LMS/RFS/S04648-0.0
Formerly DOE-LM/GJ1193-2006

Operations and Maintenance Plan for the Rocky Flats Surface Water Control Project

U.S. Department of Energy

Office of Legacy Management

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Dams A-1, A-2, A-3, A-4, B-1, B-2, B-3, B-4, B-5, C-1, C-2, and the Present Landfill Dam

Associated Diversion Structures, Bypass Pipelines, Canals, and Functional Channels

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Acronyms and Abbreviations

CDPHE	Colorado Department of Public Health and Environment
cfs	cubic feet per second
COU	Central Operable Unit
DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
ERP	Emergency Response Plan
FC	functional channel
fps	feet per second
HEC-RAS	Hydrologic Engineering Center-River Analysis System
IC	institutional control
LM	Legacy Management
NPH	No Public Hazard
OU	operable unit
PLFTS	Present Landfill Treatment System
POU	Peripheral Operable Unit
PVC	polyvinyl chloride
RFLMA	*Rocky Flats Legacy Management Agreement*
RFSOG	*Rocky Flats Site Operations Guide*
SEO	State Engineer's Office
SID	South Interceptor Ditch
UDFCD	Urban Drainage and Flood Control District
USDCM	*Urban Storm Drainage Criteria Manual*
USFWS	U.S. Fish and Wildlife Service

Communications Directory

Title Department/Agency	Contact Name	Contact Numbers	Email and/or address
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Dam Engineer Stoller Legacy Management	Mel Madril	(W) 970-248-6487	mel.madril@gjo.doe.gov
Field Technician Stoller Legacy Management	Andy Carpenter	(W) 720-377-9670 (M) 303-994-0168 (H) [redacted] (Fax) 720-377-3829	andy.carpenter@gjo.doe.gov

Off-Site Agencies	Contact Name	Contact Numbers	Email and/or address
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City of Westminster	Public Works	(W) 303-430-2400	
Colorado Department of Public Health and Environment	Carl Spreng	(W) 303-692-3358 (Fax) 303-759-5355	carl.spreng@state.co.us
Office of State Engineer	Mike Hammer	(W) 970-352-8712 (Fax) 970-892-1816	mike.hammer@state.co.us
Jefferson County	Mark Gutke	(Fax) 303-271-4905	mgutke@co.jefferson.co.us
U.S. Environmental Protection Agency	Vera Moritz	(W) 303-312-6981 (Fax) 303-312-6067	moritz.vera@epa.gov
Colorado Division of Wildlife	Thomas Nesler	(W) 303-291-7461 (Fax) 303-291-7114	tom.nesler@state.co.us
Rocky Flats Stewardship Council	Rik Getty	(Fax) 303-412-1211	rgetty@rockyflatssc.org

Emergency Preparedness Plan

Although not required by the *Rules and Regulations for Dam Safety and Dam Construction* (State of Colorado 2007) based on dam classifications for the Rocky Flats Site dams, the site has prepared the *Emergency Response Plan for the Rocky Flats Site Dams* (DOE 2008a). This plan describes response actions required in the event of an actual or potential unplanned release or emergency discharge of water from detention ponds at the Rocky Flats Site, or the actual or potential failure of a dam. It defines action levels for categorizing conditions up to and including dam failure and addresses responses used in mitigating actual or potential dam failures and unplanned releases, including emergency spillway discharges.

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1.0 Introduction

The Rocky Flats Site (Rocky Flats) is under the jurisdiction of the U.S. Department of Energy (DOE) Office of Legacy Management (LM). Long-term surveillance and maintenance activities at Rocky Flats are conducted under the Legacy Management Support contract by S.M. Stoller Corp. (Stoller). Operation and management of the site surface water dams are performed as part of the surveillance and maintenance activities implemented at Rocky Flats, which include activities conducted pursuant to the Rocky Flats Legacy Management Agreement (RFLMA) (DOE 2007). RFLMA established the regulatory framework to implement the final response action selected and approved in the Rocky Flats Corrective Action Decision/Record of Decision under the Comprehensive Environmental Response, Compensation and Liability Act, the Resource Conservation and Recovery Act, and the Colorado Hazardous Waste Act to ensure the response action remains protective of human health and the environment.

This *Operations and Maintenance Plan for the Rocky Flats Surface Water Control Project* (O&M Plan) was prepared to establish in one primary document (with associated supporting documents) the complete, accurate, current, and structure-oriented operating instructions for each dam and reservoir and its related structures. The purpose of the O&M Plan is to ensure adherence to approved operating procedures over long periods of time and during changes in operating personnel. The instructions will also permit responsible persons who are knowledgeable in reservoir operation, but are unfamiliar with the conditions at a particular dam, to operate the dam and reservoir during emergency situations and at such times when the normal duties of the regular operator cannot be performed.

While the dams and reservoirs (also called “ponds”) are not a component of the final response action, the following RFLMA requirements apply to some aspects of the instructions in this O&M Plan.

- Institutional controls (ICs) that prohibit certain activities without prior approval or that require activities to be conducted in accordance with approved procedures. The ICs are contained in RFLMA Attachment 2, Table 4, and include, among other things, prohibitions on excavations, certain uses of surface water and groundwater, and activities that may impair water monitoring components; and
- Protocol for pre-discharge sampling of Ponds A-4, B-5, and C-2 and notification of discharges.

This O&M Plan was produced primarily for the use of operating personnel located at or nearest to the dam and their immediate supervisors who are assigned the responsibility for the operation and maintenance of the dam. This O&M Plan contains, at a minimum, all information and instructions necessary for operating personnel to perform their duties. Operating procedures shall not deviate from those stated in this O&M Plan without appropriate authorization and shall be reviewed and updated periodically by qualified personnel.

This O&M Plan details the site water management practices, operations, maintenance, and monitoring for the 12 surface water retention ponds and other major stormwater management structures. The following details are provided:

- Infrastructure descriptions—Detailed descriptions of dams, ponds, spillways, outlet works, diversion structures, functional channels, and canals;
- Pond management practices—Overview of water management strategies under both normal and emergency[1] conditions for all site ponds;
- Operating instructions—Instructions for pond drawdown rates, drain bed valve operation, outlet works operation, and methods for evaluating and reporting unusual conditions;
- Maintenance and inspection instructions—Discussion of operating record generation and maintenance/inspection instructions for dams, ponds, spillways, outlet works, pipe crossings, diversion dams, functional channels, and canals; and
- Monitoring instructions—Detailed instructions for monitoring data collection associated with pond water levels, piezometer water levels, seepage, and dam structures (displacement, movement monuments, and inclinometers).

Supporting information is presented in a series of appendixes as follows:

- Appendix A—Dam Data;
- Appendix B—Operation Log;
- Appendix C—Monthly Observation Report;
- Appendix D—Piezometer and Pond Levels Field Sheet;
- Appendix E—Flume Ratings;
- Appendix F—Inspection and Maintenance Schedule;
- Appendix G—References;
- Appendix H—Capacity Charts and Graphs;
- Appendix I—Dam Locations and Access Roads;
- Appendix J—Permanent Instrumentation Data;
- Appendix K—Piezometer Summary Data;
- Appendix L—Example Data Reports; and
- Appendix M—Schematic for Current Flow and Water Transfer Network.

[1]Detailed emergency response procedures are contained in the *Emergency Response Plan for the Rocky Flats Site Dams* (ERP; DOE 2008a). Any references to emergency operations in this document are subject to modification by the ERP. In case of discrepancies between this document and the ERP, the ERP will take precedent.

2.0 General Information

2.1 Project Purpose

The Rocky Flats Surface Water Control Project consists of 12 earthfill dams and appurtenant spillways, 2 concrete and rockfill diversion dams, 2 concrete diversion structures with bypass pipelines, 5 engineered functional channels, and several canals/ditches (Table 2−1). The majority of the project features are located within the Central Operable Unit (COU)[1] (Figure 2−1 and Figure 2−2), and access is normally from roads from the west of the site as shown on the Dam Location and Access Roads map in Appendix I.

The general purpose of the project is to collect runoff originating west of the site and divert the flow around the COU and to collect runoff from the COU and retain it or safely route it through the site.

Table 2−1. Project Features and Functions

Project Feature	Function
Dam A-4	Stores or passes the 100-year Rocky Flats Plant (plant) runoff in North Walnut Creek and passes greater flows. During normal operation water is retained, sampled, and discharged when water quality standards are met.
Dam B-5	Stores or passes the 100-year plant runoff in South Walnut Creek and passes greater flows. During normal operation water is retained, sampled, and discharged when water quality standards are met.
Dam C-2	Stores or passes the 100-year plant runoff in Woman Creek area and passes greater flows. During normal operation water is retained, sampled, and discharged when water quality standards are met.
Present Landfill Dam	Stores or passes the 100-year event (runoff and seepage from the Present Landfill area).
Dam A-3	Routes North Walnut Creek flows into A-4 and provides additional storage capacity.
Dams A-1, A-2, B-1, B-2, and B-3	Provide a small amount of emergency capacity and provide wetlands habitat. No available data indicate that these dams were designed to store or pass any specific storm events.
Dams B-4 and C-1	Flow-through structures that provide some flow attenuation and settlement. No available data indicate that these dams were designed to store or pass any specific storm events.
North Walnut Creek Diversion Structure and Bypass Pipeline	Intercepts flow from North Walnut Creek and delivers water to any of the A-Series ponds.
South Walnut Creek Diversion Structure and Bypass Pipeline	Intercepts flow from South Walnut Creek and delivers water to either B-1 or B-4.
West Interceptor Canal	*Intercepts 100-year runoff from west of the COU and delivers water to Walnut Creek Diversion Dam.*
Walnut Creek Diversion Dam	*Diverts 100-year flow from Walnut Creek and the West Interceptor Canal through headworks into McKay Bypass Canal. Passes larger flows to North Walnut Creek and the A-Series Ponds.*

[1] The COU represents the DOE retained land and defines DOE's area of responsibility. Although several structures outside the COU are not maintained by DOE, they are discussed in this document due to their function as diversion structures and their importance to downstream DOE structures.

Table 2−1 (continued). Project Features and Functions

Project Feature	Function
McKay Bypass Canal	*Bypasses 100-year flow from Walnut Creek Diversion Dam around the A-Series ponds.*
McKay Bypass Pipeline (operated and maintained by the City of Broomfield)	*Intercepts flows in the McKay Bypass Canal and delivers water downstream of the Broomfield Diversion Structure.*
Woman Creek Diversion Dam	Diverts 100-year flow from Woman Creek through headworks into Woman Creek Bypass Canal. Passes larger flows to Pond C-2.
Woman Creek Diversion Canal	Bypasses 100-year flow from Woman Creek Diversion Dam around Pond C-2.
South Interceptor Ditch	Intercepts 100-year runoff from the southern portion of the COU and delivers water to Pond C-2.
Functional Channel (FC)-1	Routes runoff from the northwest corner of the COU to North Walnut Creek.
FC-2 and FC-3	Route runoff from the northern portion of the COU to North Walnut Creek.
FC-4 and FC-5	Route runoff from the central portion of the COU to South Walnut Creek.

Note: *Italicized* features are outside the COU and are not maintained or managed by DOE.

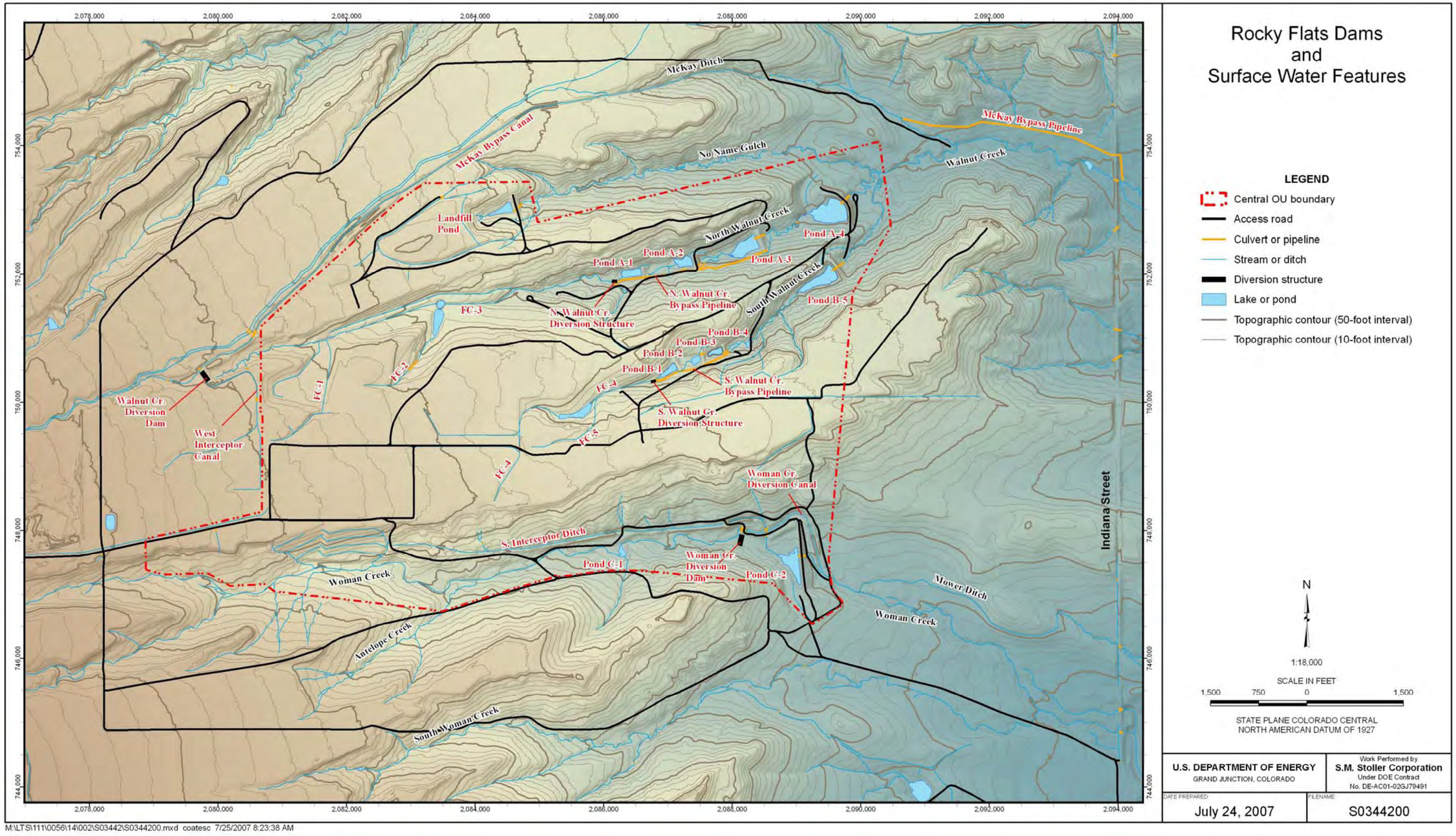

Figure 2−1. Rocky Flats Dams and Surface Water Features

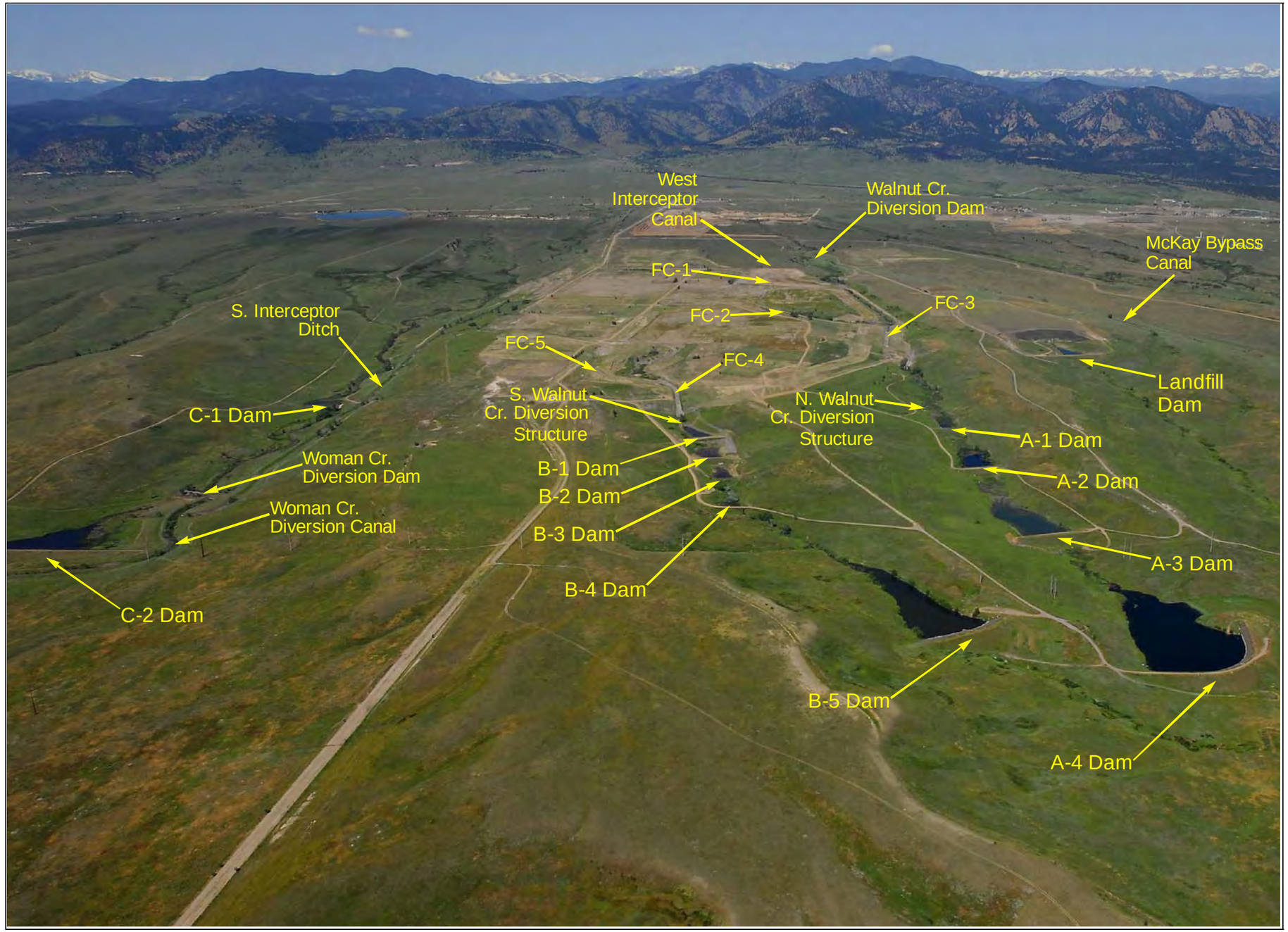

Figure 2−2. Aerial Image with Rocky Flats Dams and Surface Water Features

2.2 Assignment of Responsibility

DOE has a prime interest in the dam and reservoir area and a continuing responsibility for ascertaining that unauthorized encroachments do not occur, existing or potential conditions do not lead to public criticism or injury to the public, and nothing is done that conflicts with the primary purpose of the project.

Responsible site personnel are listed below:

- Dam owner representative—Scott Surovchak (DOE);
- Caretaker/pond operations project engineer—George Squibb (LM Stoller);
- Superintendent—Jeremiah McLaughlin (LM Stoller);
- Dam engineer—Mel Madril (LM Stoller); and
- Field technician—Andy Carpenter (LM Stoller).

The personnel listed above comprise monitoring, engineering, and supervisory individuals who respond to normal and emergency conditions affecting the project. The responsibilities include:

- Inspecting and monitoring the status of detention ponds and dams to identify conditions adversely affecting a dam;
- Coordinating periodic formal safety inspections;
- Coordinating periodic monument surveys;
- Performing periodic inclinometer readings;
- Performing periodic inspections of shorelines, riprap, embankments, spillways, outlet structures, trash racks, gates/valves, flumes, pipe crossings/headworks, channels, and rock grade controls;
- Ensuring availability of essential materials and, if needed, coordinating storage to ensure access in an emergency response;
- Performing monitoring, notification, and assistance in an EMERGENCY condition, on-scene assessment, emergency response actions, and issuance of personnel protective measures;
- Providing personnel to operate the equipment and/or open valves, as required;
- Ensuring resources are coordinated with emergency response personnel;
- Monitoring and sampling detention pond water on a routine basis;
- Performing routine pool elevation and piezometer monitoring;
- Performing pond water transfers and discharges;
- Providing pumps and associated materials as required for pond transfers and/or discharges; and
- Performing periodic maintenance for all items listed above.

The State of Colorado Department of Water Resources (State Engineer) has jurisdiction over the site dams. Site dams must be managed according to the *Rules and Regulations for Dam Safety*

and Dam Construction (State of Colorado 2007). Dams A-4, B-5, C-2, and the Present Landfill Dam are rated as "Low Hazard" by the State. Dams A-1, A-2, A-3, B-1, B-2, B-3, B-4, and C-1 are rated as "No Public Hazard (NPH)." State dam classifications range from "High Hazard" (highest concern, loss of human life expected if dam fails) to "No Public Hazard (NPH)" (lowest concern, no loss of human life expected if dam fails; damage limited to dam owner's property). Modification of a dam and related structures and appurtenances cannot be accomplished without the concurrence of the State Engineer.

The Inspection and Maintenance Schedule is provided in Appendix F.

2.3 Attendance, Communications, and Warning Systems

The primary communications system for site personnel is the commercial telephone system. The hydrometeorological data collection system (telemetry system) transmits pond data, including select pool elevations, discharge rates, inflow rates, and piezometer water levels to the Rocky Flats office at 11025 Dover Street, Suite 1000, Westminster, Colorado 80021. Precipitation is also transmitted from three locations at the site. The telemetry system is accessible remotely via network infrastructure.

Refer to the Communications Directory section at the front of this O&M Plan for normal and emergency telephone numbers and other methods of communication.

2.4 Cooperation with Other Agencies

2.4.1 U.S. Fish and Wildlife Service (USFWS)

The original OU boundaries of the site have been reconfigured to consolidate all areas potentially requiring additional remedial actions into the COU. The remaining portions of the site were consolidated into the Peripheral OU (POU). The site was declared officially closed on December 7, 2005. With cleanup of the site complete, portions have been transitioned to a National Wildlife Refuge pursuant to the Rocky Flats National Refuge Act of 2001 (Public Law 107-303). USFWS is responsible for the POU property that has been transferred for refuge purposes, while DOE is responsible for the COU and the remainder of the POU not yet transferred. The majority of the structures covered by this O&M Plan are located in the COU. However, several diversion structures and canals/ditches related to the downstream dams within the COU are located in the POU.

2.4.2 Colorado Department of Public Health and Environment (CDPHE) and the U.S. Environmental Protection Agency (EPA)

RFLMA establishes a consultative process in implementing the environmental regulatory requirements at the site. With regard to this O&M Plan, EPA and CDPHE are primarily concerned with water-quality issues. Any discharges from the terminal ponds (Ponds A-4, B-5, and C-2) and the Landfill Pond are conducted in cooperation with these agencies.

DOE, EPA, and CDPHE have agreed to certain notification requirements in the event that emergency conditions require activation of the site's Emergency Response Plan (ERP)

(DOE 2008a). The intent of the agreement is to proactively delineate the "alternative water management practices" and reach agreement on implementation and responses.

2.4.3 State of Colorado Department of Water Resources (State Engineer)

The State of Colorado Department of Water Resources (State Engineer) has jurisdiction over the site dams. Site dams must be managed according to the *Rules and Regulations for Dam Safety and Dam Construction* (State of Colorado 2007).

2.4.4 City and County of Broomfield

On September 26, 2006, DOE signed a Lease Agreement (Agreement; City and County of Broomfield and DOE 2006) with the City and County of Broomfield to comply with the water law and regulations of the State of Colorado as they apply to the holding ponds at the site. Since DOE has implemented a system of holding ponds for the purpose of controlling and testing surface water that collects on the Site, and the water law and regulations of the State of Colorado require that stream depletions resulting from out-of-priority storage of water be replaced, Broomfield agreed to lease to DOE a certain amount of Broomfield's reusable Windy Gap effluent. This water is to be released to the Big Dry Creek Basin to replace depletions resulting from out-of-priority storage in ponds at the site.

To determine the out-of-priority storage in the site ponds, the site must collect pond level data as follows:

- Hourly levels via telemetry for Ponds A-3, A-4, B-5, and the Landfill Pond; and
- Monthly field levels for Ponds A-1, A-2, B-1, B-2, and B-3.

The Agreement requires that several routine reports be transmitted by the site to Broomfield (Section 2.5.4).

2.5 Data Reporting

Several periodic data reports are required for the project. Instructions for collecting the associated data are given in Sections 3.2 and 4.0. Examples of these reports are provided in Appendix L.

2.5.1 Pond Status Report

A monthly Pond Status Report is transmitted via email to the regulatory agencies and interested members of the public (Table 2−2). This report consists of pond levels, piezometer levels, and select summary information for discharges and transfers (Appendix L).

Table 2−2. Pond Status Report Recipients

Contact Name	Agency/Organization	Email Address
Carl Spreng	CDPHE	carl.spreng@state.co.us
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Craig Hoffman	City of Broomfield	choffman@ci.broomfield.co.us
Clark Johnson	City of Arvada	cjohnson@ci.arvada.co.us
Jeremiah McLaughlin	Stoller LM	jeremiah.mcLaughlin@gjo.doe.gov
Jim Holliday	Woman Creek Reservoir Authority	ownersrep@comcast.net
Kathy Schnoor	City of Broomfield	kschnoor@ci.broomfield.co.us
Larry Kimmel	EPA	kimmel.larry@epa.gov
Laura Hubbard	City of Broomfield	lhubbard@ci.broomfield.co.us
Linda Kaiser	Stoller LM	linda.kaiser@gjo.doe.gov
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Rik Getty	Rocky Flats Stewardship Council	rgetty@rockyflatssc.org
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S. Ramer	City of Westminster	sramer@ci.westminster.co.us
Shelly Stanley	City of Northglenn	sstanley@northglenn.org

2.5.2 Pond Discharge Notifications

Prior to a terminal pond discharge, two Pond Discharge Notifications are transmitted via email to the regulatory agencies and interested members of the public (Table 2−3). The first report consists of predischarge sampling dates, pond levels, expected discharge dates, and expected discharge volumes. The subsequent report consists of updated pond levels, expected discharge dates, expected discharge volumes, and analytical data for predischarge samples, including the data validation summary (Appendix L).

Table 2−3. Pond Discharge Notification Recipients

Contact Name	Agency/Organization	Email Address
Carl Spreng	CDPHE	carl.spreng@state.co.us
Mark Aguilar	EPA	aguilar.mark@epa.gov
Vera Moritz	EPA	moritz.vera@epa.gov
Steve Berendzen	USFWS	steve_berendzen@fws.gov
Amy Thornburg	USFWS	amy_thornburg@fws.gov
Mike Bartleson	City of Broomfield	mbartleson@ci.broomfield.co.us
Shirley Garcia	City of Broomfield	sgarcia@ci.broomfield.co.us
Laura Hubbard	City of Broomfield	lhubbard@broomfield.org
Dan Mayo	City of Broomfield	dmayo@ci.broomfield.co.us
Kathy Schnoor	City of Broomfield	kschnoor@ci.broomfield.co.us
Shelley Stanley	City of Northglenn	sstanley@northglenn.org
David Allen	City of Northglenn	dallen@northglenn.org
Bud Hart	City of Thornton	bud.hart@cityofthornton.net
Scott Niebur	City of Thornton	scott.niebur@cityofthornton.net
Cathy Shugarts	City of Westminster	cshurgarts@ci.westminster.co.us
Mark Gutke	JeffCo	mgutke@co.jefferson.co.us
Paul Winkle	Colorado DOW	paul.winkle@state.co.us
David Abelson	Rocky Flats Stewardship Council	dabelson@rockyflatssc.org

2.5.3 Dam Safety Inspection Reports

Requirements for dam safety inspections are determined by the State of Colorado Department of Water Resources (State Engineer) and detailed in the *Rules and Regulations for Dam Safety and Dam Construction* (State of Colorado 2007). The State of Colorado requires a formal safety inspection of site dams, based on hazard classification, every 6 years. DOE may use its own *qualified* engineer, as defined in the regulations. An example Engineer's Inspection Report is provided in Appendix L.

2.5.4 Broomfield Water Lease Reports

As presented in Section 2.4.4, DOE signed an Agreement with the City and County of Broomfield in September 2006 to comply with the water law and regulations of the State of Colorado as they apply to the holding ponds at the site. The Agreement requires that several routine reports be transmitted by the site to the City of Broomfield. The reports are produced in a semiautomated manner using a spreadsheet application that is dynamically linked to the site telemetry system. Examples of these reports are provided in Appendix L and detailed below.

Evaporation estimates will be based on the pool elevation data for each pond (derived from stage-area curves for each pond), and gross evaporation rates for the site area as published in the Evaporation Atlas for the Contiguous 48 United States (NOAA Technical Report NWS33), 1982 (Table 2−4) and using the Colorado State Engineer's Office (SEO) standard procedure for determining monthly net evaporation.

Table 2−4. Estimated Gross Evaporation Rates—Rocky Flats Site

Month	Monthly Distribution of Annual Evaporation[a] (percent)	NOAA TR-33 Annual Evaporation[b] Distributed Monthly (inches/month)	NOAA TR-33 Annual Evaporation[b] Distributed Daily (inches/day)
January	3.0	1.17	0.038
February	3.5	1.37	0.049
March	5.5	2.15	0.069
April	9.0	3.51	0.117
May	12.0	4.68	0.151
June	14.5	5.66	0.189
July	15.0	5.85	0.189
August	13.5	5.27	0.170
September	10.0	3.90	0.130
October	7.0	2.73	0.088
November	4.0	1.56	0.052
December	3.0	1.17	0.038
Annual Total	100.0	39.0	

References:
[a]General Guidelines for Substitute Supply Plans for Sand and Gravel Pits. Submitted to the State Engineer Pursuant to SB 89-120 and SB 93-260
[b]NOAA Technical Report NWS 33 Evaporation Atlas for the Contiguous 48 United States, June 1982. (Annual estimated free water surface evaporation for RFETS area is 39 inches.)

Monthly Reports—Water volume data for all of the Walnut Creek basin ponds will be transmitted electronically from DOE to Broomfield in a standardized report. The report quantifies the amount of change in water volume stored for each of the ponds and estimated evaporative losses since the prior report. In addition, the monthly report includes an estimate of evaporative losses, the total volume change, the outflow volume from terminal Ponds A-4 and B-5, and calculated daily inflow volumes for the preceding month for all Walnut Creek basin ponds.

Biweekly Reports (Ponds A-3, A-4, B-5, and Landfill Pond only)—Water volume data from Ponds A-3, A-4, B-5, and the Landfill Pond will be transmitted electronically from DOE to Broomfield in a standardized report. The report will quantify the amount of change in water volume stored for each of the four ponds since the prior report, as well as the estimated evaporative losses, the outflow volume from terminal Ponds A-4 and B-5, and calculated daily inflow volumes during that time period.

Special Reports for Conditions with Increased Storage (Ponds A-3, A-4, B-5, and Landfill Pond only)—During wet conditions when a specified threshold increase of 1 acre-foot (threshold quantity to be approved by the water administration officials or by the water court) or more in water volume stored in the site ponds has occurred during the prior day, data will be transmitted from DOE to Broomfield in the following manner:

Water volume data from Ponds A-3, A-4, B-5, and the Landfill Pond will be transmitted electronically from DOE to Broomfield in a standardized report. The report will quantify the amount of change in storage volume for each of the four ponds since the day before

the increase-in-storage event began, as well as estimated evaporative losses, the outflow volume from terminal Ponds A-4 and B-5, and the calculated inflow volume. Daily reports will continue to be transmitted electronically from DOE to Broomfield until the daily increase in storage volume is less than a specified amount (to be determined by administrative officials or through a judicial proceeding), on which day a standardized end-of-event report will be transmitted from DOE to Broomfield, including the beginning and ending dates of the event, as well as the daily measured storage volumes, estimated evaporative losses, terminal pond outflow volumes, and calculated inflow volumes that occurred during the event period.

The Agreement also provides language regarding the release of water from terminal Ponds A-4 and B-5 (reproduced from the Agreement):

DOE contemplates it will release water stored in the A- and B-Series ponds after: 1) the pond levels reach a predetermined percentage of capacity that would normally cause initiation of the release process, and 2) the water that will be released to flow off the site has been sampled and tested in accordance with the plans listed above. During routine operations, water will be released from Ponds A-4 and B-5 until they are drawn down to approximately 10 percent of their individual capacities.

a. *If the released water is acceptable to Broomfield in Broomfield's sole discretion, said water may be captured by Broomfield in Great Western Reservoir for any use decreed or otherwise allowed to Broomfield.*

b. *If the water is not acceptable to Broomfield, Broomfield may route said water away from the Great Western Reservoir.*

c. *Broomfield may request that water stored in ponds A-4 or B-5 be released to facilitate operations at Great Western Reservoir if either Pond A-4 or B-5 is filled to at least 20 percent or more of its individual capacity. If the request is implemented by DOE, the water to be discharged from the pond will be sampled and released in accordance with protocols specified in the documents referenced above. During such operations, water will be released from Ponds A-4 and B-5 until they are drawn down to approximately10 percent of their individual capacities.*

DOE will attempt to facilitate the requested release, provided that the release does not conflict with pond operation protocols, regulatory requirements, or violation of water quality standards. However, failure to honor the request will not constitute a breach of this agreement.

2.6 Supporting Documents

The following documents support this O&M Plan:

- *Rocky Flats Site Operations Guide* (DOE 2008b)—Includes detailed information on every aspect of site operations;
- *Emergency Response Plan for the Rocky Flats Site Dams* (DOE 2008a)—Includes detailed information on emergency response actions;
- *Rules and Regulations for Dam Safety and Dam Construction* (State of Colorado 2007); and
- *Dam Safety Manual* (State of Colorado 2002).

Appendix G includes a listing of applicable engineering drawings and reference reports.

3.0 Electrical, Mechanical, and Structural Information

This O&M Plan for the Rocky Flats dams has been prepared to provide the information and data needed by operating personnel for the operation of the project works. This section consists of the project works descriptions and inspection and maintenance instructions. Applicable appendixes include:

- Appendix A Dam Data;
- Appendix C Monthly Observation Report;
- Appendix F Inspection and Maintenance Schedule;
- Appendix G References;
- Appendix I Dam Locations and Access Roads;
- Appendix J Permanent Instrumentation Data; and
- Appendix M Schematic for Current Flow and Water Transfer Network.

The Inspection and Maintenance Schedule is a summary of the recommended observation, inspection, and maintenance frequencies and procedures. The list of references provides dam drawing numbers and titles; engineering report titles; and the names of general contractors, subcontractors, and materials and equipment suppliers for various projects.

These instructions do not contain information on major repairs. Operating personnel at Rocky Flats should not be expected to correct problems that cannot be corrected by following the operating procedures, or by normal maintenance functions, such as lubrication and regular adjustments. Skilled personnel will be needed to make monthly observations, perform more extensive maintenance work, and make necessary repairs. Manufacturers should be contacted for instructions on equipment repair work.

In 1983, signs of distress were noted in Dam B-5. Modifications to this manual were made in 1984 to incorporate repairs and changes in operation procedures. In late 1995 and early 1996, engineering designs were completed for the upgrade of the pond outlet works in the existing A-4 and B-5 dams. An O&M manual to supplement the August 1984 *Operations and Maintenance Instructions for Rocky Flats Surface Water Control Project (Dams & Reservoirs)* was prepared. The supplement is incorporated into this update to the manual. The Dam A-4 outlet modifications were completed in 1996. The B-5 outlet modifications were completed in 1998. An alternate design and modifications to the C-2 outlet were made in 2005, and further minor valve modifications to B-5 were also made at that time. This O&M Plan reflects as-constructed conditions and includes manufacturer's O&M instructions for these modifications.

3.1 Infrastructure Descriptions

3.1.1 Dams and Ponds

Figure 3−1 through Figure 3−12 present photographs of the various dams at the Rocky Flats Site. Dams A-1, B-1, B-2, B-3, B-4, and C-1 (Figure 3−1, Figure 3−5 through Figure 3−8, and Figure 3−10) were built in the 1950s and 1960s as small, poorly compacted, earthen dikes. As part of a project to increase water retention capabilities, the dams were enhanced and enlarged in

1972 and a new dam, A-2 (Figure 3−2), was built. The dams were built from clayey site soils. The enlarged dams, with the exception of Dam A-1, were equipped with internal drains. Dam A-2 was keyed into stable soil and was constructed as a zoned dam, with semipervious sand-clay outer shells and a relatively impervious clay core. Upstream slopes at all dams were designed at 2:1, and downstream slopes at 2.5:1, except A-2, which was designed at 2:1. These dams were designed with features consistent with standard design for long-term water retention, as described above. Historically, these dams have performed acceptably during pool elevation conditions up to their spillways.

The Present Landfill Dam (Figure 3−12) was built in 1974 as part of renovations to the Present Landfill. The Present Landfill Dam was keyed to bedrock and was constructed as a zoned dam from site soils, with semipervious clayey or silty sand and gravel outer shells and a relatively impervious clay core. The upstream slope of the dam was constructed at a 3:1 slope and the downstream at a 2.5:1 slope. The normal maximum water surface elevation, as indicated on the design drawings, was expected to be at the spillway.

Dam A-3 (Figure 3−3) was also built in 1974. Dam A-3 was keyed to bedrock and was constructed as a zoned dam from site soils, with semipervious sandy gravelly outer shells and a relatively impervious clay core. Dam A-3 was also equipped with an internal drain. The upstream slope of the dam was constructed at a 3:1 slope and the downstream at a 2.5:1 slope. Dam A-3 contains features consistent with those designed for long-term storage.

Dams A-4, B-5, and C-2 (Figure 3−4, Figure 3−9, and Figure 3−11) are homogenous embankments constructed of predominantly clayey material obtained from required spillway excavation or borrow areas (initially constructed in 1979). Located at the center of the foundation of each dam is a cutoff trench extending to claystone bedrock for the length of the structure. The 2.5:1 (horizontal to vertical) downstream slopes of the dams are covered with 1 foot of seeded topsoil, while the upstream 2:1 slopes have 18 inches of riprap slope protection underlain by 9 inches of bedding material, except for Dam B-5 as discussed below. The upstream riprap slope protection on Dam A-4 extends down to the berm, and the slope below the berm is protected by seeded topsoil. Dam C-2 has no upstream berm and the riprap extends to original ground. The 20-foot-wide crest of each dam is surfaced with 4 inches of selected roadway surfacing material.

Dam B-5, as modified in 1984, has an upstream slope of 2.5:1 from the crest to mid-height and is covered with at least 12 inches of riprap bedding and 18 inches of riprap and a 5:1 slope from mid-height to the toe with no protective covering. Modifications to the outlet in 1998 included installation of an 8-foot-wide berm covered with riprap running up the central portion of the dam at 3.6:1 feet per feet under the valve stem for support. Upstream of the dam a sand and perforated pipe drain bed was installed to filter remaining sediment and to provide a means to drain the pond below the elevated inlet.

The purpose of Dams A-4, B-5, and C-2 is to retain surface water originating on the site until it is determined that the impounded water is free of contamination and to permit treatment of the water if necessary. These dams were designed for flood retention not for permanent water storage. Flood storage should be released as soon as practical to provide storage for a subsequent flood event. Rocky Flats operating personnel will issue instructions governing testing and

releasing of floodwaters. The ponds formed by Dams A-4, B-5, and C-2 are designed to hold in excess of the runoff produced by a 100-year precipitation event.

In 1991, the Dam B-1 downstream slope was flattened from a 1.5:1 to a 2:1 slope, and clean, free-draining gravel was installed in the toe with a riprap covering to protect against further erosion from B-2 tail waters. In 1995, sand/rock filter blankets were installed at the downstream toe of Dams B-2 and B-4 to control seepage. Sediment removal operations in Ponds B-2 and B-3 in 2005 may have at least partially modified or damaged toe drains at B-1 and B-2.

Modifications to the Dam C-1 structure were completed in 2005 and included removal of the existing outlet structure and filling the existing spillway, and installing a new grouted boulder discharge channel with a stop log structure to regulate the water level and maintain water within the pond. The same type of modification has been designed for Dams A-1, A-2, B-1, B-2, B-3, and B-4 but has not been implemented at the time of this writing.

Pond data, including capacities, elevations, and other pertinent information are provided in the appendixes.

