

ROCKY MOUNTAIN ARSENAL

**Annual Covers Report for Basin F
2015**

**Revision 0
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**U.S. Department of the Army
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ACRONYMS

ACR	Annual Covers Report
AMA	Army Maintained Areas
AS	Arsenic
CHCL3	Chloroform
CL	Chloride
CPMSO2	p-Chlorophenylmethyl sulfone
DCPD	Dicyclopentadiene
DIMP	Diisopropylmethyl phosphonate
DLDRN	Dieldrin
DQO	Data Quality Objective
FY14	Fiscal Year 2014
FY15	Fiscal Year 2015
FY16	Fiscal Year 2016
IC	Indicator Compound
LTCP	Long-Term Care Plan
µg/L	micrograms per liter
NNDMEA	n-nitrosodimethylamine
NRAP	Non-Routine Action Plan
O&M	Operations and Maintenance
PCGMP	Post-Closure Groundwater Monitoring Plan
PCP	Post-Closure Plan
PT	Principal Threat
RCRA	Resource Conservation and Recovery Act
SO4	Sulfate
SOP	Standard Operating Procedure
TCLEE	Tetrachloroethylene
UFS	Unconfined Flow System
USFWS	U.S. Fish and Wildlife Service
WP	Wastepile



EXECUTIVE SUMMARY

This 2015 Annual Covers Report (ACR) for Basin F for the Rocky Mountain Arsenal Federal Facility Site was prepared in accordance with the *Basin F Post-Closure Plan (PCP)*, Revision 0 (TtEC 2011a) and the *RCRA-Equivalent, 2-, and 3-Foot Covers Long-Term Care Plan (LTCP)*, Revision 2 (TtEC 2011b). The purpose of this Basin F ACR is to document compliance with post-closure requirements, cover inspection and monitoring results, and maintenance activities performed during the reporting period, and to describe future plans to improve or sustain cover conditions. This Basin F ACR documents monitoring and cover maintenance-related activities performed on the Basin F Army Maintained Area (AMA) during the 2015 fiscal year (FY15), that is, between October 1, 2014 and September 30, 2015.

The Basin F AMA was seeded and irrigated in 2009 and is currently in post-closure and the Interim Operations and Maintenance (O&M) Period defined in Section 1.0 of the LTCP. This report addresses the sixth year of O&M for the Basin F cover since the Final Inspection in March 2010.

Precipitation is recorded at the Shell Disposal Trenches Resource Conservation and Recovery Act (RCRA)-Equivalent Cover in Section 36 by a rain gauge located near Lysimeter 002. The combined total precipitation measured between October 1, 2014 and September 30, 2015 was 18.62 inches. Precipitation data are provided in Appendix A.

In general, the Basin F cover was in excellent condition throughout FY15. Potential deficiencies observed during the reporting period include bare areas, noxious or undesirable weeds, excessive silt in the concrete lined channels, and ponding on the perimeter road. Cover inspection documentation is provided in Appendix C and repair documentation is provided in Appendix D. Soil cover thickness loss was within the compliance standard and the non-routine action trigger level for FY15. Soil cover thickness loss measurements are provided on Table 5.0-1.

Percolation collected at each of the five lysimeters on Basin F was below the non-routine action level (1.0 mm) and the compliance standard (1.3 mm). Table 6.0-2 presents rolling nine-month percolation totals for comparison to the non-routine action trigger level, and Table 6.0-3 presents twelve-month rolling totals for comparison to the compliance standard.

The 2015 Vegetation Performance Assessment of the Basin F RCRA-Equivalent Cover was conducted in accordance with Standard Operating Procedure 002 of the Basin F PCP, Revision 0. Results of the assessment are summarized on Table 7.0-1. In all, 15 vegetation transects were sampled in 2015 on the Basin F cover. A total of 100 observations were made along each transect. Appendix B includes cover and frequency summary tables, vegetation performance assessment tables for each of the sample areas, and the specific transect data for each sample.

Based on data from the 15 vegetation transects sampled, total live vegetation was estimated to be 51 percent, well above the performance standard of 25 percent. Total ground cover was high at 90 percent, and corresponding bare ground was relatively low at four percent. The two-year running average for absolute total ground cover was 95 percent, well above the standard of 50 percent. The three-year running average for absolute total ground cover was 96 percent; also well above the standard of 67 percent.

Upgradient and downgradient groundwater data collected during post-closure monitoring of Wastepile (WP) and Principal Threat (PT) wells were evaluated to assess contaminant trends in order to demonstrate that post-closure care of the Basin F Surface Impoundment and the Basin F WP satisfies RCRA closure performance standards. Sampling of all nine Basin F network wells (26015, 26017, 26028, 26073, 26128, 26133, 26157, 26163, and 26173) was conducted in April 2015. Water level measurements and analytical results for Basin F post-closure groundwater monitoring are provided in the *Basin F Post-Closure Groundwater Monitoring Report 2015*, included as Appendix E. Indicator Compounds were detected in addition to the detections of anions, cations, metals and general chemical parameters that are common to most natural waters.

The flow direction and groundwater elevations in the Unconfined Flow System are consistent with historical flow and elevations. Since 2006, water levels in downgradient wells 26015, 26017, 26157, and 26163 and upgradient wells 26028, and 26073 have shown only minor fluctuations due to seasonal or storm events. Since 2006, water levels have increased slightly in upgradient wells 26028, 26128, and downgradient wells 26133 and 26173.

