ROCKY MOUNTAIN ARSENAL

Annual Summary Report for Groundwater and Surface Water Fiscal Year 2014

Revision 0

September 28, 2015

U.S. Department of the Army
Shell Oil Company

Prepared by:

Navarro Research and Engineering, Inc.

00057274 22731 - 3

This page intentionally left blank.

Table of Contents

EXECUTIVE SUMMARY ..... **XIII**

ACRONYMS ..... **XXI**

1.0 INTRODUCTION **1**

1.1 REPORT PURPOSE 1
1.2 TREATMENT SYSTEMS OPERATIONS AND MONITORING OVERVIEW 1
1.2.1 Selected Groundwater Remedy 1
1.2.2 Sources of Contamination 1
1.2.3 Overview of Treatment Systems CSRG Water Quality Monitoring 1
1.2.4 Treatment Systems Statistics for FY14 3
1.2.5 Treatment Systems Off-Site Waste Shipment Summary 4
1.2.6 Systems Modifications 4
1.3 SITE-WIDE MONITORING PROGRAMS OVERVIEW 4
1.3.1 Water Level Network 5
1.3.2 Water Quality Tracking 5
1.3.3 Confined Flow System Monitoring 5
1.3.4 Off-Post Exceedance Monitoring 5
1.3.5 Surface Water Monitoring 6
1.4 OVERVIEW OF PRE-SHUT-OFF, SHUT-OFF, AND POST-SHUT-OFF MONITORING 6
1.5 QUALITY ASSURANCE SUMMARY 6
1.5.1 Precision 7
1.5.2 Accuracy/Bias 8
1.5.3 Representativeness 10
1.5.4 Completeness 10
1.5.5 Comparability 10
1.5.6 Sensitivity 11
1.5.7 Field and Quality Control Samples 11
1.5.8 Data Usability Evaluation 13
1.6 REPORT ORGANIZATION 14

2.0 ON-POST OPERATIONS MONITORING PROGRAMS **15**

2.1 ON-POST CONTAINMENT AND MASS REMOVAL SYSTEM EVALUATION 15
2.1.1 Northwest Boundary Containment System (NWBCS) 15
2.1.2 North Boundary Containment System (NBCS) 20
2.1.3 Railyard Containment System (RYCS) 27
2.1.4 Basin A Neck System (BANS) 30
2.1.5 Bedrock Ridge Extraction System (BRES) 40
2.1.6 Complex Army Disposal Trenches (CADT) Dewatering System 41
2.1.7 Shell Trenches 42
2.1.8 Lime Basins Slurry Wall Dewatering System (LB) 44
2.1.9 Lime Basins DNAPL Remediation Project 45
2.1.10 North Plants Pilot LNAPL Removal Action 48
2.2 POST-SHUT-OFF MONITORING 50
2.2.1 GWMRP 50
2.2.2 MPS/ICS 52
2.3 SITE-WIDE ON-POST MONITORING 54
2.3.1 Water Level Tracking 54
2.3.2 Water Quality Tracking 54

2.3.3 Confined Flow System Monitoring....56
2.3.4 Surface Water Monitoring....58

3.0 OFF-POST OPERATIONS MONITORING PROGRAMS....59

3.1 OFF-POST GROUNDWATER INTERCEPT AND TREATMENT SYSTEM (OGITS)....59
3.1.1 OGITS Operations....59
3.1.2 Performance Evaluation, including OGITS Mass Removal Evaluation....60
3.1.3 Performance Evaluation, including CSRG Concentrations in Performance and Operational Wells....67
3.1.4 Compliance Evaluation....74
3.1.5 Quality Assurance Review for OGITS Water Quality Monitoring....74
3.1.6 Conclusions and Recommendations....76
3.2 SITE-WIDE OFF-POST MONITORING....76
3.2.1 Off-Post Exceedance Monitoring....76
3.2.2 Surface Water Monitoring....78
3.2.3 Surface Water Monitoring....78
3.2.4 Tri-County Health Department Off-Post Groundwater Monitoring for FY14....80
3.2.5 Annual Well Networks Update for FY14....80

4.0 CONCLUSIONS AND RECOMMENDATIONS....81

5.0 REFERENCES....85

Overview of Appendices

Appendix A. Northwest Boundary Containment System Figures....Tab A

Appendix B. North Boundary Containment System Figures....Tab B

Appendix C. Railyard Containment System Figures....Tab C

Appendix D. BANS, BRES, CADT, and LB Figures....Tab D

Appendix E. Shell Trenches, North Plants, GWMRP Figures....Tab E

Appendix F. First Creek Pathway System Figures....Tab F

Appendix G. Northern Pathway System Figures....Tab G

Appendix H. Site-Wide On-Post Monitoring Figures....Tab H

Appendix I. FY14 QA/QC Summary Tables....Tab I

Appendix J. FY14 TCHD Off-Post Groundwater Monitoring Report....Tab J

Appendix K. FY14 Annual Well Networks Update Report....Tab K

Appendix L. Lab Codes, Flag Codes, and Chemical Codes....Tab L

Appendix M. Statistical Computational Guidelines....Tab M

List of Tables

Table 1. Overview of Treatment System/Project Tables for FY14 2
Table 2. Treatment Systems Statistics for FY14..... 3
Table 3. Overview of FY14 CSRG Analyte Sampling for NWBCS Performance and Operational Wells 19
Table 4. Overview of FY14 CSRG Analyte Sampling from NBCS Performance and Operational Wells 26
Table 5. Overview of FY14 CSRG Analyte Sampling from Railyard Performance and Operational Wells 30
Table 6. FY14 BANS Estimated Contaminated Flow Rate, Mass Flux, and Mass Removed..... 33
Table 7. Overview of FY14 CSRG Analyte Sampling from BANS/CADT/BRES Performance and Operational Well 39
Table 8. Shell Trenches Boring Water Elevations (July 2013) and Trench Bottom Elevations..... 43
Table 9. Lime Basins DNAPL Remediation Project. FY14 DNAPL Thickness, PRAS, and DNAPL Removal 46
Table 10. GWMRP Post-Shut-Off Benzene Results..... 51
Table 11. FY14 OGITS Estimated Contaminated Flow Rate, Mass Flux, and Mass Removed 64
Table 12. Overview of FY14 CSRG Analyte Sampling from OGITS First Creek Pathway Performance and Operational Wells 69
Table 13. Overview of FY14 CSRG Analyte Sampling from OGITS Northern Pathway Performance Wells 71
Table 14. Overview of FY14 CSRG Analyte Sampling from OGITS Northern Pathway Operational Wells..... 72
Table 15. Overview of FY14 CSRG Analyte Sampling from OGITS Northern Pathway Extraction Wells..... 73

List of Figures and Appendixes

Figures within Main Body of Document

Figure 1. BANS Hydrogeologic Cross Section....32

Figure 2. Chart for Piezometer 25125....49

Figure 3. Chart for Piezometer 25134....49

Figure 4. FCS Hydrogeologic Cross Section....62

Figure 5. NPS Hydrogeologic Cross Section....63

Appendix A: Northwest Boundary Containment System Figures **Tab A**

Figure A-1. Northwest Boundary Water Levels (1st and 2nd Quarters)....A-1

Figure A-2. Northwest Boundary Water Levels (3rd and 4th Quarters)....A-2

Figure A-3. Northwest Boundary Treatment Plant Influent/Effluent - CHCL3....A-3

Figure A-4. Northwest Boundary Treatment Plant Influent/Effluent - DIMP....A-4

Figure A-5. Northwest Boundary Treatment Plant Influent/Effluent - DLDRN....A-5

Figure A-6. Northwest Boundary Upgradient/Downgradient Performance Wells - CHCL3....A-6

Figure A-7. Northwest Boundary Upgradient/Downgradient Performance Wells - DLDRN....A-7

Figure A-8. FY14 Northwest Boundary Monitoring Well Network - Unconfined Aquifer....A-8

Figure A-9. FY14 1st Quarter Groundwater Elevation Contours of the Unconfined Aquifer, Northwest Boundary Containment System....A-9

Figure A-10. FY14 2nd Quarter Groundwater Elevation Contours of the Unconfined Aquifer, Northwest Boundary Containment System....A-10

Figure A-11. FY14 3rd Quarter Groundwater Elevation Contours of the Unconfined Aquifer, Northwest Boundary Containment System....A-11

Figure A-12. FY14 4th Quarter Groundwater Elevation Contours of the Unconfined Aquifer, Northwest Boundary Containment System....A-12

Figure A-13. FY14 Chloroform (CHCL3) Concentration for Selected Wells in the Unconfined Aquifer, Northwest Boundary Containment System....A-13

Figure A-14. FY14 Dieldrin (DLDRN) Concentration for Selected Wells in the Unconfined Aquifer, Northwest Boundary Containment System....A-14

Appendix B: North Boundary Containment System Figures **Tab B**

Figure B-1. North Boundary Water Levels (Alluvial, 1st and 2nd Quarters) B-1

Figure B-2. North Boundary Water Levels (Alluvial, 3rd and 4th Quarters) B-2

Figure B-3. North Boundary Water Levels (Denver, 1st and 2nd Quarters) B-3

Figure B-4. North Boundary Water Levels (Denver, 3rd and 4th Quarters) B-4

Figure B-5. North Boundary Treatment Plant Influent/Effluent - CCL4..... B-5

Figure B-6. North Boundary Treatment Plant Influent/Effluent - CHCL3 ..... B-6

Figure B-7. North Boundary Treatment Plant Influent/Effluent - CL B-7

Figure B-8. North Boundary Treatment Plant Influent/Effluent - DIMP B-8

Figure B-9. North Boundary Treatment Plant Influent/Effluent - DLDRN B-9

Figure B-10. North Boundary Treatment Plant Influent/Effluent - NNDMEA B-10

Figure B-11. North Boundary Upgradient/Downgradient Performance Wells - CCL4 ..... B-11

Figure B-12. North Boundary Upgradient/Downgradient Performance Wells - CHCL3 ..... B-12

Figure B-13. North Boundary Upgradient/Downgradient Performance Wells - CL B-13

Figure B-14. North Boundary Upgradient/Downgradient Performance Wells - DIMP B-14

Figure B-15. North Boundary Upgradient/Downgradient Performance Wells - DLDRN B-15

Figure B-16. North Boundary Upgradient/Downgradient Performance Wells - NNDMEA .. B-16

Figure B-17. FY14 North Boundary Monitoring Well Network - Unconfined Aquifer B-17

Figure B-18. FY14 4th Quarter Groundwater Elevation Contours of the Unconfined Aquifer, North Boundary Containment System B-18

Figure B-19.1 FY14 Carbon Tetrachloride (CCL4) Concentration for Selected Wells in Section 23 of the Unconfined Aquifer, North Boundary Containment System B-19.1

Figure B-19.2 FY14 Carbon Tetrachloride (CCL4) Concentration for Selected Wells in Section 24 of the Unconfined Aquifer, North Boundary Containment System B-19.2

Figure B-20.1 FY14 Chloride (CL) Concentration for Selected Wells in Section 23 of the Unconfined Aquifer, North Boundary Containment System B-20.1

Figure B-20.2 FY14 Chloride (CL) Concentration for Selected Wells in Section 24 of the Unconfined Aquifer, North Boundary Containment System B-20.2

Figure B-21.1 FY14 Diisopropylmethyl phosphonate (DIMP) Concentration for Selected Wells in Section 23 of the Unconfined Aquifer, North Boundary Containment System B-21.1

Figure B-21.2 FY14 Diisopropylmethyl phosphonate (DIMP) Concentration for Selected Wells in Section 24 of the Unconfined Aquifer, North Boundary Containment System B-21.2

Figure B-22.1 FY14 Dieldrin (DLDRN) Concentration for Selected Wells in Section 23 of the Unconfined Aquifer, North Boundary Containment System B-22.1

Figure B-22.2 FY14 Dieldrin (DLDRN) Concentration for Selected Wells in Section 24 of the Unconfined Aquifer, North Boundary Containment System B-22.2

Figure B-23.1 FY14 N-Nitrosodimethylamine (NNDMEA) Concentration for Selected Wells in Section 23 of the Unconfined Aquifer, North Boundary Containment System B-23.1

Figure B-23.2 FY14 N-Nitrosodimethylamine (NNDMEA) Concentration for Selected Wells in Section 24 of the Unconfined Aquifer, North Boundary Containment System B-23.2

