ROCKY MOUNTAIN ARSENAL

2024 BASIN F COVER AND GROUNDWATER MONITORING REPORT

Revision 0 November 19, 2024

U.S. Department of the Army Shell Oil Company

Prepared by:



Navarro Research and Engineering, Inc.

TABLE OF CONTENTS

Sec	tior	Page						
EXE	CU	TIVE SUMMARY ES-1						
1.0	0 INTRODUCTION AND METHODOLOGY							
2.0		INSPECTIONS AND MAINTENANCE 1						
	2.1	Precipitation and Weather Conditions4						
3.0		PERCOLATION MONITORING ASSESSMENT						
4.0		COVER SOIL THICKNESS LOSS						
5.0		VEGETATION PERFORMANCE ASSESSMENT7						
6.0		GROUNDWATER MONITORING 8						
	6.1	Groundwater Levels						
	6.2	Well Network Analytical Results9						
	6.3	WP Well Prediction Limit Exceedances9						
	6.4	PT Well Prediction Limit Exceedances10						
	6.5	Groundwater Monitoring Conclusions11						
7.0		NON-ROUTINE ACTIONS AND O&M CHANGES11						
	7.1	Non-Routine Actions11						
	7.2	O&M Changes						
8.0		CONCLUSIONS AND CORRECTIVE MEASURES						
9.0		FY24 COSTS AND FY25 BUDGETS 12						
10.	0	REFERENCES						



TABLES

- 2.0-1 Cover Inspections
- 2.0-2 Basin F Inspection Observations and Repairs
- 2.0-3 Basin F Vegetation Management
- 3.0-1 Monthly Percolation Measurements
- 3.0-2 Rolling Nine-Month Percolation Totals
- 3.0-3 Rolling Twelve-Month Percolation Totals
- 4.0-1 Soil Cover Thickness Loss
- 5.0-1 Vegetation Performance Assessment Summary

FIGURES

- 1.0-1 Site Location Map
- 2.0-1 2024 Basin F Routine and Non-Routine Maintenance Activities
- 2.1-1 Average Monthly Temperature for FY24
- 2.1-2 Average Monthly Precipitation for FY24

APPENDICES

- A Precipitation Data (October 1, 2023 through September 30, 2024)
- B 2024 Vegetation Performance Assessment Documentation
- C Cover Inspection Documentation (October 1, 2023 through September 30, 2024)
- D Maintenance and Repair Documentation (October 1, 2023 through September 30, 2024)
- E 2024 Basin F Post-Closure Groundwater Monitoring Report
- F Non-Routine Action Plans
- G Operations and Maintenance Change Notices



ACRONYMS

AMA	Army Maintained Areas
CPMSO2	p-Chlorophenylmethyl sulfone
DCPD	Dicyclopentadiene
DIMP	Diisopropylmethyl phosphonate
FY24	Fiscal Year 2024
FY25	Fiscal Year 2025
IC	Indicator Compound
LTCP	Long-Term Care Plan
NNDMEA	n-Nitrosodimethylamine
NRAP	Non-Routine Action Plan
NWS	National Weather Service
0&M	Operations and Maintenance
OCN	O&M Change Notice
PCGMP	Post-Closure Groundwater Monitoring Plan
РСР	Post-Closure Plan
PT	Principal Threat
RCRA	Resource Conservation and Recovery Act
RMA	Rocky Mountain Arsenal
SOP	Standard Operating Procedure
SQAPP	Sampling Quality Assurance Project Plan
TCLEE	Tetrachloroethene
UFS	Unconfined Flow System
UPL	Upper Prediction Limit
USFWS	United States Fish and Wildlife Service
WP	Wastepile



EXECUTIVE SUMMARY

This 2024 Basin F Cover and Groundwater Monitoring Report for the Rocky Mountain Arsenal (RMA) was prepared in accordance with the Basin F Post-Closure Plan (PCP), Revision 2 (Navarro 2023b) and the RCRA-Equivalent, 2-, and 3-Foot Covers Long-Term Care Plan (LTCP), Revision 3 (Navarro 2021b). The purpose of this report is to evaluate compliance with post-closure requirements, document cover inspection and monitoring results and maintenance activities performed during Fiscal Year 2024 (FY24) (i.e., October 1, 2023 to September 30, 2024), and to describe plans to improve or sustain cover conditions. This report addresses the fifteenth year of Operations and Maintenance (O&M) for the Basin F Cover since construction finished with the Final Inspection in March of 2010. The Basin F Army Maintained Area (AMA) is currently in post-closure as defined in Section 1.0 of the Basin F PCP, and in the long-term O&M Period defined in Section 1.0 of the LTCP. Figure 1.0-1 illustrates the location of the Basin F AMA within the RMA National Wildlife Refuge.

The Basin F Cover was in excellent condition throughout FY24. Cover deficiencies observed during the reporting period include prairie dog activity, expansion joint and Carsonite marker damage, which are all typical for the site and addressed through routine maintenance activities.

Percolation collected at each of the lysimeters on Basin F was below the non-routine action trigger level and met the compliance standard.

Soil cover thickness loss met the compliance standard and was below the non-routine action trigger level for FY24.

The 2024 Vegetation Performance Assessment was performed on the Basin F Resource Conservation and Recovery Act (RCRA)-Equivalent Cover. The total live vegetation values were well above the compliance standard. The two-year average and three-year average of total ground cover were also comfortably above the minimum compliance standard values.

Upgradient and downgradient groundwater data collected during post-closure monitoring of Wastepile (WP) and Principal Threat (PT) wells were evaluated to demonstrate post-closure O&M of the Basin F surface impoundment and that the Basin F WP meets the RCRA closure performance standards. Sampling of all nine Basin F network wells was conducted in April and May of 2024.

Similar to previous years, groundwater flow in the vicinity of Basin F is generally to the north. A groundwater divide has become evident as local and regional water levels have decreased, resulting in groundwater flow to the north-northwest and north-northeast beneath the north end of the former Basin F.



The overall decrease in unconfined flow system water levels in the vicinity of Basin F is consistent with a general decreasing trend noted across RMA over the past several years. Historical changes in water levels in wells near Basin F are consistent with regional fluctuations in the water table and are not related to the performance of the Basin F cover.

Based on the distribution of the analyte concentrations and water quality trends, it appears that the PT groundwater flow path is having a greater impact on water quality downgradient of the former Basin F compared to the WP flow path. Concentrations downgradient of the PT indicate an impact due to contaminated groundwater migrating from upgradient sources and/or residual contamination within the unsaturated zone beneath the Basin F PT area.

In accordance with the *Basin F Post-Closure Groundwater Monitoring Plan*, Revision 2 (Navarro 2023b, Appendix B), there are no chemical-specific standards that apply to Basin F groundwater since the RMA remedy addresses contaminated groundwater downgradient at the North Boundary Containment System and Northwest Boundary Containment System, where it is extracted and treated.

Routine inspections and maintenance of the Basin F AMA will continue throughout FY25 in accordance with the requirements of the Basin F PCP. The Basin F RCRA-Equivalent Cover met the compliance standards for percolation, cover soil thickness, and vegetation in FY24. No corrective measures are planned for Fiscal Year 2025 (FY25).

Cost incurred performing post-closure care of the Basin F AMA during FY24, including groundwater sampling described in the *Optimization Plan for the Basin F Post-Closure Groundwater Monitoring Network,* Revision 1 (Navarro 2023a) was \$221,655. The estimated FY25 budget is \$282,709.



1.0 INTRODUCTION AND METHODOLOGY

This 2024 Basin F Cover and Groundwater Monitoring Report for the Rocky Mountain Arsenal (RMA) was prepared in accordance with the Basin F Post-Closure Plan (PCP), Revision 2 (Navarro 2023b) and the RCRA-Equivalent, 2-, and 3-Foot Covers Long-Term Care Plan (LTCP), Revision 3 (Navarro 2021b).

The purpose of this report is to evaluate compliance with post-closure requirements, document cover inspection and monitoring results and maintenance activities performed during Fiscal Year 2024 (FY24) (i.e., October 1, 2023 to September 30, 2024), and to describe plans to improve or sustain cover conditions. This report addresses the fifteenth year of Operations and Maintenance (O&M) for the Basin F Cover since construction finished with the Final Inspection in March of 2010. The Basin F Army Maintained Area (AMA) is currently in post-closure as defined in Section 1.0 of the Basin F PCP, and in the long-term O&M Period defined in Section 1.0 of the LTCP. Figure 1.0-1 illustrates the location of the Basin F AMA within the RMA National Wildlife Refuge.

The Basin F Resource Conservation and Recovery Act (RCRA)-Equivalent Cover and associated non-cover area within the outside shoulder of the perimeter access road, collectively referred to as the Basin F AMA, was inspected, monitored, repaired, and maintained in accordance with the Basin F PCP, Revision 2. The results of inspections and monitoring of vegetation, percolation, and cover soil thickness were used to verify cover performance and to trigger cover maintenance and repair activities.

2.0 INSPECTIONS AND MAINTENANCE

The procedure for inspecting soil cover conditions and infrastructure features is detailed in Basin F PCP Standard Operating Procedure (SOP) 001, *Cover Conditions Inspections*. Routine maintenance and repair activities are listed in Table 3.2-1 of the Basin F PCP, while conditions requiring non-routine actions are listed in Table 3.2-2 of the Basin F PCP.

All inspections were performed in accordance with SOP 001 presented in Appendix A of the PCP. A summary of inspections is provided in Table 2.0-1.

Date	Inspection Type	Note
October 12, 2023	Type I with erosion/settlement monuments	Regularly scheduled semiannual inspection.
January 3, 2024	Туре І	Regularly scheduled quarterly inspection.
April 4, 2024	Type II	Regularly scheduled semiannual inspection.

Table 2.0-1: Cover Inspections



Date	Inspection Type	Note				
May 1, 2024	Post-Storm	1.27" of rain fell on April 27, 2024.				
July 3, 2024	Туре І	Regularly scheduled quarterly inspection.				

Figure 2.0-1 illustrates the locations of maintenance activities performed on the Basin F AMA. Completed inspection forms are provided in Appendix C of this report. Documentation of maintenance activities is provided in Appendix D of this report.

Summaries of observations and repairs are provided in Table 2.0-2. Summaries of vegetation management are provided in Table 2.0-3.

Inspection Item	Observation	Action
Erosion rills, gullies, or sheet erosion	None	N/A
Conditions that could interrupt cover surface drainage (ponding areas, ruts, holes greater that 3" in diameter)	None	N/A
Excessive animal trails	None	N/A
Widespread burrowing animal holes	Prairie dog holes were identified on the northwest corner of Basin F. (Inspection Form 7/3/24)	Animal and Pest Control Services made multiple site visits in July and August to fumigate prairie dog holes in the northwest portion of the Basin F AMA. During these events, holes were identified on the southeast portion of the Basin F AMA and these holes were also treated. Holes were also fumigated approximately 100 feet east of the east Basin F perimeter road.
Extensive linear cracks	None	N/A
Vandalism, or intrusive damage such as unplanned excavation, drilling, grading, damage to engineering or access controls	None	N/A

Table 2.0-2: Basin F Inspection Observations and Repairs



Inspection Item	Observation	Action
Bare area or areas of poor growth greater than 100 square feet	None	N/A
Areas of vegetation stress greater than 100 square feet (over grazing, discoloration, pedestalling)	None	N/A
Deep rooted, noxious, or undesirable weedy species	None	N/A
Excessive litter accumulation	None	N/A
The Basin F AMA perimeter fence is damaged	None	N/A
Debris has collected along the Basin F AMA perimeter fence	None	N/A
Obelisks are damaged, not visible, or not legible	None	N/A
Warning signs are not legible from 25 feet	None	N/A
Damage to the Perimeter Access Road such as potholes, washouts, washboard, or burrowing	None	N/A
Impeded drainage or ponding in the channel (siltation/debris present)	None	N/A
Inadequate protective vegetation	None	N/A
Erosion rills or gullies in the grass- lined channel	None	N/A
Cracked or degraded concrete	None	N/A
Expansion joint damage (missing caulk)	Caulk was identified to be missing from some of the expansion joints in Channels 24 and 25. (Inspection Form: 5/1/24)	Not addressed during this reporting period.
Inhibited drainage from the soil to the concrete-lined channel	None	N/A
Subsidence or undercutting of the concrete-lined channel	None	N/A

2024 BF CGMR - Rev 0



Inspection Item	Observation	Action
Erosion/Settlement Monuments	None	N/A
Basin F Percolation Monitoring System Data Collection and Operation Form SOP 003-1	Lysimeter 017 needs a new Carsonite marker. The old one was damaged in the prescribed burn in March of 2024. (Inspection Form SOP 003-1: 5/1/24)	Replaced the Carsonite marker in May of 2024.

The maintenance items listed below are focused on routine vegetation management to facilitate effective O&M of the Basin F cover. These maintenance items were often observed independently of routinely scheduled inspections due to the timing of seasonal growth.

Table 2.0-3: Basin F Vegetation Management

Task	Action	Date
Weed Control	Ground clear herbicide Plainview SC [®] was broadcast sprayed to working surfaces.	October 2023
Mowing	Mowed around the exterior and interior of the perimeter fence in anticipation for a prescribed burn.	October 2023
Prescribed burn	United States Fish and Wildlife Service (USFWS) performed a successful prescribed burn on the entire Basin F AMA.	March 2024

Non-Routine Action Plan (NRAP)-2023-002 (Navarro 2023c) documented the prescribed burn of the Basin F AMA that was successfully performed by the USFWS in March of 2024. This NRAP was approved in October of 2023.

2.1 Precipitation and Weather Conditions

The rain gauge located west of the Lime Basins RCRA-Equivalent Cover, near the Lime Basins Metering Building collects precipitation data for the RMA. The precipitation measured at the Lime Basins gauge during FY24 was 11.31 inches. Precipitation data are provided in Appendix A. A significant rain event, greater than 1.0 inch in 24 hours, occurred on April 27, 2024.

Figures 2.1-1 and 2.1-2 illustrate the Rocky Mountain Region's monthly temperature and precipitation values for FY24 as published by the National Oceanic and Atmospheric Administration, National Weather Service (NWS) Forecast Office for Denver/Boulder, Colorado. Climate data reported by the NWS were collected at the Primary Local Climatological Data Site, located at the Denver International Airport. FY24 had near average temperatures and above normal spring precipitation in the Rocky Mountain Region.



3.0 PERCOLATION MONITORING ASSESSMENT

The Basin F RCRA-Equivalent Cover uses a network of five lysimeters to monitor deep percolation. Percolation is reported in millimeters, which is calculated by dividing the measured percolation volume by the area of the lysimeter pan. Lysimeters 016, 017, 018 and 019 each have a surface area of 1,500 square feet (139.35 square meters), while Lysimeter 020 has a surface area of 7,500 square feet (696.75 square meters).

The procedure for monitoring percolation is detailed in Basin F PCP SOP 003, *Percolation Monitoring System Data Collection and Operation*. All lysimeter inspections were performed in accordance with SOP 003 and the inspection documentation is provided in Appendix C.

Quarterly submission of percolation monitoring results for all cover lysimeters were issued to the regulatory agencies. Each quarterly submittal included monthly measurements, 9-month cumulative totals, and 12-month cumulative totals. Percolation data for FY24 were transmitted in December (Navarro 2023d), March (Navarro 2024b), June (Navarro 2024c), and September (Navarro 2024e).

The percolation measurements are presented in Table 3.0-1. Table 3.0-2 presents rolling ninemonth percolation totals for comparison to the non-routine action trigger level of 1.0 mm in nine months, and Table 3.0-3 presents twelve-month rolling totals for comparison to the compliance standard of 1.3 mm in 12 months.

Lysimeter No.		Monthly Percolation Measurement (Liters)										
	Oct-23	Nov-23	Dec-23	Jan-24	Feb-24	Mar-24	Apr-24	May-24	Jun-24	Jul-24	Aug-24	Sep-24
016		0						0		0		0
017		0						0		0		0
018		0						0		0		0
019		0						0		0		0
020		0						0		0		0

Table 3.0-1: Monthly Percolation Measurements

Note 1: Basin F lysimeters are inspected in May, July, September, and November.



No.		Rolling Nine-Month Percolation Total (mm)											
Lysimeter	Oct-23	Nov-23	Dec-23	Jan-24	Feb-24	Mar-24	Apr-24	May-24	Jun-24	Jul-24	Aug-24	Sep-24	
016	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
017	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
018	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
019	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	

Table 3.0-2: Rolling Nine-Month Percolation Totals

No.		Rolling Twelve-Month Percolation Total (mm)											
Lysimeter	Oct-23	Nov-23	Dec-23	Jan-24	Feb-24	Mar-24	Apr-24	May-24	Jun-24	Jul-24	Aug-24	Sep-24	
016	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
017	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
018	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
019	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	

All Basin F lysimeters have met the compliance standard throughout the reporting period.

4.0 COVER SOIL THICKNESS LOSS

The Basin F RCRA-Equivalent Cover includes a network of 18 erosion/settlement monuments embedded within the cover soil on a 500-foot grid. Cover soil thickness loss was measured at each of the monuments during the inspections in October of 2023 and April of 2024 in accordance with Basin F PCP SOP 001, *Cover Conditions Inspections*. The measurements for each monument are provided on Table 4.0-1 and inspection documentation is provided in Appendix C.



Monument No.	Oct 11, 2023 Loss (in.)	Apr 3, 2024 Loss (in.)
ER92	0.00	0.00
ER93	0.00	0.00
ER94	0.00	0.00
ER95	0.25	0.00
ER96	0.00	0.00
ER97	0.25	0.00
ER98	0.00	0.00
ER99	0.75	0.00
ER100	0.00	0.00

Table 4.0-1: Soil Cover Thickness Loss

Monument No.	Oct 11, 2023 Loss (in.)	Apr 3, 2024 Loss (in.)
ER 101	1.25	0.75
ER102	0.25	0.00
ER103	0.00	0.00
ER104	1.25	1.00
ER105	0.00	0.00
ER106	0.00	0.00
ER107	0.50	0.00
ER108	0.00	0.00
ER109	0.00	0.00

All measurements were below the compliance standard of 0.5 foot.

5.0 VEGETATION PERFORMANCE ASSESSMENT

The 2024 Vegetation Performance Assessment was conducted on September 19, 2024, in accordance with Basin F PCP SOP 002, *Cover Vegetation Performance Assessment*. A map showing the pre-selected sample locations and bearings is included in Appendix B of this report.

Results of the assessment are summarized on Table 5.0-1. Appendix B includes additional tables that provide cover and frequency by species, expanded vegetation performance assessments providing two and three year running average comparisons, sample adequacy checks, and raw transect data. These tables meet the reporting requirements set forth by the *Revegetation of the Basin A Soil Cover*, developed during the Basin A dispute resolution process in 1999.

Table 5.0-1: Vegetation Performance Assessment Summa
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Performance Criterion and Evaluation	Annual Value	Was the criterion met?	Is this a compliance criterion?
Allowable Total Absolute Live Vegetation Cover ≥ 25%	83.6	Yes	Yes
Two Year Running Average for Total Absolute Ground Cover ≥ 50%	91.7	Yes	Yes
Three Year Running Average for Total Absolute Ground Cover ≥ 67%	91.78	Yes	Yes



Performance Criterion and Evaluation	Annual Value	Was the criterion met?	Is this a compliance criterion?
Sample Adequacy ≤ 5	0.04	Yes	No
Relative Weed Cover ≤ 10%	0	Note 1	No

Note 1: The relative weed cover is less than 10 percent, therefore, subtracting all but 10 percent of the total live vegetation cover fraction that is comprised of weeds does not affect the Total Live Vegetation calculation. The Total Live Vegetation values are within the Non-Routine Action Trigger Levels.

The Basin F RCRA-Equivalent Cover met all three vegetation-related compliance standards (i.e., total absolute live vegetation cover, two-year running average for total absolute ground cover, and three-year running average for total absolute ground cover).

In 2024 the vegetation community was primarily composed of cool season grass species which interrupts a trend of warm season grasses primarily being observed over the past few years. The shift in cool season grasses may be attributed to the early spring precipitation and prescribed burn that was conducted in March of 2024. The prescribed burn was beneficial to the health of established native perennial grasses and removed the litter left behind after the robust growth of vegetation during the above average precipitation experienced during Fiscal Year 2023.

There did not appear to be excessive stress due to low soil moisture or biological stressors on the grassland community at the time of the assessment. Insects and other wildlife, such as small rodents, grassland birds and deer were observed in all areas.

6.0 GROUNDWATER MONITORING

This section summarizes the water level monitoring, analytical results, and statistical evaluation of groundwater quality for the 2024 post-closure groundwater monitoring at Basin F. Refer to the 2024 Basin F Post-Closure Groundwater Monitoring Report, provided in Appendix E of this report for a complete set of water level monitoring data and analytical results, as well as a statistical evaluation of groundwater quality in both Basin F groundwater monitoring networks.

Groundwater monitoring being conducted under the *Optimization Plan for the Basin F Post-Closure Groundwater Monitoring Network* (Navarro 2023a) is outside of the scope of postclosure monitoring, and data collected under this plan will be evaluated and presented in a separate report upon completion of the program in late 2026.

6.1 Groundwater Levels

Groundwater levels were measured in March 2024 in 27 Basin F network wells to evaluate unconfined flow system (UFS) conditions in the area of Basin F. Additional wells used to further delineate the water table in the vicinity were measured during the same time. Similar to



previous years, groundwater flow in the vicinity of Basin F is generally to the north. A groundwater divide has become evident as local and regional water levels have decreased, resulting in groundwater flow to the north-northwest and north-northeast beneath the north end of the former Basin F.