Concentrations for most ICs during post-closure monitoring have decreased compared to baseline data. Increases in contaminant concentrations or high concentrations in downgradient wells may be the result of residual contamination that is present in the saturated zone or may be continuing to migrate from the vadose zone to the saturated zone. Ponding of water in excavations during key-cut excavation around the perimeter of Basin F may have mobilized additional contamination into the groundwater. Contaminants occurring in the Basin F pathway occur primarily in alluvial-filled paleo-channels and weathered bedrock, affecting migration pathways and travel times from WP and PT sites to downgradient wells. These likely are short-term increases, and will continue to be assessed in future monitoring events.

Cost incurred performing post-closure care of the Basin F AMA during FY15, including inspections, repairs, maintenance, and groundwater monitoring, was \$126,059. A complete budget for FY16 has not been approved as of the issuance of this report. However, the FY16 budget is estimated to be approximately \$164,843.

In summary and based on the information presented in this report, there are no corrective measures required. Recommendations for FY16 include continued diligence in weed control efforts; and continued examination and repair of erosion rills or gullies, ponding areas, excessive tire tracks and ruts, burrowing animal holes, excessive siltation, and localized settlement. These recommendations will be performed in FY16 and will be discussed in the 2016 Basin F ACR.

1.0 INTRODUCTION

This 2015 Annual Covers Report (ACR) for Basin F for the Rocky Mountain Arsenal Federal Facility Site was prepared in accordance with the *Basin F Post-Closure Plan (PCP)*, Revision 0 (TtEC 2011a) and the *RCRA-Equivalent, 2-, and 3-Foot Covers Long-Term Care Plan (LTCP)*, Revision 2 (TtEC 2011b). The purpose of this Basin F ACR is to document compliance with post-closure requirements, cover inspection and monitoring results, and maintenance activities performed during the reporting period, and to describe future plans to improve or sustain cover conditions. This Basin F ACR documents monitoring and cover maintenance-related activities performed on the Basin F Army Maintained Area (AMA) during the 2015 fiscal year (FY15), that is, between October 1, 2014 and September 30, 2015.

The Basin F AMA was seeded and irrigated in 2009 and is currently in post-closure and the Interim Operations and Maintenance (O&M) Period defined in Section 1.0 of the LTCP. This report addresses the sixth year of O&M for the Basin F cover since the Final Inspection in March 2010.

2.0 METHODOLOGY

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 0, and related Standard Operating Procedures (SOPs). The results of inspections and environmental monitoring of vegetation, percolation, and cover soil thickness were used to verify cover performance and to trigger cover maintenance and repair activities.

2.1 Type I and Type II Cover Inspections

The procedure for inspecting soil cover conditions and infrastructure features is detailed in Basin F PCP SOP 001, *Cover Conditions Inspections*. This SOP includes procedures for Type I and Type II cover inspections, as well as a procedure for collecting cover soil thickness data, which were used to evaluate the actual cover thickness against the cover thickness compliance standard. Where feasible, multiple inspections were conducted concurrently for efficiency and to minimize traffic on the cover, i.e. Type I inspections were implemented concurrently with the Type II inspections. Copies of the cover inspection forms are provided in Appendix C.

2.2 Vegetation Performance Assessment

Basin F PCP SOP 002, *Cover Vegetation Performance Assessment*, provides the procedure to collect and document vegetation conditions for assessment and future management. This SOP includes a procedure for conducting the annual quantitative vegetation survey. Data collected using Basin F PCP SOP 002 was used to evaluate the vegetation against the vegetation performance standard. The results of the evaluation are presented in Section 7.0. Refer to Appendix B for photos and other information collected during the 2015 Vegetation Performance Assessment.

2.3 Percolation Monitoring

The procedure for collecting percolation data and operating the lysimeters is provided in Basin F PCP SOP 003, *Percolation Monitoring System Data Collection and Operation*. Data collected under Basin F PCP SOP 003 were used to evaluate the measured percolation against the

percolation compliance standard. The results of the evaluation are presented in Section 6.0. Monthly percolation measurements from all Basin F lysimeters are provided in Table 6.0-1. The nine-month and twelve-month rolling percolation totals are provided in Tables 6.0-2 and 6.0-3, respectively.

2.4 Groundwater Monitoring

Groundwater monitoring was performed in April of 2015 at wells surrounding the former Basin F Surface Impoundment and the former Basin F Wastepile (WP) in accordance with the *Basin F Post-Closure Groundwater Monitoring Plan*, Revision 0 (PCGMP) (TtEC 2011a). The groundwater monitoring program is designed to demonstrate that post-closure maintenance of the Basin F Surface Impoundment and the Basin F WP satisfies RCRA performance standards, which include the requirement to control, minimize or eliminate post-closure escape of hazardous contaminants to groundwater (6 Code of Colorado Regulations 1007-3, Section 265, Subpart G).

2.5 Maintenance and Repair Activities

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. There was one non-routine action performed on the Basin F AMA in FY15. NRAP-2014-001 documents the prescribed burn that was conducted by the USFWS in October 2014. Routine repair activities performed in FY15 are discussed in Section 4.0 of this report.

3.0 PRECIPITATION AND WEATHER CONDITIONS

Precipitation is recorded at the SDT RCRA-Equivalent Cover by a rain gauge located near Lysimeter 002. The combined total precipitation measured between October 1, 2014 and September 30, 2015 was 18.62 inches. Precipitation data are provided in Appendix A.