Appendix C: Railyard Containment System Figures **Tab C**

Figure C-1. Railyard Adsorber 302 Influent/Effluent - DBCP C-1

Figure C-2. Railyard Adsorber 303 Influent/Effluent - DBCP C-2

Figure C-3. Railyard Treatment Plant Effluent - DBCP C-3

Figure C-4. Railyard Upgradient/Downgradient Performance Wells - DBCP C-4

Figure C-5. FY14 Railyard Treatment System Monitoring Well Network of the Unconfined Aquifer C-5

Figure C-6. FY14 1st Quarter Groundwater Elevation Contours of the Unconfined Aquifer, Railyard Treatment System C-6

Figure C-7. FY14 2nd Quarter Groundwater Elevation Contours of the Unconfined Aquifer, Railyard Treatment System C-7

Figure C-8. FY14 3rd Quarter Groundwater Elevation Contours of the Unconfined Aquifer, Railyard Treatment System C-8

Figure C-9. FY14 4th Quarter Groundwater Elevation Contours of the Unconfined Aquifer, Railyard Treatment System C-9

Figure C-10. FY14 Dibromochloropropane (DBCP) Concentration for Selected Wells in the Unconfined Aquifer, Railyard Containment System C-10

Appendix D : BANS, BRES, CADT, and LB Figures **Tab D**

Figure D-1. Basin A Neck Treatment System Process Diagram D-1

Figure D-2. FY14 Complex Army Disposal Trenches Paired Wells/Compliance Wells D-2

Figure D-3. Basin A Neck Treatment Plant Influent/Effluent - CHCL3 ..... D-3

Figure D-4. Basin A Neck Treatment Plant Influent/Effluent - DLDRN D-4

Figure D-5. Basin A Neck Treatment Plant Influent/Effluent - DITH D-5

Figure D-6. Basin A Neck Upgradient/Downgradient Performance Wells - CHCL3 ..... D-6

Figure D-7. Basin A Neck Upgradient/Downgradient Performance Wells - DLDRN D-7

Figure D-8. Basin A Neck Upgradient/Downgradient Performance Wells - DITH D-8

Figure D-9. FY14 Basin A Neck Monitoring Well Network of the Unconfined Aquifer D-9

Figure D-10. FY14 4th Quarter Groundwater Elevation Contours - Basin A Neck D-10

Figure D-11. FY14 Arsenic (AS) Concentration for Selected Wells in the Unconfined Aquifer, Basin A Neck D-11

Figure D-12. FY14 Diisopropylmethyl phosphonate (DIMP) Concentration for Selected Wells in the Unconfined Aquifer, Basin A Neck D-12

Figure D-13. FY14 Dithiane (DITH) Concentration for Selected Wells in the Unconfined Aquifer, Basin A Neck D-13

Figure D-14. FY14 Dieldrin (DLDRN) Concentration for Selected Wells in the Unconfined Aquifer, Basin A Neck D-14

Figure D-15. Bedrock Ridge Upgradient/Downgradient Performance Wells - CHCL3 ..... D-15

Figure D-16. Bedrock Ridge Upgradient/Downgradient Performance Wells - DIMP D-16

Figure D-17. Bedrock Ridge Upgradient/Downgradient Performance Wells - TCLEE D-17

Figure D-18. FY14 Bedrock Ridge Monitoring Well Network of the Unconfined Aquifer ... D-18

Figure D-19. FY14 1st Quarter Groundwater Elevation Contours - Bedrock Ridge System... D-19

Figure D-20. FY14 2nd Quarter Groundwater Elevation Contours - Bedrock Ridge System.. D-20

Figure D-21. FY14 3rd Quarter Groundwater Elevation Contours - Bedrock Ridge System .. D-21

Figure D-22. FY14 4th Quarter Groundwater Elevation Contours - Bedrock Ridge System .. D-22

Figure D-23. FY14 Chloroform (CHCL3) Concentration for Selected Wells in the Unconfined Aquifer, Bedrock Ridge D-23

Figure D-24. FY14 Diisopropylmethyl phosphonate (DIMP) Concentration for Selected Wells in the Unconfined Aquifer, Bedrock Ridge D-24

Figure D-25. FY14 Tetrachloroethylene (TCLEE) Concentration for Selected Wells in the Unconfined Aquifer, Bedrock Ridge D-25

Figure D-26. FY14 Complex Army Trenches Monitoring Well Network D-26

Figure D-27. FY14 Lime Basins Monitoring Well Network D-27

Figure D-28. FY14 Lime Basins Reverse Gradients for Northern and Southern Wells D-28

Figure D-29. FY14 Lime Basins Dewatering System: Water Elevations and Flow Rate D-29

Figure D-30. FY14 Lime Basins Delineation of Suspected DNAPL Source Zones D-30

Figure D-31. FY14 Lime Basins Groundwater System Water Table July 2014 ..... D-31

Appendix E: Shell Trenches, North Plants, and GWMRP Figures **Tab E**

Figure E-1. Shell Trenches Well and Borehole Locations July 2014 Water Elevations E-1

Figure E-2. North Plants Pilot LNAPL Removal System July 2014 Water Elevations E-2

Figure E-3. South Tank Farm System GWMRP Post-Shut-Off SAP E-3

Figure E-4. Rocky Mountain Arsenal MPS/ICS Post-Shut-Off Monitoring Well Location Map E-4

Appendix F: First Creek Pathway System Figures **Tab F**

Figure F-1. Offpost Treatment Plant Influent/Effluent - AS F-1

Figure F-2. Offpost Treatment Plant Influent/Effluent - CHCL3 ..... F-2

Figure F-3. Offpost Treatment Plant Influent/Effluent - CL F-3

Figure F-4. Offpost Treatment Plant Influent/Effluent - DBCP F-4

Figure F-5. Offpost Treatment Plant Influent/Effluent - DLDRN F-5

Figure F-6. Offpost Treatment Plant Influent/Effluent - DIMP F-6

Figure F-7. Offpost Treatment Plant Influent/Effluent - NNDMEA F-7

Figure F-8. Offpost Treatment Plant Influent/Effluent - TCLEE F-8

Figure F-9. Offpost Upgradient/Downgradient Performance Wells - AS F-9

Figure F-10. Offpost Upgradient/Downgradient Performance Wells - CHCL3.....F-10

Figure F-11. Offpost Upgradient/Downgradient Performance Wells - CL F-11

Figure F-12. Offpost Upgradient/Downgradient Performance Wells - DBCP.....F-12

Figure F-13. Offpost Upgradient/Downgradient Performance Wells - DLDRN.....F-13

Figure F-14. Offpost Upgradient/Downgradient Performance Wells - DIMP F-14

Figure F-15. Offpost Upgradient/Downgradient Performance Wells - NNDMEA.....F-15

Figure F-16. Offpost Upgradient/Downgradient Performance Wells - TCLEE.....F-16

Figure F-17. FY14 First Creek Pathway Monitoring Well Network - Unconfined Aquifer F-17

Figure F-18. FY14 1st Quarter Groundwater Elevation Contours - First Creek Pathway F-18

Figure F-19. FY14 2nd Quarter Groundwater Elevation Contours - First Creek Pathway.....F-19

Figure F-20. FY14 3rd Quarter Groundwater Elevation Contours - First Creek Pathway.....F-20

Figure F-21. FY14 4th Quarter Groundwater Elevation Contours - First Creek Pathway F-21

Figure F-22. FY14 Chloride (CL) Concentration for Selected Wells in the Unconfined Aquifer at the First Creek Pathway F-22

Figure F-23. FY14 Dicyclopentadiene (DCPD) Concentration for Selected Wells in the Unconfined Aquifer at the First Creek Pathway F-23

Figure F-24. FY14 Diisopropylmethyl phosphonate (DIMP) Concentration for Selected Wells in the Unconfined Aquifer at the First Creek Pathway F-24

Appendix G: Northern Pathway System Figures **Tab G**

Figure G-1. Northern Pathway Monitoring Well Network of the Unconfined Aquifer G-1

Figure G-2. FY14 1st Quarter Groundwater Elevation Contours - Northern Pathway G-2

Figure G-3. FY14 2nd Quarter Groundwater Elevation Contours - Northern Pathway G-3

Figure G-4. FY14 3rd Quarter Groundwater Elevation Contours - Northern Pathway..... G-4

Figure G-5. FY14 4th Quarter Groundwater Elevation Contours - Northern Pathway..... G-5

Figure G-6. FY14 Carbon Tetrachloride (CCL4) Concentration for Selected Wells in the Unconfined Aquifer at the Northern Pathway G-6

Figure G-7. FY14 Chloroform (CHCL3) Concentration for Selected Wells in the Unconfined Aquifer at the Northern Pathway G-7

Figure G-8. FY14 Chloride (CL) Concentration for Selected Wells in the Unconfined Aquifer at the Northern Pathway G-8

Figure G-9. FY14 Diisopropylmethyl phosphonate (DIMP) Concentration for Selected Wells in the Unconfined Aquifer at the Northern Pathway G-9

Figure G-10. FY14 Dieldrin (DLDRN) Concentration for Selected Wells in the Unconfined Aquifer at the Northern Pathway..... G-10

Figure G-11. FY14 Tetrachloroethylene (TCLEE) Concentration for Selected Wells in the Unconfined Aquifer at the Northern Pathway..... G-11

Appendix H: Site Wide Monitoring On-Post Figures **Tab H**

Figure H-1. Site Wide Groundwater Level Contour Map for Fiscal Year 2014..... H-1

Figure H-2. Rocky Mountain Arsenal Water Quality Tracking Wells…….. H-2

Figure H-3. Rocky Mountain Arsenal Confined Flow System Water Quality Wells…… H-3

Figure H-4. Rocky Mountain Arsenal Surface Water Monitoring Locations..... H-4

Appendix I: FY14 QA/QC Summary Tables **Tab I**

Table I-1. FY2014 Relative Percent Difference Evaluation Limits.....I-1

Table I-2. FY2014 Investigative/Duplicate Comparable Results I-9

Table I-3. FY2014 Investigative/Duplicate Non-Comparable Results.....I-69

Table I-4. FY2014 Spike Recovery Evaluation Limits.....I-73

Table I-5. FY2014 Spike Recovery Results Outside Evaluation Limits I-84

Table I-6. FY2014 Analytical Lots with LCS and MS Recoveries Outside Evaluation Limits I-95

Table I-7. FY2014 Spike Recovery Summary.....I-97

Table I-8. FY2014 Rejected Samples I-112

Table I-9. FY2014 Method Blank Detections above the Method Reporting Limit.....I-113

Table I-10. FY2014 Field Blank Detections above the Method Reporting Limit I-114

Table I-11. FY2014 Rinse Blank Detections above the Method Reporting Limit I-115

Table I-12. FY2014 Trip Blank Detections above the Method Reporting Limit.....I-116

Table I-13. FY2014 Statistical Outliers I-117

Table I-14. FY2014 Statistical Trends I-120

Appendix J: TCHD Off-Post Groundwater Monitoring Report for FY14 **Tab J**

TCHD Off-Post Groundwater Monitoring Report for FY14 ..... J-1

TCHD Sampling Results for FY2014 Candidate Sampling List ..... Table 1.0

Map of DIMP Sampling Results for FY2014 Off-Post Private Wells.....Figure 1.0

Map of 1,4-Dioxane Sampling Results for FY2014 Off-Post Private Wells.....Figure 2.0

Appendix K: Annual Well Networks Update Report for FY14 **Tab K**

Annual Well Networks Update Report for FY14 .....K-1

Appendix L: Lab Codes, Flag Codes, and Chemical Codes **Tab L**

Laboratory Codes L-1

Flagging Codes L-2

Chemical Codes L-3

Appendix M: Statistical Computational Guidelines **Tab M**

Statistical Computational Guidelines M-1

This page intentionally left blank.

Executive Summary

This fiscal year 2014 (FY14) Annual Summary Report (ASR) for Groundwater and Surface Water includes an evaluation of collected data against the performance criteria and compliance requirements for the operating systems, site-wide water-table maps, and data reporting for any site-wide monitoring conducted during FY14, and any Consultative Process notification. The Regulatory Agencies will be notified of performance issues in accordance with the consultation triggers presented in the Section 4 and 5 Consultative Process tables of the 2010 Long-Term Monitoring Plan (LTMP) for Groundwater and Surface Water.

The current system-related monitoring categories, as shown in the 2010 LTMP are as follows:

- Compliance Monitoring: Effluent water quality monitoring is conducted to confirm that Containment System Remediation Goals (CSRGs) or Colorado Basic Standards for Groundwater (CBSGs) are met by on-post and off-post treatment systems. Compliance is based on moving averages for the last four quarters instead of single samples.