Figure 3−1. Dam A-1

Figure 3−2. Dam A-2

Figure 3−3. Dam A-3

Figure 3−4. Dam A-4

Figure 3−5. Dam B-1

Figure 3−6. Dam B-2

Figure 3−7. Dam B-3

Figure 3−8. Dam B-4

Figure 3−9. Dam B-5

Figure 3−10. Dam C-1

Figure 3−11. Dam C-2

Figure 3−12. Present Landfill Dam

3.1.2 Spillways

The Dam A-4, B-5, and C-2 emergency spillways are ungated, open-channel, earth-lined structures with 3:1 side slopes (Figure 3−13). The bottom widths of the spillways are 150 feet, 80 feet, and 250 feet, respectively. Each spillway was overexcavated by 9 to 12 inches and replaced with seeded topsoil. All three spillway channels have a long, flat section to minimize erosion. In each spillway channel, the flat section has claystone bedrock underlying the topsoil for the most part. The spillways are designed to handle floods in excess of the 100-year event for pre-site reconfiguration conditions. Runoff from a pre-site reconfiguration, probable maximum precipitation, or thunderstorm event will be safely passed through these spillways. Although this would be a rare event, it is not considered an unusual condition.

The Present Landfill Dam emergency spillway is an ungated concrete box culvert and open-channel, earth-lined structure with 2:1 side slopes and a bottom width of 10 feet. The spillway is covered with seeded topsoil. The spillway is capable of handling flows from the 100-year event for pre-site reconfiguration conditions.

Figure 3−13. Dam A-4, B-5, C-2, and Present Landfill Emergency Spillways

The Dam A-3 emergency spillway is an ungated, open-channel, earth-lined structure with 3:1 side slopes (Figure 3−14). The spillway is armored with riprap and bedding, and has a cutoff wall at the downstream edge of the dam crest. The spillway is capable of handling flows from the 50-year event for pre-site reconfiguration conditions.

The A-1, A-2, B-1, B-2, and B-3 emergency spillways are ungated, open-channel, earth-lined structures capable of routing the pre-site reconfiguration conditions 50-year storm in the case of A-1 and A-2, and the 100-year storm in the case of B-3 (Figure 3−14). Due to modifications to the B-1 and B-2 spillways during sediment removal operations in 2005, the spillway capacities are unknown for those dams.

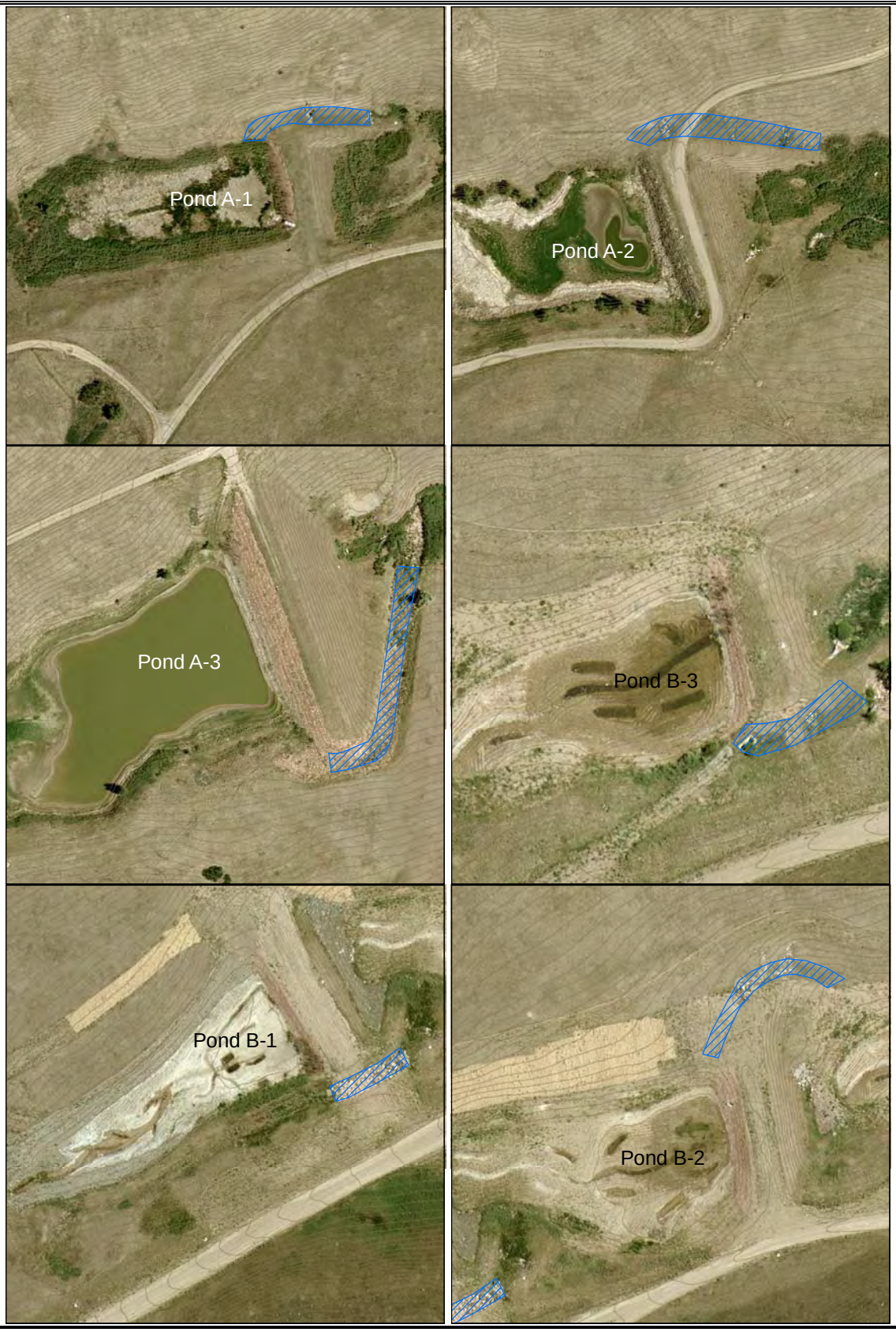


Figure 3−14. Dam A-1, A-2, A-3, B-1, B-2, and B-3 Emergency Spillways

Dams A-2, B-2, and B-3 are equipped with service spillways (Figure 3−15 through Figure 3−17) consisting of corrugated metal pipes with ungated concrete inlets that operate at an elevation and capacity lower than the emergency spillway elevation. The Dam B-4 spillway (Figure 3−18) serves as both the emergency and service spillway, as well as outlet structure, and consists of a concrete box culvert and concrete chute with a flip bucket energy dissipation structure that is capable of routing the 50-year event. The Dam B-1 service spillway was inadvertently grouted partially full during efforts to line the conduit with a plastic pipe and was subsequently grouted full to render it totally ***inoperable***.

Figure 3−15. Dam A-2 Service Spillway (Ungated Concrete Inlet)

Figure 3−16. Dam B-2 Service Spillway (Ungated Concrete Inlet)

Figure 3−17. Dam B-3 Service Spillway (Ungated Concrete Inlet)

Figure 3−18. Dam B-4 Emergency and Service Spillway (Concrete Box and Chute)

3.1.3 Outlet Works

Under each of Dams A-4, B-5, and C-2 is an 18-inch pre-stressed concrete cylinder pipe that serves as an outlet. Each pipe rests on a poured concrete cradle. An inlet structure with a trash rack is connected to each 18-inch pre-stressed concrete cylinder pipe. Each outlet conduit has six concrete cutoff collars spaced at 20-foot intervals. Near the downstream end of each conduit, an 18-inch medium-pressure gate valve is installed. This original outlet valve is buried 4 feet underground near each outlet structure (valves A4-1, B5-1, and C2-1; Appendix M). Each valve is covered with a valve box that has a locking device on the cover. Within a few feet of each box is a section of galvanized pipe embedded vertically in the ground to provide a holder for the valve wrench. A butterfly valve is also bolted on the outlet end of each outlet pipe (valves A4-2, B5-2, and C2-2). Both the gate and the butterfly valves are left open (locked where possible) and should only be used as emergency backup valves. The energy developed by water flowing through each sloped outlet pipe is dissipated in a concrete, impact-type stilling basin. A flow-measuring concrete Parshall flume with a galvanized steel liner is installed downstream of each impact-type stilling basin. The gauge house contains flow monitoring and measuring equipment, while a separate shed houses water quality sampling equipment. Inlet and outlet channels near the flumes have a maximum side slope of 3:1 with a seeded topsoil layer (Figure 3−19 through Figure 3−21).

The primary purpose of the outlet modifications performed in the 1990s and in 2005 at Dams A-4, B-5, and C-2 was to provide upstream control gates at each dam. Secondly, in conjunction with the upstream inlet control, an inlet control structure was provided at a raised elevation to provide controlled detention operation for water-quality purposes. At A-4, a low-level valve was provided to drain the pond below the inlet control structure. At B-5, the existing low-level 6-inch-diameter pipe with a gate valve connected to the inlet structure was left in place, with modification to the drain to add a standpipe with an intake just above the pond bottom. C-2 has no low-level valve.

The control gates for the inlets at A-4, B-5, and C-2 are slide gates (valves A4-MG, A4-WQG, B5-MG, and C2-MG). The face of the gates is specially machined to reduce seepage to a negligible amount (100 to 200 gallons per day). The low-level 6-inch drain gate valve at B-5 also experiences minor leakage. The slide gate operating stems at A-4 and B-5 are located within a synthetic oil-filled encasement pipe. The C-2 gate is hydraulically actuated and also uses a synthetic oil of a different type. Appendix G provides the name and supplier of the synthetic oils. Oil should be checked as part of the regular maintenance schedule.

B-5 can alternatively be pump-transferred to A-4 through an existing pipeline located at the side of the spillway. Two flat areas are located in the pond basin at the spillway to serve as pump stations.

The Present Landfill Dam outlet (Figure 3−22) is a controlled low-level outlet consisting of a 10-inch-diameter ductile iron pipe with a butterfly valve installed on the upstream end (valve DE-S) and gate valve on the downstream end (valve DE-N). The inlet is a concrete structure with a trash rack. Eight concrete cutoff collars are located along the outlet pipe. Normal operations currently consist of continual direct discharge of water from the Landfill Pond to No Name Gulch through the partially open outlet works. The energy developed by water flowing through the sloped outlet pipe is dissipated in a concrete impact-type stilling basin.

Dam A-3 (Figure 3−23) has a controlled low-level outlet consisting of a 16-inch-diameter ductile iron pipe that necks down to a 12-inch-diameter pipe with a gate valve and a butterfly valve (valve A3-4) on the downstream end. A gate value (valve A3-3) is located just upstream of the butterfly valve; this gate valve leaks into the dam structure when closed. As such, ***this gate should remain open at all times***. The inlet is a concrete structure with a trash rack that rests on the bottom of the pond. The energy developed by water flowing through the sloped outlet pipe is dissipated in a concrete impact-type stilling basin. A flow-measuring concrete Parshall flume with a galvanized steel liner is installed downstream of the impact-type stilling basin.

The Dam A-1 outlet structure (valve A1-4), a 48-inch corrugated metal pipe, is grouted shut and is ***inoperable***. The upstream gate (valve A2-3) of the Dam A-2 outlet, a 10-inch ductile iron pipe, has been dismantled and a grout plug installed in the pipe, and is also ***inoperable***. The Dam B-1 outlet, a 10-inch ductile iron pipe with a valve, is ***grouted shut*** from the downstream end to the valve. The Dam B-2 outlet is a 10-inch-diameter ductile iron pipe ***plugged with grout*** on the upstream end; the valve is not known to be operable (valve B2-3). The Dam B-3 outlet (Figure 3−24) is an operational, gated, 10-inch ductile iron pipe with a 2.5-foot riser on the inlet that exits into a 48-inch corrugated metal pipe that also serves as the service spillway (the riser gate [valve B3-3] is maintained in an open configuration). The concrete spillway previously described serves as the outlet for Dam B-4 (Figure 3−18). Dam C-1's 48-inch corrugated metal pipe outlet has been removed and replaced with a channel and stop log structure to attenuate flows through the pond (Figure 3−25). The configuration has been designed so that the stop log structure can be removed in the future so the dam functions as a fully breached structure. The same designs, which would also include removal of existing outlet structures, have been completed for Dams A-1, A-2, B-1, B-2, B-3, and B-4, but have not been implemented at this time.

Dam A-4 Upstream Control Gates and Inlets (Dual Gates at 10% and 20% of Capacity)

Dam A-4 Downstream Impact Basin and Butterfly Valve

Discharge Monitoring Location GS11

Figure 3−19. Dam A-4 Outlet Works

Dam B-5 Upstream Control Gate and Inlet

Dam B-5 Downstream Impact Basin and Butterfly Valve

Discharge Monitoring Location GS08

Figure 3−20. Dam B-5 Outlet Works

Dam C-2 Upstream Control Gate and Inlet

Dam C-2 Downstream Impact Basin and Butterfly Valve

Discharge Monitoring Location GS31

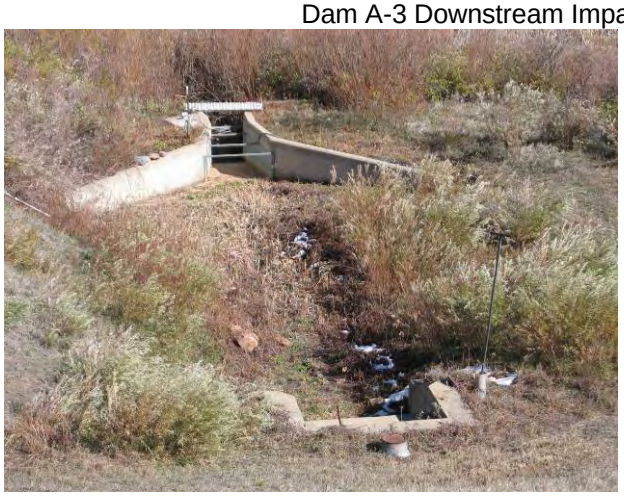
Figure 3−21. Dam C-2 Outlet Works

Present Landfill Dam Upstream Inlet Structure (Butterfly Valve) and Controls

Present Landfill Dam Downstream Impact Basin and Gate Valve Opening

Figure 3−22. Present Landfill Dam Outlet Works

Dam A-3 Downstream Impact Basin and Butterfly Valve



Discharge Monitoring Location GS12

Figure 3−23. Dam A-3 Outlet Works

Figure 3−24. Dam B-3 Outlet Works Riser and Gate Control

Figure 3−25. Dam C-1 Channel and Stop Log Structure

3.1.4 Diversion Structures

The North and South Walnut Creek Diversion Structures (Figure 2−1 [map], Figure 3−26, and Figure 3−27) are concrete walls built across the channels. North Walnut Creek flows can be routed through a 24-inch corrugated metal pipe (single gate [valve A1-1]) into the furthermost upstream dam in the series (A-1), or through dual gates (valves A1-2 and A1-3) to a 42-inch corrugated metal pipeline running on the south side of the A-series dams. South Walnut Creek flows can also be routed through a 24-inch corrugated metal pipe (single gate [valve B1-2]) into the furthermost upstream dam in the series (B-1), or through dual gates (valves B1-1A and B1-1B) to a 48-inch corrugated metal pipeline running on the south side of the B-series dams.

The North Walnut Creek pipeline has valved diversion boxes that allow flow to be routed into Pond A-2 via the A-1 outlet channel (Figure 3−28; valve A2-2), into Pond A-3 just downstream of Pond A-2 (this gate valve [A3-2] is not known to be operable and is currently open), or into Pond A-4 (valve A3-1) through the A-3 spillway (Figure 3−29). The South Walnut Creek pipeline has no such boxes and will only route flows into Pond B-4 just downstream of Pond B-3. The North Walnut Creek Diversion Structure has a capacity of approximately 90 cubic feet per second (cfs) before overtopping and flowing into Pond A-1, which is significantly less than the modeled 25-year post-site reconfiguration storm event peak flows (approximately 190 cfs). The South Walnut Creek Diversion Structure has a capacity of approximately 160 cfs before overtopping and flowing into Pond B-1, which is adequate for a modeled post-site reconfiguration 25-year storm event (approximately 97 cfs).

Figure 3−26. North Walnut Creek Diversion Structure

Figure 3−27. South Walnut Creek Diversion Structure

Figure 3−28. North Walnut Creek Diversion Box to Pond A-2

Figure 3−29. North Walnut Creek Diversion Box to Pond A-3 or A-4

3.1.5 Diversion Dams

The diversion dams (Woman and Walnut Creeks; Figure 3−30 and Figure 3−31, respectively; Figure 2−1 [map]) are constructed as a cutoff wall of caulked interlocking steel sheet piles. The top of the steel cutoff wall is embedded into a 24-inch square concrete cap for the length of the structure. The steel piling extends approximately 15 feet below the concrete cap at the Walnut Creek Diversion Dam. The Woman Creek Diversion Dam steel piling wall extends approximately 8 to 14 feet below the concrete cap and is embedded 12 to 18 inches into claystone bedrock for the length of the structure. The 2:1 upstream slopes have 36 inches of riprap slope protection underlain by 12 inches of bedding material. Upstream of this riprap are ponding areas protected by 6 inches of seeded topsoil. The 3:1 downstream slopes have 48 inches of riprap slope protection underlain by 12 inches of bedding material. The headworks of the Walnut and Woman Creek diversion dams consist of three and seven, respectively, 60-inch corrugated metal pipes with cutoff collars.

The purpose of the Woman and Walnut Creek diversion dams is to divert the 100-year flood run, originating west of the site, through the headworks into the Woman Creek Diversion and McKay Bypass Canals (Section 3.1.6), respectively, passing the flow around Pond C-2 and the A-Series ponds, respectively. Larger amounts of runoff in excess of the 100-year flood will overflow the diversion dam crest.

Figure 3−30. Woman Creek Diversion Dam

Figure 3−31. Walnut Creek Diversion Dam

3.1.6 Diversion Canals

Four canals exist at or near the site: the West Interceptor Canal, South Interceptor Ditch (SID), McKay Bypass Canal, and Woman Creek Diversion Canal (Table 3−1). The locations of the West Interceptor Canal and McKay Bypass Canal are shown on Figure 2−1. Typical sections of the West Interceptor Canal, McKay Bypass Canal, Woman Creek Diversion Canal, and SID are shown on Figure 3−32, Figure 3−33, Figure 3−34, and Figure 3−35, respectively. The SID and Woman Creek Diversion Canal traverse several sizeable areas of unstable slump-prone materials. Several sections along the SID have experienced slumping and a decrease of cross section.

The canals consist of open-channel, earthen cut-and-fill sections interrupted by drop structures and road crossings where needed. Excavated portions of the canals produced materials for construction of adjacent fills, and excess excavation was placed above and outside the required fill lines. Most of the canal slopes were excavated and placed at a 2:1 slope, while unstable areas were flattened to a maximum 4:1 slope. Slopes are stabilized with 6 inches of topsoil that was placed across the entire width of the canal and seeded.

Some of the canals have a considerable drop in elevation from the inlet to the outlet. A portion of the energy created by water dropping in elevation is dissipated by the use of rock grade controls. However, the structures along the McKay Bypass and Woman Creek Diversion Canals have experienced damage during past large flows. Most of the rock grade controls drop 10 feet and have a 1-foot-deep stilling basin at the bottom. A riprap dam was placed at the top of the drop to provide normal velocities and water surfaces in the preceding portion of the canal. The rock riprap dam is required primarily because of the closeness in spacing of some of the structures. The rock grade controls are protected by 24 inches of riprap placed on 12 inches of bedding

material. In some sections of the canals, energy is dissipated by inverted siphon corrugated metal pipe crossings. The inverted siphon pipe crossings take the place of a rock grade control and provide a vehicle crossing. The inverted siphon pipes were used where a crossing or headworks was needed and where excess elevation drop is not available.

Table 3−1. Canal Physical and Hydraulic Characteristics

Canal	Length (feet)	Total Drop (feet)	Maximum Normal Water Depth (feet)	Maximum Normal Flow (cfs)
West Interceptor Canal	784	0.16	3.85	91
McKay Bypass Canal	10,500	260.05	5.82	368
Woman Creek Diversion Canal	2,005	31.36	8.14	1,032
South Interceptor Ditch	6,355	195.37	5.61	327

Figure 3−32. Typical West Interceptor Canal Section

Figure 3−33. Typical McKay Bypass Canal Section

Figure 3−34. Typical Woman Creek Diversion Canal Section

Figure 3−35. Typical SID Section

3.1.7 Functional Channels

Five functional channels (abbreviated as FC-1 through FC-5; Figure 2−1 and Figure 3−36 through Figure 3−39) were constructed during site closure to convey runoff and minimize erosion. The FCs were constructed as either grass-lined, nongrouted riprap or grouted riprap based on gradient and expected flow rates/velocities. Selected physical and hydraulic characteristics for the functional channels are given in Table 3−2.

Table 3−2. Functional Channel Physical and Hydraulic Characteristics

Functional Channel	Length (feet)	Total Drop (feet)	100-Year Peak Flow (cfs)
FC-1	1,138	27	76
FC-2 (upper segment; lower segment)	823; 509	37; 10	72
FC-3	1,554	57	264
FC-4	3,656	107	277
FC-5	1,555	61	37

Figure 3−36. FC-1 Looking NW

Figure 3−37. FC-2 Looking NW

Figure 3−38. FC-3 Looking E

Figure 3−39. FC-4 and FC-5 Looking E

The FCs were designed to adequately convey the 100-year event runoff flows. The rational method described in the *Urban Storm Drainage Criteria Manual, Volume I* (USDCM) (UDFCD 2001) was used to estimate peak flow rates. The maximum watershed size for the rational method varies from 160 acres in the Urban Drainage Manual to 600 acres in *Introduction to Hydrology* (Viessman and Lewis 2003). Since the largest drainage area for the FCs is less than 250 acres, the rational method was used to determine peak runoff rates.

The equation for peak runoff is as follows:

$$Q = CIA \qquad \text{(Equation RO-1 of the USDCM)}$$

Where Q = peak runoff (cubic feet per second)
C = runoff coefficient (dimensionless)
I = rainfall intensity (inches/hour)
A = subcatchment area (acres)

This equation was used to calculate the 100-year runoff rates. The 100-year 1-hour point rainfall for the site (2.7 inches from USDCM, Figure RA-6) and the time of concentration for each drainage basin were used to calculate the rainfall intensity.

The U.S. Army Corps of Engineer's Hydrologic Engineering Center-River Analysis System (HEC-RAS) program was used to model channel hydraulics. HEC-RAS is an interactive, integrated, menu-driven program that uses the standard step method to calculate subcritical water surface profiles. Manning's equation is used to account for channel roughness as it pertains to channel conveyance. Supercritical flow parameters are calculated using the momentum equation. HEC-RAS allows three options for computing the flow profile: subcritical, supercritical, and mixed. For the mixed mode, which was used for the design, the program computes the profile twice. The first calculation uses the subcritical flow regime and the second uses a supercritical flow regime. Of the two regimes analyzed, the regime with the greater specific force was assumed the correct profile.

The Manning's roughness coefficient, n, used for channel design, was obtained from the USDCM. Subcritical flow (typically smooth, nonturbulent flow) occurs when the Froude number (F) is less than 1, critical flow occurs when the Froude number equals 1, and supercritical flow (typically turbulent flow) occurs when the Froude number is greater than 1. Where the flow regime changes from subcritical to supercritical flow (or vice versa), a hydraulic jump occurs, which can be unstable and erosive. Thus, channels were designed at critical flows (F = 1) since the flow can jump quite frequently, leading to unstable, erosive channels. General practice is to design channels so the Froude number is less than 0.8 or greater than 1.2. This confines hydraulic jumps to grade breaks (changes in channel slope) where thickened riprap keys can be provided to counter the potential erosive effects of the jump. For the FC, channels were designed so the Froude number was less than 0.8 or greater than 1.2.

For ease of construction, the minimum channel bottom width was designed to be 8 feet. Note that a 7-foot width could have been used on riprap-lined channels as long as the subgrade bottom width (bottom of riprap layer or bedding layer) was at least 8 feet. In accordance with the USDCM, side slopes were designed to be 4:1 or flatter for grass-lined channels, and 2.5:1 or flatter for riprap-lined channels.

A minimum of 1 foot was added to the 100-year water surface elevations to meet the freeboard criteria of the USDCM. Superelevations at the outside of the channel curves were calculated using Equation MD-9 of the USDCM for subcritical flows and Equation 8.19 of *Urban Flood Channel Design and Culvert Hydraulics* (Guo 2004a) for supercritical flows. Superelevation effects are in addition to the freeboard depth. Cross-waves were checked on curved steep reaches

to verify that the height of the waves was less than the height of the channel depth with freeboard. Cross-wave heights were calculated using the cross-wave calculation program in *Trapezoidal Channel Design and Flow Analysis* (Guo 2004b).

3.1.7.1 Grass-Lined Channels

Per the USDCM, the maximum velocity for grass-lined channels is 5 feet per second (fps) in erosive soils and 7 fps in nonerosive soils. The site has an abundance of Rocky Flats Alluvium, which can be erosive. Thus, 5 fps was used as the maximum velocity for grass-lined channels. In addition, per the USDCM, the maximum Froude number was selected to be 0.5. Section 4.1.6 of the Major Drainage chapter in the USDCM was used to determine if channel bends of grass-lined channels require a riprap lining.

3.1.7.2 Non-Grouted and Grouted Riprap-Lined Channels

Subcritical Flow

In accordance with the USDCM, riprap was used to line channels with Froude numbers between 0.5 and 0.8 and velocities less than 12 fps. Riprap size was determined using Equation MD-13 and Table MD-10 of the USDCM. The Manning's roughness coefficient, n, was calculated using the following equation:

$$n = 0.0395 * D50^{1/6} \qquad \text{(Equation MD-14 of the USDCM)}$$

Where D50 = the mean riprap stone size in feet.

Channels lined using riprap with a D50 of 6 inches or 9 inches were mixed with 30 percent (by volume) topsoil and buried with 6 inches or more of topsoil (this mix is referred to as soiled riprap). Grouted riprap was used when the flow velocity was determined to be above the Urban Drainage maximum criteria of 12 fps.

Supercritical Flow

The *Surface Mining Water Diversion Design Manual* (Simons, Li & Associates 1982*)* was developed for steep channel design (supercritical flows). This manual provides charts for determining D50 using the flow rate, channel cross section, and channel slope. It was used to determine the D50 for channels with Froude numbers greater than 1.2 and velocities below 12 fps. Grouted riprap was used when the flow velocity was determined to be above the Urban Drainage maximum criteria of 12 fps.

3.2 Maintenance and Inspection

A regular program of inspection and maintenance is implemented to properly maintain the project works. Regular observations are required to locate potential sources of trouble so that minor corrections and repairs can be made in time to prevent more serious deterioration or damage. Regular maintenance, consisting primarily of good housekeeping, is likewise essential to minimize the major causes of wear and deterioration of equipment and structures.

Instructions for inspections and maintenance, including a brief discussion of the procedures to be followed and a tabular Inspection and Maintenance Schedule, are attached in the appendixes. Detailed instructions and parts lists are given in manufacturers' manuals and bulletins for equipment where available. For convenient reference, the equipment items and respective suppliers are included in Appendix G.

Each operator should become familiar with the structures, equipment, and inspection and maintenance requirements and procedures. The operator has the responsibility of keeping the dams, outlet works, canals, and structures in good operating condition at all times. The operator will make observations where the dismantling of equipment is not required and will make necessary adjustments and repairs that do not require skilled specialized personnel and facilities.

These instructions and the instructions contained in the manufacturers' literature are necessarily general. Experience in working with the structures and equipment may produce additional maintenance procedures or modification of the procedures contained herein. The operator is encouraged to suggest such changes, but they should be adopted only after careful consideration of their possible long-term effects, and after obtaining approval of an engineer who is thoroughly familiar with the design and function of the equipment and structures.

Water level staff gauges of some type are present in all ponds except at Dams B-4 and C-1, since these operate as flow-through structures. These staff gauges are:

- I-beams with numbered face plates (A-4 and B-5);
- Numbered face plates bolted to inlet structures (A-4 and B-3);
- Steel channels with numbered face plates; or
- Fence posts with numbered face plates.

At Dams A-3, A-4, B-1, B-3, B-5, C-2, and the Present Landfill Dam, open-well piezometers have been installed. The water levels in the piezometers should be measured at least monthly. A piezometer record sheet is included in Appendix D. Higher-than-normal piezometer levels should be reported and evaluated immediately. Movement monuments have been installed on the crests of A-4, B-5, and C-2 and should be surveyed at least twice yearly by qualified surveyors and the results reviewed by a qualified engineer. Additional temporary monuments were installed on the downstream face of B-5 in March 2008; these monuments are to be surveyed quarterly until further notice. Inclinometers have also been installed at these dams, one at A-4, two each at B-5 and C-2, which should also be read by qualified personnel and results reviewed by a qualified engineer.

In addition to regular observations by operating personnel, an inspection by an engineer qualified in dam design and inspection should be conducted:

- At least annually for Dams A-3, A-4, B-5, C-2, and the Present Landfill Dam; and
- Every 3 years for Dams A-1, A-2, B-1, B-2, B-3, B-4, and C-1 or more often as special conditions arise.

The engineer may increase the frequency of periodic inspections when conditions warrant.

3.2.1 Operating Records

Records on O&M of the dams must be accurate and current. A sample operations log form is included in Appendix B. A record of precipitation, inflow volumes, and pond level, both upon opening and closing the outlet valve, should be maintained. Operability of remote monitoring equipment should be checked periodically. If the remote monitoring equipment is nonoperable, levels of ponds where inflow is occurring should generally be read weekly; monthly for all others. All observations and monitoring of the dams should be reported. Various record sheets are provided in the appendixes.

In addition to field records and logs, monthly status sheets are sent to the Dam Owner, DOE, CDPHE, the downstream Cities of Broomfield and Westminster, and other interested parties (Section 2.5.1). These status sheets are developed with a spreadsheet that has been specifically developed for pond operations.

3.2.2 Dams and Ponds

The dam embankments, spillways, outlet works, and pond shoreline should be inspected monthly, with general maintenance in the early spring and late fall. A Monthly Observation Report form is included in Appendix C.

Shoreline debris found below the normal operating level should be raked up and removed as required to avoid the possibility of clogging the outlet works.

The riprap protection on the upstream slope of the dam should be inspected at times when the pond is drawn down to a minimum level and after any major windstorm has produced prolonged wave action. The riprap should be maintained in good condition, and rock for repair can be obtained from the Asphalt Paving Company quarry or other quarries of equivalent quality. In cases where the bedding under the riprap has been removed by severe wave action, the bedding should be replaced prior to replacing the riprap. If erosion extends into the embankment beyond the riprap and bedding, the dam engineer should be notified immediately for prompt repair. Weeds and woody plants should be removed from upstream riprap slopes either manually or using an appropriate herbicide in coordination with the Site Ecology Lead and in consideration of water-quality impacts.

The dam embankments should be thoroughly inspected at least once a year after the season's major runoff event(s). When the pond levels reach their highest levels, the downstream slopes and abutments should be inspected for new seepage, damp spots, or swampy areas. In addition, the dams should be closely inspected for any evidence of surface cracking, settlement, or slope changes. In general, any condition that has changed from a previous inspection should be investigated. Embankments should be periodically mowed/weed-whacked to a height of 3 inches to facilitate dam inspections. Mowing/weed-whacking is generally performed annually in July. Deep-rooted woody plants should not be allowed to grow on the dam structure.

3.2.3 Spillways

A certain amount of erosion of the spillways can be expected to occur if a significant amount of water flows through the spillways. Every time a spillway flows, it should be checked for eroded

areas; if the eroded areas extend only into the topsoil, the topsoil need only be replaced and seeded. If erosion is more significant and extends into the underlying soils or bedrock, repairs should be made with the approval of an engineer who is thoroughly familiar with the design and operation of similar structures. Trash or vegetation that might interfere with flow should be removed from the spillway channel. Weeds and woody plants should be removed/cut from riprapped slopes either manually (to 3 inches) or using an appropriate herbicide in coordination with the Site Ecology Lead and in consideration of water-quality impacts. All grass spillways should be periodically mowed/weed-whacked to a height of 3 inches. Mowing/weed-whacking is generally performed annually in July.

3.2.4 Outlet Works

Every time the ponds are drained, the trash rack on the inlet structure should be inspected for accumulation of debris. If enough debris is present to cover approximately half of the area of the trash rack, it should be cleaned. Any large debris, such as logs or branches, should be removed immediately.

Valves should be operated for their full travel distances to ensure proper internal lubrication every year. The outlet structure should be checked after each major flow for large rocks or logs that might be trapped in the structure and would interfere with normal operation. Cleaning sediment from the impact structure is generally not necessary, as running water through the structure will clean it adequately.

The Parshall flume concrete should be checked yearly for any evidence of deterioration, cracking, or heaving, as should all exposed concrete surfaces. Sediment in the flume and larger material should be removed. Trash or vegetation in the outlet channel that could interfere with flow should be removed. All channels to 15 feet upstream of flumes should be periodically mowed/weed-whacked to a height of 3 inches to facilitate flow measurement. Mowing/weed-whacking is generally performed annually in July.

3.2.5 Pipe Crossings and Diversion Dam Headworks

No regular maintenance is expected to be required for structures that use corrugated metal pipe. Inspections should be made after every major runoff event to ensure that no large logs or branches are present that could plug the pipe inlets. Buildup of sediment in the pipes is normal, and it is expected that during high flows water will clean the pipe adequately. If the pipes become clogged because of abnormally large amounts of weeds or sediment, it will be necessary to clean the pipes. Movement of riprap or erosion of side overflows should be checked after a major runoff event.

3.2.6 Diversion Dams

The area immediately upstream of the diversion dams should be inspected annually. Debris found within the normal floodplain that could plug the pipe inlets should be removed.

The riprap protection on the upstream and downstream slopes of the diversion dams should be inspected after every major runoff event. The riprap shall be maintained in good condition, and rock for repair can be obtained from the Asphalt Paving Company quarry or other quarries of

equivalent quality. In cases where the bedding material under the riprap has been damaged, the bedding material should be repaired prior to replacing the riprap.

The concrete pile cap should be checked yearly for any evidence of deterioration, cracking, or heaving.

3.2.7 Canals and FCs

The channels should be inspected after every major runoff event. Problems that result from large accumulation of sediment or debris, slumps, or slides along the channel, or movement of riprap on the drop structures, should be corrected. Particular attention should be paid to the condition of the raised riprap control section at the upstream end of the rock grade controls. Materials may be piped from under rock grade controls by prolonged relatively minor flows in the channels; therefore, grade control structures should be inspected frequently, particularly in those reaches where the drops are close together. Any damage that could affect the structural integrity of the channel, such as cracks or seepage, should be investigated immediately. Trash or vegetation should be removed if the accumulation is sufficient to be a major impediment to normal flow.

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4.0 Monitoring and Instrumentation

The following sections provide detailed field data collection instructions for the following activities:

- Pond elevation monitoring;
- Piezometer elevation monitoring;
- Displacement monitoring;
- Movement monument monitoring;
- Inclinometer monitoring; and
- Seepage monitoring.

4.1 Pond Elevation Monitoring

Pond elevations shall be monitored to determine current pond volumes and remaining capacities.

Monitoring Locations—Elevation monitoring staff gages are located at all ponds except Ponds B-4 and C-1. Pond elevations at Ponds B-4 and C-1 are not measured, as the dams are operated as flow-through structures.

Monitoring Frequency—Pond elevations shall be monitored monthly unless conditions warrant more frequent monitoring. Biweekly pond level readings at Dams A-3, A-4, B-5, and the Present Landfill Dam are required by the Broomfield Water Lease reporting (Section 2.5.4).

Monitoring Equipment and Guidelines

- Resetting of pond elevation stakes that have shifted due to ice, wave action, etc. may need to be periodically performed.

  — Elevation shall be based from control monuments or other features of known elevation that are located at each pond.

  — A series of pond elevation stakes shall be set at each pond to enable measurement at varying water elevations and aid in determining when stakes need to be reset.

- No specialized equipment is required to read the elevation stakes. Pond elevation monitoring shall be performed under the following guidelines:

  — Stakes are marked to tenths or hundredths of feet. The foot markings may be indicated by the full elevation marking or the last two significant figures of the elevation.

  — The water level shall be estimated based on available markings: to the nearest 0.025 foot for tenth markings, and to the nearest 0.01 foot for hundredth markings.

  — If the stakes have shifted, a best estimate of the pond elevation shall be made.

Field Work Documentation—Field measurements shall be recorded on a data sheet or in a logbook. Examples of these field data sheets have been provided in Appendix D.

Evaluation and Reports

- Pond elevations shall be evaluated per the ERP. If a change in action level is required, members of the Dam Response Team will complete the appropriate notifications.
- The reports for pond elevation monitoring are the computer-generated spreadsheets "Rocky Flats Pond Status." The elevations of the ponds are entered on these sheets in the Pond Model spreadsheet; information including volume, percent full, and other pertinent data is automatically calculated by the spreadsheet. Additional notes and information regarding inflows, discharges, and precipitation shall be entered as appropriate.
- Copies shall be distributed, typically by email, to CDPHE, Cities of Broomfield and Westminster, DOE, and other interested parties (Section 2.5.1). Hard and computer copies should be maintained for record purposes. Command buttons are available on the introduction page of the spreadsheet that automatically create a new file and print the status sheet, with or without the piezometer history sheets, for distribution.
- A detailed, comprehensive, year-end report that includes descriptions, evaluations and analyses, and graphs of the pond level fluctuations for the year should be prepared. This report is typically prepared in support of formal dam inspections.

4.2 Piezometer Elevation Monitoring

Piezometer elevations shall be monitored to determine current water surface elevations as an indication of pore water pressure conditions within the dam.

Monitoring Locations—Piezometers are located at Dams A-3, A-4, B-1, B-3, B-5, C-2, and the Present Landfill Dam (Figure 4−1, Appendix J, and Appendix K).

Monitoring Frequency—Piezometer elevations shall be monitored monthly unless conditions warrant more frequent monitoring.

Monitoring Equipment and Guidelines—A water level indicator is required to measure the piezometer water elevations. Piezometer elevation monitoring shall be performed under the following guidelines:

- Depth to water, from the top of the piezometer casing, shall be determined for each piezometer with a water level indicator by dropping the probe down the piezometer well until the alarm sounds, slowly reeling in the line until the alarm stops, and determining the exact spot on the line at which the alarm began. This is the point at which the electrode is just touching the water in the well. The length of the line at that point shall be measured to the nearest hundredth of a foot.
- The depth to the water shall be subtracted from the elevation of the top of each piezometer casing to determine the elevation of water in the piezometer. The casing elevation is located on the Piezometer Field Sheet (Appendix D), indicated in mean feet above sea level.

Field Work Documentation—Field measurements shall be recorded on the Piezometer and Pond Levels Field Sheet at the time of the observation. Example field data sheets are available in Appendix D.

Evaluation and Reports

- Piezometer elevations shall be evaluated per the ERP. If a change in action level is required, members of the Dam Response Team will complete the appropriate notifications.
- The reports for piezometer elevation monitoring are the computer-generated spreadsheets "Rocky Flats Pond Status." The elevations of the piezometers are entered on the "FieldPiezTerm" and "FieldPiezInt" sheets in the Pond Model spreadsheet; information including volume, percent full, and other pertinent data is automatically calculated by the spreadsheet. Additional notes and information regarding inflows, discharges, and precipitation shall be entered as appropriate.
- Copies shall be distributed, typically by email, to CDPHE, Cities of Broomfield and Westminster, DOE, and other interested parties (Section 2.5.1). Hard copies and computer copies should be maintained for record purposes. Command buttons are available on the introduction page of the spreadsheet that automatically create a new file and print the status sheet with the piezometer history sheets for distribution.
- A detailed, comprehensive, year-end report that includes descriptions, evaluations and analyses, and graphs of the piezometer level fluctuations for the year should be prepared. This report is typically prepared in support of formal dam inspections.

4.3 Displacement Monitoring

Displacements in the dam embankment and/or concrete structures associated with the dams should be evaluated to identify potential problems before they threaten the safety of the dam.

Monitoring Locations—Displacements shall be monitored where and when they occur.

Monitoring Frequency—Displacements on terminal dams shall be monitored annually or more frequently if conditions warrant (see the ERP).

Monitoring Equipment and Guidelines—Displacement monitoring shall be performed under the following guidelines:

- Cracks caused by displacement of the dam shall be monitored by driving stakes/markers on both sides of the crack and each end. Cracks in concrete shall be monitored by spray-painting markers on the concrete on both sides of the crack and each end.
- Horizontal displacement shall be measured by using a tape measure to determine the initial distance between the markers and subsequent distances, or the width of the crack and subsequent widths at the marker in concrete structures, in order to calculate the amount of additional displacement between the markers.
- The ends of cracks shall also be marked to determine if the length of the crack is changing.
- Vertical displacement shall be measured using a carpenter's level and tape measure to determine initial distance between the tops of the markers and subsequent distances, in order to calculate the amount of additional displacement.