The climate backdrop for the Rocky Mountain Region for the fall months can be variable and 2014 was no different. October was warmer and drier than average, November was colder and slightly wetter than normal, and December wrapped up to be somewhat wetter and warmer than normal. An Arctic air mass entrenched the region with high temperatures failing to make it into the teens from November 11th through the 13th. This is the first time since records have been taken in Denver beginning in 1872 that there were three consecutive days with max temperatures below 20 degrees F in the month of November.

The winter months of 2015 proved to be warmer than the historical norm. January was warmer and drier than normal, February was wetter and slightly warmer than normal, and March wrapped up to be warmer and drier than normal. February recorded 22.4 inches of snowfall which is 16.7 inches above normal. This made February 2015 the snowiest February on record and broke the old record of 22.1 inches set back in 1912.

The spring months typically bring unpredictable weather conditions and 2015 was no different. April was warmer and wetter than normal, May was wetter and colder than normal, and June wrapped up to be warmer and wetter than normal. The total precipitation for the month of April was 2.51 inches which was 0.80 inches above the historical norm of 1.71 inches. May recorded

4.83 inches of precipitation which was 2.71 inches above normal and June recorded 4.89 inches of precipitation which was 2.91 inches above normal

The summer months also brought variable weather conditions to the Rocky Mountain Region in 2015. July was slightly cooler with near normal precipitation, August was much warmer and drier, and September set a new record for temperature and was also drier than average. The average temperature at Denver International Airport for the month of September was 69.4 degrees which was 6.0 degrees above normal. This makes September 2015 the warmest September on record.

4.0 SOIL COVER ASSESSMENT, MAINTENANCE AND REPAIR ACTIONS

During FY15, the condition of the Basin F AMA was inspected during the Type I and Type II inspections in accordance with the Basin F PCP. Type I inspections were conducted on December 3, 2014, March 11, 2015, May 13, 2015, June 3, 2015, July 1, 2015, and August 5, 2015. The spring Type II inspection was conducted on April 1, 2015 and the fall Type II inspection was conducted on September 23, 2015.

One significant storm event occurred in FY15 where the RMA received more than one inch of precipitation in a 24-hour period. The date of this event recorded by the Lysimeter 002 rain gauge was June 4, 2015. However, post-storm inspections are triggered by a second rain gauge located near the Lime Basins Metering Building, which reports 24-hour precipitation totals in real time. The Lime Basins rain gauge recorded three significant storm events in FY15. The significant storm events recorded by the Lime Basins rain gauge occurred on April 17, 2015, June 4, 2015, and July 9, 2015. The Operations and Maintenance Contractor (OMC) staff drove the perimeter road and access roads following each significant storm, as recorded by the Lime Basins rain gauge, and documented all observations in the project logbook. Post-storm inspections were performed when field conditions improved, minimizing the potential for damaging the cover. The post-storm inspections were performed on May 13, 2015, July 1, 2015, and August 5, 2015. The soil covers were inspected for the following:

- Surface Conditions
- Vegetative Cover
- Engineering and Access Controls
- Monthly Percolation Monitoring - Lysimeters
- Surface Drainage Controls
- Erosion/Settlement Monuments
- Other deleterious conditions

In general, the Basin F cover was in excellent condition throughout FY15. Observations made during the reporting period are described below and cover inspection documentation is located in Appendix C. The repair actions associated with these observations are shown on Figure 4.0-1 and are described below.

Excessive Siltation in the Channel: Excessive silt was observed in the outlet portions of Channels 24 and 25. In October 2014, the silt and debris was removed from these concrete lined

channels. Also in October 2014, the rip rap outlet at Channel 24 was repaired. The rip rap was removed, the subgrade was graded to allow drainage, the rip rap was replaced, and lastly the disturbance was hand seeded to complete the repair of Channel 24.

Bare Areas of Vegetation: Three areas were observed that could benefit from overseeding during the spring 2014 Type II inspection. These points were near 612D, 618E, and 623E. These areas were over seeded using a drill seeder in November 2014.

Perimeter Road: In October 2014, all of the Basin F drainage crossings had the silt and sediment removed. Also, more gravel was added in between the Articulated Concrete Blocks using a walk behind broom. In May 2015, the south perimeter road was graded in order to alleviate a ponding issue just east of Gate W.

Cover Perimeter Survey Monuments: The Cover Perimeter Survey Monuments (CPSM) were inspected and surveyed in November 2014 as a part of the Five Year Review.

Noxious or Undesirable Weeds: Canada and Musk thistles and bindweed were identified on Basin F. Weed control efforts were performed as needed during FY15.

In November 2014, OMC personnel sprayed a patch of cheatgrass on Basin F.

A combination of Diuron, Perspective, and Roundup was applied as a ground clear in March 2015 along the shoulders of the Basin F roadways, the cattle guards, in between the bollards for the groundwater wells located on the perimeter road, and the gate entrances.

NRAP-2014-001 documents the plan to perform a prescribed burn over the entire Basin F AMA. In October 2014, the USFWS performed a successful prescribed burn over the entire Basin F AMA.

Carsonite Markers: In March 2015, five of the Carsonite Markers on Basin F were replaced. These markers were damaged in the controlled burn that was conducted in October 2014. These markers were identifying Lysimeters 017 and 020 and Erosion Monuments 096, 098, and 100.

Cracked or Degraded Concrete: During the Type I inspection conducted in May 2014, there was one joint in Channel 25 that was observed to need caulk. In January 2015, this joint was repaired.

Lysimeters: In October 2014, Lysimeters 016, 017, and 019 had the standing water pumped from the bottoms of the manholes. The collection procedure was made difficult for these lysimeters due to the amount of water in the bottom of the manholes.