- Performance Monitoring: Water level and water quality monitoring conducted to measure performance against specific criteria.

- Pre-Shut-Off Monitoring: Monitoring or operational activities to confirm that shut-off should proceed and that the shut-off monitoring program should be initiated. A program will be designed for each specific system.

- Shut-Off Monitoring: Water quality monitoring at or near systems that have met shut-off criteria for a time period of at least five years. Sampling frequency is quarterly for the first and last years, and annually in the intervening years.

- Post-Shut-Off Monitoring: Monitoring to track groundwater levels, flow directions, and water quality in the area after successful completion of the shut-off monitoring program and termination of system operation.

- Operational Monitoring: Monitoring of containment system extraction wells and monitoring wells located near the systems to optimize system performance and ensure that Remedial Action Objectives are met. Monitoring to evaluate whether individual extraction wells can be shut off or will remain shut off is conducted under this program instead of the five-year shut-off monitoring.

The site-wide monitoring program categories identified in the LTMP include:

- Water Level Tracking: On-post water level monitoring used to track the effects of the soil remedy to groundwater in the On-Post Operable Unit.

- Water Quality Tracking: On-post water quality monitoring of indicator analytes is conducted to track contaminant migration in and downgradient of source areas within the identified plumes.

- Confined Flow System (CFS) Monitoring: Monitoring as required by the On-Post Record of Decision (ROD) requirement to monitor water quality in the confined aquifer in three Areas: Basin A, South Plants, and Basin F.

- Exceedance Monitoring: Long-term water quality monitoring of off-post groundwater to assess contaminant concentration reduction and remedy performance and to create groundwater CSRG exceedance area maps to support well permit institutional controls.

- Off-Post Water Level Monitoring: Off-post water level monitoring conducted in support of the exceedance monitoring to assess flow paths and contaminant migration in the exceedance areas. The off-post water level monitoring category is separate from the water level tracking category because it serves a different purpose.

- Surface Water Monitoring: Off-post and on-post surface water monitoring to assess changes in surface water quality related to the Rocky Mountain Arsenal (RMA) remedy. ROD-related surface water monitoring was added to the LTMP. Surface water monitoring will continue off-post, but long-term monitoring will be discontinued on-post, based on completion of the soil remedy. The Remediation Venture Office (RVO) prepared a Surface Water Monitoring Report (URS 2013) to evaluate post-ROD surface water monitoring data and future data needs. On-post short-term surface water monitoring will be conducted while the cover vegetation is established to assess the impacts of the covers on surface water quality.

All of the groundwater containment and mass removal systems discussed in this FY14 report met the objectives identified in the On-Post ROD, Off-Post ROD and LTMP. The systems are functioning as intended, except possibly the Northwest Boundary Containment System (NWBCS), as discussed below.

The September 2013 500- to 1000-year storm event, followed by an extremely wet period during May 2014 affected the groundwater levels and performance of some of the groundwater systems and projects during FY14. For example, the performance of the NWBCS and BANS may have been adversely affected. The Shell Trenches dewatering goal was met during the first quarter of FY14, but lost the compliance dewatering goal in one of six compliance boreholes during the subsequent quarters. This was caused by a rise in water levels directly related to the storm events. The dewatering goals have not yet been attained at the Complex Trenches and the Lime Basins Dewatering Project, but progress is being made toward meeting the goals. The storm events affected the water levels at the Complex Trenches, but the effects were not significant at the Lime Basins. Attainment of the dewatering goals in the three dewatering systems will be evaluated further in the 2015 Five-Year Review.

At the NWBCS, effluent water quality requirements were met in FY14. The NWBCS had no CSRG-analyte exceedances of the four-quarter moving averages in the treatment system effluent in FY14. The NWBCS appears to be functioning as intended, but additional monitoring data are needed to confirm that all the performance criteria are being met. The primary performance requirement (a reverse hydraulic gradient across the system) was met during all quarters. The secondary performance requirement was also met with CSRG-analyte concentrations in all downgradient performance wells below CSRGs/Practical Quantitation Limits (PQLs), except dieldrin. Dieldrin concentrations were slightly above the new PQL in all five of the Original System downgradient performance wells and in two Northeast Extension downgradient performance wells. Dieldrin concentrations above the PQL may be caused by a combination of factors: 1) mobilization of residual dieldrin in the aquifer sediments downgradient of the slurry wall, which was caused by rising regional water levels, 2) concentrations near or above the PQL in the NWBCS effluent, and 3) a small amount of contaminated flow for the Northeast Extension area may be migrating toward one or more of the downgradient performance wells. Since the concentrations were below the previous PQL and Method Reporting Limit (MRL), which changed in FY12, additional data are needed to evaluate

the concentration trends. The dieldrin analytical method and MRL changed again in FY14. The secondary performance criterion is met if the concentrations in the downgradient performance wells are above CSRGs/PQLs, but the concentrations are decreasing based on the previous period of at least five years. Thus, it is premature to draw conclusions about the FY14 performance based on the downgradient well data. Operational changes were implemented during FY12 and FY13 that are anticipated to improve the NWBCS treatment performance for meeting the new dieldrin PQL. NWBCS dieldrin treatment effectiveness and the downgradient performance well detections above the PQL will be evaluated further in the 2015 Five-Year Review.

At the North Boundary Containment System (NBCS), effluent water quality requirements, including for chloride and sulfate, were met in FY14. The primary performance requirement is to maintain a reverse hydraulic gradient across the system and to ensure plume-edge capture. Both requirements were met during FY14. Thus, the NBCS is functioning as intended. The secondary performance requirement is that the downgradient performance well concentrations are at or below the CSRG/PQLs, or show decreasing trends. The secondary criteria are used to evaluate performance if the primary criteria are not met. Downgradient performance well concentrations were below CSRGs/PQLs or showed generally decreasing concentration trends. Thus, the secondary criteria were also met.

The Railyard Containment System (RYCS) is effectively capturing and treating the dibromochloropropane (DBCP) plume. The primary performance requirement is to demonstrate plume capture through groundwater flow directions and DBCP concentrations in performance wells. Water-table maps indicate that the plume is captured and concentrations of DBCP were below the CSRG in all performance wells sampled in FY14. A RYCS pre-shut-off monitoring program was successfully completed in FY14, and the shut-off process will proceed to the next phase. A Decision Document and Draft Shut-Off Monitoring SAP will be prepared for review and approval by the Regulatory Agencies in 2015.

The Off-post Groundwater Intercept and Treatment System (OGITS) met its ROD objective as a mass removal system in FY14. An operational change was made during the fourth quarter of FY12 that improved the First Creek Pathway System (FCS) performance in FY13 and FY14 to exceed the mass removal goal. An Operations and Maintenance Change Notice (OCN) to the LTMP OGITS mass removal performance criteria may be needed to clarify how the mass removal evaluation is conducted when CSRG analytes are present at concentrations below the CSRGs/PQLs. The mass removal calculation methodology will be evaluated further during the 2015 Five-Year Review. Flow meter inspection and calibration procedures were implemented in FY13 to improve the accuracy of the flow meter readings, which are used in the mass removal calculations. The mass removal of dieldrin in the Northern Pathway System (NPS) had been declining (76 percent in FY13), but increased to nearly 100 percent in FY14. All four-quarter moving averages for the CSRG analytes in the effluent were below the CSRGs/PQLs, including chloride and sulfate in FY14. The second performance requirement is to demonstrate that concentrations of CSRG analytes are stable or decreasing in downgradient performance wells. Downgradient performance wells in the FCS and NPS were below the OGITS organic analyte CSRGs/PQLs except for dieldrin in one FCS well. The downgradient performance wells exceeded the inorganic analyte CSRGs for chloride, sulfate, and fluoride in a few wells. These analytes showed stable or decreasing trends. The inorganic standards for chloride and sulfate at OGITS are expected to be met by attenuation consistent with the On-Post ROD.

All four-quarter moving averages for the CSRG analytes in the BANS effluent were below the CSRGs/PQLs for FY14. The BANS met the 75 percent mass removal goal for FY14, which satisfies one of the performance requirements. The second performance requirement is to demonstrate that concentrations in downgradient performance wells are below CSRGs/PQLs or are stable or decreasing. This is the generally the case for the four downgradient performance wells. However, the concentrations of several analytes increased to above CSRGs/PQLs in two wells (26505 and 35525) in FY14. Historically high water elevations were experienced in FY14, which were caused by the 500- to 1000-year storm event in September 2013, followed by an extremely wet period during May 2014. The high water levels caused the extent and magnitude of the reverse hydraulic gradient to decrease in FY14. The LTMP does not include performance criteria for the BANS reverse gradient. Although the concentrations for several analytes increased in FY14, the long-term trends did not increase, as determined by Mann-Kendall statistical tests. Therefore, the BANS functioned as intended in FY14. A revision to the 2010 LTMP is being considered, and establishing performance criteria for the BANS reverse gradient will be evaluated.

The Bedrock Ridge Extraction System (BRES) water-table contours and water quality monitoring data likely indicate that the plume was captured during all quarters of FY14. In FY14, five sampling events for the performance wells have occurred and the trends in the downgradient wells can be used to evaluate the performance. However, this time frame may be too short for evaluating one of the wells. Concentrations in one of the four BRES downgradient performance wells are still above CSRGs. Some analytes in the downgradient performance well show decreasing trends and some show increasing trends. The well is located downgradient of the system where the hydraulic gradient is much flatter than at the other performance wells and the contamination would be expected to clean up more slowly. Thus, additional monitoring is needed to determine whether the well is appropriate as a downgradient performance well. Thus, based on the available information, the BRES appears to be functioning as intended.

The Complex Army Disposal Trenches (CADT) dewatering system was effective in lowering the water table to levels below the dewatering goal in one of the two compliance wells and maintaining an inward hydraulic gradient. The dewatering goal in the second compliance well was not attained by the 2010 LTMP-established date of September 2014, after the RCRA-equivalent cover vegetation is established. Water levels inside the Complex Trenches slurry wall were affected by the September 2013 and May 2014 storms. However, progress is being made toward meeting the goals, even with the recent storm events. Thus, continued water level monitoring is the proposed action. Attainment of the dewatering goals will be evaluated further in the 2015 Five-Year Review.

The Shell Trenches system met the dewatering goal in the first quarter of FY14. The September 2013 and May 2014 storms caused water levels inside the Shell Trenches slurry wall to rise above the trench-bottom elevation at one of the six compliance boreholes during the last three quarters of FY14. Once the effects of the storms have passed, the water levels inside the slurry wall are expected to fall and the dewatering goal will be re-attained. Thus, continued water level monitoring is the proposed action. Attainment of the dewatering goal will be evaluated further in the 2015 Five-Year Review.

The objectives of the Lime Basins Dewatering Project are to establish an inward hydraulic gradient across the slurry wall and to lower the water level inside the slurry-wall enclosure to below the bottom of the waste. The dewatering goals were not attained by the 2010 LTMP-established date of September 9, 2014, after the RCRA-equivalent cover vegetation is established. At the end of FY14, the water elevation was below the waste elevation in one well, and is steadily approaching the goal in the other wells. An inward hydraulic gradient has been achieved in the southern well pairs and the

difference in water elevation in the northern wells is decreasing. From 2009 to FY14, the average outward hydraulic gradient head differentials were reduced from 9.2 feet to 4.5 feet on the north side. Thus, progress toward meeting the goals is being made. A corrective action has been taken to improve the system performance, which involves changing the dewatering well and treatment operations from batch mode to more continuous operation. Attainment of the dewatering goals will be evaluated further in the 2015 Five-Year Review.

In August 2009, monitoring of the Lime Basins dewatering wells indicated the potential presence of dense non-aqueous phase liquid (DNAPL). A Remedial Investigation/Feasibility Study (RI/FS) was conducted and three suspected DNAPL source zones were identified in the Lime Basins area. Eight new monitoring wells (four well pairs adjacent to the slurry wall) were installed in late FY12, and data collection specified in the Design Analysis Report (DAR) began in FY13. In FY13, the observed presence of DNAPL and the water quality data indicated that the suspected DNAPL source zones were larger than characterized in the RI Summary Report. The FY14 data showed similar results, however, the DNAPL-related compound concentrations were lower in many wells than in FY13. The water level data indicate that the slurry wall has not been impacted by DNAPL. During FY14, a total of 5.8 gallons of DNAPL was removed from one dewatering well and one monitoring well. During FY14, the Lime Basins DNAPL Remediation Project functioned as intended.