Field Work Documentation—Field measurements should be recorded on field sheets or in logbooks at the time of the observation.

Evaluation and Reports—An evaluation and report shall be generated for displacement monitoring. This report is typically prepared as part of the annual dam inspections. Displacements with significant changes should be evaluated by the Dam Engineer.

4.4 Movement Monument Monitoring

Dam movement monuments were installed on Dams A-4, B-5, and C-2 in 1993 to allow for a quantifiable survey of horizontal and vertical movement in the dams. Monuments installed were "Bernsten Top Security," high-precision, and three-dimensional accuracy. The monuments were constructed to reduce the effect of environmental conditions by encasing the monument in a protective polyvinyl chloride (PVC) case with lid; installing a greased, finned sleeve; and driving the monument to refusal. Additional temporary monuments were installed on the downstream face of B-5 in March 2008; these monuments are to be surveyed quarterly until further notice. An experienced surveyor shall perform field monitoring of movement monuments.

Monitoring Locations—On Dam A-4, a radial monument layout was installed to accommodate the curve of the dam crest, with five monuments on the dam crest at approximately 150-foot intervals; two control points are located off the dam crest. On Dam B-5, movement monuments were installed in a straight-line/baseline configuration with two monuments on the dam crest at approximately 140-foot intervals; two control points are located off the dam crest. The additional temporary B-5 monuments were installed in an essentially straight line extending from the crest (near inclinometer B5-I2) to the toe in a north-northwest direction. On Dam C-2, movement monuments were installed in a straight-line/baseline configuration with five monuments on the dam crest at approximately 200-foot intervals; two control points are located off the dam crest. See topographic maps of the dams with locations of movement monuments (Figure 4−1 and Appendix J).

Monitoring Frequency—The primary movement monuments shall be monitored twice a year, in June and December, unless more frequent monitoring is considered necessary (i.e., in extremely high pool conditions, following heavy rains or flooding, following an earthquake, or the appearance of potential structural cracking). The additional B-5 monuments are to be surveyed quarterly until further notice.

Monitoring Equipment and Guidelines—A survey of the movement monuments at each dam shall be completed under the direction and supervision of a licensed land surveyor. The fieldwork shall be completed by surveyors who understand statistical reduction of error by repetitive measuring techniques. Initial baseline readings were taken and subsequent readings shall be taken using the following described guidelines and meeting the stated accuracy requirements:

- Vertical location data for all of a dam's movement monuments shall come from a spirit level loop run through the monuments. The surveyor will use procedures that will produce repeatable results that meet a second order accuracy requirement.

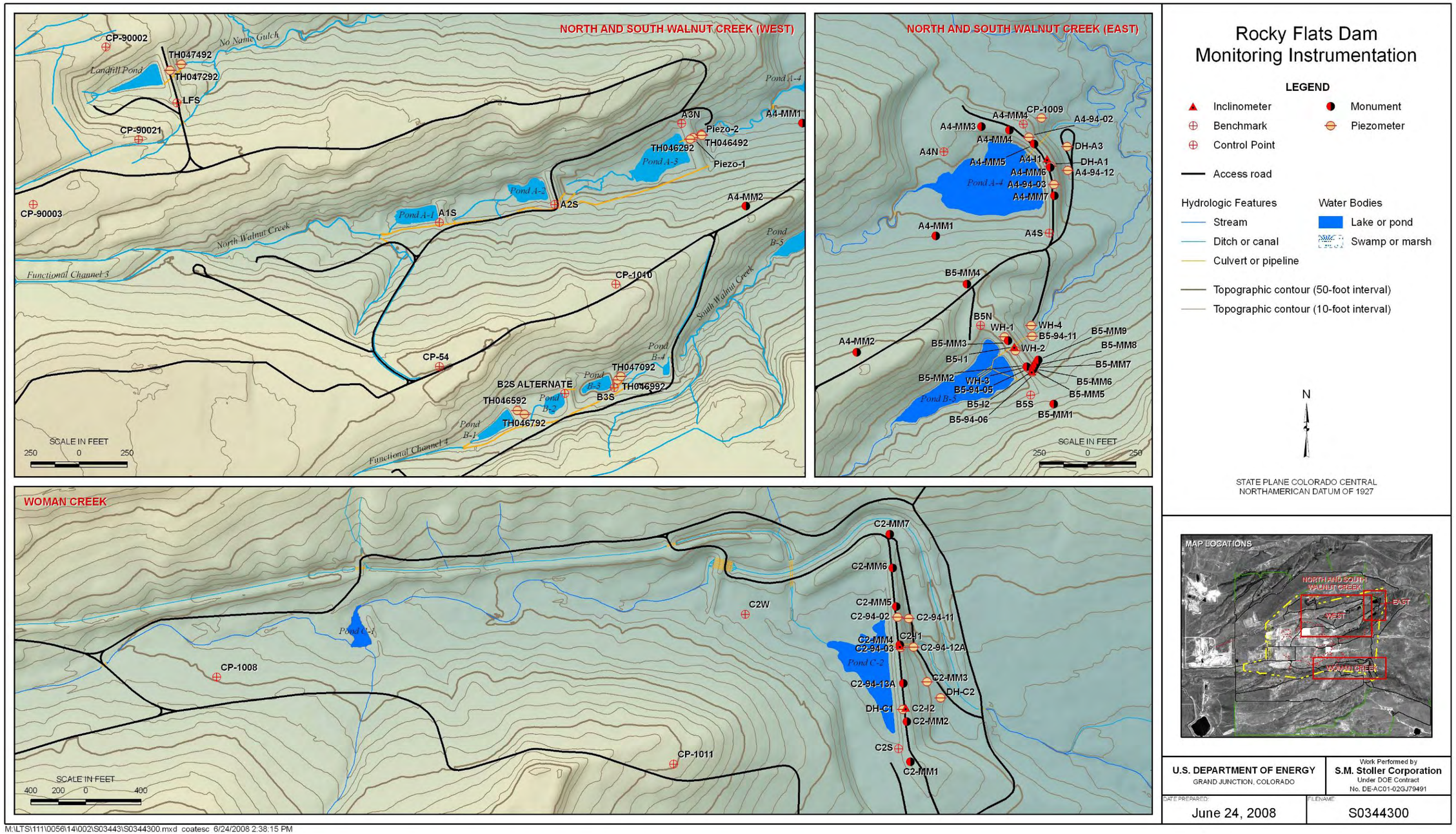

Figure 4−1. Rocky Flats Dam Monitoring Instrumentation

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- Horizontal location data for Dams B-5 and C-2 movement monuments shall be measured as offsets from a consistent baseline with a minimum three-second accuracy gun. This will provide horizontal location data of the fill slope monuments relative to the baseline. The surveyor will use procedures that will produce repeatable results that meet a second order accuracy requirement.
- Horizontal location data for Dam A-4 movement monuments shall be obtained from a radial distance check.

  — Set up on one of the off-dam monuments and check the distance to the other off-dam monument. This provides an electronic distance meter calibration check.

  — Measurements shall be taken to the crest monuments. Matching prisms to tribrach and tripod, and then placing those matched sets on the same crest monuments every survey session, is recommended to minimize measurement errors due to target variation. The surveyor will use procedures that will produce repeatable results that meet a third order accuracy requirement.

Field Work Documentation—Field measurements shall be documented by field notes kept by standard survey techniques.

Evaluation and Reports

- The surveyor shall provide notes and/or results showing field measurements and clarifying the delta measurement from the initial or baseline readings. Qualified personnel shall evaluate the movement monument fieldwork results by entering data into the spreadsheet "Rfpcmon_new.xls" and evaluating the charts and graphs for excessive movement and trends in movement. If a change in action level per the ERP is warranted, appropriate notifications should be made.
- The report for movement monument monitoring shall be the graphs and charts contained within the spreadsheet showing the results of the monitoring and any comments.
- A report shall be generated for monument monitoring. This typically is done in the annual dam inspection report.

4.5 Inclinometer Monitoring

Inclinometers were installed at various locations along the crests of Dams A-4, B-5, and C-2 in 1994 to allow for quantifiable measurement of internal movement in the dam embankments. The inclinometer system consists of a 2.75-inch outside diameter. ABS casing with grooves on the inside at the quarter points, aligned perpendicular and parallel to the dam axis. Inclinometers were installed in near-vertical drill holes to bedrock during field investigations for a geotechnical evaluation. Experienced personnel should perform field monitoring of inclinometers.

Monitoring Locations—One inclinometer was installed at Dam A-4, and two inclinometers were installed at both Dams B-5 and C-2. At each dam, an inclinometer was installed near the dam's maximum section. At Dam B-5, an additional inclinometer was installed at the southern portion of the dam in an old landslide area. At Dam C-2 an additional inclinometer was installed at the southern portion of the dam due to the long length of the dam. Topographic maps of dams indicate approximate locations of inclinometers (Figure 4−1 and Appendix J).

Monitoring Frequency—The inclinometer casings shall be monitored twice a year, in June and in December, unless more frequent monitoring is considered necessary (i.e., in extremely high pool conditions, following heavy rains or flooding, following an earthquake, or the appearance of potential structural cracking).

Monitoring Equipment and Guidelines—Readings and data reduction shall be performed by personnel experienced in the use of an inclinometer probe and its data reduction. An inclinometer probe shall be used, in accordance with manufacturer's directions and previous readings, to traverse the length of the casing to determine the casing profiles in the two perpendicular directions. For all inclinometers the A0 direction is downslope; top/bottom depths and reading intervals are given in Appendix J.

Field Work Documentation—Field measurements shall be recorded in the data recorder module for the inclinometer probe.

Evaluation and Reports

- Data shall be downloaded from the data collector with "DMMWin" software and the data subsequently imported into "Digipro" software for graphing and evaluation. Qualified personnel shall evaluate the inclinometer results as monitoring is performed for excessive movement and trends in movement. If a change in action level per the ERP is warranted, appropriate notifications shall be made. Inclinometer movement evaluation shall be based on comparison of current profiles with the initial profile, as well as the previous profiles, to determine if significant changes have occurred.
- The report for inclinometer monitoring shall be graphs showing the results of the monitoring and any comments.
- A report shall be generated for inclinometer monitoring. This typically is done in the annual dam inspection report.

4.6 Seepage Monitoring

Seepage through the dams through drain systems and wet areas on the downstream slope, abutments, and toe should be monitored to determine seepage patterns, identify and correct potential problems before they threaten the safety of the dam if possible, and identify conditions that threaten the safety of the dam.

Monitoring Location—Currently, Dams A-1, A-2, A-3, B-1, B-2, B-3, B-4, and C-1 have existing seeps. Additional seepage that may occur shall be monitored as indicated in these guidelines.

Seepage should be monitored annually during dam inspections unless conditions indicate more frequent monitoring is appropriate (see the ERP).

Monitoring Equipment and Guidelines—Seepage monitoring shall be performed under the following guidelines:

- If an area on a dam is damp, the wet area shall be staked out and the length and width measured.
- The quantity of flow shall be measured when possible. When the seepage shows a measurable quantity of flow, the rate of flow shall be monitored by creating a drop in the drainage channel and installing either a weir, flume, or pipe. When installation of a flow-measurement device is not possible, a "bucket-and-stopwatch" and/or visual estimation may be used.

  — Flow measurements for weirs and flumes shall be calculated from the stage height of water flowing through the device.

  — Flow from pipes shall be measured by using a bucket and stopwatch to catch a known volume of flow in a given time and calculating the flow rate.
- If flows are unmeasurable, the quantity shall be estimated or the degree of wetness described.
- Seepage quality (i.e., turbidity) shall be observed and jar samples taken as appropriate.
- Subsequent monitoring shall indicate any changes in the above items.

Field Work Documentation—Field measurements shall be recorded on field sheets or in a logbook.

Evaluation and Reports—An evaluation and report shall be generated for seepage monitoring. This report is typically performed as part of the annual dam inspections. Seeps with significant changes or unusually high flow rates should be evaluated by the Dam Engineer.

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5.0 Pond Operations

This O&M Plan has been prepared to provide the information and data needed by operating personnel for the operation of the project works. This section consists of instructions for normal operations and procedures to be followed in the event of abnormal operation. Applicable appendixes include:

- Appendix A Dam Data;
- Appendix B Operation Log;
- Appendix D Piezometer and Pond Levels Field Sheet;
- Appendix E Flume Ratings;
- Appendix G References;
- Appendix H Capacity Charts and Graphs;
- Appendix I Dam Locations and Access Roads;
- Appendix K Piezometer Summary Data; and
- Appendix M Schematic for Current Flow and Water Transfer Network.

The Operation Log or a logbook is a suggested form for keeping records of routine operation of the dams and ponds. The list of References provides dam drawing numbers and titles; engineering report titles; and the names of general contractors, subcontractors, and materials and equipment suppliers for various surface water projects. The outlet works rating curves are contained within the referenced drawing series where data are available and applicable. The pond areas and capacities at various pond levels are shown on the Capacity Charts herein.

Operations are described as “normal,” “elevated awareness,” or “emergency” based on a combination of retained volume, weather conditions, dam safety concerns, and water quality. Normal operations are defined as those operations that are conducted on a routine and relatively continuous basis. Emergency operations (see the ERP) are defined as specific actions or operations taken in response to abnormal, nonroutine occurrences. The transition from normal to emergency operations occurs in response to specified action levels, or in response to confirmed or suspected water contamination.

Action levels are determined by dam and pond conditions at which operational decisions become less of a function of water quality considerations (as for normal operations mode) and more of a function of weather conditions and dam safety concerns. In addition, water will be discharged in deference to water quality or pond volume in an emergency operation to prevent dam failure. Of the seven action levels (designated 0 through 6), only two action levels (4 and 5) have general applicability to emergency conditions posing imminent threat to dam and pond integrity:

- **Action Level 4** is triggered by pond conditions that potentially threaten the integrity of the dam and could result in failure, and any additional water inputs or minor storm events will result in overtopping of the dam.

  Monitoring frequency for pond levels and dam conditions is increased to daily, and weather forecasts are immediately evaluated. If minor dam problems are observed, and precipitation is forecasted to be minimal, normal operations mode is maintained. If significant dam

problems are observed, or significant precipitation is forecast, emergency operations mode is initiated.

- **Action Level 5** is triggered by pond conditions more serious than Action Level 4 and may include seepage and overtopping of the dam.

  Monitoring of pond levels and dam conditions are conducted every 8 hours, and emergency operations are initiated unless extenuating circumstances exist. Extenuating circumstances may include:

  — Positive knowledge of unacceptable concentrations of contaminants in the pond. In this case, transfers or discharges will be postponed until the last possible moment, unless dam safety considerations take precedent.

  — Analytical results demonstrating acceptable water quality are received concurrent with reaching the action level, no dam problems are observed, and no precipitation is forecast. In this case, normal operations will be followed.

Action Level 6 is actual failure of the dam and uncontrolled release of water, sediments, and dam materials to the downstream watershed. All emergency operations are subject to modification by the ERP.

In case of discrepancies between the above-described operations and the ERP, the ERP will take precedent.

5.1 Operating Instructions

The operating instructions are intended to cover normal operating functions of the Rocky Flats Surface Water Control Project. Instructions for normal operation in this section are limited to the outlet works valves of the dams because of the inherent automatic operations of the remainder of the project. Floods in excess of the pre-site reconfiguration 100-year event, up to the probable maximum flood, will pass safely over the emergency spillways at Dams A-4, B-5, and C-2, and lesser storms in the remainder of the dams as indicated in Section 3.1.2. Should emergency spillway flows occur, the flow over the spillway should be observed until such flow stops. After cessation of the flow, the spillway should be inspected for damage and repairs made as discussed in Section 3.2.3. The outlet works valves are not required to be operated during spillway operation; however, outlet works may be used to lower pond levels at acceptable drawdown rates if the action can be performed ***safely***. Operating personnel should not attempt to repair malfunctioning mechanical equipment. Such repairs require the services of skilled personnel.

5.1.1 Ponds

The water storage elevation should generally be maintained at less than 50 percent of pond capacity on each dam. This water level should typically be exceeded only for storm containment for short time intervals. The water levels in the ponds should not be drawn down faster than a rate of 1 foot per day except under emergency situations, when the integrity of the dam is threatened. Discharge rates, which correspond to a drawdown rate of 1 foot per day for each pond, are modeled with a spreadsheet that has been developed to aid in pond operations. In the case of Dam B-5, the upstream slope has been flattened to permit an increase in the drawdown whenever the pond level is below elevation 5,792 (30.5 percent of capacity), if necessary.

Frequent use of rapid rates, in excess of 1 foot per day, can increase the risk of localized sloughing of the embankments and may cause increased sloughing of the unstable pond slopes.

5.1.2 Outlet Works

The slide gate operators at A-4 and B-5 are hand wheels located at the crest. Dam A-4 contains a 24-inch-diameter main gate (valve A4-MG) and an 8-inch water quality gate (valve A4-WQG). Only one gate at a time should be operated to release water from Pond A-4. Dam B-5 has one 12-inch-diameter slide gate (valve B5-MG). The Dam C-2 slide gate (valve C2-MG) is operated with a hydraulic hand pump located in a vault in the C-2 crest. A switch on the pump must be set to the close or open position prior to operating the hand lever on the pump. To make desired releases, the slide gates should be partially opened and the flow out of the pond observed at the staff gauge on the flume and the valve adjusted to produce the desired flow rate. A sufficient amount of time should be allowed between valve adjustments to allow the flow to stabilize before reading the flume.

Access to gate valves on the downstream end of the outlet pipes at A-3, A-4, B-5, and C-2 is through a locking cover on a valve box located several feet upstream of the end of each outlet (valves A4-1, B5-1, and C2-1). The valves are operated by the 6-foot T-handle valve wrench located in the holder between the valve box and outlet structure. These valves are not currently used and are left in the open position unless failure of the primary valve necessitates using them as an emergency backup. The Dam A-3 gate valve (valve A3-3) leaks into the dam structure when closed—***this gate should remain open at all times***. Each of these dams is also equipped with a butterfly valve located on the downstream end of the outlet pipe (valves A3-4, A4-2, B5-2, and C2-2). The butterfly valve is operated with the same or similar valve wrench. At Dam A-3, this butterfly valve is the primary operating valve for the outlet; and at other dams, it is left open and used only as emergency backup.

At the Present Landfill Dam, a hand wheel located on the crest operates the upstream butterfly valve (valve DE-S). The downstream gate valve (valve DE-N) is equipped with a hand wheel located inside a manhole several feet upstream of the end of the outlet. To initiate discharge through the outlet when the valves are closed, the **downstream valve must be opened prior to opening the upstream valve** or a water hammer will occur.

In Dams A-4, B-5, C-2, and the Present Landfill Dam, a pool will develop between the inlet elevation and the bottom of the pond. Dams A-4 and B-5 have drain valves in addition to the slide gate inlets (two inlets for Dam A-4). To drain this pool at A-4 and B-5, the drain bed valves can be used. Water below the inlet elevation at C-2 and the Present Landfill Pond will have to be pumped if complete draining is necessary. The Present Landfill Dam and Dam C-2 do not have drain valves. The A-3 inlet is located on the pond bottom such that no pool will develop.

The drain valve for Dam A-4 is a 4-inch-diameter valve. The operating stem for the A-4 drain valve extends to just above the main inlet, and a 2-foot-long operating “key” is provided with the valve. The key is stored near the hand wheel at the crest, and uses a standard 2-inch nut connection. The Dam B-5 drain valve (6-inch-diameter) is located within the concrete tower structure. The operating stem is extended vertically to near the top of the concrete tower just above the water quality perforations. An opening is cut in the trash rack/safety grating to allow use of the drain valve key. An existing filter drain system that includes four branches of slotted

PVC drain pipe installed in a filter drainage sand and a vertical riser pipe that extends approximately 2 feet above the existing pond bottom provides inflow to the drain valve. These drain valves should not be operated except in the event of draining the ponds below the primary operating levels. This is anticipated only for maintenance purposes of the structures.

Under normal operations, Pond A-1 is discharged by pumping into the North Walnut Creek Bypass Pipeline diversion box to Ponds A-2 or A-3, or through its spillway into Pond A-2. Pond A-2 is discharged by pumping through its service spillway to Pond A-3. Pond B-1 is discharged by pumping through its spillway to Pond B-2; alternatively, B-1 can be pumped to a manhole on the South Walnut Creek Bypass Pipeline (located in the upstream end of the B-1 spillway). Pond B-2 is discharged by pumping through its service spillway to Pond B-3. Pond B-3 is discharged through the 10-inch overflow standpipe riser equipped with a gate valve (valve B3-3) with the operator located on the upstream face of the dam; this valve is typically left open so the dam performs as a flow through structure. Ponds B-4 and C-1 perform as flow through structures and require no special operation to discharge. These dams were not designed for rapid drawdown rates. Preliminary design documents indicate a rate of 6 inches or less per day was expected to be used. Typically, drawdown rates of up to 1 foot per day have been used for Rocky Flats dams, per recommendations for later Rocky Flats dams and the historical performance of these dams. The semipervious nature of the Dam A-2 outer shell may provide capability for somewhat faster drawdown rates. However, the Dam A-2 outer shell is not a completely free-draining material, and the upstream slope is relatively steep, so that excessive drawdown rates are likely to cause, at a minimum, shallow localized upstream slope failures.

To prevent clogging and facilitate later inspections, the pipe and outlet valves at some of the dams are a larger diameter than required for almost all operating conditions. Water released from the ponds should be controlled such that the **drawdown rate is limited to 1 vertical foot per day.** Drawdown rates more rapid than 1 foot per day can affect the stability of the dam, resulting in slumps or landslides on the face of the dam. The semipervious nature of the outer shells, as well as the relative flatness of the slopes of Dam A-3 and the Present Landfill Dam, may provide for drawdown rate capabilities in excess of 1 foot per day. However, these outer shells do not consist of completely free-draining materials, and overly excessive drawdown rates may cause, at a minimum, shallow localized upstream slope failures. The valves on dams with operating outlets may only be fully opened when making water releases if the water level in the pond is quite low or the integrity of the dam is threatened. Extra capacity is generally available in the flumes in the event rapid evacuation of the pond becomes necessary. Maximum discharge through the outlet works should be restricted to emergency situations. Operating experience will indicate the maximum rate of outflow that can be maintained without undue downstream channel erosion. Key operating parameters for each pond, including (1) stage, storage, and surface area, (2) outlet discharge rating curves, and (3) percent openings to limit drawdown to 1 foot per day, are provided in the design drawings listed for each dam and in the appendixes. Discharges should be monitored at least daily, and the operations should be recorded on a log form similar to that included in the appendixes.

5.1.3 Unusual Conditions

Unusual conditions are defined as an occurrence not normally encountered in the routine operation of the dams and ponds that may endanger the dams or necessitate revision of the operating procedures. Examples of unusual conditions include floods or evidence of riprap

movement, surface cracking, or slope changes in the dams; significant change in quantity or color of seepage flows from the dams or new damp spots or swampy areas that develop near the dams; deflection of cutoff walls or pipe movements; landslides or earthquakes; and structural damage or operational failures of equipment. When unusual conditions occur or are encountered during the routine operation of the dams and ponds, operating personnel must immediately take appropriate precautionary and protective action and then report the conditions promptly. Reports should be made to the dam owner or their representative, or a higher authority, by the most rapid means of communication commensurate with the seriousness of the unusual condition. Use the ERP to determine the appropriate action level and actions to be taken for unusual conditions.

Reports unusual conditions should be accurate and as complete as possible. They should include at least (1) a description of the unusual condition, (2) remedial measures taken or planned, (3) assistance that may be needed, and (4) an estimate of the probable duration of the unusual condition. Further developments, including the end of the unusual condition, should be described in follow-up reports. The follow-up report should be dispatched as soon as possible.

Reports should include measured information to the extent practical. Estimates by personnel untrained in handling unusual conditions can be unreliable and misleading. Reports should include the following:

- Record of date and time of observations;
- Measured location of unusual condition with respect to permanent landmarks or project features;
- Measured extent of unusual condition, such as length and width of newly identified features;
- Staking and/or measurement of seepage flow, or other quantification of unusual conditions, when first observed so that possible changes in area or flow rates can be evaluated later; and
- Site photography if practicable. Placement of hard hats or other well-known size standard in each photograph will provide scale.

If unusual conditions are such that downstream inhabitants or property owners will be or are likely to be threatened, they should be warned. State and county law enforcement offices and local radio stations should be notified if it becomes apparent that pond releases may cause downstream flooding. Use the ERP to determine the appropriate notifications and personnel that will make the notifications.

5.2 Present Landfill Pond Management

The Present Landfill Pond receives direct precipitation and runoff from approximately 12.1 acres and effluent flows from the Present Landfill Treatment System (PLFTS). Operations information for the Present Landfill Pond is provided in Table 5−1.

Table 5−1. Present Landfill Pond Operations Information

	Elevation (feet)	Volume (MG)	% Full	Ops Mode
Maximum (spillway elevation)	5,921.0	8.74	100	Emergency
Action Level 5[a]	>5,920.0	>7.87	90	Emergency
Action Level 3/4[a]	5,919.0	7.07	80	Elevated Awareness
Preferred Max. Elevation	5,914.7	4.38	50	Normal
Normal Elevation (flow-through; outlet elevation)	5,907.3	1.86	21.3	Normal
Minimum Elevation	5,901.6	0.87	10	Normal
Pond Management Sequence: Present Landfill Pond to No Name Gulch (discharge)				

[a]For reference only. Action levels are determined by pond and piezometer elevations, as well as dam conditions.
MG = million gallons

5.2.1 Normal Operations

Past operation at the Present Landfill Pond prior to closure was to transfer water to Pond A-2 and eventually to A-3 for analysis and eventual discharge. Transfer lines have been removed, and normal operations now maintain an open outlet works with direct discharge into No Name Gulch and Walnut Creek.

A normal pool level of 21.3 percent will typically be maintained when the Present Landfill Pond is in a flow-through configuration. However, the Present Landfill Pond may be periodically maintained at higher levels, with the outlet valve closed, for wetland enhancement.

Flow-through operations may be terminated, after consultation between the RFLMA Parties, should water quality results from the Present Landfill Pond suggest the water is unacceptable for discharge. The sampling, data evaluation, and decision rule regarding the Present Landfill Pond and PLFTS are detailed in RLFMA and the Rocky Flats Site Operations Guide (RFSOG) (DOE 2007, 2008b).

Notification of the Present Landfill Pond operations will include the following guidelines:

- Operations personnel will provide, at a minimum, DOE, CDPHE, the Cities of Broomfield and Westminster, and EPA with the Rocky Flats pond status approximately monthly (Section 2.5.1). Pond and piezometer levels and dam observations shall be field-collected once per month at a minimum and more frequently where conditions or action levels warrant.

5.2.2 Emergency Operations

The Present Landfill Pond will be discharged regardless of water quality under the following conditions:

1. The water elevation is 1 foot from the spillway elevation (Action Level 4), and further precipitation or inflow is predicted, or
2. The water elevation is less than 1 foot from the spillway elevation and uncontrolled overflow is imminent, or
3. An emergency condition requiring immediate discharge exists, per the ERP.

The above emergency operations are subject to modification by the ERP. In case of discrepancies between the above-described operations and the ERP, the ERP will take precedent.

5.3 Pond A-1 Management

Pond A-1 will receive water from direct runoff and occasional diversions of North Walnut Creek for wetland enhancement. Pond A-1 is generally maintained and used as a secondary storage pond for the North Walnut Creek drainage. Operations information for Pond A-1 is provided in Table 5−2.

Table 5−2. Pond A-1 Operations Information

	Elevation (feet)	Volume (MG)	% Full	Ops Mode
Maximum (spillway elevation)	5,929.1	1.40	100	Emergency
Action Level 5[a]	>5,828.1	>1.06	76	Emergency
Action Level 3/4[a]	5,827.1	0.75	54	Elevated Awareness
Preferred Max. Elevation	5,826.9	0.69	50	Normal
Normal Transfer Elevation	<5,826.4	<0.56	<40	Normal
Minimum Elevation	5,824.5	0.14	10	Normal
Primary Pond Management Sequence: A-1 to A-3 to A-4 to North Walnut Creek (transfer) Secondary Pond Management Sequence: A-1 to A-2 (transfer)				

[a]For reference only. Action levels are determined by pond and piezometer elevations, as well as dam conditions.
MG = million gallons

5.3.1 Normal Operations

The preferred operation at Pond A-1 is to transfer water to Pond A-3 for eventual discharge.

A functional outlet is not available at Pond A-1. Water transfers from the pond must be accomplished with portable pumping equipment. Water can be pumped to the diversion box on the North Walnut Creek Bypass Pipeline, subsequently flowing to Pond A-3.

Transfer will normally be initiated at any time the pond approaches 40 percent of volume. No sampling is required prior to transfer operations.

Notification of Pond A-1 operations will include the following guidelines:

- Operations personnel will provide, at a minimum, DOE, CDPHE, the Cities of Broomfield and Westminster, and EPA with the Rocky Flats pond status approximately monthly (Section 2.5.1). Pond levels and dam observations shall be field-collected once per month at a minimum and more frequently where conditions or action levels warrant.
- Pre-notification to DOE and others of transfer between interior ponds is not generally required. At a minimum, transfers will be noted on the Pond Status sheet.

5.3.2 Emergency Operations

Pond A-1 will be transferred to Pond A-2 or A-3, regardless of water quality constraints listed above, under the following conditions:

1. The water elevation is 1 foot from the spillway elevation (Action Level 4), and further precipitation or inflow is predicted, or
2. The water elevation is less than 1 foot from the spillway elevation and uncontrolled overflow is imminent, or
3. An emergency condition requiring immediate discharge exists, per the ERP.

The above emergency operations are subject to modification by the ERP. In case of discrepancies between the above-described operations and the ERP, the ERP will take precedent.

5.4 Pond A-2 Management

Pond A-2 will receive water from direct runoff, routine diversions of North Walnut Creek for wetland enhancement, and transfers from Pond A-1. Pond A-2 is generally maintained as a secondary storage pond for the North Walnut Creek drainage. Operations information for Pond A-2 is provided in Table 5−3.

Table 5−3. Pond A-2 Operations Information

	Elevation (feet)	Volume (MG)	% Full	Ops Mode
Maximum (drop structure elevation)	5,816.9	5.99	100	Emergency
Action Level 5[a]	>5,815.9	5.17	86	Emergency
Action Level 3/4[a]	5,814.9	4.43	74	Elevated Awareness
Preferred Max. Elevation	5,812.7	3.02	50	Normal
Normal Transfer Elevation	<5,811.5	<2.38	<40	Normal
Minimum Elevation	5,806.7	0.61	10	Normal
Primary Pond Management Sequence: A-2 to A-3 to A-4 to North Walnut Creek (discharge)				

[a]For reference only. Action levels are determined by pond and piezometer elevations, as well as dam conditions.
MG = million gallons

5.4.1 Normal Operations

The preferred operation at Pond A-2 is to transfer water to Pond A-3 for eventual discharge.

A functional outlet is not available at A-2. Water transfers from the pond must be accomplished with portable pumping equipment. Water can be pumped to the A-2 service spillway, subsequently flowing to Pond A-3.

Transfer will normally be initiated at any time the pond approaches 40 percent of volume. No sampling is required prior to transfer operations.

Notification of Pond A-2 operations will include the following guidelines:

- Operations personnel will provide, at a minimum, DOE, CDPHE, the Cities of Broomfield and Westminster, and EPA with the Rocky Flats pond status approximately monthly (Section 2.5.1). Pond levels and dam observations shall be field-collected once per month at a minimum and more frequently where conditions or action levels warrant.
- Pre-notification to DOE and others of transfer between interior ponds is not generally required. At a minimum, transfers will be noted on the Pond Status sheet.

5.4.2 Emergency Operations

Pond A-2 will be transferred to Pond A-3, regardless of water quality constraints listed above, under the following conditions:

1. The water elevation is 1 foot from the spillway elevation (Action Level 4), and further precipitation or inflow is predicted, or
2. The water elevation is less than 1 foot from the spillway elevation and uncontrolled overflow is imminent, or
3. An emergency condition requiring immediate discharge exists, per the ERP.

The above emergency operations are subject to modification by the ERP. In case of discrepancies between the above-described operations and the ERP, the ERP will take precedent.

5.5 Pond A-3 Management

Pond A-3 will receive normal base flow and stormwater runoff from the North Walnut Creek drainage, and occasional transfers from Ponds A-1 and A-2. Pond A-3 will discharge through its outlet works to Pond A-4. Operations information for Pond A-3 is provided in Table 5−4.

Table 5−4. Pond A-3 Operations Information

	Elevation (feet)	Volume (MG)	% Full	Ops Mode
Maximum (spillway elevation)	5,793.0	12.36	100	Emergency
Action Level 5[a]	>5,792.0	>10.91	88	Emergency
Action Level 3/4[a]	5,791.0	9.56	77	Elevated Awareness
Preferred Max. Elevation	5,788.1	6.08	50	Normal
Normal Discharge Elevation	<5,786.8	<4.92	<40	Normal
Minimum Elevation	5,781.4	1.24	10	Normal
Pond Management Sequence: A-3 to A-4 to North Walnut Creek (discharge)				

[a]For reference only. Action levels are determined by pond and piezometer elevations, as well as dam conditions.
MG = million gallons

5.5.1 Normal Operations

The method of operation for Pond A-3 is to discharge through the outlet works directly to Pond A-4.

Discharge will normally be initiated at any time the pond exceeds 40 percent of volume, although normal discharges will occur at less than 40 percent of volume. No sampling is required prior to discharge operations.

Pond A-3 discharge rates and quantity shall be measured at gaging station GS12 during the discharge.

Notification of Pond A-3 operations will include the following guidelines:

- Operations personnel will provide, at a minimum, DOE, CDPHE, the Cities of Broomfield and Westminster, and EPA with the Rocky Flats pond status approximately monthly (Section 2.5.1). Pond and piezometer levels and dam observations shall be field-collected once per month at a minimum and more frequently where conditions or action levels warrant.
- Pre-notification to DOE and others of discharge to A-3 is not generally required. At a minimum, transfers will be noted on the Pond Status sheet.

5.5.2 Emergency Operations

Pond A-3 will be transferred to Pond A-4, regardless of water quality constraints listed above, under the following conditions:

1. The water elevation is 1 foot from the spillway elevation (Action Level 4), and further precipitation or inflow is predicted, or
2. The water elevation is less than 1 foot from the spillway elevation and uncontrolled overflow is imminent, or
3. An emergency condition requiring immediate discharge exists, per the ERP, or
4. Overtopping of Pond A-2 is imminent.

The above emergency operations are subject to modification by the ERP. In case of discrepancies between the above-described operations and the ERP, the ERP will take precedent.

5.6 Pond A-4 Management

Pond A-4 will receive routine discharges from Pond A-3 and nonroutine transfers from Pond B-5. Pond A-4 will discharge directly to North Walnut Creek below Dam A-4. Operations information for Pond A-4 is provided in Table 5−5.

Table 5−5. Pond A-4 Operations Information

	Elevation (feet)	Volume (MG)	% Full	Ops Mode
Maximum (spillway elevation)	5,757.9	32.14	100	Emergency
Action Level 5[a]	>5,756.9	29.38	91	Emergency
Action Level 3/4[a]	5,755.9	26.75	83	Elevated Awareness
Preferred Max. Elevation	5,751.1	15.86	50	Normal
Normal Sample Elevation	<5,749.3	<12.87	<40	Normal
Minimum Elevation	5,741.2	3.26	10	Normal
Pond Management Sequence: A-4 to North Walnut Creek (discharge)				

[a]For reference only. Action levels are determined by pond and piezometer elevations, as well as dam conditions.
MG = million gallons

5.6.1 Normal Operations

The method of operation for Pond A-4 is to discharge it directly into North Walnut Creek without treatment upon receipt and dissemination of acceptable pre-discharge sample results.

Discharge activities may be terminated after a 0.5-inch storm event. The pond may need to be resampled for the required analytes if the potential for contaminant inflow exists.[1] Otherwise, the discharge can be reinitiated 24 hours after the end of the storm event.

Pre-discharge sampling will normally be initiated at any time the pond exceeds 40 percent of capacity, although normal pre-discharge sampling will occur at less than 40 percent of volume. Pre-discharge sampling will not be conducted until transfers from Ponds A-3 and B-5 have ceased.

Analysis for Pond A-4 water quality will include the following guidelines (see RFLMA and the RFSOG):

- Pond A-4 shall be sampled prior to discharge. Samples shall be split with CDPHE.
- Pond A-4 samples shall be analyzed by the Site and CDPHE for analytes listed for pre-discharge sampling in RFLMA.
- If the water meets stream standards for Walnut Creek, the water may be discharged without treatment. If the water does not meet standards, the water should be reanalyzed for the analyte of concern and an attempt made to identify the source of the exceedance. Additionally, DOE will consult with CDPHE.

Notification of Pond A-4 operations will include the following guidelines:

- Operations personnel will provide, at a minimum, DOE, CDPHE, the Cities of Broomfield and Westminster, and EPA with the Rocky Flats pond status approximately monthly (Section 2.5.1). Pond and piezometer levels and dam observations shall be field-collected once per month at a minimum and more frequently where conditions or action levels warrant.

[1] In most cases, Pond A-4 will be isolated from inflows by Pond A-3.

- Operations personnel will provide, at a minimum, DOE, CDPHE, the Cities of Broomfield and Westminster, EPA, and other interested parties with copies of water quality analytical data 24 hours prior to discharging for normal discharges (Section 2.5.2). Emergency discharges may be immediately initiated upon dissemination of results, or without results, as warranted by the ERP.
- Operations personnel will obtain approval to discharge from DOE.

5.6.2 Emergency Operations

Pond A-4 will be discharged, with or without treatment, to North Walnut Creek, if water quality analysis is incomplete or exceeds standards, under the following conditions:

1. The water elevation is 1 foot from the spillway elevation (Action Level 4), and further precipitation or inflow is predicted, or
2. The water elevation is less than 1 foot from the spillway elevation and uncontrolled overflow is imminent, or
3. An emergency condition requiring immediate discharge exists, per the ERP.

The above emergency operations are subject to modification by the ERP. In case of discrepancies between the above-described operations and the ERP, the ERP will take precedent.

5.7 Pond B-1 Management

Pond B-1 will receive water from direct runoff and routine diversions of South Walnut Creek for wetland enhancement. Pond B-1 is generally maintained and used as a secondary storage pond for the South Walnut Creek drainage and as wetlands habitat. Operations information for Pond B-1 is provided in Table 5−6.

Table 5−6. Pond B-1 Operations Information

	Elevation (feet)	Volume (MG)	% Full	Ops Mode
Maximum (spillway elevation)	5,882.0	0.86	100	Emergency
Action Level 5[a]	>5,881.0	0.60	70	Emergency
Action Level 3/4[a]	5,880.0	0.38	45	Elevated Awareness
Preferred Max. Elevation	5,880.0	0.38	45	Normal
Normal Transfer Elevation	Per Wetlands Requirements			Normal
Minimum Elevation	Per Wetlands Requirements			Normal
Pond Management Sequence: B-1 to B-2 to B-3 to B-4 to B-5 to South Walnut Creek (discharge)				

[a]For reference only. Action levels are determined by pond and piezometer elevations, as well as dam conditions.
MG = million gallons

5.7.1 Normal Operations

The method of operation for Pond B-1 is to transfer water to the South Walnut Creek Bypass Pipeline. Normal operation of B-1 is as a wetlands habitat.

A functional outlet is not available at Pond B-1. Water transfers from the pond must be accomplished with portable pumping equipment. Water can be pumped to the manhole in the South Walnut Creek Bypass Pipeline, subsequently flowing to Pond B-4.

Pond B-1 will maintain a minimum pool elevation as directed by the Site Ecology Lead for wetlands habitat. Pump intake lines will be situated so as to minimize the disturbance of pond sediments.

Transfer may be initiated when the pond exceeds required levels for wetlands habitat. No sampling is required prior to transfer operations.

Notification of Pond B-1 operations will include the following guidelines:

- Operations personnel will provide, at a minimum, DOE, CDPHE, the Cities of Broomfield and Westminster, and EPA with the Rocky Flats pond status approximately monthly (Section 2.5.1). Pond and piezometer levels and dam observations shall be field-collected once per month at a minimum and more frequently where conditions or action levels warrant.
- Pre-notification to DOE and others of transfer between interior ponds is not generally required. At a minimum, transfers will be noted on the Pond Status sheet.

5.7.2 Emergency Operations

Pond B-1 will be transferred to Pond B-2, regardless of water quality constraints listed above, under the following conditions:

1. The water elevation is 1 foot from the spillway elevation (Action Level 4), and further precipitation or inflow is predicted, or
2. The water elevation is less than 1 foot from the spillway elevation and uncontrolled overflow is imminent, or
3. An emergency condition requiring immediate discharge exists, per the ERP.

The above emergency operations are subject to modification by the ERP. In case of discrepancies between the above-described operations and the ERP, the ERP will take precedent.