Water levels measured in the nine Basin F water quality network wells since 2006 are shown on hydrographs in Appendix E of this report. Beginning in 2018, groundwater elevations began to decrease in all wells with the exception of well 26128. Groundwater in well 26128 shows an increasing trend from 2014 through 2018, but has decreased since 2019. Water level data for well 26128 appears different from the other wells in the vicinity of Basin F because it is screened deeper within the unweathered Denver Formation. As such, this well does not provide an accurate depiction of the UFS upgradient of Basin F. The overall decrease in UFS water levels in the vicinity of Basin F is consistent with a general decreasing trend noted across RMA over the past several years (Navarro 2021a). Historical changes in water levels in wells near Basin F are consistent with regional fluctuations in the water table and are not related to the performance of the Basin F cover.

6.2 Well Network Analytical Results

Groundwater samples were collected from the wells identified in the Basin F Waste Pile (WP) and Principal Threat (PT) groundwater monitoring networks in accordance with procedures defined in the *Basin F Post-Closure Groundwater Monitoring Plan* (PCGMP), and the *Rocky Mountain Arsenal Sampling Quality Assurance Project Plan* (SQAPP) (Navarro 2019). Samples collected during post-closure monitoring were submitted to Applied Research and Development Laboratory in Mount Vernon, Illinois. The analytical methods were developed as described in the SQAPP. The groundwater samples were tested for the analytes and indicator compounds (ICs) listed in the Basin F PCGMP. Analytical data for the 11 ICs applicable to the Basin F water quality network wells are presented in Appendix E of this report.

6.3 WP Well Prediction Limit Exceedances

The 2024 Basin F WP upper prediction limits (UPLs) were applied to data for downgradient wells 26015 and 26017. The 2023 reported values for ICs detected in wells exceeding their respective UPLs are presented in Appendix E of this report. The following analytes were detected at concentrations exceeding their respective UPLs in 2024.

<u>Well 26015</u>	<u>Well 26017</u>
Chloroform	Dieldrin
Dieldrin	

The concentrations of chloroform and dieldrin in exceedance of their respective UPLs are within the historical range of detected concentrations and their presence is likely attributable to



higher water levels that have mobilized residual contamination and have remained as the water table has decreased over the past few years.

The reported concentrations of analytes not listed above and detected in downgradient Basin F WP wells are below the respective UPLs. Based on the UPL comparison, it appears that groundwater quality downgradient of the Basin F WP area has been affected in the vicinity of wells 26015 and 26017.

6.4 PT Well Prediction Limit Exceedances

The 2024 Basin F PT UPLs were applied to data for downgradient wells 26015, 26133, 26157, 26163 and 26173. The 2024 reported values for ICs detected in wells exceeding their respective UPLs are presented in Appendix E of this report. The following analytes were detected at concentrations exceeding their respective UPLs in 2024.

<u>Well 26133</u>	<u>Well 26157</u>	<u>Well 26163</u>	<u>Well 26173</u>
Chloroform	CPMSO2	Arsenic	CPMSO2
CPMSO2	DCPD	Chloride	DCPD
DCPD	NNDMEA	Copper	Dieldrin
Dieldrin	TCLEE	CPMSO2	TCLEE
NNDMEA		DCPD	
TCLEE		DIMP	
		NNDMEA	
		TCLEE	

CPMSO2 - p-Chlorophenylmethyl sulfone

DCPD - Dicyclopentadiene

DIMP - Diisopropylmethyl phosphonate

NNDMEA - n-Nitrosodimethylamine

TCLEE - Tetrachloroethene

The 2024 concentrations of all analytes in exceedance of UPLs in wells 26133, 26157, 26163 and 26173 are within the historical ranges of detected concentrations and many are likely attributable to higher water levels that have mobilized residual contamination. The reported concentrations of analytes not listed above were not detected or were detected at levels below the respective UPLs in downgradient Basin F PT wells. Based on the statistical evaluation, it appears that groundwater quality downgradient of the Basin F PT area has been affected in the vicinity of wells 26133, 26157, 26163, and 26173.

In 2024, no analyte concentrations exceeded PT UPLs in downgradient well 26015.



6.5 Groundwater Monitoring Conclusions

Groundwater along the PT flow path appears to have been impacted by residual soil contamination that remains within the PT area and may also be impacted by sources associated with the Sand Creek Lateral located east of the former basin, as demonstrated by increases of select ICs in wells northeast of the PT area.

To a lesser extent as compared to the PT area, groundwater along the WP flow path appears to have been impacted by residual soil contamination that remains within the western portion of the Basin F area.

Based on the distribution of the analyte concentrations and water quality trends, it appears that the PT groundwater flow path is having a greater impact on water quality downgradient of the former Basin F compared to the WP flow path. Concentrations downgradient of the PT indicate an impact due to contaminated groundwater migrating from upgradient sources and/or residual contamination within the unsaturated zone beneath the Basin F PT area.

7.0 NON-ROUTINE ACTIONS AND O&M CHANGES

7.1 Non-Routine Actions

The implementation of non-routine actions is described in the Basin F PCP. The Basin F PCP provides criteria for non-routine actions, and a mechanism for consultation between the parties and documentation of the consultative outcome. NRAP-2023-002 (Navarro 2023c) was the only NRAP in FY24 applicable to Basin F. The NRAP is described in Section 2.0 of this report and is provided in Appendix F.

7.2 O&M Changes

There were two O&M Change Notices (OCNs) for Basin F prepared during this reporting period. The OCNs are included in Appendix G.

OCN-BASINF-2024-001 (Navarro 2024a) updates the language used in the Basin F PCP for consistency with the United States Army's electronic records management system requirements. The various forms found in the Basin F PCP were converted into fillable portable document format with minor format changes that were intended to facilitate form usage. This OCN was approved in March of 2024.

OCN-BASINF-2024-002 (Navarro 2024d) updated the Basin F PCP to address internal inconsistencies between the plan and SOPs 001 and 003. The PCP was also changed to address comments and requirements by Colorado Department of Public Health and Environment and United States Environmental and Protection Agency. This OCN was approved in July of 2024.



8.0 CONCLUSIONS AND CORRECTIVE MEASURES

The Basin F RCRA-Equivalent Cover met the compliance standards for percolation, cover soil thickness, and vegetation in FY24. No corrective measures are planned for Fiscal Year 2025 (FY25).

Routine inspections and maintenance of the Basin F AMA will continue throughout FY25 in accordance with the requirements of the Basin F PCP.

9.0 FY24 COSTS AND FY25 BUDGETS

Cost incurred performing post-closure care of the Basin F AMA during FY24, including groundwater sampling described in the *Optimization Plan for the Basin F Post-Closure Groundwater Monitoring Network*, Revision 1 (Navarro 2023a) was \$221,655. The estimated FY25 budget is \$282,709.

10.0 REFERENCES

Navarro (Navarro Research and Engineering, Inc.)

2024a (Mar 4)	OCN-BASINF-2024-001.
2024b (Mar 26)	Rocky Mountain Arsenal Integrated Cover System and Basin F Cover Lysimeter Monitoring Data, October 2023 through March 2024.
2024c (Jun 06)	Rocky Mountain Arsenal Integrated Cover System and Basin F Cover Lysimeter Monitoring Data, January 2024 through June 2024.
2024d (Jul 09)	OCN-BASINF-2024-002.
2024e (Sep 10)	Rocky Mountain Arsenal Integrated Cover System and Basin F Cover Lysimeter Monitoring Data, April 2024 through September 2024.
2023a (Mar 2)	<i>Optimization Plan for the Basin F Post-Closure Groundwater Monitoring Network,</i> Revision 1.
2023b (Apr 10)	Basin F Post-Closure Plan. Revision 2.
2023c (Oct 10)	NRAP-2023-002.
2023d (Dec 12)	Rocky Mountain Arsenal Integrated Cover System and Basin F Cover Lysimeter Monitoring Data, July 2023 through December 2023.
2021a (Jul 21)	Fiscal Year 2020 Annual Summary and Five-Year Summary Report for Groundwater and Surface Water. Revision 0.
2021b (Aug 12)	RCRA-Equivalent, 2-, and 3-Foot Covers Long-Term Care Plan. Revision 3.



2019 (Jan 30) Rocky Mountain Arsenal Sampling Quality Assurance Project Plan Final.



FIGURES





Legend



 Note 1. The outside shoulder of the Perimeter Access Road defines the Army Maintained Area Boundary (AMA).
 Note 2. A prescribed burn was conducted over the entire Basin F AMA.

Flow System / Aquifer Unconfined Monitoring Well/ Piezometer Network Unconfined Alluvial Alluvial/ Denver Unconfined Denver 0 Water Level Network Δ Basin F Wastepile ٠ Water Quality Network Basin F Principal Threat Water . Quality Network Optimization 0 Δ Network Wells



NAD27-NGVD29 Datum, US Survey Feet, Colorado North Zone Sources: U.S. Army, RMA GIS, OMC, Shell/AECOM



Figure 2.0-1

2024 Basin F Routine and Non-Routine Maintenance Activities

10/28/2024

M:\projects\\CSandBasinF_RoutineAndNonRoutineMaintenanceActivities\2024\BasinF_RoutineMaintenanceActivities_Oct2024.mxd

Figure 2.1-1: Average Monthly Temperature for FY24



Figure 2.1-2: Average Monthly Precipitation for FY24



APPENDICES

- A Precipitation Data (October 1, 2023 through September 30, 2024)
- B 2024 Vegetation Performance Assessment Documentation
- C Cover Inspection Documentation (October 1, 2023 through September 30, 2024)
- D Maintenance and Repair Documentation (October 1, 2023 through September 30, 2024)
- E 2024 Basin F Post-Closure Groundwater Monitoring Report
- F Non-Routine Action Plans
- G Operations and Maintenance Change Notices

Note: Software used to compile this report does not transfer electronic signatures, therefore, electronic forms provided in the following appendices are unsigned. Documentation with electronic signatures is available in the project files.

APPENDIX A

Precipitation Data

(October 1, 2023 through September 30, 2024)

Appendix A: Precipitation Data (October 1, 2023 through September 30, 2024)

Note 1: This table provides precipitation data for all dates when precipitation was recorded. For dates not shown, there was no recorded precipitation.

Note 2: The yellow highlighted boxes indicate that there was more than one inch of precipitation in a 24-hour period.

Date	Lime Basins Daily
Butt	Precipitation (in.)
October 3, 2023	0.01
October 11, 2023	0.02
October 12, 2023	0.01
October 24, 2023	0.03
October 26, 2023	0.02
October 29, 2023	0.06
October 30, 2023	0.30
October 31, 2023	0.04
November 20, 2023	0.03
November 26, 2023	0.17
December 9, 2023	0.09
December 10, 2023	0.01
December 13, 2023	0.01
December 14, 2023	0.04
December 23, 2023	0.01
December 24, 2023	0.01
December 26, 2023	0.08
December 27, 2023	0.09
January 8, 2024	0.01
January 9, 2024	0.01
January 16, 2024	0.17
January 17, 2024	0.01
January 26, 2024	0.07
February 2, 2024	0.04
February 3, 2024	0.24
February 4, 2024	0.08
February 5, 2024	0.37
February 6, 2024	0.15
February 11, 2024	0.10
February 12, 2024	0.14
February 17, 2024	0.16
February 27, 2024	0.08
February 28, 2024	0.01
March 8, 2024	0.02
March 13, 2024	0.13
March 14, 2024	0.28
March 15, 2024	0.28
March 16, 2024	0.89
March 24, 2024	0.03
March 25, 2024	0.11

Date	Lime Basins Daily Precipitation (in.)
March 26, 2024	0.17
April 1, 2024	0.09
April 2, 2024	0.01
April 16, 2024	0.17
April 18, 2024	0.02
April 19, 2024	0.05
April 20, 2024	0.28
April 21, 2024	0.26
April 25, 2024	0.18
April 26, 2024	0.36
April 27, 2024	1.27
April 28, 2024	0.02
May 11, 2024	0.04
May 12, 2024	0.36
May 15, 2024	0.08
May 20, 2024	0.03
May 21, 2024	0.22
May 30, 2024	0.68
May 31, 2024	0.03
June 9, 2024	0.19
June 10, 2024	0.01
June 19, 2024	0.01
June 20, 2024	0.04
June 26, 2024	0.12
June 29, 2024	0.01
July 2, 2024	0.03
July 16, 2024	0.06
July 18, 2024	0.01
July 20, 2024	0.27
July 21, 2024	0.05
July 27, 2024	0.01
July 28, 2024	0.01
August 2, 2024	0.01
August 5, 2024	0.30
August 6, 2024	0.11
August 10, 2024	0.01
August 13, 2024	0.19
August 15, 2024	0.01
August 19, 2024	0.02
August 22, 2024	0.05

Appendix A: Precipitation Data (October 1, 2023 through September 30, 2024)

Date	Lime Basins Daily Precipitation (in.)	
August 23, 2024	0.04	
September 4, 2024	0.04	
September 5, 2024	0.27	
September 15, 2024	0.05	
September 21, 2024	0.04	
September 22, 2024	0.62	
Total:	11.31	

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	•		

APPENDIX B

2024 Vegetation Performance Assessment Documentation

Table 5.0-1 Table 5.0-1 Cover and Frequency summary for the Basin F at Rocky Mountain Arsenal. Based on data from 5 sampling locations. 2024 data. +/- values equal the standard deviation. Incidental Species present within 1 meter on either side of the data transect, but not quantitatively encountered.	024
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Species	Mean Cover (%)	Relative Cover (%)	Range of Cover Values (%)	Percent Frequency (%)	Relative Frequency(%)	²Rank
COOL SEASON PER	RENNIAL GRA	ASSES				
Hesperostipa comata	1.2	1.44	0 - 4.00	60.0	11.11	6.0
Pascopyrum smithii	49.0	58.61	25.00 - 67.00	100.0	18.52	1.0
Sub-Total	50.2	60.05				
WARM SEASON PE	ERENNIAL GR	ASSES				
Bouteloua curtipendula	8.2	9.81	3.00 - 15.00	100.0	18.52	4.0
Buchloe dactyloides	8.4	10.05	3.00 - 15.00	100.0	18.52	3.0
Chondrosum gracile	14.4	17.22	3.00 - 25.00	100.0	18.52	2.0
Sporobolus airoides	2.4	2.87	0 - 6.00	80.0	14.81	5.0
Sub-Total	33.4	39.95				
SUM OF SPECIES COVER	83.6	100.0				

³ Total Absolute Mean Vegetation Cover	83.60	+/-0.78
³ Total Absolute Mean Litter Cover	3.40	+/-1.97
³ Total Absolute Mean Bare Soil	13.00	+/-1.45
³ Total Absolute Mean Weedy Cover	0.00	+/-0.00
Total Absolute Ground Cover	87.00	+/-1.45
Relative Weed Cover	0	
Relative Allowable Weed Cover	10.0	
Relative Non-Allowable Cover by Weeds	0.00	
Non-Allowable Absolute Weedy Cover	0.00	
Allowable Total Absolute Live Vegetation Cover	83.60	
Mean Number of Species/Sample	5.4	
Mean Species Density/100sq. meters	5.00	+/-0.59

	Incid	ental	Spe	cies	
	i.e < 0.()1 Me	an (Cover	•
-	•	• •	-		

Panicum capillare

¹ Weedy Species

² Based on total cover

³ Based on 1st hit data

Table 5.0-2

Vegetation Performance Assessment Basin F Reporting Years 2022, 2023, 2024

2024

	<u>R</u>	<u>eporting Y</u>	ear: 2022			
Species	Mean Cover (%)	Relative Cover (%)	Range of Cover Values (%)	Percent Frequency (%)	Relative Frequency(%)	²Rank
COOL SEASON PERENNIA	AL GRASSES					
Hesperostipa comata	1.47	2.06	0 - 8.00	53.33	5.71	10
Pascopyrum smithii	1.60	2.24	0 - 24.00	6.67	.71	9
Pascopyrum smithii	15.60	21.87	0 - 32.00	93.33	10.00	2
Sub-Total	18.67	26.17				
WARM SEASON PERENNI	AL GRASSE	S				
Bouteloua curtipendula	7.13	10.00	2.00 - 16.00	100.00	10.71	4
Buchloe dactyloides	10.27	14.40	3.00 - 24.00	100.00	10.71	3
Chondrosum gracile	15.87	22.25	6.00 - 32.00	100.00	10.71	1
Sporobolus airoides	3.47	4.86	0 - 9.00	86.67	9.29	8
Sporobolus cryptandrus	3.60	5.05	0 - 8.00	93.33	10.00	7
Sub-Total	40.34	56.56				

Species	Mean Cover (%)	Relative Cover (%)	Range of Cover Values (%)	Percent Frequency (%)	Relative Frequency(%)	²Rank
	<u>R</u> (<u>eporting Y</u>	<i>Cear: 2023</i>			
Vegetation Cover 2022	66.87					
Total Absolute Cover	91.93					
CRITERIA ASSESSMENT						
SUM OF SPECIES COVER	71.35	100.0				
Sub-Total	12.27	17.19	0 - 10.00	40.00	4.29	11
¹ Salsola collina ¹ Sisumbrium altissimum	6.67 1.20	9.35 1.68	2.00 - 18.00	100.00	10.71	5
¹ Bassia sieversiana	3.67	5.14	0 - 10.00	93.33	10.00	6
ANNUAL AND BIENNIAL F Amaranthus arenicola	ORBS 0.73	1.02	0 - 2.00	60.00	6.43	12
Sub-Total	0.07	0.10				
¹ Bromus tectorum	0.07	.10	0 - 1.00	6.67	.71	13
ANNUAL GRASSES						

COOL SEASON PERENNIA	L GRASSES					
Hesperostipa comata	1.00	1.15	0 - 4.00	40.00	5.00	9
Pascopyrum smithii	32.60	37.39	13.00 - 57.00	100.00	12.50	1
Sub-Total	33.60	38.54				
WARM SEASON PERENNLA	AL GRASSES	5				
Bouteloua curtipendula	9.60	11.01	0 - 18.00	80.00	10.00	4
Buchloe dactyloides	11.20	12.84	0 - 27.00	80.00	10.00	3
Chondrosum gracile	18.00	20.64	6.00 - 26.00	100.00	12.50	2
Sporobolus airoides	1.80	2.06	0 - 6.00	60.00	7.50	8
Sporobolus cryptandrus	3.40	3.90	1.00 - 9.00	100.00	12.50	5
Sub-Total	44.00	50.45				
INTRODUCED PERENNIAI	GRASSES					-
Psathyrostachys juncea	0.40	.46	0 - 2.00	20.00	2.50	10
Sub-Total	0.40	0.46				
ANNUAL GRASSES						
Panicum capillare	1.80	2.06	0 - 9.00	20.00	2.50	8
Sub-Total	1.80	2.06				
ANNUAL AND BIENNIAL F	FORBS					
¹ Bassia sieversiana	2.60	2.98	0 - 5.00	80.00	10.00	7
Descurainia incana	1.80	2.06	0 - 9.00	20.00	2.50	8

¹ Melilotus officinale	0.20	.23	0 - 1.00	20.00	2.50	11
¹ Salsola collina	2.80	3.21	0 - 9.00	80.00	10.00	6
Sub-Total	7.40	8.48				
SUM OF SPECIES COVER	87.20	100.0				
CDITEDIA ACCECCMENIT						
CRITERIA ASSESSIVIEN I						
Total Absolute Cover	96.40					
Allowable Total Absolute Live Vegetation Cover 2023	87.20					

Reporting	Year:	2024

Species	Mean Cover (%)	Relative Cover (%)	Range of Cover Values (%)	Percent Frequency (%)	Relative Frequency(%)	² Rank
COOL SEASON PERENNLA	AL GRASSES					
Hesperostipa comata	1.20	1.44	0 - 4.00	60.00	11.11	6
Pascopyrum smithii	49.00	58.61	25.00 - 67.00	100.00	18.52	1
Sub-Total	50.20	60.05				

WARM SEASON PERENNIAL GRASSES

Bouteloua curtipendula	8.20	9.81	3.00 - 15.00	100.00	18.52	4
Buchloe dactyloides	8.40	10.05	3.00 - 15.00	100.00	18.52	3
Chondrosum gracile	14.40	17.22	3.00 - 25.00	100.00	18.52	2
Sporobolus airoides	2.40	2.87	0 - 6.00	80.00	14.81	5
Sub-Total	33.40	39.95				
SUM OF SPECIES COVER	83.60	100.0				
CRITERIA ASSESSMENT						
Total Absolute Cover	87.00					
Allowable Total Absolute Live Vegetation Cover 2024	83.60					
Two year running average for Total Absolute Cover	91.7					
Three year running average for Total Absolute Cover	91.78					
¹ Weedy Species						

² Based on total cover

³ Based on 1st hit data

Sample Adequacy Check

Basin F

Year : 2024

04:84 10:82 11:84 13:85
10 : 82 11 : 84 13 : 85
11:84 13:85
13:85

Sample Adequacy = 0.04

.

(Mean value: 83.6, Sample Variance: 1.14, One Tailed Value: 1.533)
Table 5.0-4 - Basin F Cover Raw Data Report

Sampled by: Kimberly Hoffman Sample Date(s): 9/17/2024

1 - Only plant species that were hit or observed along the transect are recorded in this table.

Blank boxes indicate the species was not present on the transect.

2 - Species with cover values of 0.1 were species observed within the 100 meter zone associated with each transect,

but not recorded in the quantitative data collection for each transect.