The North Plants light non-aqueous phase liquid (LNAPL) pilot removal system was implemented in 2008 to perform LNAPL removal for a historical release of fuel oil in the North Plants, and to gather operating data for the potential design of a full-scale LNAPL removal action. During the pilot study, two years of monitoring was conducted in the North Plants LNAPL recovery and monitoring wells. Sufficient quantities of LNAPL were not detected in these wells to support its removal. Beginning in FY12, quarterly monitoring for the remainder of the current Five-Year Review period was conducted. During FY14, the groundwater flow directions and hydraulic gradients were consistent with previous years. The LNAPL thicknesses and extent have continued to decrease since 2008, and only 0.02 feet of LNAPL was measured in one piezometer during one quarter. No other LNAPL was detected. The amounts of LNAPL since 2008 have been less than the minimum thickness required for testing/recovery to begin. Future monitoring and project status will be evaluated in the 2015 Five-Year Review.

Post-shut-off monitoring for the Groundwater Mass Removal Project was conducted in the South Tank Farm area in FY14. In FY12, the benzene concentration in one of the three monitoring wells sampled exceeded its historical maximum. Consequently, a fourth well was added in FY13 and FY14. Benzene was not detected in the four wells sampled in FY14 and no LNAPL was detected. It is likely that the higher benzene concentrations in one well in FY12 decreased to below detectable levels in FY14 due to naturally occurring biodegradation, which was previously determined to be occurring in the STF benzene plume.

Post-shut-off monitoring for the Motor Pool System/Irondale Containment System was conducted in FY14 and the contaminant concentrations were below CSRGs.

The site-wide on-post monitoring in FY14 included water level tracking, water quality tracking, and confined flow system well monitoring. The FY14 site-wide water table map is included in this report, and all of the site-wide data will be evaluated during the 2015 Five-Year Review.

An on-post short-term surface water sampling program was implemented in FY12 and continued in FY13 to confirm that surface water quality is not adversely impacted by cover soils during the establishment of cover vegetation and that groundwater plumes are not migrating into the lakes. The seven sites were not sampled in FY14, but selected sites will be sampled in FY15 if conditions allow.

The off-post exceedance monitoring well network was sampled for water quality in FY14 and the FY14 Off-post CSRG Exceedance Map is in progress.

Off-post surface water sampling was conducted in First Creek during FY14 at two downstream sites, one near 96th Avenue and one near Highway 2, and at an upstream First Creek site located near Buckley Road. No analytes were detected at concentrations above the CSRGs/PQLs in the investigative samples at the upstream and downstream First Creek sites.

Fifteen off-post private wells and two surface water sites were sampled for diisopropylmethyl phosphonate (DIMP) by Tri-County Health Department (TCHD) in FY14. None of the wells or sites contained DIMP above the CSRG of 8 micrograms/Liter (µg/L). The surface water sites were located in former storage impoundments owned by the Denver Water Department northwest of Rocky Mountain Arsenal. The surface water discharges into the South Platte River and it did not contain DIMP above 8 µg/L. Fourteen private wells and two surface-water sites were also sampled for 1,4-dioxane in FY14. The result from one well was above the 2013 State groundwater standard of 0.35 µg/L for 1,4-dioxane. The surface water samples for 1,4-dioxane were non-detect.

Table E-1: Summary of Trigger Events/Agency Notifications

Date	Issue	Description	Corrective Action
11/1/2013	Missed sample event for RYCS in FY13.	Missed RYCS effluent compliance sample for TRCLE in FY13.	Sample collected on 10/28/2013.
3/12/2014	CFS well concentration increases.	Concentration increases that met criteria for notification occurred in CFS wells 01067 (11DCLE), 02057 (CLC6H5), 26153 (DLDRN), and 35083 (CL). The concentrations were within or near the historical ranges. Some of the CFS wells may be semi-confined.	Adjacent unconfined flow system (UFS) wells were sampled for comparison to the CFS well data, which will be evaluated further in the 2015 Five-Year Review.
3/21/2014	Shell Trenches water levels exceed dewatering goal.	Shell Trenches water levels exceeded dewatering goal, January 2014. After meeting the Shell Trenches dewatering goal in July and October 2013, water levels rose above the target elevation at one of the six compliance boreholes. Higher water levels were caused by the 500- to 1000-year storm event in September 2013.	After the effects of the September 2013 storm event have passed, the water elevations inside the slurry wall should decrease and the dewatering goal will be re-attained. Continued quarterly water level monitoring was proposed.

Table E-1: Summary of Trigger Events/Agency Notifications (Continued)

Date	Issue	Description	Corrective Action
4/28/2014	CSRG exceedance in OGITS effluent.	Arsenic exceeded the CSRG in OGITS effluent, January 2014. Arsenic concentration in effluent was higher than in influent and was questionable.	OGITS effluent re-sampled on 3/19/2014 and arsenic was LT 1 µg/L. The January 2014 sample result was rejected based on an unknown source of arsenic contamination in the sample. Subsequent arsenic sample on 4/3/2014 also was LT 1 µg/L. No further action was proposed.
5/8/2014	NWBCS and OGITS downgradient performance wells exceed PQL for dieldrin.	Dieldrin concentrations in NWBCS and OGITS downgradient performance wells exceeded the PQL in March 2014. The dieldrin concentrations above the PQL at NWBCS likely are caused by a combination of higher water levels, concentrations near or at the PQL in the NWBCS effluent, and a small amount of contaminated flow from the Northeast Extension area. Higher water levels likely caused the increase in the OGITS well.	Additional sampling of two NWBCS wells was conducted in fourth quarter of FY14. Changes in NWBCS treatment operation have included more frequent pulsing of higher amounts of regenerated carbon, and use of virgin carbon. No further action besides continued annual monitoring was proposed at OGITS.
5/14/2014	Missed data collection in LTMP well 01312 in FY13.	Missed water level and LNAPL measurement in LTMP water level tracking well 01312 in FY13.	Data were collected in FY14. The RMAED and RMA Water Data sampling program were reviewed for completeness and inclusion of changes to the LTMP (OCNs). Operations and Management Contractor Sampling Manager and RMA Database Manager will be included in future OCN distributions.
7/7/2014	Dieldrin concentration exceeded PQL in NWBCS SWE cross-gradient performance well.	Dieldrin exceeded PQL in NWBCS SWE cross-gradient well 27516 in May 2014. Well is in capture zone, so plume capture was maintained.	Evaluated next quarterly sample in well 27516, which was below the PQL. No further action was needed.
7/7/2014	Shell Trenches water levels exceed dewatering goal.	Shell Trenches water levels exceeded dewatering goal at one of the six compliance boreholes for second consecutive quarter, April 2014.	After the effects of the September 2013 storm event have passed, the water elevations inside the slurry wall should decrease and the dewatering goal will be re-attained. Continued quarterly water level monitoring was proposed.

Table E-1: Summary of Trigger Events/Agency Notifications (Concluded)

Date	Issue	Description	Corrective Action
9/29/2014	Shell Trenches water levels exceed dewatering goal.	Shell Trenches water levels exceeded dewatering goal at one of the six compliance boreholes for third consecutive quarter, July 2014. May 2014 storms caused additional rise in water levels.	After the effects of the September 2013 and May 2014 storm events have passed, the water elevations inside the slurry wall should decrease and the dewatering goal will be re-attained. Continued quarterly water level monitoring was proposed and the status will be reported in the Quarterly Effluent Reports in lieu of notifications.
9/29/2014	Complex Trenches dewatering goal not met by projected LTMP date.	Due to a variety of factors, the dewatering goal in one of the two compliance wells has not been attained. Both long-term and short-term trends (i.e., during the five years since the ICS was completed) show that progress is being made toward meeting the goal in the second compliance well, even with the September 2013 and May 2014 storms.	Continued quarterly water level monitoring was proposed and the status will be reported in the Quarterly Effluent Reports in lieu of notifications.
9/29/2014	Lime Basins dewatering goal not met by projected LTMP date.	Due to a variety of factors, the Lime Basins dewatering goals have not been attained. Monitoring data shows that significant progress is being made toward meeting the goals.	Transitioning the dewatering and treatment operations from batch mode to more continuous operation was implemented.
12/4/2014	Short-term surface water concentrations were above water quality criteria in FY13.	Surface water aquatic life standards were exceeded for copper at one site (North Plants) and copper, manganese, nickel, and zinc were exceeded at a second site (Former Basin E pond) in FY13.	Additional sampling will be conducted in FY15.
4/2/2015	Concentrations of several analytes increased above CSRGs/PQLs in two of the four BANS downgradient performance wells in FY14.	The concentrations of several analytes increased to above the CSRGs/PQLs in two downgradient performance wells (26505 and 35525). The reverse hydraulic gradient was reduced during part of FY14 due to historically high groundwater levels that were caused by the combined effects of the September 2013 and May 2014 storms.	The BANS dewatering well pumping rates were increased in early FY15 to increase the extent and magnitude of the reverse gradient, which has been restored to the historical extent. No further adjustments appear necessary.

Acronyms

ARDL	Applied Research & Development Laboratory
ASR	Annual Summary Report
BANS	Basin A-Neck System
BRES	Bedrock Ridge Extraction System
CADT	Complex (Army) Disposal Trenches
CBSG	Colorado Basic Standard for Groundwater
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act of 1980
CFS	Confined Flow System
COC	Contaminant of Concern
CSRG	Containment System Remediation Goal
CZ	Capture Zone
DAR	Design Analysis Report
DNAPL	Dense Non-Aqueous Phase Liquid
DQO	Data Quality Objective
EPA	Environment Protection Agency
FCS	First Creek Pathway System
FY	Fiscal Year
FYRR	Five-Year Review Report
FYSR	Five-Year Summary Report
GPM	Gallons per Minute
GWMRP	Groundwater Mass Removal Project
IQR	Interquartile Range
LCS	Laboratory Control Spike
LB	Lime Basins Slurry Wall Dewatering System
LNAPL	Light Non-Aqueous Phase Liquid
LT	Less Than (Boolean for values from chemical analysis)
LTMP	Long-Term Monitoring Plan
MGL (mg/L)	Milligrams per Liter
MPS/ICS	Motor Pool System/Irondale Containment System
MRL	Method Reporting Limit
MS	Matrix Spike

MSL	Mean Sea Level
NBCS	North Boundary Containment System
NEE	Northeast Extension
NPS	Northern Pathway System
NWBCS	Northwest Boundary Containment System
OAR	Operational Assessment Report
OCN	Operations and Maintenance Change Notice
OCP	Organochlorine Pesticide
OGITS	Off-Post Groundwater Intercept and Treatment System
OMC	Operations and Maintenance Contractor
PE	Performance Evaluation
PMRMA	Program Manager Rocky Mountain Arsenal
PPEFEF	OGITS Plant Effluent
PPINFC	FCS Plant Influent
PPINNP	NPS Plant Influent
PRAS	Percent of Relative Aqueous Solubility
PQL	Practical Quantitation Limit
QC	Quality Control
QA	Quality Assurance
RAO	Remedial Action Objective
RI/FS	Remedial Investigation/Feasibility Study
RMA	Rocky Mountain Arsenal
RMAED	Rocky Mountain Arsenal Environmental Database
ROD	Record of Decision
RPD	Relative Percent Difference
RS/S	Remediation Scope/Schedule
RTIC	RMA Technical Information Center
RVO	Remediation Venture Office
RYCS	Railyard Containment System
SAP	Sampling and Analysis Plan
SQAPP	Sampling Quality Assurance Project Plan
STF	South Tank Farm
SWE	Southwest Extension

TCHD	Tri-County Health Department
UFS	Unconfined Flow System
UGL (µg/L)	Micrograms per Liter
UV	Ultraviolet
VOC	Volatile Organic Compound

(Note: All chemical codes are listed in Appendix L.)

This page intentionally left blank.

