy of additional volume to be identified base don visual field observations. An additional 14 samples from North Plants, Toxic Storage Yards, Lake Sediments, Sand Creek Lateral and Burial Trenches and up to 1,000 additional confirmatory samples may be used to identify the contingent soil volume requiring excavation.

- Remedy components for all sites include reconditioning the surface soil and revegetating areas disturbed during remediation with locally adapted perennial vegetation.

Other

- Provision of $48.8 million held in trust to provide for the acquisition and delivery of 4,000 acre-feet of potable water to the South Adams County Water and Sanitation District (SACWSD) and the extension of the water-distribution lines from an appropriate water supply distribution system to all existing well owners within the diisopropylmethyl phosphonate (DIMP) plume footprint north of RMA as defined by the detection limit for DIMP of 0.392 parts per billion (ppb). In the future, owners of any domestic wells, new or existing, found to have DIMP concentrations of 8 ppb (or other relevant CBSG at the time) or greater will be connected to a water-distribution system or provided a deep well or other permanent solution. The Army and Shell have reached an Agreement in Principle with SACWSD, enclosed as Appendix B of the On-Post ROD regarding this matter.

- In compliance with the National Environmental Policy Act (NEPA), PMRMA will separately evaluate the potential impacts to the environment of both the acquisition of a water supply for SACWSD and for extension of water-distribution lines.

- The Army and Shell will fund the U.S. Agency for Toxic Substances and Disease Registry (ATSDR) to conduct an RMA Medical Monitoring Program in coordination with the Colorado Department of Public Health and Environment (CDPHE). The

program's nature and scope will include baseline health assessments and be determined by the on-post monitoring of remedial activities to identify exposure pathways, if any, to any off-post community.

A Medical Monitoring Advisory Group (MMAG) has been formed to evaluate information concerning exposure pathways and identify and recommend appropriate public health actions to CDPHE and ATSDR and to communicate this information to the community. CDPHE and ATSDR will use the recommendations of the MMAG to jointly develop an appropriate medical monitoring plan and jointly define the trigger for when such a plan will take effect. Any human health assessment completed by CDPHE and ATSDR will be formally reviewed by the Parties and the MMAG prior to issuance to the public. The MMAG includes representatives from the affected communities, regulatory agencies, local governments, Army, Shell, FWS, and independent technical advisors. Any necessary technical advisors will be identified in coordination with CDPHE and funded through ATSDR.

The primary goals of the Medical Monitoring Program are to monitor any off-post impact on human health due to the remediation and provide mechanisms for evaluation of human health on an individual and community basis, until such time as the soil remedy is completed. On behalf of the communities surrounding RMA, the MMAG will develop and submit to CDPHE and ATSDR specific recommendations defining goals, objectives, and the methodology of a program designed to respond effectively to RMA-related health concerns of the community.

Elements of the program could include medical monitoring, environmental monitoring, health/community education or other tools. The program design will be determined through an analysis of community needs, feasibility, and effectiveness.

- Trust Fund - During the formulation and selection of the remedy, members of the public and some local governmental organizations expressed keen interest in the creation of a Trust Fund to help ensure the long-term operation and maintenance of the remedy once the remedial structures and systems are installed. In response to this interest, the Parties have committed to good-faith best efforts to establish a Trust Fund for the operation and maintenance of the remedy, including habitat and surficial soil. Such operation and maintenance activities will include those related to the new HWL; the slurry walls, caps, and soil and concrete covers; all existing groundwater pump-and-treat systems; the groundwater pump-and-treat system to intercept the Section 36 Bedrock Ridge Plume; the maintenance of lake levels or other means of hydraulic containment; all monitoring activities required for the remedy; design refinement for on-post surficial soil as described in Section 9.4; and any revegetation and habitat restoration required as a result of remediation.

  These activities are estimated to cost approximately $5 million per year (in 1995 dollars). The principal and interest from the Trust Fund would be used to cover these costs throughout the lifetime of remedial program.

The Parties recognize that establishment of such a Trust Fund may require special legislation and that there are restrictions on the actions federal agencies can take with respect to proposing legislation and supporting proposed legislation. In addition to the legislative approach, the Parties are also examining possible options that may be adapted from trust funds involving federal funds that exist at other remediation sites. Because of the uncertainty of possible legislative requirements and other options, the precise terms of the Trust Fund cannot now be stated.

A Trust Fund group will be formed to develop a strategy to establish the Trust Fund. The strategy group may include representatives of the Parties (subject to restrictions on federal agency participation), local governments, affected communities, and other interested stakeholders, and will be convened within 90 days of the signing of the On-Post ROD.

Notwithstanding these uncertainties, it is the intent of the Parties that if the Trust Fund is created it will include the following:

- A clear statement that will contain the reasons for the creation of the Trust Fund and the purposes to be served by it.

- A definite time for establishing and funding the Trust Fund, which the Parties believe could occur as early as 2008, when the remedial structures and systems may have been installed.

- An appropriate means for competent and reliable management of the Trust Fund, including appropriate criteria for disbursements from the Trust Fund to ensure that the money will be properly used for the required purposes.

- Continued operation of the CERCLA Wastewater Treatment Plant to support the remediation activities.

- Stored, drummed waste identified in the waste management element of the CERCLA Hazardous Waste IRA may be disposed in the on-post HWL.

- Continued monitoring, as part of design refinement, for areas that may pose a potential risk to biota as outlined in the following process:

  - The Biological Advisory Subcommittee (BAS) of technical experts (such as ecotoxicologists, biologists, and range/reclamation specialists) from the Parties will focus on the planning and conduct of both the FWS biomonitoring programs and the Supplemental Field Study (SFS)/risk assessment process. The BAS will provide interpretation of results and recommendations for design refinements to the Parties' decision makers.

- The ongoing FWS biomonitoring programs and the SFS/risk assessment process will be used to refine design boundaries for surficial soil and aquatic contamination to be remediated.

    - Phase I and the potential Phase II of the SFS will be used to refine the general areas of surficial soil contamination concern. The field biomagnification factors (BMF) will be used to quantify ecological risks in the Area of Dispute, identify risk-based soil concentrations considered safe for biota, and thus refine the area of excess risks.

    - Pursuant to the FFA process, FWS will conduct detailed site-specific exposure studies of contaminant effects and exposure (tissue levels and Army-provided abiotic sampling) on sentinel or indicator species of biota (including the six key species identified in the Integrated Endangerment Assessment/Risk Characterization (IEA/RC) report as appropriate). These studies will address both the aquatic resources and at least the surficial soil in and around the Area of Dispute. These site-specific studies will be used in refining contamination impact areas in need of further remediation.

    - Results from both the SFS/risk assessment process and the site-specific studies will be considered in risk-management decisions, which may further refine the areas of surficial soil and aquatic contamination to be remediated. (In the event of a conflict between management of RMA as a wildlife refuge and performance of remedial response actions, the Refuge Act indicates that response actions will take priority.)

- The BAS will serve as a technical resource to the Parties' decision makers by using technical expertise in analyzing, and potentially collecting, data sufficient to support design refinement for surficial soil areas and aquatic resources that will break unacceptable exposure pathways in consideration of minimizing habitat disturbance. Further, it will assess through monitoring the efficacy of remedies in breaking unacceptable pathways to biota. If any additional sites are identified, the remedy will be implemented as follows:

    - It will be staged to allow habitat recovery.

    - It will be performed first on locations selected through a balance of factors such as:

        - The Parties agree an area has a negative impact on or excessive risk to fish or wildlife.

        - The effort will not be negated by recontamination from other remediation activities.

        - The existing fish and wildlife resource value.

  - It will include revegetation of a type specified by FWS; if the initial revegetation is not successful, the appropriate adjustments will be made and revegetation again implemented.

  - It will provide that the locations and timing of remediation are to be determined with consideration of and in coordination with FWS refuge management plans and activities.

- The SFS, biomonitoring programs, and recommendations of the BAS will be used to refine the areas of remediation during remedial design.

- Any UXO encountered during remediation will be excavated and transported off-post for detonation (unless the UXO is unstable and must he detonated on-post) or other demilitarization process.

- Within 180 days after issuance of the Notice of Availability for the On-Post ROD, the Army will append to the On-Post ROD a complete, detailed schedule for completion of activities associated with the selected remedy. The schedule will identify the enforceable project milestone dates for design activities. Future design documents will detail milestone dates for implementation activities. Revisions to this schedule will be initiated prior to the start of each fiscal year to allow adequate time for review and concurrence by the Parties.

- Five-year site reviews.

The 14 IRAs, as identified in the On-Post ROD, are as follows:

- OGITS

- Improvement of NBCS and Evaluation of All Existing Boundary Systems

- Groundwater Intercept and Treatment North of Basin F

- Closure of Abandoned Wells at RMA

- Basin A Neck Containment System (BANCS)

- Basin F Liquid, Sludge, and Soil Remediation

- Building 1727 Sump Liquid

- Closure of the Hydrazine Facility

- Fugitive Dust Control

- Sanitary Sewers Remediation

- Asbestos Remediation

- Remediation of Other Contamination Sources (including the Motor Pool Area, Rail Classification Yard, Lime Settling Basins, South Tank Farm Plume, Army (Complex) Disposal Trenches, Shell Section 36 Trenches and M-1 Settling Basins)

- Pretreatment of CERCLA Liquid Wastes (including the Wastewater Treatment System, Waste Management, PCBs, and Waste Storage)

- Chemical Process-Related Activities

Descriptions of these IRAs can be obtained by referring to the IRA Summary Reports.

4.2 Remedy Selection – Off-Post OU

The Off-Post ROD specified that the remedy address specific components as described below. A more detailed description of these components is available in the Off-Post ROD. Implementation of these components was detailed in the Remediation Scope and Schedule for the Off-Post OU (HLA 1996).

The Off-Post ROD includes the following remedial action components:

- Continued operation of the OGITS.

- Natural attenuation of inorganic chloride and sulfate concentrations to meet remediation goals for groundwater in a manner consistent with the on-post remedial action.

- Continued operation of the NWBCS, NBCS, and ICS (also specified in the On-Post ROD).

- Improvements to the NBCS, ICS, NWBCS, and the OGITS as necessary.

- Long-term groundwater monitoring (including monitoring after groundwater treatment has ceased) to ensure continued compliance with the CSRGs.

- Five-year site reviews.

- Exposure control/provision of alternate water as described in the both the On-Post and Off-Post RODs.

- Institutional controls, including deed restrictions on Shell-owned property, to prevent the use of groundwater exceeding remediation goals.

- Closure of poorly constructed wells within the Off-Post Study Area that could be acting as migration pathways for contaminants found in the Arapahoe aquifer.

- Continuation of monitoring and completion of an assessment by the Army and Shell of the NDMA plume by June 13, 1996 using a 20 parts per trillion (ppt) method detection limit.

- Preparation of a study that supports design refinement for achieving NDMA remediation goals at the RMA boundary.

- Tilling and revegetation of approximately 160 acres in the southeast portion of Section 14 and the southwest portion of Section 13 by the Army and Shell.

- Treatment of any contaminated extracted groundwater prior to discharge or reinjection so that it meets the current water quality standards established in the CBSGs and the Colorado Basic Standards and Methodologies for Surface Water.

- Continued monitoring of off-post confined flow system (CFS) wells with cessation of monitoring at individual wells based on criteria provided in the Off-Post ROD.

4.3 Remedy Implementation

Table 3 provides a detailed list of the On-Post and Off-Post ROD projects and the IRAs. This includes projects mentioned in the two RODs but not previously tracked as "implementation projects". This table provides the name, status of each project as of March 31, 2000, and forecast start and completion dates for each project. Only projects that have not yet begun have associated forecast start dates. Ongoing projects and IRAs that have been incorporated within the RODs do not have associated forecast completion dates.

More detailed information on the schedule of each project as well as a more comprehensive description can be found in the RDIS for On-Post ROD projects, the Remediation Scope and Schedule for Off-Post ROD projects, and the IRA Summary Reports for IRAs.

The status of each project is defined to be one of the following:

- **Not yet begun** - Defined as in the planning stages prior to completion of the 100% design by 3/31/2000

- **Under construction** - Defined as having an approved 100% design dated prior to 3/31/2000, but not yet having an approved construction completion report dated prior to 3/31/2000

- **Completed** - Defined as having a final construction completion report approved by the EPA by 3/31/2000 or an IRA Summary Report

- **Operational** – Defined as a fully operational project, e.g., Hazardous Waste Landfill

- In **Operation and Maintenance (O&M)** mode - Defined as a fully operational project that requires several years to reach cleanup levels, e.g., groundwater pump and treatment systems

- **Ongoing** - Defined as a non-construction project without an applicable design document, but with routine activities necessary to meet the requirements of the ROD (e.g. Site-Wide Groundwater Monitoring)

- **Transferred** - Applicable to IRAs, defined as a project closed out with elements transferred administratively into a specific, related ROD-identified project

Table 3 - RMA Remedial Projects

#	Project Name	Status	Forecast Start Date (Completion of 100% Design)	Forecast or Actual Completion Date
On-Post OU				
1	Construct Hazardous Waste Landfill – Cell 1	Under construction	N/A	10/00
2	Construct Hazardous Waste Landfill – Cell 2	Under construction	N/A	06/01
3	Operation of Hazardous Waste Landfill – Cells 1 & 2	Operational	N/A	12/04
4	Closure of Hazardous Waste Landfill – Cells 1 & 2	Not yet begun	07/04	03/06
5	Construction of Hazardous Waste Landfill Wastewater Treatment System	Under Construction	N/A	10/00
6	Operation of Hazardous Waste Landfill Wastewater Treatment System	Operational	N/A	TBD
7	Construct Enhanced Hazardous Waste Landfill	Not yet begun	07/02	06/04
8	Operation of Enhanced Hazardous Waste Landfill	Not yet begun	09/04	04/06
9	Closure of Enhanced Hazardous Waste Landfill	Not yet begun	TBD	05/07
10	Operation of Basin A Consolidation and Remediation Area	Operational	N/A	10/04
11	Closure of Basin A Consolidation and Remediation Area	Not yet begun	05/04	04/07
12	Sanitary and Chemical Sewer Manhole	Completed	N/A	09/98

#	Project Name	Status	Forecast Start Date (Completion of 100% Design)	Forecast or Actual Completion Date
	Plugging – Phase I			
13	Shell/Complex Trenches Slurry Walls	Under construction	N/A	09/00
14	Post-ROD Removal Actions for Structures	Under construction	N/A	07/00
15	Toxic Storage Yards Soil Remediation	Under construction	N/A	05/00
16	Existing (Sanitary) Landfills Remediation – Section 1	Completed	N/A	02/00
17	Existing (Sanitary) Landfills Remediation – Section 4	Under construction	N/A	06/00
18	Existing (Sanitary) Landfills Remediation – Sections 30 and 36	Under construction	N/A	02/04
19	Lake Sediments Remediation	Under construction	N/A	04/00
20	Burial Trenches Soil Remediation	Under construction	N/A	03/01
21	Munitions (Testing) Soil Remediation	Under construction	N/A	03/01
22	Miscellaneous Northern Tier Soil Remediation	Under construction	N/A	04/00
23	Miscellaneous Southern Tier Soil Remediation	Under construction	N/A	06/00
24	Section 36 Bedrock Ridge Groundwater Plume Extraction System	Under construction	N/A	06/01
25	South Plants Structures Demolition and Removal	Under construction	N/A	03/02
26	Miscellaneous RMA Structures Demolition and Removal	Under construction	N/A	07/09
27	Buried M-1 Pits Soil Remediation	Not yet begun	01/01	06/02
28	Hex Pit Soil Remediation	Not yet begun	11/00	12/01
29	South Plants Central Processing Area Soil Remediation	Not yet begun	10/00	04/04
30	South Plants Balance of Areas Soil Remediation	Not yet begun	10/00	04/04
31	Sanitary and Chemical Sewer Manhole Plugging Project –Phase II	Not yet begun	10/03	11/04
32	Section 36 Balance of Areas Soil	Not yet begun	12/01	05/04

#	Project Name	Status	Forecast Start Date (Completion of 100% Design)	Forecast or Actual Completion Date
	Remediation			
33	Secondary Basins Soil Remediation (Phase I)	Not yet begun	08/00	08/03
34	Secondary Basins Soil Remediation (Phase II)	Not yet begun	12/01	09/04
35	Complex (Army) Disposal Trenches Remediation	Not yet begun	09/02	05/08
36	Shell Disposal Trenches Remediation	Not yet begun	08/03	05/07
37	North Plants Soil Remediation	Not yet begun	01/03	10/04
38	Section 35 Soil Remediation	Not yet begun	03/01	10/05
39	North Plants Structure Demolition and Removal	Not yet begun	06/01	06/03
40	Basin F Wastepile Remediation	Not yet begun	01/02	11/05
41	Former Basin F Solidification	Not yet begun	04/05	05/08
42	Basin F and Basin F Exterior Remediation (Phase I)	Not yet begun	08/00	08/01
43	Basin F and Basin F Exterior Remediation (Phase II)	Not yet begun	12/01	04/11
44	Section 36 Lime Basins	Not yet begun	11/02	09/06
45	Site-Wide Biota Monitoring	Ongoing	N/A	N/A
46	Site-Wide Air Monitoring	Ongoing	N/A	N/A
47	Site-Wide Groundwater Monitoring	Ongoing	N/A	N/A
48	Medical Monitoring Program	Ongoing	N/A	N/A
49	South Adams County Water Supply	Completed	N/A	N/A
50	Henderson Distribution	Completed	N/A	09/99
51	Confined Flow System Well Closures	Under Construction	N/A	06/00
52	CAMU/Basin A Well Abandonment	Completed	N/A	09/98
53	CAMU Soil Remediation	Completed	N/A	09/98
54	Section 26 HHE and Biota Soils/CAMU Completion and Support	Under Construction	N/A	08/00
55	Western Tier Parcel	Under Construction	N/A	TBD
56	Trust Fund	Ongoing	N/A	12/08
57	Irondale Containment System	O&M	N/A	04/11
58	Basin A Neck Containment System	O&M	N/A	04/11
59	Operation of CERCLA Wastewater Treatment Facility	Operational	N/A	04/11

#	Project Name	Status	Forecast Start Date (Completion of 100% Design)	Forecast or Actual Completion Date
60	Northwest Boundary Containment System	O&M	N/A	04/32
61	North Boundary Containment System	O&M	N/A	04/32
62	South Lakes Plume Monitoring/Lake Levels	Ongoing	N/A	04/11
63	Basin F Wastepile Operations and Management	Operational	N/A	09/04
64	NDMA Monitoring and Assessment	Completed	N/A	09/98
65	UXO Management	Ongoing	N/A	N/A
66	Off-Post Groundwater Intercept and Treatment System (IRA)	Transferred[1]	N/A	N/A
67	Improvement of North Boundary Containment System and Evaluation of All Existing Boundary Systems (IRA) – North Boundary Containment System Improvements	Transferred[2]	N/A	N/A
68	Improvement of North Boundary Containment System and Evaluation of All Existing Boundary Systems (IRA) - Irondale Containment System	Transferred[3]	N/A	N/A
69	Improvement of North Boundary Containment System and Evaluation of All Existing Boundary Systems (IRA) - Northwest Boundary Containment System	Transferred[4]	N/A	N/A
70	Groundwater Intercept and Treatment System North of Basin F (IRA)	Transferred[5]	N/A	N/A
71	Closure of Abandoned Wells at RMA (IRA)	Completed[6]	N/A	10/89
72	Basin A Neck Containment System(IRA)	Transferred[5]	N/A	N/A
73	Basin F Liquid, Sludge, and Soil Remediation (IRA) – Element One, Basin F Wastepile	Transferred[7]	N/A	N/A
74	Basin F Liquid, Sludge, and Soil Remediation (IRA) – Element Two, Basin F Liquid	Completed	N/A	05/96
75	Building 1727 Sump Liquid (IRA)	Completed	N/A	11/87
76	Closure of the Hydrazine Facility (IRA)	Completed	N/A	07/92
77	Fugitive Dust Control (IRA)	Completed	N/A	05/91
78	Sanitary Sewers Remediation (IRA)	Completed	N/A	09/92
79	Asbestos Remediation (IRA)	Transferred[8]	N/A	07/09

#	Project Name	Status	Forecast Start Date (Completion of 100% Design)	Forecast or Actual Completion Date
80	Remediation of Other Contamination Sources (IRA) - Motor Pool Area, Soil Vapor Extraction	Completed	N/A	10/93
81	Remediation of Other Contamination Sources (IRA) - Motor Pool Area, Groundwater Remediation	Completed	N/A	10/93
82	Remediation of Other Contamination Sources (IRA) - Rail Classification Yard	Transferred[3]	N/A	N/A
83	Remediation of Other Contamination Sources (IRA) - Lime Settling Basins	Transferred[9]	N/A	N/A
84	Remediation of Other Contamination Sources (IRA) - South Tank Farm Plume	Completed	N/A	10/93
85	Remediation of Other Contamination Sources (IRA) - Army (Complex) Disposal Trenches	Transferred[10]	N/A	N/A
86	Remediation of Other Contamination Sources (IRA) - Shell Section 36 Trenches	Transferred[10]	N/A	N/A
87	Remediation of Other Contamination Sources (IRA) - M-1 Settling Basins	Transferred[11]	N/A	N/A
88	Pretreatment of CERCLA Liquid Wastes (IRA) – Wastewater Treatment System	Transferred[12]	N/A	N/A
89	Pretreatment of CERCLA Liquid Wastes (IRA) – Element One, Waste Management	Transferred[13]	N/A	N/A
90	Pretreatment of CERCLA Liquid Wastes (IRA) –Element Two, Polychlorinated Biphenyls (PCBs)	Completed	N/A	05/96
91	Pretreatment of CERCLA Liquid Wastes (IRA) – Element Three, Waste Storage	Transferred[13]	N/A	N/A
92	Chemical Process-Related Activities (IRA)	Transferred[14]	N/A	N/A
93	Deep Disposal Well Closure (IRA)	Completed	N/A	09/85
Off-Post OU				
94	Operation of Off-Post Groundwater Intercept and Treatment System	O&M	N/A	04/32
95	Off-Post Well Abandonment	Completed	N/A	09/99
96	Private Well Network	Ongoing	N/A	N/A

#	Project Name	Status	Forecast Start Date (Completion of 100% Design)	Forecast or Actual Completion Date
97	Off-Post Tillage Task	Completed	N/A	09/98
98	Institutional Controls	Ongoing	N/A	N/A

N/A = Not Applicable or Appropriate
TBD = To Be Determined
[1] = Incorporated in the Operation of Off-Post Groundwater Intercept and Treatment System Off-Post ROD project
[2] = Incorporated in the North Boundary Containment System On-Post ROD project
[3] = Incorporated in the Irondale Containment System On-Post ROD project
[4] = Incorporated in the Northwest Boundary Containment System On-Post ROD project
[5] = Incorporated in the Basin A Neck Containment System On-Post ROD project
[6] = Although this project was completed, new work was later identified by EPA and was covered under the Off-Post Well Abandonment Off-Post ROD project.
[7] = Operation and maintenance on the wastepile is ongoing and is covered under the Basin F Wastepile Operations and Maintenance On-Post ROD Project. Ultimate disposal of the wastepile has been incorporated in the Basin F Wastepile Remediation On-Post ROD project.
[8] = Although this project was completed, additional asbestos removal work continues under the South Plants Structures Demolition and Removal and the Miscellaneous RMA Structures Demolition and Removal On-Post ROD projects.
[9] = Incorporated in the Section 36 Lime Basins On-Post ROD project.
[10] = Incorporated in the Shell/Complex Trenches Slurry Walls, the Shell Disposal Trenches, the Complex(Army) Disposal Trenches Remediation, and the Site-Wide Groundwater Monitoring Program On-Post ROD projects.
[11] = Incorporated in the Buried M-1 Pits Soil Remediation On-Post ROD project.
[12] = Incorporated in the CERCLA Wastewater Treatment Plant On-Post ROD project.
[13] = Incorporated in the Miscellaneous RMA Structures Demolition and Removal On-Post ROD project.
[14] = Incorporated in the North Plants Structure Demolition and Removal, South Plants Structure Demolition and Removal, and Miscellaneous RMA Structure Demolition and Removal On-Post ROD projects.

5.0 FIVE-YEAR REVIEW PROCESS

5.1 General

The Rocky Mountain Arsenal Five-Year Review was conducted by the Army in accordance with Paragraph 36.3 of the FFA and CERCLA, Section 121(c). The following team members participated in the review:

- Rick Beardslee, RMA, Remedy Execution
- Bob Charles, RMA, Water Group
- MAJ Wes Erickson, RMA, Chief Counsel
- Neville Gaggiani, RMA, USGS
- Sam Garcia, EPA Region VIII
- Lou Greer, RMA, Remedy Execution
- John Isham, RMA, Health and Safety Group
- Tom James, RMA, Remedy Execution
- Greg Joyce, RMA, Quality Assurance Group
- Ellen Kaastrup, Foster Wheeler Environmental Corporation
- Mark Kearns, RMA, Project Controls
- Tim Kilgannon, RMA, Remedy Execution (Special Projects)
- Rick Kinshella, Tri-County Health Department (TCHD)
- Tony LaChance, RMA, Remedy Execution
- Ruth Mecham, RMA, Public Affairs
- Barbara Nabors, CDPHE
- Scott Perkins, RMA, Environmental Compliance Group (Team Leader)
- Jim Pearce, RMA, Water Group
- Mark Sattelberg, RMA, FWS, Biota Group
- Stephen Smith, RMA, FWS, Remedy Execution
- Lee Snowhite, Foster Wheeler Environmental Corporation
- Kerry Stavast, RMA, Health and Safety Group

This Five-Year Review primarily consisted of a thorough review of relevant documents (see Appendix A). As appropriate, specific documents were summarized in this review to illustrate the basis for conclusions of the Five-Year Review. On-site personnel responsible for all aspects of the remedy implementation were involved in developing this report.