3 - # of species/100sq meter zone

		·	Transects	5	
SPECIES/Other	04	10	11	13	19
BARE SOIL	15.0	12.0	15.0	13.0	10.0
LITTER	1.0	6.0	1.0	2.0	7.0
BOUTELOUA CURTIPENDULA	15.0	4.0	3.0	14.0	5.0
BUCHLOE DACTYLOIDES	15.0	4.0	12.0	8.0	3.0
CHONDROSUM GRACILE	23.0	3.0	25.0	14.0	7.0
HESPEROSTIPA COMATA		4.0	1.0		1.0
PANICUM CAPILLARE		0.1			
PASCOPYRUM SMITHII	25.0	67.0	41.0	48.0	64.0
SPOROBOLUS AIROIDES	6.0		2.0	1.0	3.0
Total Hits plus Incidental Species	: 100.0	100.1	100.0	100.0	100.0
Species Density	: 5	6	6	5	6

³ Sample Mean: 5.6, Variance: 0.55













APPENDIX C

Cover Inspection Documentation

(October 1, 2023 through September 30, 2024)

10-12:23 Type I w/ ER Monuments

Insp	ector Names: M Jone S								Date(s): <u>) ()</u>	-12-23Time (of Inspection: <u>0800</u>				
Туре	l inspection 🗌 Type II inspection	0	Pos	st-Stori	n in:	spec	tion [ב							
Drive Drive Note numb	Drive-around Post-Storm Inspection: Date(s) of Significant Storm Total Precipitation (in): Drive-around inspection date (taken from Logbook): N/A N/A N/A Note: Post-storm event inspection items are indicated with a * next to the Inspection Item number. N/A N/A N/A Inspection Conditions: SO'S > N/ASSS SO'S > N/ASSS SO'S > N/ASSS N/ASSS														
Inspo Previ Attac	Inspection Conditions: Previous 24-hour precipitation: Weather Conditions: Weather Conditions: Acceptable/Unacceptable for Inspection (circle one) Attachments: Photographs Figures Other CONDITION REPEAT OR CONFIRMATION THAT														
	INSPECTION ITEM CONDITION PRESENT CONDITION INSPECTION NOTE CONFIRMATION THAT ACTION IS COMPLETE (Initial and Date) CONFIRMATION THAT (Initial and Date)														
1.0	Surface Conditions														
1. 1 *	Erosion rills, gullies, or sheet erosion		~				~~	50	me						
1.2*	Conditions that could interrupt cover surface drainage (ponding areas, ruts, hole greater than 3" in diameter0		\checkmark					~0	ve						
1.3	Excessive animal trails		~				~	50	ne						
1.4	Widespread burrowing animal holes		~				\sim	∽ c	ine						
1.5*	Extensive linear cracks		\checkmark				~	N1	one						

Basin F PCP, Rev 2

Page 1 of 4

		CC IS)NDI PRE	ITION SENT	RE C CC	PEA HRO NDI	T OR NIC TION	INSPECTION NOTE	CONFIRMATION THAT ACTION IS COMPLETE
		Y	N	N/A	Y	Ν	N/A		
1.0	Surface Conditions (Continued)								
1.6	Vandalism, or intrusive damage such as unplanned excavation, drilling, grading, damage to engineering or access controls		~				\checkmark	vior-e	
2.0	Vegetative Cover					_			
2.1	Bare area or areas of poor growth greater than 100 square feet		5				1	none	
2.2	Areas of vegetation stress greater than 100 square feet (over grazing, discoloration, pedestalling)		$\overline{}$				V	none	
2.3	Deep rooted, noxious or undesirable weedy species		\checkmark				\checkmark	none	
2.4	Excessive litter accumulation		4					none	
3.0	Engineering and Access Controls								
3.1	The Basin F AMA perimeter fence is damaged		\checkmark				\$	none	
3.2	Debris has collected along the Basin F AMA perimeter fence		>				~	none	
3.3	Obelisks are damaged, not visible, or not legible		\checkmark				<	none	
3.4	Warning signs are not legible from 25 feet		J				\checkmark	none	
3.5*	Damage to the Perimeter Access Road such as potholes, washouts, washboard, or burrowing		~				>	none	

									CH	ANNE		BER							
	INSPECTION ITEM					24									25				
4.1*	Impeded drainage or ponding in the channel (siltation/debris present)					Ň									Y)			
4.2*	Inadequate protective vegetation					ř	\$								Ň	•			
4.3*	Erosion rills or gullies in the grass- lined channel					× Z	V							Ň					
4.4*	Cracked or degraded concrete					Ř	,							Ň	Y				
4.5*	Expansion joint damage (missing caulk)					Ň	10								Ň)			
4.6*	Inhibited drainage from the soil to the concrete-lined channel					Ř)								Ň	>			
4.7*	Subsidence or undercutting of the concrete-lined channel					Y								9					
5.0 E	Erosion/Settlement Monuments: Insp fall Type I inspection:	ect moi s.	numen	ts for a	lamage	e and l	egibílity	, and r	record t	he soil	thickn	ess los	s, if an	y. Per	form di	uring s	pring T	ype II a	and
	INSPECTION ITEM	ER92	ER93	ER94	ER95	ER96	ER97	ER98	ER99	ER100	ER101	ER102	ER103	ER104	ER105	ER106	ER107	ER108	ER109
5.1	Was the monument free of damage and legible?	⊗ ≥	⊗ N	⊗ _N	N N	(Y) N	Ø N	8 N	(Y) N	(Y) N	N N	(Y) N	(2) N	X N	(Y) N	⊗ _N	N (S)	N (S)	≥
5.2	Measured Soil Thickness Loss (inches)	Ø	6	đ	0.25	d	0.75	0	0.39	d	1.29	0.70	6	1.25	d	d	25	6	6

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Form SOP 001-1: Basin F Inspection Form

Form SOP 001-1: Basin F Inspection Form

Inspection Notes:	For areas with deficiencies, p of the areas, locations with G	rovide identifying labels for deficient areas, descriptions of deficiencies, approximate dimensions PS coordinates, and photographs as needed. Provide attachments as appropriate.
	stat	10-11a-23
Inspector		Signature
King H	affrican	and Date: Kni Sokonan 10-16-23
Cover Manager Re	eview of Inspection Documer	itation UV
Name: M:chael	W. Jones	Signature and Date: 10/26/23
Cover Manager Co	onfirmation of Completed Act	tions
Name:		Signature and Date: N/A

en a 💡

insp	Inspector Names: M. Smes, K. Hoffman Date(s): <u>1-3-244</u> Time of Inspection: <u>0800</u>														
Туре	I inspection 🗹 Type II inspection		Pos	st-Stori	m ins	spec	tion 🗌]							
Drive Drive Note numl	Drive-around Post-Storm Inspection: Date(s) of Significant Storm Drive-around inspection date (taken from Logbook): NIA. Note: Post-storm event inspection items are indicated with a * next to the Inspection Item number. Date(s) of Significant Storm Inspection Conditions: Symposity of Conditions														
Insp Previ	Inspection Conditions: Previous 24-hour precipitation: Weather Conditions: Weather Conditions: Weather Conditions: Sums, calue Acceptable/Unacceptable for Inspection (circle one)														
Attac	Attachments: Photographs Figures Other														
	INSPECTION ITEM CONDITION REPEAT OR CHRONIC CONDITION INSPECTION NOTE CONDITION INSPECTION NOTE (Initial and Date)														
1.0	Surface Conditions	<u> </u>			<u> </u>		IN/A				a la companya da sera a se				
1.1*	Erosion rills, gullies, or sheet erosion						~	5	ne						
1.2*	Conditions that could interrupt cover surface drainage (ponding areas, ruts, hole greater than 3" in diameter0		\checkmark				>	~~	ve						
1.3	Excessive animal trails		~				<	\sim	ne						
1.4	Widespread burrowing animal holes		\checkmark				\checkmark	\sim	me						
1.5*	Extensive linear cracks		1	1			1	\sim	me						

-

	INSPECTION ITEM	CC IS I)ND PRE		RE C CC	PEA HRO DNDI	T OR NIC TION	INSPECTION NOTE	CONFIRMATION THAT ACTION IS COMPLETE
		Y	N	N/A	Y	Ν	N/A		(Initial and Date)
1.0	Surface Conditions (Continued)			-					
1.6	Vandalism, or intrusive damage such as unplanned excavation, drilling, grading, damage to engineering or access controls		J				7	none	
2.0	Vegetative Cover								
2.1	Bare area or areas of poor growth greater than 100 square feet		J				2	none	
2.2	Areas of vegetation stress greater than 100 square feet (over grazing, discoloration, pedestalling)		J				1	none	
2.3	Deep rooted, noxious or undesirable weedy species		>				4	none	
2.4	Excessive litter accumulation		1				7	none	
3.0	Engineering and Access Controls	_							
3.1	The Basin F AMA perimeter fence is damaged		\checkmark				J	none	
3.2	Debris has collected along the Basin F AMA perimeter fence		J				5	none	
3.3	Obelisks are damaged, not visible, or not legible		5				J	none	
3.4	Warning signs are not legible from 25 feet		J				J	norre	
3.5*	Damage to the Perimeter Access Road such as potholes, washouts, washboard, or burrowing		1				J	none	

4.0	0 Surface Water Drainage Controls: Were the following conditions observed during the inspection of the stormwater drainage controls? (circle all that apply)																		
									СН	ANNEL		BER							
	INSPECTION ITEM					24									25				
4.1*	Impeded drainage or ponding in the channel (siltation/debris present)					Ď	ļ								Ň	I			
4.2*	Inadequate protective vegetation					Ý)							Y N					
4.3*	Erosion rills or gullies in the grass- lined channel					₹ S	>							Ň)				
4.4*	Cracked or degraded concrete					Y (1)								ũ.	× N)			
4.5*	Expansion joint damage (missing caulk)					Ŕ)								Y	>			
4.6*	Inhibited drainage from the soil to the concrete-lined channel					Ň)								Y)			
4.7*	Subsidence or undercutting of the concrete-lined channel					ž)								Ň				
5.0	Erosion/Settlement Monuments: Insp fall Type I inspection:	ect mo. s.	numen	ts for a	damage	e and le	əgibility	, and i	record t	he soil	thickn	ess los	s, if an	y. Per	form di	uring s _i	oring T	ype II a	and
	INSPECTION ITEM	ER92	ER93	ER94	ER95	ER96	ER97	ER98	ER99	ER100	ER101	ER102	ER103	ER104	ER105	ER106	ER 107	ER 108	ER109
5.1	Was the monument free of damage and legible?	Y N	Y N	Y N	Y N	Y N	Y	Y N	Y	N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N
5.2	Measured Soil Thickness Loss (inches)			1	ED)-	5-	6-1	•							2		
_																•			

14

Form SOP 001-1: Basin F Inspection Form

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Form SOP 001-1: Basin F Inspection Form

Inspection Notes:	For areas with deficiencies, provo of the areas, locations with GPS	vide identify coordinate	ving labels for deficient areas, descriptions of deficiencies, approximate dimensions es, and photographs as needed. Provide attachments as appropriate.
		100	22
		7.30	
	The		
Inspector			
Name:	S	Signature	
Kins t	toffman a	ind Date:	VKn 200000 1-3-22-1
Cover Manager Re	view of Inspection Documenta	tion	
Name: Michael	W. Jones a	ind Date:	1/18/24
Cover Manager Co	nfirmation of Completed Actio	ons	
Name:	S	Signature and Date:	N/A

Inspector's Names:			Insp	ection Date(s):	
Inspection Type: Type I Type II	Post-Storm				
Drive-around Post-Storm Inspection Da	Ite (taken from L	.ogbook):		Date(s) of Significant Stor	m Event:
a * next to the Inspection Item number.	re indicated with			Total Precipitation (in):	
Inspection Conditions: Previous 24-hour	r precipitation:	Weat	ther Conditions:		
Attachments: Attachments: Figu	res 🗌 Other				
Inspection Item	Condition Present	Repeat or Chronic Condition	In	spection Note	Confirm Completed Actions (Initial and Date)
1.0 Surface Conditions					
1.1* Erosion rills, gullies, or sheet erosion					
1.2* Conditions that could interrupt cover surface drainage (ponding areas, ruts, hole greater than 3" in diameter)					
1.3 Excessive animal trails					
1.4 Widespread burrowing animal holes					
1.5* Extensive linear cracks	-				
1.6 Vandalism, or intrusive damage such as unplanned excavation, drilling, grading, damage to engineering or access controls					

Inspection Item	Co F	Condition PresentRepeat Chron ConditYNN/AY		t or nic ion	Inspection Note	Confirm Completed Actions (Initial and Date)		
	Υ	Ν	N/A	Y	Ν	N/A		
2.0 Vegetative Cover								
2.1 Bare area or areas of poor growth greater than 100 square feet								
2.2 Areas of vegetation stress greater than 100 square feet (over grazing, discoloration, pedestalling)								
2.3 Deep rooted, noxious or undesirable weedy species								
2.4 Excessive litter accumulation								
3.0 Engineering and Access Controls								
3.1 The Basin F AMA perimeter fence is damaged								
3.2 Debris has collected along the Basin F AMA perimeter fence								
3.3 Obelisks are damaged, not visible, or not legible								
3.4 Warning signs are not legible from 25 feet								
3.5* Damage to the Perimeter Access Road such as potholes, washouts, washboard, or burrowing								

.0 Surface Water Drainage Controls: Were the following conditions observed during the inspection of the stormwater drainage controls? Check all that apply.																		
								С	hannel	l Numb	ber							
					24									25				
4.1* Impeded drainage or ponding in the channel (siltation/debris present)																		
4.2* Inadequate protective vegetation																		
4.3* Erosion rills or gullies in the grass- lined channel																		
4.4* Cracked or degraded concrete																		
4.5* Expansion joint damage (missing caulk)																		
4.6* Inhibited drainage from the soil to the concrete-lined channel																		
4.7* Subsidence or undercutting of the concrete-lined channel																		
5.0 Erosion/Settlement Monuments: Ins	pect m	onume	nts and	d recor	d the s	oil thicl	kness l	oss, if	any. F	Perform	during	spring	Туре	II and f	all Typ	e I insr	pection	s.
Inspection Item	ER92	ER93	ER94	ER95	ER96	ER97	ER98	ER99	ER100	ER101	ER102	ER103	ER104	ER105	ER106	ER107	ER108	ER109
5.1 Monument is damaged or illegible Check all that apply.																		
5.2 Measured Soil Thickness Loss (inches)																		

Inspection Notes:	For areas with deficiencies, provide iden	tifying labels for deficient areas,	descriptions of deficiencies, approximate dimensions of
	the areas, locations with GPS coordinate	es, and photographs as needed.	Provide attachments as appropriate.
Increator			
Inspector		0 ¹	
Name:		Signature	
	anion of languages and a sum and ation	and Date:	
Covers Manager R	eview of inspection Documentation		
Name:		Signature	
Covers Manager C	Confirmation of Completed Actions		
Name:		Signature	
		and Date:	

Inspector's Names:			Insp	Inspection Date(s):							
Inspection Type: Type I Type II	Post-Storm										
Drive-around Post-Storm Inspection Da	Ite (taken from L	.ogbook):		Date(s) of Significant Storm Event:							
a * next to the Inspection Item number.	re indicated with			Total Precipitation (in):							
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Inspection Item	Condition Present	In	Inspection Note Confirm Completed Actions (Initial and Date)								
1.0 Surface Conditions											
1.1* Erosion rills, gullies, or sheet erosion											
1.2* Conditions that could interrupt cover surface drainage (ponding areas, ruts, hole greater than 3" in diameter)											
1.3 Excessive animal trails											
1.4 Widespread burrowing animal holes											
1.5* Extensive linear cracks	-										
1.6 Vandalism, or intrusive damage such as unplanned excavation, drilling, grading, damage to engineering or access controls											

Inspection Item	Condition Present Condition						Inspection Note	Confirm Completed Actions (Initial and Date)		
	Y	Ν	N/A	Y	Ν	N/A				
2.0 Vegetative Cover										
2.1 Bare area or areas of poor growth greater than 100 square feet										
2.2 Areas of vegetation stress greater than 100 square feet (over grazing, discoloration, pedestalling)										
2.3 Deep rooted, noxious or undesirable weedy species										
2.4 Excessive litter accumulation										
3.0 Engineering and Access Controls										
3.1 The Basin F AMA perimeter fence is damaged										
3.2 Debris has collected along the Basin F AMA perimeter fence										
3.3 Obelisks are damaged, not visible, or not legible										
3.4 Warning signs are not legible from 25 feet										
3.5* Damage to the Perimeter Access Road such as potholes, washouts, washboard, or burrowing										

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								С	hannel	l Numb	ber							
					24					25								
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4.7* Subsidence or undercutting of the concrete-lined channel																		
5.0 Erosion/Settlement Monuments: Ins	pect m	onume	nts and	d recor	d the s	oil thicl	kness l	oss, if	any. F	Perform	during	spring	Туре	II and f	all Typ	e I insr	pection	s.
Inspection Item	ER92	ER93	ER94	ER95	ER96	ER97	ER98	ER99	ER100	ER101	ER102	ER103	ER104	ER105	ER106	ER107	ER108	ER109
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Inspection Notes:	For areas with deficiencies, provide iden	tifying labels for deficient areas,	descriptions of deficiencies, approximate dimensions of
	the areas, locations with GPS coordinate	es, and photographs as needed.	Provide attachments as appropriate.
Increator			
Inspector		0 ¹	
Name:		Signature	
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Inspection Item	Condition Present	In	Inspection Note Confirm Completed Actions (Initial and Date)								
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1.6 Vandalism, or intrusive damage such as unplanned excavation, drilling, grading, damage to engineering or access controls											

Inspection Item	Condition Present Condition						Inspection Note	Confirm Completed Actions (Initial and Date)		
	Y	Ν	N/A	Y	Ν	N/A				
2.0 Vegetative Cover										
2.1 Bare area or areas of poor growth greater than 100 square feet										
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3.0 Engineering and Access Controls										
3.1 The Basin F AMA perimeter fence is damaged										
3.2 Debris has collected along the Basin F AMA perimeter fence										
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3.4 Warning signs are not legible from 25 feet										
3.5* Damage to the Perimeter Access Road such as potholes, washouts, washboard, or burrowing										

4.0 Surface Water Drainage Controls: Were the following conditions observed during the inspection of the stormwater drainage controls? Check all that apply.																		
								С	hannel	l Numb	ber							
					24					25								
4.1* Impeded drainage or ponding in the channel (siltation/debris present)																		
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5.0 Erosion/Settlement Monuments: Ins	pect m	onume	nts and	d recor	d the s	oil thicl	kness l	oss, if	any. F	Perform	during	spring	Туре	II and f	all Typ	e I insr	pection	s.
Inspection Item	ER92	ER93	ER94	ER95	ER96	ER97	ER98	ER99	ER100	ER101	ER102	ER103	ER104	ER105	ER106	ER107	ER108	ER109
5.1 Monument is damaged or illegible Check all that apply.																		
5.2 Measured Soil Thickness Loss (inches)																		

Inspection Notes:	For areas with deficiencies, provide iden	tifying labels for deficient areas,	descriptions of deficiencies, approximate dimensions of
	the areas, locations with GPS coordinate	es, and photographs as needed.	Provide attachments as appropriate.
Increator			
Inspector		0 ¹	
Name:		Signature	
	anion of languages and a sum and ation	and Date:	
Covers Manager R	eview of inspection Documentation		
Name:		Signature	
Covers Manager C	Confirmation of Completed Actions		
Name:		Signature	
		and Date:	

Attachment 1: Prairie Dog holes on Basin F Coordinate List

KH00014	N39 51.269 W104 51.618
KH00024	N39 51.267 W104 51.624
KH00033	N39 51.271 W104 51.636
KH00043	N39 51.270 W104 51.643
KH00053	N39 51.268 W104 51.649
KH00063	N39 51.261 W104 51.656
KH00073	N39 51.260 W104 51.659
KH00083	N39 51.255 W104 51.667
KH00093	N39 51.253 W104 51.680

Inspe	ector Name(s): <u>M. Jones</u>	\sim	21	>		Inspection Date(s): 1)-1-23									
Cond Previ one)	litions: ous 24-Hour Precipitation:			Weath	ner C	ondi	tions:	ver.	Acceptable/Unacceptable for Inspection (circle						
		CC IS	OND		RE CC	REPEAT OR CHRONIC CONDITION			OBSERVATION Indicate recommended action, if required.			uired.	CONFIRMATION THAT ACTION IS COMPLETE (Initial and Date)		
10	Paraolation Collection Manhole /F	Y	N	N/A	Y	N	N/A			-		10 100	(
1.0	Demage to the RCM or internal				1	1	r								
1.1	components		\checkmark				\checkmark		none						
1.2	Accumulation of a quantity of water greater than that caused by natural condensation in the manhole		\checkmark				~		none	-					
1.3 If the water level observed in the PCM impacts the ability to measure percolation, remove water accumulated in the PCM, and record the quantity here. Quantity removed from the PCM (liters):										record the quantity here.					
2.0	Percolation Collection				"										
Lysiı	neter Number	Me	asu	red Wa	ter V	/olur	ne (lite	r)							
C	016			Ø											
C	17			¢	6										
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Inspection Notes: For areas with deficiencies, provide identifying labels for deficient areas, descriptions of deficiencies, approximate dimensions of the areas, locations, and photographs. Provide attachments as appropriate. wishing the standing water pumped from inside the memboles. Inspector Signature Name: and Date: Kin TUD.~~ **Cover Manager Review of Inspection Documentation** Signature Name: 23 Michael W. Jones and Date: **Cover Manager Confirmation of Completed Actions** Signature Name: and Date: N/A N/A