All of the Basin F lysimeters had the steel pipe nipples replaced with Schedule 80 PVC units in March 2015. This maintenance item was performed in order to prevent galvanic corrosion.

The maintenance items listed below were identified as improvements that were necessary to facilitate effective operation and maintenance of Basin F and were not the result of inspection observations.

Bison Expansion Project: The Hazardous Waste Caution signs and metal posts that were along the Basin F perimeter road were removed and the Caution signs were hung on the wooden posts of the perimeter fence. This was to preserve these signs so that they did not get damaged with bison activity. Also, the delineator posts that were installed along the Basin F perimeter road were removed to prevent damage from bison activity. The wings from the cattle guard at the entrance to the Basin F cover were removed in October 2014. In December 2014, the removed wings were replaced by corral panels. In November 2014, corral panels were also installed around the cattle guards that are located in the east and west perimeter road.

5.0 COVER SOIL THICKNESS LOSS

The Basin F cover also 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 Type II inspections in April and September of 2015 in accordance with the Basin F PCP SOP 001, *Cover Conditions Inspections*. The measurements for each monument are provided on Table 5.0-1. All cover soil thickness loss measurements were well below the non-routine action trigger level of 0.25 foot and the compliance standard of 0.5 foot.

6.0 PERCOLATION MONITORING ASSESSMENT

The Basin F RCRA-Equivalent cover uses a network of five lysimeters to monitor deep percolation. Percolation collected by the lysimeters was measured monthly in accordance with Basin F PCP SOP 003, *Percolation Monitoring System Data Collection and Operation*.

Percolation is reported in millimeters, which is calculated by dividing the measured percolation volume by the area of the lysimeter pan. Lysimeters 16, 17, 18 and 19 each have a surface area of 1,500 square feet (139.35 square meters), while Lysimeter 20 has a surface area of 7,500 square feet (696.75 square meters). The volume of percolation measured monthly from each lysimeter is presented in Table 6.0-1. Table 6.0-2 presents rolling nine-month percolation totals for comparison to the non-routine action trigger level of 1.0 mm, and Table 6.0-3 presents twelve-month rolling totals for comparison to the compliance standard of 1.3 mm. The compliance standard for percolation is the quantity of percolation that, if exceeded, would subject the Army to potential enforcement actions by the Regulatory Agencies. Enforcement of the compliance standard began on March 2, 2015.

The lysimeters within the Basin F cover collected no measurable percolation over the reporting period and are therefore well below the non-routine action trigger level and the compliance standard.

7.0 VEGETATION PERFORMANCE ASSESSMENT

The 2015 Vegetation Performance Assessment of the Basin F RCRA-Equivalent Cover was conducted on August 11 and 12, 2015 in accordance with SOP 002 of the LTCP. Results of the assessment are summarized on Table 7.0-1.

In all, 15 vegetation transects were sampled in 2015 on the Basin F cover. Prior to performing the assessments, transect locations and compass bearings were randomly selected using Geographical Information System software. A map showing the pre-selected sample locations and bearings is included in Appendix B. Photos, provided in Appendix B, were taken along the

compass bearing at the start of each 50-meter transect. A total of 100 observations were made along each transect. All plant species present, but not encountered during transect observations within one meter on either side of the 50-meter transect were tallied and used to calculate species density (species per 100 square meters). Appendix B includes cover and frequency summary tables, vegetation performance assessment tables for each of the sample areas, and the specific transect data for each sample. 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.

The Basin F RCRA-Equivalent Cover was seeded in 2009 and continues to maintain a successfully established plant community. Based on data from the 15 transects sampled, mean total live cover was estimated to be 71.1 percent, composed primarily of cool season grass species. Warm season species have declined at this site since the initial establishment of about 18 percent cover. In 2015, cover by the warm season species remained similar to the previous season with an average of 4.5 percent. Weedy vegetation contributed less than 1 percent to the total for live cover.

There did not appear to be any excessive soil moisture stress or other 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 on all areas. Several plant species not previously observed on the Basin F Cover were recorded. The increase in species diversity is an indication of both continued development of plant community complexity, as well as improved performance by individual established plants due to increased precipitation.

7.1 Comparison to the Performance Standard

Total live vegetation was estimated to be 71.1 percent, well above the performance standard of 25 percent. Total ground cover was high at 80.7 percent, and corresponding bare ground was relatively low at 19.3 percent. These values, particularly the higher value for bare ground, reflect the impact of the prescribed burn of the site in the fall of 2014 and increased spring precipitation. The two-year running average for absolute total ground cover was 88.4 percent, well above the standard of 50 percent. The three-year running average for absolute total ground cover was 88.9 percent; also well above the standard of 67 percent.

7.2 Comparison to the Non-Routine Action Trigger Level

The results of the quantitative vegetation assessment performed on the Basin F cover determined that less than 1 percent of the total live vegetation was comprised of undesirable annual or biennial species. Therefore, the results of comparison to the non-routine action trigger level evaluation are identical to that of the vegetative performance standard described in Section 7.1 because cover by undesirable annual and biennial species did not exceed 10 percent of the total live vegetation. The absolute live cover vegetation for this site is well above the non-routine trigger level established in the Basin F PCP.