5.8 Pond B-2 Management

Pond B-2 will receive water from direct runoff and routine transfers of Pond B-1. Pond B-2 is generally maintained and used as a secondary storage pond for the South Walnut Creek drainage and as wetlands habitat. Operations information for Pond B-2 is provided in Table 5−7.

Table 5−7. Pond B-2 Operations Information

	Elevation (feet)	Volume (MG)	% Full	Ops Mode
Maximum (drop structure elevation)	5,868.9	1.48	100	Emergency
Action Level 5[a]	>5,867.9	1.13	79	Emergency
Action Level 3/4[a]	5,866.9	0.81	55	Elevated Awareness
Preferred Operational Range, Max.	5,866.7	0.75	50	Normal
Normal Transfer Elevation	Per Wetlands Requirements			Normal
Minimum Elevation	Per Wetlands Requirements			Normal
Pond Management Sequence: B-2 to B-3 to B-4 to B-5 to South Walnut Creek (discharge)				

[a]For reference only. Action levels are determined by pond and piezometer elevations, as well as dam conditions.
MG = million gallons

5.8.1 Normal Operations

The method of operation for Pond B-2 is to transfer water to Pond B-3 for eventual discharge. Normal operation of Pond B-2 is as a wetlands habitat.

A functional outlet is not available at B-2. Water transfers from the pond must be accomplished with portable pumping equipment.

Pond B-2 will maintain a minimum pool elevation as directed by the Site Ecology Lead for wetlands habitat. Pump intake lines will be situated so as to minimize the disturbance of pond sediments.

Transfer may be initiated when the pond exceeds required levels for wetlands habitat. No sampling is required prior to transfer operations.

Notification of Pond B-2 operations will include the following guidelines:

- Operations personnel will provide, at a minimum, DOE, CDPHE, the Cities of Broomfield and Westminster, and EPA with the Rocky Flats pond status approximately monthly (Section 2.5.1). Pond levels and dam observations shall be field-collected once per month at a minimum and more frequently where conditions or action levels warrant.
- Pre-notification to DOE and others of transfer between interior ponds is not generally required. At a minimum, transfers will be noted on the Pond Status sheet.

5.8.2 Emergency Operations

Pond B-2 will be transferred to Pond B-3, regardless of water quality constraints listed above, under the following conditions:

1. The water elevation is 1 foot from the spillway elevation (Action Level 4), and further precipitation or inflow is predicted, or
2. The water elevation is less than 1 foot from the spillway elevation and uncontrolled overflow is imminent, or
3. An emergency condition requiring immediate discharge exists, per the ERP.

The above emergency operations are subject to modification by the ERP. In case of discrepancies between the above-described operations and the ERP, the ERP will take precedent.

5.9 Pond B-3 Management

Pond B-3 will receive water from direct runoff and routine transfers of Pond B-2. Pond B-3 is generally maintained in a flow-through configuration and can be used as a secondary storage pond for the South Walnut Creek drainage, but is primarily used as wetlands habitat. Operations information for Pond B-3 is provided in Table 5−8.

Table 5−8. Pond B-3 Operations Information

	Elevation (feet)	Volume (MG)	% Full	Ops Mode
Maximum (spillway elevation)	5,853.0	0.95	100	Emergency
Action Level 5[a]	>5,852.0	0.74	77	Emergency
Action Level 3/4[a]	5,851.0	0.56	56	Elevated Awareness
Preferred Max. Elevation	5,850.6	0.48	50	Normal
Normal Elevation (flow-through; riser elevation)	5,849.2	0.28	31	Normal
Minimum Elevation	Per Wetlands Requirements			Normal
Pond Management Sequence: B-3 to B-4 to B-5 to South Walnut Creek (discharge)				

[a]For reference only. Action levels are determined by pond and piezometer elevations, as well as dam conditions.
MG = million gallons

5.9.1 Normal Operations

The method of operation for Pond B-3 is to maintain an open outlet works with direct discharge to B-4 for flow-through discharge to B-5. Normal operation of B-3 is as a wetlands habitat.

A functional outlet with an overflow elevation (riser elevation) of 5,849.2 is available at Pond B-3.

Pond B-3 will maintain a minimum pool elevation as directed by the Site Ecology Lead for wetlands habitat.

Pond B-3 is typically operated as a flow-through structure with the outlet valve left open and water automatically flowing through the overflow. No sampling is required prior to discharge.

Notification of Pond B-3 operations will include the following guidelines:

- Operations personnel will provide, at a minimum, DOE, CDPHE, the Cities of Broomfield and Westminster, and EPA with the Rocky Flats pond status approximately monthly (Section 2.5.1). The B-3 pond level is generally not monitored because of the flow-through nature of the pond. Piezometer levels and dam observations shall be field-collected once per month at a minimum and more frequently where conditions or action levels warrant.
- Pre-notification to DOE and others of transfer between interior ponds is not generally required. At a minimum, transfers will be noted on the Pond Status sheet.

5.9.2 Emergency Operations

Pond B-3 will be discharged to Pond B-4, regardless of water quality constraints listed above, under the following conditions:

1. The water elevation is 1 foot from the spillway elevation (Action Level 4), and further precipitation or inflow is predicted, or
2. The water elevation is less than 1 foot from the spillway elevation and uncontrolled overflow is imminent, or
3. An emergency condition requiring immediate discharge exists, per the ERP.

The above emergency operations are subject to modification by the ERP. In case of discrepancies between the above-described operations and the ERP, the ERP will take precedent.

5.10 Pond B-4 Management

Pond B-4 will receive discharges from Pond B-3, and stormwater runoff through the B-1 bypass pipeline. No active management of Pond B-4 will occur. Pond B-4 has no appreciable usable storage volume, is maintained at 100 percent volume at all times, and discharges over its spillway directly to Pond B-5.

5.11 Pond B-5 Management

Pond B-5 will be maintained as the primary stormwater detention pond for the South Walnut Creek drainage. Pond B-5 will receive normal stormwater runoff from the South Walnut Creek drainage basin. Pond B-5 will typically be discharged directly to South Walnut Creek through its outlet works, pursuant to meeting applicable water quality criteria. Operations information for Pond B-5 is provided in Table 5−9.

Table 5−9. Pond B-5 Operations Information

	Elevation (feet)	Volume (MG)	% Full	Ops Mode
Maximum (spillway elevation)	5,803.9	23.12	100	Emergency
Action Level 5[a]	>5,802.9	21.35	93	Emergency
Action Level 3/4[a]	5,801.9	19.67	85	Elevated Awareness
Preferred Max. Elevation	5,796.3	11.59	50	Normal
Normal Sample Elevation	<5,794.3	<9.29	<40	Normal
Minimum Elevation	5,784.8	2.33	10	Normal
Primary Pond Management Sequence: B-5 to South Walnut Creek (discharge) Secondary Pond Management Sequence: B-5 to A-4 to North Walnut Creek (transfer)				

[a]For reference only. Action levels are determined by pond and piezometer elevations, as well as dam conditions.
MG = million gallons

5.11.1 Normal Operations

The preferred operational mode for Pond B-5 is to discharge it directly to South Walnut Creek without treatment upon receipt and dissemination of acceptable pre-discharge sample results.

Discharge activities may be terminated after a 0.5-inch storm event. The pond may need to be resampled for the required analytes if the potential for contaminant inflow exists. Otherwise, the discharge can be reinitiated 24 hours after the end of the storm event.

Pre-discharge sampling will normally be initiated at any time the pond exceeds 40 percent of capacity, although normal pre-discharge sampling will occur at less than 40 percent of volume. Analysis for Pond B-5 water quality will include the following guidelines (see RFLMA and the RFSOG):

- Pond B-5 shall be sampled prior to discharge. Samples shall be split with CDPHE.
- Pond B-5 samples shall be analyzed by the Site and CDPHE for analytes listed for pre-discharge sampling in RFLMA.
- If the water meets stream standards for Walnut Creek, the water may be discharged without treatment. If the water does not meet standards, the water should be reanalyzed for the analyte of concern and an attempt made to identify the source of the exceedance. Additionally, DOE will consult with CDPHE.

Notification of Pond B-5 operations will include the following guidelines:

- Operations personnel will provide, at a minimum, DOE, CDPHE, the Cities of Broomfield and Westminster, and EPA with the Rocky Flats pond status approximately monthly (Section 2.5.1). Pond and piezometer levels and dam observations shall be field-collected once per month at a minimum and more frequently where conditions or action levels warrant.
- Operations personnel will provide, at a minimum, DOE, CDPHE, the Cities of Broomfield and Westminster, EPA, and other interested parties with copies of water quality analytical data 24 hours prior to discharging for normal discharges (Section 2.5.2). Emergency discharges may be immediately initiated upon dissemination of results, or without results, as warranted by the ERP.
- Operations personnel will obtain approval to discharge from DOE.

5.11.2 Emergency Operations

Emergency discharge of Pond B-5 to South Walnut Creek, or by pipeline to Pond A-4 or both, prior to receipt of analytical results, will occur if water quality analysis is incomplete or exceeds standards, under the following conditions:

1. The water elevation is 1 foot from the spillway elevation (Action Level 4), and further precipitation or inflow is predicted, or
2. The water elevation is less than 1 foot from the spillway elevation and uncontrolled overflow is imminent, or
3. An emergency condition requiring immediate discharge exists, per the ERP.

The above emergency operations are subject to modification by the ERP. In case of discrepancies between the above-described operations and the ERP, the ERP will take precedent.

5.12 Pond C-1 Management

Pond C-1 will receive flows from Woman Creek. No active management of Pond C-1 will occur. Pond C-1 has no appreciable usable storage volume, is maintained at 100 percent volume at all times, and discharges over its stop log structure directly into Woman Creek.

5.13 Pond C-2 Management

Pond C-2 will be maintained as the primary stormwater detention pond for runoff originating from the southern portion of the COU. Pond C-2 will receive stormwater runoff through the SID. Operations information for Pond C-2 is provided in Table 5−10.

Table 5−10. Pond C-2 Operations Information

	Elevation (feet)	Volume (MG)	% Full	Ops Mode
Maximum (spillway elevation)	5,765.3	22.69	100	Emergency
Action Level 5[a]	>5,764.3	19.97	88	Emergency
Action Level 3/4[a]	5,763.3	17.53	77	Elevated Awareness
Preferred Max. Elevation	5,760.3	11.29	50	Normal
Normal Sample Elevation	<5,759.0	<9.04	<40	Normal
Minimum Elevation	5,753.4	2.31	10	Normal
Pond Management Sequence: C-2 to Woman Creek (discharge)				

[a]For reference only. Action levels are determined by pond and piezometer elevations, as well as dam conditions.
MG = million gallons

5.13.1 Normal Operations

The method of operation for Pond C-2 is to discharge without treatment to Woman Creek upon receipt and dissemination of acceptable pre-discharge sample results.

Discharge activities may be terminated after a 0.5-inch storm event. The pond may need to be resampled for the required analytes if the potential for contaminant inflow exists. Otherwise, the discharge can be reinitiated 24 hours after the end of the storm event.

Pre-discharge sampling will normally be initiated at any time the pond exceeds 40 percent of capacity, although normal pre-discharge sampling will occur at less than 40 percent of volume. Analysis for Pond C-2 water quality will include the following guidelines (see RFLMA and the RFSOG):

- Pond C-2 shall be sampled prior to discharge. Samples shall be split with CDPHE.
- Pond C-2 samples shall be analyzed by the Site and CDPHE for analytes listed for pre-discharge sampling in RFLMA.
- If the water meets stream standards for Woman Creek, the water may be discharged without treatment. If the water does not meet standards, the water should be reanalyzed for

the analyte of concern and an attempt made to identify the source of the exceedance. Additionally, DOE will consult with CDPHE.

Notification of Pond C-2 operations will include the following guidelines:

- Operations personnel will provide, at a minimum, DOE, CDPHE, the Cities of Broomfield and Westminster, and EPA with the Rocky Flats pond status approximately monthly (Section 2.5.1). Pond and piezometer levels and dam observations shall be field-collected once per month at a minimum and more frequently where conditions or action levels warrant.
- Operations personnel will provide, at a minimum, DOE, CDPHE, the Cities of Broomfield and Westminster, EPA, and other interested parties with copies of water quality analytical data 24 hours prior to discharging for normal discharges (Section 2.5.2). Emergency discharges may be immediately initiated upon dissemination of results, or without results, as warranted by the ERP.
- Operations personnel will obtain approval to discharge from DOE.

5.13.2 Emergency Operations

Emergency discharge of Pond C-2 to Woman Creek, with or without treatment, prior to receipt of analytical results, will occur if water quality analysis is incomplete or exceeds standards, under the following conditions:

1. The water elevation is 1 foot from the spillway elevation (Action Level 4), and further precipitation or inflow is predicted, or
2. The water elevation is less than 1 foot from the spillway elevation and uncontrolled overflow is imminent, or
3. An emergency condition requiring immediate discharge exists, per the ERP.

The above emergency operations are subject to modification by the ERP. In case of discrepancies between the above-described operations and the ERP, the ERP will take precedent.

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Rocky Flats, Colorado, Site Emergency Response Plan for the Rocky Flats Site Dams

U.S. Department of Energy

Office of Legacy Management

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Rocky Flats, Colorado, Site

Emergency Response Plan for the Rocky Flats Site Dams

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Acronyms and Abbreviations

cfs	cubic feet per second
DOE	U.S. Department of Energy
DRT	Dam Response Team
LM	Office of Legacy Management
NPH	No Public Hazard
RFLMA	Rocky Flats Legacy Management Agreement
SEO	State Engineer's Office

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1.0 Introduction

The Rocky Flats Site (Rocky Flats) is under the jurisdiction of the U.S. Department of Energy (DOE) Office of Legacy Management (LM). Long-term surveillance and maintenance activities at Rocky Flats are conducted under the Legacy Management Support contract by S.M. Stoller Corporation (Stoller). The Rocky Flats dams are maintained as part of the surveillance and maintenance activities conducted at the Site, which include activities conducted pursuant to the Rocky Flats Legacy Management Agreement (RFLMA). RFLMA established the regulatory framework to implement the final response action selected and approved in the Rocky Flats Corrective Action Decision/Record of Decision under the Comprehensive Environmental Response, Compensation, and Liability Act; the Resource Conservation and Recovery Act; and the Colorado Hazardous Waste Act to ensure the response action remains protective of human health and the environment.

2.0 Purpose

This plan describes response actions required in the event of (1) an actual or potential unplanned release, (2) emergency discharge of water from detention ponds at Rocky Flats (also known as the Site),[1] or (3) the actual or potential failure of a dam. It defines action levels for categorizing conditions up to and including dam failure. This plan supersedes procedure RMRS/OPS-PRO.063, *Action Level Response Plan for Dams A-4, B-5 or C-2.*

Site detention pond dams are earthen structures that are carefully monitored to ensure dam safety. Dams A-4, B-5, C-2, and the Landfill Dam are rated as "Low Hazard" by the State of Colorado. Dams A-1, A-2, A-3, B-1, B-2, B-3, and B-4 are rated as "No Public Hazard (NPH)." State dam classifications range from "High Hazard" (highest concern, loss of human life expected if dam fails) to "NPH" (lowest concern, no loss of human life expected if dam fails; damage limited to dam owner's property). Although an Emergency Action Plan is not required by the Colorado State Engineer for Rocky Flats dams, as a best management practice, a series of action levels and corresponding response actions have been developed to prevent overtopping, uncontrolled discharge, and/or actual dam failure. These action levels and response actions are delineated in this plan.

3.0 Scope

This plan applies to Site contractor, subcontractor, and DOE-LM employees who are tasked with or become involved in response actions affecting the detention pond dams. This procedure addresses action levels and responses used in mitigating actual or potential dam failures and unplanned releases, including emergency spillway discharges. All persons with specific roles and responsibilities are identified herein.

[1] The D-Series Ponds (D-1 and D-2), located in the southeast corner of the Site, are not owned by DOE and thus are not included in this plan.

The following appendices to this Emergency Response Plan are included to provide supporting information:

- Appendix A—data for the subject dams
- Appendix B—pond capacity charts
- Appendix C—piezometer action levels
- Appendix D—flow chart for determining action levels
- Appendix E—guidance on classifying the level of urgency for dam structure issues
- Appendix F—action level response flow charts
- Appendix G—potential problems and emergency actions
- Appendix H—emergency notifications flow chart
- Appendix I—contacts directory and standard notifications
- Appendix J—inundation map for Ponds A-4, B-5, and C-2 in the event of dam failure
- Appendix K—schematic for the current flow and water transfer network at Rocky Flats
- Appendix L—information on environmental water and sediment/soil sampling associated with an unplanned release or emergency discharge from the dams

4.0 Overview

The Site surface water management system includes a series of ponds and dams that retain surface water runoff and control flooding. The system comprises 11 ponds located in three separate drainage basins and the Landfill Pond. Ponds are designated by letters (A, B, or C) indicating its series or group, followed by a number, further identifying the specific pond and dam (e.g., C-2) in the group. All ponds, except the last in the series, are classified as interior ponds. The last pond, designated as the terminal retention pond, becomes the final control point for regulating surface water runoff within a series.

Seven different action levels inform and warn Site personnel of circumstances affecting the integrity of terminal ponds and dams. Action Levels 0 through 2 are referred to as “low” action levels, and Action Levels 3 through 6 are referred to as “high” action levels.

- **Action Level 0** identifies the day-to-day monitoring activities.
- **Action Levels 1** and **2** permit low-level monitoring and observation with increased awareness of the potential development of adverse conditions.
- **Action Levels 3** and **4** provide a guided response to potentially adverse conditions affecting the ponds. Specifically, these levels identify preparatory actions for members of the Dam Response Team (DRT) (Appendix H) and support agencies. The DRT provides technical expertise during incipient stages and later in support of emergency conditions.
- **Action Levels 5** and **6** are implemented when conditions indicate the potential for an unplanned release or once one has occurred from a terminal pond, or conditions indicate

the potential for a structural dam failure is present or has occurred. Either instance may require declaration of an emergency condition.

Water release from a dam failure will likely be a high-volume release in a short time period. High-velocity and high-volume spillway flows will likely cause erosion and scouring of the downstream creek bed.

Water from North and South Walnut Creek (Ponds A-4 and B-5, respectively) and the Landfill Pond will flow into Walnut Creek and into the Broomfield Diversion Ditch (if flow rate is less than 40 cubic feet per second [cfs]), while the internal A- and B-Series Ponds may flow into the next downstream pond during flood conditions.

The Broomfield Diversion Ditch is designed to handle flows up to 40 cfs before overtopping the diversion and entering Great Western Reservoir. Water from Pond C-2 will flow into Woman Creek. A short distance downstream of Pond C-2 is the Mower Ditch Head Gate; the gate is normally closed to direct flow into Woman Creek and the Woman Creek Reservoir. When requested by the City of Westminster, the gate can be opened to redirect flow (partially or completely) into Mower Ditch to provide water for Mower Reservoir.

5.0 Responsibilities

The DRT comprises monitoring, engineering, and supervisory personnel who respond to normal conditions and emergency conditions affecting detention dams (Appendix H). The DRT's responsibilities include:

- Inspecting and monitoring the status of detention ponds and dams to identify conditions adversely affecting the dam (to include incipient stages of dam failure);
- Ensuring availability of essential materials and, if needed, coordinating storage to ensure access in an emergency response;
- Performing monitoring, notification, and assistance in an emergency condition, on-scene assessment, emergency response actions, and issuance of personnel protective measures;
- Providing personnel to operate the equipment and/or open valves, as required;
- Ensuring resources are coordinated with emergency response personnel;
- Monitoring and sampling detention pond water on a routine basis;
- Performing routine pool elevation and piezometer monitoring;
- Performing pond transfers and discharges; and
- Providing pumps and associated materials as required for pond transfers and/or discharges.

Responsible DRT personnel are as follows:

- Dam owner representative—Scott Surovchak (DOE);
- Caretaker/pond operations project engineer—George Squibb (Stoller);
- Superintendent—Jeremiah McLaughlin (Stoller);

- Dam engineer—Mel Madril (Stoller); and
- Field technician—Andy Carpenter (Stoller).

6.0 Review of Plan and Training of Personnel

The DRT will train new personnel in the operation and inspection of the dams and the Emergency Response Plan within 1 month of beginning work. In addition, the DRT will review this plan each year and revise and distribute it as needed.

7.0 Instructions

7.1 Action Level Determination, Actions, and Reporting

The action level for each dam will be determined through monitoring and inspections as listed in this plan and from the Action Level Determination Flow Chart in Appendix D, in conjunction with the guidance for classifying the level of urgency for the dam structure issues provided in Appendix E, and the dam-specific data in Appendixes A, B, and C.

Action level responses will be performed in accordance with flow charts in Appendix F and will include emergency notifications per the flow chart in Appendix H and emergency actions per Appendix G where appropriate. These actions will only be taken when they can be accomplished safely without unnecessary risk to personnel. Materials needed for emergency action will be available at the Site or easily obtainable.

The inundation map in Appendix J is based upon a failure of Dam A-4, B-5, or C-2 during the inflow design flood with the reservoir full to the crest of the dam and the emergency spillway operating. This is the worst possible condition expected. The potential floodplain boundary should be considered as a minimum for evacuation planning purposes. No critical public facilities are in the dam failure floodplain.

The DRT will typically be responsible for determining the urgency of any problems and the action level of the dam and communicating the situation at the dam to the emergency authorities for emergency conditions. Other participants will notify their parties in accordance with the Emergency Notifications Flow Chart (Appendix H). The DRT will determine when a dam's action level can be downgraded. The DRT or dam owner's representative will notify the emergency authorities when the emergency is over. Dam structure issues will be reported to the dam engineer immediately upon observation. The dam engineer will generally be the one responsible for determining the urgency of any problems. The engineer will also be responsible for at least the initial monitoring of these types of conditions and may delegate monitoring responsibilities to other DRT personnel.

Under Elevated Awareness Conditions, a weekly status report will be submitted (via e-mail) to those parties listed under Standard Notifications by the DRT. The DRT may submit more frequent status reports at its discretion.

7.2 Monitoring Plan

7.2.1 Visual Observation

The dams will, at a minimum, be visually observed at least once a month when the reservoir is at less than half-full storage capacity, and twice a month when the reservoir is at greater than half-full storage capacity, immediately after heavy flooding, and following an earthquake. Visual observation of the dams will occur when pond elevation and piezometer level monitoring is conducted and will be performed by DRT personnel. The visual observation will include evaluation of the dam structure for issues listed in Appendix E, "Classifying the Level of Urgency for Dam Structure Issues."

7.2.2 Instrumentation Monitoring

Instrumentation will be monitored and the data recorded as described below.

Pond elevations will be field-measured **monthly**, except where an elevated action level for a dam warrants an increased monitoring frequency. Many of the pond elevations can also be monitored remotely using the telemetry system; however, field measurements will still be collected monthly (at a minimum) to ensure the telemetry is properly calibrated and to assess the condition of the dam in the field. DRT personnel will perform pond level monitoring.

Piezometer levels will be field-measured **monthly**, except where an elevated action level for a dam warrants an increased monitoring frequency. Many of the piezometers can also be monitored remotely using the telemetry system; however, field measurements will still be collected monthly (at a minimum) to ensure the telemetry is properly calibrated and to assess the condition of the dam in the field. Piezometer monitoring will be performed by pond operations personnel and evaluated by the pond operations project engineer or dam engineer as an indicator of the level of saturation within the dam embankment or of unusual pore water pressures.

Inclinometers and **crest monuments** will be measured **twice a year**, in June and December, except where an elevated action level for a dam warrants an increased monitoring frequency. The dam engineer will evaluate the results to determine embankment movement, including settlement and slides. DRT personnel will perform inclinometer readings, and surveyors experienced with surveying the dam monuments at the Site will perform crest monument surveys.

7.2.3 Inspections

The dam engineer and/or a qualified consulting engineer will perform thorough inspections once a year for Dams A-4, B-5, C-2, and the Landfill Dam, and every third year for all other dams. These inspections will include field inspection of dam slopes, crests, abutments, spillways, outlet systems, appurtenant structures, and monitoring instrumentation. The inspections will also include monitoring of any seepage, slides, or other structural issues, as well as an evaluation of instrumentation data, as applicable. Results of the inspection, as well as recommendations for repairs and maintenance if necessary, will be reported to the dam owner representative.

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Appendix A

Dam Data

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Table A−1. Rocky Flats Dam Data

DAM NAME	D.O E. ROCKY FLATS LF	D.O.E. ROCKY FLATS A-1	D.O E. ROCKY FLATS A-2	D.O.E. ROCKY FLATS A-3	D.O.E. ROCKY FLATS A-4	D.O E. ROCKY FLATS B-1	D.O.E. ROCKY FLATS B-2	D.O.E. ROCKY FLATS B-3	D.O E. ROCKY FLATS B-4	D.O.E. ROCKY FLATS B-5	D.O E. ROCKY FLATS C-2
HAZARD CLASS	LOW	NPH	NPH	NPH	LOW	NPH	NPH	NPH	NPH	LOW	LOW
DAM TYPE	JURISDICTIONAL; SMALL	JURISDICTIONAL; M NOR	JURISDICTIONAL; SMALL	JURISDICTIONAL; SMALL	JURISDICTIONAL; SMALL	NON-JURISDICTIONAL; MINOR	JURISDICTIONAL; M NOR	NON-JURISDICTIONAL; MINOR	NON-JURISDICTIONAL; M NOR	JURISDICTIONAL; SMALL	JURISDICTIONAL; SMALL
DAM ID	20413	25619	25620	20410	25621	25622	25623	25624	25625	25626	25628
NAT D	2341	2143	973	2100	2243	2669	2670	2671	2672	2244	2245
COUNTY	JEFFERSON	JEFFERSON	JEFFERSON	JEFFERSON	JEFFERSON	JEFFERSON	JEFFERSON	JEFFERSON	JEFFERSON	JEFFERSON	JEFFERSON
SECTION	2	11	11	11	1	11	11	11	11	12	13
TOWNSHIP	2S	2S	2S	2S	2S	2S	2S	2S	2S	2S	2S
RANGE	70W	70W	70W	70W	70W	70W	70W	70W	70W	70W	70W
PR NC PAL MERIDIAN	SIXTH	SIXTH	SIXTH	SIXTH	SIXTH	SIXTH	SIXTH	SIXTH	SIXTH	SIXTH	SIXTH
DOWNSTREAM TOWN	BROOMF ELD	BROOMFIELD	BROOMFIELD	BROOMF ELD	BROOMFIELD	BROOMF ELD	BROOMF ELD	BROOMFIELD	BROOMF ELD	BROOMFIELD	WESTM NSTER
DISTANCE TO TOWN DOWNSTREAM (M LES)	4	3	3	3	3	3	3	3	3	3	4
STREAM	WALNUT CREEK	WALNUT CREEK	WALNUT CREEK	WALNUT CREEK	WALNUT CREEK	WALNUT CREEK	WALNUT CREEK	WALNUT CREEK	WALNUT CREEK	WALNUT CREEK	WOMAN CREEK
DAM TYPE	RE (Earth)	RE (Earth)	RE (Earth)	RE (Earth)	RE (Earth)	RE (Earth)	RE (Earth)	RE (Earth)	RE (Earth)	RE (Earth)	RE (Earth)
DAM HEIGHT (ft)	32	17	27	33	36	8	12	9	8	43	23
DAM LENGTH (ft)	550	185	260	440	1100	200	225	135	200	525	1200
CREST WIDTH (ft)	18	18	36	20	20	30	26	25	25	20	20
CREST ELEVATION (ft)	5926 3	5833.6	5823.1	5799 0	5764.0	5885 0	5875.5	5856.7	5839 8	5810.4	5775.3
SURFACE AREA (acres)	0.7	<0.1	<0.1	1 5	2.8	0 2	0.2	0.4	0.4	1.8	0.9
NORMAL STORAGE (acre-ft)	5.7	<0.1	<0.1	4.4	14.1	<0.1	<0.1	0.4	0 6	11.1	1.6
MAXIMUM STORAGE (acre-ft)	26 8	4.3	18.4	37 9	98.6	2 6	6.7	2.9	0 6	71.0	69.6
DRA NAGE BASIN AREA (acres)	12 6	9.3	51.0	331 0	365.0	9.1	11.5	8.4	282 0	365.0	195.0
MAX. OUTLET CAPACITY (cfs)	10	0	0	33	35	0	0	UNKNOWN	NA	36	40
SPILLWAY TOTAL CAPACITY (cfs)	350	960	780	1200	6600	45	390	615	200	3500	19100
SERVICE SPILLWAY TYPE	NONE	NONE	UCOND	NONE	NONE	NONE	UCOND	UCOND	UCHAN	NONE	NONE
SERVICE SPILLWAY CODE	NONE	NONE	CMP	NONE	NONE	NONE	HDPE	CMP	CONC	NONE	NONE
SERVICE SPILLWAY W DTH (ft)	NONE	NONE	4	NONE	NONE	NONE	2	4	7	NONE	NONE
SERVICE SPILLWAY FREEBOARD (ft)	NONE	NONE	6 2	NONE	NONE	NONE	6.6	3.7	4 0	NONE	NONE
SERVICE SPILLWAY ELEVATION (ft)	NA	NA	5816 9	NA	NA	NA	5868.9	5853.0	5835 8	NA	NA
EMERGENCY SP LLWAY TYPE	UCHAN	UCHAN	UCHAN	UCHAN	UCHAN	UCHAN	UCHAN	UCHAN	NONE	UCHAN	UCHAN
EMERGENCY SP LLWAY CODE	CONC	EARTH	EARTH	EARTH	EARTH	EARTH	EARTH	EARTH	NONE	EARTH	EARTH
EMERGENCY SP LLWAY WIDTH (ft)	8	20	20	20	150	18	10	10	NONE	80	250
EMERGENCY SP LLWAY FREEBOARD (ft)[1]	5 3	4.5	2 9	6 0	6.1	3 0	4.8	3.7	NONE	6.5	10.0
EMERGENCY SP LLWAY ELEVATION (ft)	5921.0	5829.1	5820.2	5793.0	5757 9	5882.0	5870.7	5853.0	NA	5803 9	5765.3

[1] Values are from original design storm and dam configuration and are not current in all cases
NPH = No Public Hazard

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Appendix B

Pond Capacity Charts

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Table B−1. Pond Capacity Charts

POND A-4
Main Inlet Elev. 5741.3'
Water-Quality Inlet Elev. 5744.9'
Spillway Crest Elev. 5757.9'
Dam Crest Elev. 5764.0'

Elevation (Ft)	Volume (MG)	Capacity (%)
5727.0	0.00	0.0%
5728.0	0.00	0.0%
5729.0	0.00	0.0%
5730.0	0.00	0.0%
5731.0	0.01	0.0%
5732.0	0.04	0.1%
5733.0	0.13	0.4%
5734.0	0.28	0.9%
5735.0	0.49	1.5%
5736.0	0.74	2.3%
5737.0	1.05	3.3%
5738.0	1.43	4.5%
5739.0	1.90	5.9%
5740.0	2.45	7.6%
5741.0	3.10	9.7%
5741.3	3.33	10.4%
5742.0	3.87	12.1%
5743.0	4.76	14.8%
5744.0	5.76	17.9%
5744.9	6.75	21.0%
5745.0	6.86	21.3%
5746.0	8.07	25.1%
5747.0	9.39	29.2%
5748.0	10.82	33.7%
5749.0	12.37	38.5%
5750.0	14.04	43.7%
5751.0	15.86	49.4%
5752.0	17.83	55.5%
5753.0	19.91	62.0%
5754.0	22.14	68.9%
5755.0	24.50	76.2%
5756.0	27.00	84.0%
5757.0	29.64	92.2%
5757.9	32.14	100.0%

POND B-5
Main Inlet Elev. 5785.1'
Spillway Crest Elev. 5803.9'
Dam Crest Elev. 5810.4'

Elevation (Ft)	Volume (MG)	Capacity (%)
5772.0	0.00	0.0%
5773.0	0.00	0.0%
5774.0	0.01	0.0%
5775.0	0.05	0.2%
5776.0	0.12	0.5%
5777.0	0.23	1.0%
5778.0	0.37	1.6%
5779.0	0.54	2.3%
5780.0	0.75	3.3%
5781.0	1.00	4.3%
5782.0	1.29	5.6%
5783.0	1.61	7.0%
5784.0	1.99	8.6%
5785.0	2.42	10.5%
5785.1	2.47	10.7%
5786.0	2.90	12.5%
5787.0	3.45	14.9%
5788.0	4.05	17.5%
5789.0	4.71	20.4%
5790.0	5.43	23.5%
5791.0	6.21	26.8%
5792.0	7.05	30.5%
5793.0	7.96	34.4%
5794.0	8.96	38.7%
5795.0	10.04	43.4%
5796.0	11.21	48.5%
5797.0	12.46	53.9%
5798.0	13.79	59.6%
5799.0	15.19	65.7%
5800.0	16.66	72.0%
5801.0	18.21	78.7%
5802.0	19.83	85.7%
5803.0	21.52	93.1%
5803.9	23.12	100.0%

POND C-2
Main Inlet Elev. 5749.5'
Spillway Crest Elev. 5765.3'
Dam Crest Elev. 5775.3'

Elevation (Ft)	Volume (MG)	Capacity (%)
5745.0	0.00	0.0%
5746.0	0.00	0.0%
5747.0	0.03	0.1%
5748.0	0.13	0.6%
5749.0	0.31	1.4%
5749.5	0.43	1.9%
5750.0	0.56	2.5%
5751.0	0.91	4.0%
5752.0	1.39	6.1%
5753.0	2.00	8.8%
5754.0	2.77	12.2%
5755.0	3.70	16.3%
5756.0	4.81	21.2%
5757.0	6.09	26.8%
5758.0	7.50	33.1%
5759.0	9.04	39.9%
5760.0	10.73	47.3%
5761.0	12.59	55.5%
5762.0	14.62	64.4%
5763.0	16.82	74.1%
5764.0	19.19	84.6%
5765.0	21.80	96.1%
5765.3	22.69	100.0%

Table B−1 (continued). Pond Capacity Charts

POND A-1
Spillway Crest Elev. 5829.1'
Dam Crest Elev. 5833.6

Elevation (Ft)	Volume (MG)	Capacity (%)
5822.0	0.00	0.0%
5823.0	0.00	0.0%
5824.0	0.05	3.8%
5825.0	0.22	16.0%
5826.0	0.45	32.1%
5827.0	0.72	51.6%
5828.0	1.03	73.7%
5829.0	1.36	97.4%
5829.1	1.40	100.0%

POND B-1
Spillway Crest Elev. 5882.0'
Dam Crest Elev. 5885.0'

Elevation (Ft)	Volume (MG)	Capacity (%)
5876.0	0.00	0.0%
5877.0	0.00	0.3%
5878.0	0.05	6.1%
5879.0	0.19	22.6%
5880.0	0.38	44.5%
5881.0	0.60	70.1%
5882.0	0.86	100.0%

POND A-2
Drop Structure Elev. 5816.9'
Spillway Crest Elev. 5820.2'
Dam Crest Elev. 5823.1'

Elevation (Ft)	Volume (MG)	Capacity (%)
5798.0	0.00	0.0%
5799.0	0.00	0.0%
5800.0	0.00	0.1%
5801.0	0.01	0.2%
5802.0	0.04	0.6%
5803.0	0.08	1.3%
5804.0	0.16	2.7%
5805.0	0.28	4.7%
5806.0	0.45	7.6%
5807.0	0.67	11.3%
5808.0	0.95	15.9%
5809.0	1.29	21.5%
5810.0	1.68	28.1%
5811.0	2.13	35.5%
5812.0	2.63	43.9%
5813.0	3.19	53.2%
5814.0	3.81	63.6%
5815.0	4.49	75.0%
5816.0	5.25	87.6%
5816.9	5.99	100.0%
5817.0	6.07	101.4%
5818.0	6.97	116.4%
5819.0	7.94	132.6%
5820.0	8.98	149.9%
5820.2	9.19	153.5%

POND A-3
Spillway Crest Elev. 5793.0'
Dam Crest Elev. 5799.0'

Elevation (Ft)	Volume (MG)	Capacity (%)
5775.0	0.00	0.0%
5776.0	0.01	0.0%
5777.0	0.06	0.5%
5778.0	0.20	1.7%
5779.0	0.42	3.4%
5780.0	0.70	5.7%
5781.0	1.06	8.6%
5782.0	1.51	12.2%
5783.0	2.04	16.5%
5784.0	2.67	21.6%
5785.0	3.39	27.4%
5786.0	4.21	34.0%
5787.0	5.10	41.3%
5788.0	6.08	49.2%
5789.0	7.15	57.8%
5790.0	8.31	67.2%
5791.0	9.56	77.3%
5792.0	10.91	88.2%
5793.0	12.36	100.0%

Table B−1 (continued). Pond Capacity Charts

POND B-2
Drop Structure Elev. 5868.9'
Spillway Crest Elev. 5870.7'
Dam Crest Elev. 5875.5'

Elevation (Ft)	Volume (MG)	Capacity (%)
5862.0	0.00	0.0%
5863.0	0.02	1.3%
5864.0	0.11	7.6%
5865.0	0.29	19.5%
5866.0	0.54	36.4%
5867.0	0.84	56.6%
5868.0	1.17	78.6%
5868.9	1.48	100.0%
5869.0	1.52	102.4%
5870.0	1.90	127.9%
5870.7	2.18	147.1%

POND B-3
Riser Elev. 5849.2'
Spillway Crest Elev. 5853.0'
Dam Crest Elev. 5856.7'

Elevation (Ft)	Volume (MG)	Capacity (%)
5846.0	0.00	0.0%
5847.0	0.02	2.3%
5848.0	0.12	12.4%
5849.0	0.25	26.6%
5849.2	0.28	29.7%
5850.0	0.40	42.2%
5851.0	0.56	59.3%
5852.0	0.74	78.3%
5853.0	0.95	100.0%

LANDFILL POND
Spillway Crest Elev. 5921.0'
Dam Crest Elev. 5926.3'

Elevation (Ft)	Volume (MG)	Capacity (%)
5896.0	0.00	0.0%
5897.0	0.00	0.0%
5898.0	0.33	3.7%
5899.0	0.35	4.0%
5900.0	0.65	7.5%
5901.0	0.71	8.1%
5902.0	0.98	11.2%
5903.0	1.07	12.2%
5904.0	1.30	14.9%
5905.0	1.44	16.5%
5906.0	1.60	18.3%
5907.0	1.79	20.5%
5908.0	2.01	23.0%
5909.0	2.26	25.8%
5910.0	2.53	29.0%
5911.0	2.76	32.5%
5912.0	3.02	36.5%
5913.0	3.33	41.0%
5914.0	3.77	46.1%
5915.0	4.52	51.7%
5916.0	5.07	58.0%
5917.0	5.68	64.9%
5918.0	6.34	72.5%
5919.0	7.07	80.9%
5920.0	7.87	90.0%
5921.0	8.74	100.0%

POND B-4
Spillway Crest Elev. 5835.8'
Dam Crest Elev. 5839.8'
Flow Through Structure

Elevation (Ft)	Volume (MG)	Capacity (%)
5832.0	0.00	0.0%
5833.0	0.00	1.8%
5834.0	0.03	16.5%
5835.0	0.09	52.3%
5835.8	0.18	100.0%

Note: Capacity charts are included for information only for Pond B-4. Action Levels based on percent capacity do not apply to this dam because it is a flow-through structure.

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Appendix C

Piezometer Action Levels

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Table C−1. Piezometer Action Levels

Dam	Piezometer	Lower Action Level (ft)	Upper Action Level (ft)
A-4	DH-A1	5737	5746
	A4-94-02	5727	5752
	A4-94-03	5729	5750
	DH-A3	5722	5724
	A4-94-11	5724	5730
	A4-94-12	5721	5725
B-5	WH-1	5785	5787
	WH-2	5783	5786
	WH-3	5791	5801
	B5-94-05	5788	5800
	B5-94-06	5791	5800
	WH-4	5758	5760
	B5-94-11	5758	5762
C-2	DH-C1	5754	5763
	C2-94-02	5755	5761
	C2-94-03	5742	5760
	DH-C2	5736	5739
	C2-94-11	5744	5747
	C2-94-12A	5741	5750
	C2-94-13A	5735	5751
A-3	Piezo 1	5769	NA
	046292	5776	NA
	Piezo 2	5765	NA
	046492	5765	NA
Landfill	047292	5907	NA
	047092	5889	NA
B-1	046592	5871	NA
	046792	5869	NA
B-3	046992	5842	NA
	047492	5840	NA

Piezometer action levels for A-4, B-5, and C-2 are based on recommendations in Woodward Clyde *Final Geotechnical Analysis Report for Dam Upgrades (Dams A-4, B-5, and C-2)* November 11, 1994.