5.2 Community Involvement and Public Notification

Community involvement was encouraged throughout the Five-Year Review process. The Army, Shell, FWS, EPA, CDPHE, and TCHD all agreed that an inclusive Five-Year Review process would best serve the interests of the public and all involved parties. Initial public notification of this review was provided by notices in local newspapers in April 2000. This notification informed the public that the Five-Year Review had begun and solicited input from the public on concerns or issues to be addressed in the Five-Year Review. This public comment period extended through June 1, 2000. Comments received during this period, along with RMA's responses (where appropriate), are included in Appendix B of this report. In May 2000, presentations were made to the Restoration Advisory Board (RAB) and Site Specific Advisory Board (SSAB) to inform the public, further encourage community involvement, and to respond to any questions or concerns. A draft final copy of this report was issued for public comment in September 2000. Comments received during this second public comment period, along with RMA's responses, are included in Appendix B of this report. Upon completion and issuance of the final report, a second formal public notification will be made. This will include a formal

notice that the Five-Year Review process has been completed. It will also provide details on where to obtain a copy of the report. The final report, along with a summary page detailing major findings and recommendations, will be available at the Joint Administrative Record and Document Facility (JARDF) located at RMA's West Gate and 72nd Avenue and Quebec Street. In addition, a presentation is planned for the RAB and the SSAB upon issuance and distribution of this report.

6.0 FIVE-YEAR REVIEW FINDINGS

6.1 Documentation Reviewed

All documents relevant to the IRAs and the On-Post and Off-Post OUs that were reviewed as part of this Five-Year Site Review are listed in Appendix A.

6.2 Risk Information Review

This section includes a discussion of all applicable or relevant and appropriate requirements (ARARs) and to-be-considered criteria (TBCs) that are identified in the RODs. The ARARs are standards-based criteria, such as federal and state standards for soil, groundwater, or worker protection. ARARs can be chemical-specific, action-specific, or location-specific. TBCs are risk-based criteria established through risk assessments conducted for the relevant media and exposure pathways. The primary routes for potential exposure are consumption, dermal contact, and inhalation.

Included in this section are those ARARs and TBCs that have changed between the respective dates of ROD issuance and March 31, 2000. For those ARARs and TBCs that have changed, a determination has been made whether the change may impact the protectiveness of the remedy. Where this is the case a further discussion is provided. Conclusions and recommendations for further action are provided, as appropriate, in Sections 8.0 and 9.0 respectively. For organizational purposes, the ARARs and TBCs are broken into three categories; "groundwater containment system ARARs and TBCs", "worker exposure ARARs and TBCs", and "other ARARs and TBCs".

6.2.1 Groundwater Containment System ARARs, TBCs, and PQLs

This section addresses ARARs, TBCs, and associated practical quantitation limits (PQLs) relevant to the groundwater containment systems that have changed since the Off-Post and On-Post RODs were issued. Groundwater ARARs were identified only for specific systems in the RODs. Each of the five RMA containment systems has a list of CSRGs for specific compounds identified as potential concerns for that system. The CSRGs are based on state and federal standards as well as risk-based values. The On-Post ROD identified ARARs for each containment system in accordance with the CSRG list. Potential changes in ARARs and TBCs for the different systems are addressed in the following subsections. ARAR and TBC changes that are addressed here will not be used to assess past system performance but will be considered during the second five-year period.

6.2.1.1 PQL's

Note: To clarify the contents of this section a few of the technical phrases are defined as follows:

- **Practical Quantitation Limit (PQL)** –This limit is the lowest contaminant level at which a laboratory can assign a known precision and accuracy to the analytical results for a given analyte. Below this limit the precision and accuracy is uncertain. It is typically determined by a mathematical process incorporating data generated by an analytical method and the method reporting limit (the lowest level that an analytical method can detect). The State of Colorado has commonly accepted PQLs for contaminants based on values generated at the State of Colorado's laboratory.

- **Certified Reporting Limit (CRL)** – A type of PQL determined based on an Army algorithm above which a method is expected to have a constant precision and accuracy. The CRL algorithm uses four sets of data.

- **Method Reporting Limit (MRL)** – Also a type of PQL. The MRL is determined based on a slightly different Army algorithm using two sets of data. The MRL is also a limit above which a method is expected to have a constant precision and accuracy.

In cases where the ARAR or TBC identified as a CSRG could not be measured with the analytical methods available at the time, both the On-Post and Off-Post RODs identified either CRLs or State of Colorado PQLs as the interim goals. It should be noted that this approach applies only to CSRGs with values below the State of Colorado PQLs or Army-defined CRLs. In most cases, CRLs (rather than State of Colorado PQLs) were identified by the RODs in place of the ARARs or TBCs that can not typically be measured by available methods.

The Off-Post ROD identifies "PQL attainable by the U.S. Army" (i.e. the CRLs) for aldrin, dieldrin, chlordane and carbon tetrachloride and the PQL for 1,2-dichloroethane as the "PQL listed in the CBSG standards" (i.e. the State of Colorado PQL). It should be noted that these PQLs are now contained under the Colorado Discharge Permit System Regulations in Title 5, Colorado Code of Regulations (CCR), Part 1002-61. Likewise, CRLs and PQLs were used for the NBCS and the NWBCS in the On-Post ROD, which identifies "CRLs or PQLs....." as the footnoted, interim values in the CSRG tables for the different systems. In this case "PQL" is interpreted to mean the State of Colorado PQL. For the BANCS, which is an internal system, State of Colorado PQLs were listed in the CSRG table for carbon tetrachloride and dieldrin.

Since the RODs were signed, the MRL has replaced the CRL as the official laboratory reporting limit used at RMA for the Army methods currently being used to analyze RMA groundwater. (to reiterate, the MRL is a type of PQL, is determined based on slightly different Army algorithm than that used for the CRL, and is a limit above which a method is expected to have a constant precision and accuracy). The change to MRLs was made as a cost saving measure. It should be noted that from a statistical reliability standpoint there is no difference between the MRLs and the CRLs and RMA's ability to quantify contaminants in samples has in no way been

compromised by the switch to MRLs. MRLs are generally equivalent with "industry" standards and procedures for MRL-determination are identified in Appendix A of the RMA Chemical Quality Assurance Plan (CQAP) (PMRMA 1996a). For those compounds that were assigned CRLs in the ROD, MRLs will continue to be used as the interim values, and correspondingly, for compounds that were assigned PQLs, the State of Colorado PQLs will continue to be used.

The boundary system compounds for which CSRGs could not be measured at the time the RODs were finalized are listed in Tables 4-7. It should be noted that for the BANCS, different and slightly higher quantitation limits were assigned to the compounds for which CSRGs could not be measured (e.g. PQL for 1,2-dichloroethane = 1.1 µg/L). These higher quantitation limits were used because this is an internal, rather than a boundary, system. Water reinjected by this system passes through to subsequent RMA boundary containment systems that further treat the water.

The tables show what compounds were assigned Army CRLs (now defined as MRLs), which were assigned State of Colorado PQLs, and which were assigned other PQLs (e.g., BANCS) as the interim values. The table's reference values cited in both RODs (Tables 7.1 - 7.3 in the Off-Post ROD and Tables A-3 – A-6 and Tables 9.1-1 – 9.1-4 in the On-Post ROD). Considering the differences in the footnoted values, the approach used in assigning PQLs and CRLs is reflected in the following tables.

There has not been a process in place up to this point to determine when or how new quantitation limits are to be adopted for the groundwater systems. Although this has not impacted the protectiveness of the remedy, it could impede the timely adoption of lower quantitation limits in the future. This issue is further addressed in detail in this report and a recommended process is included in Section 9.0.

Table 4 - Northwest Boundary Containment System Quantitation Limits

Chemical Group/Compound	CSRG (µg/L)	Off-Post ROD Quantitation Limit (µg/L)	On-Post ROD Quantitation Limit (µg/L)
OCPs (Organochlorine Pesticides)			
Dieldrin	0.002	0.05 (CRL)	0.05 (CRL)[1]
Other Organics			
NDMA	0.007	0.033 (CRL)	0.033 (CRL)[1]

CRL = Certified Reporting Limit as defined by the Army laboratory at RMA
[1] = Number taken from the On-Post ROD, Table 9.1-1 *CSRGs for the Northwest Boundary Containment System* and described as "current CRL or PQL readily available from a certified commercial laboratory".

Table 5 - North Boundary Containment System Quantitation Limits

Chemical Group/Compound	CSRG (µg/L)	Off-Post ROD Quantitation Limit (µg/L)	On-Post ROD Quantitation Limit (µg/L)
VHOs (Volatile Halogenated Organics)			
1,2-Dichloroethane	0.4	1.0 (PQL)	1 (PQL)[1]
Carbon tetrachloride	0.3	0.99 (CRL)	0.99 (CRL)[1]
OCPs (Organochlorine Pesticides)			
Aldrin	0.002	0.05 (CRL)	0.05 (CRL)[1]
Dieldrin	0.002	0.05 (CRL)	0.05 (CRL)[1]
Other Organics			
NDMA (n-Nitrosodimethylamine)	0.007	0.033 (CRL)	0.033 (CRL)[1]

PQL = State of Colorado PQL
CRL = Certified Reporting Limit as defined by the Army laboratory at RMA
[1] = Number taken from the On-Post ROD, Table 9.1-3 *CSRGs for the North Boundary Containment System* and described as "current CRL or PQL readily available from a certified commercial laboratory".

Table 6 - Off-Post Groundwater Intercept and Treatment System Quantitation Limits

Chemical Group/Compound	CSRG (µg/L)	Off-Post ROD Quantitation Limit (µg/L)	On-Post ROD Quantitation Limit (µg/L)
VHOs (Volatile Halogenated Organics)			
1,2-Dichloroethane	0.4	1.0 (PQL)	NA
Carbon tetrachloride	0.3	0.99 (CRL)	NA
OCPs (Organochlorine Pesticides)			
Aldrin	0.002	0.05 (CRL)	NA
Chlordane	0.03	0.095 (CRL)	NA
Dieldrin	0.002	0.05 (CRL)	NA
Other Organics			
NDMA (n-Nitrosodimethylamine)	0.007	0.033 (CRL)	NA

NA = Not Applicable
PQL = State of Colorado PQL
CRL = Certified Reporting Limit as defined by the Army laboratory at RMA

Table 7 - Basin A Neck Containment System Quantitation Limits

Chemical Group/Compound	CSRG (µg/L)	Off-Post ROD Quantitation Limit (µg/L)	On-Post ROD Quantitation Limit (µg/L)
VHOs (Volatile Halogenated Organics)			
1,2-Dichloroethane	0.4	NS	1.1 (PQL)[1]
Carbon tetrachloride	0.3	NS	1.0 (PQL)[2]
OCPs (Organochlorine Pesticides)			
Dieldrin	0.002	NS	0.1 (PQL)[2]

NS = Not Specified
PQL = State of Colorado PQL
[1] = Number take from the On-Post ROD, Table 9.1-4 *CSRGs for the Basin A Neck IRA Treatment System* and described as "current PQL or CRL", understood to be a system-specific PQL for an internal groundwater treatment system and not the State of Colorado PQL per reasoning included in the third paragraph in Section 6.2.1.1.
[2] = Number taken from the On-Post ROD, Table 9.1-4 *CSRGs for the Basin A Neck IRA Treatment System* and described as "current PQL or CRL".

6.2.1.2 ARARs

North Boundary Containment System

The ARARs for the NBCS were defined in Table A-5 in the On-Post ROD. The compounds for which ARARs were identified are based on the CSRG list presented in Table 9.3-2 in the same document. There has been only one change in state standards that could affect ARARs and consequently NBCS CSRGs. This change, along with explanations of nature of change, are listed in Table 8.

Table 8 – ARAR Changes for Groundwater

Compound	Citation*	Old	New	Comment/Action
Endrin	Old: 5 CCR 1002-8, CBSG; New: 5 CCR 1002-41 CBSG	0.2 µg/L	2.0 µg/L	CSRG for NBCS redefined as 2.0 µg/L for next five-year period

* The citation numbers for CBSGs have changed since the On-Post ROD was issued.
CCR = Colorado Code of Regulations

In the case of endrin, the CDPHE CBSG, which is the ARAR listed as the CSRG, has increased from 0.2 to 2.0 µg/L. The new endrin CBSG is the same as the federal standard; there are currently no other applicable standards for this compound that are more stringent. A change in the CSRG to the new CBSG for endrin is therefore recommended and is discussed in Section 7.1.4.2.

Off-Post Groundwater Intercept and Treatment System

The ARARs for the OGITS were described in Section 10.1.2 of the Off-Post ROD. The compounds for which ARARs were applied as CSRGs are identified in Table 7.1 in the same document. The only change in federal and state standards that will affect OGITS ARARS and CSRGs is the increase in the CBSG for endrin reported for NBCS.

6.2.1.3 Groundwater TBCs

There were no reported changes to groundwater TBCs.

6.2.2 Worker Exposure ARARs and TBCs

Several worker exposure ARARs and TBCs changed since the issuance of the RODs. Nine ARARs or TBCs were deemed to affect the protectiveness of workers at RMA and, as all mandatory standards are, were immediately adopted. These are detailed in the following Tables 9-11.

6.2.3 Other Media ARARs and TBCs

This section addresses ARARs and TBCs for all other "Chemical Specific," "Location Specific" and "Action Specific" requirements beyond those listed in Sections 6.2.1 and 6.2.2 above. Table 12 details the two changes in ARARs that could potentially affect the protectiveness of the remedy. The first set includes 12 Federal Water Quality Criteria that were used as the basis for determining the effluent limitations on the on-post HWL Wastewater Treatment System's CERCLA Compliance Document (CCD) (Appendix A of MKC 1999a). The second change relates to PCB decontamination and storage standards. These changes are discussed further in Sections 7.2.1, 8.6, and 9.6.

Table 9 – ARAR Changes for Worker Exposure Standards, General

Contaminant in Air	Organization	ROD Listed Exposure Limit	New Exposure Limit	Source/Year	Mandatory ?
Asbestos	ACGIH	Amosite = 0.5 f/cc	All Forms = 0.1 f/cc	TLV Booklet, 1999	No
		Chrysotile = 2 f/cc			
		Crocidolite = 0.2 f/cc			
		Other Forms = 2 f/cc			
	OSHA	All Forms = 0.2 f/cc	All Forms = 0.1 f/cc	29 CFR 1910.1001, 1998	Yes
Cadmium	OSHA	Fume 0.1 mg/m^3; 0.3 mg/m^3 (C) Dust 0.2 mg/m^3; 0.6 mg/m^3 (C)	0.005 mg/m3	29 CFR 1910.1027, 1998	Yes
Methylene chloride	OSHA	500 ppm; 1,000 ppm (C); 2,000 ppm (peak)	25 ppm; 125 (STEL)	29 CFR 1910.1052, 1998	Yes

ACGIH: American Conference of Government Industrial Hygienists
OSHA: Occupational Safety and Health Administration
f/cc: fibers per cubic centimeter
mg/m^3: milligram per cubic meter
ppm: parts per million
STEL: short term exposure limit
TLV: threshold limit value
CFR: Code of Federal Regulations

Table 10 – ARAR Changes for Worker Exposure Standards, UXO Demil/Chemical Agent Decontamination

Contaminant in Air, AR, or DA PAM	Organization	ROD Listed Exposure Limit	New Exposure Limit	Source/Year	Mandatory ?
Cyclonite (RDX)	ACGIH	1.5 mg/m3	0.5 mg/m3	TLV Booklet, 1999	No
2,4,6-Trinitrotoluene (TNT)	ACGIH	0.5 mg/m3	0.1 mg/3	TLV Booklet, 1999	No
AR 385-61	Army		See Note 1, below	28-Feb-97	Yes
DA PAM 385-61	Army		See Note 2, below	31-Mar-97	Yes

AR: Army Regulation
DA PAM: Department of Army Pamphlet
Note 1: Entire text has been revised. Provides new DA policy and procedures for the management of the chemical agent safety program.
Note 2: New regulation, ROD listed PAM 385-61 was just a draft. Provides chemical agent technical safety standards and agent information, monitoring requirements, and protective clothing. To be used in conjunction with AR 385-61.

Table 11 – ARAR Changes for Worker Exposure Standards, Chemical Agent

Contaminant in Air	Organization	ROD Listed Exposure Limit	New Exposure Limit	Source/Year	Mandatory ?
Ethyl Chloride	ACGIH	1,000 ppm	100 ppm	TLV Booklet, 1999	No

Table 12 - Other ARARs and TBCs Changes

Medium	Subject Matter	Citation	Old	New
Surface Water	Arsenic (V)	FWQC, chronic toxicity to freshwater aquatic life	850 µg/L	340 µg/L
	Chromium (III)	FWQC, chronic toxicity to freshwater aquatic life	836 µg/L	74 µg/L
	Chromium (III)	FWQC, acute toxicity to freshwater aquatic life	7,015 µg/L	570 µg/L
	Copper	FWQC, chronic toxicity to freshwater aquatic life	51 µg/L	9 µg/L
	Copper	FWQC, acute toxicity to freshwater aquatic life	88 µg/L	13 µg/L
	Dieldrin	FWQC, acute toxicity to freshwater aquatic life	2.5 µg/L	0.24 µg/L
	Endrin	FWQC, acute toxicity to freshwater aquatic life	0.18 µg/L	0.086 µg/L
	Lead	FWQC, chronic toxicity to freshwater aquatic life	27.9 µg/L	2.5 µg/L
	Lead	FWQC, acute toxicity to freshwater aquatic life	715 µg/L	65 µg/L
	Mercury	FWQC, acute toxicity to freshwater aquatic life	2.4 µg/L	1.4 µg/L
	Zinc	FWQC, chronic toxicity to freshwater aquatic life	439 µg/L	120 µg/L
	Zinc	FWQC, acute toxicity to freshwater aquatic life	485 µg/L	120 µg/L
Waste Management	PCB Decontamination Standards	40 CFR Sec 761.79	Required flushing internal surfaces three times; did not address PCB radioactive wastes, storage approvals; did not address packaging; recovered	Much more detailed and extensive requirements relating to decontamination practices and std., also addresses PCB

Medium	Subject Matter	Citation	Old	New
			spill/release contaminated materials to be disposed per 761.61; did not address recovered spill contaminated materials	radioactive waste storage allowances and practices; added new regulations relating to storage area approvals; 30 day or less storage must be in DOT approved packaging

FWQC: Federal Water Quality Criteria
µg/L: Micrograms per liter

6.3 Data Review

6.3.1 Groundwater

On-post and off-post groundwater monitoring programs not directly associated with the containment and treatment systems are summarized and evaluated in the Five-Year Groundwater Summary Report (Foster Wheeler 2000). The report uses 1994 as the baseline year since that was the last major sampling event at RMA prior to the issuance of the RODs. The report includes 1) water level monitoring results used to track potential changes in water table elevations or flow directions resulting from remedy implementation; 2) water quality data from areas upgradient of systems and from source areas; 3) CFS water quality data from the Basin A, Basin F, and South Plants areas; and 4) off-post exceedance monitoring results. Conclusions from the site-wide data in the Five-Year Groundwater Summary Report are used in project-specific reviews later in this report to justify statements that specific projects did not have adverse impacts on the groundwater. The conclusions of the Five-Year Groundwater Summary Report are summarized below.

6.3.1.1 Water Level Tracking

During the first five-year period, water level tracking was conducted in accordance with the pre-ROD monitoring program to track aquifer conditions in previously identified plume areas, and prior to and during initial implementation of soil remedies. Since most remedies were not implemented during this period, it was not possible to address how soil remedies will affect water levels and groundwater flow patterns. Beginning in Water Year (WY) 2000, a well network that was established in the Long-Term Groundwater Monitoring Plan (LTMP)(Foster Wheeler 1999) for the purposes of tracking the remedies will be used to monitor changes in water levels and to assess the influence of the soil remedies on water levels and groundwater flow patterns during the second five-year period.

The On-Post ROD (Figure 5.4-3) identified five plume groups consisting of 15 contaminant plumes on-post. The off-post plumes addressed by the Off-Post ROD have been tracked by exceedance mapping. The on-post plume groups that were all included in the water level tracking during the past five-year period are as follows:

- North Boundary Plume Group upgradient of NBCS
- Northwest Boundary Plume Group upgradient of the NWBCS
- Western Plume Group upgradient of ICS
- Basin A Plume Group upgradient of BANCS
- South Plants Plume Group which includes plumes emanating in the South Plants Central Processing Area.

Sources and remedy areas are also addressed by the water level tracking program, including:

- Former Basin F/Basin F Wastepile
- HWL and the proposed ELF
- Basin A
- Complex Disposal Trenches and Shell Trenches
- South Plants and South Lakes

Off-post water level elevation data was used to support the exceedance monitoring program. Detailed information on the water level tracking evaluation is presented in the Five-Year Groundwater Summary Report (Foster Wheeler 2000). It should be noted that the water level tracking program described here addresses the site-wide impacts and water level trends. Site-specific details will be addressed in the monitoring reports for the individual remedies that require monitoring. Based on the Five-Year Groundwater Summary Report evaluation, the following conclusions were made:

- There were no changes in groundwater levels or flow patterns in the areas upgradient of the containment systems that affected the effectiveness of the systems during the first five-year period.
- There have been no changes in water levels that would affect groundwater flow directions and contaminant migration toward the boundary containment systems.
- In the Basin F area upgradient from the NBCS, water levels continued to decline during the past five-year period, resulting in reduced flow toward the NBCS.
- Water levels in the South Plants area have shown an overall decline since 1992, with fluctuations during high precipitation years as described in the Five-Year Groundwater Summary Report. The impacts of precipitation are expected to be significantly reduced as a result of installation of soil covers and caps, with corresponding declines in water levels. Such effects will be assessed in future site reviews after remedy implementation.
- While fluctuations in water levels occurred off-post during the period considered, there were no changes that affected the direction of flow and contaminant migration pathways. Consequently there should be no impact to the exceedance monitoring program and no need to revise the planned monitoring network.
- Implementation of new remedy components that will affect groundwater levels and flow patterns has not begun in many areas. Water level tracking will continue in accordance with the LTMP during the next five-year period.

6.3.1.2 Site-Wide Water Quality

During the first five-year period, operational water quality monitoring was conducted in areas upgradient of the containment systems to supplement the water level tracking data. Beginning in WY2000, a well network that is established in the LTMP will be used to monitor changes in water quality and to assess the influence of the soil remedies on groundwater contaminant levels and plume migration during the second five-year period.

Operational water quality monitoring data were used to address potential changes in water quality related to the on-post plume areas described in Section 6.3.1.1, in source areas, and in areas and for categories specifically identified in the On-Post ROD. The results presented here are based on an evaluation of indicator compounds identified in the LTMP. The specific compounds addressed by this review are also discussed further in the Five-Year Groundwater Summary Report. In addition to the plume areas, the following areas and monitoring categories were specifically addressed in accordance with the On-Post ROD:

- South Plants source area
- Basin A
- Section 36 Bedrock Ridge
- North Plants
- South Lakes
- Chloride and sulfate attenuation upgradient of NBCS
- NDMA monitoring in the NBCS area

It should be noted that data were not available for some of the source areas (Basin A, South Plants, and North Plants) because of their stages of remedy implementation, i.e. planning, design or preparation. Any remedy impacts for these areas will be addressed in future site reviews after the remedies have been implemented. The site-wide water quality monitoring results can be summarized as follows:

- The trichloroethylene (TCE) and DBCP extraction wells in the Motor Pool and Irondale areas upgradient of ICS achieved cleanup criteria during the first five-year period. Shut-down monitoring will continue in these areas.
- The concentrations of indicator contaminants in plumes upgradient of the systems did not change significantly during the first five-year period with the exception of an increase in dieldrin concentrations at the southwest end of the NWBCS. Due to concerns about potential bypass of the NWBCS, pumping rates were increased and capture of the plume was maintained.

- The installation and monitoring of additional wells was carried out during design of an intercept system at the Section 36 Bedrock Ridge. Data collected in this area helped to delineate a groundwater contaminant plume that extends from the Bedrock Ridge north to North Plants. The LTMP included continued monitoring in this area during installation and operation of the new intercept system, which will be completed during the second five-year period.

- Natural attenuation was identified in the ROD as the mechanism to achieve CSRGs for chloride and sulfate at the NBCS within 30 and 25 years, respectively, from the signing of the ROD. So far, sulfate concentrations have achieved its CSRG at NBCS. Data available for the first five-year period indicate that upgradient concentrations of chloride and sulfate are on track to meet the CSRGs within 30 years. Monitoring will continue in accordance with the LTMP and the results will be assessed again at the next five-year site review.

- Limited data available for the plume upgradient of South Lakes showed slight decreases in concentrations. However, continued monitoring is needed to evaluate if contamination is migrating toward the lake. This monitoring will be conducted in accordance with the South Lakes Groundwater Monitoring Work Plan (currently under preparation) to be implemented in WY 2001.

- NDMA monitoring upgradient of NBCS continued after the installation of an ultraviolet (UV) treatment system at NBCS during the past five-year period. NDMA concentrations in downgradient wells decreased to below the reporting limit in response to operation of the NBCS UV treatment system. The NDMA program is addressed separately in Section 7.1.3.1.2 of this report.