7.3 Sample Adequacy

Sample Adequacy calculations were performed for the cover area. The intent of the sample adequacy calculation is to determine whether sufficient samples have been gathered to be able to



detect a 10 percent reduction in the mean with 90 percent confidence. Sample adequacy was calculated using the formula provided in SOP 002:

$$N_{\min} = t_{\alpha}^2 s^2 / (d\bar{x})^2$$

To ensure that the sample size is adequate, N_{\min} must be less than, or equal to the number of transects sampled in the respective area. If N_{\min} is greater than the number of transects sampled, additional vegetation transects need to be sampled until N_{\min} becomes less than, or equal to the number of transects sampled, or all transect blocks within the respective area have been sampled, whichever comes first. Sample adequacy was calculated for total live vegetation only. The sample adequacy calculation yielded an N_{\min} of less than one, which is well below the number of samples collected.

8.0 GROUNDWATER MONITORING

This section summarizes the water level monitoring and analytical results for the 2015 post-closure groundwater monitoring at Basin F. Refer to the *Basin F Post-Closure Groundwater Monitoring Report 2015*, provided in Appendix E, for a complete set of water level monitoring data and analytical results.

Nine wells screened in the Unconfined Flow System (UFS) are used to monitor groundwater conditions in the uppermost aquifer. Six downgradient wells 26015, 26017, 26133, 26157, 26163, and 26173; and three upgradient wells 26028, 26073, and 26128 are used for post-closure groundwater monitoring at Basin F. Three of the wells including upgradient well 26028, and downgradient wells 26015 and 26017 are specific to the Basin F WP. Seven wells including upgradient wells 26073 and 26128 and downgradient wells 26015, 26133, 26157, 26163, and 26173 are associated with the Principal Threat (PT) excavation. Downgradient well 26015 is included in both groups due to overlapping groundwater flow paths.

8.1 Basin F Well Network Analytical Results

The groundwater samples were tested for the analytes and indicator compounds (ICs) listed in the Basin F Post-Closure Groundwater Monitoring Plan. The 11 indicator compounds selected are arsenic (AS), chloroform (CHCL3), chloride (CL), p-chlorophenylmethyl sulfoxide (CPMSO2), copper (CU), dicyclopentadiene (DCPD), diisopropyl methyl phosphonate (DIMP), dieldrin (DLDRN), n-nitrosodimethylamine (NNDMEA), sulfate (SO4), and tetrachloroethene (TCLEE). The analytical data for the ICs detected in the Basin F water quality network wells are presented in Appendix E.

8.1.1 Indicator Compounds in Upgradient Wells

Annual sampling of the Basin F upgradient PT and WP wells as part of the post-closure monitoring was conducted in May 2015. Results from the 2015 sampling indicate the following ICs were detected in upgradient WP well 26028:

Well 26028

- CL – 876,000 µg/L;
- DIMP – 582 µg/L;
- DLDRN – 0.0195 µg/L;

- SO₄ - 422,000 µg/L.

Results from the 2015 sampling indicate the flowing ICs were detected in upgradient PT wells 26073 and 26128

Well 26073

- CHCL₃ – 35.3 µg/L;
- CL - 195,000 µg/L;
- DIMP - 1.29 µg/L;
- DLDRN - 0.0932 µg/L;
- SO₄ - 829,000 µg/L;
- TCLEE - 0.948 µg/L.

Well 26128

- AS – 2.55 µg/L;
- CHCL₃ - 0.527 µg/L;
- CL - 992,000 µg/L;
- CPMSO₂ – 1.99 µg/L;
- DIMP – 7.86 µg/L;
- DLDRN - 0.127 µg/L;
- NNDMEA - 0.0967 µg/L;
- SO₄- 489,000 µg/L;
- TCLEE - 0.366 µg/L.

Additional compounds detected in the upgradient WP and PT wells include alpha-chlordane, aldrin (ALDRN), aluminum (AL), ammonia (NH₃), benzene (C₆H₆), calcium (CA), carbon tetrachloride (CCL₄), chlorobenzene (CLC₆H₅), dithiane (DITH), dissolved organic carbon, endrin (ENDRN), fluoride (F), gamma-chlordane (GCLDAN), isopropylmethyl phosphonic acid (IMPA), iron, lead, magnesium, manganese, nitrate, nitrogen by kjeldahl method (N₂KJEL), 1,4-oxathiane (OXAT), potassium, 4,4-DDT/2,2-bis(p-chlorophenyl)-1,1,1-trichloroethane (PPDDT), selenium, sodium, total organic carbon (TOC), total organic halogen (TOX), trichloroethene (TRCLE), and zinc (ZN).

8.1.2 Indicator Compounds in Downgradient Wells

Results from the 2015 sampling indicate the following ICs were detected in downgradient WP wells 26015 and 26017:

Well 26015

- AS – 2.18 µg/L;
- CL - 915,000 µg/L;

- DIMP – 5.38 µg/L;
- DLDRN - 0.448 µg/L;
- SO4 - 155,000 µg/L.

Well 26017

- CHCL3 – 0.241 µg/L;
- CL - 348,000 µg/L
- DIMP – 5.67 µg/L;
- DLDRN - 0.477 µg/L;
- SO4 - 199,000 µg/L.

Results from the 2015 sampling indicate the following ICs were detected in the downgradient PT wells 26015, 26133, 26157, 26163, and 26173. The IC detections in well 26015 are included above with the downgradient WP well network.

Well 26133

- AS - 1.62 µg/L;
- CHCL3 – 210 µg/L;
- CL - 822,000 µg/L;
- CPMSO2 – 20.6 µg/L;
- DCPD - 397 µg/L;
- DIMP - 170 µg/L;
- DLDRN - 1.26 µg/L;
- NNDMEA - 0.28 µg/L;
- SO4 - 491,000 µg/L;
- TCLEE - 173 µg/L.