Piezometer action levels for the Landfill, A-3, B-1, and B-2 are based on the historical maximum levels within the piezometer and only include a lower action level number.

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Appendix D

Action Level Determination Flow Chart

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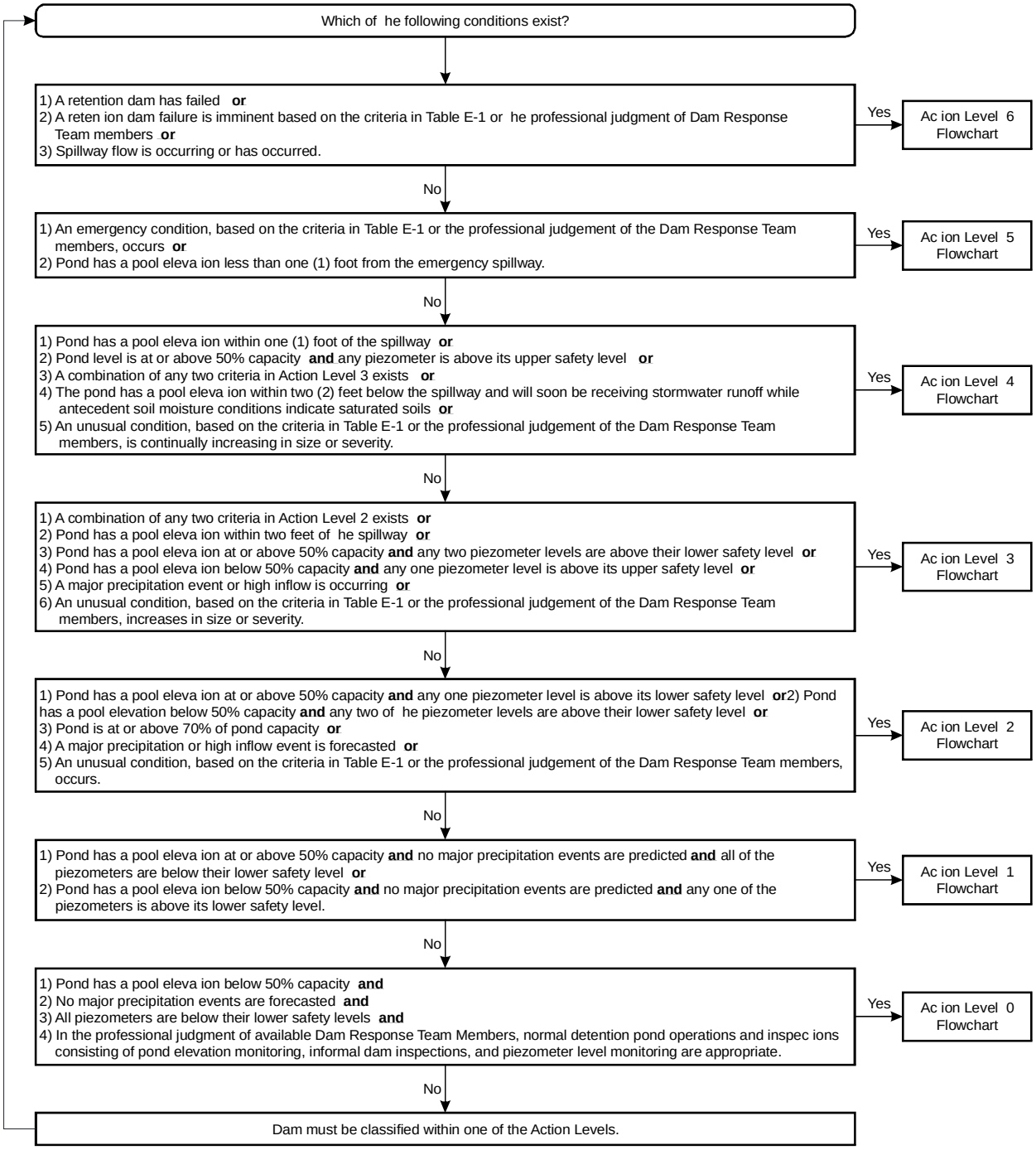
Table D−1. Action Level Determination Flow Chart



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Appendix E

Classifying the Level of Urgency
for
Dam Structure Issues

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Table E−1. Guide for Classifying the Level of Urgency for Dam Structure Issues

INCIDENT	LEVEL OF URGENCY		
	UNUSUAL CONDITION	**EMERGENCY CONDITION**	**FAILURE IS IMMINENT**
	New or increased problem	Possible failure developing (Stand-by alert, begin mobilizing for failure)	Partial failure, or dynamic failure of dam is in progress (Evacuation should begin)
PROBLEM	**EXAMPLES OF POSSIBLE OBSERVATIONS**		
BACKCUTTING OF SPILLWAY	Erosion of spillway is progressing slowly	Erosion of spillway is progressing rapidly	Spillway has washed out, dam is breached
CRACKING	Dry, open cracks	Cracks with displacement, or minor seepage (clear water)	Significant cracking with muddy seepage
OUTLET FAILURE	Broken gate or operator, rusty, scaling pipe, seepage	Cracked or perforated pipe, sediment in seepage, deeply scoured or undermined conduit	Significant, muddy seepage from or adjacent to outlet; Sinkholes in embankment over outlet conduit
OVERTOPPING OF DAM	Reservoir at crest due to a blocked spillway	Flood overtopping dam causing minor erosion	Flood overtopping dam causing significant erosion
PIPING	Small amount of sediment in seepage or drains	Significant amount of sediment in seepage, drains, muddy water	Seepage has caused large slide which has reduced freeboard to the reservoir level, or dam is overtopping
SEEPAGE	Downstream slope of dam is wet, soft; minor sloughing; water running on ground	Seepage is causing slides which narrows dam cross section, or settlement of crest and loss of freeboard	Seepage has caused large slide which has reduced freeboard to the reservoir level, or dam is overtopping
SETTLEMENT	Minor settlement (less than 1 foot) Small depressions in dam or foundation	Moderate settlement (One-half of freeboard)	Significant settlement, reservoir is overtopping dam
SINKHOLES	Small depressions in dam or foundation	Large hole over outlet, or on dam or foundation. Not increasing	Unstable hole over outlet, or on dam or foundation. Whirlpool in reservoir
SLIDES	Small, or surface slide with minor reduction of dam cross section, and minor crest settlement	Moderate slide which reduces dam cross section, but there is no seepage or overtopping problem	Large slide which reduces dam cross section significantly, with seepage or an overtopping problem
WAVE EROSION OF DAM	Minor erosion of crest height, and/or minor scarping of upstream slope	Moderate erosion of crest height, and/or significant scarping of the upstream slope which is progressing	Significant erosion of crest height and/or rapidly progressing loss of upstream slope
PIEZOMETER LEVELS	An unusual piezometer response occurs based on normal historical responses, or piezometer(s) exceed lower safety levels in an unusual pattern or pattern different than historical levels	Piezometer(s) exceed upper safety levels or are at unusually high levels different from historical levels	Piezometer(s) exceed upper safety levels or are at unusually high levels different from historical levels and are accompanied by seepage, piping, or slides as indicated above

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Appendix F

Action Level Response Flow Charts

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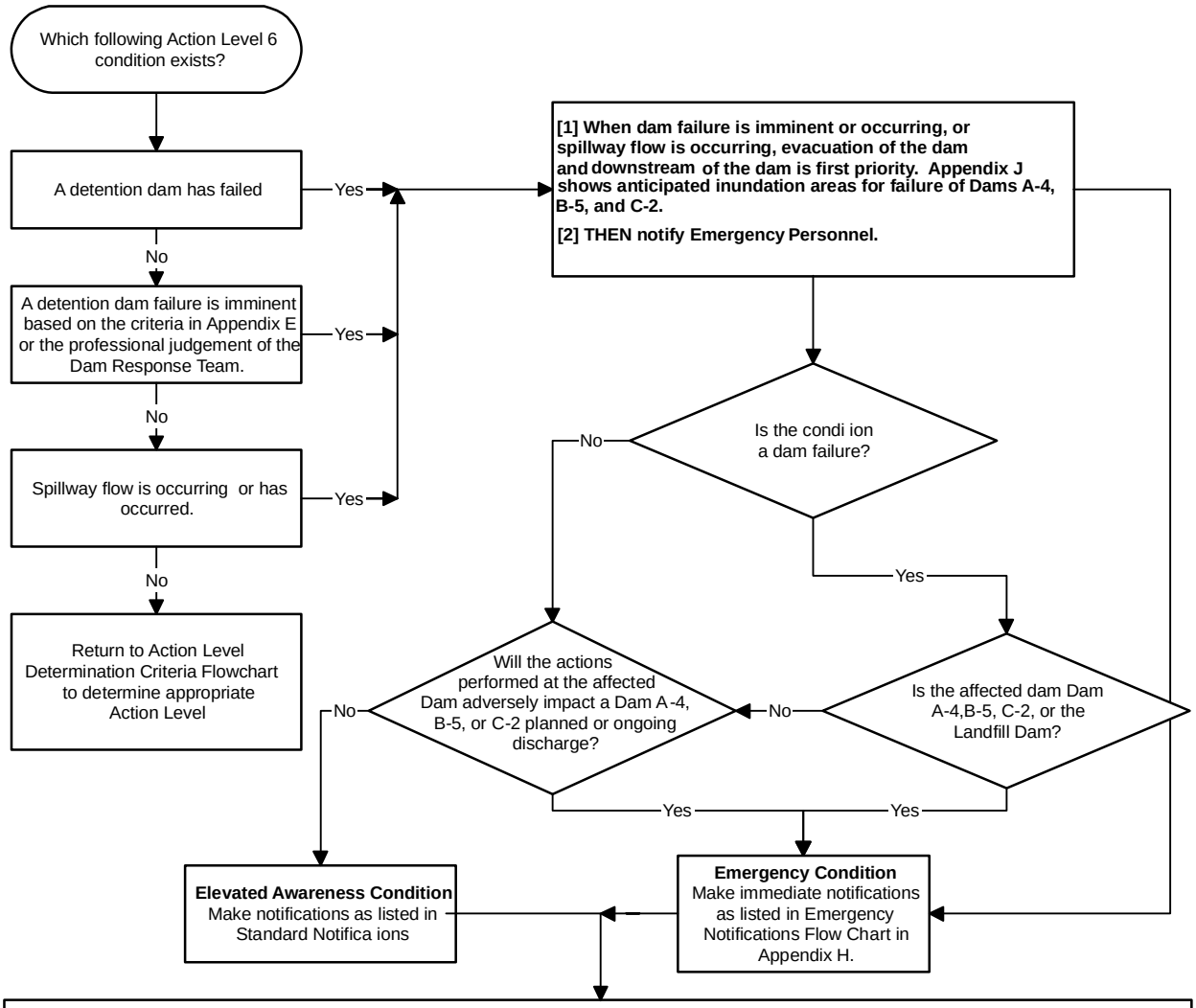
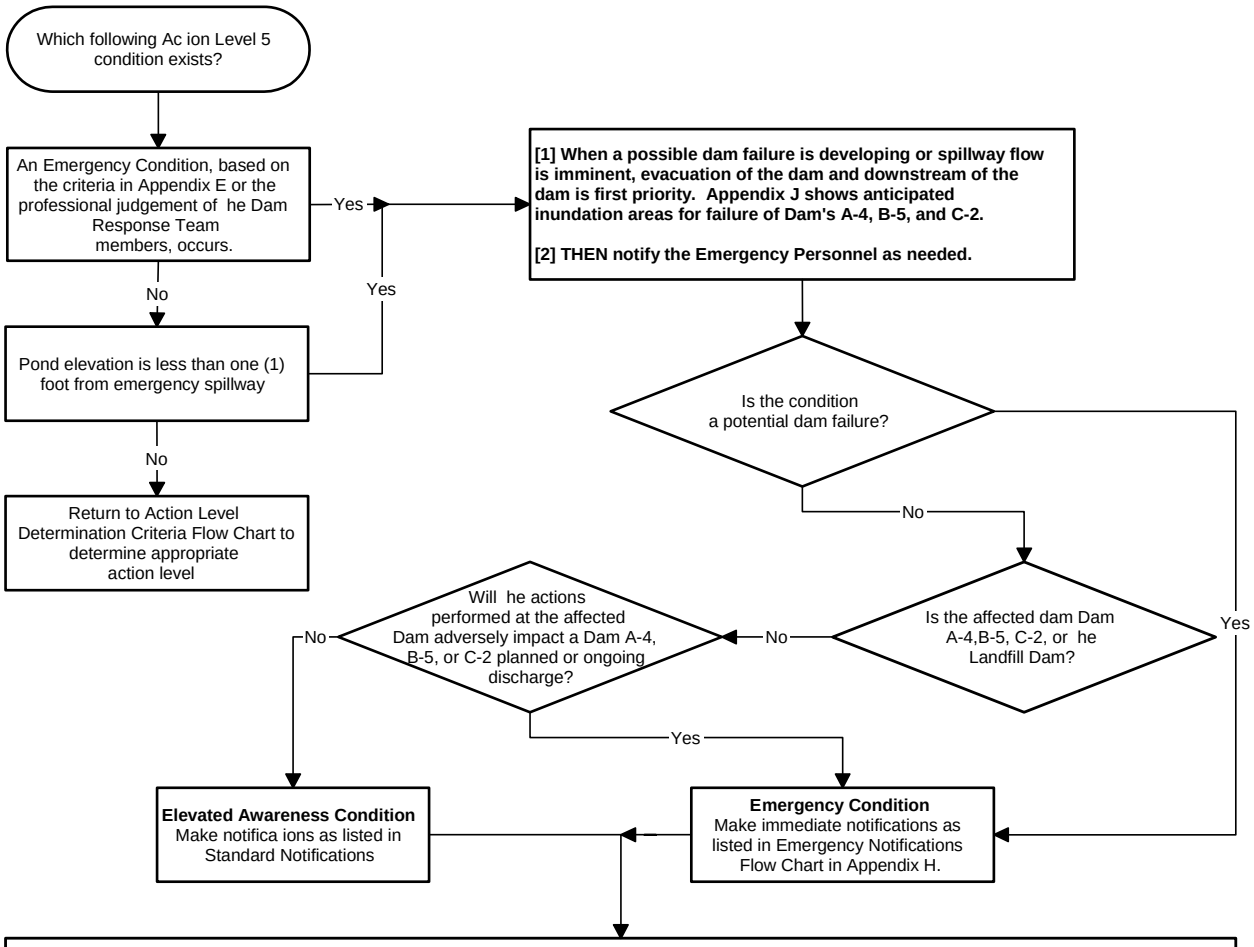
Action Level 6 Response Flowchart



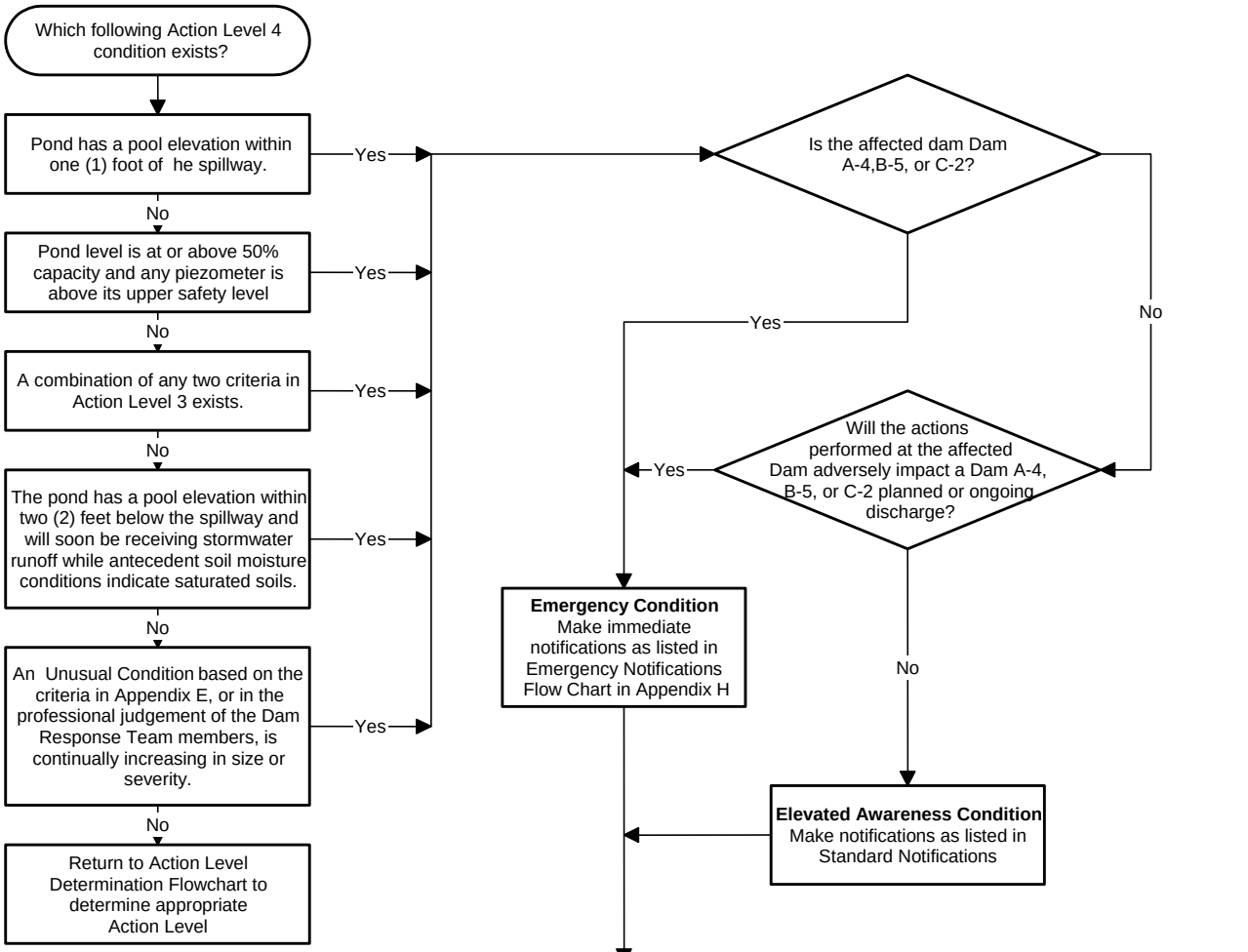
Dam Response Team:
[1] Coordinate with other members of the Dam Response Team and ensure assessment/evaluation of the on-scene situation.
[2] Coordinate on-scene emergency response activities as necessary.
[3] Ensure data for public and employee information development and dissemination is given to appropriate personnel.
[4] Establish safety guidance for personnel collecting sampl es or working on or below the dam.
[5] Monitor emergency conditions and perform duties as requested by he Dam Engineer and DOE, as applicable.
[A] Report conditions affecting Action Levels immediately to the Dam Engineer and DOE, as applicable.
[6] Implement "Emergency Actions" listed in Appendix G, as appropriate.
[7] Establish emergency discharge rates, as feasible.
[8] Provide and operate pumps and associated materials, or operate outlet valves, as required for pond transfers and/or discharges,
[A] Begin emergency discharge or transfer, with or without sample results, as appropriate.
[9] Coordinate with off-Site agency field monitoring response teams.
[10] Increase dam observation frequency to "con inuously".
[A] Report findings of dam inspections affecting Action Levels immediately to the Dam Engineer and DOE, as applicable.
[11] Implement environmental sampling as required in accordance with Appendix L, Environmental Water and Sediment/Soil Sampling.
[12] Gather and evaluate engineering inspec ion data, meteorological data, piezometer readings and assessment information.
[A] Evaluate conditions relative to failure modes listed in Appendix E in conjunction with the Dam Engineer and Consulting Engineer (if necessary).
[B] Coordinate on-Site inspection by the State Engineer's Office to assess the situation and provide recommendations, as appropriate
[13] Change Action Levels, drawdown rate (if approved by the Dam Engineer), inspection frequency, and monitoring activities and frequencies, as circumstances warrant.

Action Level 5 Response



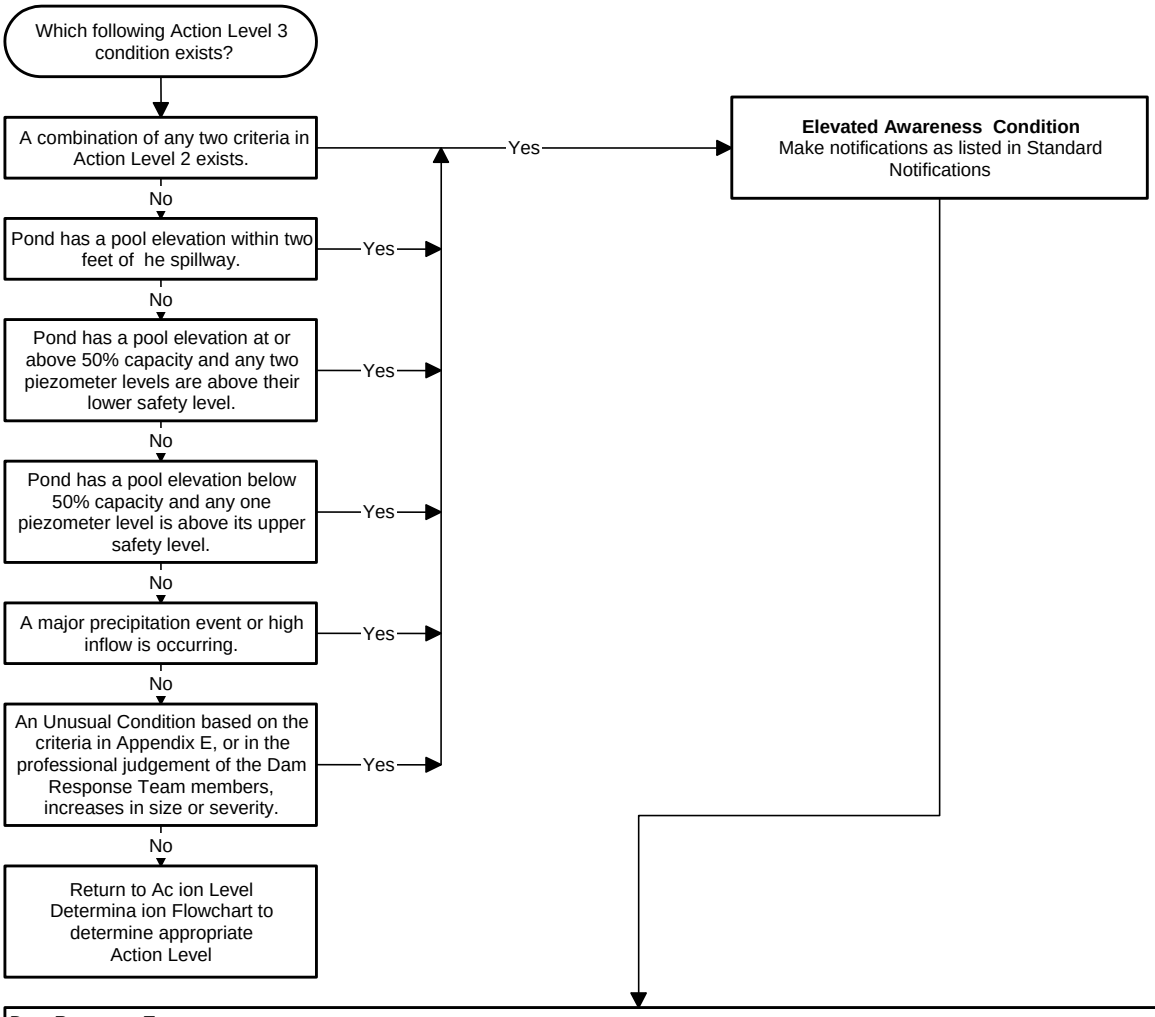
Dam Response Team:
[1] Coordinate with other members of the Dam Response Team and ensure assessment/evaluation of he on-scene situation.
[2] Coordinate on-scene emergency response activities as necessary.
[3] Ensure data for public and employee information development and dissemination is given to appropriate personnel.
[4] Establish safety guidance for personnel collecting samples or working on or below the dam.
[5] Monitor emergency conditions and perform duties as requested by the Dam Engineer and DOE, as applicable.
[A] Report conditions affec ing Action Levels immediately to the Dam Engineer, and DOE, as applicable.
[6] Implement "Emergency Actions" listed in Appendix G, as appropriate.
[7] Establish emergency discharge rates as required to provide a drawdown rate of approximately one foot per day, or more if approved by the Dam Engineer.
[8] Provide and operate pumps and associated materials, or operate outlet valves, as required for pond transfers and/or discharges.
[A] Begin emergency discharge or transfer, with or without sample results, as appropriate.
[9] Coordinate with off-Site agency field monitoring response teams.
[10] Increase he dam observation frequency to a minimum of every 8 hours.
[A] Report findings of dam inspections affecting Ac ion Levels immediately to the Dam Engineer and DOE, as applicable.
[11] Implement environmental sampling as required in accordance with Appendix L, Environmental Water and Sediment/Soil Sampling, as approriate.
[12] Ga her and evaluate engineering inspection data, meteorological data, piezometer readings and assessment informa ion.
[A] Evaluate conditions relative to failure modes listed in Appendix E in conjunction wi h the Dam Engineer and Consulting Engineer (if necessary).
[B] Coordinate on-Site inspection by the State Engineer's Office to assess the situa ion and provide recommenda ions, as appropriate
[13] Change Action Levels, drawdown rates (if approved by the Dam Engineer), inspection frequency, and monitoring activities and frequencies, as circumstances warrant.

Action Level 4 Response



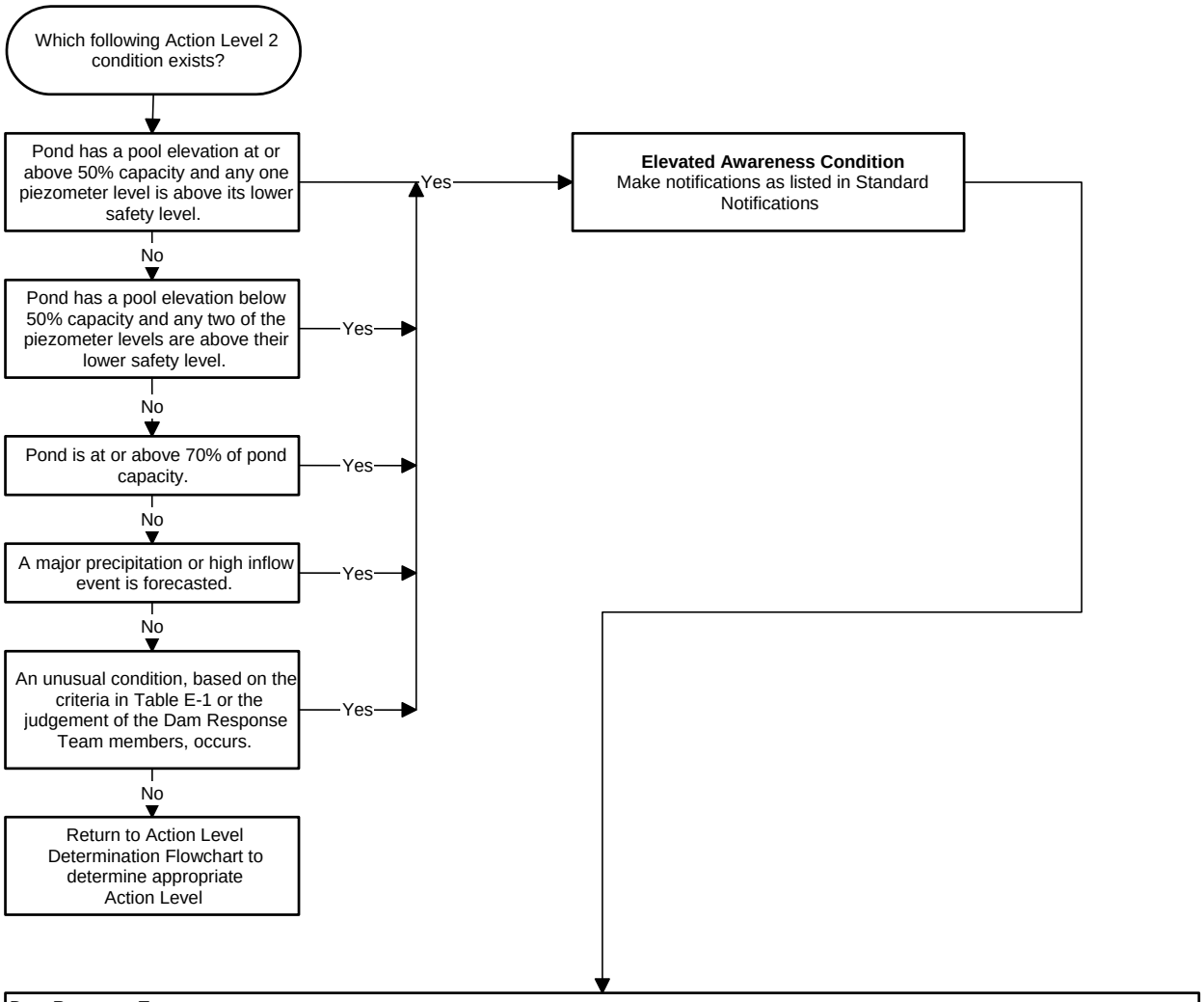
Dam Response Team:
[1] Coordinate with other Dam Response Team and ensure assessment/evaluation of the on-scene situation.
[2] Coordinate on-scene emergency response activities if necessary.
[3] Ensure data for public and employee information development and dissemination is given to appropriate personnel as necessary
[4] Establish safety guidance for personnel collecting samples or working on or below the dam.
[5] Monitor emergency conditions and perform duties as requested by theDam Engineer or DOE as applicable.
  [A] Report conditions affecting Action Levels immediately to the Dam Engineer and DOE, as applicable.
[6] Implement "Emergency Actions" listed in Appendix G, as appropriate.
[7] Establish emergency discharge rates through the ou let or pumping station at a rate of approximately one foot of drawdown per day,.
  [A] Utilize computer modeling to calculate the flow rates necessary to meet the one foot/day drawdown rate.
  [B] Set pumps or outlet valves to calculated flowrates for the duration of the event or until revised flowrates are calculated.
[8] Provide and operate pumps and associated materials, or operate outlet valves, as required for pond transfers and/or discharges.
  [A] Begin emergency discharge or transfer, with or without sample results, as appropriate.
[9] Coordinate with off-Site agency field monitoring response teams.
[10] Increase dam observation frequency and monitoring to 24 hour intervals, seven days per week.
  [A] Report findings of dam inspections affecting Action Levels immediately to the Dam Engineer and DOE, as applicable.
[11] Implement environmental sampling as required in accordance with Appendix L, Environmental Water and Sediment/Soil Sampling, as required.
[12] Gather and evaluate engineering inspection data, meteorological data, piezometer readings and assessment information.
  [A] Evaluate conditions relative to failure modes listed in Appendix E in conjunction with the Dam Engineer and Consulting Engineer (if necessary).
  [B] Coordinate on-Site inspection by the State Engineer's Office to assess the situation and provide recommendations, as appropriate
[13] Change Action Levels, drawdown rates (if approved by the Dam Engineer), inspection frequency, and monitoring activities and frequencies, as circumstances warrant.

Action Level 3 Response



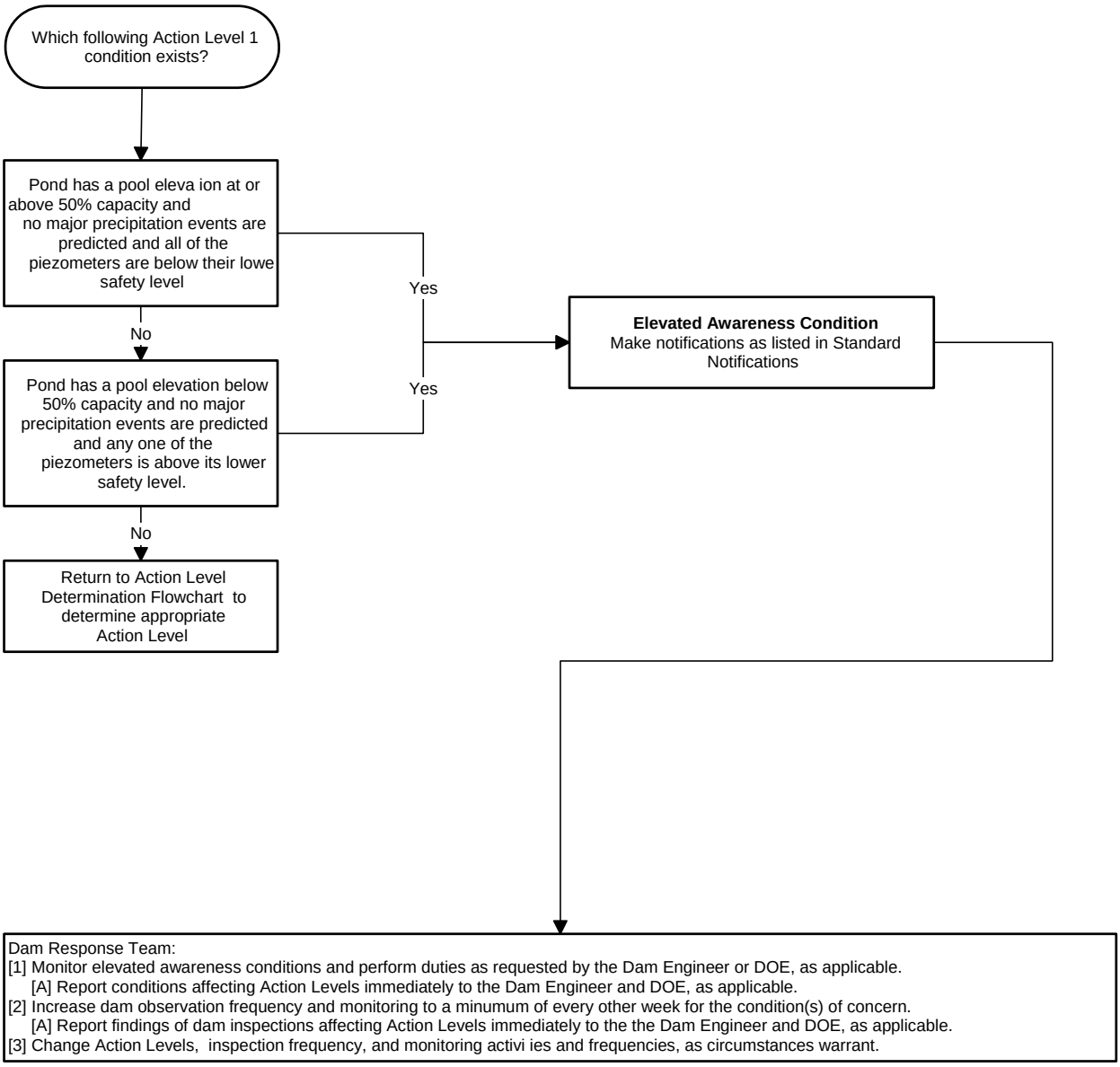
Dam Response Team:
[1] Coordinate with other members of the Dam Response Team and ensure assessment/evaluation of the on-scene situation.
[2] Establish safety guidance for personnel collecting samples or working on or below the dam.
[3] Monitor elevated awareness conditions and perform duties as requested by the Dam Engineer or DOE as applicable.
  [A] Report conditions affecting Action Levels immediately to the Dam Engineer and DOE as applicable.
[4] Implement "Emergency Actions" listed in Appendix G, as appropriate.
[5] Establish emergency discharge rates hrough the outlet or pumping station at a rate of approximately one foot of drawdown per day,.
  [A] Utilize computer modeling to calculate the flow rates necessary to meet the one foot/day drawdown rate.
  [B] Set pumps or outlet valves to calculated flowrates for the duration of the event or until revised flowrates are calculated.
[6] Provide and operate pumps and associated materials, or operate outlet valves, as required for pond transfers and/or discharges.
  [A] Begin discharge or transfer with acceptable sample results.
[7] Coordinate with off-Site agency field monitoring response teams.
[8] Increase dam observation frequency and monitoring to a minimum of every three days for the condition(s) of concern.
  [A] Report findings of dam inspections affecting Action Levels immediately to the Dam Engineer and DOE, as applicable.
[9] Implement environmental sampling as required in accordance with Appendix L, Environmental Water and Sediment/Soil Sampling, as required.
[10] Gather and evaluate engineering inspection data, meteorological data, piezometer readings and assessment information.
  [A] Evaluate conditions relative to failure modes listed in Appendix E in conjunction with the Dam Engineer and Consulting Engineer (if necessary).
  [B] Coordinate on-Site inspection by the State Engineer's Office to assess the situation and provide recommendations, as appropriate
[11] Change Action Levels, drawdown rates (if approved by the Dam Engineer), inspection frequency, and monitoring activities and frequencies, as circumstances warrant.

Action Level 2 Response

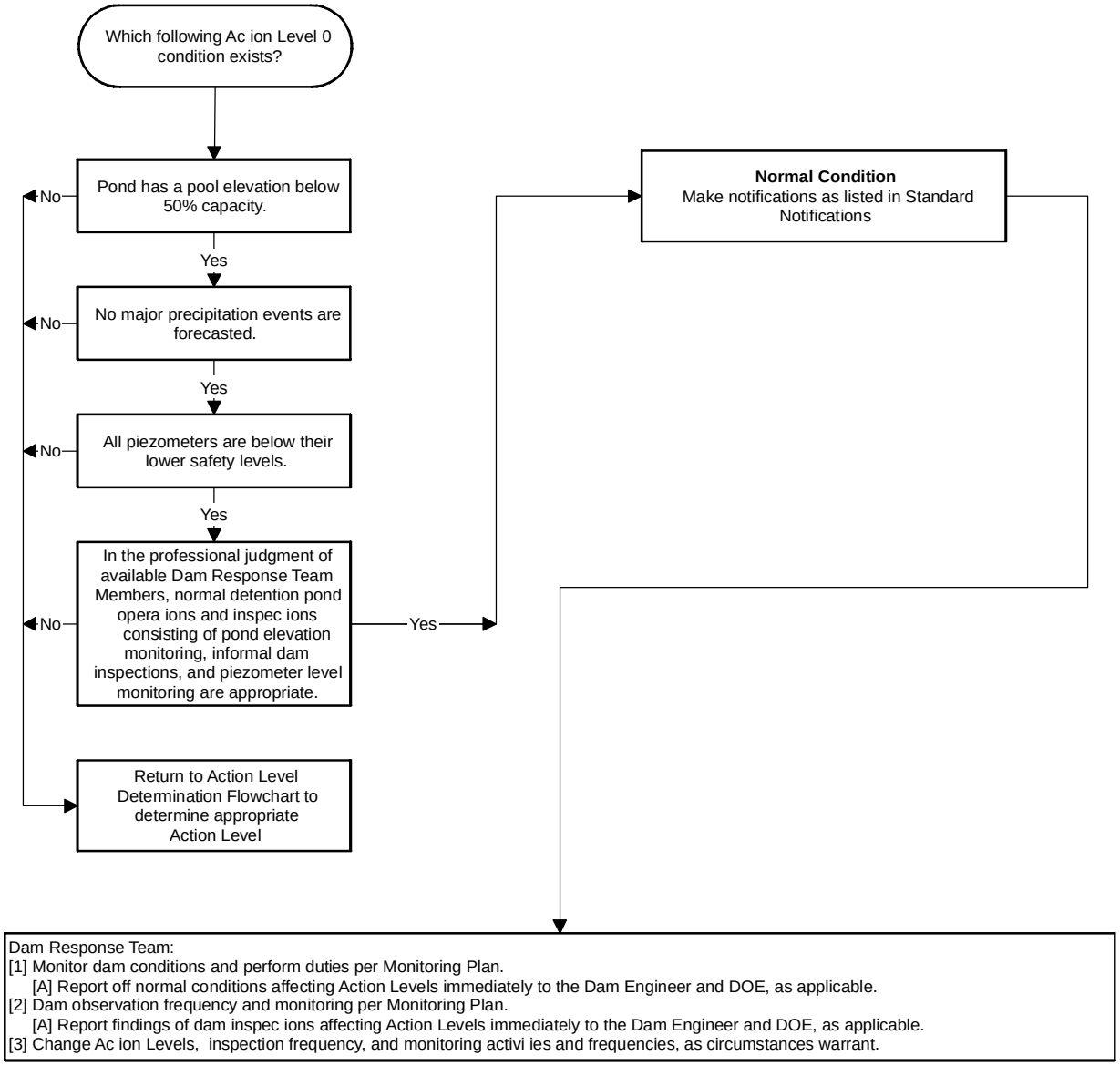


Dam Response Team:
[1] Monitor elevated awareness conditions and perform duties as requested by the Dam Engineer, or DOE, as applicable.
[A] Report conditions affecting Action Levels immediately to the Dam Engineer and DOE, as applicable.
[2] Identify pumps and associated materials, or outlet valves, required for pond transfers and/or discharges.
[3] Implement "Emergency Actions" listed in Appendix G, as
[4] Increase dam observation frequency and monitoring to a minumum of once per week for the condi ion(s) of concern.
[A] Report findings of dam inspections affecting Action Levels immediately to the the Dam Engineer, and DOE, as applicable.
[5] Implement environmental sampling as required in accordance wi h Appendix L, Environmental Water and Sediment/Soil Sampling, as required.
[6] Gather and evaluate engineering inspection data, meteorological data, piezometer readings and assessment information.
[A] Evaluate conditions relative to failure modes listed in Appendix E in conjunction with the Dam
[7] Change Action Levels, inspection frequency, and monitoring activities and frequencies, as circumstances warrant.