Basin F PCP, Rev 2

Inspector's Name	s:							Inspection Date(s):		
Inspection Condit	ions: Previous 24-hour p	orecip	oitatic	n:			Wea	ther Conditions:		
Inspe	C (F	Condition Present Y N N/A			epea Chror ondit	t or nic tion	Inspection Note	Confirm Completed Actions (Initial and Date)		
1.0 Percolation	Collection Manhole (P	CM)	Cond	dition	<u> </u>	1.1	1.071			
1.1 Damage to t components	he PCM or internal									
1.2 Accumulatio greater than condensatio	n of a quantity of water that caused by natural n in the manhole									
1.3 If the water I Quantity ren	1.3 If the water level observed in the PCM impacts the ability to measure percolation, remove water accumulated in the PCM, and record the quantity here.									
2.0 Percolation	Collection									
Lysimeter Number								Measured Water Volume (liter)		
016										
017										
018										
019										
020										

Inspection Notes:	For areas with deficiencies, provide of the areas, locations, and photogra	identifying labels for deficient areas, descriptions of deficiencies, approximate dimensions aphs. Provide attachments as appropriate.						
Inspector								
Name:		Signature and Date:						
Cover Manager Re	anager Review of Inspection Documentation							
Name:		Signature and Date:						
Cover Manager Co	ver Manager Confirmation of Completed Actions							
Name:		Signature and Date:						

Inspector's Names:							Inspection Date(s):			
Inspection Conditions: Previous 24-hour precipitation: Weather Conditions:										
Inspection Item		Condition Present		Repeat or Chronic Condition		t or nic tion	Inspection Note	Confirm Completed Actions (Initial and Date)		
1.0 Percolation Collection Manhole (P		CM)	Cond	dition	<u> </u>	1.1				
1.1 Damage to the PCM or internal components										
1.2 Accumulation of a quantity of water greater than that caused by natural condensation in the manhole										
1.3 If the water level observed in the PCM impacts the ability to measure percolation, remove water accumulated in the PCM, and record the quantity here. Quantity removed from the PCM (liters):										
2.0 Percolation	2.0 Percolation Collection									
Lysimeter Number	₋ysimeter Number						Measured Water Volume (liter)	Measured Water Volume (liter)		
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020										

Inspection Notes:	For areas with deficiencies, provide of the areas, locations, and photogra	identifying labels for deficient areas, descriptions of deficiencies, approximate dimensions aphs. Provide attachments as appropriate.						
Inspector								
Name:		Signature and Date:						
Cover Manager Re	anager Review of Inspection Documentation							
Name:		Signature and Date:						
Cover Manager Co	ver Manager Confirmation of Completed Actions							
Name:		Signature and Date:						

Inspector's Names:							Inspection Date(s):			
Inspection Conditions: Previous 24-hour precipitation: Weather Conditions:										
Inspection Item		Condition Present		Repeat or Chronic Condition		t or nic tion	Inspection Note	Confirm Completed Actions (Initial and Date)		
1.0 Percolation Collection Manhole (P		CM)	Cond	dition	<u> </u>	1.1				
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2.0 Percolation	2.0 Percolation Collection									
Lysimeter Number	_ysimeter Number						Measured Water Volume (liter)	Measured Water Volume (liter)		
016										
017										
018										
019										
020										
Form SOP 003-1 Basin F Percolation Monitoring System Data Collection and Operation Form

Inspection Notes:	For areas with deficiencies, provide identifying labels for deficient areas, descriptions of deficiencies, approximate dimensions of the areas, locations, and photographs. Provide attachments as appropriate.	
Inspector		
Name:		Signature and Date:
Cover Manager Review of Inspection Documentation		
Name:		Signature and Date:
Cover Manager Confirmation of Completed Actions		
Name:		Signature and Date:

APPENDIX D

Maintenance and Repair Documentation

(October 1, 2023 through September 30, 2024)

Project Information	1	
Subcontractor/Partner: MRC Services	Project: Basin F O&M	
Task: maintenance	Date: 10/23/23	
Weather AM: acceptable	Weather PM: acceptable	
Activities Inspected and Observed:		
MRC Services mowed around the exterior and inter	ior of the Basin F perimeter fence in anticipation for	
a fall prescribed burn. The mowing will help keep the fire low around the wooden fence posts and act		
as an additional fire buffer zone.		
Summer Meetings and Discussions Hold or Attended	including Job Cofety	
N/A	, including Job Salety.	
	:	
Comments:		
N/A		
Additional Documentation Submitted:		
N/A		
	ν.	
Sign Off:		
Inspector Name: Kim Hoffman	Title/company: Landfills and Covers Lead/Navarro	
Signature:	Date:)0-23-23	
Reviewer Name: Michael Jones	Title/company: Landfills and Covers Manager/Navarro	
Signature:	Date: 10/26/23	

Project Information	200 Bak	
Subcontractor/Partner: Weed Wranglers	Project: Basin F O&M	
Task: maintenance	Date: 10/25/23	
Weather AM: acceptable	Weather PM: acceptable	
Activities Inspected and Observed:	2	
Weed Wranglers sprayed Plainview SC as a ground	clear herbicide around Basin F. The roadways,	
entrances to gates, around groundwater wells on the perimeter road, and other hardened surfaces		
were sprayed.		
Summary Meetings and Discussions Held or Attended	d, including Job Safety:	
N/A		
Comments:	۰	
N/A		
Additional Documentation Submitted:		
N/A		
Sign Off:	1	
Inspector Name: Kim Hoffman	Title/company: Landfills and Covers Lead/Navarro	
Signature: yking 2000	Date: 12-27-23	
Reviewer Name: Michael Jones	Title/company: Landfills and Covers Manager/Navarro	
Signature	Date: 1/8/24	



Project Information	
Subcontractor:	Project:
Task:	Date:
Weather AM:	Weather PM:
Activities Inspected and Observed:	
Summary Meetings and Discussions Held or Attended	, including Job Safety:
2 mm and a	
Comments:	
Additional Documentation Submitted:	
Sign Off:	
Inspector Name:	Title/company:
Signature and Date:	· · · · · · · · · · · · · · · · · · ·
Reviewer Name:	Title/company:
Signature and Date:	



Project Information	
Subcontractor:	Project:
Task:	Date:
Weather AM:	Weather PM:
Activities Inspected and Observed:	
Summary Meetings and Discussions Held or Attended	, including Job Safety:
2 mm and a	
Comments:	
Additional Documentation Submitted:	
Sign Off:	
Inspector Name:	Title/company:
Signature and Date:	· · · · · · · · · · · · · · · · · · ·
Reviewer Name:	Title/company:
Signature and Date:	



Project Information	
Subcontractor:	Project:
Task:	Date:
Weather AM:	Weather PM:
Activities Inspected and Observed:	
Summary Meetings and Discussions Held or Attended	, including Job Safety:
2 mm and a	
Comments:	
Additional Documentation Submitted:	
Sign Off:	
Inspector Name:	Title/company:
Signature and Date:	· · · · · · · · · · · · · · · · · · ·
Reviewer Name:	Title/company:
Signature and Date:	



Project Information	
Subcontractor:	Project:
Task:	Date:
Weather AM:	Weather PM:
Activities Inspected and Observed:	
Summary Meetings and Discussions Held or Attended	, including Job Safety:
2 mm and a	
Comments:	
Additional Documentation Submitted:	
Sign Off:	
Inspector Name:	Title/company:
Signature and Date:	· · · · · · · · · · · · · · · · · · ·
Reviewer Name:	Title/company:
Signature and Date:	



Project Information	
Subcontractor:	Project:
Task:	Date:
Weather AM:	Weather PM:
Activities Inspected and Observed:	
Summary Meetings and Discussions Held or Attended	, including Job Safety:
2 mm and a	
Comments:	
Additional Documentation Submitted:	
Sign Off:	
Inspector Name:	Title/company:
Signature and Date:	· · · · · · · · · · · · · · · · · · ·
Reviewer Name:	Title/company:
Signature and Date:	



Project Information	
Subcontractor:	Project:
Task:	Date:
Weather AM:	Weather PM:
Activities Inspected and Observed:	
Summary Meetings and Discussions Held or Attended	, including Job Safety:
2 mm and a	
Comments:	
Additional Documentation Submitted:	
Sign Off:	
Inspector Name:	Title/company:
Signature and Date:	· · · · · · · · · · · · · · · · · · ·
Reviewer Name:	Title/company:
Signature and Date:	



Project Information	
Subcontractor:	Project:
Task:	Date:
Weather AM:	Weather PM:
Activities Inspected and Observed:	
Summary Meetings and Discussions Held or Attended	, including Job Safety:
2 mm and a	
Comments:	
Additional Documentation Submitted:	
Sign Off:	
Inspector Name:	Title/company:
Signature and Date:	· · · · · · · · · · · · · · · · · · ·
Reviewer Name:	Title/company:
Signature and Date:	

APPENDIX E

2024 Basin F Post-Closure Groundwater Monitoring Report

ROCKY MOUNTAIN ARSENAL

BASIN F POST-CLOSURE GROUNDWATER MONITORING REPORT

Revision 0 November 19, 2024

U.S. Department of the Army Shell Oil Company

Prepared by:



Navarro Research and Engineering, Inc.

TABLE OF CONTENTS

Section

Page

1.0	INTRO		1
2.0	GROUNDWATER MONITORING RESULTS 2		
	2.1 2.2 2.3 2.4	Field Activities. Field Activities. Groundwater Levels . Field Activities. Groundwater Quality. Field Activities. Analytical Data Review Field Activities. 2.4.1 Data Quality Control Review 2.4.2 Data Usability	2 2 5 6
3.0	STATI	STICAL EVALUATION	6
	3.13.23.33.4	2024 Prediction Limit Evaluations3.1.1 Wastepile 2024 UPL Comparison3.1.2 Principal Threat 2024 UPL Comparison2025 Upper Prediction LimitsStatistical Trend AnalysisShewhart-CUSUM Control Charts	7 7 9 9 9
4.0	SUM	1ARY14	4
5.0	REFEF	ENCES	6



TABLES

- Table 12024 Post-Closure Water Quality Results
- Table 2Data Quality Summary
- Table 32024 Quality Control Samples
- Table 4
 Upper Prediction Limits for 2024 Water Quality Evaluations
- Table 5
 Upper Prediction Limits for 2025 Water Quality Evaluations
- Table 6
 Statistical Summary for UPL Exceedances in Basin F Downgradient Wells

FIGURES

- Figure 1 Former Basin F Well and Piezometer Location Map
- Figure 2 Former Basin F 2023 Potentiometric Surface of the Unconfined Flow System
- Figure 3 Former Basin F 203 Well Network Indicator Compound Detection Map

ATTACHMENTS

- Attachment A Hydrographs for Basin F Water Quality Wells
- Attachment B Shewhart-CUSUM Control Charts

ACRONYMS

CUSUM	Cumulative Sum
DQI	Data Quality Indicator
EPA	U.S. Environmental Protection Agency
IC	Indicator Compound
LT	Less Than
MRL	Method Reporting Limit
PCGMP	Post-Closure Groundwater Monitoring Plan
РТ	Principal Threat
RCRA	Resource Conservation and Recovery Act
RMA	Rocky Mountain Arsenal
RMAED	Rocky Mountain Arsenal Environmental Database
SQAPP	Sampling Quality Assurance Project Plan
UCL	Upper Confidence Limit
UFS	Unconfined Flow System
UPL	Upper Prediction Limit
WP	Wastepile
µg/L or UGL	micrograms per liter



1.0 INTRODUCTION

The post-closure groundwater monitoring program for the former Basin F Surface Impoundment and Basin F Wastepile (WP) at the Rocky Mountain Arsenal (RMA) is designed to monitor the groundwater flow directions, groundwater quality beneath and in the vicinity of the of the former Basin F and evaluate the potential for hazardous constituent releases into the groundwater sourced from the former basin. This report presents data generated by the Basin F post-closure groundwater monitoring system and an evaluation of the monitoring objectives.

The Basin F groundwater monitoring program—in conformance with post-closure care for RCRA interim status units regulated under 6 CCR 1007-3 Subpart F, Section 265.90-265.94—was designed to monitor general trends and provide information on water quality by means of statistical evaluations. Thus, comparisons to chemical-specific standards do not apply to Basin F groundwater, since the RMA remedy addresses downgradient contaminated groundwater at the North Boundary Containment System and Northwest Boundary Containment System, where it is extracted and treated.

Annual well sampling events were conducted in April and May of 2024. The following information is presented in accordance with the *Basin F Post-Closure Groundwater Monitoring Plan* (PCGMP) (Navarro 2023).

- Groundwater level data collected from the Basin F post-closure water level monitoring well network.
- Analytical results of groundwater samples collected from the Basin F post-closure water quality monitoring well network.
- Evaluation of data to determine compliance with post-closure groundwater monitoring criteria as presented in the Basin F PCGMP.

Background information related to the Basin F monitoring approach, including site-specific characterization, applicable regulatory requirements, laboratory methods, statistical evaluation procedure, and monitoring program development are presented in the Basin F PCGMP, the *Rocky Mountain Arsenal Sampling Quality Assurance Project Plan* (SQAPP) (Navarro 2019), and previous annual groundwater reports.



2.0 GROUNDWATER MONITORING RESULTS

2.1 Field Activities

The field crew inspected the monitoring wells and well pads prior to each sampling event. As part of the annual sampling event, the casing height and total depths were measured for monitoring wells. The inspection information, casing heights, and total depths are documented in the records.

2.2 Groundwater Levels

The wells used in the Basin F post-closure groundwater level monitoring are presented in Table 3.3-2 of the Basin F PCGMP and Figure 1 of this report. Water levels were measured in wells to evaluate unconfined flow system (UFS) conditions in the vicinity of former Basin F and to identify any significant changes in flow direction in the area.

Figure 2 presents the potentiometric surface map for the UFS depicting water levels measured in March 2024. Similar to previous years, groundwater flow in the vicinity of Basin F is generally to the north. A groundwater divide has become evident as local and regional water levels have decreased, resulting in groundwater flow to the north-northwest and north-northeast beneath the north end of the former Basin F. The confined flow system in the Basin F area is addressed as part of the *Long-Term Monitoring Plan for Groundwater and Surface Water* (Navarro 2021a). A complete description of the subsurface lithology and groundwater flow in the vicinity of Basin F can be found in the PCGMP (Navarro 2023).

Water levels measured in the nine Basin F water quality network wells since 2006 are shown on hydrographs (Attachment A). Beginning in 2018, groundwater elevations began to decrease in all of the wells with the exception of well 26128. Groundwater in well 26128 shows an increasing trend from 2014 through 2018, but has decreased since 2019. Water level data for well 26128 appears different from the other wells in the vicinity of Basin F because it is screened deeper within the unweathered Denver Formation. As such, this well does not provide an accurate depiction of the UFS upgradient of Basin F. The overall decrease in UFS water levels in the vicinity of Basin F is consistent with a general decreasing trend noted across RMA over the past several years (Navarro 2021b). Historical changes in water levels in wells near Basin F are consistent with regional fluctuations in the water table and are not related to the performance of the Basin F cover.

2.3 Groundwater Quality

The Basin F post-closure water quality network wells are identified in Table 3.3-1 of the Basin F PCGMP. There are two networks—Basin F Wastepile and Basin F Principal Threat. Well 26015 is included in both groups due to overlapping groundwater flow paths evident at the initiation of post-closure groundwater monitoring (Navarro 2023).



Groundwater samples collected from the two Basin F water quality monitoring networks were shipped to Applied Research and Development Laboratory (ARDL) in Mount Vernon, Illinois for analysis. Annual samples were analyzed for the complete analyte list as shown in Table 3.3-2 of the Basin F PCGMP. The eleven Basin F indicator compounds (ICs) are identified in bold text within the table.

The ICs detected in the Basin F Wastepile network wells and the Basin F Principal Threat network wells are shown in Table 1 and Figure 3, respectively.



Table 1. 2024 Post-Closure Water Quality Results

	Concentrations by Well (µg/L)								
Designation	Downgi	radient	Upgradient			Downgradient			
Network	WP/PT	WP	WP	РТ	РТ	РТ	РТ	РТ	РТ
Analyte	26015 4/23/2024	26017 5/15/2024	26028 5/13/2024	26073 5/13/2024	26128 5/22/2024	26133 5/16 & 5/20/2024	26157 5/20/2024	26163 5/21/2024	26173 5/14/2024
Arsenic	2.72	1.14	1.45	1.15	2.39	2.67	1.09	7.8	2.1
Chloroform	0.59	0.188	LT 0.2	34.7	0.205	3,130	0.556	LT 0.2	46.4
Chloride	744,000	431,000	1,020,000	187,000	1,250,000	752,000	730,000	3,100,000	455,000
CPMSO2	LT 1.2	LT 1.2	LT 1.2	LT 1.2	LT 1.2	18.3	16.3	7.9	4.6
Copper	LT 10	LT 10	LT 10	LT 10	LT 10	LT 10	LT 10	17.5	LT 10
DCPD	LT 0.2	LT 0.2	LT 0.2	LT 0.2	LT 0.2	536	236	445	70.2
DIMP	4.38	5	1,170	2.2	40.8	86.3	88.9	508	56.7
Dieldrin	0.483	0.612	0.0237	0.139	0.269	1.89	0.608	0.564	1.29
NNDMEA	0.00786	LT 0.0048	0.0186	LT 0.0048	0.028	0.355	0.354	0.619	0.0103
Sulfate	456,000	236,000	549,000	980,000	779,000	455,000	396,000	1,080,000	341,000
TCLEE	0.198	LT 0.2	LT 0.2	0.613	0.396	514	69.1	4.45	807

<u>Note</u>: Concentrations that increased in 2024 are in **bold**.

Well 26015 is included in both the WP and PT groups due to overlapping groundwater flow paths evident at the initiation of post-closure groundwater monitoring.

WP – Wastepile

PT – Principal Threat

LT – less than

 μ g/L – micrograms per liter



2.4 Analytical Data Review

The objective of the analytical data review is to determine whether the analytical results are acceptable for use in making decisions for the project. As a component of the data review process, the analytical data were reviewed using the Data Quality Indicators (DQI) including precision, accuracy, representativeness, completeness, comparability, and sensitivity to interpret the degree of acceptability of data. These six parameters are identified in the SQAPP (Navarro 2019). Failure to meet performance criteria did not necessarily result in rejection or qualification of the data. Professional judgement combined with the DQI evaluation were used to determine data usability.

The analytical data were collected in accordance with the Basin F PCGWP and were reviewed consistent with the DQI process as presented in the SQAPP. Results of the DQI review are summarized below in Table 2. DQI evaluation data are available in the project files.

Indicator	Summary			
Precision	A total of 88 duplicate pair analyses of Basin F target analytes were performed. Duplicate and investigative results are considered comparable in 87 cases and not comparable in 1 case. The data are considered acceptable for their intended use and no additional action in addition to the data qualification is considered necessary.			
Accuracy/Bias	The average recovery rate for the 99 matrix spike analyses was 85.67 percent. Recovery rates outside the lower or upper warning limits were observed in zero analyses. Recovery rates outside the lower or upper control limits were observed in zero analyses. <i>No issues were identified requiring data qualification</i> .			
	The average recovery rate for the 99 corresponding laboratory control spike analyses was 98.66 percent. Recovery rates outside the lower or upper warning limits were observed in three analyses. Recovery rates outside the lower or upper control limits were observed in zero analyses. <i>No issues were identified requiring data qualification</i> .			
Representativeness	Field blanks are collected and analyzed to evaluate possible cross contamination of the investigative samples. <i>Field blanks were not collected in 2024</i> .			
Completeness	Completeness was calculated at 100 percent. The completeness goal of 90 percent was achieved. All results were determined to be acceptable by the laboratory.			
Comparability	Standard sampling and analysis techniques, based on certified analytical methods approved by Navarro or promulgated SW-846 methods, and standard procedures for sample collection were used throughout the groundwater monitoring programs at Basin F. Consistent procedures for the reporting and management of the data generated were also followed. <i>All data are considered comparable</i> .			
Sensitivity	The laboratories prepared and analyzed method blanks as part of their analytical protocols. Method blanks measure potential contamination from laboratory sources such as glassware, reagents, and laboratory water. There were 80 method blank analyses in 2024 with no detections above the method reporting limit (MRL). <i>Data qualification is not necessary as the associated investigative data is below the MRL</i> .			

Table 2. Data Quality Summary



2.4.1 Data Quality Control Review

Data validation was conducted on a representative subset of the Basin F groundwater analytical data. Validation checklists were completed, and laboratory case narratives were reviewed to determine potential problems identified by the analysts. The completeness result for all analytes achieves the minimum specification of 90 percent. No data were flagged as rejected in 2024.

Table 3 lists QC samples collected and analyzed as part of the Basin F post-closure monitoring for 2024.

Sample Type/Site ID	Sample Date			
Field Duplicate				
26157	5/20/2024			
Lab Duplicate				
26105	4/23/2024			

Table 3. 2024 Quality Control Samples

2.4.2 Data Usability

A data usability evaluation was conducted for data collected during 2024. The evaluation identified zero statistical outliers. The data are considered acceptable for their intended use and no additional action is considered necessary.

Based on the findings of the DQI review, the sample results are considered valid and usable for their intended purpose. Data quality requirements were sufficiently met for the analytical data, and data are appropriate for use in evaluation of the water quality conditions present at the site. The primary objectives of the sampling program were met.