Well 26157

- AS - 2.04 µg/L;
- CHCL3 – 11.2 µg/L;
- CL - 840,000 µg/L;
- CPMSO2 – 79.8 µg/L;
- DCPD - 354 µg/L;
- DIMP - 141 µg/L;
- DLDRN - 0.498 µg/L;

- NNDMEA - 0.68 µg/L;
- SO4 - 455,000 µg/L;
- TCLEE - 149 µg/L.

Well 26163

- AS - 1.77 µg/L;
- CL - 3,730,000 µg/L;
- CPMSO2 - 20.8 µg/L;
- CU - 15.8 µg/L;
- DCPD - 50.9 µg/L;
- DIMP - 360 µg/L;
- NNDMEA - 1.05 µg/L;
- SO4 - 1,380,000 µg/L;
- TCLEE - 1.92 µg/L.

Well 26173

- AS - 1.48 µg/L;
- CHCL3 - 35.5 µg/L;
- CL - 608,000 µg/L;
- CPMSO2 - 8.92 µg/L;
- DCPD - 40 µg/L;
- DIMP - 112 µg/L;
- DLDRN - 1.32 µg/L;
- NNDMEA - 0.0639 µg/L;
- SO4 - 361,000 µg/L;
- TCLEE - 595 µg/L.

Additional compounds detected in downgradient WP and PT wells include 1,1-dichloroethene, 1,1-dichloroethane, 1,2-dichloroethane, 1,2-dichloroethene, 1,2-dichloropropane, 1,2-dichlorobenzene, 1,3-dichlorobenzene, 1,1,2-trichloroethane, alpha-chlordane, ALDRN, AL, C6H6, bicycloheptadiene, bromide, CA, CCL4, CLC6H5, p-chlorophenylmethyl sulfide, p-chlorophenylmethyl sulfone, cobalt, cyanide, dibromochloropropane, DITH, ENDRN, F, GCLDAN, hexachlorocyclopentadiene, heptachlor, heptachlor epoxide, isodrin (ISODR), IMPA, iron, magnesium, manganese, mercury, N2KJEL, nickel, nitrite, OXAT, 4,4-DDE/2,2-bis(p-chlorophenyl)-1,1-dichloroethene, PPDDT, potassium, selenium, sodium, thiodiglycol, TOC, TOX, TRCLE, and ZN.

8.2 Upper Prediction Limit Exceedances

The 2015 Upper Prediction Limit values were exceeded in PT and WP downgradient wells.

8.2.1 WP Well Prediction Limit Exceedances

Analytical concentration of 0.241 µg/L for chloroform in downgradient well 26017 exceeded the 2015 prediction limit of 0.2 µg/L. The remaining reported values from the downgradient Basin F WP wells were below the respective prediction limits. The 2015 chloroform concentration in well 26015 is within the historical range of chloroform values for the well. A conclusion can be made from the statistical evaluation that groundwater quality downgradient of the Basin F WP has not been significantly affected.

8.2.2 PT Well Prediction Limit Exceedances

Analytical results from downgradient wells 26133, 26157, and 26173 collected in 2015 exceeded the upper prediction limit for CHCL₃, CPMSO₂, DCPD, and TCLEE. The 2015 reported values from the wells exceeding the respective upper prediction limits are presented below.

Well 26133

- CHCL₃ - 210 µg/L exceeded the UPL of 36.1 µg/L
- DCPD - 397 µg/L exceeded the UPL of 51.2 µg/L

Well 26157

- CPMSO₂ - 79.8 µg/L exceeded the UPL of 45.7 µg/L
- DCPD - 354 µg/L exceeded the UPL of 51.2 µg/L

Well 26173

- TCLEE - 595 µg/L exceeded the UPL of 321 µg/L

The remaining reported values from the downgradient Basin F PT wells are below the respective prediction limits.

8.3 Groundwater Levels

Water levels were measured in 27 Basin F network wells in April 2015 to evaluate UFS conditions in the area of Basin F. This information is used to evaluate groundwater flow for significant changes in flow direction over time. Additional information regarding groundwater levels is available in the *Basin F Post-Closure Groundwater Monitoring Report 2015*, included in Appendix E.

Groundwater flow in the vicinity of Basin F continues to be to the northwest. Local variations occur beneath the north side of Basin F where groundwater flows to the north. The confined flow system in the Basin F area is addressed as part of the *Long-Term Monitoring Plan* (TtEC/URS 2010). A complete description of the subsurface lithology and groundwater flow in the vicinity of Basin F can be found in the *Basin F Post-Closure Groundwater Monitoring Plan* (TtEC 2011a).

The water level in downgradient well 26015 has remained steady over time. The water levels in downgradient wells 26017, 26133, 26157, 26163, and 26173; and upgradient wells 26028, 26073, and 26128 have generally increased over time with minor fluctuations resulting from seasonal or storm events. The minor increases in water levels in several wells may explain the increasing concentrations for some analytes.

8.4 Groundwater Monitoring Conclusions

Concentrations for most ICs during post-closure monitoring have decreased compared to baseline data. Increases in contaminant concentrations or high concentrations in downgradient wells may be the result of residual contamination that is present in the saturated zone or may be continuing to migrate from the vadose zone to the saturated zone. Ponding of water in excavations during key-cut excavation around the perimeter of Basin F may have mobilized additional contamination into the groundwater. Contaminants occurring in the Basin F pathway occur primarily in alluvial-filled paleo-channels and weathered bedrock, affecting migration pathways and travel times from WP and PT sites to downgradient wells. These likely are short-term increases, and will continue to be assessed in future monitoring events.