Action Level 1 Response



Action Level 0 Response Flowchart



Dam Response Team:
[1] Monitor dam conditions and perform duties per Monitoring Plan.
[A] Report off normal conditions affecting Action Levels immediately to the Dam Engineer and DOE, as applicable.
[2] Dam observation frequency and monitoring per Monitoring Plan.
[A] Report findings of dam inspec ions affecting Action Levels immediately to the Dam Engineer and DOE, as applicable.
[3] Change Ac ion Levels, inspection frequency, and monitoring activi ies and frequencies, as circumstances warrant.

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Appendix G

Potential Problems and Emergency Actions

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Potential Problems and Emergency Actions

The following are emergency actions that should be performed immediately for several problems that are considered to be serious and can affect the safety of dam. The recommended actions are potential solutions to emergency conditions that can be used to prevent the breaching of a dam. Perform these actions only when it is safe to do so.

Backcutting of the Spillway

1. Lower the water level by opening the outlet (and/or pumping). Continue to lower the reservoir until the State Engineer's personnel (SEO), or the dam engineer, determines that the conditions are safe.
2. Provide emergency protection at the eroding surface by placing plastic sheeting, riprap, or other erosion-resistant materials.
3. Mark where the spillway erosion is occurring. Monitor the rate of erosion (backcutting), and rate of flows from the spillway and outlets.

Cracking

1. Lower the water level by opening the outlet (and/or pumping). Continue until the water is below the cracking or as advised by the SEO or the dam engineer.
2. Attempt to block water movement into cracks by placing plastic sheeting over them.
3. Mark the extent of cracking with adequate stakes in order to monitor any increase or change in pattern. Document the observations.

Outlet Failure

1. Close the outlet gate to protect the embankment from washing out (piping).
2. Lower the water level by pumping, siphoning, or digging out a temporary spillway at the abutments. The temporary spillway should be located in an erosion-resistant material and/or at a flat slope to control the discharge velocities.
3. Monitor the outlet/embankment for settlement, occurrence of sinkholes, and muddy leakage. Observe outlet discharge for changes in flow (quantities). Document observations.

Overtopping

1. Open the outlet works completely to reduce overflow.
2. Divert inflow to the reservoir if possible.
3. Increase freeboard by placing sandbags, or other materials that will not wash away, on the crest of the dam.
4. Provide erosion protection for the crest and downstream slope using plastic sheeting and/or riprap.

5. Increase outflow by constructing temporary spillway at abutments. The spillway should be located in an erosion-resistant material and/or at a flat slope to control the discharge velocities.
6. Monitor the depth, duration, and location of overtopping. Watch for erosion, backcutting, and slides. Document the observations.

Piping

1. If the piping is not related to a problem with the outlet works, open the outlet to its safe capacity to drawdown the reservoir. Divert inflow to the reservoir if possible. Increase outflow by constructing a temporary spillway at the abutments. The spillway should be located in erosion-resistant material and/or at a flat slope to control the discharge velocities.
2. If the entrance to the leak can be found in the reservoir (whirlpool), on the embankment or abutments (sinkhole), try to plug it with whatever materials are available, such as plastic sheeting, hay bales, mattresses, etc.
3. Construct a reverse filter (large rock to finer material) over the exit area to trap fine materials from washing out the embankment.
4. Monitor the leakage/piping conditions. Measure the rate of leakage and the clarity of the water (muddy looking). Document the observations.

Saturation of the Embankment/Abutments (Seepage)

1. Lower the reservoir with the outlet works to a level determined by the dam engineer and/or approved by the SEO.
2. Monitor the conditions frequently for leakage, piping, cracking, and slides. Document the observations.

Settlement of Embankment

1. Determine whether the settlement is related to piping. If it is, see **Piping**.
2. Survey the existing monuments to determine the amount and rate of settlement. Install measurement points if necessary. Document the observations.
3. If the settlement is greater than 1 foot, lower the reservoir with the outlet works to a level determined by the dam engineer and approved by the SEO.

Sinkhole

A sinkhole is an indication of piping. See **Piping**.

Slides

1. Lower the reservoir with the outlet works to a level determined by the dam engineer and/or approved by the SEO. If the slide is on the upstream slope, consult with the dam engineer on the safe rate of drawdown.
2. If the outlet works is blocked/damaged by the slide, lower the reservoir using pumps, siphons, or construct temporary spillways at the abutments. See **Outlet Failure**.

3. Stabilize the toe of the slide (downstream slope) by constructing a berm with additional soil and rock. If there is significant leakage (muddy), construct a reverse filter. See **Piping**.
4. Monitor settlement, rate of movement, and extent of slide. See **Settlement of Embankment**. Document observations.

Wave Erosion of Embankment

1. Lower the reservoir at a safe rate with the outlet works to a level below the damaged area.
2. Restore any freeboard that may be lost using sandbags.
3. Place suitable-sized riprap on the damaged area in an emergency by whatever means necessary (dumping) to stop erosion.

Mark the damaged areas with stakes and monitor the situation. Document the observations.

Piezometer Levels

Piezometer levels are an indicator of the level of saturation of the dam embankment. See **Saturation of the Embankment/Abutments**.

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Appendix H

Emergency Notifications Flow Chart

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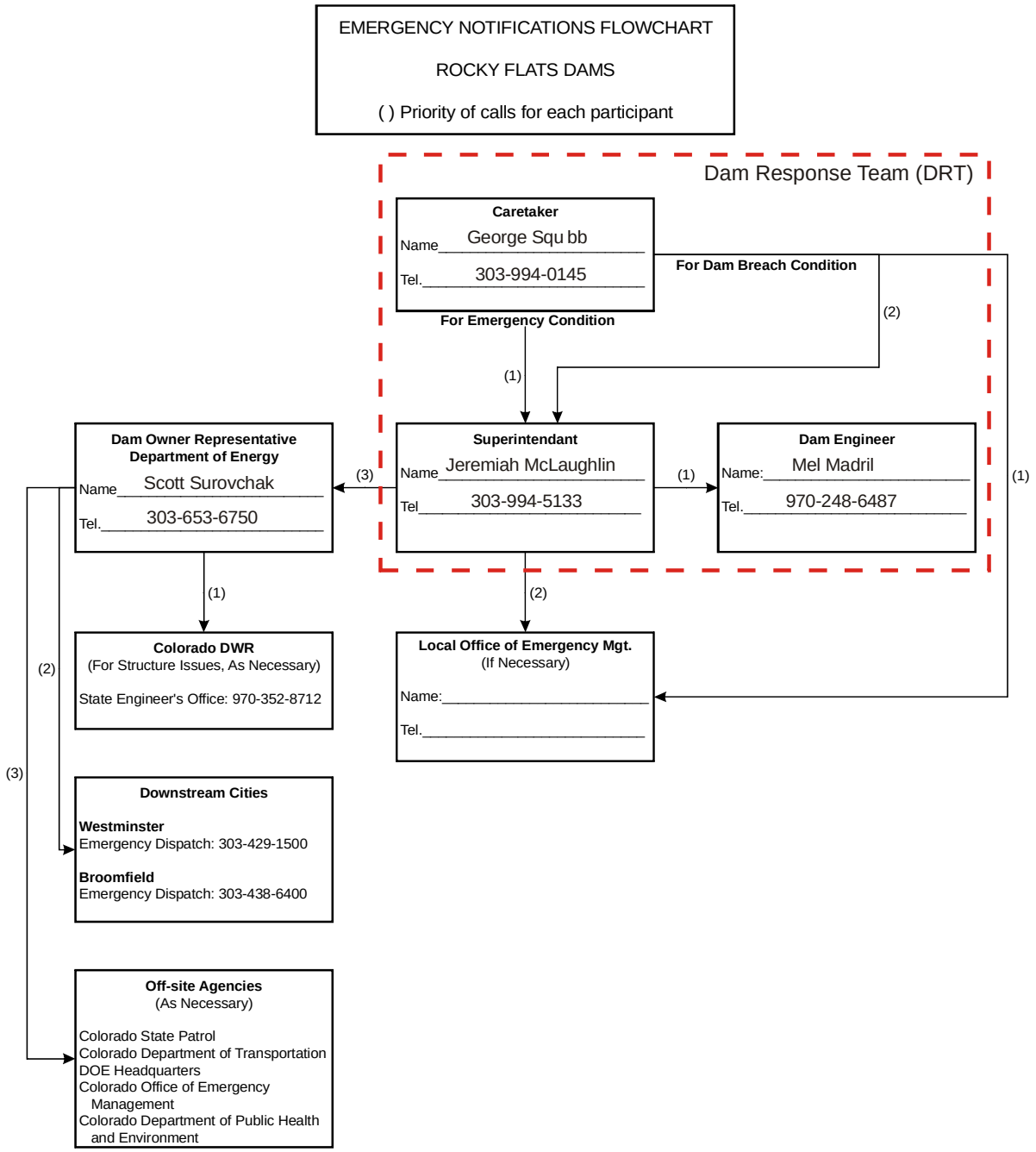
Emergency Notifications Flow Chart



Note: Flow chart indicates minimum notifications that should be made and ideal persons to make notifications. Failure to reach personnel shown as responsible for making required notification does not eliminate necessity for making notification. In such case, respons bility for making notifications should be delegated to other personnel.

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Appendix I

Contacts Directory and Standard Notifications

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Table I−1. Contacts Directory and Standard Notifications

Department/ Agency	Contact Name	Contact Numbers	Email and/or address
Stoller Legacy Management	George Squibb	(W) 720-377-9675 (M) 303-994-0145 (H) [redacted] (Fax) 720-377-3829	george.squibb@gjo.doe.gov
Stoller Legacy Management	Jeremiah McLaughlin	(W) 720-377-9676 (M) 303-994-5133 (H) [redacted] (Fax) 720-377-3829	jeremiah.mclaughlin@gjo.doe.gov
Site Dam Engineer Stoller Legacy Management	Mel Madril	(W) 970-248-6487 (H) (Fax)	mel.madril@gjo.doe.gov
U.S. Department of Energy	Scott Surovchak	(W) 720-377-9682 (M) 303-653-6750 (Fax) 720-377-3829	scott.surovchak@lm.doe.gov

Contractors	Contact Name	Contact Numbers	Email and/or address
Engineering		(W) (H) (Fax)	
Construction		(W) (H) (Fax)	
Diving		(W) (H) (Fax)	

Off-Site Agencies	Contact Name	Contact Numbers	Email and/or address
City of Broomfield	Public Works	(W) 303-438-6360 (H) (Fax)	
City of Westminster	Public Works	(W) 303-430-2400 (H) (Fax)	
Colorado Department of Public Health and Environment	Carl Spreng	(W) 303-692-3358 (H) (Fax) 303-759-5355	carl.spreng@state.co.us
Office of State Engineer	Mike Hammer	(W) 970-352-8712 (H) (Fax) 970-892-1816	
Jefferson County	Mark Gutke	(W) (H) (Fax) 303-271-4905	
U.S. Environmental Protection Agency	Vera Moritz	(W) 303-312-6981 (H) (Fax) 303-312-6067	moritz.vera@epa.gov
Division of Wildlife	Thomas Nesler	(W) 303-291-7461 (H) (Fax) 303-291-7114	tom.nesler@state.co.us
Rocky Flats Stewardship Council	Rik Getty	(W) (H) (Fax) 303-412-1211	rgetty@rfclog.org

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Appendix J

Inundation Map

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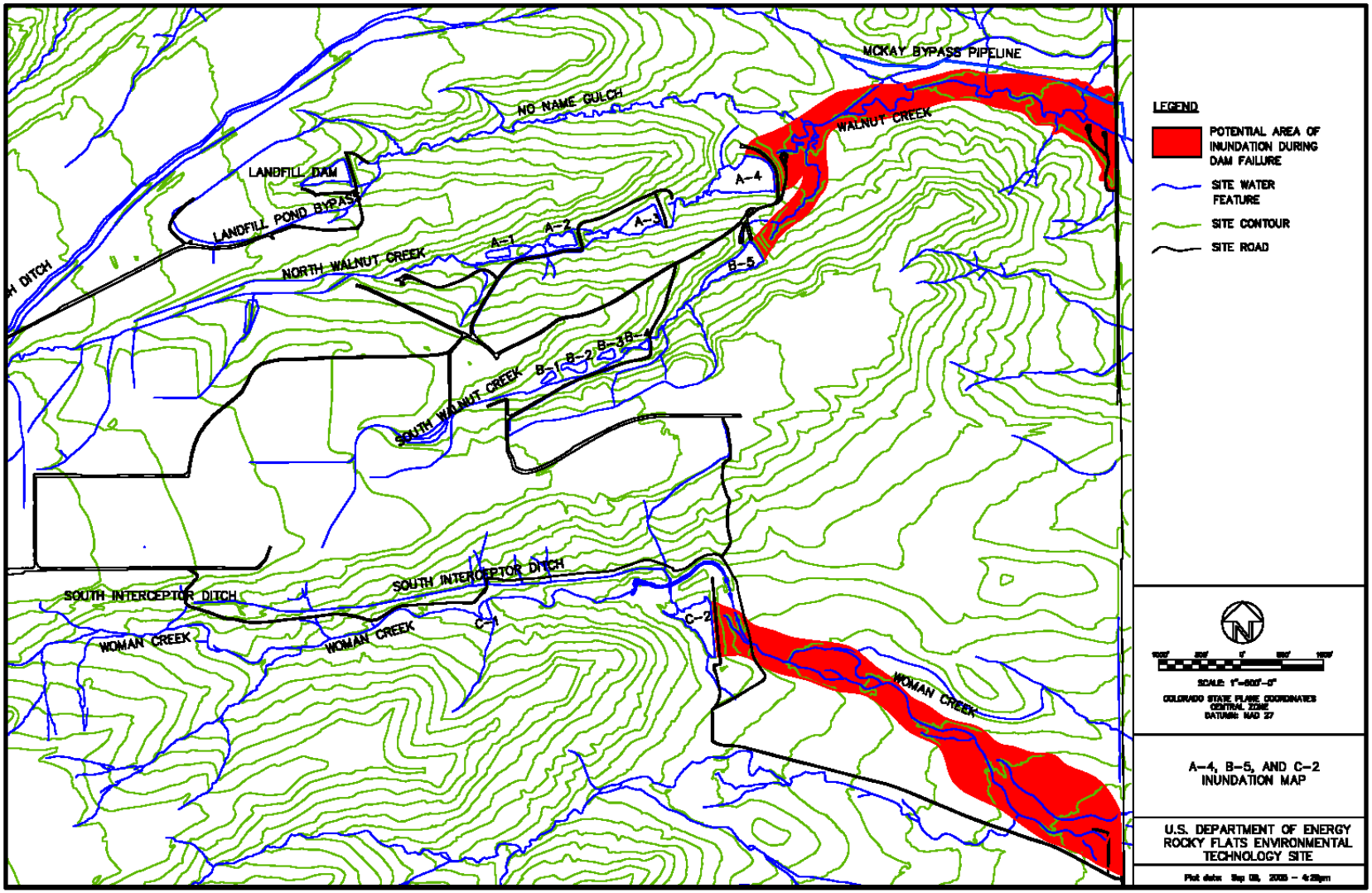

Figure J−1. Inundation Map for A-4, B-5, and C-2

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Appendix K

Schematic for Current Flow and Water Transfer Network at Rocky Flats

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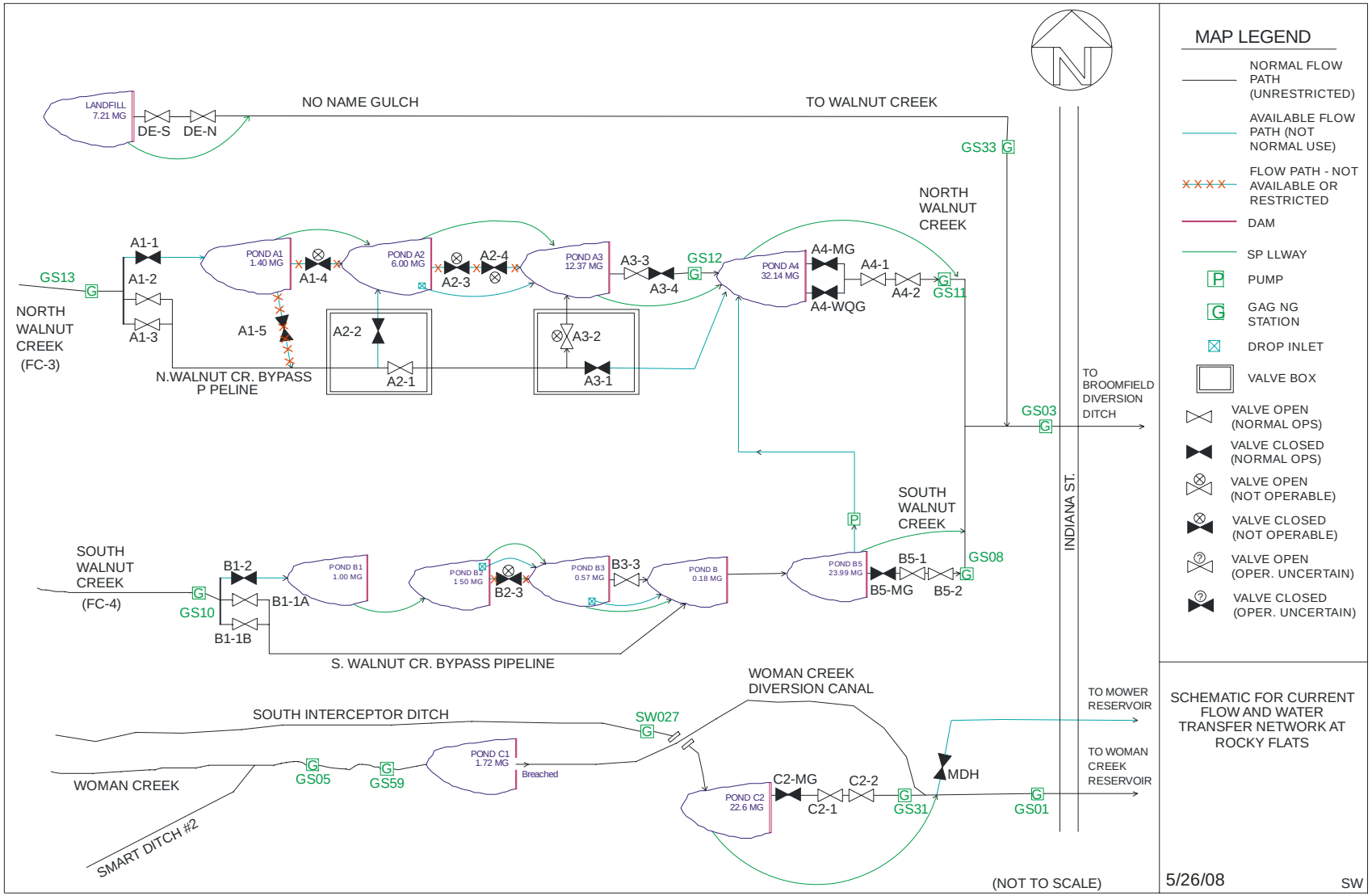

Figure K–1. Schematic for Current Flow and Water Transfer Network

Table K-1. Dam Drawings

The table below lists the drawings pertaining to the configuration of the dams that are not included in this document.

Series#	Numbers	Date	Description
24961	1 - 16	1972	Original Design Drawings for A-1, A-2, B-1, B-2, B-3, B-4, C-1
27038	1 - 10	1974	Original Design Drawings for A-3
27318	1 - 6	1974	Original Design Drawings for the Landfill Dam
27165	210 - 216	1978	Original Design Drawings for A-4
27165	220 - 225	1978	Original Design Drawings for B-5
27165	230 - 236	1978	Original Design Drawings for C-2
28895	001 - 016	1984	B-5 slope repair and modifications
39873	001 - 021	1997	Capacity study and topography
50320	0100 - 0102	1992	B-1 Rehabilitation
51043	100 - 101	1994	B-2 and B-4 Toe Blankets
51505	0001 - 0004	2000	A-1 and B-2 outlet modifications
51420	0001 - 0011	1996	A-4 outlet modifications
51420	0021 - 0030	1998	B-5 outlet modifications
51784	0101 - 0105	2004	C-1 stop log installation and outlet removal
51420	0051 - 0056	2005	C-2 outlet modifications

Appendix L

Environmental Water
and
Sediment/Soil Sampling

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Environmental Water and Sediment/Soil Sampling

Water samples may be collected at the initiation of or during an unplanned release or emergency discharge (see table below). In some instances, pre-discharge sample collection may have occurred prior to the declaration of a new action level, and the initiation of an unplanned release or emergency discharge. The intent is to conduct sampling as required by the Rocky Flats Legacy Management Agreement, provided that sampling activities can be conducted safely. If the unplanned release includes pond sediments or soils, analysis of these materials may be performed for the items listed in the following table:

Water Samples		**Soil and Sediment Samples**		
Water Quality Parameters		**Radiochemical Parameters (Total)**		
Nitrate + Nitrite as N		Americium-241		
		Plutonium-239,240		
		Uranium-233,234		
		Uranium-235		
Radiochemical Parameters (Total)		Uranium-238		
Americium-241				
Plutonium-239,240				
Uranium-233,234				
Uranium-235				
Uranium-238				

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Formerly DOE-LM/1483-2007

Operations and Maintenance Manual for the Rocky Flats Groundwater Treatment Systems

U.S. Department of Energy

Office of Legacy Management

Work Performed Under DOE Contract No. DE–AM01–07LM00060
for the U.S. Department of Energy Office of Legacy Management.
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U.S. Department of Energy
Office of Legacy Management

Operations and Maintenance Manual for the Rocky Flats Groundwater Treatment Systems

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Appendix C Solar Ponds Plume Treatment System Manufacturer Operation and Maintenance Information
Appendix D Zero-Valent Iron Specifications
Appendix E Photographs of Media Replacement Activities
Appendix F Monthly Inspection Log for Rocky Flats Groundwater Treatment Systems

Acronyms and Abbreviations

DOE	U.S. Department of Energy
ETPTS	East Trenches Plume Treatment System
FC	Functional Channel
ft	foot
ft^2	square foot
ft^3	cubic foot
gpm	gallons per minute
GWIS	groundwater intercept system
HDPE	high-density polyethylene
IHSS	Individual Hazardous Substance Site
LED	light emitting diode
M&M	Monitoring and Maintenance
MSPTS	Mound Site Plume Treatment System
O&M	operations and maintenance
PLF	Present Landfill
PLFTS	Present Landfill Treatment System
PPE	personal protective equipment
PVC	polyvinyl chloride
PZ	piezometer
RFS	Rocky Flats Site
Site	Rocky Flats Site
SPP	Solar Ponds Plume
SPPTS	Solar Ponds Plume Treatment System
VOC	volatile organic compound
ZVI	zero-valent iron

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1.0 Purpose

This operations and maintenance (O&M) manual describes the routine O&M of four groundwater treatment systems at the Rocky Flats Site (RFS). These facilities include the Mound Site Plume Treatment System (MSPTS), East Trenches Plume Treatment System (ETPTS), Solar Ponds Plume (SPP) Treatment System (SPPTS), and Present Landfill (PLF) Treatment System (PLFTS). The locations of these systems are shown on Figure 1.

2.0 Scope and Applicability

This document contains instructions for the O&M of the MSPTS, ETPTS, SPPTS, and PLFTS and applies to personnel performing work on these systems. This includes routine maintenance, from visual inspections to raking media to replacing treatment media (at the first three systems listed above) and other activities that constitute this type of maintenance. This document does not include system replacement, removal, abandonment, significant changes to the design or intent of the systems, and maintenance of the groundwater intercept trenches (since they typically require no maintenance).

The groundwater treatment systems at the Site are designed to treat contaminated groundwater containing volatile organic compounds (VOCs) or elevated nitrates and uranium.

The MSPTS, ETPTS, and SPPTS consist of a groundwater collection trench with a collection sump that feeds intercepted groundwater to the treatment cells. Under normal operations, the treatment cells are configured so that water flows through the cells in series for treatment and then to the metering manholes for release to an infiltration or exfiltration gallery. Because of their similarities, the MSPTS, ETPTS, and SPPTS are collectively referred to herein as simply the “three similar systems.”

The PLFTS consists of a manhole that collects water that issues from a seep at the east face of the PLF and from the north and south segments of the groundwater intercept system (GWIS) and an engineered riffle structure that aerates the water to volatilize VOCs. Treated water then flows to the Landfill Pond.

Several appendices are included to provide supporting information. Appendix A contains the Job Safety Analysis for routine inspection and maintenance operations at the treatment systems. Appendix B provides as-built drawings of the groundwater treatment systems. Appendix C contains manufacturers’ operation, maintenance, and specification information for the SPPTS solar-powered pump system. Appendix D includes specifications on the zero-valent iron (ZVI) used in the treatment cells. Appendix E contains a selection of photographs of media replacement activities. Appendix F contains the monthly inspection log used to document routine treatment system maintenance.

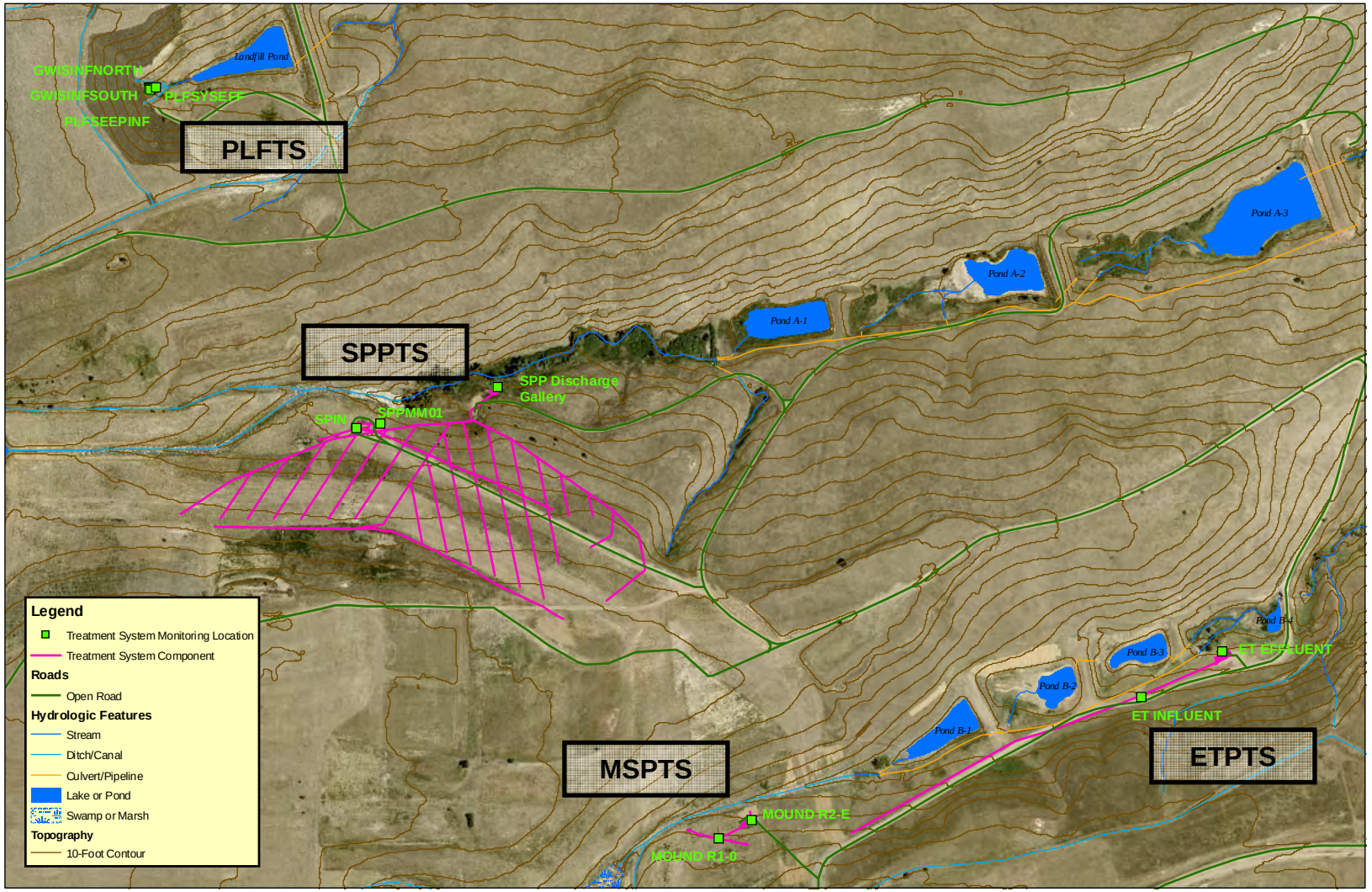


Figure 1. General Locations of Groundwater Treatment Systems at RFS

3.0 Routine Surveillance and Maintenance

Routine surveillance and maintenance of the four groundwater treatment systems at the site shall be performed as described in Table 1. Routine operations shall be fully documented as soon as possible in the Monthly Inspection Log (Appendix F) and the Rocky Flats maintenance log on the Condor server (\\Condor\Projects\ESL\VDV\SOARS\User Files\Activity Logs).

Table 1. Routine Surveillance and Maintenance of RFS Treatment Systems and Instrument Vaults

Activity	Frequency[a]	MSPTS	ETPTS	SPPTS	PLFTS
Check water levels in treatment cells and collection sump (Section 3.1 or 3.9.1)	Weekly	✔	✔	✔	
Check manhole flow rates/flow meter flume (Section 3.2)	Weekly	✔	✔	✔	
Calibrate manhole flow meter/clear flow meter flume (Section 3.2)	Monthly	✔	✔	✔	
Check valves and piping (Section 3.3)	Biannually	✔	✔	✔	
Clean influent lines (Section 3.10)	Annually				✔
Clean effluent lines (Sections 3.3.1 and 3.10)	Annually	✔	✔		✔
Conduct routine raking/puncturing of pea gravel/iron mixture (Section 3.4)	Weekly	✔	✔		
Replace treatment media (Sections 3.6 and 3.9.6)	As necessary	✔	✔	✔	
Check solar pump, panels, and charging system (Section 3.9.4)	Weekly			✔	
Check voltages and currents on solar system (Section 3.9.4)	Semiannually			✔	
Check flow rates in instrumentation vault (Section 3.7)	Weekly	✔	✔		
Check and clean filters in instrumentation vault (Section 3.7)	Weekly	✔	✔		
Check data transmission (Section 3.7)	Weekly	✔	✔	✔	
Check and document instrument calibration (Section 3.7)	As necessary	✔	✔	✔	
Check automated data output for indications of abnormal behavior (Section 3.7)	Weekly	✔	✔	✔	
Adjust flow rates based on automated data (Section 3.7)	As necessary	✔	✔		

[a]Listed frequency is minimum requirement. If inspection indicates more frequent action is appropriate, increase frequency accordingly.

For the three similar systems, the effectiveness of the treatment cells is strongly influenced by the permeability of the media. At the MSPTS and ETPTS, this is adversely affected by the high dissolved oxygen content that is typical of Rocky Flats groundwater (which causes the ZVI to oxidize, binding it and rendering it essentially useless) and the dissolved ions in the groundwater (particularly calcium and carbonate, which result in calcium carbonate and iron carbonate precipitates). The sawdust media in the SPPTS does not appear to be significantly affected by the oxidizing groundwater nor the dissolved ions entering this system.

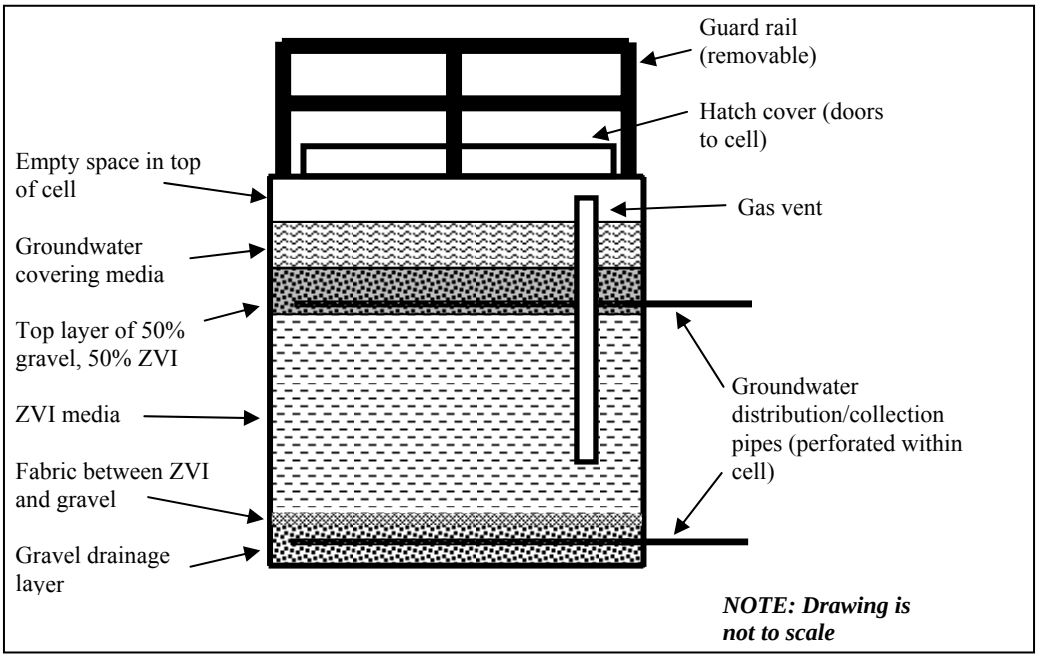
When operating in a downflow configuration, the groundwater flowing through the MSPTS and ETPTS treatment cells can cause surface crusting that periodically must be broken up to ensure an even flow across the entire surface of the treatment cell. (Crusting may also occur when these

systems are operating in the upflow configuration; however, the crust is not accessible and cannot be broken up during routine maintenance activities.)

At the SPPTS, proper system operation and required treatment of the groundwater depends on the use of an energized pump. Therefore, each of the three similar systems must be routinely inspected and maintained to ensure proper operation and continued groundwater treatment.

Additionally, the MSPTS and ETPTS are supported by automated instrumentation that monitors such parameters as flow rate and water pressure, among others. These instruments are located in a vault adjacent to the treatment cells and must be checked, and in some cases maintained, periodically. The PLFTS is a simpler system that requires less in the way of maintenance.

Figure 2 provides a conceptual cross-section of a treatment cell at the MSPTS or ETPTS. Cells at the SPPTS are similar, with several differences as described in the notes to this figure.



Notes: This representation is conceptual only. See Appendix B for as-built drawings.
Groundwater enters from the collection trench or from the other cell (not shown). In upflow configuration, the lower pipe is the distribution pipe, and the upper pipe is the collection pipe; the opposite is true in downflow configuration.
At the SPPTS, the medium in Cell 1 is sawdust with ZVI, and in Cell 2 is gravel with ZVI; these media are buried under approximately 12 ft of wood chips and soil overburden. The plumbing also differs somewhat, although the concepts are the same; see Appendix B.

Figure 2. Schematic of a Treatment Cell at the ETPTS or MSPTS

Table 2 presents typical ranges (following site closure in October 2005) for water levels in the treatment cells for the systems and anticipated flow rates for normal operations. Flow rates for pre-closure conditions are not included, because the volume and distribution of groundwater was strongly controlled by the presence of leaky utilities, impermeable surfaces (buildings, parking lots, roads, etc.), and, as closure progressed, the addition of dust-suppression water. These perturbations of the hydrologic system will continue to impact it for some time, potentially

several years. In addition, closure efforts included routing subsurface flow from a utility corridor immediately west of the MSPTS (draining former Oil Burn Pit No. 2, i.e., Individual Hazardous Substance Site [IHSS] 153) into the MSPTS intercept trench, increasing flow rates and contaminant concentrations at that system relative to those typical of the first 7 years of MSPTS operation.

Table 2. Typical Operating Ranges (Rounded) for Flow Rate and Depth to Water in Treatment Cells

Operating Parameters	Minimum	Maximum
Treatment System Flow Rate (gpm)		
MSPTS	0	2.3
ETPTS	0	2.5
SPPTS[a]	0	5.0
PLFTS	N/A	N/A
Depth to Water in Treatment Cells (in feet from the treatment cell doors)[b]		
MSPTS	1.5	4.5
ETPTS	0.8	2.7
SPPTS	N/A	N/A
PLFTS	N/A	N/A

[a]The SPPTS pump does not operate continuously; flow rate oscillates between these two values several times per hour.
[b]The SPPTS and PLFTS are not equipped with treatment cell doors. Water level measurement is not applicable at the PLFTS, and is not routinely performed at the SPPTS.
gpm = gallons per minute
N/A = not available (not measured or not applicable to the corresponding system)

Each of the treatment systems may show higher flow rates than those shown above if a recent heavy precipitation event occurred. The flow rates and water levels listed in Table 2 are based on data collected through mid-2008 and reflect varying conditions. These values are provided only as a general observation; while values outside of these ranges are usually cause for significant concern and require closer examination, values falling within these ranges do not necessarily signify proper treatment system functioning. Sudden changes observed in any of the above parameters will require closer examination of both the treatment system and the automated data in order to determine the cause.

Flow rates at the flume in the three similar systems may be artificially increased if the flow meter flume is obstructed; such obstructions shall be removed at least monthly. Reported flow rates must be corrected for systematic errors that may be discovered (such as obstructions in the flume). Water levels above those listed may indicate flow through the treatment media is obstructed, potentially requiring that the media be replaced. High water levels may also be a natural, temporary response to precipitation events or can be an indication of fouling in the effluent plumbing.

3.1 Monitoring Water Levels at MSPTS and ETPTS

Water levels are manually measured at the MSPTS and ETPTS on a weekly basis. These manual water level measurements are then compared to the automated water level data to determine if

instrument recalibration is necessary. Instructions for collecting water levels in the treatment cells and collection trench sumps are presented below.

3.1.1 Monitoring Water Levels in Treatment Cells

The following steps shall be taken to measure water levels in the MSPTS and ETPTS treatment cells. These steps do not require entry into the treatment cells.

[1] Open the doors on the treatment cells and allow to ventilate for approximately 5 minutes.

[2] Using a measuring tape or similar calibrated measuring device, measure the water level in each treatment cell. Always measure from the mark on the middle of the left door on the south side of the cell doors. Measure to the nearest 0.01 foot (ft) and document the result.

[3] Close and lock the doors on the treatment cells.

Note **It is important to limit the amount of air entering the system, because the addition of fresh air can contribute to oxidation of the ZVI media. Although the cell doors are not airtight, proper closure can help limit oxygen in the cells. Therefore, after completion of maintenance, make sure cell doors are completely closed and that the system is isolated from outside air. The doors overlap. Close the door with the overlap on the bottom edge first, before closing the second door. There should not be a gap.**

[4] Document routine operations in the Monthly Inspection Log (Appendix F) and the Rocky Flats maintenance log on the Condor server.

[5] Compare measured water level to automated water level data for the same time to check for instrument drift. If necessary, remove transducer, recalibrate, and reinstall.

3.1.2 Monitoring Water Levels in Collection Trench Sumps

The following steps shall be taken to measure water levels in the MSPTS and ETPTS collection trench sumps. These steps do not require entry into the sumps.

MSPTS

The collection trench sump for the MSPTS is located within a trench approximately 30 yards west of the system (Mound R1-0 on Figure 1). The sump cover can remain in place while water level is being measured.

[1] Using a measuring tape or similar calibrated measuring device, measure the water level in the collection trench sump. The measuring device should be lowered through the hole in the middle of the sump cover and the measurement taken from the edge of the hole. Measure to the nearest 0.01 ft and document the result.

Note **DO NOT stand or lean on the cover of the collection trench sump. Doing so can dislodge the cover and create a fall hazard.**

[2] Document routine operations in the Monthly Inspection Log (Appendix F) and the Rocky Flats maintenance log on the Condor server.

[3] Compare measured water level to automated water level data for the same time to check for instrument drift. If necessary, remove transducer, recalibrate, and reinstall.

ETPTS

The collection trench sump for the ETPTS is located along the road and approximately 100 yards west of the system (ET INFLUENT on Figure 1).