1.0 Introduction

1.1 Report Purpose

This fiscal year 2014 (FY14) Annual Summary Report (ASR) for Groundwater and Surface Water includes an evaluation of collected data against the performance criteria and compliance requirements for the operating systems, treatment systems, and site-wide water-table maps as well as data reporting for any site-wide monitoring conducted within FY14, project-specific monitoring, and any Consultative Process notification. This report has been prepared to document and evaluate monitoring data collected at Rocky Mountain Arsenal (RMA) for the period October 2013 through September 2014 (first, second, third, and fourth quarters FY14) for the following systems: the Northwest Boundary Containment System (NWBCS); the North Boundary Containment System (NBCS); the Off-Post Groundwater Intercept and Treatment System (OGITS); the Basin A Neck System (BANS), the Complex Army Disposal Trenches (CADT), the Bedrock Ridge Extraction System (BRES), and the Lime Basins Slurry Wall Dewatering System and Dense Non-Aqueous Phase Liquid (DNAPL) Remediation Project (LB); the Irondale/ Railyard Containment System (RYCS), Shell Trenches, and North Plants Light Non-Aqueous Phase Liquid (LNAPL) Pilot Recovery Action. Also included in this ASR are annual data summaries for all long-term site-wide, Long-Term Monitoring Programs (LTMPs) during years when monitoring is conducted. In FY14, the site-wide programs where monitoring was conducted included: Water Level Tracking, Water Quality Tracking, Confined Flow System (CFS), Off-post CSRG Exceedance, Tri-County Health Department (TCHD) off-post private well sampling, and the site-wide water-table map. Surface water sampling of two off-post First Creek sites at the north fence line and at Highway 2 and one on-post First Creek site was conducted. Annual data summaries for any on-going shut-off monitoring programs are also included in the ASRs. Post-shut-off monitoring for the Groundwater Mass Removal Project (GWMRP) in the South Tank Farm (STF) area and for the Motor Pool/Irondale Containment System (MPS/ICS) was conducted in FY14. All water level measurements and water quality analyses for FY14 are on the attached data CD.

1.2 Treatment Systems Operations and Monitoring Overview

1.2.1 Selected Groundwater Remedy

The selected groundwater remedies from the On-post and Off-post Records of Decision (RODs) include the operation of all groundwater intercept and treatment systems and on-post groundwater Interim Removal Action systems, installation of a new extraction system at the Bedrock Ridge, and an extended monitoring program.

1.2.2 Sources of Contamination

Contaminants were introduced into the RMA environment beginning in the early 1940s by disposal of liquid waste in open basins, solid waste burial in trenches, accidental spills of feedstock and product chemicals, leakage from sewer and process water systems, emissions from air stacks, and use of commercial chemical products during normal facility operation. The most highly contaminated sites are located at South Plants, Basins A and F, and the Army and Shell disposal trenches in Section 36. Other contaminated sites include storage areas, maintenance areas, and sewer lines. Over time contaminants have migrated from the soil and sediments to groundwater at RMA.

1.2.3 Overview of Treatment Systems CSRG Water Quality Monitoring

The treatment systems were operated to maintain the concentrations of the Containment System Remediation Goal (CSRG) analytes in the effluent below their respective regulatory requirements. Effluent samples were collected from the treatment plants and analyzed for CSRG analytes and other analytes using Environmental Protection Agency (EPA) and Program Manager for Rocky Mountain

Arsenal (PMRMA) methods specified in the Sampling and Analysis Plan (SAP) for each treatment system. Results are reported in the "RMA Treatment Plant Effluent Water Quality Data Report – Fourth Quarter FY14" (February, 2015), document number 00056998 available from the RMA Technical Information Center (RTIC). The effluent reports are published quarterly by the Army/Shell. A pdf of the effluent report is available on the attached data CD.

The CSRGs in this FY14 ASR for Groundwater and Surface water are those identified in the On-Post ROD (Foster Wheeler Environmental Corporation, 1996), the Off-Post ROD (Harding Lawson Associates 1995), the Remediation Scope and Schedule (Harding Lawson Associates 1996), and subsequent modifications documented in Explanation of Significant Difference reports, and Five-Year Review reports (FYRRs). The Practical Quantitation Limits (PQLs) in this FY14 report are those readily available from a certified commercial laboratory. The PQLs for aldrin, dieldrin, and n-nitrosodimethylamine (NNDMEA) were developed during a site-specific PQL study, which became effective in April 2012.

An overview of CSRG-analyte sampling results from performance wells and operational wells for all the systems, and extraction wells for OGITS and BANS are shown in the following summary tables: Table 3 (for NWBCS wells), Table 4 (for NBCS wells), Table 5 (for RYCS wells), Table 7 (for BANS/CADT/BRES wells), Table 12 (for OGITS First Creek Pathway wells), Table 13 (for OGITS Northern Pathway performance wells), Table 14 (for OGITS Northern Pathway Operational wells), and Table 15 (for OGITS Northern Pathway Extraction wells). Project-specific tables also are included in Table 1 below.

Table 1. Overview of Treatment System/Project Tables for FY14

Table Number	Treatment System/Project
2 (page 3)	Treatment Systems Statistics for FY14
3 (page 19)	Overview of FY14 CSRG Analyte Sampling for NWBCS Performance and Operational Wells
4 (page 26)	Overview of FY14 CSRG Analyte Sampling from NBCS Performance and Operational Wells
5 (page 30)	Overview of FY14 CSRG Analyte Sampling from Railyard Performance and Operational Wells
6 (page 33)	FY14 BANS Estimated Contaminated Flow Rate, Mass Flux, and Mass Removed
7 (page 39)	Overview of FY14 CSRG Analyte Sampling from BANS/CADT/BRES Performance and Operational Wells
8 (page 43)	Shell Trenches Boring Water Levels and Trench Bottom Elevations
9 (page 46)	Lime Basins DNAPL Remediation Project. FY14 DNAPL Thickness, Percent of Relative Aqueous Solubility (PRAS), and DNAPL Removal
10 (page 51)	Groundwater Mass Removal Project Post-Shut-Off Benzene Results
11 (page 64)	FY14 OGITS Estimated Contaminated Flow Rate, Mass Flux, and Mass Removed
12 (page 69)	Overview of FY14 CSRG Analyte Sampling from OGITS First Creek Pathway Performance and Operational Wells
13 (page 71)	Overview of FY14 CSRG Analyte Sampling from OGITS Northern Pathway Performance Wells
14 (page 72)	Overview of FY14 CSRG Analyte Sampling from OGITS Northern Pathway Operational Wells
15 (page 73)	Overview of FY14 CSRG Analyte Sampling from OGITS Northern Pathway Extraction Wells

The overview tables list all the CSRG analytes for each system. A plus sign (+) within a table cell indicates that a reported concentration was equal to or higher than the CSRG or PQL for a specific

analyte in a specific well. Blank cells indicate that reported concentrations for the well samples were lower than the CSRG or PQL for the respective analytes. A shaded cell indicates that the water from that well was not sampled, not analyzed for that specific analyte in FY14, or the analysis was not usable.

Selected CSRG-analyte concentrations in the treatment plants and in upgradient and downgradient monitoring wells are plotted on graphs for all systems (see Appendices A through G). The graphs for the treatment plants are arranged so that the influent concentrations are plotted above the effluent concentrations, showing the amount of reduction in contaminant concentrations. The graphs for the performance wells are arranged so that the upgradient well concentrations are plotted above the downgradient well concentrations, and show the distribution of analyte concentrations along the line of upgradient and downgradient performance wells for each system. The four-quarter moving averages of all treatment plant effluent compliance samples collected during FY14 met the CSRGs or PQLs designated for each treatment plant. The inorganic standards for chloride and sulfate at OGITS are expected to be met by attenuation, consistent with the on-post remedial action. However, the four-quarter moving averages for chloride and sulfate were met for NBCS and OGITS during FY14.

1.2.4 Treatment Systems Statistics for FY14

System downtime, downtime attributable to equipment failures and maintenance, downtime attributable to power failure, the average annual flow rate, total treated volume, total mass of contaminants removed, major contaminants removed, carbon usage for all systems, and cost of operation are listed in Table 2.

Table 2. Treatment Systems Statistics for FY14

Category	NWBCS	NBCS	OGITS	BANS/CADT/ BRES/LB	RYCS
Total Downtime:	79.75 hours	142.00 hours	0.00 hours	146.50 hours	291.00 hours
Downtime attributable to maintenance, equipment failure, or other events:	2.00 hours	28.75 hours	0.00 hours	28.25 hours	290.00 hours
Downtime attributable to power failure:	77.75 hours	113.25 hours	0.00 hours	118.25 hours	1.00 hour
Average flow rate measured in gallons per minute (gpm) and total volume treated (gallons):	924.0 gpm 485,650,266	216.3 gpm 114,570,012	204.8 gpm* 107,663,904*	17.3 gpm 9,099,741	113.6 gpm 59,786,431
Total mass of contaminants removed:	3.5 lbs	7.0 lbs	5.9 lbs*	242.7 lbs	0.007 lbs
Major contaminants # removed (lbs):	CHCL3 2.4 DLDRN 0.9 ENDRNK 0.1	DIMP 2.6 CPMSO 1.4 CHCL3 0.6 TCLEE 0.5 DCPD 0.5 CCL4 0.3 DLDRN 0.3 ENDRN 0.2 TRCLE 0.1	DIMP 5.3* CHCL3 0.2* TCLEE 0.2* MEC6H5 0.1* DCPD 0.1*	CHCL3 124.6 TRCLE 44.0 DIMP 31.6 TCLEE 10.4 DITH 6.2 ACET 4.9 CPMSO2 4.8 TCLEA 3.7 12DCE 2.4 CH2CL2 2.3 12DCLP 1.8 CLC6H5 1.0 CPMSO 0.9	DBCP 0.007
Carbon Usage :	54,300 lbs	40,000 lbs	40,000 lbs	11,100 lbs	2,200 lbs
Cost of Operation:	$563,189	$479,448	$615,507	$584,620	$105,962

Notes: * Flow testing of the FCS and NPS was conducted in FY14 to calibrate the flow meters used to provide the OGITS flow rate, treated volume, and contaminant removal data. The corrected FY14 OGITS average flow rate is estimated to be 204.8 gpm, and the volume treated and contaminant removal values were revised accordingly. # Refer to Appendix L for listing of contaminant names.

1.2.5 Treatment Systems Off-Site Waste Shipment Summary

During FY14, the following wastes from water treatment systems were shipped off-site for disposal, or as otherwise noted.

- 309,400 pounds of wet spent carbon shipped to Evoqua Water Technologies (formerly Siemens Water Technologies) in Darlington, Pennsylvania for regeneration.

- Various containers (approximately 3,713 pounds) of water treatment systems' waste materials (e.g., spent carbon filters, personal protective equipment, poly-piping, and debris) shipped to Clean Harbors Environmental Services in Kimball, Nebraska for incineration.

- Ten drums of well development sludge shipped to Clean Harbors Environmental Services in Kimball, Nebraska for incineration.

- Two containers of DNAPL waste from the Section 36 Lime Basins DNAPL Remediation Project shipped to Clean Harbors Environmental Services in El Dorado, Arkansas for incineration.

- Various labpack wastes (approximately 143 pounds) shipped to Clean Harbors Environmental Services in Kimball, Nebraska and El Dorado, Arkansas for incineration.

1.2.6 Systems Modifications

No system modifications were made in FY14.

1.3 Site-Wide Monitoring Programs Overview

The site-wide monitoring program categories presented in the 2010 LTMP (TtEC and URS 2010) are shown below.

- Water Level Tracking: On-post water level monitoring used to track the effects of the soil remedy to groundwater in the On-Post Operable Unit.

- Water Quality Tracking: On-post water quality monitoring of indicator analytes is conducted to track contaminant migration in and downgradient of source areas within the identified plumes.

- Confined Flow System Monitoring: Monitoring as required by the On-Post ROD requirement to monitor water quality in the confined aquifer in three areas: Basin A, South Plants, and Basin F.

- Exceedance Monitoring: Long-term water quality monitoring of off-post groundwater to assess contaminant concentration reduction and remedy performance and to create a groundwater CSRG exceedance area map twice-in-five years to support well permit institutional controls.

- Off-Post Water Level Monitoring: Off-post water level monitoring conducted in support of the exceedance monitoring to assess flow paths and contaminant migration in the exceedance areas. The off-post water level monitoring category is separate from water level tracking category because it serves a different purpose.

- Surface Water Monitoring: Off-post and on-post surface water monitoring to assess changes in surface water quality related to the RMA remedy. ROD-related surface water monitoring was added to the 2010 LTMP. Surface water monitoring will continue off-post, but long-term monitoring will be discontinued on-post based on completion of the soil remedy. The Remediation Venture Office (RVO) prepared a Surface Water Monitoring Report to evaluate post-ROD surface water monitoring data and future data needs. On-post short-term surface water monitoring will be conducted while the cover vegetation is established to assess the impacts of the covers on surface water quality.

1.3.1 Water Level Network

Water levels in FY14 were measured in the on-post water-level network and the off-post water level monitoring network in order to draw the site-wide FY14 water-table map (Figure H-1 in Appendix H).