3.0 STATISTICAL EVALUATION

The statistical evaluation of data includes comparing upgradient water quality to downgradient compliance wells. Prediction intervals are calculated for each IC using upgradient data. The prediction limits discussed in this section refer to the upper limit of each analyte-specific prediction interval. Comparison of downgradient water quality data to prediction limits should provide an indication of whether groundwater has been impacted by former Basin F.

If downgradient groundwater analyte concentrations exceed upper prediction limits (UPL), additional statistical analyses, including the Mann-Kendall test for trends and Shewhart-CUSUM control charts, are conducted in order to evaluate downgradient water quality trends. The Mann-Kendall test for trends is a nonparametric tool used to determine the statistical trend of post-closure data over time, while Shewhart-CUSUM control charts provide an indication of



statistically significant increases above background or baseline conditions (EPA 1989, 1992, 2009).

ChemStat statistical analysis software (StarPoint Software 2023) is utilized to calculate the prediction limit values, and statistical software output is available in the project files. The prediction limit values for 2024 are included in Table 4. If a compound was not detected in any sample, the default non-parametric prediction limit for the analyte is the 99 percent upper confidence limit (UCL). In accordance with the PCGMP, the 99 percent UCL is defined as 1.3 times the MRL. The following sections describe the results of the approach used for the statistical evaluation of Basin F groundwater data.

3.1 2024 Prediction Limit Evaluations

Table 4 presents the 2024 prediction limits that were calculated using upgradient well data collected during the post-closure groundwater monitoring period (2006–2023).

The analytical results for samples collected from the downgradient Basin F groundwater monitoring networks in 2024 were compared to the prediction limits presented in Table 4 to determine whether the groundwater quality was impacted by Basin F.

3.1.1 Wastepile 2024 UPL Comparison

Table 4 presents the 2024 selected UPLs for Basin F WP ICs. UPLs for 2024 were calculated for the Basin F WP ICs using groundwater data from 2006 through 2023 for upgradient well 26028. The 2024 Basin F WP UPLs were applied to data for downgradient wells 26015 and 26017. The 2024 reported values for ICs detected in wells exceeding their respective UPLs are presented in Table 4 and are shown in Figure 3. The following analytes were detected at concentrations exceeding their respective UPLs in 2024.

Well 26015	<u>Well 26017</u>
Chloroform	• Dieldrin
• Dieldrin	

The 2024 concentrations of chloroform and dieldrin in exceedance of their respective UPLs in well 26015 are within the historical range of detected concentrations and their presence is likely attributable to higher water levels that have mobilized residual contamination and have remained as the water table has decreased over the past few years.

The 2024 concentrations of dieldrin in exceedance of the UPL in well 26017 is also within the historical range of detected concentrations.

The reported concentrations of analytes not listed above and detected in downgradient Basin F WP wells are below the respective UPLs. Based on the UPL comparison, it appears that groundwater quality downgradient of the Basin F WP area has been affected in the vicinity of wells 26015 and 26017.



Indicator Compound	Method Reporting Limit (µg/L)	Percentage of Upgradient Nondetections	Statistical Method Used	2024 Upgradient UPL (μg/L)		
Wastepile		-		-		
Arsenic	1	60	Nonparametric	3.43		
Chloride	1,000	0	Parametric	1,368,760		
Chloroform	0.2	100	Nonparametric	0.2 ¹		
Copper	10	100	Nonparametric	10 ¹		
CPMSO2	1.6	100	Nonparametric	2.08 ²		
DCPD	0.212	100	Nonparametric	2.8 ²		
Dieldrin	0.00252	15	Parametric	0.471		
DIMP	0.602	0	Parametric	1,899		
NNDMEA	0.0048	45	Nonparametric	0.0278		
Sulfate	2,500	0	Parametric	584,720		
TCLEE	0.2	100	Nonparametric	0.2 ¹		
Principal Threat						
Arsenic	1	49	Nonparametric	3.17		
Chloride	1,000	0	Nonparametric	1,330,000		
Chloroform	0.2	0	Nonparametric	96		
Copper	10	100	Nonparametric	10 ¹		
CPMSO2	1.2	75	Nonparametric	2.54 ³		
DCPD	0.212	100	Nonparametric	0.28 ²		
Dieldrin	0.00252	3	Nonparametric	1.24		
DIMP	0.602	0	Nonparametric	249		
NNDMEA	0.0048	41	Nonparametric	0.1		
Sulfate	2,500	0	Parametric	1,178,090		
TCLEE	0.2	0	Parametric	0.81		

Table 4. Upper Prediction Limits for 2024 Water Quality Evaluations

Notes:

¹ Because this compound has not been detected in an upgradient well, the UPL value for this analyte is the current MRL.

² This compound was not detected during baseline sampling; therefore, the prediction limit value for this analyte is the 99 percent UCL of the MRL. The 99 percent UCL is defined as 1.3 times the maximum historical MRL (Navarro 2023).

³ Data validated as Questionable; therefore, CPMSO2 result for sample collected from 26073 in 2018 was excluded from consideration as a nonparametric UPL.



3.1.2 Principal Threat 2024 UPL Comparison

Table 4 presents the 2024 selected UPLs for Basin F PT ICs. UPLs for 2024 were calculated for the Basin F PT using upgradient groundwater data from 2007 through 2023 for upgradient wells 26128 and 26073. The 2024 Basin F PT UPLs were applied to data for downgradient wells 26015, 26133, 26157, 26163 and 26173. The 2024 reported values for ICs detected in wells exceeding their respective UPLs are presented in Table 4 and are shown in Figure 3. The following analytes were detected at concentrations exceeding their respective UPLs in 2024.

- Well 26133
- Chloroform
- CPMSO2
- DCPD
- Dieldrin
- NNDMEA
- TCLEE

- <u>Well 26157</u>
- CPMSO2
- DCPD
- NNDMEA
- TCLEE
- <u>Well 26163</u>
- Arsenic Chloride
- CopperCPMSO2
- CPMSO2
- DCPD
- DLDRN
- TCLEE
- D
- DCPDDIMP
- NNDMEA
- TCLEE
- The 2024 concentrations of all analytes in exceedance of UPLs in wells 26133, 26157, 26163 and 26173 are within the historical ranges of detected concentrations and many are likely attributable to higher water levels that have mobilized residual contamination. The reported concentrations of analytes not listed above were not detected or were detected at levels below the respective UPLs in downgradient Basin F PT wells. Based on the statistical evaluation, it appears that groundwater quality downgradient of the Basin F PT area has been affected in the vicinity of wells 26133, 26157, 26163, and 26173.

In 2024, no analyte concentrations exceeded PT UPLs in downgradient well 26015.

3.2 2025 Upper Prediction Limits

Table 5 presents the UPLs that will be applied to downgradient wells in 2025. The MRLs can change based on the method re-certification required every three years by the SQAPP. In February 2024 the MRL for dieldrin was revised, and the current MRL is reflected in Table 5. No prediction limit calculations were adjusted due to the updated MRL.

3.3 Statistical Trend Analysis

Statistical trends using the Mann-Kendall test were evaluated for downgradient wells where the concentration of ICs exceeded their respective UPL in order to determine whether a statistical trend exists that indicates increasing concentrations downgradient of Basin F. The Mann-Kendall test for trend is a non-parametric test commonly used to evaluate whether a linear trend exists within time-dependent data. According to EPA guidance, the Mann-Kendall test assumes that the lack of trend correlates with concentrations over time (e.g., time series plot)



that fluctuate about a constant mean level, without a visually apparent upward or downward pattern (EPA 1989, 1992, 2009). As a nonparametric test, the actual concentrations (or ranks) are not used to calculate the test statistic, only the relative magnitudes of the concentrations.

Indicator Compound	Method Reporting Limit (µg/L)	Percentage of Upgradient Nondetections	Statistical Method Used	2024 Upgradient UPL (μg/L)		
Wastepile						
Arsenic	1	57	Nonparametric	3.43		
Chloride	1,000	0	Parametric	1,383,280		
Chloroform	0.2	100	Nonparametric	0.2 ¹		
Copper	10	100	Nonparametric	10 ¹		
CPMSO2	1.6	100	Nonparametric	2.08 ²		
DCPD	0.212	100	Nonparametric	2.8 ²		
Dieldrin	0.00543	14	Nonparametric	0.8		
DIMP	0.602	0	Parametric	1,934		
NNDMEA	0.0048	43	Nonparametric	0.0278		
Sulfate	2,500	0	Parametric	604,247		
TCLEE	0.2	100	Nonparametric	0.2 ¹		
Principal Threat	Principal Threat					
Arsenic	1	46	Nonparametric	3.17		
Chloride	1,000	0	Nonparametric	1,330,000		
Chloroform	0.2	0	Nonparametric	96		
Copper	10	100	Nonparametric	10 ¹		
CPMSO2	1.2	74	Nonparametric	2.54 ³		
DCPD	0.212	100	Nonparametric	0.28 ²		
Dieldrin	0.00543	3	Nonparametric	1.24		
DIMP	0.602	0	Nonparametric	249		
NNDMEA	0.0048	41	Nonparametric	0.1		
Sulfate	2,500	0	Parametric	1,203,900		
TCLEE	0.2	0	Parametric	0.77		

Table 5. Upper Prediction Limits for 2025 Water Quality Evaluations

Notes:

¹ Because this compound has not been detected in an upgradient well, the UPL value for this analyte is the current MRL.

² This compound was not detected during baseline sampling; therefore, the prediction limit value for this analyte is the 99 percent UCL of the MRL. The 99 percent UCL is defined as 1.3 times the maximum historical MRL (Navarro 2023).

³ Data validated as Questionable; therefore, CPMSO2 result for sample collected from 26073 in 2018 was excluded from consideration as a nonparametric UPL.



As presented in Sections 3.1.1 and 3.1.2 the concentrations of ICs in WP and PT downgradient wells exceeded UPLs and further evaluation for statistical trends was conducted. Table 6 includes a summary of the Mann-Kendall trend analyses conducted for ICs detected at concentrations exceeding their respective 2024 UPLs. Detailed information related to the Mann-Kendall analyses is available in the project files.

For WP UPL exceedances, chloroform exceeded the UPL in downgradient well 26015 and concentrations indicate an increasing trend. This trend is a continuation of previously-evaluated trends that show chloroform increasing in well 26015 during post-closure monitoring. Chloroform and dieldrin detected in well 26015 at concentrations greater than the WP prediction limits are likely attributable to higher water levels previously present beneath the former Basin F footprint that mobilized residual contamination.

Dieldrin exceeded the WP UPL in downgradient wells 26015 and 26017, however Mann-Kendall analysis indicated no discernible trend in either well in 2024.

Increasing trends of ICs are evident in downgradient PT wells 26133, 26163, and 26173 (Table 6). The following ICs indicate increasing trends in groundwater downgradient of the former Basin F:

<u>Well 26133</u>	<u>Well 26163</u>	<u>Well 26173</u>
Chloroform	Arsenic	CPMSO2
• DLDRN	 DCPD 	 DCPD
NNDMEA	 TCLEE 	 TCLEE
TCLEE		

The presence of elevated concentrations of analytes in wells 26133 and 26173—as compared to well 26163, which is adjacent and immediately downgradient of the former basin—indicate that contamination historically may have mobilized from Basin F prior to the remedy (Figure 3). Alternatively, water level maps developed annually during the closure and post-closure periods indicate wells northeast of the former Basin F are located along a groundwater flow path east of the former basin which was historically impacted by contamination from the Sand Creek Lateral (Figure 2). Therefore, it is likely that groundwater in wells 26133, 26157, and 26173 may be affected by contamination associated with the Sand Creek Lateral, and not exclusively by former Basin F.

3.4 Shewhart-CUSUM Control Charts

In accordance with the PCGMP, in situations where ICs are detected in groundwater downgradient of Basin F but are not present in upgradient groundwater, control charts can be used to evaluate the trend in concentrations over time compared to baseline conditions. Chloroform and DCPD detected in downgradient wells 26015, 26163, and 26173 exceeded their respective UPLs and demonstrated increasing trends. In these situations, Shewhart-CUSUM



control charts were developed to demonstrate whether the trends are statistically significant. An intrawell Shewhart-CUSUM control chart is a viable alternative to the use of UPLs to evaluate whether there is evidence that concentrations in a downgradient well exceeds upgradient, or background, water quality (EPA 2009). Control charts are a parametric analytical tool; thus, data must follow normal or lognormal distributions.

Control charts depicting Basin F water quality compare baseline data to post-closure data for a single downgradient well in order to identify whether the increase is statistically significant. Control charts were constructed using downgradient well baseline data collected prior to closure and data collected after closure. Refer to Attachment B for the control charts evaluated in 2024.

Further evidence of statistical significance was identified in the intrawell control charts for the analytes detected in the downgradient WP and PT wells below.

<u>WP Well 26015</u>	<u>PT Well 26163</u>	<u>PT Well 26173</u>
CHCL3	• DCPD	 DCPD

While water quality in well 26173 has likely been impacted by releases not related to Basin F, elevated concentrations of DCPD in well 26163 and chloroform in well 26015 likely represent groundwater impacted by the remobilization of residual soil contamination caused by fluctuating water levels within the unsaturated zone beneath the former basin.



Well	Indicator Compound	2024 Concentration (μg/L)	2024 Selected UPL (µg/L)	Statistical Method Used	Mann-Kendall Trend Analysis (2010-2024)		
Wastepile	Wastepile						
26015	Chloroform	0.59	0.2	Nonparametric	Increasing		
20015	Dieldrin	0.483	0.471	Parametric	No Discernible Trend		
26017	Dieldrin	0.612	0.471	Parametric	No Discernible Trend		
Principal	Threat						
26133	Chloroform	3,130	96	Nonparametric	Increasing		
	CPMSO2	18.3	2.54	Nonparametric	No Discernable Trend		
	DCPD	536	0.28	Nonparametric	No Discernible Trend		
	Dieldrin	1.89	1.24	Nonparametric	Increasing		
	NNDMEA	0.355	0.1	Nonparametric	Increasing		
	TCLEE	514	0.81	Parametric	Increasing		
26157	CPMSO2	16.3	2.54	Nonparametric	Decreasing		
	DCPD	236	0.28	Nonparametric	No Discernable Trend		
	NNDMEA	0.354	0.1	Nonparametric	Decreasing		
	TCLEE	69.1	0.81	Parametric	Decreasing		
26163	Arsenic	7.8	3.17	Nonparametric	Increasing		
	Chloride	3,100,000	1,330,000	Nonparametric	Decreasing		
	Copper	17.5	10	Nonparametric	No Discernable Trend		
	CPMSO2	7.9	2.54	Nonparametric	No Discernable Trend		
	DCPD	445	0.28	Nonparametric	Increasing		
	DIMP	508	249	Nonparametric	No Discernible Trend		
	NNDMEA	0.619	0.1	Nonparametric	Decreasing		
	TCLEE	4.45	0.81	Parametric	Increasing		
26173	CPMSO2	4.6	2.54	Nonparametric	Increasing		
	DCPD	70.2	0.28	Nonparametric	Increasing		
	DLDRN	1.29	1.24	Nonparametric	No Discernible Trend		
	TCLEE	807	0.81	Parametric	Increasing		



4.0 SUMMARY

Upgradient and downgradient groundwater data collected during post-closure monitoring of WP and PT wells were evaluated to demonstrate post-closure operations and maintenance of the Basin F surface impoundment and that the Basin F WP meets the RCRA closure performance standards.

The elevated concentrations of some contaminants in downgradient wells—including arsenic, chloroform, CPMSO2, DCPD, DIMP and TCLEE—may be the result of residual contamination present in the unsaturated and saturated zones that was mobilized with rising water levels or continuing migration from the vadose zone to the saturated zone. Before Basin F was drained in 1988, significant contamination leaked through the basin liner and migrated through the 40-to 45-foot-thick unsaturated zone to the water table. Therefore, residual contamination is present in the sediments above and below the water table, which serves as a continuing contaminant source to the groundwater as water levels fluctuate. Leaks from the Basin F liner primarily occurred on the east side of Basin F, specifically in the area where PT excavation took place, which accounts for the higher concentrations in the downgradient PT wells.

The following conclusions are based on the groundwater monitoring results for the 2024 Basin F post-closure groundwater monitoring program:

- In 2024, groundwater elevations decreased in all downgradient and upgradient monitoring wells associated with the Basin F monitoring program. The decrease in UFS water levels in the vicinity of Basin F is consistent with a general decreasing trend noted across RMA over the past several years.
- Based on the results of the data QA review, the analytical data collected in 2024 are of acceptable quality for their intended uses.
- To a lesser extent as compared to the PT area, groundwater along the WP flow path appears to have been impacted by residual soil contamination that remains within the western portion of the Basin F area. Concentrations of chloroform and dieldrin in downgradient well 26015 exceeded their respective UPLs, but only the concentrations of chloroform appear to be increasing based on the Mann-Kendall statistical trend analysis. The concentration of dieldrin in downgradient well 26017 exceeded the UPL, however Mann-Kendall analysis indicated no discernible trend (Table 5).
- Groundwater along the PT flow path appears to have been impacted by residual soil contamination that remains within the PT area and may also be impacted by sources associated with the Sand Creek Lateral located east of the former basin, as demonstrated by observed increases of select ICs in wells northeast of the PT area. Concentrations of several ICs exceeded UPLs—including arsenic, chloride, chloroform, copper, CPMSO2, DCPD, dieldrin, DIMP, NNDMEA, and TCLEE. Mann-Kendall trend analyses for the following ICs detected in downgradient wells exhibited increasing trends:



- Well 26133 Chloroform, Dieldrin, NNDMEA, and TCLEE
- Well 26163 Arsenic, DCPD, and TCLEE
- Well 26173 CPMSO2, DCPD, and TCLEE

Based on the distribution of the analyte concentrations and water quality trends, it appears that the PT groundwater flow path is having a greater impact on water quality downgradient of the former Basin F compared to the WP flow path. Concentrations downgradient of the PT indicate an impact due to contaminated groundwater migrating from upgradient sources and/or residual contamination within the unsaturated zone beneath the Basin F PT area.



5.0 REFERENCES

- EPA (U.S. Environmental Protection Agency)
 - 2009 Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities Unified Guidance. EPA 530/R-09-007. March 2009.
 - 1992 Addendum to the Interim Final Guidance Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities. July 1992.
 - 1989 Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities Interim Final Guidance Facilities. April 1989.

Navarro (Navarro Research and Engineering, Inc.)

- 2023 Basin F Post-Closure Groundwater Monitoring Plan. Revision 2, April 2023.
- 2021a Long-Term Monitoring Plan for Groundwater and Surface Water. Revision 1, May 2021.
- 2021b Fiscal Year 2020 Annual Summary and Five-Year Summary Report for Groundwater and Surface Water. Revision 0, July 2021.
- 2019 *Rocky Mountain Arsenal Sampling Quality Assurance Project Plan.* Revision 2, January 2020.

Starpoint (Starpoint Software, Inc.)

2023 ChemStat Environmental Statistical Analysis Software Solution for Windows. Version 6.5.



FIGURES



Legend



Former Basin F Surface Impoundment



```
= = = = Unpaved Roads
```

* Well 26015 is used in both Wastepile and Principal Threat Water Quality Networks.

	Flow System / Aquifer			
Monitoring Well/ Piezometer Network	Unconfined Alluvial	Unconfined Alluvial/ Denver	Unconfined Denver	
Water Level Network	Δ		0	
Other Network Wells	Δ		ο	
Basin F Wastepile Water Quality Network		•	•	
Basin F Principal Threat Water Quality Network			•	
Optimization Network Wells	Δ			



NAD27-NGVD29 Datum, US Survey Feet, Colorado North Zone Sources: U.S. Army, RMA GIS, OMC, Shell/AECOM



Figure 1



M:/projects/basin-F_post-closure/2023/mxds/BF_CurrentMon/WellNetwork_101823.mxd 10/23/2023









Former Basin F Surface Impoundment



= = = = Unpaved Roads

Well 26015 is used in both Wastepile Water Quality and Principal Threat Water Quality Networks.



Note: Values in red indicate analytical results that exceeded 2024 upper prediction limits.



NAD27-NGVD29 Datum, US Survey Feet, Colorado North Zone Sources: U.S. Army, RMA GIS, OMC, Shell/AECOM



Figure 3

Former Basin F 2024 Well Network Indicator Compound Detection Map

M:\projects\basin-F_post-closure\2024\mxds\BasinF_ind_comp_2024.mxd 10/16/2024
ATTACHMENTS

ATTACHMENT A

Hydrographs for Basin F Water Quality Wells

2006-04-01 to 2024-06-01 (Validated Data)



Water Levels for Well 26017

2006-04-01 to 2024-06-01 (Validated Data)





2006-04-01 to 2024-06-01 (Validated Data)



The water elevation increase of 0.94 feet on January 14, 2011 in well 26073 coincided with a top-of- casing elevation change resulting from modifications to the well. The well was resurveyed and updated in the Rocky Mountain Arsenal Database (RMAED). May 2024 measurement is anomalous and likely does not represent the true elevation.