[1] Open the door on the sump and allow to ventilate for approximately 5 minutes.

[2] Using a measuring tape or similar calibrated measuring device, measure the water level in the collection trench sump. Always measure from the mark on the northern edge of the sump casing. Measure to the nearest 0.01 ft and document the result.

[3] Close and lock the sump cover.

[4] Document routine operations in the Monthly Inspection Log (Appendix F) and the Rocky Flats maintenance log on the Condor server.

[5] Compare measured water level to automated water level data for the same time to check for instrument drift. If necessary, remove transducer, recalibrate, and reinstall.

3.2 Inspection and Maintenance of Manhole Flow Meters and Flumes

The effluent manhole flow meters on all three similar systems shall be calibrated at a frequency and in the manner described by the associated instruction manuals. The associated flumes shall be inspected on a weekly basis (simple visual check, no entry required) and cleared of any debris. The PLFTS is not equipped with a flow meter or flume. The frequency for flume inspection and maintenance is listed in Table 1.

The following steps shall be taken for flow meter and flume inspection and maintenance. These steps may not require entry into the treatment cells. If entry is required, the proper equipment, training, personnel, and paperwork for entry must be ensured, as these are permit-required confined spaces.

When entry is required, a minimum of two individuals are needed (one full-time attendant and one entrant). The attendant cannot perform ANY duties other than acting as attendant. Therefore, three individuals are more commonly used, so that the attendant may act as full-time attendant for the entrant, and the third person can inspect the flow meter, perform documentation, trigger a purge of the bubbler line, and perform other miscellaneous activities that the attendant is barred from performing because of the full-time requirement of being the attendant.

3.2.1 Remote Maintenance

Minor flume maintenance can be performed remotely without entering the metering manhole. This maintenance is limited to clearing larger obstructions from the flume and performing general inspections. More thorough inspections and maintenance, including clearing the flow meter bubbler line and scrubbing out the flume, should not be performed remotely.

[1] Open the cover on the metering manhole and allow to ventilate for a minimum of 5 minutes.

Note **Poor air quality within the metering manholes is common. At the ETPTS, this often includes elevated levels of carbon monoxide. At the SPPTS, this may include insufficient oxygen.**

[2] Inspect the condition of the flume from the outside of the metering manhole.

[3] Gently remove any obstructions in the flume using a wooden pole or similar implement, taking care to prevent damage or potential dislocation of the flume, bubbler line, and other associated equipment.

[4] Close the cover on the metering manhole.

Note **It is very important to limit the amount of air entering the system. After completion of maintenance, make sure cell doors are completely closed and locked, and the system is isolated from outside air.**

[5] Document routine operations in the Monthly Inspection Log (Appendix F) and the Rocky Flats maintenance log on the Condor server.

IF the above actions cannot be performed satisfactorily without entry into the metering manhole, **THEN** enter the metering manhole as described in the following section.

3.2.2 Maintenance through Confined Space Entry

The following requirements shall be met for permit-required confined space entry. The metering manhole monitors treated groundwater; therefore, harmful gases are not expected to be present in the system. Elevated levels of carbon monoxide have been recorded in the past at these locations, primarily the ETPTS, and low levels of oxygen, particularly at the SPPTS. Therefore, monitoring the atmosphere prior to entry is required to verify that it is safe to enter.

[1] Open the cover on the metering manhole and allow it to ventilate for a minimum of 5 minutes. Using an appropriate multigas meter that has been freshly and properly calibrated, check the air quality within the manhole.

Note **Poor air quality within the metering manholes is common. At the ETPTS, this often includes elevated levels of carbon monoxide. At the SPPTS, there may be insufficient oxygen. Do not enter any metering manhole until acceptable air quality has been confirmed throughout, from the very top to the very bottom of the manhole.**

[2] Complete required confined space entry paperwork, properly don required safety equipment, and ensure attendant is appropriately trained. Attendant shall not perform any duty other than acting as confined space attendant.

IF work needs to be performed at the surface while the confined space entrant is in the manhole,
THEN a third individual needs to be present to perform this work. The attendant shall not perform any activity other than act as attendant throughout the confined space entry.

[3] Enter manhole using manufacturer's installed ladder.

Note **Continue to monitor air quality and confirm it remains acceptable throughout activities within the confined space. If air quality degrades, the entrant shall exit the manhole immediately.**

[4] Read water level on flume staff gage.

[5] Gently clean out flume and remove debris as necessary.

[6] Gently clear bubbler line and request flow meter inspector (third support individual other than attendant) to trigger a purge of the line.

[7] Confirm proper operation of all components. Repeat actions as necessary to achieve proper operation.

[8] Exit manhole and doff safety equipment.

[9] Close cover on the metering manhole.

Note **It is very important to limit the amount of air entering the system. After completion of maintenance, make sure cell doors are completely closed and locked, and the system is isolated from outside air.**

[10] Dispose of debris as sanitary waste.

[11] Document routine operations in the Monthly Inspection Log (Appendix F) and the Rocky Flats maintenance log on the Condor server.

IF obstruction persists,
THEN check for problems with valves and piping (Section 3.3).

3.3 Inspection of Valves and Piping

During normal operations, treatment cells shall be plumbed so that water flows through them in series. Normal valve positions are shown in Appendix B.

A valve key is provided at each treatment system for opening and closing these valves. Valves shall not be "exercised" routinely, as this may cause damage (such as internal scoring due to iron filings within the lines). Instead, valve changes will be made when necessary (i.e., to support media replacement, troubleshooting, or for other specific purposes).

Perform the following steps:

[1] Verify that valves are in the appropriate position for serial flow.

[2] Verify that water is flowing through the metering manhole.

[3] Verify that water is flowing out of the effluent piping.

[4] Assure all doors are closed and that outside air has no means to enter the system.

[5] Document routine operations in the Monthly Inspection Log (Appendix F) and the Rocky Flats maintenance log on the Condor server.

IF valves are not in the appropriate positions,
THEN immediately inform management. At management's direction, return valves to normal positions.

IF water is not flowing through metering manhole but water levels within the treatment cells indicate there should be flow,
THEN check for and clear obstructions as described in Section 3.2.

IF flow is not restored,
THEN immediately inform management.

IF water is not flowing through effluent pipeline but water levels within the treatment cells indicate there should be flow,
THEN check for and clear obstructions as described in Section 3.3.

IF flow is not restored,
THEN immediately inform management.

Note **During drought and low-flow periods, water may not be observed in the metering manhole or effluent piping. A lack of flow is normal in this case. After flow resumes, the valve and piping inspection should be performed.**

3.3.1 Clearing Effluent Piping (MSPTS and ETPTS)

The ETPTS and MSPTS effluent piping discharges to the respective hillsides below the metering manholes. At the MSPTS, the effluent discharge point is below ground in an exfiltration gallery and is accessed via a cleanout port. At the ETPTS, the effluent discharge point is at the surface. (Discharge from the SPPTS is at the SPP Discharge Gallery, which is inaccessible. Discharge from the PLFTS is accessible along its entire route, as it does not flow through any lengthy piping. These two systems are not addressed in this section.)

The effluent piping (and/or cleanout port, as applicable) may plug with iron bacteria or debris. This is cleared as follows.

Assemble the following tools and equipment as required:

- Clean water (e.g., distilled or deionized; suitable for disposal to ground);
- Shovel;
- Powered plumber's snake at least 50 ft long;
- Generator to power snake; and
- Freshly calibrated multigas meter.

Perform the following steps:

ETPTS

[1] Open doors to the metering manhole and allow to vent for a minimum of 5 minutes.

Note **Poor air quality within the metering manholes is common. At the ETPTS, this often includes elevated levels of carbon monoxide.**

[2] Move riprap around the ETPTS effluent piping outfall as necessary to provide clear access to the pipe opening.

[3] Clear any accumulated mud and/or debris from the ETPTS effluent piping outfall.

[4] Re-establish drainage away from the effluent piping outfall as necessary.

[5] Following the operator's manual for the plumber's snake, clear the line between the metering manhole and outfall.

Note **The line may be cleared from the manhole end or the outfall end.**
> If cleared from the outfall end, post a watch at the metering manhole to watch for and keep the plumber's snake from entering the flume and potentially damaging flow meter components.
> If cleared from the manhole end, follow confined space entry requirements.

[6] As the snake is retracted, rinse off and dispose of residue in place.

[7] Ensure all doors are closed and that system is isolated from outside air.

[8] Reconfigure riprap below outfall as necessary to minimize erosion.

[9] Document routine operations in the Monthly Inspection Log (Appendix F) and the Rocky Flats maintenance log on the Condor server.

MSPTS

The MSPTS configuration is slightly different than that of the ETPTS. At the MSPTS, the effluent flows through the metering manhole and then into a small, vertically oriented French drain. If infiltration is insufficient in this drain, it then flows to an exfiltration gallery (adjacent to Functional Channel [FC]-4) that is equipped with cleanout ports.

[1] Open doors to the metering manhole and remove lid from the small French drain manhole (located a few feet northeast of the metering manhole). Allow to vent for a minimum of 5 minutes.

Note **Block access to small French drain manhole (using cones, barricades, etc.) while it is open so that no one inadvertently steps into it.**

Note **Poor air quality within the manholes is common.**

Note **If entering the metering manhole, confined space entry requirements apply. The French drain manhole is considered too small for entry.**

[2] Remove caps on exfiltration gallery cleanout ports. Following the operator's manual for the plumber's snake, gently push the snake through to clear the port across its entire length. If possible, do not power the snake up.

Note **Use care when operating the plumber's snake. Do not aggressively force it through any line, especially if powered, as this may damage or destroy the polyvinyl chloride (PVC) construction.**

[3] Following the operator's manual for the plumber's snake, clear the line between the metering manhole and vertical French drain. Due to the short distance, this also may be accomplished without powering the snake. It may be possible to perform this task from ground surface, using a long-poled hook or other tool to guide the end of the snake into the drain opening and through the drain to its opening in the metering or French drain manhole.

[4] Following the operator's manual for the plumber's snake, clear the line between the small French drain manhole and the exfiltration gallery. It may be possible to perform this task from ground surface, using a long-poled hook or other tool to guide the end of the snake into the drain opening and along the length of the drain to the T-connection at the exfiltration gallery.

Note **Do not aggressively ram the plumber's snake against the end of the discharge line (the T-connection at the exfiltration gallery), especially if powered, as this may damage or destroy the PVC construction.**

[5] As the snake is retracted, rinse off and dispose of residue in place.

[6] Flush cleared lines with clean water.

[7] Assure all doors are closed, manhole lid is properly replaced, and that the system is isolated from outside air.

[8] Document routine operations in the Monthly Inspection Log (Appendix F) and the Rocky Flats maintenance log on the Condor server.

3.4 Routine Media Maintenance (MSPTS and ETPTS Only)

The following steps describe the basic treatment cell maintenance. These steps do not require entry into the treatment cells.

ETPTS

[1] Open the access doors and allow the treatment cell to ventilate for a minimum of 5 minutes.

[2] Inspect the condition of the media from above the treatment cell.

[3] Break up crust by raking surface as required with a long-handled rake, scaling bar, or equivalent tool. The gravel should also be punctured at least 10 to 15 times with a digging or scaling bar in different locations across the surface of the media (and in continuously differing locations, from visit to visit) to enhance media permeability and release trapped gases that might have accumulated in the media.

[4] If the ZVI surface is too hard to rake or break up, notify management.

[5] After breaking up any iron crust, regrade the media surface with the back of the rake or a similar tool. Ensure that all the media are submerged.

[6] Rinse tools with clean water and discharge the water to the treatment cell. Close the treatment cell doors.

Note **It is very important to keep air from entering the system. After completion of maintenance, make sure doors are completely closed and that the system is isolated from outside air. The doors overlap. Close the door with the overlap on the bottom edge first, before closing the second door. There should not be a gap.**

[7] Document routine operations in the Monthly Inspection Log (Appendix F) and the Rocky Flats maintenance log on the Condor server.

MSPTS

[1] Open the access doors and allow the treatment cell to ventilate for a minimum of 5 minutes.

[2] Inspect the condition of the gravel covering the media from above the treatment cell.

[3] Rake gravel/ZVI surface as required with a long-handled rake, scaling bar, or equivalent tool. Break up crust in underlying iron media by punctured at least 10 to 15 times with a digging or scaling bar in different locations across the surface of the media (and in continuously differing locations, from visit to visit) to enhance media permeability and release trapped gases that might have accumulated in the media.

[4] If ZVI is too hard to rake or break up, notify management.

[5] After breaking up any iron crust, regrade the gravel/iron media surface with the back of the rake or a similar tool. Ensure that all the media are submerged.

[6] Rinse tools with clean water and discharge the water to the treatment cell. Close the treatment cell doors.

Note **It is very important to keep air from entering the system. After completion of maintenance, make sure doors are completely closed and that the system is isolated from outside air. The doors overlap. Close the door with the overlap on the bottom edge first, before closing the second door. There should not be a gap.**

[7] Document routine operations in the Monthly Inspection Log (Appendix F) and the Rocky Flats maintenance log on the Condor server.

IF the above cannot be performed satisfactorily without entry into the treatment cells, **THEN** proceed to Section 3.5.

3.5 Routine Media Maintenance Requiring Treatment Cell Entry (MSPTS and ETPTS Only)

The following steps are maintenance activities that require entry into the treatment cells such as breaking up crust in the gravel and iron layers.

Note **If entry into any of the system components is necessary, permit-required confined space entry requirements apply.**

Respiratory hazards may exist in the treatment cells and/or metering manhole (e.g., hydrogen gas, hydrogen sulfide, carbon monoxide, ethane, methane, and/or low levels of oxygen). In addition, low concentrations of VOCs are likely in the water. These hazards shall be addressed prior to entry. Safety personnel may require use of a freshly calibrated photoionization detector, multigas meter, and/or combustible gas indicator for entry.

Assemble the following tools and equipment as required:

- Aluminum or fiberglass extension ladder with an extended length of at least 10 ft;
- Long-handled shovels;
- A pick or Pulaski tool;
- Standard garden cultivator rake, lute, or scaling bar;
- Air compressor and tools for breaking up crust if hand tools are not sufficient; and
- Additional safety equipment required for a confined space entry.

Perform the following steps after securing necessary personnel and permits for confined space entry:

[1] Open the access doors and allow the treatment cell to ventilate for a minimum of 5 minutes.

[2] Measure and record depths to the top of the water and top of the media.

[3] Place the ladder into the treatment cell and tie it off securely.

[4] Enter treatment cell.

[5] Rake any gravel overlayer to the side to expose surface of iron media.

[6] Inspect media for formation and accumulation of precipitates and iron crust.

[7] Break up iron crust and disposition as directed by management. (In most cases, the crust will remain in the cell.) The gravel should also be punctured across the entire surface of the cell with a digging or scaling bar to release trapped gases that might have accumulated in the beds.

[8] After breaking up any iron crust, regrade the media surface with the rake or lute.

[9] Redistribute any gravel to form an even layer over the iron media.

[10] Ensure that all of the media are submerged.

IF media are not submerged,
THEN notify management immediately.

[11] Exit treatment cell.

[12] Remove the ladder, rinse tools with clean water, and discharge the water to the treatment cell. Close the treatment cell doors.

Note **It is very important to keep air from entering the system. After completion of maintenance, make sure doors are completely closed and that the system is isolated from outside air. The doors overlap. Close the door with the overlap on the bottom edge first, before closing the second door. There should not be a gap.**

[13] Document routine operations in the Monthly Inspection Log (Appendix F) and the Rocky Flats maintenance log on the Condor server.

[14] If the treatment cell beds are not draining after breaking up the crust, then media replacement is most likely required as described in Section 3.6. Notify management immediately.

3.6 Media Replacement at the MSPTS and ETPTS

Media replacement is occasionally necessary. This may be due to consumption of the ZVI but is more likely a result of oxidation of the ZVI or precipitation of other minerals causing the ZVI to be inaccessible (i.e., insufficient permeability through the media).

Media replacement may be conducted for a portion of the media or the entire media. Both of these activities require a significant expenditure of time and effort to plan and complete.

When media replacement (partial or complete) is necessary at the MSPTS or ETPTS, determining the amount of media required in advance is crucial. Replacement media currently cannot be obtained locally or on short notice; instead, out-of-state vendors supply the material and may need several weeks or longer to fill an order. **The first step in any media replacement activity must be to calculate the volume of media (gravel and ZVI, separately) that needs to be replaced.**

Basic geometry is used to calculate the volumes of material required, because the cells at these systems are regular forms (cylinders). The following assumptions are made to simplify the calculations:

- Assume that the volume change resulting from mixing ZVI into a given volume of pea gravel is negligible. While not strictly true, the volume increase is too small to warrant a corresponding decrease in the quantities of gravel and ZVI ordered.
- Assume as-built drawings in Appendix B contain small amounts of error, requiring that final measurements (i.e., prior to installing media, not prior to ordering it) be made of treatment cell internal dimensions.

- Assume that the wall thickness of each vessel is 1 to 1.5 inches.
- Assume that each cell in both systems will have a 1-ft-thick upper layer of gravel/ZVI over the treatment media, and every cell needs to maintain a minimum depth of 6 inches of groundwater above the top of that layer.

Calculations:

The depth to each layer was based on an estimated depth to water from the lip of the opening for the treatment cell doors.

The volume of each material (gravel, ZVI, or mixture) was estimated by calculating the cross-sectional area of the cell and multiplying by the thickness of the particular layer of interest. The cross-sectional area and the volume are calculated as follows:

$$A = \pi r^2$$

where
A = cross-sectional area (square feet [ft^2])
r = inside radius of vessel (ft)

and

$$V = \pi r^2 h$$

where
V = volume (cubic feet [ft^3])
r = inside radius of vessel (ft)
h = height (thickness) of material (ft)

3.6.1 Partial Media Replacement at the MSPTS and ETPTS

Note **If entry into any of the system components is required, permit-required confined space entry requirements apply.**

The steps outlined below may be used for partial media replacement, including replacement of just the gravel/ZVI layer or just the upper portion of the gravel/ZVI layer as needed. Based on the depth of crusting in the media, determine the amount of ZVI and gravel/ZVI mixture that requires replacement. Table 3 lists approximate volumes of gravel/ZVI mixture in the treatment cells. However, it must be stressed that several different versions of the treatment system dimensions have been published, both in previous versions of this manual and elsewhere. Therefore, these figures should be considered working approximations. The volume of ZVI is not provided, as it is based on the amount of iron requiring replacement. ZVI specifications are found in Appendix D.

Table 3. Approximate Depth, Thickness, and Volume of MSPTS and ETPTS Treatment Cell Contents

Parameter	ETPTS[a]	MSPTS[b]
Outside diameter (ft)	11.83	9.83
Inside diameter (ft)	11.58	9.67
Inside radius (ft)	5.79	4.83
Cross-sectional area (ft^2)	105.4	73.4
Inside tank height (ft)	12.33	11.58
Depth to water from treatment cell doors (ft)	4.83	4.57
Groundwater head over gravel layer (ft)	0.5	1
Gravel layer thickness (ft)	1	0.5
Depth to top of iron from treatment cell doors (ft)	6.33	6.07
Depth to top of gravel from treatment cell doors (ft)	5.33	5.57
Volume of ZVI/gravel layer (ft^3)	105.4	36.7
Volume of ZVI (ft^3) in ZVI/gravel mixture	10.54	4.08
Volume of ZVI layer (ft^3)	588.4	367.7
Drainage layer thickness (inches)	11	12

[a]Based on calculations provided by the closure contractor; not confirmed since Site closure.
[b]Based on engineering drawings.
Note: Top gravel layer is a mix of gravel and ZVI, but for convenience is often referred to simply as a gravel layer.

The following requirements shall be met for permit-required confined space entry for any entry into the treatment cells, sump, or metering manhole. Respiratory hazards may exist in the treatment cells and/or metering manhole (e.g., hydrogen gas, hydrogen sulfide, carbon monoxide, ethane, methane, and/or low levels of oxygen). In addition, low concentrations of VOCs are likely in the water. These hazards shall be addressed prior to entry. Safety personnel may require use of a freshly calibrated photoionization detector, multigas meter, and/or combustible gas indicator for entry.

Assemble the following tools, materials, and equipment as appropriate and necessary for the condition and estimated volume of ZVI to be removed:

- Erosion control materials such as straw wattles or silt fence;
- Aluminum or fiberglass extension ladder with an extended length of at least 10 ft;
- Shovels;
- Logbook;
- Standard garden cultivator rake or equivalent;
- Pry bars, breaker bars, or other manual tools for breaking up crust;
- Air compressor, chippers or air hammers, and/or other tools for breaking up crust;
- Backhoe with a hoe ram attachment;
- Vacuum truck or equivalent to remove loose media;
- Dump truck or other means of containment and transport for spent material;
- Sturdy tarp(s) or sheet plastic;
- Plywood sufficient in size to cover tarp(s)/sheet plastic;

- Pea gravel;
- Replacement, fresh ZVI (as required);
- Pump capable of draining treatment cell along with necessary hoses and storage tanks (if needed); and
- Portable generator (if needed).

Perform the following steps:

[1] Establish erosion controls downgradient of the area that will be disturbed by the construction activities.

[2] Prior to entry, open the access doors on each treatment cell and allow treatment cells to ventilate for a minimum 5 minutes before entry. Handrails, doors, and frames may be removed to allow better access. The treatment cell tops can also be removed if desired for easier access to media.

[3] **IF** removed media are not immediately placed into a waste container,
THEN set up a staging area for the spent ZVI and gravel. Create a bermed area capable of holding the volume of material planned to be removed, cover it with tarp/sheet plastic, and place plywood boards or the equivalent on top of the polyethylene tarp to hold it down and minimize damage from the removed materials.

[4] Measure and record the depth to the top of the water and to the top of the gravel/media. Note: The level of the media and the water level might not be the same after media replacement. The final level is based on the height of the interior pipes and maintaining sufficient water over the top of the gravel/iron mixture as described in Table 3 and Figure 2.

[5] Close the valve(s) on the influent line to the system. (Groundwater will continue to collect in the collection trench, but will not enter the system.)

[6] Remove water from the cells by placing a pump or pump intake into a treatment cell (into a depression if possible). Place pump discharge line into the collection trench sump or into a storage tank. Remove as much water as possible to expose media. Remove pump and/or intake line. The pump intake may be tied into the cell's effluent line if appropriate (e.g., if media permeability is sufficient and pump rate is low enough to pose minimal stress on the plumbing and other components of the system, and if fittings are compatible).

[7] After media are exposed, remove as much loose material as possible with a suction line from a vacuum truck or a backhoe.

[8] Break up hardened material either using the backhoe with hoe ram attachment or hand-held equipment. Repeat media removal steps as needed to remove the identified material from each treatment cell. Continue water removal as necessary.

IF using a backhoe,
THEN break up the material in the center of the treatment cell, staying 6 to 12 inches away from the vessel wall. Remove as much media as possible in this manner.

IF using hand-held equipment,
THEN place the ladder in the treatment cell and tie it off securely. Use air hammers with

chisel attachments (or equivalent) to carefully remove material adjacent to and adhering to the wall of the treatment cell, and loosen other material as necessary.

Note **The treatment cells are made of high-density polyethylene (HDPE), and are therefore fragile. Use caution when working near the walls. Damage must be repaired prior to media replacement.**

[9] Removed iron and gravel shall be placed in appropriate waste containers or a staging area. This material shall be managed and disposed of as directed by Environmental Compliance personnel.

Note **If replacement iron appears oxidized (rusted or clumped), do not use.**

[10] After the material is removed, add ZVI until it reaches the height specified in Table 3. Vent pipes should be reinstalled or replaced (see Figure 2 for conceptual design and Figure 3 for a generalized as-built from the ETPTS prior to Site closure).

[11] Verify that the height of the ZVI is at the specified depth below the doors on the vessel (Table 3).

Note **The height of the ZVI shall not be more than 1.5 ft below the bottom of the influent opening to the vessel, regardless of the volume of iron added to the treatment cell or as listed in Table 3.**

[12] Once the iron has been added (if any), the surface shall be raked level.

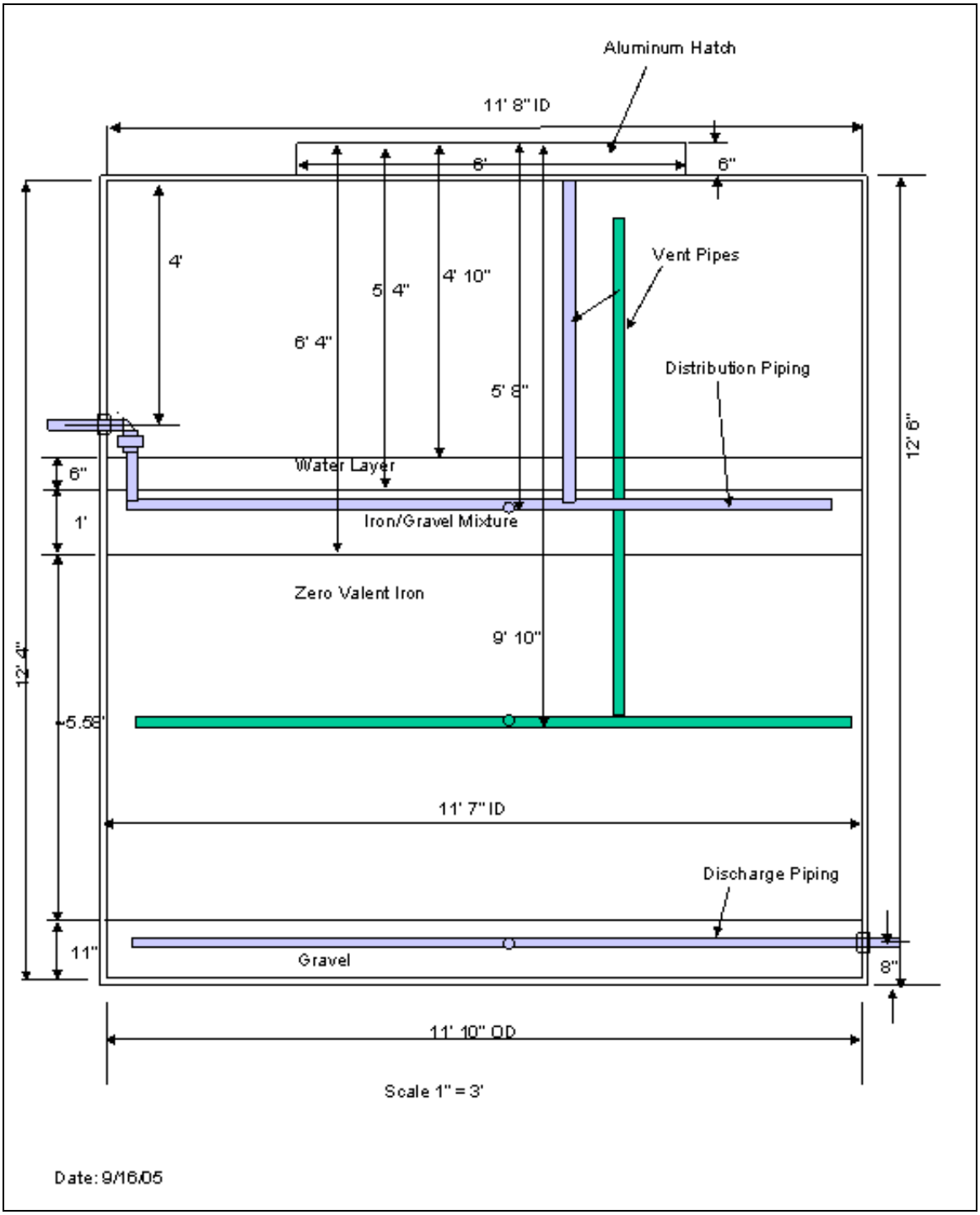
[13] Add a mixture of 10 percent ZVI and 90 percent pea gravel by volume as per Table 3. The gravel/iron shall be completely mixed in a concrete mixer or similar mixing device. The resulting volume will likely be similar to the volume of pea gravel because the finer-grained iron will fill the void space in the pea gravel. The top of this layer shall not be higher than 10 inches below the bottom of the upper influent/effluent opening. Do not overfill the treatment cell. Vent piping and distribution piping should be reinstalled or replaced as shown on Figure 3.

[14] Rake the top of the gravel/iron mixture to level it.

[15] Once all work on the treatment cell is complete, remove the ladder and replace the cell top, railings, and doors if previously removed.

[16] Open the valves to ensure that the treatment cells will operate in series.

[17] Open the valve on the system influent line (from the collection trench). If sufficient water is not available from that source to quickly submerge the media, add sufficient clean water to accomplish this. Insert a board or other flat surface if necessary to prevent inflow from disrupting the flat surface of the media/gravel. Allow the vessel to fill. Check the water level against historic levels. If a storage tank was used to contain water pumped from the cells, this water should be returned to the top of the first cell or to the collection trench sump.



Notes: ETPTS media were completely replaced in September 2005, generally corresponding to the date of this drawing. It is not known how accurate this diagram is, nor whether it represents conditions before or after media replacement.
Subsequent to the date of this drawing, the system was revised (during installation of the instrument vault) to allow upflow configuration. Therefore, what is shown as “Discharge Piping” and “Distribution Piping”—denoting a downflow configuration—can now be reversed to allow upflow.

Figure 3. Cross-Section of ETPTS Treatment Cell Prior to Site Closure

[18] **IF** the gravel/iron mixture is not submerged below the water at the depth in Table 3, **THEN** quickly determine whether this is due to slow filling or excessive material in the gravel/iron layer.

[19] **IF** the incomplete submergence is due to slow filling,
THEN add clean water as necessary to achieve full submergence of the top layer and monitor cell conditions continuously for several hours frequently (at least twice daily) over the next several weeks to confirm the water level remains above the top of this layer. Emergence of any portion of this top layer at any time will require material removal as described in Step 20. Failure to remove this material could result in early failure of the ZVI, making this a critical step.

[20] **IF** the incomplete submergence is due to excessive material in the top layer,
THEN immediately remove excess material to achieve full submergence of the top (gravel/ZVI) layer.

Note **No portion of the gravel/iron mixture shall extend above the water surface at any time.**

[21] Remove the board (if used) and the ladder from the treatment cell.

[22] Rinse tools with clean water and discharge the rinse water to the treatment cell. Close the treatment cell doors.

Note **It is very important to keep air from entering the system. After completion of maintenance, make sure doors are completely closed and that the system is isolated from outside air. The doors overlap. Close the door with the overlap on the bottom edge first, before closing the second door. There should not be a gap.**

[23] Polyethylene tarps, personal protective equipment (PPE), and other materials shall be managed and disposed as directed by Environmental Compliance staff (most likely as sanitary waste).

[24] Document routine operations in the Monthly Inspection Log (Appendix F) and the Rocky Flats maintenance log on the Condor server.

3.6.2 Total Media Replacement at the MSPTS and ETPTS

Note **If entry into any of the system components is required, permit-required confined space entry requirements apply.**

The following steps describe complete replacement of the media in one or both cells of a system. (See Appendix E for photographs of previous media replacement activities.) However, this procedure can also be used for partial replacement, including replacement of only the gravel/iron layer or just the upper portion of the gravel/iron layer as needed.

Table 3 shows the approximate volumes of ZVI and gravel/ZVI mixture in the treatment cells. These calculations are explained in Section 3.6.1. Specifications for the ZVI are provided in Appendix D.

Follow requirements for permit-required confined space entry for any entry into the treatment cells, sump, or metering manhole. Respiratory hazards may exist in these locations (e.g., hydrogen gas, hydrogen sulfide, carbon monoxide, ethane, methane, and/or low levels of oxygen). In addition, low concentrations of VOCs are likely in the water. These hazards shall be addressed prior to entry. Safety personnel may require use of a freshly calibrated photoionization detector, multigas meter, and/or combustible gas indicator for entry.

Assemble the following tools, materials, and equipment:

- Erosion control materials such as straw wattles or silt fence;
- Aluminum or fiberglass extension ladder with an extended length of at least 10 ft;
- Shovels;
- Logbook;
- Standard garden cultivator rake or equivalent;
- Pry bars, breaker bars, or other manual tools for breaking up crust;
- Air compressor, chippers or air hammers, and/or other tools for breaking up crust;
- Backhoe with a hoe ram attachment (as needed);
- Vacuum truck or equivalent to remove loose media (optional);
- Tarp(s) or sheet plastic;
- Plywood sufficient in size to cover tarp(s)/sheet plastic;
- Pea gravel (3/8 inch);
- Appropriate quantity and type(s) of ZVI;
- Pump capable of draining treatment cell along with necessary hoses;
- Dump truck or other means of containment and transport for spent material;
- Filter fabric;
- Plumber's snake (at least 50 ft long);
- Portable generator (if needed);
- Equipment required for a permit-required confined space entry;
- PVC pipes, joints, couplers, elbows, slotted pipe, caps, plugs, and so forth as necessary to replace internal plumbing components;
- Liquid bleach (5.25 percent sodium hypochlorite solution);
- Water storage tank;
- Paper towels and brushes; and
- Sprayer.

Perform the following steps:

[1] Establish erosion controls downgradient of the area that will be disturbed by the construction activities.

[2] Prior to entry, open the access doors on each treatment cell and allow treatment cells to ventilate for a minimum of 5 minutes. Guardrails, doors, and frames may be removed to allow better access to the treatment cell; for best access, remove cell tops.

[3] **IF** the removed media will not be immediately placed into a waste container,
THEN set up a staging area for the spent ZVI and gravel. Create a bermed area capable of holding the volume of material planned to be removed, cover it with tarp/sheet plastic, and place plywood boards or the equivalent on top of the polyethylene tarp to hold it down and minimize damage from the removed materials.

[4] Measure and record the depth to the top of the water and to the top of the gravel/media. Note: The level of the media and the water level might not be the same after media replacement. The final level is based on the height of the interior pipes and maintaining sufficient water over the top of the gravel/iron mixture as described in Table 3 and Figure 2.

[5] Close the valve(s) on the influent line to the system. (Groundwater will continue to collect in the collection trench but will not enter the system.)

[6] Remove water by placing a pump or pump intake into the treatment cell (into a depression if possible). Place pump discharge line into the collection trench sump or into a storage tank. Remove as much water as possible to expose media. Remove pump and/or intake line. The pump intake may be tied into the cell's effluent line if appropriate (e.g., if media permeability is sufficient and the pump rate is low enough to pose minimal stress on the plumbing and other components of the system, and if fittings are compatible).

[7] After media are exposed, remove as much loose material as possible with a suction line from a vacuum truck or a backhoe.

[8] Break up hardened material either using the backhoe with hoe ram attachment or hand-held equipment. Repeat media removal steps as needed to remove the planned material from each treatment cell. Continue water removal as necessary.

IF using a backhoe,
THEN break up the material in the center of the treatment cell, staying 6 to 12 inches away from the vessel wall. Remove as much media as possible in this manner.

IF using hand-held equipment,
THEN place the ladder in the treatment cell and tie it off securely. Use air hammers with chisel attachments (or equivalent) to carefully remove material adjacent to and adhering to wall of treatment cell, and loosen other material as necessary.

Note **The treatment cells are made of HDPE and are therefore fragile. Use caution when working near the walls. All damage must be repaired prior to media replacement.**

[9] Remove remaining iron along with gravel at the bottom of the treatment cell. Place removed materials in a waste container or in the staging area. This material shall be managed and disposed as directed by Environmental Compliance personnel.

Note **There is PVC pipe at the bottom of each treatment cell. Do not use excessive force when loosening iron at the bottom of the cell to avoid breaking these pipes. All broken pipes must be repaired or replaced prior to media replacement.**

[10] Measure the height of the treatment cell and the height from the bottom of the cell to the inlet piping.

[11] Check the lines entering and exiting the treatment cells. If plugging occurs, the lines to both treatment cells shall be cleaned. Because of the presence of the instrumentation vault and its many associated plumbing components, using a plumber's snake for this activity may not be appropriate. The subcontracted construction support should be consulted to determine whether a snake may damage this plumbing, and if so, alternatives to using a snake shall be explored. Potential alternatives include replacing obstructed lines or running an appropriate quantity and concentration of acid through the obstructed lines (while incorporating all necessary safety precautions and properly managing and disposing of used acid).

[12] If biological growth ("slime") is present, disinfect the influent line by pushing a cloth with chlorinated solution along the inside of the pipe or by similar means. The chlorinated solution consists of approximately ¼ cup household bleach (e.g., Clorox) in 1.5 gallons of water.

[13] If biological growth ("slime") is present, disinfect the lines between the cells by sealing the end with a threaded plug and filling the line with chlorine solution prepared as above. (The same solution may be reused if desired.) Allow the chlorinated solution to remain for 12 hours and then drain. Rinse with water. Collect chlorinated water and rinsate. This rinsate may be used for spraying the sidewalls of the tank.

[14] If biological growth ("slime") is present, disinfect the inside of the tank by spraying the tank walls and bottom with chlorinated solution prepared as above. (The same solution may be reused if desired.) Place the distribution/collection piping in the bottom of the tank and cover with chlorinated solution. Let it sit for 12 hours and then remove excess water and wipe or rinse off distribution piping, walls, and tank bottom. Collect chlorinated water and rinsate, if any, for proper management and disposition.

Note **Air with elevated concentrations of chlorine gas is hazardous. The risk is greatest when disinfecting tank insides but may also be of concern when disinfecting the lines. Personnel shall consult the dedicated safety professional for appropriate controls and shall implement those controls as directed.**

[15] After disinfection is complete, add gravel as listed in Table 3. Rake the gravel drainage layer so that it is level and covers the distribution/collection piping at the bottom of the cell. If the treatment cells will be filled with -8 +50 iron, cut new filter fabric and place it over the gravel layer.

If replacement iron appears oxidized (rusted or clumping), do not use.

Note

[16] Add iron to the heights listed in Table 3. Carefully add the first few feet of iron to avoid disrupting the gravel layer. Vent piping should be reinstalled or replaced as shown on Figure 3. Rake the iron surface level.

[17] Add a mixture of 10 percent iron and 90 percent pea gravel by volume up to the height indicated in Table 3. The gravel/iron shall be completely mixed in a concrete mixer or similar mixing device and should be placed into the cell in lifts with each lift spread evenly across the media surface before adding the next lift. This will help keep the gravel and iron mixed as it is placed. The resulting total volume will be similar to the volume of pea gravel, because the iron will fill void spaces in the pea gravel. Upper distribution/collection piping shall be reinstalled or replaced as shown on Figure 4.

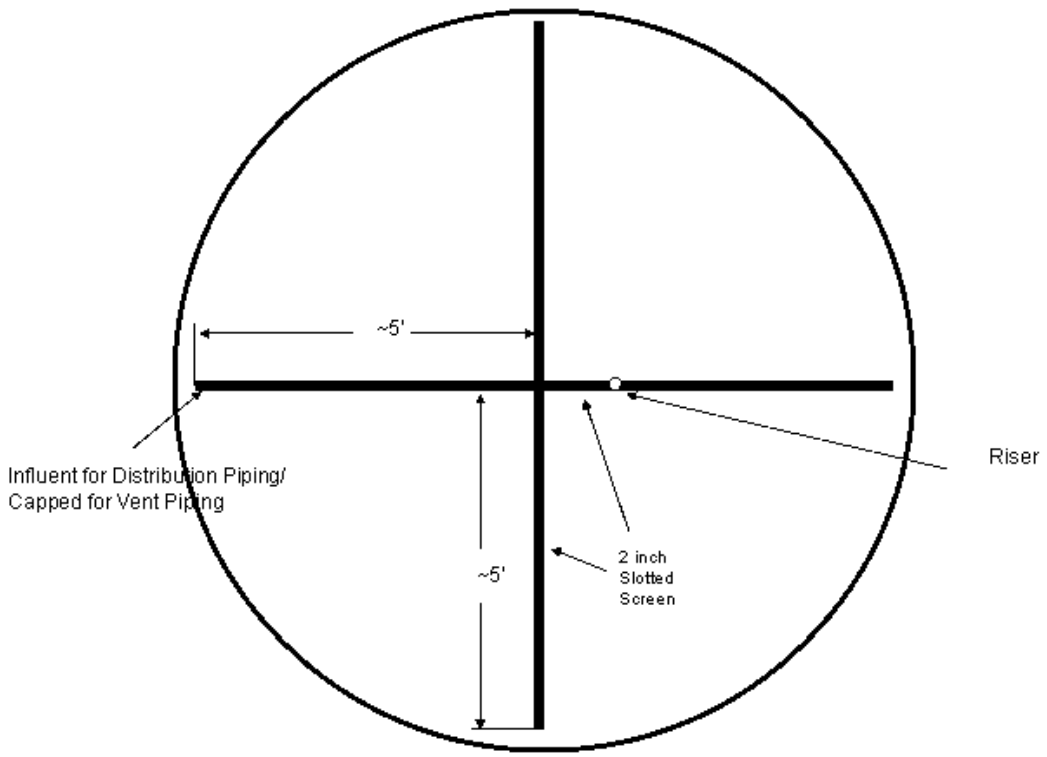


Figure 4. Vent, Distribution, and Discharge Piping Layout

[18] Do not overfill treatment cell. The top of the media must remain below the water level in the cell at all times. Rake the top of the gravel/iron mixture to level it.