6.3.1.3 Confined Flow System

Confined flow system monitoring is required by the On-Post ROD to identify vertical or lateral migration of contaminants to or within the CFS in the Basin A, Basin F, and South Plants areas. During the past five years, many of the confined flow system wells in these areas were closed under the Confined Flow System Well Closures project. This well closure project is defined as under construction in Table 3.

A detailed evaluation of the water level and water quality monitoring for CFS wells is presented in the Five-Year Groundwater Summary Report. In addition to review of chemical data, this evaluation included comparisons of CFS water level data with unconfined flow system (UFS) water level data to help address potential downward migration. The wells considered for the past five-year period were monitored in accordance with the pre-ROD monitoring program. The new CFS monitoring program, designed specifically to address the ROD requirements is presented in the LTMP and will be implemented during the next five-year period. Based on the review conducted in the Five-Year Groundwater Summary Report, the following conclusions can be made:

- No contamination was detected in any previously uncontaminated CFS wells.

- Water quality data from CFS wells in the Basin A, Basin F, and South Plants area indicate that no detectable vertical migration has occurred during the past five-year period, although water levels continue to show a potential for vertical flow from the UFS to the CFS.

These results suggest that no contaminant migration to the CFS has occurred during the first five-year period. Confined flow system monitoring will continue in accordance with the LTMP and be evaluated in the next five-year site review.

6.3.1.4 Exceedance Monitoring

The purpose of the off-post exceedance monitoring program is to support the institutional controls component of the off-post remedy. This is accomplished by the tracking and mapping of off-post contaminants to support the State Engineer's well notification program as discussed in the Off-Post ROD to prevent use of groundwater in areas where contaminant levels exceed CSRGs. During the past five-year period exceedance monitoring was conducted in 1996, 1997 and 1999 and exceedance maps were provided to the State Engineer.

Groundwater sampling is performed on a network of off-post monitoring and private wells. The exceedance monitoring program includes all contaminants identified in the combined CSRG lists for the NBCS and OGITS. It should be noted that private well monitoring, which is described in Section 7.1.3.2, is conducted in addition to the program discussed here. The private well monitoring program has objectives in addition to augmenting the CSRG exceedance mapping. Monitoring well data and available private well data are used in the development of exceedance maps. The exceedance monitoring results are presented and discussed in the Five-Year Groundwater Summary Report. The monitoring program evaluated for this five-year period has been revised and the new program, presented in the LTMP, will be implemented in WY 2000.

The following summary of results is based on a detailed evaluation in the Five-Year Groundwater Summary Report:

- The exceedance maps for 1996, 1997, and 1999 show contaminant distributions consistent with the previously mapped exceedance areas. Consequently, the LTMP exceedance monitoring program, which is based on these areas, provides adequate coverage for planned exceedance monitoring during the next five-year period.

- It should be noted that only the DIMP, chloride, fluoride, and sulfate exceedance areas were mapped. DIMP is the only organic contaminant that typically exceeds CSRGs downgradient of the OGITS. Other organic contaminants are present at levels exceeding CSRGs upgradient of the OGITS. The exceedance areas of these other organic contaminants have decreased significantly since 1994. The concentration trends in wells are described below.

- Chloroform concentrations downgradient from the NWBCS were reduced to below the CSRG during the early part of the five-year period.

- DIMP concentration trends varied in individual wells within its exceedance area, but the total exceedance area has decreased over the past five years.

- Chloroform, DBCP, and NDMA concentrations in all wells evaluated in this review decreased during the past five years. Dieldrin concentrations in most wells decreased, while no significant changes were observed in other wells. Tetrachloroethylene (PCE) concentrations have decreased in all except one of the wells evaluated. TCE concentrations decreased to below CSRGs. Benzene exceedances detected in several wells in WY95 have not been confirmed in subsequent years.

- Since early 1994, DCPD concentrations in seven wells within the First Creek pathway decreased to below the CSRG. In other wells, there have not been significant changes in concentrations. There have been no significant changes in carbon tetrachloride concentrations, however, it exceeded the PQL in only one monitoring well.

- Arsenic concentrations have decreased in most wells evaluated. Endrin has been reported in only one well and the endrin concentration in this well has decreased.

- There was no specific trend observed for chloride during this first five-year period; concentrations in some wells increased while decreases were observed in other wells. Likewise, no definite trends were observed for sulfate.

- Analytical problems with interference effects affected a large number of fluoride samples. 1,2-dichloroethane results are inconclusive due to detections in QC blanks. CPMSO results were inconclusive because of method and laboratory inconsistencies. These three compounds will be addressed with proper methods in the next exceedance monitoring events that will be used for exceedance mapping as well as in the next five-year site review.

6.3.2 Biota

Biota monitoring results are detailed annually in the RMA National Wildlife Refuge Annual Progress Reports (FWS 1990, ND, 1992, 1993, 1994, 1995, 1996, 1997, 1998, 1999, 2000). Early biomonitoring consisted mostly of wildlife land use surveys; location of wildlife, population of wildlife at those locations, and what habitat they are utilizing. In 1991, the first contaminant-related biomonitoring started with a deer herd health study, American kestrel nest box monitoring, and archiving and recording fortuitously collected animals. The following year, water quality was added and the need for an integrated biomonitoring plan was identified. In 1993, surface water quality monitoring continued, as did the fortuitous collections. A specific study was conducted concerning bird use and mortality around Building 111. Three research projects also began involving European starlings, American badgers, and deer mice. In 1994, biomonitoring studies were initiated to determine contaminant levels in tissues of mourning

doves, deer mice, Plains pocket gopher, European starlings, American kestrel, great horned owls, and the American badger. The following year, black-billed magpies and aquatic monitoring were included. Subsequent years were spent refining the biomonitoring program and comparing current results with previous year's results.

The biota constituents of concern include the OCPs, arsenic, and mercury. Previous biota studies determined that wildlife at the Rocky Mountain Arsenal National Wildlife Refuge have been exposed to contaminants in the soil, particularly in the core area, however, wildlife is currently considered to be thriving. Interim response actions have broken many major exposure pathways to the wildlife. Historically, large numbers of waterfowl died in operating basins. Draining the basins and consolidating the sludges have stopped waterfowl mortalities due to contamination in the basins. It is expected that as remedial actions continue, additional exposure pathways will be broken. The biota studies have shown that avian species tend to be the most sensitive to the OCPs. The bird studies suggest that dieldrin contributes to local population declines primarily through adult mortality and that the reproductive processes are not markedly sensitive to dieldrin. Mammals, although exposed to the contaminants, are not as sensitive to the chemicals as are the birds. Fortuitous collections for this year are indicating lower mortality numbers from those of previous years. Additional discussion of the site-wide biota monitoring and compliance with ROD provisions is included in Section 7.1.3.2.

6.3.3 Air

Air monitoring results are detailed in annual air summary reports. The report for Fiscal Year (FY) 1996 (Foster Wheeler 1998) was published under the former Comprehensive Air Quality and Meteorological Monitoring Program. The report for calendar year (CY) 1999 (Foster Wheeler 2000a) was generated under the current Site-Wide Air Quality Monitoring Program. Reports for 1997 and 1998 have not been formally generated, but the data from those years are maintained in the RMA Environmental Database. Based on the results of the monitoring programs in place since the signing of the Off-Post ROD in December 1995, both prior to and after the startup of remediation in October 1997, no exceedances of established chronic criteria have resulted due to RMA remediation activity. Two detections of mercury were observed at levels above the established acute criteria, but these results were rejected from consideration because they were believed to have been due to sampling equipment contamination and not to RMA remediation or construction activities.

The established criteria included fenceline acute and chronic criteria that are designed to ensure that the community is not adversely affected from chemical exposures during remediation. The acute criteria are also applied at specific on-site locations to be protective of visitors to RMA. The Interactive Comprehensive Air Pathways Analysis (IC-APA) model or alternative air pathways analysis (APA) is used to predict impacts from each remediation project. Results of the APA are used to prescribe the level of monitoring conducted at any time. The monitoring program is then implement in accordance with this plan. The IC-APA and monitoring programs are functioning as designed and are meeting the objectives and requirements of the On-Post ROD. To date, they have also been successful in characterizing impacts of remediation so as to be protective of public health and to minimize nuisance odors. Additional discussion related to site-wide air monitoring and ROD compliance is included in Section 7.1.3.2.

6.3.4 Surface Water

Surface-water monitoring was conducted as required by the On-Post and Off-Post RODs. Surface water monitoring to be conducted at the RMA north boundary and along First Creek within the Off-Post OU was specified in the Off-Post OU Remediation Scope and Schedule. According to the Off-Post Remediation Scope and Schedule, the purpose of the monitoring is to evaluate the effect of groundwater treatment on surface water quality. This is because there is interaction between groundwater and surface water along First Creek to the north of RMA.

Surface water monitoring results are compiled annually in RMA surface water reports. For this Five-Year Review these monitoring data were evaluated in a separate report (RVO 2000). The report concludes that at the RMA north boundary at 96th Avenue, First Creek does not contain any organic target analytes and the inorganic constituents are not at elevated concentrations.

Downstream of 96th Avenue, First Creek primarily has flow during the spring and early summer months and seasonally gains flow from groundwater. Surface water collected at the Highway 2 monitoring station, which is located near the downstream end of the First Creek portion of the Off-Post Groundwater Intercept and Treatment System, occasionally contains organic target analytes and elevated levels of inorganic analytes. When these compounds are detected, the surface water flow data indicate that groundwater in the First Creek area is discharging into the stream, thus the surface water quality is indicative of the groundwater quality. When the groundwater is not discharging into First Creek, organic contaminants are not detected and concentrations of inorganic contaminants are not elevated.

The Colorado Basic Standard for Surface Water (CBSSW) for DIMP was exceeded in 1999. The presence of DIMP in First Creek surface water samples will be addressed by continued treatment of groundwater at the NBCS and OGITS until shut-off criteria are met. Groundwater treatment at the NBCS and the OGITS has caused concentrations of organic contaminants in off-post groundwater to decrease. The monitoring data show that concentrations in First Creek surface water have also decreased overall during the five-year review period. Therefore, groundwater treatment is having the desired effect on First Creek water quality because it has caused concentrations of surface water contaminants to decrease. The frequency of detections and the concentration levels of organic target analytes in the surface water samples will continue to decrease as the groundwater quality is improved due to operation of these treatment systems.

6.4 Remedy Costs

The original estimate for the remediation of RMA was 2.2 billion dollars in FY1995 dollars. As of March 31, 2000 RMA recorded the current estimated final remedial cost at 2.18 billion dollars and a cost-to-date figure of 1.08 billion dollars. Approximately 750 million dollars of this cost-to-date figure was spent prior to the signing of the On-Post ROD. Remediation at RMA is estimated to be 49.3% complete with 49.5% of the estimated budget already consumed.

7.0 ASSESSMENT

7.1 Question A: Is the remedy functioning as intended by the decision documents?

To answer question A, each of the projects identified in Table 3 were reviewed to a level of detail appropriate to the project's level of completion. The EPA Office of Solid Waste and Emergency Response (OSWER) Directive 9355.7-03B-P states that as projects are completed, they receive more scrutiny during the Five-Year Review. Projects that are completed, ongoing, in O&M status, or are operational therefore received a higher degree of review in this five-year review than did projects that have not yet begun or are under construction. Table 13 summarizes the level of review for each category of projects. For example, projects that have not yet begun are reviewed to determine the level of access controls, to confirm the health and safety and contingency plans are in place, the impacted media, contaminants of concern, and the selected remedy are specified, and it is confirmed that actions have been taken to mitigate immediate hazards. It should be noted that projects that have been administratively transferred from IRA status to a ROD-defined project are reviewed concurrently with the ROD project to which they have been transferred (see Table 3).

7.1.1 HASP/Contingency Plan

The RMA Remediation Venture Office (RVO) Health and Safety Program and the RMA RVO Integrated Contingency Plan are site-wide documents that protect workers and visitors at RMA as well as provide a reduction of long- and short-term threats to surrounding communities. Both programs have been operating at a high level of excellence and have been consistently implemented by performing organizations. RMA successes include OSHA Injury Rates that are less than one half the equivalent industry rates and award of the OSHA STAR rating for excellence in safety. RMA is the first remediation project of its kind to be awarded OSHA's highest level of recognition for safety performance.

7.1.2 Access and Institutional Controls

RMA has a multi-tiered access control program in place that governs all activities. The entire facility is fenced with 24-hour security to prohibit unauthorized access. Access to individual project sites or sites that may pose a health risk is further limited by an effective personnel badging and vehicle permit program to ensure personnel are only permitted access to sites for which they have received training. Clearly visible signs are also provided throughout the site to clarify access restrictions. By limiting individual site access to trained personnel, RMA ensures that only those with the proper level of personal protective equipment (as communicated during site-specific training) are allowed access to sites that may potentially pose a risk.

Table 13 - Summary of Project Review Standards

	Project Status					
REVIEW STANDARD (AS SPECIFIED IN EPA GUIDANCE (EPA 1999))	**Not Yet Begun**	**Under Construc-tion**	**Completed**	**Operational**	**Ongoing**	**O&M**
Describe access controls	✓	✓	✓	✓	✓	✓
Confirm the Health and Safety and Contingency Plans are in place	✓	✓	✓	✓	✓	✓
Describe the impacted media, contaminants of concern, and the selected remedy	✓	✓	✓	✓	✓	✓
Confirm actions have been taken to mitigate immediate hazards	✓	✓	✓	✓	✓	✓
Verify the remedy is functioning as described in decision documents and whether performance standards are met			✓	✓	✓	✓
Evaluate the implementation of system operations and O&M				✓	✓	✓
Consider ways to optimize the performance of systems			✓	✓	✓	✓
Check for early indicators of potential remedy failure			✓	✓	✓	✓

The FWS conducted a review of the potential risks posed to visitors to RMA (Stoller 1998). The purpose of this document was to ensure that visitors are not presented with unacceptable soil-related risks via soil ingestion, dermal contact, and particulate inhalation. Population types included were adults and children engaged in Refuge activities and biological workers (equipment operators, maintenance workers and mechanics, and habitat management specialists). The outcome of the screening process performed in this plan aids RMA personnel in decisions regarding proposed visitor activities to ensure protectiveness.

In addition to the aforementioned risk review, the FWS has developed an interim five-year Visitor Access Plan (FWS 1999a). The Visitor Access Plan delineates specific protective guidelines for visitors and is implemented in conjunction with existing RMA safety plans. One of the programs specifically identified in the Visitor Access Plan is the Sportfishing Program. This program enables the public to purchase permits for catch-and-release fishing in designated lake areas. Initiated in the 1960's, the fishing program was transferred from the Army to the FWS in 1990. The FWS closely regulated the program to ensure participants were

not exposed to unacceptable risk levels associated with the contamination at RMA. The program was suspended in 1998 due to dam reconstruction (a non-remediation activity). Subsequent to the dam reconstruction, maintenance on lake level control equipment and lake level adjustments as a result of remediation activities have further delayed the reopening of the program. The program is currently expected to reopen in the next several years.

Although the Visitor Access Plan was only recently implemented (January 1999) the overall effectiveness of the access control program is evident by the fact that there have only been five minor instances of breeches of access control by visitors at RMA during the period reviewed. None of these events resulted in the exposure of the individuals to unacceptable levels of risk. These events have resulted in improvements to the access control program to minimize the chance for future breeches of access control.

Institutional controls associated with the Off-Post OU are covered by project #98 as listed in Table 3 and discussed in Section 7.1.3.2.

7.1.3 Remedial Action Performance and System Operations/O&M

There are more than 50 remedial actions that are completed, ongoing, operational or in O&M status. Each individual project was evaluated to determine whether the remedial action continues to operate as specified in the RODs and is performing as expected in achieving cleanup levels, where appropriate. System operations and O&M procedures were also evaluated, where appropriate, to determine whether they will maintain the effectiveness of the response actions.

For ongoing projects, such as the various site-wide monitoring programs, the project was reviewed to ensure it was being properly implemented as described in the RODs and in compliance with applicable regulations.

7.1.3.1 Completed Projects

7.1.3.1.1 IRAs:

All 28 IRA projects listed in Table 3 as projects #66-93 will be discussed here. These IRA projects are considered completed. RMA officials and the regulators have agreed that any work associated with these IRAs that was completed up to the time the RODs were issued would be considered work under the IRAs and be covered by the IRA Summary Reports while any IRA related work completed after the RODs were issued would be covered by construction completion reports associated with the appropriate ROD-defined project. 28 IRA Summary Reports summarize these pre-ROD actions. These IRA Summary Reports specify the nature of interim response actions that were agreed to by all involved parties as well as how these actions were carried out.

Any work associated with IRA projects that was not completed at the time the RODs were issued was transferred, for administrative purposes, to specific remedial projects described in the RODs. These post-ROD remedial actions will be discussed as they relate to individual ROD projects as detailed in Table 3. Specifically, any IRA work continued under the RODs is denoted by the

term "transferred" in the Table 3 "status" column with a footnote referring to one or more ROD projects.

The IRA projects were reviewed in detail and found to have been implemented in accordance with the interim response decision and implementation documents as documented in the IRA Summary Reports. The IRA Summary Reports accurately reflect the work completed and all immediate risks to human health and the environment that necessitated the actions were mitigated. The current status of the IRA projects were evaluated, where appropriate, to determine the degree to which they are functioning as designed and as specified in their respective decision documents.

IRA projects with continuing operations were found to be functioning as designed except for the Basin F Liquid Sludge and Soil Remediation, Element One, Basin F Wastepile IRA. The wastepile is not functioning as designed in the second cell (there are three cells in the wastepile). Significant volumes of leachate are being collected in the secondary sump, not in the primary sump as the system was designed to do. The secondary liner is capturing this leachate as intended. An evaluation of downgradient groundwater monitoring wells does not indicate any contamination is passing through the secondary liner and into the groundwater. A comparison of indicator analytes for samples collected in wells downgradient of the wastepile during the previous five years versus baseline data indicate that contaminant levels are either consistent or decreasing (Foster Wheeler 2000). Because the wastepile does not meet RCRA Subtitle C liner and cover requirements it will be re-excavated, the landfill material de-watered if necessary, and placed in the ELF as specified in the Basin F Wastepile Remediation and Basin F Wastepile Solidification On-Post ROD projects. The treatability study for this work has already begun and excavation of the wastepile is scheduled to begin in September 2004.

7.1.3.1.2 Completed Projects with Construction Completion Reports

Each of the following projects have been completed in accordance with On- or Off-Post ROD requirements and documented in a project-specific construction completion report. Evidence of compliance with the appropriate ROD is indicated in acceptance letters received from the EPA which state the following:

- Remedial action activities have completed all construction items identified in the Scope of Work and the Final Design Package, as modified, for these projects;
- RMA officials have certified that the projects have been completed in accordance with the appropriate ROD;
- The State has concurred with the construction completion reports; and
- The EPA has approved the construction completion report and accepted the projects as complete.

These completed projects were reviewed in more detail than were projects not yet begun or under construction. This reflects the added emphasis placed on completed ROD projects as stated in the draft EPA guidance on Five-Year Reviews.

Existing (Sanitary) Landfills Remediation - Section 1

This project addressed remedial actions stated in the On-Post ROD for a distinct portion of the Existing (Sanitary) Landfills (ESL) project. The selected remedy in the ROD for Sanitary Landfills requires:

> "excavation and landfill of human health exceedance soil and excavation and consolidation to Basin A of landfill debris and soil posing a potential risk to biota. The consolidated material is contained under the Basin A cover. The excavated area is backfilled with on-post borrow material."

Additionally, the ROD remediation standard that applies to the sanitary landfills is to:

> "excavate all contaminated soil identified in the ROD for treatment, landfilling, or consolidation that corresponds to the aerial and vertical extent detailed by the soil volume calculations in the Administrative Record."

The overall ESL Remediation Project consists of seven separate sites. The completed portion of the overall project, as documented within the construction completion report (Foster Wheeler 2000b) for this project, includes remediation activities that took place at one of the component ESL sites identified as Study Area Report (SAR) site SSA-4. Site SSA-4 was a trash dump located in Section 1 of RMA.

Site SSA-4 contained approximately 10 acres of contaminated soils. Biota exceedance soils were excavated to a depth of one foot and hauled to Basin A. Human health exceedance soils were excavated to a depth of two feet and hauled to the HWL. A small area of asbestos-containing material was encountered during soil excavation and taken to the HWL. Small areas located within the limits of the biota exceedance soils, which surrounded mature trees, were identified to be left undisturbed in order to provide a more valuable wildlife habitat than would be gained by removing the soils and trees.

To meet requirements under Section 9.3 of the On-Post ROD, a confirmatory sampling program has been developed for implementation projects to determine whether contingent soils will be excavated. Accordingly, following excavation of design volumes during the ESL project, confirmatory samples were taken to confirm that contaminated soils had been excavated. Sampling results identified a small area of contaminated soil, which was excavated and disposed in the HWL. All soils removed were verified by pre-and post-excavation surveys. The only area that required backfilling was the excavation from the contingent soil volume. After the remedial excavation and backfilling was completed and survey documentation and inspections approved by the RMA program management contractor, RMA officials and regulatory agencies, the site was finish graded to promote positive drainage and to blend into the surrounding grades.

As documented in the construction completion report, remedial actions under this project have been completed, have achieved the intent of the ROD to be protective of human health and the environment and, having been inspected by RMA officials and regulatory agencies, are fully functional. This project does not require any long-term operations and maintenance. Per the design specifications, revegetation work under this project required the use of an interim seed mixture to allow removal of the new vegetative layer of soil as necessary to clear work areas for future work. There are no early indicators of potential remedy failure and no adverse results indicated by air, water, or biota monitoring in the area where the remedial actions were implemented. The EPA accepted the construction completion report for this project on February 29, 2000.

Off-Post Tillage Task

The Off-Post ROD specifies that approximately 160 acres in the southeast portion of Section 14 and the southwest portion of Section 13 will be tilled and seeded with an appropriate seed mix. The objective of this project was to thoroughly mix the top 8-10 inches of soil through tillage of appropriate areas within the area of estimated dieldrin concentration greater than 0.04 μg/g (micrograms per gram), and establish self-sustaining vegetation at those sites, thereby mitigating the impact of the elevated dieldrin levels.

The soil was tilled and thoroughly mixed to a depth of 8-10 inches by a Madge Rotoclear implement pulled by a large horsepower agricultural tractor. Observation of the equipment during operation and visual inspection of the tilled areas by RMA officials and the regulators resulted in agreement that only one pass was needed for thorough mixing. After tilling, seed was broadcast over the soil surface and incorporated into the soil through light harrowing to ensure good soil/seed contact.

Two different seed mixes were planted. A diverse native mix consisting of species adapted to the local climate was used for areas around the reservoir and adjacent to the wetland areas bordering First Creek. Upland sites were treated differently since future land use as wildlife habitat is less certain. This mix, although less diverse, consisted of easily established species that will stabilize soils for the long term while providing suitable habitat.

One problematic effect of the tillage program was that Canada thistle, a noxious weed species, became widely re-established over the site. Considerable effort was expended to successfully control this troublesome plant species from becoming a nuisance to adjoining agricultural and housing development land.

Goals stated in the task plan for this project were for establishment of a minimum average of one perennial grassland species per square meter with no visible soil erosion within the till area. Both visual inspection and quantitative estimates of perennial plant density and annual plant cover indicated that goals were met. Confirmation of these observations were made during the final project inspection conducted October 17, 1996.

This project was a comprehensive correction that met the requirements of the Off-Post ROD, and does not require active operation or maintenance. However, the areas are routinely inspected for

noxious weed control as part of RMA's ongoing vegetation monitoring. There are no early indicators of potential remedy failure and no adverse impacts indicated by air, water, or biota monitoring in the areas where these remedial actions were implemented. The Final Inspection/Implementation Report for the Off-Post Tillage Task (PMRMA 1997h) was submitted to the EPA on August 26, 1997.

Off-Post Well Abandonment

This project involved closure of seven off-post, domestic water supply and monitoring wells to seal the well and annulus to prevent downward migration of contaminants from the alluvial aquifer to the Arapahoe Aquifer. Five of the wells were domestic water supply wells that were closed per requirements of the Off-Post ROD. These wells were closed by perforating or removing the casing, followed by pressure-grouting the entire interval of the well. The remaining two wells were monitoring wells not covered under the Off-Post ROD, but closed under this work scope because they were no longer being used for groundwater monitoring. These wells were closed by backfilling with a mixture of Portland cement, bentonite and water. Following well closure, two replacement wells were constructed in a manner that prevents downward migration of contaminants. These wells were installed at the request of the landowners for lawn irrigation.

The main goal of this project was to eliminate the potential for vertical leakage of contamination from the alluvial aquifer downward to the Arapahoe Aquifer. The measures taken to achieve this goal during abandonment of the five water supply wells identified in the Off-Post ROD were as follows:

- Perforation of as much as possible of the well casings prior to grouting to seal off any voids behind the casings. In all cases the perforations extended well beyond the interface of the alluvium and Arapahoe Formation.

- Overdrilling of the casing at one well, where perforation was not possible. The casing was completely removed from the borehole to a point well below the interface of the alluvium and Arapahoe Formation.

- Filling the entire length of the wells with cement/bentonite grout using a tremie pipe to eliminate the possibility of leaving voids or cavities inside the casings.

The potential for downward migration from the alluvium in the replacement wells was eliminated by installing and grouting steel surface casings through the alluvium into the confining layer, and also installing bentonite and grout seals in the annulus of the wells from just above the screens to within the surface casings.