2006-04-01 to 2024-06-01 (Validated Data)



Water Levels for Well 26133

2006-04-01 to 2024-06-01 (Validated Data)





2006-04-01 to 2024-06-01 (Validated Data)



2006-04-01 to 2024-06-01 (Validated Data)



ATTACHMENT B

Shewhart-CUSUM Control Charts



CHCL3 Intra-Well Shewhart-CUSUM Control Chart (Unified Guidance) of 26015 Baseline Mean = 0.27825; Baseline Std Dev = 0.140062; k = 1; h = 5;





Page 1

APPENDIX F

Non-Routine Action Plans

NRAP Number	NRAP-2023-002
Applicable Design(s)	 SDT Remediation Project RCRA-Equivalent Cover Construction – Record Documents ICS Design Project – Record Documents Basin F/Basin F Exterior Remediation Project – Part 2 (Basin F Cover) – Record Documents
Applicable Design Document(s)	 Drawing Number/Title/Revision: Spec. Number /Title/Revision: Plan Title/Revision:
Description of the Condition Requiring Action	Periodic prescribed burning of the Basin F Army Maintained Area (Basin F AMA) benefits the site by removing dead debris and allowing new shoots to grow uninhibited. After an above average precipitation year during 2023, Basin F would benefit from having a prescribed burn to remove an excess of growth in vegetation and prevent this vegetation from becoming a nuisance of litter accumulation. In addition, a percentage of the soil weed seed bank may be depleted, and removal of litter will allow better control of weedy species that are present after the fire. Prescribed fire may also result in the stimulation of warm season grass species, and a prescribed burn will allow for an unobstructed inspection of the ground surface. The last successful prescribed burn was conducted on the Basin F AMA in April of 2019.
	According to Section 3.3.4 of the <i>Basin F Post-Closure Plan</i> , Rev. 2, prescribed burns for the purpose of vegetation management are considered non-routine actions and require consultation between the Army, Shell, and Regulatory Agencies, and preparation of a Non-Routine Action Plan in accordance with Section 3.5 of the Post-Closure Plan.
Description of the Action	The affected area will include the entirety of the Basin F AMA, or approximately 112 acres. The intent is to burn the entire Basin F AMA but field conditions, limitation on available resources, or other circumstances may prevent a complete burn of the area. The intended buffer zone to control the burn will be the Basin F perimeter road. Please see the attached map of the affected area for location information.
	The U.S. Fish and Wildlife Service (USFWS) will coordinate a prescribed burn in the fall of 2023 or spring of 2024. The precise timing of the burn will be dependent upon field conditions, meteorological conditions, weather forecasts, available resources, and smoke permit restrictions. The USFWS <i>Fire Management Plan for the Rocky Mountain Arsenal National Wildlife Refuge Complex</i> (revised 2017) is available at the following link for reference: https://ecos.fws.gov/ServCat/Reference/Profile/81000
	An Incident Action Plan for the burn will be finalized by the Burn Boss as one of the pre-burn activities.
	Protection of sensitive cover features is a significant concern and will be addressed prior to, and during performance of the burn. The perimeter fence, including wooden fence posts, is the only feature on the Basin F AMA that requires protection. Prior to initiating the burn, the USFWS and/or the OMC will protect the perimeter fencing by mowing along the fence in order to remove as much fuel from the immediate area as possible. Following the mowing, heavy accumulations of litter may be moved into the burn area if practicable. USFWS personnel controlling the burn will use fire control vehicles to apply water as necessary to prevent damage to the perimeter fence posts.
	Material Kequirements: None
	Performance Criteria: None

	Does the action deviate from the requirements of the applicable design package(s)? \Box Yes \boxtimes No					
	II so, provide rationa	ue for the devis	ation from the	uesign pac	mage(s).	
Closeout	Is a multi-Agency po	ost-action inspe	ection required	? 🗌 Yes	No	
Requirements	Are modifications to	monitoring or	inspection free	quencies re	equired? 🗌 Yes 🖾 No	
	Others: An inspection potential issues	on of the burn sues with the co	area(s) will be over surface.	performed	following the burn to identify	
Consultation	Consultation Date: S	September 12,	2023			
Record	Consultation Method	l: email				
	Consulted Parties: E	PA, CDPHE, T	ГCHD			
Attached	☑ None☑ Inspection Form(s)			Supplemental Work Plan(s)		
Exhibits				Rationale for Deviation From Design		
	Map of Affected Area			Modified Inspection Frequencies		
				Others:		
Approvals	Approvals					
Signature indica	tes the Parties are in c	consensus and	concur with the	e proposed	l action and closeout requirements.	
Cover Manager, or Designee Signature and Date: Army Program Manager, or Designee Signature and Da			r, or Designee Signature and Date:			
EPA Signature a	nd Date:	CDPHE Sign	nature and Date:		ACHD Signature and Date:	



APPENDIX G

Operations and Maintenance Change Notices

ROCKY MOUNTAIN ARSENAL O&M CHANGE NOTICE

WBS Number: 4.01.04.24		OCN Number: OCN-BASINF-2024-001				
ب HWL Post-Closure Plan				Long-Term Monitoring Plan for GW & Surface Water		
cted ocedun	ELF Post-Closure Plan			Land Use Controls Plan		
Affe an/Pro	Basin F Post-Closure Plan			RVO SOP No:		
Pla	Long-Term Care Plan			Other:		
Recon	nmended disposition: <u>Class 1</u> Mo	dification (rec	quired	d for HWL, ELF, and	d Basin F Post-Closure Plans)	
Re A E	efer to 6 CCR 1007-3 Part 100, A A. General Permit Provisions, 1 3. General Facility Standards, 3.	Appendix I to § Administrative Changes in pr	§ 100 e and oced	.63 – Classification of informational changures for maintaining	of Permit Modification: ges the operating record.	
 Describe proposed change (Exact change in redlined/strike-through format preferred. Provide below or in attachment): This OCN updates the language used in the Basin F Post-Closure Plan (PCP) for consistency with the U.S. Army's electronic records management system requirements. The various forms found in the Basin F PCP have been converted into fillable PDF forms with minor format changes that are intended to facilitate form usage. Forms in other electronic formats may also be used as they become available. Redline/strike-through text for the Basin F PCP is attached, with fillable PDF forms. 				Reason for change In accordance wi Budget Memorat transitioned to a system. The lan F PCP assumes t document O&M would be produc project files wou contractor and tr OCN updates the O&M recordkee	the office of Management and ndum M-19-21, the U.S. Army has paperless records management guage used in Revision 2 of the Basin that paper forms would be used to activities, that hardcopy reports activities, that hardcopy and that hardcopy and be maintained by the O&M cansmitted to the Army annually. This e Basin F PCP to allow for electronic ping.	
Exhibi	 Exhibits attached: None List: Basin F PCP, Revision 2 with redline/strike-through text (affected pages only) Forms in fillable PDF format: Form 3.5.2-1 – Non-Routine Action Plant Template Form 3.6.1-1 – Percolation Assessment Form Form SOP 001-1 – Basin F Cover Inspection Form Form SOP 001-2 – Basin F Cover Perimeter Survey Monument Inspection Form Form SOP 003-1 – Basin F Percolation Monitoring System Data Collection and Operation Form 					
Origin	ator: Michael W. Jones		Date	Date: February 26, 2024		
Final Approval: Navarro Project Manager Signature and Date				Army Project Manager Signature and Date		
Navarro Project Engineer Signature and Date (required for record drawing/design changes)			ed	ed Navarro Regulatory Compliance Manager Signature and Date		
Regulatory Approvals:						
EPA Signature and Date CDPHE Signatur			nature	e and Date	ACHD Signature and Date	

Rocky Mountain Arsenal Basin F WBS 4.01.04.23 Basin F Post-Closure Plan Revision 2 April 10, 2023

ACRONYMS

ACHD	Adams County Health Department	
AMA	Army Maintained Area	
APM	Army Project Manager	
BBM	Biota Barrier Material	
BMPs	Best Management Practices	
CCR	Code of Colorado Regulations	
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act	
CDPHE	Colorado Department of Public Health and Environment	
Denver Fm	Denver Formation	
DTC	Document Tracking Center	Commented [A1]: OCN-BASINF-2024-001
EPA	U.S. Environmental Protection Agency	
FFA	Federal Facility Agreement	
FR	Federal Register	
ICS	Integrated Cover System	
LTCP	Long-Term Care Plan	
NRAP	Non-Routine Action Plan	
O&M	Operations and Maintenance	
PCP	Post-Closure Plan	
RCRA	Resource Conservation and Recovery Act	
RMA	Rocky Mountain Arsenal	
RMANWR	RMA National Wildlife Refuge	
ROD	Record of Decision for the On-Post Operable Unit	
SOP	Standard Operating Procedure	
UFS	Unconfined Flow System	
USFWS	U.S. Fish and Wildlife Service	

Rocky Mountain Arsenal	Basin F Post-Closure Plan
Basin F	Revision 2
WBS 4.01.04.23	April 10, 2023

This document describes the post-closure activities for the Basin F AMA shown on Figure 1.0-1. This PCP was prepared in accordance with requirements of the Final Closure Plan, which incorporate requirements of the Colorado Hazardous Waste Regulations 6 CCR 1007-3, Part 265, Subpart G.

1.2 Document Organization

Information is presented within this PCP as follows:

- Section 2 presents a general description of Basin F.
- Section 3 describes the requirements for implementing post-closure inspection, monitoring, maintenance, and reporting activities.
- Section 4 describes the anticipated schedule for the post-closure period.
- Section 5 provides a list of references used in this document.

Documents contained within the appendices of this plan are maintained electronically and are available at the Document Tracking Center (DTC), currently located in Building 129 at RMA.

1.3 Document Maintenance

The point of contact for RMA regarding this PCP is the Army Project Manager (APM), U.S. Army, Rocky Mountain Arsenal, 7270 Kingston Parkway, Commerce City, Colorado, 80022. The Army will be responsible for ensuring those activities described in this PCP are implemented, documented, and reported. The PCP documents, reports, monitoring data, and records will be maintained by the Covers Manager in the project file or electronically by the Army(e.g., spreadsheets, databases) and transferred at least annually for permanent storage to the DTC. The project reports generated by Army contractors will be transferred to the Army and stored in accordance with Army Records Management Standards. Certain monitoring data will be maintained in the RMA Environmental Database, as indicated in this PCP and appendices.

When changes to any of the Basin F PCP documents are proposed, the Army will submit the revised document to the regulatory agencies for review and approval prior to implementation.

1.4 Amendments to the Post-Closure Plan

If necessary, this PCP will be modified in accordance with state regulations [6 CCR 1007-3 Section 265.118(d)]. When modifications to this PCP are proposed by the Army, a written request to CDPHE will be made 60 days prior to the proposed change or no later than 60 days after an unexpected event has occurred that has affected the PCP. The ACHD and EPA will be notified of the Army's request for proposed change. Modifications are mandatory when changes identified in state regulations (6 CCR 1007-3, Section 100.63) are made. A history of approved changes to previous revisions is provided in Appendix E of this plan.

1.5 Roles and Responsibilities

The Army established an integrated management team with the capabilities required to implement post-closure activities for Basin F. The organizational structure, functional responsibilities, minimum qualifications, lines of communication, and interfaces for long-term O&M of the facilities are identified in the following subsections.

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Commented [A3]: OCN-BASINF-2024-001

Rocky Mountain Arsenal	Basin F Post-Closure Plan
Basin F	Revision 2
WBS 4.01.04.23	April 10, 2023

through the Covers Manager and approval by the Army. In addition, any USFWS activities within the Basin F AMA for non-routine actions require review and approval by the regulatory agencies through the consultative process, prior to implementation. The USFWS will also coordinate with the Covers Manager regarding RMANWR activities that may impact the Basin F AMA.

1.6 Training

All above listed personnel will receive on-the-job training specific to the requirements in this PCP. Additional training will be provided in environmental, health, safety, and quality requirements, as appropriate. Training will be documented, and records maintained in the project fileby the Army.

1.7 CERCLA Long-Term O&M Requirements

On July 22, 1987, the RMA site, including Basin F, was listed on the National Priority List (52 Federal Register [FR] 27620 and 52 FR 27643). Thus, the Basin F Cover is subject to CERCLA O&M requirements defined in the *RCRA-Equivalent*, *2-*, and *3-Foot Covers Long-Term Care Plan* (LTCP), Revision 3 (Navarro 2021b). This includes the post-construction process and "Operational and Functional" determination described in items 1 and 2 of Section 1.0 of the LTCP. In their letter dated September 18, 2019 (EPA 2019) the EPA, in coordination with CDPHE, and Tri-County Health Department (predecessor of the ACHD), notified the Army that the Basin F Cover was Operational and Functional based on information contained within the *Basin F/Basin F Exterior Remediation Project Part 2 (Basin F Cover Project) Construction Completion Report – Part 2* (Navarro 2017).

During the post-closure period, compliance with other CERCLA O&M requirements is achieved through implementation of the O&M activities identified in this post-closure plan.

2.0 FACILITY DESCRIPTION

This section describes the RMA site location and history, the physical setting of Basin F, hydrogeologic conditions in the Basin F area, current groundwater quality and groundwater level monitoring well networks, and a description of the Basin F Cover.

2.1 General Description

The RMA, owned by the Army, currently occupies approximately 1,100 acres within the RMANWR, which is owned by the USFWS. The RMA initially spanned more than 17,000 acres in Adams County, Colorado, northeast of the metropolitan Denver area. The property was primarily used for agriculture prior to 1942, when the federal government purchased the land and created the RMA. The original mission of the RMA was to manufacture and assemble chemical warfare materiel and incendiary munitions during World War II. A significant amount of chemical warfare materiel destruction took place during the 1950s, 1960s, and 1970s. The last demilitarization operations ended in the early 1980s. In addition to military activities, major portions of the RMA facilities were leased to private industries, including Shell Oil Company, for the manufacture of various pesticides and herbicides. These commercial activities ended in 1982. In November 1988, RMA was reassigned to inactive military status with the only remaining mission at RMA being contamination cleanup.

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Rocky Mountain Arsenal	
Basin F	
WBS 4.01.04.23	

Basin F Post-Closure Plan Revision 2 April 10, 2023

designated to receive RCRA-equivalent covers. These areas include Basin F, the South Plants Central Processing Area, Lime Basins, Basin A, Complex (Army) Trenches, and Shell Disposal Trenches. A description of these areas and the wastes associated with them can be found in the ROD and supporting Remedial Investigation/Feasibility Study documents. Construction of the RCRA-equivalent cover over Basin F was also required in the Final Closure Plan as part of the RCRA closure of the Basin F interim status unit. These documents can be located in the DTCare available from the APM upon request.

During the closure period a RCRA-equivalent cover was constructed over Basin F as required by the Final Closure Plan. Following cover construction, record drawings were prepared using survey data collected during construction. Record condition drawings for the Basin F Cover are provided in Appendix C.

The Basin F Cover is maintained to accomplish the goals identified in the design documents:

- Serve as an effective long-term barrier
- Maximize runoff and minimize ponding
- Minimize erosion by wind and water
- Prevent damage to integrity of cap by biota and humans
- Maintain a cover of locally adapted perennial vegetation

The Basin F Cover has been designed and constructed with the objective of isolating wastes and reducing percolation of moisture to minimize the migration of contamination to groundwater.

The Basin F Cover is located within the boundaries of the Basin F AMA, defined by the outside shoulder of the perimeter access road. This cover is an evapotranspirative cover that includes a capillary barrier and has performance requirements identified in Section 3.6 related to percolation, vegetation, and soil thickness. The cover components and arrangement are illustrated in Figure 2.4.1-1. The thickness of the cover soil layer is designed to be maintained at a minimum of 42 inches for soil moisture storage, and works in conjunction with a capillary barrier at the bottom of the cover soil layer. The soil layer was constructed with a minimum thickness of 48 inches to account for potential erosion and/or settlement. The cover also includes surface water drainage controls and engineering controls, as well as a network of lysimeters to monitor deep percolation.

2.4.2 Water Quality and Water Level Monitoring Well Networks

Wells included in the Basin F water quality monitoring network are listed in Appendix B and their locations are shown on a figure in the same appendix. The nine water quality wells are screened in the UFS and will monitor groundwater conditions in the uppermost aquifer. Six wells (26015, 26017, 26133, 26157, 26163, and 26173) will be monitored downgradient and three wells (26028, 26073, and 26128) will be monitored upgradient. The water chemistry in Basin F shows pesticides, volatile organic compounds, semivolatile organic compounds, metals, mercury, diisopropyl methylphosphonate, as well as naturally occurring compounds. Both upgradient and downgradient groundwater data show these contaminants and, in some cases, upgradient concentrations are greater than downgradient concentrations.

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Rocky Mountain Arsenal	Basin F Post-Closure Plan	
Basin F	Revision 2	
WBS 4.01.04.23	April 10, 2023	

3.9 Recordkeeping and Reporting

A comprehensive and stand-alone report, referred to as the *Basin F Cover and Groundwater Monitoring Report*, will be prepared annually during the post-closure period and will include the following elements:

- I. Executive Summary
- II. Introduction
- III. Methodology
- IV. Precipitation/Irrigation Data
- V. Soil Cover Assessment
- VI. Vegetation Monitoring Assessment
- VII. Percolation Monitoring Assessment
- VIII. Groundwater Monitoring Assessment and Data
- IX. Discussion of Routine Activities
- X. Discussion of Non-Routine Activities
- XI. Recommendations and Corrective Measures
- XII. Annual O&M Cost and Projected Budget
- XIII. References

The annual *Basin F Cover and Groundwater Monitoring Report* will include a map showing the location of routine and non-routine maintenance and repair actions at an appropriate scale to clearly see the repair and maintenance locations. The report will also have an appendix that includes all of the inspection and maintenance records and data collected for the year. The information in the appendix may be provided on a compact disk.

The annual *Basin F Cover and Groundwater Monitoring Report* will summarize the results of percolation monitoring including the 12-month rolling evaluation throughout the reporting period and comparison to the percolation performance standard.

The annual *Basin F Cover and Groundwater Monitoring Report* will summarize the results of the annual vegetation performance assessment as compared with the standards, maintenance and repair activities that occurred during the reporting period, and, if needed, recommended measures to sustain or improve vegetative conditions on the cover. In addition, Section VI will include a map showing the vegetation sample locations and the sample adequacy calculations. The report will include the following information:

- A brief introduction with general description of environmental conditions of note such as notes on wildlife use, weed infestation, and insect abundance.
- Recitation of methods, including any variance from the standard procedure in SOP 002.
- Review of climatic data since the previous year's sampling using any site data available or the closest available data.
- Presentation of collected data including individual transect data and mean cover values by vascular plant species, cryptograms, bare soil, litter, standing dead, and rock as well as total vegetation cover and total ground cover (vegetation plus litter plus standing dead

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Rocky Mountain Arsenal	Basin F Post-Closure Plan
Basin F	Revision 2
WBS 4.01.04.23	April 10, 2023

plus rock). Standard deviation (n-1) will be shown for the latter two totals. Relative cover values will also be presented. Overall species density will be presented by transect and as a mean in number of species per 100 square meters. Frequency (constancy) will be shown by species. Relative frequency and importance values may be calculated also.

- A species presence table will be provided in which all species encountered during the year's sampling are presented by lifeform and provenance (native or introduced).
- Compilation of previous year's data for convenient and direct comparison of current year's values to previous values. The compilation should present mean values by species as well as bare soil, litter, standing dead, rock, total vegetation cover, and total ground cover.
- A direct statement as to whether the 2-year running mean for coverage is less than 50 percent, the 3-year running mean is less than 67 percent, and if total live vegetation for the current year sampling does not equal or exceed 25 percent. For ease of reference, this statement should be placed prominently in an executive summary near the beginning of the report.

The annual *Basin F Cover and Groundwater Monitoring Report* will cover the period from October through September and will be submitted to the regulatory agencies within 60 days following the completion of the vegetation performance assessment, or by November 30th of each year. Groundwater monitoring results from the prior annual sampling event will be summarized in the annual *Basin F Cover and Groundwater Monitoring Report* and presented as an appendix to the report in a *Basin F Post-Closure Groundwater Monitoring Report*.

Regular meetings shall be held semiannually with the regulatory agencies to review all inspections, routine and non-routine maintenance, and repairs conducted during that 6-month period. The meeting shall be held within 30 days of the April Type II and October Type I inspections.

Post-closure records including inspection data and reports, maintenance and repair records, groundwater monitoring results, evaluations, and plans of actions will be maintained at RMA as discussed in Section 1.3.

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Rocky Mountain Arsenal
Basin F
WBS 4.01.04.23

Basin F Post-Closure Standard Operating Procedures Revision 2 April 10, 2023

ROCKY MOUNTAIN ARSENAL BASIN F POST-CLOSURE STANDARD OPERATING PROCEDURE

SOP NO.	001	
TITLE	Cover Conditions Inspections	
DATE	April 2023	
PURPOSE	To describe the procedures for inspecting, monitoring, and documenting cover conditions.	
RELATED SOPs AND PLANS	SOP 002 Cover Vegetation Performance Assessment SOP 003 Percolation Monitoring System Data Collection and Operation Basin F Post-Closure Plan	
FREQUENCY	Type II inspections will be performed in April and if necessary following prescribed burns.	
	Type I inspections will be performed in January, July, and October, unless otherwise determined by the Covers Manager.	
	Type I inspections will be performed after significant storm events (>1 inch of precipitation per 24-hour period).	
	Cover Perimeter Survey Monument Inspections will be performed once every five years prior to the CERCLA Five-Year Review.	
HEALTH & SAFETY	Implement health and safety requirements described in the PM-A- 102: <i>RMA Emergency Management Contingency Plan</i> , Contractor's Health and Safety Plan, and task-specific Job Hazard Analyses.	
FIELD EQUIPMENT	All-terrain vehicle (ATV) Mobile Phone Permanent black marker Global Positioning System device (GPS) with sub-meter accuracy Digital Camera	Commented [A8]: OCN RASINE 2024 00
	Binoculars (optional)	Commented [A0]. OCN-BASINF-2024-00

PROCEDURES

Notes: This SOP applies to the entire Basin F AMA.