1.3.2 Water Quality Tracking

The water quality tracking well network is sampled on-post once every five years or twice every five years in conjunction with water level tracking, to track contamination in and downgradient of source areas within the identified plumes. Water quality tracking is divided into two subgroups: source monitoring (monitored once-in-five years) and monitoring downgradient of sources (monitored twice-in-five years). Source monitoring is identified as a separate component of water quality tracking because of the On-Post ROD requirement for groundwater monitoring in source areas where human health exceedance soils are left in place. Monitoring downgradient of sources pertains to sources where human health exceedance soils are left in place and other sources. The water quality tracking well network was sampled in FY14 (Figure H-2 in Appendix H). The next Water Quality Tracking sampling is scheduled for FY17.

1.3.3 Confined Flow System Monitoring

Based on the low potential for contaminant migration within the CFS and very slow groundwater flow rates within the CFS, the monitoring frequency is twice-in-five years. The CFS monitoring well network was sampled in FY14 (Figure H-3 in Appendix H). The next CFS sampling is scheduled for FY17.

1.3.4 Off-Post Exceedance Monitoring

The off–post exceedance well network was sampled in FY14. The next off-post exceedance sampling is scheduled for FY17.

Off-post water quality monitoring is conducted to assess contaminant concentration reduction and remedy performance, and to support the Institutional Controls component of the off-post remedy. The Off-Post ROD (HLA 1995) states,

"The preferred alternative includes long-term monitoring of off-post groundwater and surface water to assess contaminant concentration reduction and remedy performance. Groundwater monitoring will continue utilizing both monitoring wells and private drinking water wells."

The Off-Post Remediation Scope/Schedule (RS/S) added that the purpose of the off-post regional monitoring program is to provide data to:

(1) Assist in the assessment of the effectiveness of the remedy,
(2) assist in the assessment of contaminant concentration reduction,
(3) prepare the CSRG exceedance area map, and
(4) assist in the assessment of groundwater flow direction and hydraulic gradient.

This is accomplished by monitoring water quality in a network of off-post monitoring wells and private wells. The off-post component of the regional monitoring category in the RS/S is now called Exceedance Monitoring in the 2010 LTMP. Exceedance monitoring wells, which were sampled in FY14, have a sampling frequency of twice-in-five years.

1.3.5 Surface Water Monitoring

Surface water monitoring programs are conducted at RMA in order to meet the ROD requirements for surface water monitoring. Long-term on-post surface water monitoring was conducted through 2009. A monitoring report was prepared to evaluate the post-ROD on-post and off-post data and evaluate future data needs (URS 2013). A SAP was issued to address the future data needs. Off-Post surface water monitoring, not including storm event monitoring, will continue to be conducted in accordance with the Remedial Action Objectives (RAOs) for surface water presented in the Off-Post ROD.

An on-post short-term surface water sampling program was implemented in FY12 and continued in FY13 to confirm that surface water quality is not adversely impacted by cover soils during the establishment of cover vegetation and that groundwater plumes are not migrating into the lakes. The surface water sampling locations are shown on Figure H-4 (Appendix H). The seven sites were not sampled in FY14, but follow-up sampling of selected sites will be conducted in FY15 as conditions allow.

Two LTMP First Creek sites, one at RMA's north boundary fence line and the other off-post at Highway 2, are sampled annually (Figure H-4 in Appendix H). One on-post upstream First Creek site was added in FY13. Surface water samples from these sites were collected in FY14 and the results are discussed in Section 3.2.2.

1.4 Overview of Pre-Shut-Off, Shut-Off, and Post-Shut-Off Monitoring

In FY14, pre-shut-off monitoring was conducted for the RYCS, and post-shut-off monitoring was conducted for the GWMRP in the STF area and for the MPS/ICS. Results are reported in Sections 2.1.3 and 2.2 on pages 27 and 50, respectively.

1.5 Quality Assurance Summary

The data evaluated in this report were collected in accordance with the 2010 LTMP, the RMA Sampling Quality Assurance Project Plan (SQAPP) (Navarro 2014) and the following SAPs:

- RYCS Pre-Shut-Off Monitoring SAP
- GWMRP Post-Shut-Off Monitoring SAP
- MPS/ICS Post-Shut-Off Monitoring SAP
- LTMP Surface Water Monitoring SAP

Data review was limited to the respective CSRGs or LTMP analytes for each system or monitoring category. Diisopropylmethyl phosphonate (DIMP) is not a BANS CSRG analyte but is included in the

BANS review as DIMP values are utilized in the BANS mass balance calculations. Individual data summary reports for treatment systems or monitoring categories addressed in this ASR were not prepared in FY14.

The purpose of the data review is to evaluate data quality with respect to the established Data Quality Objectives (DQOs). Components of the data review process include; evaluating the data against the data quality indicators of precision, accuracy/bias, representativeness, sensitivity, completeness, and comparability; review of field and laboratory quality control (QC) results; and evaluating the data for suitability based on the intended use. Data was reviewed according to the procedures specified in the SQAPP. The data review has determined that the data quality meets or exceeds the established DQOs and is of the correct type, quality, and quantity to support the intended use. The data review parameters and results are discussed below.

1.5.1 Precision

Results of laboratory duplicates and field duplicates will be used to calculate precision. Note that laboratory duplicates are collected by the laboratory and analyzed for inorganics only. The precision criteria for individual analytes will be determined using the Relative Percent Difference (RPD) values calculated from data where both the investigative sample and the duplicate sample are above the Method Reporting Limit (MRL). If one or both results are rejected or not analyzed, there will be no comparison of results. Duplicate samples determined to be not comparable will be subject to data qualification. The default performance criteria for analytes without detections above the MRL will be a RPD value of less than or equal to 30 percent. The formula for calculating RPD is:

RPD (%) = (difference between concentrations)/(average of concentrations)* 100

Where:

difference between concentrations = investigative value – duplicate value
average of concentrations = (investigative value + duplicate value)/2

The performance criteria for analytes with detections above the MRL will be calculated from historical RPD values for each location-specific analyte. The data utilized for the historical RPD value calculations will be limited to data values from the analytical methods used for analysis of samples data values from historical analytical methods with similar MRLs. The analytical data utilized to calculate limits for individual analytes is included in the Data History subfolder on the attached data CD.

For each location/analyte with a regulatory standard, the median, 25th percentile, and 75th percentile RPD value is calculated. The interquartile range (IQR) for each analyte is calculated by subtracting the 25th percentile value from the 75th percentile value. The acceptance, or upper, RPD limit is determined by adding 1.5 times the IQR to the median RPD value. The RPD evaluation limits are included in Appendix I (Table I-1).

The investigative and duplicate results will be considered comparable if any of the following statements are true:

- If both sample results are less than the MRL.
- If both sample results are greater than the MRL; but less than or equal to twice the MRL.

- If both sample results are greater than twice the MRL and the RPD is less than or equal to the specified upper RPD limit.

- If both sample results are greater than the MRL; one result is less than or equal to twice the MRL; one result is greater than twice the MRL; and the RPD is less than or equal to the specified upper limit.

- If one sample result is less than the MRL; and one result is greater than the MRL and less than or equal to twice the MRL.

The investigative and duplicate results will be considered not comparable if any of the following statements are true:

- If both sample results are greater than twice the MRL and the RPD is greater than the specified upper RPD limit.

- If both sample results are greater than the MRL; one result is less than or equal to twice the MRL; one result is greater than twice the MRL; and the RPD is greater than the specified upper limit.

- If one sample result is less than the MRL; and one result is greater than twice the MRL.

A total of 673 duplicate analyses were performed. The duplicate and investigative samples were above the MRL in 269 of the analyses. The RPD was only calculated for those analyses where the duplicate and investigative sample values were above the MRL.

The average RPD for the 269 analyses was 9.2 percent. A total of 37 investigative/duplicate pairs were not considered comparable. No discernible trends or QC issues were observed in the not comparable pairs. The non-comparable investigative and duplicate data will be assigned a "Z" data qualifier with the comment "Duplicate and investigative values are not comparable". The data are considered acceptable for their intended use and no additional action in addition to the data qualification is considered necessary. The duplicate pairs determined to be comparable and not comparable are included in Appendix I (Table I-2 and Table I-3, respectively).

1.5.2 Accuracy/Bias

Accuracy is the degree of agreement between an observed value (sample result) and an accepted reference value. Bias is the systematic or persistent distortion of a measurement process that causes errors in one direction (high or low). The terms accuracy and bias are used interchangeably. Accuracy/bias is indicated by percent recovery calculated from laboratory spike data using the following formula:

Recovery Rate (%) = (measured value/true value) * 100

Where:

measured value = the value after the spike – the value before the spike
true value = the value of the spike added

Accuracy/bias will be calculated based on results of laboratory control spikes (LCS) and matrix spikes (MS). Laboratory control spikes utilize laboratory grade water with some additions of inorganic constituents to mimic RMA water. Matrix spikes utilize RMA water to account for matrix-related interferences.

The calculated recovery rate is compared to the lower and upper recovery rate limits specific to each analyte. The median, 25th percentile, and 75th percentile for each analyte are calculated. The ICR is calculated by subtracting the 25th percentile value from the 75th percentile value. The lower and upper recovery limits are determined respectively by subtracting and adding 1.5 times the IQR to the median value. Data will not be qualified solely on a recovery rate outside the calculated recovery limits. Additional factors must be present in order for the data qualification. The recovery evaluation limits for MSs and LCSs are listed in Appendix I (Table I-4).

The data utilized for the historical recovery rate calculations was limited to the spike values for the analytical lots of the investigative data included on the attached data CD (Data_History_FY2005_ thru_FY2014.xlsx). Spikes associated with highly contaminated sites are excluded from the calculation since the MS could possibly be diluted out due to the high original concentration. The spike recoveries used in the calculations are also included on the attached data CD (Matrix Spike Recovery Rate Limit Calculations.xlsx and Laboratory Control Spike Recovery Rate Limit Calculations.xlsx).

The average recovery rate for the 1,109 MS analyses was 88.9 percent. Spikes associated with highly contaminated sites at BANS were excluded from the calculation since the MS could possibly be diluted out due to the high original concentration. Analyses with an @ flag code (value is estimated) or “B” flag code (analyte found in the method blank or QC blank as well as the sample) were also excluded from recovery rate calculations. Recovery rates outside the lower or upper limits were observed in 58 analyses; 28 were below the lower limit and 30 were above the upper limit. A listing of the MS sample results outside the evaluation limits is included in Appendix I (Table I-5).

The average recovery rate for the 1,292 LCS analyses was 95.3 percent. Recovery rates outside the lower or upper limits were observed in 110 analyses. The LCS recovery rates outside the evaluation limits are included in Appendix I (Table I-5).

The percent recoveries were outside the evaluation limits for both the MS and LCS analyses for six analytical lots identified in Appendix I (Table I-6). Additional action was necessary for two analytical lots; ABUT and ACES.

Lot ABUT (DIMP) was recommended for rejection by the laboratory. The affected samples were re-collected within approximately 30 days from the original sample date. Based on the laboratory recommendation, Lot ABUT will be placed in the Rejected table of the Rocky Mountain Arsenal Environmental Database (RMAED).

The analyst noted low surrogate recoveries associated with Lot ACES (DIMP) for samples collected from well 23095 and the MS for the lot. Based on the analyst’s comments, the affected samples will be qualified with a “Z” flag indicating low surrogate recoveries.

The remaining data are considered acceptable for their intended use and no additional action is considered necessary. The Spike Recovery Summary Table in Appendix I (Table I-7) lists the number of spikes as well as the minimum, average, and maximum percent recoveries for spike analyses.

The Performance Evaluation (PE) program was conducted as specified in the SQAPP. PE samples were submitted in November 2013, March 2014, June 2014, and September 2014. A review of the November 2013 PE program data found the Volatile Organic Compounds (VOCs) and DIMP methods are performing in an acceptable manner. The Organochlorine Pesticides (OCPs) did not perform in an acceptable manner initially; however an additional sample was subsequently submitted and found to have acceptable results. The March 2014 PE program data found the VOCs and DIMP methods are performing acceptably. The OCPs performed acceptably, however there is some concern regarding the reported concentrations for dichlorodiphenyldichloroethane (PPDDD) and endrin ketone (ENDRNK). The June 2014 and September 2014 PE program data found the OCPs, VOCs, and DIMP methods were performing in an acceptable manner. PE program reports and spreadsheets are included on the attached data CD. The PE program indicated the data are acceptable for their intended use.