A final inspection was conducted on December 16, 1998 which verified that all work was completed in accordance with the statement of work and met the requirements of the Off-Post ROD. There are no operations and maintenance requirements. As documented in the construction completion report (LATA 1999), remedial actions under this combined project have

been completed, have achieved the intent of the Off-Post ROD to be protective of human health and the environment and are fully functional. There are no early indicators of potential remedy failure and no adverse impacts indicated by air, water, or biota monitoring in the areas where the remedial actions were implemented. The EPA accepted the construction completion report for this project on September 30, 1999.

Sanitary and Chemical Sewer Manhole Plugging – Phase I

The project combined two remedial actions required by the On-Post ROD by addressing distinct portions of both the sanitary sewers and the chemical sewers. Under the Sanitary Sewer Manhole Plugging – Phase I portion of the project, the ROD requires that:

> "Sanitary/Process Water Sewers - Void space inside sewer manholes is plugged with a concrete mixture to prohibit access and eliminate manholes as a potential migration pathway for contaminated groundwater. Aboveground warning signs are posted every 1,000 feet along sewer lines to indicate their location underground."

Additionally, the On-Post ROD presents Remediation Goals and Standards, which were identified as design criteria for the remediation of sanitary sewers, as follows:

- Permanently plug sanitary and process water sewer manholes with a compatible concrete mixture to prohibit access to these lines and eliminate them as a potential migration pathway for contaminated groundwater.

- Plug all sewer manholes regardless of future excavation activities in the areas where the manholes are located.

The On-Post ROD requirements and associated standards and goals have been achieved for Phase I of the Sanitary Sewer Manhole Plugging Project through the development and execution of the project design criteria and placement of warning signs at every major turning point with a maximum distance of 1,000 feet along the sanitary sewer alignment. A separate "Phase II" project will complete the remaining portion of the sanitary sewers at a later date.

Under the South Plants Central Processing Area and Complex Trenches Chemical Sewer Plugging portion of the project, the On-Post ROD requires that:

> "Chemical Sewers - For sewers located within the South Plants Central Processing Area and Complex Trench Area, the sewer void is plugged with a concrete mixture to prohibit access to these lines and eliminate them as a potential migration pathway for contaminated groundwater. The plugged sewers are contained beneath the soil cover or cap in their respective sites."

The On-Post ROD also presents Remediation Goals and Standards, which were identified as design criteria for the remediation of chemical sewers, as follows:

- Permanently plug chemical sewer lines and manholes with a compatible grout or concrete mixture to prohibit access to these lines and eliminate them as a potential migration pathway for contaminated groundwater.

- Plug only the sewer lines that are located below the maximum depth of future excavation activities. Sewer lines above this depth are not to be plugged and will be removed with future excavated soil and debris. Plug all sewer manholes regardless of future excavation activities in the areas where the manholes are located. Future excavation activities will have to remove sewer lines and manholes to the depth of excavation.

The ROD requirements and associated standards and goals have been achieved for the South Plants Central Processing Area and Complex Trenches Chemical Sewer Plugging Project through the development and execution of the project design criteria. Chemical sewers located within the ROD-defined extent of excavation will be similarly dealt with under other projects.

As documented in the construction completion report (RVO 1998a), remedial actions under this combined project have been completed, have achieved the intent of the ROD to be protective of human health and the environment and, having been inspected by RMA officials and regulatory agencies, are fully functional. This project requires periodic inspection of signs and placards denoting sewer locations as part of site maintenance requirements. The status of the plugged manholes and warning signs and placards denoting sewer locations were evaluated as part of the Five-Year Review. Several warning signs had either fallen down or had been removed and were replaced as necessary prior to the issuance of this report. There are no adverse results indicated by air, water, or biota monitoring in the areas where the remedial actions were implemented. The EPA accepted the construction completion report for this project on September 30, 1998.

CAMU Soil Remediation

In order to begin construction of the HWL, certain soils posing a potential risk to biota (biota soils) or posing a potential residual risk to biota (priority one soils) needed to be removed from the Corrective Action Management Unit (CAMU) and the designated borrow area. The primary focus of this project was to remove these soils since the On-Post ROD requires removal of biota soils. The On-Post ROD also mandated a remedial action for Basin A for it to be used as a consolidation area for certain waste materials. Prior to placement of other waste materials, the Basin A design required placement of a one-foot thick foundation layer of soils over the entire Basin A footprint . The biota and priority one soils were used to construct a one-foot thick foundation layer thus effectively meeting this design requirement.

The original scope of work included the removal of a minimum of one foot of soils from two major areas. The first of those areas included a 38.5-acre portion of Borrow Area 5 located in Section 24. The second major area of excavation included the CAMU, which is the site where the HWL is constructed. An area of human health exceedance soils located south of the former Submerged Quench Incinerator (SQI) Office area was not within the scope of this project and therefore was not disturbed.

To verify that the minimum one-foot of soil had been excavated the subcontractor performed a pre- and post-excavation survey. Reverification of the depth was also performed by an independent registered surveyor under contract to the program management contractor.

The majority of the designated soils were excavated and hauled into Basin A. Once hauled into Basin A, the soils were placed and compacted as foundation and fill layers over an area of approximately 131 acres designated as the Basin A footprint. Soils excavated from a designated area (a portion of what is referred to as Basin F Exterior) around the former SQI Office area (west of D Street) were placed in a specially designated area north of Basin F due to requirements in the Basin F Closure Plan (HLA 1996a). Along with the described excavation activities, the subcontractor was required to remove numerous existing items within the areas designated for excavation. These items included power poles, security fences, piezometers and concrete water control structures.

Numerous small areas within the work areas were not excavated due to a specification requirement that certain existing structures and items be protected and soils not be removed within a five-foot boundary surrounding them. These protected items included certain groundwater monitoring wells, survey markers, chemical sewer manholes, the sensors and radio shack north of the former Air Force Building 836, and the sanitary sewer drain field and septic tank northwest of Building 836. Any contaminated soils that were left in place are being removed under the Section 26 Human Health Exceedance and Biota Soils/CAMU Completion and Support On-Post ROD project.

Once the excavated areas were verified to be at the appropriate depth to ensure that a minimum of one foot of soils had been removed, the excavated areas were revegetated according to the project design. The placement of the one-foot thick foundation layer and subsequent fill layers over the appropriate areas of Basin A accomplished the requirements for a safety buffer for the field workers. The activities involved with the excavation, hauling, placement and consolidation of soils under this project were subject to monitoring for airborne dust and odors. Water spray was the primary method of dust control employed throughout the project.

The final inspection was held June 24, 1998 at the conclusion of the project. Due to the nature of the soil removal and placement activities, no long-term operations and maintenance is required for this project. Per the design specifications, all of the revegetation efforts performed by the subcontractor required the use of an interim seed mixture to allow follow-on subcontracts to easily remove the new vegetative layer of soil as necessary to clear their work areas at the start of their subcontracts.

RMA officials and the regulatory agencies have determined that this remedial action has been completed in accordance with the On-Post ROD, has met the intent of the On-Post ROD to be protective of human health and the environment, and complies with the final design package (MKC 1998a). There are no early indicators of potential remedy failure and no adverse results indicated by air, water, or biota monitoring in the area where this remedial action was implemented. The construction completion report (RVO 1998b) for this project was accepted by the EPA on September 30, 1998.

CAMU/Basin A Well Abandonment

This project addressed a well closure requirement in the On-Post ROD and was performed as a prelude to two other projects that required either soil excavation from the CAMU or soil placement into Basin A. Monitoring wells located in these two areas, previously installed to characterize the nature and extent of contamination, were evaluated to determine if they would be left in place and protected or abandoned. Well abandonment is conducted to close a well so that it does not create an avenue for contaminants to migrate into other zones of soil or into the groundwater.

The majority of the groundwater wells within the Basin A footprint were determined to be expendable due to the following rationale:

- Preservation of existing wells will be disruptive to waste consolidation and cover construction operations.

- Abandonment of wells and construction of new wells will likely be more economical than preserving existing wells, particularly where the placed waste and fill is of considerable depth and would interfere with waste/fill placement and compaction activities.

- Most wells within Basin A would likely be abandoned because of reduced long-term monitoring requirements.

Similar rationale was used in review of the status of existing monitoring wells in the CAMU area. That review also concluded that the majority of the affected wells should be abandoned and removed.

Based on review of the installation methods utilized during the installation of each of the monitoring wells, an abandonment specification was developed which addressed the closure requirements specific to each well. During the abandonment activities, two of the wells were found to require the use of additional specialized equipment and methods, which were determined to be beyond the capabilities of the original subcontractor. Additional work to close these two wells was performed by a second subcontractor utilizing specialized tools and equipment. A total of 108 wells were removed and abandoned under this project.

A final inspection was conducted on June 23, 1998 at the conclusion of the project. As documented in the construction completion report (RVO 1998), remedial actions under this project have been completed, have achieved the intent of the On-Post ROD to be protective of human health and the environment and have complied with the project design. Due to the nature of the monitoring well abandonment methods specified under this project, no long-term operations and maintenance or further actions are required. Once the well abandonment project activities were completed, all pre-existing above ground physical evidence of the location of the wells were removed. There are no early indicators of potential remedy failure and no adverse results indicated by air, water, or biota monitoring in the area where this remedial action was

implemented. The EPA accepted the construction completion report for this project on September 30, 1998.

NDMA Monitoring and Assessment

The On-Post and Off-Post RODs included remedial action components related to monitoring, assessment, design refinement/design characterization, and preparation of a feasibility study (FS) for NDMA contamination in groundwater in order to achieve remediation goals at the boundary systems. The NDMA assessment and FS were completed and an UV-oxidation treatment system was installed at the NBCS to treat NDMA and has been in operation since September 1997 (HLA 1996b, 1996c, 1997). A construction completion report was issued for the UV system in 1998 (MKC 1998b).

Henderson Distribution Project

The On-Post ROD requires the extension of water-distribution lines to existing domestic use well owners within the DIMP plume footprint as defined by the Army and Shell in cooperation with the State of Colorado, EPA and SACWSD.

In the latter part of 1996, the Army, working in conjunction with TCHD, CDPHE, and the EPA, mapped the off-post DIMP plume. The agencies then determined which well owners had wells within the DIMP footprint and thereby qualified for connection to the SACWSD municipal water supply. The TCHD contacted the individual well owners and provided SACWSD with a list of owners who agreed to have their domestic water connected to the SACWSD system.

The SACWSD contracted the design and construction of the water line extensions and service connections in early 1997. Construction of the project began in August 1997 and was completed in September 1998. The following were constructed under the project:

- Approximately 68,000 linear feet of 8-inch, 12-inch, 16-inch and 24-inch diameter potable water distribution piping

- Approximately 42,000 linear feet of ¾-inch through 3-inch service line piping

- Completion of 146 service line connections to existing residential and commercial properties with qualifying wells

In accordance with On-Post ROD requirements, owners of any new or existing domestic wells found to have DIMP concentrations of 8 ppb (or other relevant CBSG at the time) or greater will be connected to a water-distribution system or provided a deep well or other permanent solution.

Actions taken in support of this project provided an additional layer of protectiveness with respect to exposure to groundwater. All On-Post ROD requirements associated with this project have been successfully completed. The construction completion report (Black & Veatch 1999) for this project was accepted by the EPA on September 30, 1999.

7.1.3.1.3 Other Completed Projects

The project discussed here was completed, but did not require a construction completion report due to the nature of the action.

South Adams County Water Supply

The On-Post ROD states that $48.8 million will be provided for the acquisition and delivery of 4,000 acre-feet of potable water to SACWSD. SACWSD has entered into an agreement with Denver Water for the acquisition and delivery of 4,000 acre-feet of potable water (McLaughlin 1999). The Army made final payment of the $48.8 million to SACWSD on May 5, 2000. All On-Post ROD requirements associated with this project have been successfully completed.

7.1.3.2 Ongoing Projects

Medical Monitoring Program

The On-Post ROD directed that a medical monitoring program be instituted that would respond effectively to RMA-related health concerns of the surrounding communities during the soil cleanup. CDPHE has the lead role in the medical monitoring program. The On-Post ROD also stipulated that a MMAG be formed to recommend appropriate program components. Regulatory agencies, local governments, Army, Shell, FWS, independent technical advisors and representatives from the affected communities made up the MMAG, as directed by the On-Post ROD.

The MMAG completed its work in October 1998 and submitted a final report to CDPHE for acceptance. CDPHE formally accepted all twelve of the program recommendations developed by the MMAG and began program implementation. The program recommendations included systematic evaluation of air quality data and its health significance, systems to track birth defects and cancer rates in the neighborhoods around RMA, improvements to RMA's air quality and odor monitoring programs, improvements to emergency response programs, a process for selecting appropriate public health actions, health professional education and public involvement and education.

CDPHE has already implemented many key components of the recommendations.

- Established a 24-hour, multi-lingual, toll free number at the Rocky Mountain Poison and Drug Center (RMPDC) to respond to citizens or health care providers who may have RMA-related health concerns or questions. The RMPDC provides expert advice and works with CDPHE for case follow-up. CDPHE mailed an "RMA Health Line" information magnet to about 20,000 nearby residences and businesses to let people know about this service. Since December 1998 "RMA Health Line" inception through March 2000, 343 calls have been received; 324 callers listened to the recording only, two callers asked general, non-health related questions, 12 callers asked general, non-personal health-related questions and five calls related to personal health concerns of the caller or family member. In these five cases, the RMPDC physicians, collaborating with the State

Health Department, determined that it was unlikely that the caller's symptoms were related to the RMA cleanup.

- Formed a Health Response Review panel consisting of representatives from CDPHE, EPA, TCHD and Denver Environmental Health. This panel is assigned responsibility for oversight and identification of appropriate public health actions.

- Established a Medical Monitoring Program Citizen Advisory Board (CAB) in 1999. The CAB meets quarterly and advises CDPHE on program implementation.

- The MMAG recommendations for improvements to the air and odor monitoring plans have been adopted.
- CDPHE systematically evaluates RMA air quality monitoring data for its public health significance.

- CDPHE, collaborating with medical professionals, prepared and mailed a Health Professional Resource Handbook to interested metro-area health professionals. Providing this assistance will allow health care providers to respond more effectively to their patient's RMA-related health questions or concerns.

- An existing state program, Colorado Responds to Children with Special Needs, is being used to track birth defects in the neighborhoods around the RMA during the remediation.

- Cancer rates, during and after the cleanup, will be tracked by the Colorado Central Cancer Registry for these same neighborhoods.

- A regular program newsletter and a web page will communicate RMA air and odor monitoring data and program developments. The introductory issue of the newsletter, "Health Matters", was mailed in August 1999. The web page was scheduled to be available in the summer of 2000.

Evidence of successful implementation of the medical monitoring program includes:

- As part of the Medical Monitoring Program, a CDPHE air quality specialist compares each RMA air measurement against health-protective limits to make sure the cleanup is safe.

- The 1999 air quality monitoring data and its associated health significance have been documented by RMA officials in the 1999 annual air report (Foster Wheeler 2000a). The combined risk from all chemicals measured will also be evaluated and compared to acceptable benchmarks.

- No measurements in excess of acute health-protective criteria were recorded in 1999. Annual averages for RMA-specific compounds did not exceed long-term (cancer or chronic) limits. This is an indicator that emissions from the RMA cleanup are within protective limits.

- The RMA Health Line and the Birth Defects surveillance program have not revealed health impacts to date.

The medical monitoring program, as required under the On-Post ROD, has been successfully implemented. A review of administrative protocols and work plans indicates that each key program component has been developed. These protocols and work plans are consistent with the MMAG recommendations and provide implementation procedures. As described above, the key components of the program are intended to monitor the success of community and RMA visitor exposure prevention and to make certain a response framework is in place in case of failure. These operating procedures can be refined, if necessary, in response to community needs or unforseen events.

Off-Post Institutional Controls

The Off-Post ROD includes the use of institutional controls. The Off-Post ROD identifies the following objective for institutional controls as a component of the remedial action in the Off-Post OU:

> "Prevention of the use of the groundwater underlying areas of the Off-Post OU exceeding groundwater containment system remediation goals."

The Remediation Scope and Schedule for the Off-Post OU provides further specifics on the implementation of institutional controls. The primary mechanism for implementing the institutional controls is the well notification program developed by the Colorado Department of Natural Resources and RMA. Under the program, the State Engineer's Office (SEO) has the responsibility to notify persons who apply for groundwater well permits in the area north of RMA.

The Army provided the SEO and the State of Colorado, with maps identifying areas in the Off-Post Study Area where groundwater could potentially exceed CSRGs. The Estimated Areas Exceeding CSRG maps (Exceedance Maps) were produced and transmitted to the SEO in March 1997, February 1999, and July 2000.

The first map was not available in June 1996 because water samples were still being collected, analyzed, and checked. When the all the data was available, the information was assembled and the map was reviewed by the EPA, CDPHE, and TCHD. Suggestions and comments were addressed and the map was provided to the SEO in March 1997.

RMA and the SEO agreed to a notification process tied to well permit applications for drilling and installation of water wells within the Off-Post OU. The well notification program was

implemented by the SEO in March 1997 after RMA finalized the 1997 map. The SEO agreed to include on each well permit application, well permit, and drilling permit for the affected area a notice that the applicant should contact TCHD and the EPA for information regarding groundwater quality. The notifications read:

WELL PERMIT NOTICE
NOTICE: THIS WELL IS IN THE ROCKY MTN. ARSENAL AREA WHERE CONTAMINATION MAY BE ENCOUNTERED. CONTACT THE TRI-COUNTY HEALTH DEPARTMENT (303) 288-6816 OR THE EPA (303) 312-6247 FOR DETAILS PRIOR TO DRILLING THIS WELL.

CORRESPONDENCE NOTICE
NOTICE: THIS PROPOSED WELL IS IN THE ROCKY MTN. ARSENAL AREA WHERE GROUNDWATER CONTAMINATION MAY BE ENCOUNTERED. PRIOR TO PROCEEDING WITH THIS APPLICATION YOU SHOULD CONTACT THE TRI-COUNTY HEALTH DEPARTMENT (303) 288-6816 OR THE EPA (303) 312-6247 FOR MORE DETAILS CONCERNING THE LIKELIHOOD OF ENCOUNTERING THIS CONTAMINATION, OR PROCEDURES AND PRECAUTIONS NEEDED DURING WELL CONSTRUCTION.

To provide a straight-forward process for determining who should be notified, RMA requested that the SEO notify applicants for well permits over a broad area. Well permits and correspondence in the following sections were to include the notification: T 1S, R 67W, sections 34 and 35; T 2S, R 67W, sections 1, 2, 3, 9, 10, 11, 12, 13, 14, 15, 16, and 22; and T 2S R 66W, section 18. Only portions of each of these sections include areas where RMA contaminants are above the CSRG levels.

TCHD compiled all well permits from the potentially affected area for the period June 1996 to March 31, 2000. Thirty-six well applications for domestic use were filed with the SEO during this period. Of the 36 well applications, eight were applied for before March 1997 (i.e., before the first exceedance map was available), one was an application for a replacement well, and one was an application for registration of an existing well, leaving 26 applications requiring notification. The SEO included notification on 16 of the remaining 26 well applications. None of the 26 wells were located within the area of groundwater exceeding the CSRGs. However, the information included with the application for registration of the existing well indicated that it is within the area where DIMP is above the CSRG. According to their contact list, the TCHD received five inquiries regarding groundwater contamination in the off-post area.

The SEO also received 26 well applications for groundwater monitoring wells. Sixteen of the applications were from the Army and 10 were from the Denver Water Department related to construction of gravel pits near the South Platte River.

The Off-Post ROD-stated objective of the Off-Post Institutional Controls ("prevention of the use of the groundwater underlying areas of the Off-Post OU exceeding groundwater containment system remediation goals") has been met and the project, therefore, has effectively protected human health and the environment.

Private Well Network

This project consists of Off-Post private well sampling, database inventory management, and information services that are provided by TCHD through a memorandum of agreement with RMA. These services initially were performed to assist in identifying which households would receive bottled water, which households should be included in the Henderson South Adams County Water and Sanitation hookup program, and which wells met the requirements for the off-post well closure program. As these functions are no longer needed, the current TCHD Off-Post Private Well Inventory, Sampling and Information Response Program serves to:

- Sample all private wells that continue to have CSRG exceedances
- Sample private wells at the request of residents
- Monitor CFS wells for presence of RMA-related contamination to assess the need for closure of the wells
- Sample private wells to assist in plume delineation for the site-wide groundwater monitoring program

This work performed by TCHD effectively helps to ensure that off-post residents are not exposed to groundwater with contaminant concentrations in excess of the CSRGs, a critical element of the Off-Post ROD.

With respect to the third bullet above (monitoring CFS wells), the Off-Post ROD states that at the time of the Five-Year Review, the monitoring information will be reviewed and it will be determined whether continued monitoring is warranted. The evaluation of the monitoring data is provided in the Five-Year Groundwater Summary Report. The results of the evaluation indicate that reducing the number of off-post private wells monitored to meet this requirement is warranted. Of 17 candidate wells, monitoring of DIMP in 8 wells (1070B, 343A, 359A, 486C, 588A, 589A, 848A, and 914B) is recommended to continue annually until they can be eliminated based on the criteria developed in the evaluation. These criteria are 1) when contaminant concentrations fall below analytical reporting limits, or 2) when the well has been sampled at least five times by the Army/TCHD and the mean concentration plus two standard deviations is less than the CSRG. Wells 1070B and 914B should also be monitored for chloroform until they meet these criteria.

These criteria differ from the monitoring criteria in Appendix C of the Off-Post ROD and are intended to replace criterion 2.d in Appendix C. An ESD or Fact Sheet should be used to formalize this change in the Off-Post ROD criteria. It should be noted that eliminating wells for monitoring under the Off-Post ROD well closure criteria does not preclude their sampling for other objectives in the TCHD private well monitoring program (e.g., owner requests, exceedance mapping of the UFS, and other objectives).

Site-Wide Air Monitoring

The IC-APA and air and odor monitoring programs at RMA are operating in compliance with the Site-Wide Air Quality Monitoring Program Plan (SWAQMP) (Foster Wheeler 1999a) and the Site-Wide Odor Monitoring Program Plan (SWOMP) (Foster Wheeler 1999b), the two relevant documents developed in response to requirements prescribed in the On-Post ROD. As required in the On-Post ROD, RMA has, in conjunction with the regulatory agencies, developed an IC-APA program that is designed to ensure that remediation actions will be protective of human health and the environment and minimize nuisance odors. The program consists of five discrete tasks that have been completed and one task (Task 6) that is an ongoing, evolving effort. The IC-APA approach has been implemented and is utilized as intended to support remediation and meet the goals established in the On-Post ROD.

Under IC-APA Task 5, the site-wide air and odor monitoring program plans (SWAQMP and SWOMP) were developed. Ambient air and odor monitoring conducted at RMA currently follows these programs as outlined in the relevant program plans. These plans were written to specifically address language in the On-Post ROD and are being implemented so as to meet stated objectives. Prior to 1999, monitoring was conducted in accordance with the former Comprehensive Air Quality and Meteorological Monitoring Program, which over time evolved into the SWAQMP and SWOMP.

Program operating procedures include a series of flow diagrams that are included in the air and odor plans and that specify action levels and response actions that may be triggered as remediation progresses. The actions specified in these diagrams have been successfully implemented on several occasions. They have proven to be effective in identifying situations that require response action, mitigating the potentially threatening situation, and in prescribing the proper notifications of the events. Thus, current operating procedures are maintaining the effectiveness of response actions. More detail on the air monitoring program was included in Section 6.3.3.

Site-Wide Biota Monitoring

Site-wide biota monitoring was reviewed and found to meet the requirements of both the RODs and the Cooperative Agreement for Conservation and Management of Fish and Wildlife Resources at Rocky Mountain Arsenal. This cooperative agreement has periodically been revised to reflect the Service's expanding and changing role at RMA. Biomonitoring of the effects of and/or efficacy of the remediation efforts has and will continue to be a major facet of the Service's technical assistance to the remediation effort. More detail on this program is provided in Section 6.3.2.

Site-Wide Groundwater Monitoring

Groundwater monitoring is a requirement of both the Off-Post and On-Post RODs. The On-Post ROD states that a network of monitoring wells will be sampled to monitor remedy effectiveness and that where human health exceedances are left in place at soil sites, groundwater will be monitored, as necessary, to evaluate the effectiveness of the remedy. The On-Post ROD also

states that groundwater monitoring will be used to ensure that South Plants plumes are prevented from migrating into the lakes at concentrations exceeding (CBSG) in groundwater at the point of discharge. Groundwater monitoring is also required by both RODs to monitor the effectiveness of groundwater treatment systems as well as the natural attenuation of chloride and sulfate. Finally, the Off-Post ROD requires long-term groundwater monitoring to ensure continued compliance with the CSRGs.

The LTMP presents the monitoring program designed to meet the On- and Off-Post ROD requirements. The main purpose of the LTMP was to develop a program to monitor the remedy during and after implementation and this program replaces the previous site-wide investigation type monitoring programs as of WY2000. The LTMP includes operational water level and water quality monitoring associated with the containment and treatment systems, water quality monitoring in source areas and upgradient of the systems, water level tracking on-post and off-post, CFS monitoring on-post, off-post exceedance monitoring, and private well monitoring in the Off-Post Study Area. More detail on this program is provided in Section 6.3.1.

South Lakes Plume Monitoring/Lake Levels

The On-Post ROD states that groundwater monitoring will be used to demonstrate compliance with the requirement that South Plants plumes are prevented from migrating into the lakes at groundwater concentrations that exceed CBSGs. A groundwater monitoring program was initiated in 1997 (Foster Wheeler 1997). The program, which has been limited to Lake Ladora is being revised and will be implemented with a new Work Plan during WY2001.