The time versus concentration graphs for the ICs detected in WP and PT monitoring wells provided in Appendix E.

9.0 ROUTINE AND NON-ROUTINE ACTIONS

9.1 Routine Actions

Routine maintenance and repairs were performed on Basin F and were intended to ensure that the cover continues to function as designed. Routine maintenance and repair actions were identified during inspections and are discussed in Section 4.0 of this report. Figure 4.0-1 illustrates the locations of routine maintenance and repair activities performed on Basin F. Appendix D includes Contractor Daily Quality Control Reports that describe the work performed.

9.2 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. Each time a non-routine action is identified, a NRAP will be prepared to document the substandard condition, the actions that will be carried out to remedy the condition, consultation between the parties, and concurrence on the proposed action. There was one NRAP that was applicable to Basin F for this reporting period. This NRAP was NRAP-2014-001 which documents the prescribed burn on the Basin F AMA that was conducted in October 2014.

10.0 RECOMMENDATIONS AND CORRECTIVE MEASURES

Inspections and assessments performed during FY15 produced the following recommendations for the 2016 fiscal year (FY16):

- The site should be examined for weeds throughout FY16. Occurrences of bindweed, cheatgrass, Canada thistle and other noxious weeds should be spot sprayed.

- The site should continue to be examined for erosion rills or gullies, ponding areas, excessive tire tracks and ruts, burrowing animal holes, excessive siltation, and localized settlement.

No corrective measures are currently planned for FY16.

11.0 FY15 COSTS AND FY16 BUDGETS

Cost incurred performing post-closure care of the Basin F AMA during FY15, including inspections, repairs, maintenance, and groundwater monitoring, was \$126,059. A complete budget for FY16 has not been approved as of the issuance of this report. However, the FY16 budget is estimated to be approximately \$164,843.

12.0 REFERENCES

TtEC (Tetra Tech EC Inc.)

2011a (Oct 6) *Basin F Post-Closure Plan*. Revision 0.

2011b (Sep 29) *RCRA-Equivalent, 2-, and 3-Foot Covers Long-Term Care Plan*. Revision 2.

2011c (Mar 11) *Basin F Closure and Post-Closure Groundwater Monitoring Sampling and Analysis Plan*, Revision 1.

TtEC/URS (Tetra Tech EC, Inc./URS Corporation)

2010 (Mar 3) *Long-Term Monitoring Plan for Groundwater and Surface Water*. Final.



TABLES

Table 5.0-1: Basin F Soil Cover Thickness Loss

Monument No.	Loss (in.) April 8, 2015	September 23, 2015
ER92	0.00	0.00
ER93	0.00	0.00
ER94	0.00	0.25
ER95	0.00	0.00
ER96	0.00	0.25
ER97	0.00	0.00
ER98	0.00	0.00
ER99	0.50	0.75
ER100	0.00	0.00
ER101	0.25	0.50
ER102	0.25	0.25
ER103	0.00	0.00
ER104	1.25	1.00
ER105	0.00	0.00
ER106	0.00	0.00
ER107	0.50	0.50
ER108	0.00	0.00
ER109	0.00	0.25