1.5.3 Representativeness

Representativeness is a qualitative term achieved by evaluating whether measurements were made and samples were collected in a manner that the resulting data appropriately reflects the sampling unit. The performance criterion is a positive evaluation of representativeness. A review of field and laboratory documentation determined that samples were collected and analyzed as specified for each system or category. Field instruments utilized to collect field measurements were calibrated according to the respective instrument manual and recorded in the Groundwater Sampling Calibration Record database. As a result, the data appropriately reflects the operation of the RMA treatment systems.

1.5.4 Completeness

Completeness is the measure of the amount of valid data obtained from a measurement system; it is expressed as a percentage of the number of valid measurements compared to the total number of measurements planned in the DQOs. Completeness is calculated using the following formula:

Completeness (%) = (amount of valid data / amount of valid data expected) * 100

Completeness was calculated at 99.94 percent. Completeness calculations of greater than or equal to 90 percent are acceptable. The criterion for the completeness calculation to exceed 90 percent was achieved. Rejected analyses include the DIMP Lot ABUT discussed in Section 1.5.2 and the arsenic analysis from the OGITS plant effluent (PPEFEF) collected on January 8, 2014. The sample was rejected due to arsenic contamination in the sample container. The source of the contamination is unknown. The rejected analyses are included in Appendix I (Table I-8).

1.5.5 Comparability

Comparability is a qualitative term achieved by using standard techniques to collect and analyze representative samples and reporting data in appropriate units. Standard techniques as identified in the respective SAPs were utilized to collect and analyze samples and the data was reported in the appropriate units. The analytical results reported are equivalent to data obtained from similar analyses and the MRLs met the project goals.

1.5.6 Sensitivity

Sensitivity is the ability of the method or instrument to detect the target analytes at the level of interest. The performance criterion for sensitivity will be no analyte detections above the MRL in the laboratory method blank. Analytical lots with method blank detections of target analytes exceeding the MRL may be qualified.

Method blank samples are analyzed for each analytical lot. A total of 3,064 method blanks consisting of laboratory water were analyzed for LTMP analytes in conjunction with each analytical lot. There was a single method blank detection of NNDMEA above the MRL. The investigative sample analyses for the analytical lot ACME associated with the NNDMEA method blank detection were qualified with a "B" flag indicating the analyte was found in the method blank or QC blank as well as the sample. The investigative sample analysis above the MRL for the analytical lot ACKF associated with the NNDMEA method blank detection was also qualified with a "B" flag. The other investigative analysis in lot ACKF was less than the MRL so data qualification based on the method blank detection is not required. Information for the two method blanks above the MRL is included in Appendix I (Table I-9).

1.5.7 Field and Quality Control Samples

Field QC samples collected include trip blanks, field blanks, rinse blanks, and duplicate samples. Duplicate sample results are discussed in Section 1.5.1. Laboratory QC samples include lab duplicates and method blanks in addition to the MS and LCS samples previously discussed. A total of 7,780 field and LCS analyses were performed. A field QC data summary table is shown below.

FY14 Field Quality Control Data Summary

Category	Location	Total Number of Analyses	Number of Analyses above the MRL	Percent of Analyses Above the MRL
TRIP BLANKS	BANS	234	0	0.0%
	CFS	3	0	0.0%
	EXCEEDANCE	52	0	0.0%
	GWMR	0	0	0.0%
	MPS/ICS	0	0	0.0%
	NBCS	130	0	0.0%
	NWBCS	22	0	0.0%
	OGITS	317	1	0.3%
	WATER QUALITY TRACKING	13	0	0.0%
	TOTAL	**771**	**1**	**0.1%**
FIELD BLANKS	BANS	26	0	0.0%
	CFS	2	0	0.0%
	EXCEEDANCE	18	0	0.0%
	GWMR	0	0	0.0%
	MPS/ICS	0	0	0.0%
	NBCS	30	0	0.0%
	NWBCS	15	1	6.7%
	OGITS	63	0	0.0%
	LTMP SURFACE WATER	6	0	0.0%
	WATER QUALITY TRACKING	15	0	0.0%
	TOTAL	**175**	**1**	**0.6%**

FY14 Field Quality Control Data Summary (Concluded)

Category	Location	Total Number of Analyses	Number of Analyses above the MRL	Percent of Analyses Above the MRL
RINSE BLANKS	BANS	9	0	0.0%
	CFS	3	0	0.0%
	EXCEEDANCE	55	2	3.6%
	GWMR	0	0	0.0%
	MPS/ICS	1	0	0.0%
	NBCS	60	3	5.0%
	NWBCS	29	0	0.0%
	OGITS	59	0	0.0%
	WATER QUALITY TRACKING	28	3	10.7%
	TOTAL	**247**	**8**	**3.2%**

QC samples with values exceeding the MRL are evaluated according to the following criteria:

- If the associated investigative sample value is less than the MRL, then no action is required.
- If the associated investigative sample value is greater than the blank value, then no action is required.
- If the associated investigative sample value is less than the blank value, then validation of the analytical lot is requested.

Field blanks are collected to determine if cross-contamination exists from ambient sources, such as engine exhaust or dust. In certain instances, field blanks may also be used as an indicator of contamination in the sample containers or the deionized water used to decontaminate sample equipment and collect field QC samples. A total of 175 field blank analyses were performed with a single NNDMEA analysis above the MRL. No additional action is required as the associated investigative sample value is less than the MRL.

Trip blanks were collected during each sampling episode to determine the effects of storage, shipping, and ambient conditions on water quality samples. A total of 771 trip blank analyses were performed with a single toluene analysis result above the MRL. No additional action is required as the associated investigative sample value is less than the MRL.

Rinse blanks were collected to determine if the sampling equipment decontamination procedures are effective, thus preventing cross-contamination of samples and/or wells. A total of 247 rinse blank analyses were performed with eight results above the MRL. No qualification of the data is required as the rinse blank values are less than the investigative sample values or the associated investigative sample value is less than the MRL.

1.5.8 Data Usability Evaluation

The data usability determination evaluates data quality with respect to the established data quality objectives. Components of the data review process include; evaluating the data against the data quality indicators of precision, accuracy/bias, representativeness, completeness, comparability, and sensitivity; review of field and laboratory quality control (QC) results; data verification and validation results; and evaluating the data for suitability based on the intended use. Data was evaluated as specified in the RMA SQAPP (Navarro 2014).

Data verification was performed by the RMA Data Management Contractor (DPRA, Inc.) as described in the SQAPP. Data verification was performed on all data prior to final submittal to the RMAED. Issues identified by the data verification process are addressed prior to the final submittal of the data into the RMAED. Data verification results are included in the attached data CD in the Data Usability subfolder (see filename: Data_Verifaction_Summary_2014.xlsx).

Data validation was performed on selected lots by the Operations and Maintenance Contractor (OMC) Chemist. Validation was performed as specified in the SQAPP. Data validation was performed on 97 analytical lots (20.3 percent of the total number of analytical lots). Issues identified during the data validation process are noted in the validation summaries found in the attached data CD in the Data Validation Reports subfolder.

The suitability evaluation was conducted for only the CSRG or LTMP analytes specific to the sample location. In addition to the components specified above, the data was evaluated for potential outliers and trends. Data was evaluated using the EPA software *ProUCL Version 5.0.00 Statistical Software for Environmental Applications for Data Sets with and without Nondetect Observations*, September 2013. The specifications for the data review include:

- Preparation of a box plot of the current data in addition to historical data with the same or similar MRLs.
- Conduct an outlier test to evaluate the data for potential outliers using the Dixon (fewer than 25 values) or the Rosner (greater than or equal to 25 values) test. An assumption for the use of either outlier test is that the data be from a normal or lognormal distribution.
- Conduct the Mann-Kendall test to evaluate the data for trends.
- Identify compliance samples exceeding the CSRG.

A data usability evaluation was conducted on 4,808 records. An evaluation was not performed on treatment plant process control samples as this data is closely tracked throughout the fiscal year. The spreadsheets with the data usability evaluation results are included in the attached data CD in the Data Usability subfolder.

The data usability evaluation identified 33 analyses as statistical outliers. Eighteen analyses were qualified “Z” in the RMAED with the associated comment identifying it as a statistical outlier. The remaining 2014 data identified as statistical outliers were not qualified. A listing of the all analytes identified as outliers and the justification related to data qualification is included in Appendix I (Table I-13).

The Mann-Kendall test for trends identified 292 decreasing location/analyte trends and 85 increasing location/analyte trends. No data quality issues were found with the identified trends. A listing of the identified trends is included in Appendix I (Table I-14).

The data usability evaluation did not positively identify data quality issues, thus the data is considered to be of acceptable quality and meets or exceeds the established DQOs. The data is of the correct type, quality, and quantity to support the intended use.

1.6 Report Organization

This report is the fifth annual assessment report that summarizes annual site-wide and treatment systems groundwater monitoring, project-specific monitoring, and surface-water monitoring. This report includes operational and effluent information used to determine if the systems are operating as intended. The data are presented in a summary format.

As previously mentioned in Section 1.1, the following treatment systems are included in this report: NWBCS, NBCS, OGITS, BANS, CADT, BRES, LB, and RYCS. A detailed description of each treatment system can be found in their respective annual Operational Assessment Reports (OARs) published for FY85 to FY01 and in the SQAPP (Navarro 2014). Summary OARs were completed between 2002 and 2009. These publications are available in the RTIC from the PMRMA. Also included in this report are the Shell Trenches (which is a system that has a slurry wall but no extraction wells), the GWMRP post-shut-off monitoring, the North Plants LNAPL monitoring, and site-wide monitoring programs.

Section 2 (beginning on page 15) and Section 3 (beginning on page 59) assess on-post and off-post system performance, respectively, using criteria listed in the 2010 LTMP. Performance criteria such as reverse gradients across a slurry wall, direction of groundwater flow, CSRG-analyte concentrations and trends, and other information are discussed in Sections 2 and 3. The FY14 Treatment Plant Quarterly Effluent Reports, published quarterly by PMRMA, contain summary tables and averages of effluent water quality data from all the treatment systems, and are available from the RTIC. The fourth quarter effluent report includes effluent water quality data for all quarters for FY14. The FY14 effluent report is in the attached data CD.

This report was prepared by Mr. Robert Charles, Mr. Wade Thornburg, Ms. Nicole Luke, and Dr. George Chadwick from Navarro Research and Engineering. Project management was provided by Mr. Tony LaChance (Navarro) and Mr. Scott Ache (Navarro). Navarro acknowledges the support and assistance of Mr. Bruce Fritz, Mr. Josh Thompson, and Ms. Susan Walden (DPRA, Incorporated).

2.0 On-Post Operations Monitoring Programs

2.1 On-Post Containment and Mass Removal System Evaluation

Performance monitoring is conducted in wells upgradient and downgradient of the containment and mass removal systems to evaluate system performance against established performance criteria and objectives. The performance criteria are specific to each system and depend on the location of the system and whether it is a containment or mass removal system. Depending on the criteria, performance monitoring includes water quality monitoring for all systems and in most cases water level monitoring. In some cases operational wells are included in the performance monitoring networks as well, thereby serving a dual purpose.

Operational water level and/or water quality monitoring is conducted by the OMC in extraction, recharge, and monitoring wells located near the containment or mass removal systems. Operational water quality monitoring is also conducted for the system influent and at sampling points within the system. Operational monitoring is conducted to:

- optimize system performance, and
- ensure that RAOs are achieved.

Most of the wells are used for water level monitoring to ensure proper extraction and recharge system operation; selected wells are also used for water quality monitoring of indicator analytes. These monitoring data are used to evaluate and adjust the system to ensure optimal operation for containment, capture, and treatment. As operating conditions change, the operational monitoring program may also change. Therefore, the operational monitoring program is flexible with respect to monitoring locations, frequencies, and chemical analyses, and may be modified independently from the 2010 LTMP.

2.1.1 Northwest Boundary Containment System (NWBCS)

The NWBCS treatment facility consists of a groundwater extraction system, monitoring wells, pre-filtration, carbon adsorption, post-filtration and a groundwater recharge system. The NWBCS was designed to intercept contaminated groundwater from the upgradient side of the soil-bentonite barrier, treat it to remove the organic contaminants, and inject the treated water back into the alluvial aquifer on the downgradient side of the barrier. The NWBCS Original System was constructed in 1984.