Basin F PCP Rev 2 with OCNs

Appendix A, SOP 001-1

Rocky Mountain Arsenal	Basin F Post-Closure Standard Operating Procedures
Basin F	Revision 2
WBS 4.01.04.23	April 10, 2023

- 7. Inspect the visibility, legibility, and integrity of the following engineering controls during Type I and Type II inspections: perimeter signs, fencing, obelisks, and the perimeter access road. Inspect erosion/settlement monuments during the spring Type II inspection and fall Type I inspection. Refer to the Record Drawings for the location of all engineering controls. Document the observed conditions on Form SOP 001-1.
- Inspect and recover cover perimeter survey monuments every five years prior to the CERCLA Five-Year Review. Cover perimeter survey monuments are shown on Figure SOP 001-1 and survey coordinates for each monument are provided on Table SOP 001-2. Document the observed conditions on Form SOP 001-2.
- 9. At the conclusion of the inspection, ensure all applicable items on the appropriate cover inspection form are completed and forward the inspection form to the Covers Manager for evaluation, scheduling and scoping of maintenance and repair work.
- 10. Following maintenance/repair work, verify completion of appropriate actions and provide digital photograph(s) and original cover inspection form to the Covers Manager for signature approval that all items on the form have been completed.

ATTACHMENTS

Figure SOP 001-1 Basin F RCRA-Equivalent Cover Plan

Figure SOP 001-2 Erosion/Settlement Monument and Survey Monument Detail

Figure SOP 001-3 Sign and Obelisk Details

Form SOP 001-1 Basin F Cover Inspection Form

Form SOP 001-2 Basin F Cover Perimeter Survey Monument Inspection Form

Table SOP 001-1 Erosion/Settlement Monument Record Survey Coordinates

Table SOP 001-2 Cover Perimeter Survey Monument Record Survey Coordinate

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Rocky Mountain Arsenal
Basin F
WBS 4 01 04 23

Basin F Post-Closure Standard Operating Procedures Revision 2 April 10, 2023

ROCKY MOUNTAIN ARSENAL BASIN F POST-CLOSURE STANDARD OPERATING PROCEDURE

SOP NO.	003	
TITLE	Percolation Monitoring System Data Collection and Operation	
DATE	April 2023	
PURPOSE	To describe the procedures for monitoring lysimeter manhole conditions and for measuring percolation collected by the RCRA- Equivalent Cover percolation monitoring system.	
RELATED SOPs AND PLANS	SOP 001 Cover Conditions Inspections SOP 002 Cover Vegetation Performance Assessment Basin F Post-Closure Plan	
FREQUENCY	Monthly. Additional percolation measurements may be taken in response to weather or abnormal percolation readings.	
HEALTH & SAFETY	Implement health and safety requirements described in the <i>RMA</i> <i>Incident and Emergency Management Policy and Contingency</i> <i>Plan</i> and task-specific Activity Hazard Analyses. Comply with confined space entry permit requirements when applicable.	
FIELD EQUIPMENT	Two-way radio Flashlight ATV (as field conditions permit) Clipboard and appropriate forms (optional) Global Positioning System device (GPS) 5-gallon poly bucket and rope (20 feet minimum) Graduated measuring vessel capable of measuring liquid volume to within 1 liter Portable manhole ladder (for maintenance and repair only) Portable pump with hose (20 feet minimum)	Commented [A12]: OCN-BASINF-2024-001

PROCEDURES

1

- 1. Document the precipitation over the previous 24 hours. Obtain precipitation information from a precipitation gauge located on RMA.
- 2. Gather necessary equipment to measure percolation and proceed to the Basin F AMA. Park vehicle off the cover.
- 3. Verify that field conditions are acceptable for traversing the Basin F AMA, either on-foot and/or with an ATV. If conditions exist that could cause damage to the cover, especially

Basin F PCP Rev 2 with OCNs

Appendix A, SOP 003-1

Rocky Mountain Arsenal	Basin F Post-Closure Vegetation Lists
Basin F	Revision 2
WBS 4.01.04.23	April 10, 2023

The following table provides a record of changes to previous revisions of the Basin F Post-Closure Plan and associated appendices. Each of the changes described below were approved by the regulatory agencies prior to implementation. All changes to the Basin F Post-Closure Plan were made in accordance with state regulations [6 CCR 1007-3 Section 265.118(d)]. Operations and Maintenance Change Notices (OCNs) were used to document each change, provide rationale for the change, and to record approval by the regulatory agencies, unless noted otherwise.

OCN Number	Description of Change	Approval Date							
	Changes to Revision 0								
OCN-BASINF-2013-001	The resolution of annual aerial photography was changed from 1:5,000 to 1:9,000.	July 18, 2013							
OCN-BASINF-2013-002	The Type II inspection procedure was modified to allow for the use of north/south oriented transects.	August 28, 2013							
OCN-BASINF-2014-001	Record drawings were revised to add cattle guards to the perimeter road, additional fencing between cattle guards and the Basin F AMA perimeter fence, modify the existing cattle guard, and move warning signs from metal posts to the wood fence posts. Section and detail numbering and lettering convention were also corrected throughout the drawing set.	July 9, 2014							
OCN-BASINF-2016-001	Valves located in lysimeter manholes for use in percolation measurements were changed from a ³ / ₄ " hose bib with T- handle to a ³ / ₄ " manual ball valve with PVC extension handle to the manhole cover ring.	June 16, 2016							
OCN-BASINF-2019-001	The allowable date range was changed for performance of the annual vegetation assessment described in Basin F Post-Closure Plan SOP 002: <i>Cover Vegetation Performance Assessment</i> .	October 23, 2019							
OCN-BASINF-2020-001	The response to exceedances of the percolation standard was changed. The change provided options to correct cover conditions that may have contributed to excess percolation. This OCN added a flow chart to the Post-Closure Plan that illustrates the response process, as well as a form intended to document the assessment of the percolation event.	March 10, 2020							
OCN-BASINF-2022-001	June 27, 2022								
	Changes to Revision 1								
N/A	Changes were made in accordance with Army responses to comments submitted by CDPHE on the Basin F Post-Closure Plan, Revision 1. Refer to CDPHE correspondence dated November 1, 2022. Changes include the addition of Figure 1.0-1, text revisions, and other editorial changes where necessary.	N/A							
	Changes to Revision 2								

Basin F PCP Rev 2 with OCNs

Appendix E-1

Rocky Mountain Arsenal Basin F WBS 4.01.04.23	Basin F Po	st-Closure Vegetation Lists Revision 2 April 10, 2023	
OCN Number	Description of Change	Approval Date	
OCN-BASINF-2024-001	Changes were made for consistency with the U.S. Army's electronic records management system requirements. The various forms found in the Basin F PCP have been converted into fillable PDF forms with minor format changes that are intended to facilitate form usage.	TBD	Commented [A14]: OCN-BASINF-2024-001

Form 3.5.2-1 Non-Routine Action Plan Template

NRAP Number	NRAP-									
Applicable Design(s)	Basin F/Basin F Exterior Remediation Project - Part 2 (Basin F Cover) – Record Documents									
Applicable Design Document(s)	Drawing Number	 Drawing Number/Title/Revision: Spec. Number /Title/Revision: Plan Title/Revision: 								
Description of the Condition Requiring Action										
Description of the Action	Action:	Action:								
	Material Requirements:									
	Performance Criteria	Performance Criteria:								
	Does the action deviate from the requirements of the applicable design package(s)? Yes No If so, provide rationale for the deviation from the design package(s).									
Closeout Requirements	Is a multi-Agency post-action inspection required? Yes No Are modifications to monitoring or inspection frequencies required? Yes No Others:									
Consultation Record	Consultation Date: Consultation Method: Consulted Parties:									
Attached Exhibits	Image: None Image: Supplemental Work Plan(s) Image: Ima									
Approvals Signature indica	tes the Parties are in c	consensus and concu	r with the	e proposed	action and closeout requirements.					
Covers Manager	, or Designee Signatur	e & Date:	Army F	Project Man	ager, or Designee Signature & Date:					
EPA Signature &	k Date:	CDPHE Signature	& Date:		ACHD Signature & Date:					

PERCOLATION EVENT INFORMATION								
Assessment Form Number:					Lysimeter Number:			
Percolation Quantity: Percolation Date Range:								
Applicable Design: SDT Remediation Project RCRA-Equivalent Cover Construction – Record Documents ICS Design Project – Record Documents Basin F/Basin F Exterior Remediation Project – Part 2 (Basin F Cover) – Record Documents								
The percolation performance standard is	s 1.3 mm/	/year.	Y	N	Date(s) of previous performance standard exceedance(s).			
Has the lysimeter exceeded the performance standard previously?								
			P	ERCOLA	TION ASSESSMENT			
Inspect Cover Surface Conditions								
Assessment Item Assessment		sment plete?	Non-Typical Condition Identified?		Description of Non-Typical Condition(s)	Condition Repaired?		on 1?
	Y	Ν	Y	Ν		Y	Ν	N/A
Inspect the area for macro-features such as holes, cracks, or animal burrows.								
Inspect the surface for depressions.								
Survey the area to identify potential ponding or slope abnormalities.								
Inspect the area for large bare areas or sparse vegetation.								
Inspect the area for weedy species or other undesirable vegetation.								
Collect vegetation transect sample data.								

Review Construction and Maintenanc	e Recor	ds			
Assessment Item	Assessment Complete?		Non-Typical Condition Identified?		Description of Non-Typical Condition(s)
	Y	Ν	Y	Ν	
Review construction records for atypical activities or test results.					
Review Annual Covers Reports for previously-documented issues.					
Review O&M inspection records for recurring issues.					
Review maintenance activities for potential disturbances.					
Review non-routine work performed in the area.					
Evaluate Other Data Sources					
Assessment Item	Asses Com	sment olete?	-		Summarize Data Evaluation Findings
	Y	Ν			
Evaluate previous percolation data for similar patterns at the same location.					
Compare lysimeter performance to the Melchior study for RCRA-equivalence.					

Assessment Item	Assessment Complete?		Summarize Data Evaluation Findings					
	Y	Ν						
Review data collected by other lysimeters over the same period.								
Review recent weather patterns for extreme conditions including drought and historic rain events.								
			ATTACHMEN	ITS				
None Topographical Survey Data Map of Affected Area Vegetation Assessment Data Photos Construction Records Inspection Records	Maintenance Records Previous Percolation Data Percolation Data from Other Lysimeters Meteorological Data Correspondence Other			List:				
			CONCLUSIO	NS				

PATH FORWARD (Check all that apply)									
Continue monitoring Provide description if necessary.									
Initiate cover repairs									
Prepare Investigation Schedule									
Prepare Corrective Measures Plan of Action	Action								
Other									
APPROVALS									
Cover Manager, or Designee Signature and Date:	APM, or Designee Signature and Date:	Other:							
EPA Signature and Date:	CDPHE Signature and Date:	ACHD Signature and Date:							

Form SOP 001-1 Basin F Cover Inspection Form

Inspector's Names:		Insp	ection Date(s):				
Inspection Type: Type I Type II	Post-Storm						
Drive-around Post-Storm Inspection Da	m Event:						
a * next to the Inspection Item number.	re indicated with		Total Precipitation (in):				
Inspection Conditions: Previous 24-hour precipitation: Weather Conditions:							
Attachments: Attachments: Figu	res 🗌 Other						
Inspection Item				spection Note	Confirm Completed Actions (Initial and Date)		
1.0 Surface Conditions							
1.1* Erosion rills, gullies, or sheet erosion							
1.2* Conditions that could interrupt cover surface drainage (ponding areas, ruts, hole greater than 3" in diameter)							
1.3 Excessive animal trails							
1.4 Widespread burrowing animal holes							
1.5* Extensive linear cracks	-						
1.6 Vandalism, or intrusive damage such as unplanned excavation, drilling, grading, damage to engineering or access controls							

Form SOP 001-1 Basin F Cover Inspection Form

Inspection Item		Condition Present			Repeat or Chronic Condition		Inspection Note	Confirm Completed Actions (Initial and Date)
	Υ	Ν	N/A	Y	Ν	N/A		
2.0 Vegetative Cover								
2.1 Bare area or areas of poor growth greater than 100 square feet								
2.2 Areas of vegetation stress greater than 100 square feet (over grazing, discoloration, pedestalling)								
2.3 Deep rooted, noxious or undesirable weedy species								
2.4 Excessive litter accumulation								
3.0 Engineering and Access Controls								
3.1 The Basin F AMA perimeter fence is damaged								
3.2 Debris has collected along the Basin F AMA perimeter fence								
3.3 Obelisks are damaged, not visible, or not legible								
3.4 Warning signs are not legible from 25 feet								
3.5* Damage to the Perimeter Access Road such as potholes, washouts, washboard, or burrowing								

Form SOP 001-1 Basin F Cover Inspection Form

4.0 Surface Water Drainage Controls: Were the following conditions observed during the inspection of the stormwater drainage controls? Check all that apply.														oply.				
	Channel Number																	
Inspection item	24									25								
4.1* Impeded drainage or ponding in the channel (siltation/debris present)																		
4.2* Inadequate protective vegetation																		
4.3* Erosion rills or gullies in the grass- lined channel																		
4.4* Cracked or degraded concrete																		
4.5* Expansion joint damage (missing caulk)																		
4.6* Inhibited drainage from the soil to the concrete-lined channel																		
4.7* Subsidence or undercutting of the concrete-lined channel																		
5.0 Erosion/Settlement Monuments: Inspect monuments and record the soil thickness loss, if any. Perform during spring Type II and fall Type I inspections.															s.			
Inspection Item	ER92	ER93	ER94	ER95	ER96	ER97	ER98	ER99	ER100	ER101	ER102	ER103	ER104	ER105	ER106	ER107	ER108	ER109
5.1 Monument is damaged or illegible Check all that apply.																		
5.2 Measured Soil Thickness Loss (inches)																		
Form SOP 001-1 Basin F Cover Inspection Form

Inspection Notes:	For areas with deficiencies, provide iden	tifying labels for deficient areas,	descriptions of deficiencies, approximate dimensions of
	the areas, locations with GPS coordinate	es, and photographs as needed.	Provide attachments as appropriate.
Increator			
Inspector		0 ¹	
Name:		Signature	
	anion of languages and a sum and ation	and Date:	
Covers Manager R	eview of inspection Documentation		
Name:		Signature	
Covers Manager C	Confirmation of Completed Actions		
Name:		Signature	
		and Date:	

Form SOP 001-2 Basin F Cover Perimeter Survey Monument Inspection Form

Inspector's N	lames:	Inspection Date(s):									
Inspection C Previous 24-h	Inspection Conditions: Previous 24-hour precipitation: Weather Conditions:										
Attachments	: Photographs] Figures 🗌 Surve	ey Report 🔲 0	Dther							
CPSM	Check all that apply.										
Number	Monument has been located.	Monument has been disturbed.	Monument intact.	is Monument is legible.	Monument requires repair.						
CPSM-231											
CPSM-232											
CPSM-233											
CPSM-234											
CPSM-235											
CPSM-236											
CPSM-237											
CPSM-238											
CPSM-239											
CPSM-240											
CPSM-241											
CPSM-242											
CPSM-243											
CPSM-244											
CPSM-245											
CPSM-246											
CPSM-247											

Form SOP 001-2 Basin F Cover Perimeter Survey Monument Inspection Form

Inspection Notes:

-					
Inspector					
Name:	Signature and Date:				
Covers Manager Review of Inspection	Documentation				
Name:	Signature and Date:				
Covers Manager Confirmation of Completed Actions					
Name:	Signature and Date:				

Form SOP 003-1 Basin F Percolation Monitoring System Data Collection and Operation Form

Inspector's Names:			Inspection Date(s):						
Inspection Conditions: Previous 24-hour precipitation: Weather C						ther Conditions:			
Inspection Item		Condition Repeat or Chronic Present Condition Y N N/A		t or nic tion	Inspection Note	Confirm Completed Actions (Initial and Date)			
1.0 Percolation	Collection Manhole (P	CM)	Cond	dition	L •	1			
1.1 Damage to t components	1.1 Damage to the PCM or internal components								
1.2 Accumulatio greater than condensatio	1.2 Accumulation of a quantity of water greater than that caused by natural condensation in the manhole								
1.3 If the water I Quantity rem	evel observed in the PCI noved from the PCM (lite	M imp rs):	oacts	the ab	oility t	o me	asure p	ercolation, remove water accumulated in the PCM,	and record the quantity here.
2.0 Percolation	Collection								
Lysimeter Number	simeter Measured Water Volume umber (liter)								
016									
017									
018									
019									
020									

Form SOP 003-1 Basin F Percolation Monitoring System Data Collection and Operation Form

Inspection Notes:	For areas with deficiencies, provide of the areas, locations, and photogra	identifying labels for deficient areas, descriptions of deficiencies, approximate dimensions aphs. Provide attachments as appropriate.				
Inspector						
Name:		Signature and Date:				
Cover Manager Re	Cover Manager Review of Inspection Documentation					
Name:		Signature and Date:				
Cover Manager Co	onfirmation of Completed Actions					
Name:		Signature and Date:				

ROCKY MOUNTAIN ARSENAL O&M CHANGE NOTICE

WBS Number: 4.01.04.24		OCN Number: OCN-BASINF-2024-002		
e	HWL Post-Closure Plan	Long-Term Monitoring Plan for GW & Surface Water		
cted	ELF Post-Closure Plan	Land Use Controls Plan		
Affe an/Pro	Basin F Post-Closure Plan	RVO SOP No:		
Long-Term Care Plan		Other:		
Recon	nmended disposition: <u>Class 1</u> Modification (rea	quired for HWL, ELF, and Basin F Post-Closure Plans)		
Descri redline or in a The upda the p 001 of th • Both S the PC Depart on July The PC provid (EPA) respon includ map, a and 3.	be proposed change (Exact change in ed/strike-through format preferred. Provide be ttachment): Basin F Post-Closure Plan (PCP) has been ated to address internal inconsistencies betwee plan and Standard Operating Procedures (SOP and 003. Both SOPs are included in Appendia he PCP. SOP 001 updated the spacing of Type II inspection transects from 100 feet to 200 feet, changed the shifted distance of subsequent transects from 25 feet to 100 feet. SOP 003 updated the lysimeter inspection frequency from monthly to four times per year SOPs were changed to reflect the requirements CP that were approved by the Colorado tment of Public health and Environment (CDP y 26, 2023. CP was also changed to address comments led by the U.S. Environmental Protection Ager in a letter dated June 29, 2023. The Army's uses to the comments are included. Changes ed minor text revisions, and updated groundwa and updated flow charts included in Figure 3.0- 6.1-1.	Reason for change: This OCN is intended to correct inconsistencies within the document and to address comments that were submitted by the EPA. The changes improve the quality and clarity of the plan, are administrative in nature, and do not impact the Operations and Maintenance requirements or compliance standards established in the Basin F PCP. and r. of HE) hcy atter -1		
Exhibits attached: None 🛛 List:				

- PCP Figures 3.0-1: Cover Inspection and Repair Action Flow Chart
- PCP Figure 3.6.1-1: Percolation Monitoring and Response Flow Chart
- PCGMP Figure 3.1-1: 2021 Potentiometric Surface of the Unconfined Flow System, Former Basin F
- Army's Responses to EPA June 29, 2023, Technical Comments on Basin F Post-Closure Plan, Rev. 2

Originator: Michael W. Jones		Date: June 26, 2024				
Final Approval:	Final Approval:					
Navarro Project Manager Signature & Date			Army Project Mar	nager Signature & Date		
Navarro Project Engineer Signature & Date (required for record drawing/design changes)			Navarro Regulator	y Compliance Manager & Date		
Regulatory Approvals:						
EPA Signature & Date	CDPHE Signature		& Date	ACHD Signature & Date		

Rocky Mount Basin F WBS 4.01.04.	ain Arsenal Basi 23	n F Post-Closure Plan Revision 2 April 10, 2023	
	FIGURES		
1.0-1	Basin F Site Boundaries and Current Topography		
2.4.1-1	Basin F RCRA-Equivalent Cover Cross-Section		
3.0-1	Cover Inspection and Repair Action Flow DiagramChart		Commented [A1]: OCN-BASINF-2024-002
3.2.4-1	Sample Calculation for Allowable Percentage of Total Live Vegetation		
3.6.1-1	Nonconforming Percolation Monitoring and Response Process-Flow Ch	art	Commented [A2]: OCN-BASINF-2024-002

APPENDICES

А	Standard Operating Procedures				
	SOP 001	Cover Conditions Inspection			
	SOP 002	Cover Vegetation Performance Assessment			
	SOP 003	Percolation Monitoring System Data Collection and Operation			
В	Basin F Post-Closure Groundwater Monitoring Plan				
С	Basin F Cover Record Drawings				
D	Vegetation Definitions, Prohibited Plants, and Weed Watch Lists				
F	Change Record				

E Change Record

Rocky Mountain Arsenal	Basin F Post-Closure Plan
Basin F	Revision 2
WBS 4.01.04.23	April 10, 2023

plus rock). Standard deviation (n-1) will be shown for the latter two totals. Relative cover values will also be presented. Overall species density will be presented by transect and as a mean in number of species per 100 square meters. Frequency (constancy) will be shown by species. Relative frequency and importance values may be calculated also.

- A species presence table will be provided in which all species encountered during the year's sampling are presented by lifeform and provenance (native or introduced).
- Compilation of previous year's data for convenient and direct comparison of current year's values to previous values. The compilation should present mean values by species as well as bare soil, litter, standing dead, rock, total vegetation cover, and total ground cover.
- A direct statement as to whether the 2-year running mean for coverage is less than 50 percent, the 3-year running mean is less than 67 percent, and if total live vegetation for the current year sampling does not equal or exceed 25 percent. For ease of reference, this statement should be placed prominently in an executive summary near the beginning of the report.