Trust Fund

The On-Post ROD mandated "good faith" effort be exerted in establishing a Trust Fund to help ensure the long-term operations and maintenance of the remedy once the remedial structures and systems are installed. The On-Post ROD noted that establishment of the Fund may require special legislation and that federal agencies are restricted in what actions they can take in proposing and supporting legislation.

A Trust Fund Group was formed in August 1996 to identify options for establishing the Fund. The Group consisted of representatives from the Army, Shell, EPA, CDPHE, FWS, RAB, SSAB, the Governor's office, Commerce City officials and concerned citizens. Eight options were identified and, after much study and discussion, two options were agreed upon as the most feasible. One option consisted of establishing a Trust Fund under the authority granted to EPA at Superfund sites. The second option involved a payment of money by Shell (the money would have to be allocable) into a Trust Fund.

The Trust Fund Working Group proposed two strategies to the Army that would establish a Trust Fund for long-term operations and maintenance costs. One strategy would have Shell establish a Trust Fund in its lead party status. The second strategy would have established a sub-account within EPA's Superfund Trust Fund. The Deputy Assistant Secretary of the Army for Environment, Safety and Occupational Health reviewed the proposed strategies and opined that both were unacceptable due to legal and policy implications. The Army and Shell will continue

to meet with members of the Working Group to discuss additional strategies and future prospects for establishing a Trust Fund.

UXO Management

The On-Post ROD specifies that "any UXO encountered during remediation will be excavated and transported off-post for detonation (unless the UXO is unstable and must be detonated on-post) or other demilitarization process." With only one exception, all UXO encountered during remediation since the issuance of the RODs, has been deemed unstable and was detonated on-post. The one exception was a 155 mm projectile round containing GB nerve agent that was safely shipped to Dugway Proving Ground in Utah. Based on information provided by UXO management staff at RMA it was determined that monitoring, transportion, and detonation of UXO on-post was conducted in accordance with Department of Defense Standard 6055.9, Army Regulation 385-64, and Department of the Army Pamphlet 385-64. The provision of the On-Post ROD cited above has been met.

7.1.3.3 Operational Projects

Operation of the Hazardous Waste Landfill

Construction of the HWL was completed in the fall of 1998. The landfill was certified to accept waste by the same regulatory agencies in April 1999 and the first waste was received at the HWL on May 11, 1999. Since its opening the HWL has operated to receive waste from the following projects:

- Basin A
- Burial Trenches
- CAMU Soil Remediation
- Drummed, Staged, and Contained Waste Handling
- Existing Sanitary Landfill
- Lake Sediments
- Miscellaneous Northern Tier Soil
- Miscellaneous RMA Structural Demolition
- Miscellaneous Southern Tier Soil
- Munitions Testing
- RMA Remediation Operations
- Section 26 Soil Removal
- Section 35 Soil Remediation
- Section 36 Bedrock Ridge
- South Plants Balance of Areas
- South Plants Structures Demolition
- Toxic Storage Yards
- Well Abandonment Projects

The placement of waste is governed by Part 265, Subpart B, C, D and E of 6 CCR 1007-3, Standards for Owners and Operators of Hazardous Waste Treatment, Storage and Disposal Facilitities. The specific operating requirements to ensure compliance with these regulations are presented in the HWL Operations Plan (Foster Wheeler 1998a) as reviewed and approved by the regulatory agencies.

Waste receipt into the HWL complies with On-Post ROD requirements that dictate the final disposal of waste material from remediation projects. The details of these On-Post ROD requirements are contained in the RMA Remediation Waste Management Plan (RWMP) (Foster Wheeler 1999c) that clearly delineate the disposal of waste materials in the HWL or Basin A. The RWMP also provides guidance with respect to waste tracking in providing procedures and forms for ensuring the delivery of waste material to the proper location. This waste tracking is performed electronically with a backup system comprised of paper forms that accompany the waste to the disposal facility.

The requirements of the On-Post ROD as stated in the HWL Operations Plan are currently being met by the operations and maintenance activities and there are currently no early indicators of potential remedy failure.

Operation of Hazardous Waste Landfill Wastewater Treatment System

The HWL Wastewater Treatment System (LWTS) has been operated to support HWL operations following commissioning according to the requirements of the design documents. It has successfully treated in excess of 10 million gallons of stormwater, leachate and decontamination wastewater from HWL operations.

The discharge of treated water from the facility is monitored for compliance with the requirements of the CCD. The CCD comprised a discharge authority issued by the EPA that established the self-monitoring requirements of the treatment system including regulatory basis, discharge standards, monitoring requirements, and reopener provisions. Monthly discharge monitoring reports (DMRs) are required to be submitted to the regulatory agencies to certify compliance with the CCD and/or report any non-compliance events. The treatment plant has been operated in full compliance with the administrative requirements of the CCD including the timely submission of the DMRs.

Significant incidents that have occurred during operation of the LWTS include:

- An accidental release of stormwater occurred from the wastewater lift station as a result of faulty control logic that prevented automatic restart of wastewater transfer pump after shutdown. Corrective measures implemented to close the incident included: revision of the control ladder logic; removal of impacted soils around the lift station and disposal of the soils in the HWL; and construction of an earthen containment berm around the lift station.

- An accidental release of stormwater occurred from the wastewater lift station as a result of a power outage caused by a lightning storm. Corrective measures implemented to close the incident included: installation of a diesel emergency power generator and automatic transfer switch.

- An accidental release of stormwater occurred from the stormwater collection manhole when the hose connecting the manhole to the stormwater collection pump disengaged from its coupling allowing the stormwater to be discharged to the intermediate drainage ditch on the exterior of the landfill berm. The stormwater was completely contained with the intermediate drainage ditch and did not migrate beyond that point. Corrective measures implemented to close the incident included: removal of impacted soils and disposal of these soils in the HWL; and deletion of the stormwater collection manhole outside the landfill berm and provision of a direct connection of the stormwater discharge hose to the collection pipe inside the landfill berm.

Based on the information provided above, operation of LWTS has been in accordance with On-Post ROD requirements as specified in the LWTS Operations Plan (MKC 1999a).

Operation of the Basin A Consolidation and Remediation Area

The Basin A Consolidation and Remediation Area was designed to contain waste from remediation projects defined by the On-Post ROD. These wastes include all materials that are designated for on-post disposal but not designated for disposal in the HWL or the ELF. Work performed to prepare Basin A for operation included the construction of a foundation layer of approximately 1-3 foot depth to prevent contact of waste hauling and placement equipment with potential UXO in the basin. This foundation layer was comprised primarily of biota-exceedance soil that originated from the areas of the CAMU. Since its opening, Basin A has operated to receive waste from the following projects:

- Burial Trenches
- CAMU Soil Remediation
- Existing Sanitary Landfill
- Lake Sediments
- Miscellaneous Northern Tier Soil
- Miscellaneous RMA Structural Demolition
- Miscellaneous Southern Tier Soil
- Munitions Testing
- RMA Remediation Operations
- Section 26 Soil Removal
- Section 35 Soil Remediation
- Section 36 Bedrock Ridge
- South Plants Balance of Areas
- South Plants Structures Demolition
- Toxic Storage Yards

Waste receipt into Basin A complies with On-Post ROD requirements that dictate the final disposal of waste material from remediation projects. The details of these On-Post ROD requirements are contained in the RWMP that clearly delineate the disposal of waste materials in the HWL or Basin A. The RWMP also provides guidance with respect to waste tracking in providing procedures and forms for ensuring the delivery of waste material to the proper location. This waste tracking is performed electronically with a backup system comprised of paper forms that accompany the waste to the disposal facility.

The requirements of the Basin A Operations Plan (MKC 1999b) are currently being met by the operations and maintenance activities and there are currently on early indicators of potential remedy failure.

Basin A is therefore operating in accordance with requirements of the On-Post ROD as stated in the Basin A Operations Plan that has been reviewed and approved by the regulatory agencies.

Operation of CERCLA Wastewater Treatment Facility

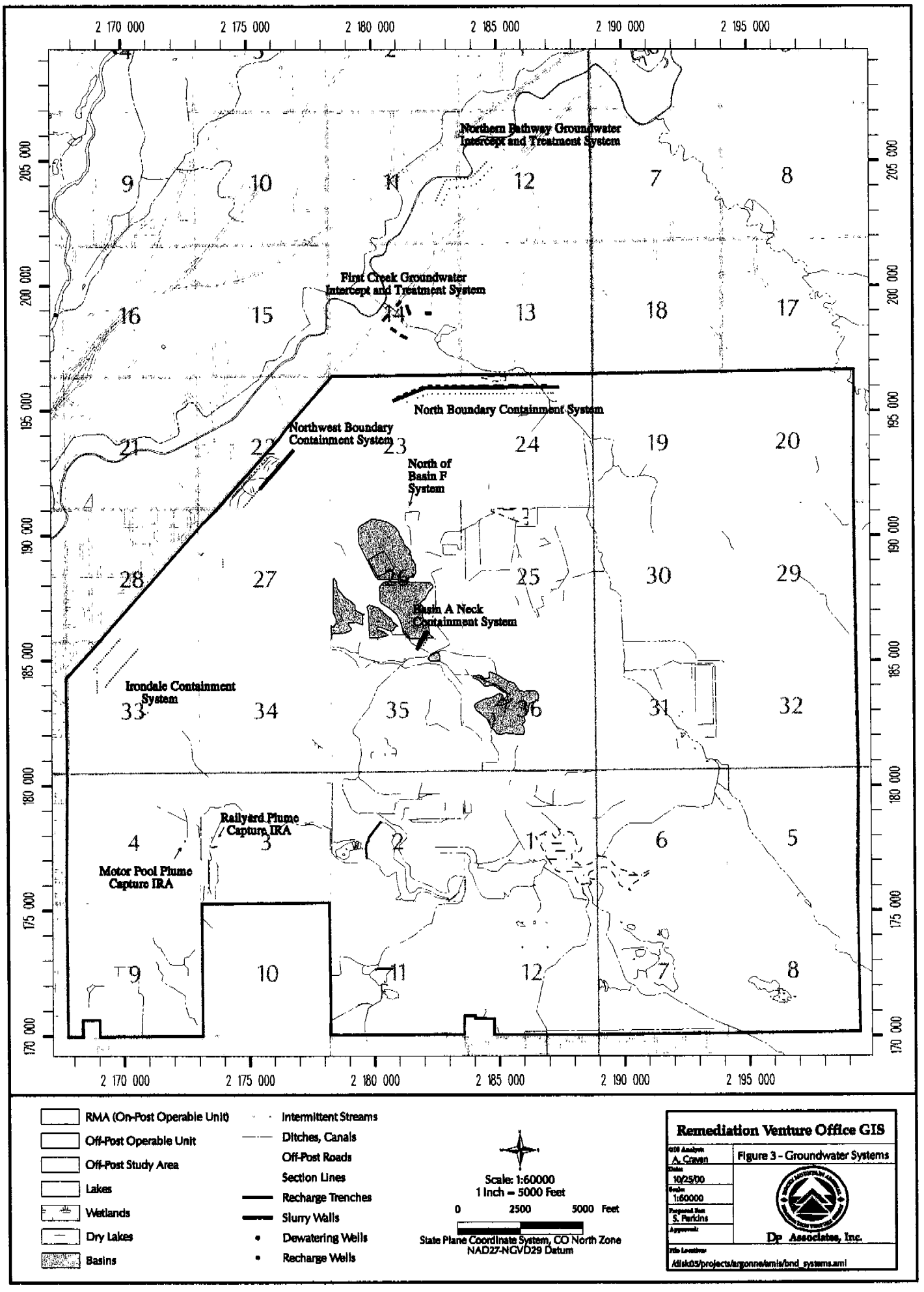
The CERCLA Wastewater Treatment Facility is a facility providing ongoing support to various RMA remedial projects. Although it began as an IRA, and has been concluded as an IRA per an IRA Summary Report (EPA et al 2000f), it continues as an integral part of the ongoing remedy. The facility has been operating in batch mode in compliance with all On-Post ROD specifications. All liquid discharges to the Basin A Neck recharge trenches have met appropriate discharge standards. All solid wastes generated have been properly disposed of either off-site or on-site in the HWL. The facility is therefore meeting all applicable provisions of the On-Post ROD.

Basin F Wastepile Operations and Maintenance

The original construction and establishment of a routine operations and maintenance schedule for the Basin F Wastepile is discussed in detail in the IRA Summary Report titled Basin F Liquid, Sludge, and Soil Remediation - Element One, Basin F Wastepile (EPA et al 2000). While this IRA was completed with an IRA Summary Report noted above, ongoing operation and maintenance of this wastepile is critical to the successful implementation of the remedy. Routine operations and maintenance have resulted in adherence with all provisions of the On-Post ROD with leachate being regularly collected and shipped off-site for disposal in accordance with RCRA. More information on the wastepile is included in the last paragraph of Section 7.1.3.1.1.

7.1.3.4 Operations and Maintenance Projects

Groundwater containment and treatment systems are identified in Figure 3. The operation of groundwater containment and treatment systems is covered in detail in the Annual Operational Assessment Reports for each system. To best protect human health and the environment, the On-Post ROD specified the following two remedial action objectives:


2 170 000
2 175 000
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Northern Pathway Groundwater Intercept and Treatment System
First Creek Groundwater Intercept and Treatment System
North Boundary Containment System
Northwest Boundary Containment System
North of Basin F System
Basin A Neck Containment System
Irondale Containment System
Railyard Plume Capture IRA
Motor Pool Plume Capture IRA
RMA (On-Post Operable Unit)
Off-Post Operable Unit
Off-Post Study Area
Lakes
Wetlands
Dry Lakes
Basins
Intermittent Streams
Ditches, Canals
Off-Post Roads
Section Lines
Recharge Trenches
Slurry Walls
Dewatering Wells
Recharge Wells
Scale: 1:60000
1 Inch = 5000 Feet
0 2500 5000 Feet
State Plane Coordinate System, CO North Zone
NAD27-NGVD29 Datum
Remediation Venture Office GIS
GIS Analyst: A. Craven
Figure 3 - Groundwater Systems
Date: 10/25/00
Scale: 1:60000
Prepared For: S. Perkins
Approved:
DP Associates, Inc.
File Location: /disk03/projects/argonne/arvis/bnd_systems.aml

Ensure that the boundary containment and treatment systems protect groundwater quality off-post by treating groundwater flowing off RMA to the specific remediation goals identified for each of the boundary systems.

- Develop on-post groundwater extraction/treatment alternatives that establish hydrologic conditions consistent with the preferred soil alternatives and also provide long-term improvement in the performance of the boundary control systems.

The Off-Post Endangerment Assessment/Feasibility Study (HLA 1992) identified the following remedial action objectives for off-post groundwater:

Human Health

- Reduce the COC concentrations in groundwater and/or prevent exposure associated with groundwater within the Off-Post OU to meet groundwater remediation goals and to attain the cumulative risk range identified in the National Contingency Plan.

- Prevent domestic use of, ingestion of crops irrigated with, and ingestion of livestock watered with groundwater containing COCs at concentration levels in excess of groundwater remediation goals.

Environmental Protection

- Prevent acute or chronic toxicity to biota from groundwater within the Off-Post OU by containing COC concentrations in excess of groundwater remediation goals.

No problems that could be anticipated to lead to remedy failure or suggest that protectiveness is at risk were identified for any of the operating systems. Current operations were deemed to be adequate to ensure future protectiveness, although as in the past, flexibility and responsiveness to changing conditions are deemed critical to successful system operations.

The treatment systems were constructed prior to development of a formal 'Operational and Functional' determination requirement by CERCLA guidance. Each of the treatment systems achieved operational and functional status shortly after their construction and have continued to be in 'Operation and Maintenance' mode ever since.

At the time of this review a process had not been adequately defined to determine new quantitation limits to be used as placeholders for CSRGs in measuring contaminant levels at the groundwater containment and treatment systems. This has not affected the protectiveness of the remedy to date but will be addressed in this review to better ensure future protectiveness. This issue applies equally to all groundwater systems and was discussed in further detail in Section 6.2.1.

Northwest Boundary Containment System

The NWBCS is identified in both the On-Post and Off-Post RODs as an integral part of the selected remedy by ensuring elevated levels of eight contaminants potentially in the groundwater don't migrate off-post.

An evaluation of the performance of this system, as presented in the Operational Assessment Reports for FY95, 96, 97, 98, and 99 (PMRMA 1996, 1997b, 1998f, 1999c, 2000d) indicates that the NWBCS is performing as intended in the RODs. Operational changes were implemented, as appropriate, to ensure protectiveness was maintained throughout the period reviewed. All groundwater intercepted and treated was reinjected with contaminant levels below CSRG's identified in the RODs. The capture of contaminant plumes migrating toward the northwest boundary was controlled by the effective operation of the system. A detailed analysis of the performance of the system can be found in the aforementioned Operational Assessment Reports.

In reviewing the NWBCS CSRGs in Table 7.3 of the Off-Post ROD it was discovered that there were inconsistencies with the NWBCS CSRGs in Table 9.1-1 of the On-Post ROD. Specifically, the Off-Post ROD incorrectly included chloride, fluoride, and sulfate. These inorganic contaminants should not have been included as contaminants with CSRGs for this system. Table 9.1-1 of the On-Post ROD correctly excludes these contaminants for this system. This issue is further addressed in Sections 8.0 and 9.0 of this report.

North Boundary Containment System

The NBCS is identified in both the On-Post and Off-Post RODs as an integral part of the selected remedy by ensuring elevated levels of 29 contaminants potentially in the groundwater don't migrate off-post.

A UV-oxidation treatment system was installed at the NBCS to treat NDMA and has been in operation since September 1997. NDMA concentrations in all downgradient NBCS conformance wells have been below the CSRG since FY98 in response to operation of the UV treatment system.

The sulfate natural attenuation goal was achieved within five years rather than the predicted 25 years as stated in the On-Post ROD. The chloride concentrations in the NBCS effluent during this five-year review period were consistent with the predicted trend for meeting the chloride CSRG within 30 years from the On-Post ROD date (i.e., by the year 2026). The chloride natural attenuation is therefore deemed to be on track in accordance with applicable guidelines (MKC/FWENC 1996). More information regarding chloride and sulfate attenuation as it pertains to NBCS operations is provided in the NBCS FY99 Operational Assessment Report (PMRMA 2000b).

An overall evaluation of the performance of this system, as presented in the Operational Assessment Reports for FY95, 96, 97, 98, and 99 (PMRMA 1997d, 1997a, 1999a, 1999b, 2000b) indicates that the NBCS is performing as intended in the RODs. As with the NWBCS operational changes have been implemented (as noted above) to ensure protectiveness is

maintained. Contaminant plumes migrating toward the NBCS were effectively contained. All groundwater extracted was effectively treated and reinjected with contaminant levels below the CSRGs. A detailed analysis of the performance of the system can be found in the aforementioned Operational Assessment Reports.

Basin A Neck Containment System

This system treats water from both the North of Basin F System as well as from the Basin A Neck Containment System. This system is identified in the On-Post ROD as an integral part of the selected remedy by minimizing the contaminant loading on the boundary treatment systems.

An evaluation of the performance of this system, as presented in the Operational Assessment Reports for FY95, 96, 97, 98, and 99 (PMRMA 1997e, 1997f, 1999d, 2000a, 2000b) indicates that the BANCS is performing as intended in the RODs. As with the other systems, operational changes have been implemented to ensure protectiveness is maintained. The North of Basin F System effectively reduced the contaminant loading on the NBCS while the BANCS minimized the spread of contaminated groundwater through the Basin A Neck. All extracted groundwater was effectively treated and reinjected with contaminant levels below the CSRGs. The North of Basin F IRA extraction well was shut down temporarily during road construction activities (from 10/27/98 to 3/8/99) and for an EPA innovative treatment technology study (from 12/14/99 to 1/25/00). A detailed analysis of the performance of both systems can be found in the aforementioned Operational Assessment Reports.

Irondale Containment System

The Irondale, Railyard, and Motor Pool Systems were identified in the On-Post ROD as integral to controlling the migration of contaminant plumes. An evaluation of the performance of these systems, as presented in the Operational Assessment Reports for FY95, 96, 97, 98, and 99 (MKC 1996, 1997, 1998, 1999, 2000) indicates that they are performing as intended in the RODs. The Irondale and Motor Pool extraction systems have been shut down since FY1998 after meeting shut-down criteria and are therefore in the ROD-required five-year shutdown-monitoring period. The Railyard extraction system continues to operate. It continues to limit the migration of the DBCP plume as intended. A detailed analysis of the performance of these systems can be found in the aforementioned Operational Assessment Reports.

Operation of Off-Post Groundwater Intercept and Treatment System

The OGITS is identified in the Off-Post ROD as an integral part of the selected remedy by mitigating migration of 34 contaminants potentially in the groundwater in the two alluvial channels intercepted by the system. An evaluation of the performance of this system, as presented in the Operational Assessment Reports for FY95, 96, 97, 98, and 99 (PMRMA 1997g, 1997c, 1999e, 2000e, 2000f) indicates that the OGITS is performing as intended in the Off-Post ROD. All extracted groundwater was effectively treated and reinjected with contaminant levels below the CSRGs. The system effectively mitigated the migration of contaminants in the alluvial channels intercepted. A detailed analysis of the performance of the system can be found in the aforementioned Operational Assessment Reports.

7.1.4 Opportunities for Optimization and Cost Reduction

7.1.4.1 Cost Reduction

Programmatic cost savings are continuously strived for that will save money while not adversely impacting the quality of the remedy. A recent example is the RMA Arsenal Transition and Analysis Team (A-TAT). The A-TAT initiative strives to optimize RMA support costs for functional areas through:

- Transition management of specific program support functions to the program management contractor;
- Reduce remedy support expenditures whenever and wherever possible; and
- Expedite program completion by removing task interferences.

This initiative has been tapping into the creative talent of the RMA workforce to develop innovative ways to cut costs while optimizing the implementation of the remedy. Another example of RMA's attempt to implement a cost-effective remedy is the RMA Cost/Productivity Improvement Program (C/PIP). The C/PIP program, like the A-TAT initiative, seeks to capitalize on the creative talent and innovative ideas of the RMA workforce. This program encourages cost savings and productivity improvements and provides appropriate recognition to individuals and organizations that participate. The program establishes a means for RMA personnel to contribute innovative ideas and provides both financial incentives as well as recognition for participation.

Air, water and biota program personnel at RMA routinely evaluate alternative methodologies and strategies for possible inclusion into their respective programs. Among the factors considered in these evaluations are the ability of the program to continue to meet its objectives and the costs of implementing alternative approaches. Opportunities to improve performance and reduce costs will be considered in these continuing evaluations. As the groundwater systems continue to meet shut-down criteria in the future, more cost savings will be realized as the systems are no longer needed.

7.1.4.2 Optimization

Remedial operations at RMA are continually evaluated not only to determine areas of potential cost savings, but also to determine where there may be opportunities to perform activities more effectively, efficiently, or simply in a more sensible manner. Two examples are provided below.

As previously discussed, the CBSG change for endrin from 0.2 µg/L to 2.0 µg/L does not impact the protectiveness of the remedy. However, to maintain consistency with existing standards, this new CBSG should be adopted. This change could be effected via an Explanation of Significant Differences (ESD).

An example of past optimization of the groundwater systems can be found at the NBCS treatment plant. Prior to May 1995 the carbon adsorbers were operated in an upflow mode. This mode of operation was resulting in short circuiting of contaminants in the carbon beds and poor carbon usage rates. The carbon beds were converted to downflow operations and the short-circuiting of contaminants was terminated. Prior to the modifications the NBCS used approximately 240,000 pounds of carbon a year. During FY1999 approximately 80,000 pounds of carbon were used at the NBCS; these modifications resulted in an annual savings of 160,000 pounds of carbon consumption which equates to an estimated $163,000 in savings. In addition to this one time example of optimization, there are ongoing activities that should be noted. Extraction wells, recharge trenches, groundwater flow patterns, contaminant plumes, and plant flow processes are all evaluated periodically to determine ways to optimize performance.

7.1.5 Early Indicators of Potential Remedy Failure

Each of the projects was reviewed to determine whether there was a realistic chance of remedy failure. There was no evidence uncovered that would lead to the conclusion that there is a potential failure of the remedy

Additionally, each of the site-wide monitoring programs has been designed to be proactive in determining potential remedy failure. For example, the air and odor programs were designed to be conservative in predicting the potential health impacts of remediation activities. If one or more assumptions that factored into the conservative nature of the APA are revealed to be grossly in error, measured impacts of remediation could approach the established health criteria. For example, if an unanticipated area of highly contaminated soil is encountered during excavation, air contaminant levels may exceed the acute criterion for a compound or severely affect the annual average relative to the long-term criteria. In a worst-case scenario, remediation activities may have to cease until applicable standards can be met. However, the monitoring programs have internal action levels and response actions in place to detect unanticipated emissions and respond in such a way to limit the resulting impacts so that long-term failures will not result. In addition, contingency sampling protocols are in effect that anticipate the potential need to conduct additional sampling to respond to situations that may affect the continued adherence of RMA to the health criteria.

7.2 Question B: Are the assumptions used at the time of the remedy selection still valid?

There are no significant changes to the assumptions used at the time of remedy selection that call into question the protectiveness of the remedy. The changes that have been identified are minor and by adopting them protectiveness will only be improved.

7.2.1 Changes in ARARs, Standards and TBCs

As indicated in Section 6.0 there are several ARAR and TBC changes that should be addressed. One ARAR applicable to NBCS and OGITS has changed since the issuance of the On-Post ROD. The CBSG for endrin has increased and adoption of the new standard recommended in Section 7.1.4.2.