[19] Once all work on the treatment cell is complete, remove the ladder and replace the top, railings, and doors if previously removed.

[20] Open the valves to operate the treatment cells in series and then open the valve on the influent line.

[21] Open the valve on the system influent line (from the collection trench). If sufficient water is not available from that source to quickly submerge the media, add clean water to accomplish this. Insert a board or other flat surface if necessary to prevent inflow from disrupting the flat surface of the media/gravel. Allow the vessel to fill. Check the water level against historic levels. If a storage tank was used to contain water pumped from the cells, this water should be returned to the top of the first cell or to the collection trench sump.

[22] **IF** the gravel/iron mixture is not submerged below the water at the depth in Table 3, **THEN** quickly determine whether this is due to slow filling, or excessive material in the gravel/iron layer.

[23] **IF** the incomplete submergence is due to slow filling,
THEN add clean water as necessary to achieve full submergence of the top layer and monitor cell conditions continuously for several hours frequently (at least twice daily) over the next several weeks to confirm the water level remains above the top of this layer. If necessary due to lack of available groundwater, close the influent valve from the collection sump and the effluent valves on each cell, fill the cells with sufficient water to cover the media surface as described above, and monitor water levels in the collection sump until sufficient groundwater is available to maintain coverage over the media, at which time these valves may be reopened and groundwater flow may be initiated through the cells. Emergence of any portion of the top layer of media at any time will require material removal, as described in the Step 24. Failure to remove this material could result in early failure of the ZVI; therefore, this step is critical.

[24] **IF** the incomplete submergence is due to excessive material in the top layer,
THEN immediately remove excess material to achieve full submergence of the top (gravel/ZVI) layer.

Note **No portion of the gravel/iron mixture shall extend above the water surface at any time.**

[25] Remove the board (if used) and the ladder from the treatment cell.

[26] Rinse tools with clean water and discharge the rinse water to the treatment cell. Close the treatment cell doors.

Note **It is very important to keep air from entering the system. After completion of maintenance, make sure doors are completely closed and that the system is isolated from outside air. The doors overlap. Close the door with the overlap on the bottom edge first, before closing the second door. There should not be a gap.**

[27] Polyethylene tarps, PPE, and other materials shall be dispositioned as sanitary waste unless otherwise directed by Environmental Compliance staff.

[28] Document routine operations in the Monthly Inspection Log (Appendix F) and the Rocky Flats maintenance log on the Condor server.

3.7 Instrument Vaults at the MSPTS and ETPTS

The MSPTS and ETPTS are both equipped with concrete vaults through which system flows are routed and various parameters measured. These components were not part of the original design of the systems but were added in 2006 to enhance maintenance and performance of the systems by allowing closer monitoring and adjustment of fundamental parameters such as flow rates and water levels.

During installation of the vaults, additional plumbing configurations were designed and installed to support potential future needs. The systems were originally designed for downward flow, with groundwater entering at the top of a cell and exiting at the bottom of the cell. Additional plumbing was installed to allow reconfiguration to upflow conditions if this ever becomes necessary or desired. This required the addition of valves and pipes. (Note that the upflow configuration at the MSPTS and SPPTS was tested for several months in late 2007 and found to result in negligible difference in water treatment. However, system maintenance requirements increased sharply due to the need to flush in-line filters up to three times weekly.)

System flow is routed through the associated instrument vault. For example, at the MSPTS, system influent from the intercept trench first flows through a pipe in the vault and then to the first cell. Upon exiting that cell, it flows through the vault and enters the second cell. Upon exiting the second cell, it flows back through the vault before leaving the system.

Parameters measured at the ETPTS include flow rates (influent, between cells, and effluent), depth to water (intercept trench sump, each of the two cells), line pressures (influent, between cells, and effluent), and cumulative flow volume (influent, between cells, and effluent). Parameters measured at the MSPTS include depth to water (intercept trench sump, each of the two cells), flow rates (influent and effluent), cumulative flow volume (influent and effluent), and line pressure (influent). In addition, battery voltages and radio signal strength are monitored.

These measurements are collected on a datalogger and automatically transmitted at least daily via a repeater (located on top of the pediment between Ponds A-1 and B-1) to a computer at the Grand Junction office. A software program (Vista DataVision) reads the data and automatically updates data files and graphs that are viewable on the SOARS website (https://soars.lm.doe.gov).

Table 4 lists the minimum required maintenance for these vaults.

Table 4. MSPTS and ETPTS Instrument Vault Maintenance Requirements

Activity	Frequency	MSPTS	ETPTS
Check general plumbing and flow maintenance	Daily to monthly[a]	X	X
Check data transmission	Weekly	X	X
Check and document instrument calibration	As necessary	X	X

Notes: [a]Depending on flow configuration and system behavior, more frequent maintenance may be required (such as during upflow conditions, when the filter may need to be flushed every day). Monitor water levels closely to determine whether more frequent maintenance is needed.
Indications of off-normal behavior (i.e., from SOARS website) may require additional maintenance than that described above.

3.7.1 General Plumbing and Flow Maintenance

The vaults at each system should be visited routinely to inspect for general condition of the plumbing and to make other observations. This activity is performed as follows:

[1] Unlock vault door.

[2] Unlock hasps surrounding vault.

[3] Open door and ensure it is locked in place.

Note **Do not enter before confirming door is locked in place. Failure to do so could result in door closing while you are entering or inside vault.**

[4] Enter vault by climbing down ladder.

[5] Inspect lines and verify that there are no leaks in the plumbing.

[6] Inspect and flush screened cylinders (i.e., filters).

[7] Turn valves on both sides of influent flow meter piping to "off."

[8] Remove cylinder that holds the influent screen and check for buildup.

IF buildup is observed on screen,
THEN clear the screen by opening the bottom valve of the screened cylinder on the other pipe and rinse screen. Some scrubbing may be required.

IF rinsing and scrubbing is insufficient to clear screen,
THEN replace screen with a new screen of identical mesh size. New screens should already be located in the vault.

[9] Reattach screen and cylinder and turn on both valves again.

[10] Flush air from cylinder and piping by opening bottom valve of cylinder. Flush until water exits cylinder in a constant stream with no sputtering. Failure to adequately flush the air can result in an air lock, potentially halting flow.

Note **Stand clear of bottom valve when flushing cylinder to avoid contact with contaminated groundwater.**

[11] Repeat Step 6, flushing between cell screen (ETPTS only) and effluent screen (both MSPTS and ETPTS).

[12] Check all flow meters to ensure they are functioning properly.

a. If there is no display on the flow meter, push the "display" button on the face of the meter once to see if the meter is still functioning properly. If flow has ceased, the meter display will shut off with the meter still being functional, but should turn back on after pressing the "display" button.

b. If the meter's display does not come on, replace the batteries in the flow meter and check the display again.

c. If the display comes on, but still shows a flow of "0.00," then flow through the meter has ceased or the flow meter turbine is obstructed. Refer to Step 9.

At the MSPTS or ETPTS:

[1] **IF** flow has ceased and water levels in the cells indicate flow should be present,
THEN ensure Step 6 has been completed and all valves in vault are in the "on" position.

[2] **IF** flow still does not continue,
THEN turn all valves off again and remove flow meters. Check for blockage in the turbines of the flow meters. This process may involve removing and inspecting the flow meter turbine; refer to the instrument manual for specific instructions. Remove debris or other material that may be fouling the turbines.

[3] Reattach flow meters and turn valves to "on" position, being sure to flush air from the piping by opening the bottom valve of each screened cylinder.

[4] **IF** flow does not commence,
THEN contact supervisor for direction.

[5] **IF** flow needs to be adjusted,
THEN adjust inlet ball valve from groundwater intercept trench (i.e., collection sump) to increase or decrease flow as appropriate. Flow increases are limited by available head in the trench; if little water is in the trench, opening the valve more may not increase flow.

[6] Check flow meter to confirm adjustment has had the desired effect.

[7] **IF** there is an indication that other valves need to be adjusted,
THEN consult management first.

[8] Exit vault and close vault door.

[9] Close hasps and lock door.

[10] Document routine operations in the Monthly Inspection Log (Appendix F) and the Rocky Flats maintenance log on the Condor server.

3.7.2 Checking Data Transmission

Data from instruments at treatment systems are collected on a datalogger and automatically transmitted at least daily to a computer at the Grand Junction office. A software program (Vista DataVision) reads in the data and automatically updates graphs. The graphs should be checked at least once weekly to assure they are being updated. This requires access to the Internet and does not require a visit to the instrumentation vault. If data on the graphs are not current or are obviously in error, inform appropriate project personnel.

3.7.3 Checking Instrument Calibration

Instrumentation may occasionally require recalibration. When automated data transmission differs from manually collected observations or otherwise indicates recalibration may be necessary, follow the calibration steps outlined below for each appropriate instrument.

In-line flow meters should be checked in the following manner:

[1] Connect a hose to the pipe at a point downstream of the flow meter.

[2] Connect a properly sized flow meter with documented accuracy to the hose.

[3] Connect a computer to the datalogger.

[4] Record the totalizer (total gallons) for the calibration meter, the meter to be tested, and the datalogger output.

[5] Run the system for a period of time sufficient to flow enough water to make valid comparisons between the calibration meter and the flow meter being tested (usually at least 10 times the maximum range; e.g., at least 10 gallons for a 1- to 10-gpm meter). Longer test periods provide better accuracy.

[6] Record the length of the test period.

[7] Repeat the test.

IF the results are more than 10 percent different,
THEN repeat at least one more time.

[8] Record the readings from the calibration meter, the meter being tested, and the datalogger output in a field book and copy them to the shared electronic calibration records.

[9] Notify appropriate project personnel of any problems or inconsistencies.

[10] Document routine operations in the Monthly Inspection Log (Appendix F) and the Rocky Flats maintenance log on the Condor server.

In-line pressure sensor/transmitters should be checked in the following manner:

[1] Connect a computer to the datalogger.

[2] Compare the pressure reading for the transmitter to the reading on the dial gauge adjacent to the transmitter.

[3] Take several readings over a period of at least a few minutes.

[4] Record the readings in a field book and copy them to the shared electronic calibration records.

[5] Notify appropriate project personnel of any problems or inconsistencies.

[6] Document routine operations in the Monthly Inspection Log (Appendix F) and the Rocky Flats maintenance log on the Condor server.

Water-level transducers should be checked in the following manner:

[1] Connect a computer to the datalogger.

[2] Record several depth-to-water readings over a period of at least a few minutes.

[3] Measure the depths to water in the treatment cells and collection trench manhole.

[4] Record manual and datalogger readings in a field book and copy them to the shared electronic calibration records.

[5] Notify appropriate project personnel of any problems or inconsistencies.

[6] Document routine operations in the Monthly Inspection Log (Appendix F) and the Rocky Flats maintenance log on the Condor server.

3.8 Changing Between Downflow and Upflow Configuration (MSPTS and ETPTS Only)

Because the ZVI treatment media have a limited lifespan, it may become necessary to change the direction of flow through the treatment systems if inadequate treatment of contaminated groundwater is observed. Under normal operations the systems are configured such that water enters the top of each treatment cell and exits from the bottom (downflow configuration). In this configuration, the effectiveness of the treatment media in the upper portions of the cell decreases over time, as the media become oxidized and bound with precipitates (hence the need to break up the media as discussed previously). Under upflow configuration, water enters the bottom of each treatment cell and exits from the top. Maintenance requirements increase significantly under upflow configuration due to the mobilization of oxidized iron precipitate from the upper portions of the treatment cells. More specifically, the screened cylinders within the instrumentation vaults become obstructed more frequently and must be checked and rinsed daily after switching to upflow.

3.8.1 Changing from Downflow to Upflow Configuration

Note **To avoid damaging valves and piping, flow configuration should not be changed in extremely cold temperatures due to increased rigidity of flex hosing and increased brittleness of PVC fittings.**

[1] Unlock vault door.

[2] Unlock hasps surrounding vault.

[3] Open door and assure it is locked in place.

Note **Do not enter before confirming door is locked in place. Failure to do so could result in door closing while you are entering or inside vault.**

[4] Enter vault by climbing down ladder.

[5] Turn all valves in vault to “off” position.

[6] Detach flex hosing from valve connections in vault walls.

[7] Arrange hosing within the vault such that upflow configuration will be achieved, ensuring that flow direction through flow meter piping is correct for proper flow meter operation. Upflow hose configuration is as follows:

- Influent from collection trench → Bottom of Tank 1
- Top of Tank 1 → Bottom of Tank 2
- Top of Tank 2 → Effluent metering manhole

Note **Each valve on piping coming into or out of the vault should be labeled with its location within the system (e.g., pipe leading to top of Treatment Cell 2 should be labeled TT2).**

[8] Securely attach hosing to correct valve connections.

[9] Verify that hosing configuration achieves upflow conditions and turn all valves in vault to "on" position.

[10] Flush air from piping as described above and ensure that water is flowing through all hoses and piping.

[11] Frequently monitor automated data transmission graphs on the Vista DataVision website to identify rising water levels within the cells, which requires the filters (screened cylinders) be flushed.

Note **It is extremely important to increase inspection frequency following the switch to upflow configuration. Screened cylinders must be checked and rinsed daily until clogging decreases, at which point the inspection frequency can decrease to 2 to 3 times weekly.**

[12] Document routine operations in the Monthly Inspection Log (Appendix F) and the Rocky Flats maintenance log on the Condor server.

3.8.2 Changing from Upflow to Downflow Configuration

To switch from upflow to downflow configuration, follow the steps outlined in Section 3.8.1 but arrange vault hosing (Step 7) such that downflow configuration is achieved. Proper downflow hose configuration is as follows:

Influent from collection trench → Top of Tank 1
Bottom of Tank 1 → Top of Tank 2
Bottom of Tank 2 → Effluent metering manhole

Note **To avoid damaging valves and piping, flow configuration should not be changed in extremely cold temperatures due to increased rigidity of flex hosing and increased brittleness of PVC fittings.**

3.9 Solar Ponds Plume Treatment System

Unlike the MSPTS and ETPTS, the SPPTS treatment cells are not directly accessible. (Gas vents installed within each cell at influent and effluent locations afford limited access [e.g., for in-cell water level checks or sampling].) However, other components need to be routinely checked to ensure that the system is operating as planned. This includes checking pump operation, visually inspecting the solar panel and the operating system, checking the automated data transmission to monitor flow rates into and out of the system, and checking the water level in SPIN (i.e., the collection sump in which the pump is installed) to verify that these components are in working condition.

IF the SPPTS pump is moved or disturbed,
THEN the pump needs to be set so that it maintains water levels within the range given in Table 5.

3.9.1 Monitoring Water Levels in SPIN

Water level measurements are monitored in SPIN, the sump installed within the groundwater collection trench. Water levels may also be measured in nearby piezometer (PZ) 71099 (i.e., pre-closure "influent" sampling location SPPMM02) if desired. Table 5 lists typical water elevations and depth to water in both of these locations. The pump in SPIN does not operate continuously; rather it cycles on periodically resulting in an oscillating water level visible on the automated data transmission graphs.

Table 5. Normal Groundwater Depths and Elevations in SPIN (SPPTS Collection Sump) and PZ 71099

Location	Depth to Water (ft)	Water Elevation
Piezometer 71099	Deeper than 21	Below 5,880 ft
Collection sump/SPIN[a]	27-30	5,871 feet−5,874 ft

[a]Measured from top of housing (elevation=5901.44 ft)

Note **After heavy precipitation events, the water levels in the trench (as determined in SPIN) may be higher than normal but should return to the normal range within a few days.**

IF the automated data show a constant depth to water in SPIN that is less than 27 feet below the top of housing and those data are confirmed to be accurate,
THEN the pump has malfunctioned. Refer to Section 3.9.3 for information on troubleshooting the pump and flow meter.

IF the pump is operating (Section 3.9.4) and water levels in SPIN are continuously rising,
THEN the sump may need to be redeveloped. Notify management immediately. Refer to Section 3.9.5.

IF water levels within the collection trench (as determined in SPIN and augmented with data from any or all trench PZs—70799, 70899, 70999, 71099) remain elevated for more than two consecutive months after a precipitation event,
THEN notify management.

3.9.2 Checking Data Transmission

Data from instruments at treatment systems are collected on a datalogger and automatically transmitted at least daily to a computer at the Grand Junction office. A software program (Vista DataVision) reads in the data and automatically updates graphs. The graphs should be checked at least once weekly to assure they are being updated. This requires access to the Internet and does not require a visit to the SPPTS. If data on the graphs are not current or are obviously in error, inform appropriate project personnel.

3.9.3 Troubleshooting Pump and Influent Flow Meter

In extremely cold weather, the SPPTS pump has occasionally malfunctioned and shut off. This is believed to be caused by ice buildup in the flow meter obstructing flow and causing the pump to

shut off, requiring a manual restart. If the automated data indicate the pump has shut off and/or the flow meter is reading a constant zero, follow the steps below.

[1] Remove cover to flow meter enclosure and clear out insulation.

Note **If signs of rodent activity (e.g., nests, droppings, carcasses, or live rodents) are observed within the enclosure, contact Health & Safety for instructions on proper handling and disposal.**

[2] The flow meter screen will likely be off even if the pump is operating correctly, because the pump does not operate continuously. Press the "display" button on the face of the flow meter.

a. **IF** display comes on and reads "0.00,"
THEN go on to Step 3.

b. **IF** display does not come on,
THEN replace batteries in flow meter, ensure display is working, and go on to Step 3.

[3] Turn both the switch on the bottom of the pump controller (located below the solar panels) and the red power switch (located to the right of the pump controller) to the "off" position. Remove flow meter and check for ice buildup or other blockage in the turbine of the flow meter. This process may involve removing and inspecting the flow meter turbine; refer to instrument manual for specific instructions. Remove debris or other material that may be fouling the turbine.

[4] Reattach flow meter and turn both switches to the "on" position. Pump should restart and flow meter should display a flow reading for 1 to 2 minutes. Ensure that pump is operating and frequently monitor the automated data transmission.

[5] **IF** pump did not restart,
THEN ensure all switches are on and flow meter is correctly installed. Inform management if problem persists.

3.9.4 Checking the SPPTS Solar Panel, Charging System, and Batteries

On a monthly basis, check the following on the electrical system:

- Check for loose or damaged wires, including checking the insulation on the wires.
- Ensure that equipment is securely mounted.
- The green light on the pump controller (ME 24/48) should be on. The red light for the treatment cell should not be on.

On a monthly basis, check the following on the solar panels:

- The panels should be facing south and tilted at a pitch angle of approximately 40 degrees.
- Remove equipment, vegetation, and bird droppings that may be blocking the panel.
- The surface of the solar panels should be clean. Light dust on the surface is acceptable, but no other soiling. (Note: The panels are in a fixed position and should not be moved during routine activities, including cleaning.)

IF the panels are more than dusty,
THEN rinse with clean water (i.e., tap, distilled, or deionized).

IF dirt is difficult to remove,
THEN wash with a wet paper towel or a wet soft cloth.

The batteries (as of January 2008) are Concorde Sun Xtender® batteries, Model PVX-2120L. These deep-cycling batteries are made specifically for backup power for photovoltaic systems. Each 12-volt battery is sealed and "maintenance-free." Additional information on the batteries is presented in Appendix C. The lid to the battery box should remain closed at all times except during inspection and repair. The batteries need to be inspected monthly for signs of corrosion and overcharging. These signs include the following:

- Is there corrosion at the terminals?
- Do the wires appear to be damaged or oxidized?
- Are the batteries bubbling?
- Is there moisture accumulation on the top of the batteries?
- Are the batteries bulging?
- Is the battery operating at full capacity?

IF there is evidence of damage or overcharging the batteries,
THEN contact management immediately. It may be necessary to contract an electrician to determine if repairs are necessary.

On a monthly basis, check the following on the charge controller. Refer to the charge controller manual in Appendix C for further information and the location of status lights.

[1] If there is sunlight, assure that the charging light emitting diode (LED) is green. If it is nighttime, this light should be off.

[2] Check the battery status LEDs. The red LED to the right should not be steadily on. If it is near the end of daylight hours, this light should not be blinking. These are both indications that the battery is not being charged and an electrician should be consulted; notify management immediately. The green and yellow lights mean that the battery is charged or is partially charged.

[3] The battery type selector should be set to the type of batteries in use. At this time, these are sealed batteries (Concorde PVX-2120L). If not set at the appropriate battery type, using a small screwdriver, turn the selector to the appropriate battery type and count the number of

flashes on the battery status lights. The number of flashes should match the battery type as stated in the manual. For example, two flashes indicate sealed batteries.

[4] Check the digital display.
IF any of the following are displayed,
THEN notify management immediately, as it will be necessary to contract an electrician for repairs:

LVD—low voltage disconnect

HVD—high voltage disconnect

Hot—high temperature disconnect

OCP—overcurrent and short circuit protection

0.0—short circuit protection (solar amp only)

[5] Three readings are on the digital display. If the following are not as stated, check the manual in Appendix C to correct:

a. The battery status should read approximately 25 to 29 volts.

b. The solar amp reading and the load amp reading should display the solar panel amps and not indicate an "off" setting. The load amp reading will likely be 0.0 because the pump is not constantly in operation, rather it cycles on periodically.

c. The solar amp should not read zero.

[6] Ensure that the system has not been disconnected from the load or the solar array. The button in the upper righthand corner of the charge controller should not be lit nor, as previously stated, should the digital display indicate off when it displays the solar amp reading.

[7] Perform the diagnostic test as described in Section 5.4 of the Prostar 30 product manual in Appendix C by pressing the load disconnect switch for at least 4 seconds. After the diagnostic test is complete, assure that neither the solar array nor the load is disconnected (the light in the upper righthand corner of the charge controller should be off and the display should read out the solar amps and load amps). If any adjustments or repairs are necessary, notify management immediately, as it will be necessary to contract an electrician.

[8] Document routine operations in the Monthly Inspection Log (Appendix F) and the Rocky Flats maintenance log on the Condor server.

Twice a year, typically in January and July to cover diverse conditions, perform the following in addition to the above:

[1] Measure the current on the solar array with an ammeter and make sure it does not exceed 30 amps.

[2] Check that the controller functions and LED indicators are correct for the system conditions.

[3] Check the voltage on the batteries with a voltmeter. These should each read approximately 12 to 14 volts.

IF any of the conditions are not met,
THEN notify management immediately, as it will be necessary to contract an electrician to determine if repairs are necessary.

3.9.5 SPPTS Sump (SPIN) Redevelopment

Due to a buildup of fine material in the collection trench, the screen on the sump is susceptible to plugging. When water levels get too high in the collection trench and the pump is functioning properly, then the sump may be clogged and may need to be evaluated to determine if redevelopment is necessary.

A water well drilling company should be used for sump redevelopment. Several methods may be used to perform this work; the method selected shall be at the discretion of the water well drilling company. In the past, a surge block has been used and successfully restored operation to the system. An advantage of this method is that fines are removed in this process. A step-by-step procedure is not listed here because the methodology varies according to the specific techniques and equipment employed, and the company performing the work. With time, the need for redevelopment should decrease as the system becomes more stable and the fines are removed. (The sump was installed in September−October 2002 and redeveloped in March 2003 and April 2004. No subsequent redevelopment has been indicated.)

Document routine operations in the Monthly Inspection Log (Appendix F) and the Rocky Flats maintenance log on the Condor server.

3.9.6 SPPTS Media Replacement

The need to replace the media in the SPPTS will be evident from the inability of the system to remove nitrates and/or uranium or by water backing up in the system due to clogging or biofouling. Removal of media is generally similar to the media replacement described for other treatment systems; however, the media at the SPPTS are buried beneath approximately 12 to 15 ft of overburden and is not easily accessible.

To access the treatment cells, the upper soil layer shall be removed and stockpiled. Then the woodchip fill over the treatment cells will be removed and stockpiled. These materials can be reused following media replacement. Management and disposal of the underlying treatment media and any associated materials shall be determined by Environmental Compliance staff; they may need to be handled as low-level waste.

Media Replacement

The following steps describe media replacement in the East Cell. Similar steps would be undertaken to replace the media in the West Cell; the West Cell includes several significant differences, as summarized below. Table 6 lists the cell dimensions and material requirements.

- The West Cell uses organic media/ZVI mixture instead of the East Cell's gravel/ZVI mixture.
- The distribution gallery in the West Cell is configured differently, as shown on Drawing 51649-0401 in Appendix B.
- The distribution gallery may be reused if not damaged but shall be connected to the influent port at the wall via a flexible connection that will allow for significant settling of the media (i.e., the line feeding the distribution gallery should allow the entire gallery assembly to drop at least 3 ft vertically as the media settle).

Table 6. Depth, Thickness, and Volume of the SPPTS Treatment Cells

Parameter	Quantity	Unit
East Cell		
Width of Cell	10.5	Feet
Length of Cell	17	Feet
Cross-Sectional Area	178.5	Square Feet
Height of Gravel Drainage Layer	1	Foot
Volume of Gravel In Drainage Layer	178.5	Cubic Feet
Height of ZVI/Gravel Mixture	8.8	Feet
Thickness of ZVI/Gravel Mixture	7.8	Feet
Volume of ZVI/Gravel Mixture	1398.3	Cubic Feet
Percent ZVI (by volume)	15	%
Percent Gravel (by volume)	85	%
Total Gravel Volume	1188.5	Cubic Feet
Total ZVI Volume	209.7	Cubic Feet
Height of Gravel Distribution Layer (Cell Height)	12.0	Feet
Volume of Distribution Layer	565.3	Cubic Feet
West Cell		
Width of Cell	31.5	Feet
Length of Cell	17	Feet
Cross-Sectional Area	535.5	Square Feet
Height of Gravel Drainage Layer	1	Foot
Volume of Gravel In Drainage Layer	535.5	Cubic Feet
Height of ZVI/Organic Media Mixture	10	Feet
Thickness of ZVI/Organic Media Mixture	9	Feet
Volume of ZVI/Organic Media Mixture	4,820	Cubic Feet
Percent ZVI (by volume)	10	%
Percent Organic Media (by volume)	90	%
Total Organic Media Volume	4,338	Cubic Feet
Total ZVI Volume	482	Cubic Feet
Height of Grade 1 Wood Chips (Cell Height)	12.0	Feet
Thickness of Grade 1 Wood Chips	2	Feet
Volume of Distribution Layer	1,071	Cubic Feet

Follow requirements for permit-required confined space entry for entry into the treatment cells or metering manhole. These hazards shall be addressed prior to entry. Safety personnel may require use of a combustible gas indicator for entry.

Assemble the following tools, materials, and equipment as required by the estimated volume of material to be removed:

- Erosion control materials such as straw wattles or silt fence;
- Aluminum or fiberglass extension ladder with an extended length of at least 25 ft;
- Shovels;
- Logbook;
- Standard garden cultivator rake or equivalent;
- Pry bars and other manual tools for breaking up crust/scraping walls clean;
- Air compressor, chippers or air hammers, and/or other tools for breaking up crust (it is not likely this will be needed, but there is some potential);
- Excavator with sufficient reach to remove material from cell;
- Plastic sheeting;
- Gravel;
- Concrete mixer or similar mixing device;
- ZVI;
- Pump capable of draining treatment cell along with necessary hoses;
- Dump truck or other means of containment and transport for spent material;
- Plumber's snake (at least 50 ft long);
- Portable generator;
- Equipment required for a permit-required confined space entry;
- PVC piping and well screen;
- Utility knife;
- Water storage tank;
- Tape measure; and
- HDPE plastic sheeting.

Perform the following steps:

[1] Establish erosion controls downgradient of the area that will be disturbed by the construction activities, as required.

[2] Protect metering manhole, PZs, wells (including collection well, SPIN), valves, and solar array/battery system outside of cell with additional riser pipes, barricades, or equivalent and appropriate methods if in the way of operations.

[3] Establish appropriate waste management process in coordination with Environmental Compliance staff.

[4] Establish waste management area lined with plastic sheeting upgradient (south) of the treatment cell. Design area to be large enough to accommodate removed media that will be disposed of as waste. Because of the sharp edges and abrasive nature of the iron/gravel media, consider multiple layers of plastic or other appropriate means of improving protection. Install wattles or berms around waste management area to help contain waste piles in the event of precipitation.

[5] Establish stockpile area for wood chip and soil overburden, and line with plastic sheeting. These materials should be segregated to the extent feasible (i.e., separate soil and wood chip piles, both separated from the waste management area) and replaced as overburden on new media.

[6] Remove guardrails to allow better access to the SPPTS East Cell.

[7] Seal off vent openings to prevent material from falling into pipes.

[8] Check valves to ensure system is configured to bypass the East Cell as follows: Close valves V-103 (transfer line), V-201 (East Cell inlet), and V-202 (East Cell outlet). Open valves V-101 (West Cell inlet) and V-102 (West Cell outlet). Valve locations are shown on as-builts in Appendix B and are labeled in the field.

[9] Measure and record the depth to water in the cell via the vent risers.

IF required,
THEN remove water by placing a pump or pump intake into the easternmost (effluent) vent riser of the East Cell, just south of valve V-202. Place pump discharge line into metering manhole. (This water has been treated.) Remove as much water as possible.

IF water flows over the wall between the cells during media removal,
THEN close the influent valve into the treatment cell (valve V-101) and shut off the solar-powered pump in SPIN.

[10] Remove topsoil and wood chips down to the top of the East Cell. ***The top of the East Cell media is approximately 14 ft 9 inches below the top of the south wall of the treatment system.*** As much as possible, keep topsoil and wood chips segregated from each other for reuse as fill; place on plastic liner in designated stockpile area.

[11] Pull back or remove the HDPE sheet. Remove wood chips under the HDPE and dispose as waste.

[12] Continue to remove gravel and gravel/iron mixture. Remove the distribution piping when it is encountered at the base of the coarse gravel layer. Place removed material in waste storage area.

Note **Piping needs to be separated/cut off with at least 6 inches remaining inside the tank (measured from the inside surface of the wall) so that new piping can be added.**

[13] Break up hardened media either using an excavator, backhoe with hoe ram attachment, or hand-held equipment.

IF using hand-held equipment,
THEN place the ladder into the treatment cell and secure. Use air hammers with chisel attachments (or equivalent) to break away remaining material from wall of treatment cell and loosen other material as needed.

[14] Using excavator/backhoe bucket or similar device, remove loose media from the cell. Stage removed material in waste storage area or load directly into waste containers or dump trucks for disposal. Repeat media removal steps as needed to remove the material from each treatment cell. Continue water removal as necessary.

[15] Remove remaining iron along with gravel at the bottom of the treatment cell. Remove PVC piping from bottom of the cell. Stage for removal as waste.

Note **Piping needs to be separated/cut off with at least 6 inches remaining inside the tank (measured from the inside surface of the wall) so that new piping can be added.**

[16] Measure the height, width, and length of the treatment cell and the height from the bottom of the cell to the inlet and outlet piping. Record in logbook or on maintenance form.

[17] While the treatment cell is empty, push a snake or other suitable flexible object through the influent and effluent lines as far as possible to remove debris. Use care so as not to damage external PVC piping and valves.

[18] Place a 3-inch-deep coarse gravel layer in the bottom of the cell. Rake this gravel drainage layer so that it is level.

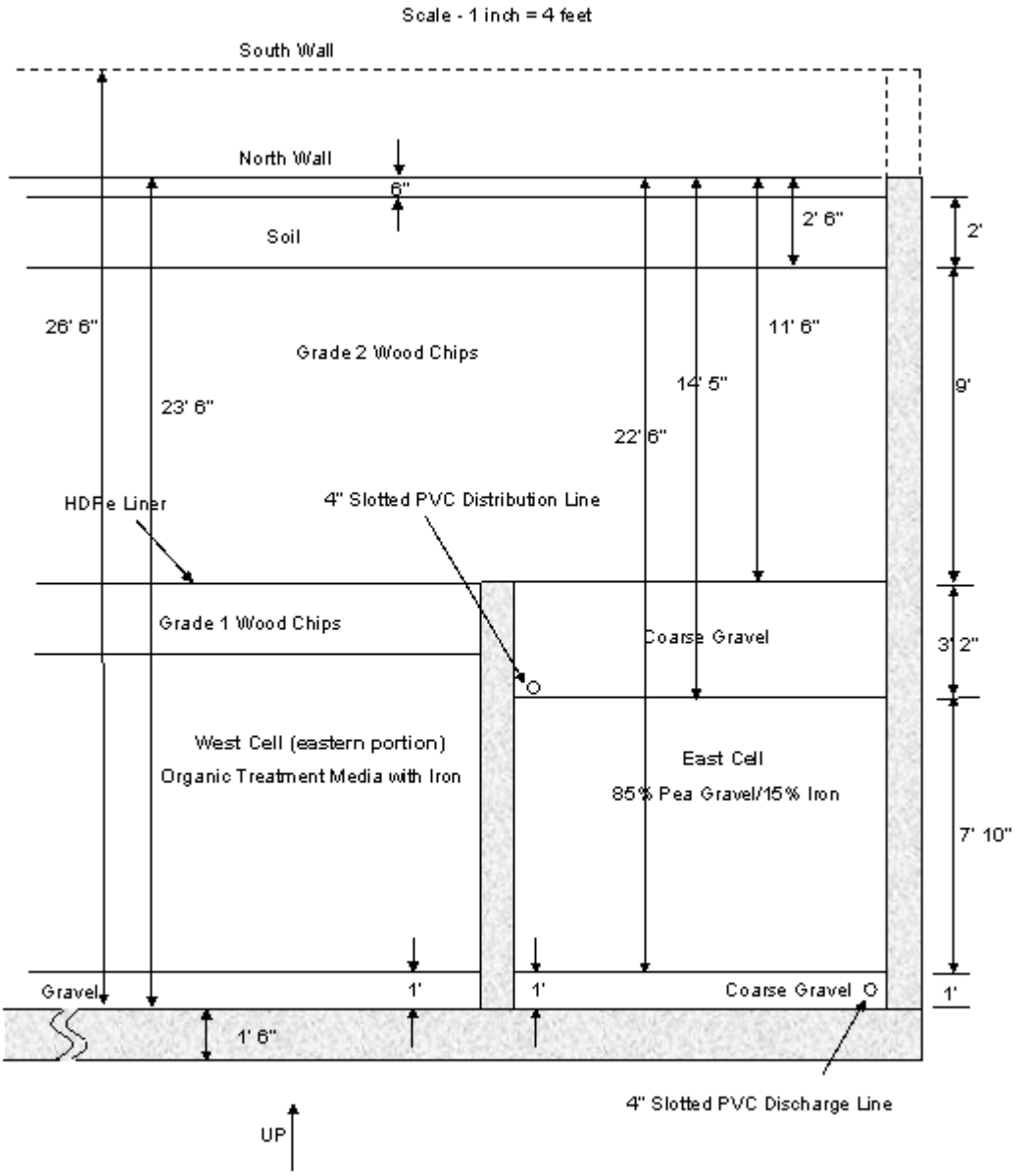
[19] Inspect PVC stubs remaining from cell influent and effluent lines, modify cut ends as necessary to ensure new lines will couple smoothly.

[20] Assemble discharge line using machine-slotted or perforated 4-inch Schedule 80 PVC pipe as shown in Drawing 51649-0401 in Appendix B. If slots or perforations are not finer than the fine fraction of the ZVI/gravel mixture, the pipe should be wrapped or sleeved in permeable fabric (such as heavy-duty landscaping fabric) to prevent clogging of the discharge line, because a clogged line would require repeating this entire process. Apply primer followed by PVC cement to the ends of pieces of pipe to be joined. Connect new line to stub of existing line using a 4-inch coupler (socket-to-socket connector).

[21] Place the remainder of the coarse gravel in the bottom of the cell to the depth listed in Table 6. Rake the gravel so that it is level.

[22] Add the mixture of 15 percent ZVI/85 percent pea gravel (by volume) in lifts, raking each lift so that it is level. Continue until media reach the height listed in Table 6 and as shown on Figure 5. The ZVI and gravel shall be completely mixed in a concrete mixer or similar mixing device and the first several feet of this mixture shall be placed carefully to minimize disruption of the coarse gravel drainage layer.

[23] Place 2 inches of coarse gravel at the top of the ZVI/gravel mixture.



Note: Wood chip types are suggested but are not critical. Any bulk wood chips will be satisfactory. The objective is to provide insulating overburden without excessive weight that might damage the internal plumbing or cause excessive compaction of the organic media.

Figure 5. Cross-Section of East Cell and Easternmost Portion of West Cell Looking North

[24] Assemble the distribution piping using machine-slotted or perforated 4-inch Schedule 80 PVC pipe as shown in Drawing 51649-0401 (Appendix B) using PVC primer and cement as described above. Connect to existing PVC stub using a 4-inch coupler. Place the distribution piping as shown on Drawing 51649-0401 in Appendix B.

[25] Open valves V-101 (West Cell inlet), V-202 (East Cell outlet), and V-103 (transfer line). Ensure valves V-102 (West Cell outlet) and V-201 (East Cell inlet) are closed. Assure solar-powered pump is on. Check to make sure water is flowing in.

IF water is not flowing into the cell or is flowing slowly,
THEN additional nonchlorinated water may be required to fill the cell. Check the water level in SPIN to confirm a sufficient supply of groundwater for the pump (see Table 5). If there is sufficient supply, periodically (over the course of an hour or so) check the water levels in the West Cell via the vent risers to confirm the water level in that cell is rising. Insufficient groundwater will require addition of nonchlorinated water to fill up the cell to the distribution line.

Any water added to the system shall not be chlorinated.

[26] Verify water flows out the flume in the metering manhole.

[27] Add the rest of the gravel to the level listed in Table 5 and level the surface as shown on Figure 5. Add this gravel carefully to avoid damaging the PVC distribution piping.

[28] Place the original HDPE or new plastic sheeting to fit completely over the East Cell as shown on Figure 5. (The original sheet may be repaired with cargo pit tape or equivalent if cuts are less than 2 ft long.)

[29] Replace the wood chips stockpiled from above the HDPE sheeting as shown on Figure 5. Level the surface.

[30] Replace topsoil that was stockpiled and level the surface.

[31] Replace the railings.

[32] Manage/dispose of wastes properly. Remove miscellaneous trash, unnecessary erosion controls, etc. to restore the area.

[33] Document routine operations in the Monthly Inspection Log (Appendix F) and the Rocky Flats maintenance log on the Condor server.

3.10 Present Landfill Treatment System

The PLFTS requires much less in the way of maintenance than the other three systems at the Rocky Flats Site (RFS) because it is much simpler, consisting of an engineered aeration surface. Most of the activity at the PLFTS is in the form of inspections and routine sample collection. Refer to the PLF Monitoring and Maintenance (M&M) Plan (DOE 2008) for details on required PLF inspections and sampling. The activities below should be considered suggestions supporting the regulatory-required activities in the M&M Plan, as the PLFTS has no specific maintenance requirements other than inspections.

Inspect the system when performing an inspection of the PLF or more frequently if conditions indicate this is warranted. Perform the following steps:

[1] Look for cracks in the north and south manholes and the treatment unit (surface and 10 steps).

- Document observations.
- If cracks are found, notify management immediately.

[2] Look for blockage of the influent and effluent pipes. These include the GWIS influent pipes (two), east face strip drain influent pipe, north and south manhole effluent pipes, and treatment unit effluent pipe.

- Document observations.
- If blockage is found, remove it if this can be easily and safely accomplished. If additional effort, planning, or equipment is required, notify management.

[3] Confirm all grating is present and in good condition.

- Document observations.
- Replace damaged or missing grating with equivalent material.

[4] Look for excessive erosion along the pathway from the treatment unit effluent pipe to the Landfill Pond.

- Document observations.
- If excessive erosion is evident, notify management.

4.0 Documentation of Maintenance

While in the field, maintenance to the groundwater treatment systems shall be documented in the Monthly Inspection Log for Rocky Flats Groundwater Treatment Systems (Appendix F). Additionally, maintenance activities shall be recorded in the Rocky Flats maintenance log on the Condor server (\\Condor\Projects\ESL\VDV\SOARS\User Files\Activity Logs). A single electronic maintenance log for all three similar systems will be kept to document system checks and repairs.

Completed maintenance logs will be kept on file (both electronic and hard copy) with the manager responsible for these systems. In addition to providing a maintenance record that can support troubleshooting and compliance, this information also will be used to interpret the flow meter data.

5.0 References

DOE (U.S. Department of Energy), 2008. *Present Landfill Monitoring and Maintenance Plan and Post-Closure Plan, U.S. Department of Energy Rocky Flats Site,* March.