The annual *Basin F Cover and Groundwater Monitoring Report* will cover the period from October through September and will be submitted to the regulatory agencies within 60 days following the completion of the vegetation performance assessment, or by November 30th of each year. Groundwater monitoring results from the prior annual sampling event will be summarized in the annual *Basin F Cover and Groundwater Monitoring Report* and presented as an appendix to the report in a *Basin F Post-Closure Groundwater Monitoring Report*. Each annual *Basin F Post-Closure Groundwater Monitoring Report*. Each potentiometric surface in the UFS with corresponding flow paths.

Regular meetings shall be held semiannually with the regulatory agencies to review all inspections, routine and non-routine maintenance, and repairs conducted during that 6-month period. The meeting shall be held within 30 days of the April Type II and October Type I inspections.

Post-closure records including inspection data and reports, maintenance and repair records, groundwater monitoring results, evaluations, and plans of actions will be maintained at RMA as discussed in Section 1.3.

Commented [A9]: OCN-BASINF-2024-002.

Commented [A10]: OCN-BASINF-2024-001, approved 3/4/24.

Rocky Mountain Arsenal Basin F WBS 4.01.04.23

4.0 SCHEDULE

4.1 Post-Closure Duration

The RCRA post-closure period began on March 2, 2010, after the Final Inspection of cover construction. The RCRA post-closure period will continue for a minimum of 30 years after that date, or until CDPHE determines that protection of human health and the environment has been securedor until cleanup goals are met.

4.2 Certification of Post-Closure Completion

When the Army proposes to end the post-closure period, a certification will be submitted to the regulatory agencies for CDPHE approval in accordance with 6 CCR 1007-3 265.120, and concurrence by EPA and ACHD. Certification of completion of post-closure will be made by the Army 60 days after completion of the established post-closure period. This certification will state that post-closure was performed in accordance with the requirements of this PCP.

Commented [A11]: OCN-BASINF-2024-002.

Basin F Post-Closure Plan

Revision 2 April 10, 2023

Rocky Mountain Arsenal	Basin F Post-Closure Standard Operating Procedures
Basin F	Revision 2
WBS 4.01.04.23	April 10, 2023

channel, and where engineering controls are located. Conduct Type II Inspections as follows:

- a. Prior to the inspection, establish transects over the portion of the Basin F AMA that is within the Basin F AMA perimeter fence. All transects utilized during a single Type II Inspection shall be oriented east-west or north-south and shall be spaced at <u>100200</u>-foot intervals. For each subsequent Type II Inspection, shift the transects <u>25-100</u> feet north when east-west oriented transects are used, or <u>25-100</u> feet east when north-south oriented transects are used, to ensure inspectors follow different transect lines. Transect locations and orientations may be physically marked in the field as necessary to facilitate the performance of the inspection. Transects are not required outside of the Basin F AMA perimeter fence, but inspect the area outside of the Basin F AMA perimeter fence by traveling the perimeter access road.
- b. Use a hand-held GPS unit or compass to follow each transect for observation during the inspection. Minimize the deviation from the established transect lines to the extent practicable. Continue following each transect until all transects have been observed.
- c. Observe and document conditions of each element as described on Form SOP 001-1. Record the following minimum information for each deficient area observed: identifying label for area, description of deficiency, approximate dimensions of the area, and location. The location may be recorded by marking the location on Figure SOP 001-1 or other map, specifying a particular structure such as an erosion/settlement monument, lysimeter, channel, etc., or by providing GPS coordinates. Take a digital photograph of the deficient area if applicable. Record a unique photo identifier number on Form SOP 001-1.
- 6. Semiannually, measure loss of cover thickness at each erosion/settlement monument shown on Figure SOP 001-1 as described below. Table SOP 001-1 provides the survey coordinates for each erosion/settlement monument.
 - a. Inspect the condition of the monuments and record observations on Form SOP 001-1.
 - b. Observe and document soil conditions surrounding the monument such as, erosion rills and/or evidence of local erosion. Use a level or other means to determine what the general grade is at the monument.
 - c. Measure cover thickness at each monument by using a tape measure to measure the distance (if any) from the top of the monument pipe cap to the ground surface. Take all measurements from the north side of the monuments. See Figure SOP 001-2 for monument detail.
 - d. Record the reading to the nearest quarter inch on Form SOP 001-1. The Covers Manager will compare readings to historical readings, monument observations and the thickness/settlement criteria to determine if and when additional action is required.

Basin F PCP Rev 2 with OCNs

Commented [A15]: OCN-BASINF-2024-002

Rocky Mountain Arsenal Basin F WBS 4.01.04.23	Basin F Post-Closure Standard Operating Procedures Revision 2 April 10, 2023	
S	ROCKY MOUNTAIN ARSENAL BASIN F POST-CLOSURE STANDARD OPERATING PROCEDURE	
SOP NO.	003	
TITLE	Percolation Monitoring System Data Collection and Operation	
DATE	April 2023	
PURPOSE	To describe the procedures for monitoring lysimeter manhole conditions and for measuring percolation collected by the RCRA-Equivalent Cover percolation monitoring system.	
RELATED SOPs AND PLANS	SOP 001 Cover Conditions Inspections SOP 002 Cover Vegetation Performance Assessment Basin F Post-Closure Plan	
FREQUENCY	Four times per year. The scheduled lysimeter inspections will be conducted in May, July, September, and November. Monthly, Additional percolation measurements may be taken in response to weather, inspection conditions, non-routine action trigger exceedances, or compliance standard exceedances or abnormal percolation readings.	Commented [A19]: OCN-BASINF-2024-002
HEALTH & SAFETY	Implement health and safety requirements described in the <i>RMA</i> <i>Incident and Emergency Management Policy and Contingency</i> <i>Plan</i> and task-specific Activity Hazard Analyses. Comply with confined space entry permit requirements when applicable.	
FIELD EQUIPMENT	Two-way radio Flashlight ATV (as field conditions permit) Clipboard and appropriate forms <u>(optional)</u> Global Positioning System device (GPS) 5-gallon poly bucket and rope (20 feet minimum) Graduated measuring vessel capable of measuring liquid volume to within 1 liter Portable manhole ladder (for maintenance and repair only) Portable pump with hose (20 feet minimum)	Commented [A20]: OCN-BASINF-2024-001, approved 3/4/24.
PROCEDURES		

1. Document the precipitation over the previous 24 hours. Obtain precipitation information from a precipitation gauge located on RMA.

Basin F PCP Rev 2 with OCNs

1

Appendix A, SOP 003-1

Rocky Mountain Arsenal	Basin F Post-Closure Standard Operating Procedures
Basin F	Revision 2
WBS 4.01.04.23	April 10, 2023

- 2. Gather necessary equipment to measure percolation and proceed to the Basin F AMA. Park vehicle off the cover.
- 3. Verify that field conditions are acceptable for traversing the Basin F AMA, either on-foot and/or with an ATV. If conditions exist that could cause damage to the cover, especially excessive soil moisture following a significant storm event, reschedule the inspection. Do not operate ATVs in a manner that may adversely affect the vegetation and/or cover surface (e.g., rutting).
- 4. Perform an on-the-ground inspection of the cover conditions over each lysimeter during Type I inspections in accordance with SOP 001.
- 5. Remove the Percolation Collection Manhole (PCM) cover.
 - a. Observe the quantity of water (e.g., condensation) collected in each PCM as follows:
 - i. <u>Monthly, observeEvaluate</u> the quantity of water collected within the PCMs. If the water level affects the ability to measure percolation as described below, remove the water from the PCM.
 - ii. Annually, at the end of the vegetation growing season (e.g., in conjunction with the SOP 001 Semiannual Inspection), remove accumulated water from the PCMs.
 - b. Remove accumulated water from PCMs using a pump and hose assembly and collect in a 5-gallon poly bucket.
 - c. Estimate the accumulated quantity of water (to the nearest liter) as it is pumped from the PCM. Record the estimate on Form SOP 003-1.
 - d. Water must be discharged downhill from the PCM, taking care not to erode or otherwise cause damage to the cover.
- 6. Measure the water collected in the percolation collection pipe as follows:
 - a. Visually inspect the interior of the PCM with a flashlight for water. If a quantity of water greater than natural condensation has accumulated in the PCM, inspect the PCM and percolation collection pipe/valve for damage.
 - i. If the PCM or the percolation collection pipe/valve are damaged, note the inspection results on Form SOP 003-1 and notify the Covers Manager immediately. Do not proceed with percolation measurement.
 - ii. If the PCM and the percolation collection pipe/valve are not damaged, note the presence of excess water and inspection results on Form SOP 003-1.

Basin F PCP Rev 2 with OCNs

Commented [A21]: OCN-BASINF-2024-002

Rocky Mountain Arsenal	Basin F Post-Closure Vegetation Lists
Basin F	Revision 2
WBS 4.01.04.23	April 10, 2023

The following table provides a record of changes to previous revisions of the Basin F Post-Closure Plan and associated appendices. Each of the changes described below were approved by the regulatory agencies prior to implementation. All changes to the Basin F Post-Closure Plan were made in accordance with state regulations [6 CCR 1007-3 Section 265.118(d)]. Operations and Maintenance Change Notices (OCNs) were used to document each change, provide rationale for the change, and to record approval by the regulatory agencies, unless noted otherwise.

OCN Number	Description of Change	Approval Date		
Changes to Revision 0				
OCN-BASINF-2013-001	The resolution of annual aerial photography was changed from 1:5,000 to 1:9,000.	July 18, 2013		
OCN-BASINF-2013-002	The Type II inspection procedure was modified to allow for the use of north/south oriented transects.	August 28, 2013		
OCN-BASINF-2014-001	Record drawings were revised to add cattle guards to the perimeter road, additional fencing between cattle guards and the Basin F AMA perimeter fence, modify the existing cattle guard, and move warning signs from metal posts to the wood fence posts. Section and detail numbering and lettering convention were also corrected throughout the drawing set.	July 9, 2014		
OCN-BASINF-2016-001	Valves located in lysimeter manholes for use in percolation measurements were changed from a ³ / ₄ " hose bib with T- handle to a ³ / ₄ " manual ball valve with PVC extension handle to the manhole cover ring.	June 16, 2016		
OCN-BASINF-2019-001	The allowable date range was changed for performance of the annual vegetation assessment described in Basin F Post-Closure Plan SOP 002: <i>Cover Vegetation Performance Assessment</i> .	October 23, 2019		
OCN-BASINF-2020-001	The response to exceedances of the percolation standard was changed. The change provided options to correct cover conditions that may have contributed to excess percolation. This OCN added a flow chart to the Post-Closure Plan that illustrates the response process, as well as a form intended to document the assessment of the percolation event.	March 10, 2020		
OCN-BASINF-2022-001	The Groundwater Monitoring Plan was changed to update the methods for statistical data analysis. The method for calculating Upper Prediction Limits for indicator compounds was improved.	June 27, 2022		
Changes to Revision 1				
N/A	Changes were made in accordance with Army responses to comments submitted by CDPHE on the Basin F Post-Closure Plan, Revision 1. Refer to CDPHE correspondence dated November 1, 2022. Changes include the addition of Figure 1.0-1, text revisions, and other editorial changes where necessary.	N/A		
Changes to Revision 2				

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Basin F PCP Rev 2 with OCNs

Appendix E-1

tocky Mountain Arsenal Basin F VBS 4.01.04.23	Basin F Po		
OCN Number	Description of Change	Approval Date	
OCN-BASINF-2024-001	Changes were made for consistency with the U.S. Army's electronic records management system requirements. The various forms found in the Basin F PCP have been converted into fillable PDF forms with minor format changes that are intended to facilitate form usage.	<u>March 4, 2024</u>	
OCN-BASINF-2024-002	Changes were made to address internal inconsistencies between the plan and Standard Operating Procedures (SOPs) 001 and 003, and to address comments provided by the EPA in a letter dated June 29, 2023.	TBD	Commented [A23]: OCN-BASINF-2024-002

Basin F PCP Rev 2 with OCNs



Figure 3.0-1: Cover Inspection and Repair Action Flow Chart







Legend

Unsaturated Alluvium

Former Basin F Surface Impoundment

- I Groundwater Flow Direction

Paved Roads

= = = = Unpaved Roads

26051 Well ID and Groundwater Elevation 5161.20

Note: Water levels were measured in FY21 Quarters 2 and 3. Unsaturated alluvium interpreted using data from 2020 and 2021.

	Flow System / Aquifer				
Monitoring Well/ Piezometer Network	Unconfined Alluvial	Unconfined Alluvial/ Denver	Unconfined Denver		
Water Level Network	Δ		0		
Other Network Wells	Δ		0		



NAD27-NGVD29 Datum, US Survey Feet, Colorado North Zone Sources: U.S. Army, RMA GIS, OMC, Shell/AECOM



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U.S. Army

• COMMITTED TO PROTECTION OF THE ENVIRONMENT •

Figure 3.1-1

2021 Potentiometric Surface of the Unconfined Flow System, Former Basin F

M:/projects/basin-F_post-closure/2023/mxds/basinf_waterelev_uncon_fig3.1-1_2023_MJones_052224.mxd 5/22/2024

Department of the Army's Responses to U.S. Environmental Protection Agency (EPA) June 29, 2023, Technical Comments on Basin F Post-Closure Plan, Revision 2

- **Comment 1.** Section 2.4.2 suggests groundwater detections are higher upgradient of Basin F than downgradient; However, in 2023 the need for a revised Basin F Optimization Plan has been identified, which suggests the monitor well network is not suited to make this determination. Revisions to the monitor well network and corresponding groundwater data collection are necessary to confirm the accuracy of this determination.
- **Response:** Agree, however, until the work described in the *Optimization Plan for the Basin F Post-Closure Groundwater Monitoring Network* (Optimization Plan) is completed and the post-closure groundwater monitoring program is modified, the existing network is the only source of information available for post-closure groundwater assessment. The statement in Section 2.4.2 regarding contaminant levels in upgradient and downgradient wells was based on analytical results from the Basin F Closure and Post-Closure groundwater monitoring efforts. The Optimization Plan is intended to improve the ability to determine the impact that Basin F may have on groundwater quality.
- **Comment 2.** Appendix B: the Basin F Post-Closure Monitoring Plan could require revision because of the actions proposed in the Basin F Optimization Plan. Recommend waiting to finalize this Basin F Post-Closure Plan until after the revised Basin F Post-Closure Monitoring Plan is finalized, to ensure this Basin F Post-Closure Plan includes the latest information and references the latest version of the Basin F Optimization Plan.
- **Response:** The Army and regulatory agencies have agreed that the *Basin F Post-Closure Groundwater Monitoring Plan* (PCGMP) may require revision after the work described in the Optimization Plan is completed. However, it will be years before the optimization work is finished and some of the changes captured in Revision 2 of the *Basin F Post-Closure Plan* (PCP) should be implemented now. Therefore, it is appropriate to implement Revision 2 of the PCP now and revise the plan again after the optimization work is complete.
- **Comment 3.** Section 3.9: In recent years the trend for electronic deliverables has been away from compact disks since most computers lack disk drives. Recommend the update simply state "The information in the appendix will be provided in electronic format.
- **Response:** Agreed. OCN-BASINF-2024-001 updated the plan to eliminate references to compact disks and hard copy records.

- **Comment 4.** Recommend including a flowchart to demonstrate the sequence of actions and documentation described in Section 3 related to Inspection, Monitoring, and Maintenance. This is essentially the purpose of Figure 3.0-1: Repair Action Flow Chart; However, more detail can be provided addressing the overall process. For instance, the following are all routine assessments summarized in the annual Basin F Cover and Groundwater Monitoring Reports: Type 1 and Type 2 Inspections, Cover Perimeter Survey monument inspections, Cover Vegetation Performance Assessments, Soil Cover Conditions, Engineering and Access Controls, Percolation Monitoring System Data Collection, and Operation Inspections. When these inspections identify a Non-Routine action trigger (table 3.2-2), that would initiate another flow cycle through Notifications, Consultations, Non-Routine Action Plans, Investigation Schedule or Corrective Measures Plan of Action, and Corrective Measures Completion Report. A well-designed flowchart could show the logic and simplicity of this program in a way that will become a quick reference tool in the future.
- **Response:** Figure 3.0-1 has been revised to clarify the inspection process and the relationship between routine, non-routine, and compliance response actions.
- **Comment 5.** Fig 3.0-1, the second-tier diamond flow path ("Proceed as agreed by the Army and Regulatory Agencies") could be revised to include an Investigation Schedule or Corrective Measures Plan of Action, Corrective Measures Completion Report, as described in the text.
- **Response:** Refer to response to Comment 4. References to an Investigation Schedule or Corrective Measures Plan of Action have been added to the first column which addresses out-of-compliance conditions.
- **Comment 6.** Fig 3.0-1, the diamond at the bottom of this flowchart figure ("Is the condition routine? (Table 3.2-1)") provides little value because there is only one path leaving it. Recommend revising how it's worded or provide another pathway for conditions that aren't routine.
- **Response:** Agreed. Refer to response to Comment 4.
- **Comment 7.** Fig 3.0-1, in the final box "Repair and Document", recommend providing more specificity in how that documentation will occur, ie: Forms, then the Annual Basin F Cover and Groundwater Monitoring Reports.
- **Response:** Agreed. Refer to response to Comment 4.
- **Comment 8.** Fig 3.6.1-1 A slight modification to this flow chart could address all percolation monitoring situations by including the process for when an out-of-compliance condition is not encountered. That flow path would lead to: Army documents percolation monitoring data within the Annual Basin F Cover and GW Monitoring Report.

- **Response:** Figure 3.6.1-1 has been modified. If the percolation standard has not been exceeded, the reader is referred to the pre-defined process described on Figure 3.0-1, which addresses other potential responses.
- **Comment 9.** Section 4.1: The thirty years mark of cap monitoring will soon be upon us but the cap will require monitoring much longer than 30 years at this site, potentially into perpetuity. For this reason, the words "or until cleanup goals are met" were added in reference to the termination of cap monitoring, but it's unclear in this document what those cleanup goals are or where those cleanup goals are identified. These referenced cleanup goals are presumably identified in the On-Post ROD. Recommend providing greater specificity in this document to the circumstances that would lead to termination of cap monitoring. EPA recommends the termination of cap monitoring is connected to a determination that Basin F has achieved unlimited use and unrestricted exposure (UU/UE).
- **Response:** Section 4.1 is intended to address the requirement of 6 Colorado Code of Regulation (CCR) 1007-3 265.117(a) which stipulated the 30-year post-closure care period and provides provisions for shortening or lengthening the post-closure care period. For consistency with language used in the refenced hazardous waste regulation, the term "...or until cleanup goals are met..." will be replaced with "...or until protection of human health and the environment has been secured."
- **Comment 10.** According to Appendix B, Basin F Post-Closure Groundwater Monitoring Plan, an approved analytical laboratory has not been subcontracted. As such, the specific EPA analytical laboratory methods for the analytes presented in Table 3.3-3 (Basin F Water Quality Monitoring Analyte List) are not listed in the table. Please revise the Post-Closure Plan to include the approved analytical laboratory information and update Table 3.3-3 as needed.
- **Response:** The laboratory currently used by the Army is Applied Research and Development Laboratory (ARDL) in Mount Vernon, Illinois. Army analytical methods are typically used for analysis of RMA samples, rather than EPA analytical methods. Army analytical methods require recertification every three years and have not been listed in the Post-Closure Groundwater Monitoring Plan because they change on a regular basis. Section 5.0 references the reader to the Sampling Quality Assurance Project Plan, prepared by Navarro, which includes the current Army method numbers.
- Comment 11. Section 2.3.2, Hydrogeology, Page 7, Appendix B, Basin F Post-Closure Groundwater Monitoring Plan, Section 3.1.2. Hydrogeology, Page Appendix B-6, PDF Page 122 and Appendix B, Figure 3.1-1, 2021 Potentiometric Surface of the Unconfined Flow System, Former Basin, PDF Page 143: Section 2.3.2 indicates that figures illustrating the water table elevation for the unconfined flow system (UFS) and the groundwater flow path are provided in Appendix B. Additionally, Section 3.1.2 of Appendix B states Figure 3.1-1 illustrates the 2021 water table elevation for the UFS and groundwater flow paths; however, groundwater flow paths are not depicted on Figure 3.1-1 as indicated in

the text. Please revise the text accordingly or revise Figure 3.1-1 to include flow path arrows for the potentiometric surface map of the UFS.

- **Response:** Figure 3.1-1 has been modified as suggested.
- **Comment 12. Section 3.9, Recordkeeping and Reporting, Pages 25 & 26:** The text does not specifically state the annual Basin F Cover and Groundwater Monitoring Report will include a figure depicting the potentiometric surface of water table elevations and corresponding flow directions recorded during the monitoring period. Please revise the text to state a figure depicting the potentiometric surface of water table elevations will be presented in the annual Basin F Cover and Groundwater Monitoring Report.
- **Response:** Section 3.9 has been changed to require a figure depicting the potentiometric surface in the UFS with corresponding flow paths.
- Comment 13. Appendix B, Figure 3.1-1, 2021 Potentiometric Surface of the Unconfined Flow System, Former Basin, PDF Page 143: The water table elevation contour line shown to the east of well 26061 and to the west of well 27018 indicates an elevation of both 5155 and 5145 feet on the same contour line. However, according to the water table elevation in wells 26061 (elevation of 5142.27 feet) and 27018 (elevation of 5147.57 feet), the elevation of the contour should be 5145 feet. Please revise the figure to resolve the discrepancy.
- **Response:** The figure has been changed as suggested.