The ARAR used as the basis for the LWTS's CCD effluent standards has changed. There is already a procedure in place to review and adjust, as necessary, the effluent standards. This review is scheduled to occur around December 2000. Therefore, these changes to the effluent standards described in Section 6.0 are not expected to affect the protectiveness of the remedy.

Several worker exposure standards and a standard for PCB storage and decontamination have changed. These changes should be adopted (and in the case of worker exposure standards, already have been) however their existence does not compromise the protectiveness of the remedy.

7.2.2 Changes in Exposure Assessment Variables

The exposure setting at both OUs has not changed significantly since the signing of the two RODs. The physical characteristics of the site (climate, vegetation, hydrology, and surface water) have remained relatively unchanged (the only exceptions to this are discussed in Section 6.3). Populations on and near the site have not changed significantly. Activity patterns and the presence of sensitive subpopulations have likewise not changed notably. While residential land development has occurred north of RMA during the past five years, this does not impact the assumptions made regarding the exposure setting.

Exposure pathways for contaminants in both OUs were evaluated. The mechanisms of release in the On-Post OU have not changed while in the Off-Post OU one of the primary exposure pathways has been eliminated by the implementation of various off-post institutional controls (to include municipal water hookups of off-post residences). The CDPHE prepared a risk assessment to evaluate the public health significance of consuming vegetables and fruits irrigated with DIMP-contaminated ground water. The assessment concluded that the risk associated with exposure to DIMP at concentrations at or near the state groundwater standard is unlikely to be a public health concern (CDPHE 2000).

Monitoring data as described in Section 6.3 of this report indicate no adverse changes in exposure concentrations were discovered. In most cases concentrations have generally decreased, yielding less risk over time. In the On-Post OU this can be primarily attributed to the removal of source areas while in the Off-Post OU this can be attributed to natural attenuation.

Overall there was no reason to conclude that contaminant intake has increased in any of the scenarios originally evaluated in the determination of the remedy.

7.2.3 Changes in Toxicity Assessment Variables

No evidence was found of any substantive changes in toxicity values used in the determination of an acceptable remedy.

7.2.4 Changes in Risk Assessment Methods

There were no changes in risk assessment methods that would require revision of the original risk assessment work.

7.3 Question C: Has any other new information come to light that could call into question the protectiveness of the remedy?

Besides information discussed in Question A and B above, no other new information has come to light during this Five-Year Review that calls into question the protectiveness of the Remedy.

8.0 CONCLUSIONS

All immediate threats to human health and the environment have been properly mitigated by both the access and institutional controls in place as well as by the successful implementation of the IRAs. All completed, ongoing, operational, and O&M projects have been, or are being, implemented in a manner to ensure protectiveness of human health and the environment.

Conclusions presented in this section are categorized as either "deficiencies" or as "conclusions related to optimizing implementation of the remedy".

8.1 Deficiencies

8.1.1 Basin F Wastepile

The Basin F Wastepile is not operating as designed as detailed in Section 7.1.3.1.1. Very little leachate is being collected in the primary system while larger volumes are collected by the secondary sump system. All evidence indicates that this is not resulting in an impact to the groundwater and it should be noted that leachate volume currently being generated (24,650 gallons in CY1999) is dramatically less than it has been in the past (81,336 gallons in CY1990) due to the gradual dewatering of the waste (PMRMA 2000f).

8.1.2 Off-Post Institutional Controls

For the period June 1996 through March 2000, there were no applications for new domestic well permits within the estimated area exceeding CSRG's (i.e., the Off-Post Plume). However, the procedure established by the Army and the SEO utilizes a conservatively large area of 15 square miles over which notifications are to be provided. Within that area, only 16 out of 26 well applications included the notification. The well notification institutional control process has therefore not been completely effective. Although no exposure occurred because the applicants did not request permits within the groundwater area exceeding CSRGs, this notification process needs improvement to ensure future protectiveness.

8.2 Conclusions Related to Optimizing Implementation of the Remedy

8.2.1 MRL/PQL Process

A defined procedure for ensuring newly available quantitation limits are implemented at the groundwater system has not been developed. This has not affected the protectiveness of the remedy but should be addressed to prevent future problems.

8.2.2 New Endrin CSRG

The CBSG for endrin at the NBCS and the OGITS has changed from 0.2 µg/L to 2.0 µg/L. This change will not impact protectiveness.

8.2.3 Hazardous Waste Landfill Wastewater Treatment System CERCLA Compliance Document

The ARARs used as a starting point for determining effluent limitations for the LWTS CCD have been lowered. There is already a process in place to review the effluent standards annually. These changes do not immediately affect the protectiveness of the remedy and will not in the future as long as the next annual review of the standards implements the new values as appropriate.

8.2.4 Other Changes in ARARs

Changes in PCB decontamination and storage standards have changed since the issuance of the RODs. These changes have not adversely impacted the protectiveness of the remedy.

8.2.5 Private Well Network

The number of off-post CFS wells monitored as part of the Private Well Network project can be reduced based on recent analytical data. The following wells should be monitored for DIMP; 1070B, 343A, 359A, 486C, 588A, 589A, 848A, and 914B. Wells 1070B and 914B should also be monitored for chloroform. This sampling should continue annually until contaminant concentrations fall below analytical reporting limits, or until the well has been sampled at least five times and the mean concentration plus two standard deviations is less than the CSRG. This criteria differs from the criteria originally stated in the Off-Post ROD.

8.2.6 Northwest Boundary Containment System

Table 7.3 in the Off-Post ROD incorrectly includes CSRGs for chloride, fluoride, and sulfate at the NWBCS. CSRGs for these contaminants should not have been included for this system. The proper list of contaminants for this system is in Table 9.1-1 in the On-Post ROD.

9.0 RECOMMENDATIONS AND FOLLOW-UP ACTIONS

9.1 MRL/PQL Process

A procedure needs to be defined to ensure new quantitation limits for CSRGs are implemented in a timely and consistent manner. This document provides a mechanism for reviewing and changing the MRLs and PQLs listed in the RODs on a five-year cycle. The next MRL/PQL review is therefore scheduled for 2005. In addition to defining a procedure for adopting new quantitation limits, new quantitation limits need to be adopted, as appropriate, for the upcoming five-year cycle.

9.1.1 New Process for Evaluating Quantitation Limits

Beginning with this first Five-Year Review Report, the following procedure is implemented. Individual contaminants at individual groundwater systems have quantitation limits that are conceptually defined as either PQLs or MRLs in the "quantitation limit" column of Table 14.

The quantitative values associated with the MRL's are defined by the procedures in Appendix A of the RMA CQAP, and depend on the availability of contract laboratories as well as the ability of these laboratories to maintain their method detection and reporting limits. During each Five-Year Review, existing MRLs will be reviewed and, if appropriate, a new MRL will be agreed upon for the upcoming five-year cycle.

The selection of a new MRL depends on the following three factors:

- The establishment of new MRLs by various laboratories under contract to RMA
- The reliability of the established MRL being considered reproducible over the upcoming five-year cycle
- The professional judgement of the Five-Year Review Team conducting the review

The quantitative value associated with the PQLs will be the State of Colorado PQLs as defined in 5 CCR 1002-61, Colorado Discharge Permit System Regulations.

After the MRLs and PQLs have been redefined at the Five-Year Review, it is conceivable that changes could occur in these quantitation limits due to laboratory changes, method changes, or other events. The MRLs may vary whenever a new laboratory is put under contract, or whenever a laboratory under current contract conducts proficiency testing (required once every three years) to redefine their operating parameters.

In the event that lower quantitation limits become available, adoption of these limits will be considered during the next Five-Year Review. In the event that quantitation limits go up, a letter will be sent by RMA to the EPA, CDPHE, and TCHD notifying them of the change and proposing action as appropriate. As has been the case the past in obtaining analytical services, laboratories will be required to meet ROD-specified quantification limits. In the event that an analytical method change is proposed, a letter will be sent by RMA to EPA, CDPHE, and TCHD prior to adopting the new method notifying them of the proposed change and the anticipated impact on quantitation limits.

9.1.2 Quantitation Limits for Upcoming Five-Year Period

By implementing the process identified in Section 9.1.1 the following new quantitation limits are implemented as of the date of the issuance of this report. Table 14 summarizes which of the two quantitation limits (MRL or PQL) apply to constituents at each of the groundwater treatment

systems. The table also provides the initial (per the RODs) and newly adopted (as appropriate) quantitation limits for the upcoming five-year cycle.

Table 14 - New Quantitation Limits for Groundwater Systems

System	Chemical	Quantitation Limit	CSRG (µg/L)	Old Quantitation Limit (µg/L)	New Quantitation Limit (µg/L)
NWBCS	Dieldrin	MRL	0.002	0.05	0.05
	NDMA	MRL	0.007	0.033	0.033
NBCS	1,2-Dichloroethane	PQL	0.4	1.0	0.2
	Carbon Tetrachloride	MRL	0.3	0.99	0.488
	Aldrin	MRL	0.002	0.05	0.025
	Dieldrin	MRL	0.002	0.05	0.05
	NDMA	MRL	0.007	0.033	0.033
OGITS	1,2-Dichloroethane	PQL	0.4	1.0	0.2
	Carbon Tetrachloride	MRL	0.3	0.99	0.488
	Aldrin	MRL	0.002	0.05	0.025
	Chlordane	MRL	0.03	0.095	0.095
	Dieldrin	MRL	0.002	0.05	0.05
	NDMA	MRL	0.007	0.033	0.033
BANCS	1,2-Dichloroethane	PQL[1]	0.4	1.1	1.1
	Carbon tetrachloride	PQL	0.3	1	1
	Dieldrin	PQL	0.002	0.1	0.1

[1] = System-specific PQL, not the State of Colorado PQL

9.2 Basin F Wastepile

Although no new action is recommended to address the deficiency noted in Section 8.1.1, the collection system and the leachate levels should continue to be carefully monitored on a daily basis until the wastepile is addressed as directed in the On-Post ROD. The On-Post ROD requires the Basin F Wastepile to be re-excavated and placed in the ELF currently scheduled to begin operation in September 2004.

9.3 New Endrin CSRG

As discussed in Section 7.4.1.2, the endrin ARAR should be changed from 0.2 µg/L to 2.0 µg/L in the On-Post and Off-Post RODs. This change should be effected via an Explanation of Significant Differences (ESD) to be completed no later than six months after the issuance of this report. This change is recommended as an optimization step.

9.4 Off-Post Institutional Controls

The following are recommendations and follow-up actions for improving the well notification program. They should be implemented no later than three months after the issuance of this report.

- The SEO has the responsibility of providing notification to well permit applicants. RMA will set up periodic meetings (e.g., annually) with the SEO staff to review status of well applications from the potentially affected area. The purpose of the meetings will be to determine if correspondence associated with the applications includes the proper notification.

- The SEO will provide the Army and TCHD copies of all well applications for the potentially affected area.

- When warranted, RMA will request TCHD to make individual contact with well applicants to provide detailed explanation of the nature and extent of groundwater contamination in the off-post area.

9.5 Hazardous Waste Landfill Wastewater Treatment System CERCLA Compliance Document

During the next annual review of the LWTS CCD the revised Federal Water Quality Criteria detailed in this report should be taken into consideration and changes, as appropriate, should be incorporated.

9.6 Other Changes in ARARs

The updated provisions of the Code of Federal Regulations, Title 40, Section 761.79 should be adopted within three months of the issuance date of this report.

9.7 Private Well Network

The number of off-post CFS wells monitored as part of the Private Well Network project should be reduced based on evidence presented in Section 7.1.3.2 of this report. The following wells should be monitored for DIMP; 1070B, 343A, 359A, 486C, 588A, 589A, 848A, and 914B. Wells 1070B and 914B should also be monitored for chloroform. This sampling should continue annually until contaminant concentrations fall below analytical reporting limits, or until the well

has been sampled at least five times and the mean concentration plus two standard deviations is less than the CSRG. This new criteria for evaluating wells in the Private Well Network should be implemented via an ESD or a Fact Sheet. This ESD or Fact Sheet should be submitted for approval within three months of the issuance date of this report.

9.8 Northwest Boundary Containment System

A Fact Sheet should be submitted within three months of the issuance date of this report to correct the improper inclusion of chloride, fluoride, and sulfate CSRGs in Table 7.3 of the Off-Post ROD.

10.0 PROTECTIVENESS STATEMENT

The protection of human health and the environment of the remedial actions at both the On-Post and Off-Post OUs are discussed below. All controls are in place to adequately minimize risks. Because the remedial actions at both the On-Post and Off-Post OUs are expected to be protective of human health and the environment upon completion, the remedy for the entire site is expected to be protective of both human health and the environment.

10.1 On-Post Operable Unit

The remedy at the On-Post OU is expected to be protective of human health and the environment upon completion. All immediate threats have been adequately addressed in the form of IRAs and their continued effectiveness has been assured by transferring them administratively into specific, related remedial projects under the On-Post ROD, as appropriate. The HWL, which is central to the effective implementation of the remedy, has been expeditiously constructed and is operational. All other implementation projects are on schedule and in compliance with all elements of the On-Post ROD. Air, water, and biota monitoring programs are comprehensive in their design and effective in their implementation. Contaminant migration is being adequately controlled. Risks to human health and the environment are also being controlled by a comprehensive worker protection and access control program, institutional controls, and the past implementation of IRAs.

10.2 Off-Post Operable Unit

The remedy at the Off-Post OU is expected to be protective of human health and the environment upon completion. All immediate threats have been adequately addressed in the form of IRAs and their continued effectiveness has been assured by transferring them administratively into specific, related remedial projects under the Off-Post ROD, as appropriate. Administrative controls to protect the public have been effective in their implementation. Groundwater contamination is being treated to Off-Post ROD remediation goals both at the RMA boundary as well as at the Off-Post Groundwater Intercept and Treatment System.

11.0 NEXT REVIEW

The next Five-Year Review for RMA should be conducted five years from the issuance of this Five-Year Review Report. The issuance date is the date of the signature shown on EPA Letter of Concurrence attached to the front of this report.

Appendix A

References

Allen, D.L.
1996 (May) *Effects of Contaminants on Small Mammal Population and Community Parameters on the Rocky Mountain Arsenal National Wildlife Refuge*. M.S. Thesis. Clemson University.

Beyers, D., N. MacRury, M. Pearson, and B. Graeb.
1998 (June 1) *Effects of Sediment Contaminants on Macroinvertebrate and Fish Assemblages in Lower Lakes at Rocky Mountain Arsenal.*

Black and Veatch
1999 (Sept. 27) *South Adams County Water and Sanitation District Henderson Pipeline Construction Completion Report.*

CDPHE (Colorado Department of Public Health and Environment)
2000 (Apr.) *Estimation of Human Health Noncancer Risks Due to Ingestion of DIMP-Contaminated Vegetables and Fruits.*

Close, D.H.
1996. *Biomonitoring at the Rocky Mountain Arsenal using the Plains Pocket Gopher (Geomys bursarius)* M.S. Thesis. Colorado State University.

Ebasco
1994 (July). *Integrated Endangerment Assessment/Risk Characterization, Final.* (4 vols.)

1992 (Jan.) *Remedial Investigation Summary Report, Final*

1992a (Dec.) *Development and Screening of Alternatives Report.*

1992b (Dec.) *Human Health Exposure Assessment Addendum for Rocky Mountain Arsenal, Version 3.2, Final.* (3 vols.)

1990 (Sept.) Human *Health Exposure Assessment for Rocky Mountain Arsenal. Final, Version 4.1.* (8 vols.)

EPA (U.S. Environmental Protection Agency)
2000 (May) *Front Range Dioxin Study, Study 3: Western Tier Parcel, Draft.*

1999 (Oct.) *Comprehensive Five Year Review Guidance*, EPA 540R-98-050, OSWER Directive 9355.7-03B-P, Draft.

EPA et al (U.S. Environmental Protection Agency et al)

2000 (May) *Interim Response Action (IRA) Summary Report – Basin F Liquids, Sludges, and Soils Remediation, Element One - Basin F Waste Pile, Final.*

2000a (May) *Interim Response Action (IRA) Summary Report, Improvement of the North Boundary System and Evaluation of all Existing Boundary Systems Northwest Boundary Containment System, Final.*

2000b (June) *Interim Response Action (IRA) Summary Report, Pretreatment of Comprehensive Environmental Response, Compensation, and Liability Act Liquid Wastes, Element One - Waste Management, Draft.*

2000c (May) *Interim Response Action (IRA) Summary Report, Closure of the Hydrazine Facility, Final.*

2000d (May) *Interim Response Action (IRA) Summary Report Remediation of Other Contamination Sources M-1 Settling Basins, Final.*

2000e (June) *Interim Response Action (IRA) Summary Report, Remediation of Other Contamination Sources, Lime Settling Basins, Draft.*

2000f (June) *Interim Response Action Summary Report, Pretreatment of Comprehensive Environmental Response, Compensation, and Liability Act Liquid Wastes, Wastewater Treatment System, Draft.*

2000g (May) *Interim Response Action (IRA) Summary Report, Groundwater Intercept and Treatment System, North of Basin F, Final.*

2000h (May) *Interim Response Action (IRA) Summary Report, Groundwater Intercept and Treatment System in the Basin A Neck Area, Final.*

2000i (May) *Interim Response Action (IRA) Summary Report Remediation of Other Contamination Sources Army (Complex) Disposal Trenches, Final.*

2000j (May) *Interim Response Action (IRA) Summary Report Remediation of Other Contamination Sources Shell Section 36 Trenches, Final.*

2000k (May) *Interim Response Action Summary Report, Pretreatment Of CERCLA Liquid Wastes Element Two – PCB, Final.*

2000l (May) *Interim Response Action Summary Report, Basin F Liquids, Sludges, and Soils Remediation Element Two - Basin F Liquid, Final.*

2000m (August) *Interim Response Action Summary Report, Remediation of Other Contaminated Sources, South Tank Farm Plume, Final.*

2000n (June) *Interim Response Action Summary Report, Chemical Process Related Activities, Draft.*

2000o (Oct) *Interim Response Action Summary Report – Closure of Abandoned Wells at Rocky Mountain Arsenal, Final.*

1999 (April) *Interim Response Action Summary Report – Offpost Groundwater Intercept and Treatment System, Draft Final.*

1999a (July) *Interim Response Action Summary Report – Deep Disposal Well Closure, Final.*

1999b (July) *Interim Response Action Summary Report – South Tank Farm Plume, Final.*

1999c (Sept.) *Interim Response Action Summary Report – Waste Staging Area, Draft.*

1998 (May) *Interim Response Action Summary Report – Sanitary Sewers, Draft Final.*

1997 (Oct.) *Interim Response Action Summary Report, Remediation of Other Contamination Sources – Motor Pool Area, Final.*

1997a (Oct.) *Interim Response Action Summary Report, Remediation of Other Contamination Sources – Rail Classification Yard, Final.*

1997b (Oct.) *Interim Response Action Summary Report, Improvement of the North Boundary System) and Evaluation of All Existing Boundary Systems Irondale Containment System, Final.*

1989 (Feb.17) *Federal Facility Agreement for the Rocky Mountain Arsenal. Pursuant to CERCLA Section 120, Docket No. CERCLA VIII-89-13.*

ESE (Environmental Science and Engineering, Inc.)

1988 *Offpost Operable Unit Remedial Investigation and Chemical Specific Applicable or Relevant and Appropriate Requirements, Final Report.*

Foster Wheeler (Foster Wheeler Environmental Corporation)

2000 (Mar.) *Five-Year Groundwater Summary, Draft.*

2000a (June) *Air and Odor Monitoring Data Assessment Report for Calendar Year 1999, Draft.*

2000b (Jan. 28) *Existing (Sanitary) Landfill Remediation Section 1 Construction Completion Report.*

1999 (Dec.) *Long-Term Monitoring Plan for Groundwater, Final.*

1999a (Sept.) *Site-Wide Air Quality Monitoring Program Plan.*

1999b (July) *Site-Wide Odor Monitoring Program Plan.*

1999c (Apr.) *Site-Wide Remediation Projects Remediation Waste Management Plan, Revision 0.*

1998 (Nov.) *Comprehensive Air Quality and Meteorological Monitoring Program Air Quality Data Assessment Report for Fiscal Year 1996.*

1998a (Aug.) *Hazardous Waste Landfill Operations Manual, Revision B.*

1997 (May) *South Lakes Groundwater Investigation, Final Work Plan.*

1996 (June) *Record of Decision for the On-Post Operable Unit, Final,* (3 vols.).

1995 (Oct.) *Detailed Analysis of Alternatives Report, Final,* Version 4.1.

Frank, R.A.

1995. *Effects of Dieldrin on Great Horned Owls at the Rocky Mountain Arsenal National Wildlife Refuge.* M.S. Thesis. University of Wisconsin-Madison.

Gannett Fleming

2000 (May 12) *Western Tier Parcel Confirmation Soil Sampling Risk Report Remedial Design / Remedial Action Oversight, Interim Final.*

2000a (May 5). *Western Tier Parcel Site Reconnaissance Report, Interim Final.*

Gard, N.W.

1995. *Introduction of Immunotoxicity and Mixed-Function Oxygenase Activity as Biomarkers of Exposure to Environmental Contaminants in the Deer Mouse (Peromyscus Manuculatus).* Ph.D. Dissertation. Clemson University.

HLA (Harding Lawson Associates)

1997 (Jan.) *NDMA Technical Meeting Summary,* Meeting December 17, 1996, with U.S. Environmental Protection Agency, Shell Oil Company, and Colorado Department of Health.

1996 (Sept. 25) *Remediation Scope and Schedule for the Offpost Operable Unit, Rocky Mountain Arsenal, Commerce City, Colorado, Final.*

1996a (Apr.) *Final Closure Plan for the Closure/Post Closure of the Basin F Surface Impoundment and Closure of the Basin F Wastepile, RMA.*

1996b (June) *n-Nitrosodimethylamine Assessment Letter Report, Rocky Mountain Arsenal.*

1996c (Nov. 19) *n-Nitrosodimethylamine Alternatives Report, Rocky Mountain Arsenal, Commerce City, Colorado, Draft Final.*

1995 (Dec. 19) *Rocky Mountain Arsenal Offpost Operable Unit, Final Record of Decision, Rocky Mountain Arsenal, Commerce City, Colorado.*

1992 (Nov. 24) *Offpost Operable Unit, Endangerment Assessment/Feasibility Study, Final Report.*

1992a *Offpost Operable Unit Remedial Investigation, Final Addendum.*

Henriques, W.D.
1996. *A Model of Spatial and Temporal Exposure and Effects of Dieldrin on Badgers at the Rocky Mountain Arsenal National Wildlife Refuge*. Ph.D. Dissertation. Clemson University.

Hoff, D.J.
1998 (May) *Integrated Laboratory and Field Investigations Assessing Contaminant Risk to American Badgers (Tacidea Taxus) On The Rocky Mountain Arsenal National Wildlife Refuge.* Ph.D. Dissertation. Clemson University.

LATA (LATA/AG&M Team)
1999 (July 9) *Final RMA Off-Post Well Abandonment Construction Completion Report.*

MacRury, N.K.
1995. *Influences of Parasites and Organochlorines on Bioenergentics and Feeding Behavior of Largemouth Bass*. M.S. Thesis. Colorado State University.

McLaughlin (McLaughlin Water Engineers Ltd.)
1999 (Nov.) *Report of Independent Qualified Agent Concerning Completion of Contract for 4,000 Acre Feet Supplemental Water Supply.*

MKC (Morrison Knudsen Corporation)
2000 *Irondale Containment System Review of Fiscal Year 1999 Operations.*

1999 (Apr.) *Irondale Containment System Review of Fiscal Year 1998 Operations.*

1999a (Jan.) *Hazardous Waste Landfill Design, Landfill Wastewater Treatment System, Operations and Maintenance Manual.*

1999b (Mar.) *Basin A Operations Plan, Revision C.*

1998 (Mar.) *Irondale Containment System Review of Fiscal Year 1997 Operations.*

1998a (Jan.) *CAMU Soils Remediation Project, Final Design Package.*

1998b (June 30) *North Boundary Containment System, System Modifications for Treatment of NDMA, Construction and Startup Completion Report.*

1997 (Mar.) *Irondale Containment System Review of Operations, January 1, 1996 – September 30, 1996.*

1996 (July) *Irondale Containment System Review of 1995 Operations.*

MKC/FWENC (Morrison Knudsen Corporation-Environmental Services and Foster Wheeler Environmental Corporation)

1996 (Mar.) *Development of Chloride and Sulfate Remediation Goals for the North Boundary Containment System at the Rocky Mountain Arsenal.*

PMRMA (Program Manager for Rocky Mountain Arsenal)

2000 (Apr.) *Basin A Neck and North of Basin F Groundwater Intercepts and Treatment Systems Operational Assessment Report, FY98 Final Report.*

2000a *Basin A Neck and North of Basin F Groundwater Intercepts and Treatment Systems Operational Assessment Report, FY99 Final Report.*

2000b *North Boundary Containment/Treatment System Operational Assessment Report, FY99 Final Report.*

2000c *Northwest Boundary Containment/Treatment System Operational Assessment Report, FY99 Final Report.*

2000d (Apr.) *Offpost Groundwater Intercept Treatment System Operational Assessment Report, FY98 Final Report.*

2000e *Off-Post Groundwater Intercept Treatment System Operational Assessment Report, FY99 Final Report.*

2000f (Aug. 15) *Basin F Interim Response Action Structures Monthly Operations Report for July 2000.*

1999a (Jan.) *North Boundary Containment/Treatment System Operational Assessment Report, FY97 Final Report.*

1999b (Dec.) *North Boundary Containment/Treatment System Operational Assessment Report, FY98 Final Report.*

1999c (Sept.) *Northwest Boundary Containment/Treatment System Operational Assessment Report, FY98 Final Report.*

1999d (Feb.) *Basin A Neck and North of Basin F Groundwater Intercepts and Treatment Systems Operational Assessment Report, FY97 Final Report.*

1999e (Feb.) *Offpost Groundwater Intercept Treatment System Operational Assessment Report, FY97 Final Report.*

1999f (Nov.) *Record of Decision for the Onpost Operable Unit Remediation Design and Implementation Schedule.*

1998f (July) *Northwest Boundary Containment/Treatment System Operational Assessment Report, FY97 Final Report.*

1997a (Aug.) *North Boundary Containment/Treatment System Operational Assessment Report, FY96 Final Report.*

1997b (July) *Northwest Boundary Containment/Treatment System Operational Assessment Report, FY96 Final Report.*

1997c (Sept.) *Offpost Groundwater Intercept Treatment System Operational Assessment Report, FY96 Final Report.*

1997d (Feb.) *North Boundary Containment/Treatment System Operational Assessment Report, FY95 Final Report.*

1997e (Feb.) *Basin A Neck and North of Basin F Groundwater Intercepts and Treatment Systems Operational Assessment Report, FY95 Final Report.*

1997f (Sept.) *Basin A Neck and North of Basin F Groundwater Intercepts and Treatment Systems Operational Assessment Report, FY96 Final Report.*

1997g (Jan.) *Offpost (Groundwater Intercept) Treatment System Operational Assessment Report, FY95 Final Report.*

1997h (Aug.) *Final Inspection/Implementation Report for the Off-Post Tillage Task.*

1996 (Aug.) *Northwest Boundary Containment/Treatment System Operational Assessment Report, FY95 Final Report.*

1996a (Apr.) *Chemical Quality Assurance Plan,* Version 1, Second Edition.