Table 6.0-1: Monthly Percolation Measurements

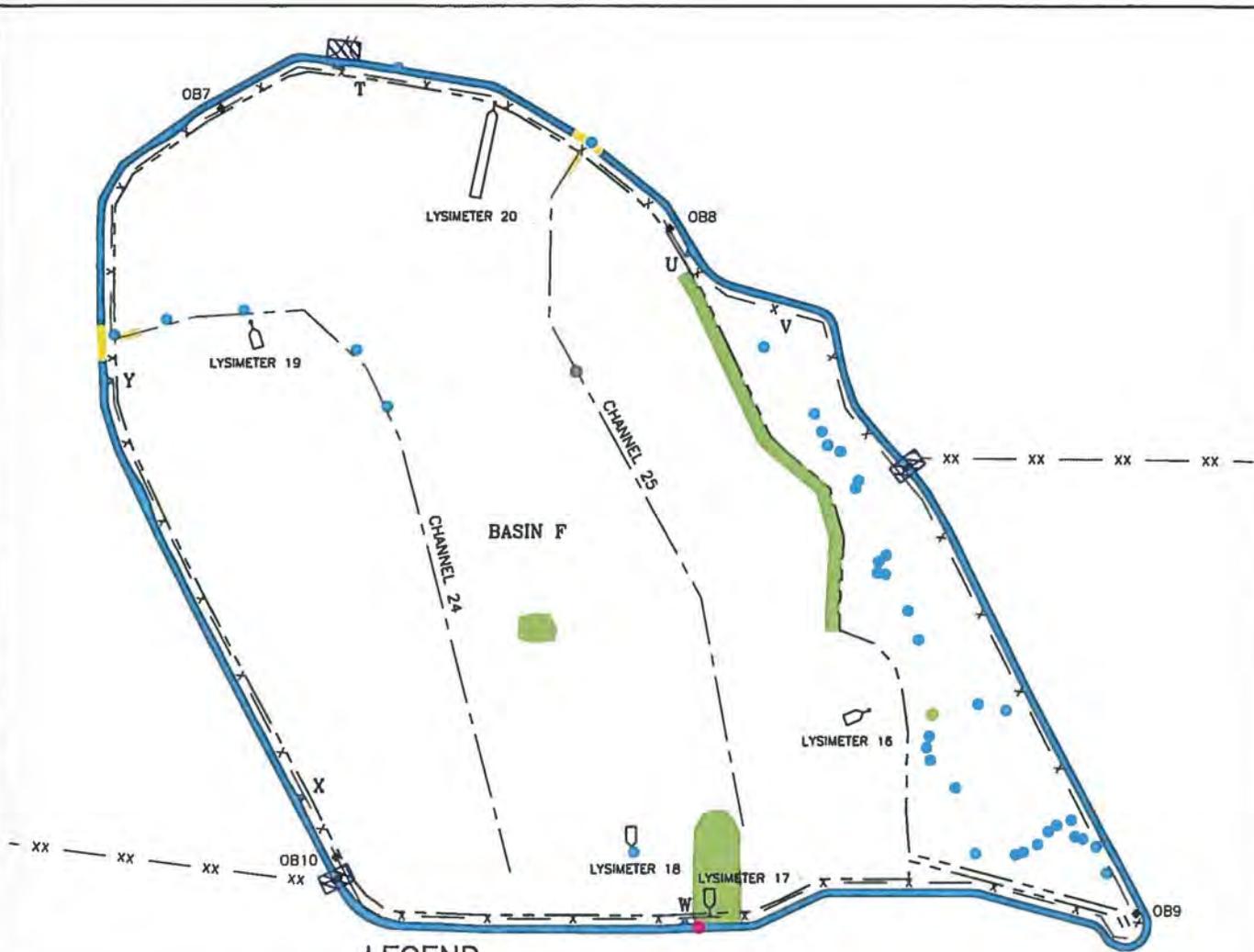
Lysimeter No.	Monthly Percolation Measurement (ml)											
	Oct-14	Nov-14	Dec-14	Jan-15	Feb-15	Mar-15	Apr-15	May-15	Jun-15	Jul-15	Aug-15	Sep-15
Lysimeter 016	0	0	0	0	0	0	0	0	0	0	0	0
Lysimeter 017	0	0	0	0	Trace	0	0	0	0	0	0	0
Lysimeter 018	0	0	0	Trace	0	0	0	0	0	0	0	0
Lysimeter 019	0	0	0	Trace	0	Trace	0	0	0	0	0	0
Lysimeter 020	0	0	0	0	0	0	0	0	0	0	0	0

Table 7.0-1: 2015 Vegetation Performance Assessment Summary

Performance Criterion and Evaluation	Basin F Cover
Total Absolute Ground Cover	80.70%
Allowable Total Absolute Live Vegetation Cover 2011	71.10%
Vegetation Performance Standard for Total Live Vegetation	≥ 25%
Is Vegetation Performance Standard met?	Yes
Two Year Running Average for Total Absolute Ground Cover	88.40%
Vegetation Performance Standard for Two Year Running Average	≥ 50%
Is Vegetation Performance Standard met?	Yes
Three Year Running Average for Total Absolute Ground Cover	88.90%
Vegetation Performance Standard for Three Year Running Average	≥ 67%
Is Vegetation Performance Standard met?	Yes
Relative Weed Cover	0.30%
Relative Allowable Weed Cover	≤ 10%
Calculate Total Live Vegetation without the weed fraction?	No (Note 1)

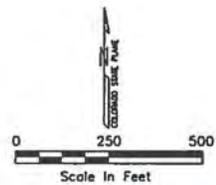
Note 1: The relative weed cover is less than 10 percent, therefore, subtracting all but 10 percent of the total live vegetation cover fraction that is comprised of weeds does not affect the Total Live Vegetation calculation. The Total Live Vegetation values are within the Non-Routine Action Trigger Levels.

FIGURES



LEGEND

- ——— COVER BOUNDARY
- x - x - PERIMETER FENCE
- xx - xx - USFWS BISON PASTURE FENCE
- ==== PERIMETER ACCESS ROAD (SEE NOTE 1)
- LYSIMETER
- - - - CHANNEL FLOW LINE
- ◆ OB9 OBELISK
- W LABELED GATES AND CATTLE GUARDS
- OVERSEEDED
- INSTALLED CORRAL PANELS
- REMOVED SILT FROM CHANNELS
- GROUND HERBICIDE
- REPAIRED PERIMETER ROAD
- REPAIRED CAULK



NOTE 1: THE OUTSIDE SHOULDER OF THE PERIMETER ACCESS ROAD DEFINES THE ARMY MAINTAINED AREA BOUNDARY (AMA).
 NOTE 2: THERE WAS A PRESCRIBED BURN CONDUCTED ON THE ENTIRE BASIN F AMA-NRAP-2014-001.

ROCKY MOUNTAIN ARSENAL COMMERCE CITY, COLORADO		
NAVARRO Research and Engineering, Inc.		
PROJECT NAME 2015 ANNUAL COVERS REPORT		
TITLE BASIN F ROUTINE AND NON-ROUTINE MAINTENANCE ACTIVITIES		
CAD FILE	DATE	FIGURE NUMBER
BF FIGURE 4.0-1.DWG	11.10.15	4.0-1

APPENDICES (All on CD)

- Appendix A Precipitation Data (October 1, 2014 through September 30, 2015)
- Appendix B 2015 Vegetation Performance Assessment Documentation
- Appendix C Cover Inspection Documentation (October 1, 2014 through September 30, 2015)
- Appendix D Maintenance and Repair Documentation (October 1, 2014 through September 30, 2015)
- Appendix E Basin F Post-Closure Groundwater Monitoring Report 2015
- Appendix F NRAP Log