1996b *On-Post Operable Unit Record of Decision Dispute Resolution Agreement.*

RVO (Remediation Venture Office)

2000 (June 12), *Letter Technical Report for the Off-Post Surface Water Data Evaluation for Data Collected From June 1996 through March 2000.*

1998 (Aug. 17) *Corrective Action Management Unit/Basin A Well Abandonment Project Construction Completion Report.*

1998a (Sept. 30) *Sanitary and Chemical Sewer Plugging Project Construction Completion Report.*

1998b (Sept. 30) *Corrective Action Management Unit Soil Remediation Construction Completion Report.*

1998d (Sept.) *Chemical Process Related Activities Free Standing Tank Removal Outside Pipeline and Equipment Removal Construction Completion Report.*

Roy, R.

1997 (Oct.) *Results from the American kestrel (Falco sparverius) Biomonitoring Study at Rocky Mountain Arsenal National Wildlife Refuge, 1993-1996. Part 1:Field Monitoring.* U.S. Fish and Wildlife Service, Department of the Interior.

Stoller (S.M. Stoller Corporation)

1998 (Sept. 8) *Rocky Mountain Arsenal National Wildlife Refuge Visitor Risk Review, Draft.*

FWS (U. S. Fish and Wildlife Service).

2000 (Feb.) *Rocky Mountain Arsenal National Wildlife Area Fiscal Year 1999 Annual Progress Report.*

1999 (Feb.) *Rocky Mountain Arsenal National Wildlife Area Fiscal Year 1998 Annual Progress Report.*

1999a (Jan.) *Rocky Mountain Arsenal National Wildlife Refuge Visitor Access Plan.*

1998 (Feb.) *Rocky Mountain Arsenal National Wildlife Area Fiscal Year 1997 Annual Progress Report.*

1997 (Jan.) *Rocky Mountain Arsenal National Wildlife Area Fiscal Year 1996 Annual Progress Report.*

1996 (Oct.) *Rocky Mountain Arsenal National Wildlife Area Fiscal Year 1995 Annual Progress Report.*

1995 (Jan.15) *Rocky Mountain Arsenal National Wildlife Area Fiscal Year 1994 Annual Progress Report.*

1994 (Feb.15) *Rocky Mountain Arsenal National Wildlife Area Fiscal Year 1993 Annual Progress Report.*

1993 (Feb.12) *Rocky Mountain Arsenal National Wildlife Area Fiscal Year 1992 Annual Progress Report.*

1992 (Feb.) *Rocky Mountain Arsenal National Wildlife Area Fiscal Year 1991 Annual Progress Report.*

(N.D.) *Rocky Mountain Arsenal National Wildlife Area Fiscal Year 1989 Annual Progress Report.*

1990 (Feb.15) *Rocky Mountain Arsenal National Wildlife Area Fiscal Year 1990 Annual Progress Report.*

Woodward-Clyde Consultants

1991 (Oct.) *Final Decision Document for the Northwest Boundary System Long-term Improvements IRA at the Rocky Mountain Arsenal.*

1989a (Apr.) *Final Decision Document for the North Boundary System Improvements IRA at the Rocky Mountain Arsenal.*

1989b (Feb.) *Final Decision Document for the Basin A-Neck Groundwater Intercept and Treatment System IRA at the RMA.*

Public Law 102-402 (H.R.1435)

Rocky Mountain Arsenal National Wildlife Refuge Act of 1992.

Appendix B

Public Comments Received

Comments Received From
South Adams County Water and Sanitation District

April 25, 2000

6595 EAST 70TH AVENUE
P.O. BOX 597
COMMERCE CITY, COLORADO 80037-0597
TELEPHONE 303 288-2646
FAX 303 288-9531

Ms. Ruth Mecham
Chief, Public Affairs
U.S. Army
Rocky Mountain Arsenal
72nd and Quebec Street
Commerce City, Colorado 80022

Dear Ms. Mecham:

On behalf of the Board of Directors of the South Adams County Water and Sanitation District (SACWSD), I am responding to the request for comments regarding the Arsenal's 5-year site review. The District was involved with the negotiations for the Record of Decision (ROD) for the cleanup of the Rocky Mountain Arsenal. The District's main role was to contribute to the discussions concerning water issues (supplemental water supplies to SACWSD, and remedies for contaminated groundwater).

The District did support the final ROD for the Arsenal. It is our belief that the plan outlined in the ROD would adequately cleanup the Arsenal in a safe, timely and cost effective manner. We felt that taking care of the water issues, cleaning up the Arsenal, and turning it into a wildlife refuge, was in the best interests of the District's customers.

With the operation of the Arsenal's Groundwater Treatment Facilities, significant efforts to treat and improve the alluvial ground water have been, and continue to, be made. Since the signing of the ROD, we have seen significant progress towards the final cleanup of the Arsenal. The District, in cooperation with the United States Army and the United States Fish and Wildlife Service, came to an agreement with the Denver Water Department to provide SACWSD with a 4,000 acre-foot potable water supply, the Army with an interim non-potable water supply for the remediation of the Arsenal, and the U.S. Fish and Wildlife Service with a permanent non-potable water supply for the operation of the Wildlife Refuge. The final components of the 4,000 acre-foot water supply project should be completed over the next 4 years, and the water supply will be on-line by the October 2004 deadline set forth in the ROD. The District is also aware of the substantial cleanup efforts that are ongoing at the Arsenal. The hazardous waste landfill has been constructed. Many of the contaminated areas and structures have been removed and put into the landfill or moved into the Basin "A" area.

The Board is encouraged by the progress of treating and improving the alluvial groundwater, the water supply projects with Denver Water and the overall cleanup of the Arsenal. It is for these reasons that we would like to congratulate you in your significant cleanup efforts.

Sincerely,

SOUTH ADAMS COUNTY WATER
AND SANITATION DISTRICT

Jean Klein
President

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Comments Received From Site Specific Advisory Board and the Army's Response to Comments

Sandra Jaquith * Daniel P. Mulqueen * Mary Light * Sandra A. Horrocks * Susan Morel
Lonna Fischer * John Yelenick * Elizabeth Montgomery * Nancy Christian
Dorothy Colagiovanni, Ph.D. * Samantha Capps * Angela Medbery * Frank Clough, Ph.D.

Citizen Members: Rocky Mountain Arsenal Restoration Advisory Board (RMA-RAB)
Rocky Mountain Arsenal Site Specific Advisory Board (RMA-SSAB)
844 Downing Street * Denver, Colorado 80218 * (303) 832-3707 * Fax (303) 832-3708

June 1, 2000

Mr. Charles Scharmann
Rocky Mountain Arsenal
Project Manager
Commerce City, Colorado 80022

Dear Mr. Scharmann:

Please find enclosed our suggestions on the scope of the 5-year review that is underway at the Rocky Mountain Arsenal (RMA). Thank you for the opportunity to comment before the scope of the review has been determined.

Since we did not receive from your office a list of the 65 areas and/or projects that are currently listed for review, we have a more complete list than we had anticipated. If you have any questions regarding any of our recommendations, please call me for clarification.

We have reviewed the EPA OSWER Directive on the *Structure and Components of Five Year Review*. Given the scope and size of the RMA remediation, a Level II (set forth on the review matrix) is the minimum review that should be conducted and we believe that a Level III is the appropriate level of review for the 5-year Review at RMA. Without question, the Level 1 and Level 1A reviews are inadequate and inappropriate, and would not meet the necessary standard of due diligence.

We note that the Army is conducting this 5-year review. Please cite agreement (including section and page) that makes the Army responsible for the 5-year review, in lieu of the EPA.

1. Please include a complete list of all acronyms and abbreviations used in documents related to this 5-year review.

2 What changes have been made to the JARDF in the last five years and why?

3. List and describe all current and proposed data bases, software applications, library resources, and document/data collection/reporting systems that are used at RMA, such as surfer files and the RMA Environmental data base.

4. Please list locations of all information provided by graduate students, wildlife researchers, volunteers, museums, colleges, and/or other institutions that relate to RMA flora and fauna.

5. Attach to each 5-year review a list of each and every document, report, contract, MOU, and other relevant data drafted by all parties, contractors, governmental entities, (i.e. USGS, ATSDR), Tri-/County Health, Sate engineer's office, and SACSWD that has been created in the preceding 5 years in relation to the RMA remediation

6. List of all inspections, with results and analyses, i.e. of caps, leachate, chemical weapons treaty, etc.

7. Review all fires, unpredicted contaminate releases, explosions, and emergency situations at RMA during past 5 years.

8. Review scope of O&M of every contaminate site on the property, frequency of repairs,changes in monitoring indicators, costs at the site, and how these relate to protectiveness.

9. Review and re-evaluation of remedies selected, including evaluation of new technologies and evaluation of the protectiveness of current technologies.

10. Review and analysis of the estimated cost (Army and Shell) vs. the actual cost of each completed remediation action

11. Federal drinking water standards for Arsenic levels are more stringent Please analyze this and any other changes in protective standards for contaminates of concern in soil and water in regard to the selected remedies.

12. Analyze protectiveness of the remedy in regard to natural attenuation and bio-remediation, i.e. benzene plume, DIMP plume, fluoride plume, DMMP plume, chloroform plume, etc.

13. Anaylze protectiveness of land farming and any other techniques that are being used to indicate the expected diminishment of contaminates including, but not limited to, proven and standard technologies.

14 Please list the reports that identify indicator compounds for contaminate monitoring of groundwater, soil and air, and analyze the extent to which the results indicate targeted effectiveness of the relevant remedy, on and off post

15. List all indicator contaminates or compounds that have been eliminated during the past 5 years.

16. List and review the effectiveness of current and proposed institutional controls, on and off post.

17. List and review the health of all types of animals in residence at RMA, including n analysis of population sizes, patterns of residence, health problems with a description of response actions taken, and an analysis of fortuituous samples including, but not limited to annual numbers, types of animals, with location and cause of death . This analysis should include a comparative analysis of these isses for each 5-year period beginning in 1980, 1985, 1990, and 1995, with an intent to include a comparative analysis in each future 5-year review.

18. Why are children and adults allowed to visit the arsenal while soil remediation is in progress?

19. List and review all health reports and problems during last 5 years for [1] workers; [2] visitors, and [3] neighbors, including the numbers of of each category that have made complaints and the total number of each category.

20. List and review all calls to the Rocky Mountain Poison Contrl Center during the past 5 years.

21 List current off-post groundwater usage and/or exposure through irrigation, wells, and other water usage.

22. List and review the current position of all parties regarding the extent and valuation of natural resources damages.

23. List and review all data related to dioxin in the soil and dioxin contamination of the animals at RMA during the past five years including, but not limited to, the effectiveness of the remedy in relation to dioxin contamination.

24. Review and explain how the benezene plume is being contained without the use of the lake waters, and the level of effectiveness and protection that are afforded by the benezene remedies.

25 Pleasee address prior assumptions, current assumptions, monitoring, and proposed means to validate hydrologic controls.

26 Please review and analyze the information previously provided by John Yelenick regarding DIMP including, but not limited to, toxicity, bio-accumulation, enzyme

deficiencies in Hispanic and Asian populations in regard to organo-phosphonates, and volatility/vapor accumulation.

27. Please report and review new, revised, or changed istems regarding the the following issues:
    - groundwater flow
    - hydrology interpretationa
    - changes in permissible exposure levels (including document regferences)

28. Review of RMA WEB site information and activities.

29. Pleaselist and review all relevant new technologies that may be applicable to the contamination issues at RMA.

30. Review and analyze the north boundary water treatment system.

31. List and review emergency review plans for RMA.

32. List and explain andy and all maintenance projects during the past five years.

33. List and analyze the impact any and all projects that have caused or have included the digging of soil during the past five years including, but not limited to, soil farming, habitat replacement, and the SACWSD pipeline.

34. Review and report and changes in ARARs including, but not limited to, the Status and likely impact of the proposed changes in dioxin toxicity.

35. Explain the purpose of the new DIMP mink study conducted by the Army and currently being reviewed by the national Academy of Sciences, including the costs to the remediation and/or to private entities of any and all aspects of the second study.

36. Explain the impact of the dioxin information collected by the Biological Assessment Subcommittee, explain why the process has taken five years, and list any and all costs associated with this review.

Sincerely,

Sandra Jaquith

Sandra Jaquith
On behalf of the RMA Site Specific Advisory Board (SSAB)

cc. Robert Martin, USEPA National Ombudsman

DEPARTMENT OF THE ARMY
PROGRAM MANAGER FOR ROCKY MOUNTAIN ARSENAL
COMMERCE CITY, COLORADO 80022-1748

September 12, 2000

REPLY TO
ATTENTION OF:

Remedy Execution

Ms. Sandra Jaquith
844 Downing Street
Denver, Colorado 80218

Dear Ms. Jaquith:

Enclosed are the Remediation Venture Office's responses to comments from the Site Specific Advisory Board on the Five-Year Review Process at Rocky Mountain Arsenal.

On Tuesday, September 12, 2000, The Denver Post and Denver Rocky Mountain News will announce that the First Five-Year Review Report will be available for public comment. Please note that any comments must be turned in by October 12, 2000, to:

Program Manager Rocky Mountain Arsenal
Public Relations Office
ATTN: Ms. Ruth Mecham
Commerce City, Colorado 80022-1748

The point of contact is Ms. Ruth Mecham at 303-289-0337.

Sincerely,

Bruce M Huenefeld

Bruce M. Huenefeld
RMA Committee Coordinator

Enclosure

Copies Furnished:

Major M. Weslyn Erickson, Chief Counsel, Program Manager Rocky Mountain Arsenal ATTN: AMSSB-PM-ORMA-CL, Commerce City, Colorado 80022-1748 (w/encl)
Program Manager Rocky Mountain Arsenal, ATTN: AMSSB-PM-ORMA-D, Document Tracking Center, Building 129, Commerce City, Colorado 80022-1748 (w/encl)

Readiness is our Profession

Remediation Venture Office's Responses to
Comments from the Site Specific Advisory Board (SSAB)
on the
Five-Year Review Process at Rocky Mountain Arsenal (RMA)

General Comments

Comment 1. Given the scope and size of the RMA remediation, a Level II is the minimum review that should be conducted.

Response: Based upon U.S. Environmental Protection Agency's (EPA) recommendation, the Army is using the new Draft Comprehensive Five-Year Review Guidance (OSWER Directive 9355.7-03B-P) (EPA 1999). This guidance does not classify reviews as Level I, II, or III.

Comment 2. Please cite agreement that makes the Army responsible for the 5-year review, in lieu of the EPA.

Response: Paragraph 36.3 of the Federal Facility Agreement assigns responsibility for periodic reviews to the Army for the On-Post and Off-Post Operable Units. Executive Order 12580 (Section 2(d)) also gives the Department of Defense authority to conduct Five-Year Reviews at NPL sites.

Specific Comments

Comment 1. Please include a complete list of all acronyms and abbreviations used in documents related to this 5-year review.

Response: Acronyms and abbreviations to be used in the Five-Year Review Report (the Report) will be defined in the Report while acronyms and abbreviations used in referenced documents are included in those referenced documents in the Joint Administrative Record and Document Facility (JARDF). All referenced documents will be available in the JARDF.

Comment 2. What changes have been made to the JARDF in the last five years and why?

Response: Changes made to the JARDF are not considered relevant to the Five-Year Review as described in OSWER Directive 9355.7-03B-P.

Comment 3. List and describe all current and proposed databases, software applications, library resources, and document/data collection/reporting systems that are used at RMA, such as surfer files and the RMA Environmental database.

Response: The existence of databases, software applications, etc., is not considered relevant to the Five-Year Review as described in OSWER Directive 9355.7-03B-P.

Comment 4. Please list locations of all information provided by graduate students, wildlife researchers, volunteers, museums, colleges, and/or other institutions that relate to RMA flora and fauna.

Response: Any data provided by graduate students, volunteers, etc. that are considered relevant to the protectiveness of the remedy as it relates to flora and fauna, if considered in the Five-Year Review process, will be included in Section 6.3 (Data Review) of the Report as well as in Appendix A (References).

Comment 5. Attach to each 5-year review a list of each and every document, report, contract, MOU, and other relevant data drafted by all parties, contractors, governmental entities, (i.e. USGS, ATSDR), Tri-County Health, State engineer's office and SACSWD that has been created in the preceding 5 years in relation to the RMA remediation.

Response: Documents used in the conduct of the Five-Year Review will be included in Appendix A (References) of the Report.

Comment 6. List of all inspections, with results and analyses, i.e. of caps, leachate, chemical weapons treaty, etc.

Response: The results of any inspections that call into question the protectiveness of the remedy will be included in the Report.

Comment 7. Review all fires, unpredicted contaminate releases, explosions, and emergency situations at RMA during the past 5 years.

Response: All of these events will be reviewed. Any unforeseen events such as fires, unpredicted contaminant releases, explosions, and emergency situations at RMA that are considered significant will be included in the Five-Year Review Report.

Comment 8. Review scope of O&M of every contaminate site on the property, frequency of repairs, changes in monitoring indicators, costs at the site, and how these relate to protectiveness.

Response: All operations and maintenance aspects of remedial operations (to include frequency of repairs) at RMA will be reviewed during the Five-Year Review but will only be included in the Report if they have impacted the protectiveness of the remedy. A separate section will be included addressing the cost of the remedy.

Comment 9. Review and re-evaluation of remedies selected, including evaluation of new technologies and evaluation of the protectiveness of current technologies.

Response: The evaluation of the protectiveness of the current technologies in place at RMA will be central to the Five-Year Review process. However, a re-evaluation of the remedy selected will not be conducted as that is not the purpose of the Five-Year Review as provided by OSWER Directive 9355.7-03B-P.

Comment 10. Review and analysis of the estimated cost (Army and Shell) vs. the actual cost of each completed remedial action.

Response: A section will be included in the report addressing estimated versus actual costs for the remedy.

Comment 11. Federal drinking water standards for arsenic levels are more stringent. Please analyze this and any other changes in protective standards for contaminates of concern in soil and water in regard to the selected remedies.

Response: All protective standards denoted as Applicable or Relevant and Appropriate Requirements (ARARs) at RMA will be reviewed. Any changes between the standards cited in the Record of Decision (ROD) and those in place as of March 31, 2000 will be evaluated for their impact on protectiveness. Those designated as potentially impacting the protectiveness of the remedy will be recommended for adoption.

Comment 12. Analyze protectiveness of the remedy in regard to natural attenuation and bioremediation, i.e. benzene plume, DIMP plume, fluoride plume, DMMP plume, chloroform plume, etc.

Response: Natural attenuation (passive bioremediation), to the extent that it is identified as the selected remedy for inorganic chloride and sulfate in the groundwater, will be carefully evaluated. The impact of natural attenuation and/or bioremediation as it relates to other constituents mentioned (e.g., benzene, chloroform, etc), will be accounted for indirectly in as much as it decreases groundwater contaminant levels.

Comment 13. Analyze protectiveness of land farming and any other techniques that are being used to indicate the expected diminishment of contaminates including, but not limited to, proven and standard technologies.

Response: Land farming was not identified as part of the selected remedy and, therefore, will be not be evaluated as part of this Five-Year Review. It is unclear what "other techniques" are being referred to.

Comment 14. Please list the reports that identify indicator compounds for contaminate monitoring of groundwater, soil and air, an analyze the extent to which the results indicate targeted effectiveness of the relevant remedy, on and off post.

Response: A detailed list of reports that identify indicator compounds for contaminant monitoring of groundwater, soil and air will be provided in the Report. The Five-Year Review will evaluate these reports with respect to the effectiveness of the on-post and off-post remedies.

Comment 15. List all indicator contaminates or compounds that have been eliminated during the past five years.

Response: The "elimination" of contaminants will be taken into consideration in evaluating the protectiveness of the remedy. An explicit list of these contaminants will not be included, but can be derived by a critical review of the Report and the referenced documents.

Comment 16. List and review the effectiveness of current and proposed institutional controls, on and off post.

Response: The effectiveness of institutional controls will be listed and reviewed in the Report.

Comment 17. List and review the health of all types of animals in residence at RMA, including an analysis of population sizes, patterns of residence, health problems with a description of response actions taken, and an analysis of fortuituous samples including, but not limited to annual numbers, types of animals, with location and cause of death. This analysis should include a comparative analysis of these issues for each 5-year period beginning in 1980, 1985, 1990, and 1995, with an intent to include a comparative analysis in each future 5-year review.

Response: A critical review and analysis of the site-wide biota monitoring at RMA will be included in the Report. Many of the specifics identified by the SSAB will not be included directly in the Report but are provided in the referenced documents.

Comment 18. Why are children and adults allowed to visit the arsenal while soil remediation is in progress?

Response: A discussion of how visitors to RMA are protected will be included in the Access and Institutional Controls section of the Report.

Comment 19. List and review all health reports and problems during the last 5 years for [1] workers; [2] visitors, and [3] neighbors, including the numbers of each category that have made complaints and the total number of each category.

Response: A detailed discussion on the Medical Monitoring Program will be included in the Report and will address the monitoring of health impacts on the surrounding communities as well as a numerical summary of the calls made to the RMA Health Line at the Rocky Mountain Poison and Drug Center. The RMA Health and Safety Program and the RMA Integrated Contingency Plan will be reviewed to evaluate potential impacts on visitors and workers at RMA and to ensure that adequate mechanisms are in place to ensure protectiveness of these two populations.

Comment 20. List and review all calls to the Rocky Mountain Poison Control Center during the past 5 years.

Response: This information will be included in the Medical Monitoring Program review discussed in the response to Comment #19.

Comment 21. List current off-post groundwater usage and/or exposure through irrigation, wells, and other water usage.

Response: Current off-post groundwater usage and/or exposure through irrigation, wells, and other water usage will be evaluated as part of the review of numerous components of the off-post selected remedy. For example, institutional controls in the Off-Post Operable Unit will be reviewed to ensure steps taken adequately protected residents potentially exposed to contaminated groundwater in the area. Another example is in the review of the South Adams County Water Supply and Henderson Distribution Projects, enacted to ensure an alternative water supply to residents in the Off-Post Operable Unit. The results of these reviews will be included in the Report.

Comment 22. List and review the current position of all parties regarding the extent and valuation of natural resources damages.

Response: A statement of positions on natural resources damages is not considered part of the Five-Year Review.

Comment 23. List and review all data related to dioxin in the soil and dioxin contamination of the animals at RMA during the past five years including, but not limited to, the effectiveness of the remedy in relation to dioxin contamination.

Response: The *Front Range Dioxin Study, Study 3: Western Tier Parcel, Rocky Mountain Arsenal* document will be reviewed as part of the Five-Year Review. The degree to which dioxin may or may not be found in biota samples collected over the past five years will be included in the biota monitoring section of the data review portion of the Report.

Comment 24. Review and explain how the benzene plume is being contained without the use of the lake waters, and the level of effectiveness and protection that are afforded by the benzene remedies.

Response: A discussion of the South Lakes Plume Monitoring program will be included in the Report.

Comment 25. Please address prior assumptions, current assumptions, monitoring, and proposed means to validate hydrologic controls.

Response: "Hydrologic controls" will be reviewed in a number of different sections in the Report. Specifically, sections will be included on the various groundwater treatment systems as well as a section that addresses the site-wide groundwater monitoring program (to include a section on water level tracking). In addition, a section will be included that discusses assumptions that went into the determination of the remedy. This section will evaluate whether those assumptions are still valid, and if not considered valid, recommendations will be made to resolve the discrepancy.

Comment 26. Please review and analyze the information previously provided by John Yelenick regardign DIMP including, but not limited to, toxicity, bioaccumulation, enzyme deficiencies in Hispanic and Asian populations in regard to organo-phosphonates, and volatility/vapor accumulation.

Response: It is our understanding that the EPA already evaluated the information provided by Mr. Yelenick. A letter from Ms. Laura Williams to Mr. Yelenick dated June 6, 2000 provides a detailed discussion of the subject matter referenced in question #26 and attaches a letter from Dr. Robert Benson, an EPA toxicologist. We believe this letter adequately addresses the questions posed by Mr. Yelenick.

Comment 27. Please report and review new, revised, or changes items regarding the following issues:

- groundwater flow
- hydrology interpretations
- changes in permissable exposure levels (including document references)

Response: Changes in groundwater flow and "hydrology interpretation" will be summarized in the "Data Review" section of the Report and detailed in referenced documents. Changes in permissible exposure levels will be reviewed in the Risk Information Review section of the Report and references cited as appropriate.

Comment 28. Review of RMA WEB site information and activities.

Response: The RMA internet site is a publicly-accessible site that provides general information relevant to both remedial activities as well as U.S. Fish and Wildlife Service actions. Information contained on the site will not be used in the Five-Year Review and is therefore will not be mentioned in the Report.

Comment 29. Please list and review all relevant new technologies that may be applicable to the contamination issues at RMA.

Response: The EPA guidance used in the conduct of this Five-Year Review requires that the implementation of the selected remedy be reviewed for protectiveness, it does not require that new technologies be screened for application unless the existing remedy is determined not to be protective.

Comment 30. Review and analyze the north boundary water treatment system.

Response: The North Boundary Containment System will be evaluated in the Report.

Comment 31. List and review emergency review plans for RMA.

Response: Emergency plans at RMA (specifically the RMA Integrated Contingency Plan) will be reviewed in the Report.

Comment 32. List and explain any and all maintenance projects during the past five years.

Response: Maintenance projects conducted at RMA will be evaluated to the extent that they impact the protectiveness of the remedy.

Comment 33. List and analyze the impact any and all projects that have caused or have included the digging of soil during the past five years including, but not limited to, soil farming, habitat replacement, and the SACWSD pipeline.

Response: All projects implemented at RMA in the conduct of the remedy will be reviewed during the course of the Five-Year Review and included, as appropriate, in the Report. The impact of non-remedy soil-digging projects that may have an impact on human health or the environment will be evaluated in several sections of the

Report. For example, air emissions from soil-digging activities not directly related to the remedy will be evaluated as part of the Site-Wide Air Monitoring project and also as part of the Data Review section.

Comment 34. Review and report any changes in ARARs including, but not limited to, the status and likely impact o the proposed changes in dioxin toxicity.

Response: All ARARs specified in the RODs will be reviewed. A discussion of the results of this review will be included primarily in the Risk Information Review section of the Report. Initial tables will be developed listing all changes to ARARs. As discussed in the Report, only those changes determined to potentially impact the protectiveness of the remedy will be included in the actual Report. For example, the change to 6 CCR 1007-3, Section 261.4 that changed the definition of wood-processing wastewaters and solutions will not be included in the Report but will be included in the original tables.

Comment 35. Explain the purpose of the new DIMP mink study conducted by the Army and currently being reviewed by the National Academy of Sciences, including the costs to the remediation and/or to private entities of any and all aspects of the second study.

Response: The review of this study by the National Academy of Sciences has not been completed as of March 31, 2000. This date was established by the Army, and agreed to by the EPA, Colorado Department of Public Health and Environment (CDPHE), and Tri-County Health Department (TCHD), as a reasonable cutoff date for materials to be included in the Five-Year Review. Any conclusions reached in the diisopropylmethylphosphonate (DIMP) mink study will therefore be evaluated during the second Five-Year Review.

Comment 36. Explain the impact of the dioxin information collected by the Biological Assessment Subcommittee, explain why the process has taken five years, and list any and all costs associated with this review.

Response: The dioxin information collected by the Biological Assessment Subcommittee is the result of several years of coordinated efforts between RMA and the regulators. The process included determining the project's scope, developing sampling and analysis plans, coordinating implementation, and documenting and reviewing results. This process took several years. The length of time associated with projects such as this is necessary to ensure the validity of the data as well as to ensure conclusions reached are reliable. The results of this project will not be included in this Five-Year Review since they have yet to be finalized.

References

EPA (U.S. Environmental Protection Agency)
1999 (Oct.) *Comprehensive Five-Year Review Guidance,* EPA 540R-98-050, OSWER Directive 9355.7-03B-P, Draft.

Comments Received From
Mr. Waldo G. Smith
and the USFWS's Response to Comments

6-23-00

To: Ruth Mecham
Rocky Mountain Arsenal
Public Relations Office

Dear Ruthie,

Please forward my comments regarding the deletion of the 815 parcel of land located on Rocky Mountain Arsenal. I look forward to a response from the Army.

Sincerely Yours,

Waldo G. Smith
3821 West 25th Ave
Denver, CO 80211

Phone: (303) 477-2333

(1)

OBSERVATIONS ON RVO 5 YR. REVIEW OF REMEDIATION AT RMA, WITH PARTICULAR REFERENCE TO 813 PARCEL AND OTHER EASEMENTS.

1. THE BOUNDARY OF THE ORIGINAL PROPERTIES ENCOMPASSING THE PRESENT RMA SHOULD NOT BE ALTERED.

2. THE TRANSPORTATION PLAN FOR ACCESS BY THE PUBLIC SHOULD AVOID EXTENSIVE WIDENING OF QUEBEC ST ON THE WEST OR 56TH AVENUE ON THE S SIDE. THE FINAL LOCATION FOR THE LEARNING AND VISITORS CENTER FOR THE REFUGE SHOULD BE ON THE EAST OF THE REFUGE TO AVOID HIGH DENSITY TRAVEL ON QUEBEC ST OR 56TH AVE. THE ACCOMMODATION TO THE CENTER ON THE E SIDE WOULD GIVE ACCESS TO THE REFUGE FROM

PENA BLVD AND TO DENVER STREETS AND I76 WITHOUT NEW ACCESS HIGHWAYS TO THE REFUGE. SEE DIAGRAM ATTACHED.

3. THE PRIARIE DOG COLONY IN THE SW AREA OF REFUGE WOULD REMAIN UNDISTURBED.

4. RETAIN 7TH AVENUE AND HAVANA ST. EXTENDED TO BOUNDARIES OF REFUGE WITH GATES AT BOUNDARIES. THESE RDS. WOULD BE FOR FWS ACTIVITIES AND EMERGENCIES ONLY, CLOSED WITH GATES TO GENERAL PUBLIC.

5. FWS VISITOR TRANSPORTATION WOULD BE ALTERED ACCORDINGLY USING FOOT TRAILS, BICYCLES, AND NON POLLUTING TROLLEYS.

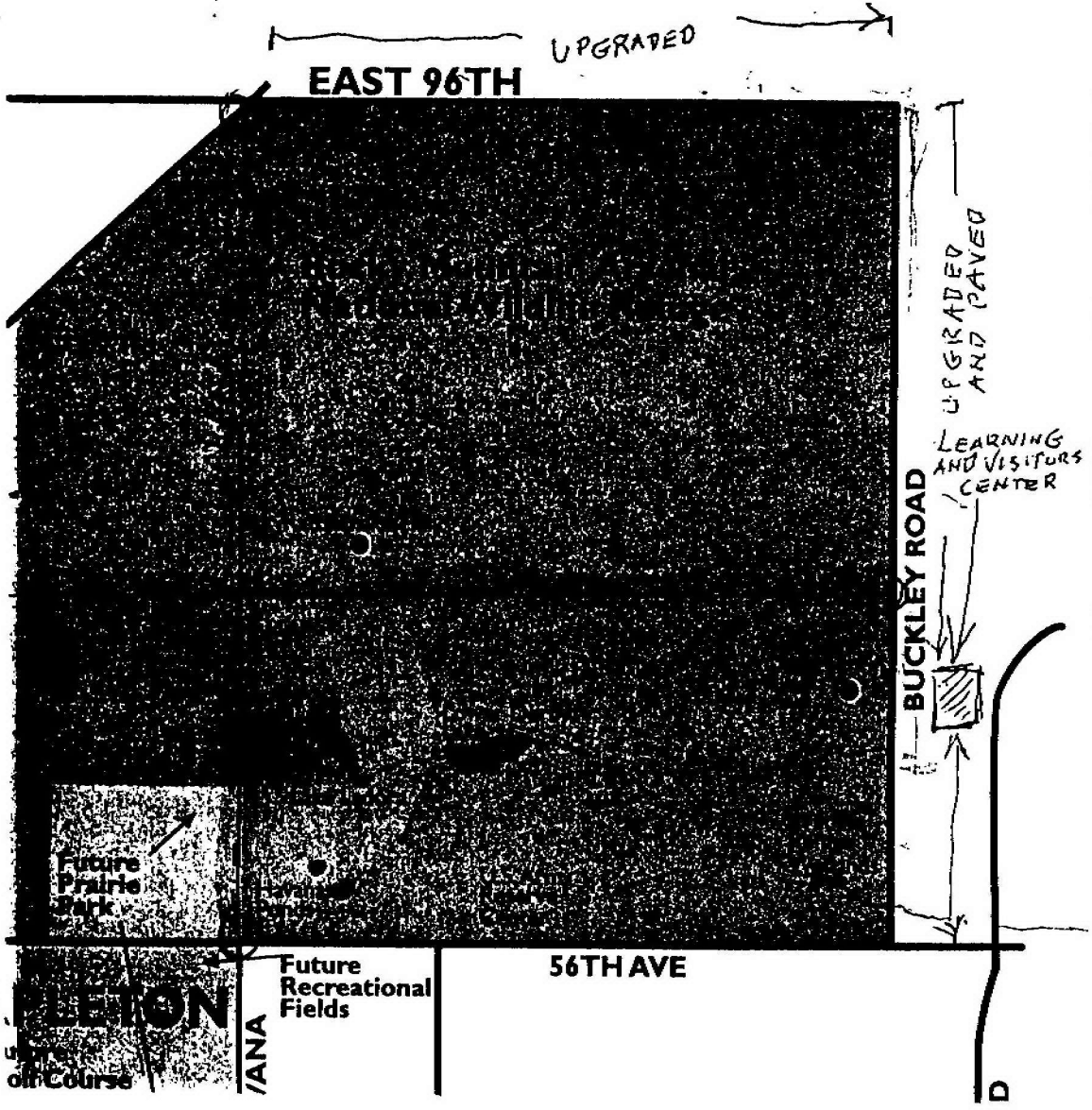
6. CONTINUE TO PURSUE A TRUST FUND TO MEET CONTINGENCIES WHICH WILL CARRY OVER AFTER THE CLEANUP OF THE REMEDY IS CERTIFIED FOR ADMINISTRATION BY USFWS AS THE NATIONAL WILDLIFE REFUGE.

Waldo Smith

[WALDO G. SMITH, P.E.
CHAIRMAN TRUST FUND
RAB/RMA
6/23/00

Waldo G. Smith, RMA
6/23/00

D CREEK
VER'S REGIONAL GREENWAYS



Amy Pulver, Executive Director of the Sand Creek Regional Greenway, stands on the bridge over Sand Creek where visitors access the trail.

SAND CREEK JAMBOREE AT STAR "K" RANCH — AUG. 27TH

Are you looking for good, old-fashioned family fun for people of all ages? Don't miss the 2000 Sand Creek Jamboree on August 27th at beautiful Star "K" Ranch in Aurora! Tickets and information are available by calling Amy Pulver at 303-393-7700.

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Rocky Mountain Arsenal National Wildlife Refuge
Building 111
Commerce City, Colorado 80022-1748
Telephone (303) 289-0232 Fax (303) 289-0579

July 14, 2000

Mr. Waldo G. Smith
3821 West 25th Avenue
Denver, Colorado 80211

Dear Mr. Smith:

This is in response to your June 23, 2000, letter to Ruth Mecham transmitting your comments regarding deletion of the "815 Parcel" at Rocky Mountain Arsenal. Your letter was forwarded to me for response. I appreciate your interest in this important issue and I will try to address your comments in the order presented:

1. Regarding the alteration of boundaries. Changes in the boundaries of the future Rocky Mountain Arsenal National Wildlife Refuge (NWR) were established by Congress in the Rocky Mountain Arsenal NWR Act of 1992. Provisions of that law include deletion and sale of the "815 Parcel", and also transfers of 100' strips of land along the south and west boundaries of the Arsenal to local units of government for transportation purposes. Those real property transfers are required by law and are not a matter of discretion for the Army or the U.S. Fish and Wildlife Service (Service).

2. The proposed location for the future Visitor Center, in the southwest corner of the Arsenal, was established through the refuge Comprehensive Management Planning (CMP) process. The CMP was completed in 1996. The planning process was open to the public and input considered from a wide variety of interested parties and the general public. It was conducted in compliance with the National Environmental Policy Act (NEPA) and is the subject of an approved Environmental Impact Statement. The southwest corner was determined to be the best place to site a Visitor Center, and is indicative of our desire to be readily accessible to our neighboring communities in Commerce City and northeast Denver. Arrangements necessary for construction of a Visitor Center are far from complete. But, changing the preferred location to the east side would require re-opening of the NEPA process. I do not anticipate doing that; we are very comfortable with the current proposed location.

The widening of Quebec Street and 56th Avenue are issues in the control of local units of

government. The Service will cooperate and coordinate with those entities as much as possible to resolve issues in ways that benefit both the local communities and refuge programs while being protective of natural resources. The final decisions on transportation infrastructure and use of the "815 Parcel" for a Visitor Center will ultimately be made by the Cities of Commerce City and Denver.

3. The refuge CMP calls for maintenance of up to 5000 acres of prairie dog colonies on the refuge, so we anticipate that occupied prairie dog habitat will increase significantly.

4/5. We agree with your comments regarding visitor/vehicle access to the refuge. Our CMP calls for all future visitor access to be through a tram system, connected to foot trails. It is anticipated that visitors will not drive private vehicles onto the refuge. We anticipate that vehicular access through existing gates (probably just the west gate off 72 Ave) will be for employees and official business vehicles only. Gates on the north, south, and east sides of the refuge would be locked and maintained for emergency and refuge project work access only. Execution of this plan is contingent on construction of the Visitor Center, as planned, with connecting tram routes for public access from the southwest corner of the Arsenal. There may be an interim period, after land transfer to the Service and before a new Visitor Center is built when we will need to allow people to drive in to the existing Visitor Center for program participation.

6. I will defer to the Army for a response to your final comment regarding a "Trust Fund" intended for long-tem operations and maintenance of the remedy. I believe the Record of Decision calls for the Army to evaluate that potential and that it will be addressed in the Five-Year Review document to be released in December. I can tell you that the Service is responding to the budget needs for the refuge and I am confident that we will develop adequate funding to operate a high quality refuge program through the normal budgeting processes of the Refuge System.

Thank you very much for your ideas and comments. Please feel free to call me at (303) 289-0350 if you have any questions or wish to further discuss any of these issues.

Sincerely,

Dean Rundle
Refuge Manager

Comments Received From
Mr. Waldo G. Smith
and the Army's Response to Comments

OBSERVATIONS ON THE RMA FIVE YEAR SITE REVIEW
DRAFT RESULTS

PROLOGUE

When the ROD (6/11/97) was signed, the environment at the RMA was definitely to be altered permanently from wartime deterrent to wildlife diversity. The transition from that time forward under review no less than every five years after commencement of remedial action to ensure that the remedy continues to provide adequate protection of human health and environment and complies with applicable regulations.

The Twentieth Century is unique in human history and concern for the environment. Two trends among several are apparent: Since 1950 an accelerated population growth everywhere on the planet and a corresponding use of fossil fueled transportation systems which demand greater use of natural resources.

The completion of the remedy for certification by the EPA is anticipated in 2011. Thereafter the administration of the area is under the FWS with monitoring by EPA and Army. Ongoing operation and maintenance (over a 10 year period beginning in 2001) is an immediate concern for the five parties associated in this project).

CRITIQUE

1. Administratively this project is complex. Encroachment upon the original 27 square miles recognized in the ROD should be firmly prevented.

2. Easements for highways should be avoided to prevent further encroachment on human health or wildlife disturbance. Two projects affecting wetlands area already in place. Note public announcement of wetland rehabilitation in Florida considered by US Senate on bipartisan basis 9/26/00.

3. Interpreting the letter of 12/1/99 (2), I assume the SSAB has no official connection with the RAB. Similarly, Ms. Sandy Jaquith is and has been no longer associated with the RAB. Yet the RVO insists on advising the SSAB on the activities of the RAB meetings even though Ms. Jaquith is apparently an active principal in said SSAB as an Determinator (which is what?). This association should be stopped. It has no purpose.

4. The bonding and bankruptcy situations concerning the principals of the two firms (Terra Therm LLc and Thermatrix) associated with the Remediation of the Hex Pits area in T35R67W should be cleared up ASAP or arrangements made for satisfactory conditions by the Army so that the work proceeds without interruption of the RDIS of the ROD. This is intolerable and could lead to an GAO audit.

5. The Sunday 6/4/2000 EPA notice in the Denver Rocky Mountain News (3) should be carefully reviewed by the parties. The economic impact of urban sprawl in regard to the arsenal is not compatible with the suggestion in this public announcement. The arsenal is now hemmed in on 3 sides by commercial and residential development and very probably on a fourth side in the foreseeable future. To sell off the Western Tier to build a visitors center for the FSW would be an unfortunate waste of taxpayers money and poor justification for a national wildlife refuge (see Prologue above). 1992 is not 2000. I would warn the RVO this project is complex enough without not reviewing the ramifications economic changes in the general area can make.

6. A trust fund or similar arrangements is in the process of consideration. This operation demands firm commitment to the present status of legal aspects at the arsenal. Any other concept developed would create bad publicity for the parties.

7. In conclusion, concerning the five year review timeline, therein is a breakdown in communication between the parites and the Restoration Advisory Board. In effect, by stating "January 2001 - Present Final Report to RAB," the parties are inferring "This is our final decision; sign the report; thanks for your efforts." A true Advisory Board should sit in on every aspect of the details leading up to the final report. In this present process the RAB meetings are seemingly sounding boards for previously parties conclusions (opinions?).

It is suggested, as an improvement in communication between the parties and the RAB, the due process leading up to the next five years review (2005) include joint meetings in the same room with representatives of the parties, and the RAB to discuss and arrive at consensus favorable to the step in the process in question. In this way, there should develop better understanding (education) of the technical and social aspects fo the overall remedy from war time deterrent to wildlife diversity.

Waldo G. Smith, RAB
10/2/00

Enclosures:
1. Five Year Review Timeline
2. Letter Trojan - Smith 12/1/99
3. Western Tier Parcel - Comments RMN 6/9/2000

RMA Five Year Site Review - Draft Results

September 2000

Scott Perkins

DEPARTMENT OF THE ARMY
HEADQUARTERS, U.S. ARMY MATERIEL COMMAND
5001 EISENHOWER AVENUE, ALEXANDRIA, VA 22333 - 0001

2

REPLY TO
ATTENTION OF

December 1, 1999

Mr. Waldo G. Smith
3821 W. 25th Ave.
Denver, Colorado 80211

Dear Mr. Smith:

Thank you for your recent letter to President Clinton concerning the clean-up operations at the Rocky Mountain Arsenal.

First, in regard to the flyer referenced in your letter, the Colorado Department of Public Health and Environment (CDPHE) provided a response directly to you on the August 31, 1999 (see enclosed letter). The response stated that the CDPHE has provided meeting support to the Rocky Mountain Arsenal Site Specific Advisory Board (SSAB) in the past and agreed to assist with the flyer. After the mailing occurred, it was noticed that the sponsor of the meeting was actually an advocate group with which a few SSAB members affiliate. The CDPHE contacted the SSAB representative and a correction was issued to the flyer.

Second, it is our understanding that the Rocky Mountain Arsenal Restoration Advisory Board community members voted to remove Ms. Sandy Jaquith as community co-chair and elect a new co-chair in December. A letter has been sent to Ms. Jaquith informing her of the decision. The board also voted to send individuals who have not attended at least the last 3 meetings a letter indicating they may be subject to dismissal from the board.

Based on the facts outlined above, the Department of Defense does not intend to conduct any further investigations into these matters. Rocky Mountain Arsenal appreciates your continued involvement in the Rocky Mountain Arsenal Restoration Advisory Board and supports your interest in the progress and the site's transition into a National Wildlife Refuge.

DIOXIN SOIL SAMPLING REPORT FOR THE WESTERN TIER PARCEL OF THE ROCKY MOUNTAIN ARSENAL IS AVAILABLE FOR PUBLIC COMMENT

The U.S. Environmental Protection Agency is releasing for public comment its draft report entitled "Front Range Dioxin Study, Study 3: Western Tier Parcel." EPA tested the soil at the Parcel to determine if dioxin was present and if levels found posed any cause for concern.

EPA conducted this soil study in response to public concerns regarding the sale and development of the Western tier Parcel. EPA tested soils for dioxin from the Parcel in December 1999 and found that existing levels are substantially lower than EPA's screening levels. Dioxin levels within the Parcel's soil were all within the expected background range and, therefore, are safe for any future use of the Parcel, such as a day-care facility, ball fields, and garden and pavilion areas.

Dioxin is the common name for a group of chemicals. It is released into the air, land, and water from mostly industrial activities. It is made by burning wastes or as an unwanted by-product of chemical manufacturing. Other common, but lesser sources of dioxin, include car and truck exhaust, cigarette smoke, and wood and forest fires.

Dioxin is found all over the earth in small amounts in soil, air and water. It is also found in most plants and animals, including people. At certain levels, dioxin becomes harmful to people and animals. Fortunately, most existing soil levels are not high enough to produce harmful health effects.

The Rocky Mountain Arsenal, located 10 miles northeast of downtown Denver, Colorado, is one of the largest sites in the country being cleaned up under the Comprehensive Environmental Response Compensation and Liability Act. The Western Tier Parcel consist of 940 acres of the Arsenal on the western perimeter along Quebec Street in Commerce City, Colorado.

The 1992 Rocky Mountain Arsenal National Wildlife Refuge Act designates most of the Arsenal to become a National Wildlife Refuge once cleanup is completed. The Western Tier Parcel was excluded from becoming a part of the refuge and was earmarked to be sold to fund a visitor/learning center for the future Wildlife Refuge.

Please submit public comment on this report to EPA by July 5, 2000.

Send written comments to:
Diane Sanelli
US EPA, Region 8
999 18th Street, Suite 500 (80c)
Denver, CO 80202-2466
Telephone 303-312-7822

Location to view reports:
Colo. Dept. of Public Health & Environment, Records Center
4300 Cherry Creek Dr. S., Bldg. B
Denver, CO
303-692-3300
M-F: 8 a.m. to 5 p.m.

Locations to view reports:
EPA Records Center
999 18th Street
Denver, CO
303-312-6473
M-F: 8 a.m. to 4:30 p.m.

Joint Administrative Records Document Facility
72nd Ave. and Quebec St.
Commerce City, CO
303-289-0362
MWF: 12-4:30 p.m.
TTh: 5-9 p.m.
Sat: 10-4 p.m.

DEPARTMENT OF THE ARMY
PROGRAM MANAGER FOR ROCKY MOUNTAIN ARSENAL
COMMERCE CITY, COLORADO 80022-1748

October 31, 2000

REPLY TO
ATTENTION OF:

Remedy Execution

Mr. Waldo Smith
3821 West 25th Aveune
Denver, Colorado 80211

Dear Mr. Smith:

This is in response to your October 2, 2000, letter to Rocky Mountain Arsenal (RMA) titled "Observations on the RMA Five Year Site Review Draft Results." This letter communicated certain areas of concern that you would like addressed by the Five-Year Review of remedial activities at Rocky Mountain Arsenal. We appreciate your interest in the Five-Year Review and have done our best to address the issues you brought up in your letter. Please keep in mind that some of the issues you brought up in your letter were not directly addressed by the Five-Year Review since they were not in the review's scope as dictated by regulatory guidance. All issues brought up in your letter, however, are being addressed by RMA in one capacity or another.

There is one issue in particular that we wanted to address directly in this letter. In Paragraph 7 of your letter you assert "concerning the five year review timeline, therein is a breakdown in communication between the Parties (sic) and the Restoration Advisory Board (RAB)." You go on to imply that the RAB has not been incorporated into the Five-Year Review process and that the only involvement the RAB will receive is in January 2001 when the final results are presented. The RAB was advised at the April 2000 RAB meeting that the Five-Year Review process was beginning. The process was described in detail at that meeting, and questions and comments were solicited both at that meeting and via the public comment process that was publicized in local newspapers. At that point all members of the public were encouraged to participate in the Five-Year Review process. More recently, at the September 2000 RAB meeting, the results of the Draft Final Five-Year Review Report were presented to RAB members, and once again comments and questions were encouraged both at the meeting as well as through a second public comment process that was publicized in local newspapers.

RMA has provided two public comment periods, and conducted two presentations at RAB meetings to better incorporate the concerns of the public with respect to the Five-Year Review process. If you have further questions regarding the status or content of the Five-Year Review Report, please don't hesitate to contact Ms. Ruth Mecham at 303-289-0337.

Sincerely,

Bruce M. Huenefeld
RMA Committee Coordinator

Copies Furnished:

Major M. Weslyn Erickson, Chief Counsel, Program Manager Rocky Mountain Arsenal, ATTN: AMSSB-PM-ORMA-CL, Commerce City, Colorado 80022-1748
Program Manager Rocky Mountain Arsenal, ATTN: AMSSB-PM-ORMA-D, Document Tracking Center, Commerce City, Colorado 80022-1748