Additional modifications to the NWBCS include the addition of the Northeast Extension constructed in 1990 to intercept a small flow in an alluvial channel and the Southwest Extension extraction and recharge system in 1991 to extract groundwater from the dieldrin plume originating in Section 2 on the RMA.

The results from CSRG-analyte sampling and water level monitoring at NWBCS performance and operations wells are shown in Table 3 on page 19 and in Appendix A, and on the attached data CD.

2.1.1.1 Operations

The NWBCS operated at an average flow rate of 924 gpm, pumping a volume of 485,650,266 gallons during FY14 (see Table 2 on page 3). Figure A-8 in Appendix A shows the NWBCS monitoring wells, extraction and recharge wells, the slurry wall at the original and northeast extension systems, and the wells at the southwest extension.

The distribution of chloroform and dieldrin in performance wells upgradient and downgradient of the NWBCS is shown in Figures A-6 and A-7, respectively. The highest concentrations of these analytes were found upgradient of the Original System, with chloroform and dieldrin exceeding the CSRGs/PQL. As per the 2010 LTMP, water samples from NWBCS performance wells were not sampled for DIMP under the LTMP, but the upgradient performance wells were sampled for DIMP under the separate 2014 On-post Plume Mapping task. The DIMP concentrations in all the upgradient performance wells were below the CSRG.

The treatment plant influent and effluent concentrations for chloroform, DIMP, and dieldrin are shown in Figures A-3, A-4, and A-5, respectively. At the influent to the treatment plant in FY14, dieldrin concentrations exceeded the PQL, and DIMP and chloroform concentrations were below the CSRG. Dieldrin concentrations in the effluent during FY14 were at or below the PQL. Operational changes made in FY12 and FY13 in the treatment plant were successful in keeping the dieldrin concentrations at or below the PQL during FY13 and FY14. However, because the dieldrin concentrations were near the PQL in FY14, additional treatment changes may be necessary in FY15. Treatment changes have included pulsing more carbon with increasing amounts over time, and using virgin carbon instead of regenerated carbon. Additionally, desorption of dieldrin from carbon fines during sample extraction and analysis is being evaluated as a possible cause of the PQL exceedances. Changing the post-treatment filters to remove more of the carbon fines prior to sample collection is also being investigated. There were no CSRG/PQL exceedances in either the individual quarterly samples or the four-quarter moving averages at the plant effluent during FY14.

2.1.1.2 Performance Evaluation

The primary performance requirement for the original NWBCS is to maintain a reverse hydraulic gradient across the system and to ensure plume-edge capture. Figures A-1 and A-2 in Appendix A show that the reverse hydraulic gradient was maintained across the system for all quarters in FY14. Plume-edge capture at the NWBCS can be verified by inspection of Table 3 on page 19, which shows no CSRG analytes above the CSRGs/PQLs for plume-edge monitoring well 27010 (see Figure A-8 for well locations). The water-table maps on Figures A-9 through A-12 show groundwater flow near upgradient well 27500, which is near the southwest end of the original NWBCS, is captured by the system.

Plume capture at the Northeast Extension (NEE) is demonstrated by the southwesterly gradients shown on Figures A-9 through A-12. However, dieldrin was detected above the PQL in downgradient performance wells 22015 and 22512, as shown in Table 3 on page 19. The dieldrin concentration in well 22512 was above the PQL during three of the four quarters in FY14. Well 22512 is sampled quarterly. Since FY12, the dieldrin concentrations in wells 22015 and 22512 show decreasing trend lines, which meets the secondary performance criterion. These data were discussed with the Regulatory Agencies at various times during FY14, and an evaluation of the dieldrin concentration data in the NWBCS downgradient performance wells was provided to the Regulatory Agencies on November 5, 2014. The conclusions of this evaluation are discussed in Section 2.1.1.5.

Plume capture at the Southwest Extension (SWE) is demonstrated by the water elevation contours and flow directions on Figures A-9 through A-12. Dieldrin is the only CSRG analyte present at the SWE. The dieldrin concentration was above the PQL in one of four FY14 samples in one cross-gradient performance well (27516). The second cross-gradient well and downgradient performance well were below the PQL (see Table 3 on page 19 and Figure A-14). Well 27516 is in the capture zone for the SWE, and the well does not display an increasing concentration trend, so operational changes were not necessary. If the dieldrin concentration trends upward in well 27516 in the future, additional monitoring and/or operational changes may be needed.

The secondary performance requirement is that downgradient performance wells are at or below the CSRGs/PQLs, or show decreasing concentration trends. Typically, the concentrations trends are determined by visual inspection of time versus concentration plots, but using a Mann-Kendall statistical analysis of the data is an option in the LTMP. For the Original System, the concentration trend is determined over the previous period of at least five years. Figures A-6 and A-13 show all downgradient performance wells either below detection or below the CSRG for chloroform. In Figure A-7 and A-14, all five Original System wells (37330, 37331, 37332, 37333, and 37600) and both NEE downgradient performance wells were above the PQL for dieldrin. Table 3 on page 19 shows that all downgradient performance wells were below the CSRGs/PQLs for all CSRG analytes, except for dieldrin.

Based on the November 5, 2014 evaluation, the dieldrin concentrations were above the PQL in the NWBCS downgradient performance wells in FY14 because of a variety of factors: 1) mobilization of residual dieldrin in the aquifer sediments downgradient of the slurry wall, which was caused by rising regional water levels; 2) dieldrin concentrations have been at or near the PQL in the NWBCS effluent; and 3) a small amount of contaminated flow from the NEE area may be migrating toward one of the downgradient performance wells.

The downgradient performance wells for the Original System are sampled annually and have only been sampled three times with the new MRL/PQL. Prior to FY12, the dieldrin results were less than the MRL of 0.03 µg/L and less than the previous PQL of 0.05 µg/L. Thus, additional dieldrin data from analytical methods with lower MRLs are needed for determining the trend and evaluating the secondary performance criterion. Furthermore, additional operational changes in treatment may be necessary to lower the treatment plant effluent concentrations, which should lower the downgradient well concentrations of dieldrin.

2.1.1.3 Compliance Evaluation

Compliance monitoring is water quality monitoring performed for all treatment system effluents at RMA. Each system has a list of compliance analytes for which CSRGs were developed in the On-Post and Off-Post RODs. The system effluent for the NWBCS was analyzed quarterly using the routine CSRG analyte list for the NWBCS, described in Section 4.3.5 of the 2010 LTMP, and annually using the complete ROD CSRG list as shown in Table 3 on page 19.

As shown in a separate Table 3 in the "RMA Treatment Plant Effluent Water Quality Data Report – Fourth Quarter FY14," the NWBCS four-quarter moving averages and the annual ROD CSRG samples had no exceedances during FY14. A pdf of the effluent report is on the attached data CD.

2.1.1.4 Quality Assurance Review for NWBCS

The purpose of the data review is to evaluate data quality with respect to the established DQOs. Components of the data review process include; evaluating the data against the data quality indicators precision, bias, representativeness, completeness, sensitivity, and comparability; review of field and laboratory QC results; and evaluating the data for suitability based on the intended use. The data review has determined that the data quality meets or exceeds the established DQOs and is of the correct type, quality, and quantity to support the intended use.

2.1.1.4.1 Precision

A total of 42 duplicate analyses were performed. The duplicate and investigative sample results were above the MRL in 20 of the analyses. The RPD was only calculated for the 20 analyses where the duplicate and investigative sample values were above the MRL.

The average RPD for the 20 analyses was 6.6 percent. All duplicate pairs were considered comparable with a single exception. The non-comparable investigative and duplicate data will be assigned a "Z" data qualifier with the comment "Duplicate and investigative values are not comparable". The data are considered acceptable for their intended use and no additional action in addition to the data qualification is considered necessary. The duplicate pairs determined to be comparable and not comparable are included in Appendix I (Table I-2 and Table I-3, respectively).

2.1.1.4.2 Accuracy/Bias

The average recovery rate for the 56 MS analyses was 86.8 percent. Recovery rates outside the lower or upper limits were observed in seven analyses; three were below the lower limit and four were above the upper limit. No discernible trends or QC issues were observed in the sample exceeding the specified limits. The data are considered acceptable for their intended use and no additional action is considered necessary.

The average recovery rate for the 56 LCS analyses for NWBCS analytical lots was 91.9 percent. Recovery rates within the lower or upper limits with the exception of seven analyses. No discernible trends or QC issues were observed in the sample exceeding the specified limits. The data are considered acceptable for their intended use and no additional action is considered necessary.

The percent recoveries were outside the evaluation limits for both the MS and LCS analyses for the DIMP analysis in analytical lot ABUT. This lot was recommended for rejection by the laboratory. Based on the laboratory recommendation, Lot ABUT will be placed in the Rejected table of the RMAED. The affected samples were re-collected approximately 30 days after the original collection date. Additional information related to this analysis is included in Appendix I (Table I-6).

2.1.1.4.3 Representativeness

A review of field and laboratory documentation determined that samples were collected and analyzed as specified. Field instruments utilized to collect field measurements were calibrated according to the respective instrument manual and recorded in the Groundwater Sampling Calibration Record database. As a result, the data appropriately reflects the operation of the NWBCS.

2.1.1.4.4 Completeness

Completeness was calculated at 99.5 percent. The criterion for the completeness calculation to exceed 90 percent was achieved.

2.1.1.4.5 Comparability

Standard techniques were utilized to collect and analyze samples and the data was reported in the appropriate units. The analytical results reported are equivalent to data obtained from similar analyses and the MRLs met the project goals.

2.1.1.4.6 Sensitivity

Method blank samples were analyzed for each analytical lot. There were no method blank detections above the MRL. Sensitivity is considered acceptable.

2.1.1.4.7 Field QC Samples

A total of 15 field blank analyses, 22 trip blank analyses, and 29 rinse blank analyses were performed with a single NNDMEA field blank result above the MRL. No additional action is required as the associated investigative sample value is less than the MRL. The data are considered acceptable for their intended use and no additional action is considered necessary.

2.1.1.4.8 Data Usability Evaluation

A data usability evaluation was conducted on 191 records. The evaluation identified two analyses as statistical outliers. The identified chloroform outlier was qualified with a "Z" flag code with a comment identifying the data as a Dixon's Test outlier. The dieldrin outlier was not qualified as an insufficient amount of recent historical data exists to determine if the value is anomalous or consistent with an unidentified trend.

The Mann-Kendall test for trends identified 17 decreasing analyte trends and three increasing analyte trends. A listing of the identified outliers and trends is included in Appendix I (Table I-13 and Table I-14, respectively). Complete data usability information is included on the attached data CD in the Data Usability subfolder.

The evaluation did not positively identify data quality issues, thus the data is considered to be of acceptable quality and meets or exceeds the established data quality objectives. The data is of the correct type, quality, and quantity to support the intended use.

2.1.1.5 Conclusions and Recommendations

In FY14, the NWBCS met the primary performance criteria and objectives established in the 2010 LTMP. Except for dieldrin, the secondary performance criterion in downgradient wells was met. Dieldrin was detected above the PQL in the five downgradient performance wells that are located off-post, but the long-term trend cannot be determined. The dieldrin concentrations were above the PQL in the NWBCS downgradient performance wells in FY14 because of a variety of factors: 1) mobilization of residual dieldrin in the aquifer sediments downgradient of the slurry wall, which was caused by rising regional water levels; 2) dieldrin concentrations have been at or near the PQL in the NWBCS effluent; and 3) a small amount of contaminated flow from the NEE area may be migrating toward one of the downgradient performance wells. Operational changes were implemented during FY12 and FY13 that improved the NWBCS performance for meeting the new dieldrin PQL, but additional treatment changes may be needed. The NWBCS had no CSRG/PQL analyte exceedances of the four-quarter moving averages in the treatment system effluent in FY14. The NWBCS appears to be functioning as intended, but additional monitoring data are needed to confirm that all the performance criteria are being met.

Table 3. Overview of FY14 CSRG Analyte Sampling for NWBCS Performance and Operational Wells

CSRG Analyte (The concentration in parentheses is the CSRG for the respective analyte)	**Performance* and Operational Well Numbers**																					
	*22008^{U}	*22015^{D}	*22043^{U}	*22053^{U}	*22081^{U}	*22505^{U}	22508^{D}	*22512^{D}	*27010^{C}	27091^{U}	*27500^{U}	*27516C	*27517^{U}	*27522^{D}	28031^{U}	28520^{U}	*28521^{C}	*37330^{D}	*37331^{D}	*37332^{D}	*37333^{D}	*37600^{D}
Diisopropylmethyl Phosphonate (8 µg/L)																						
Dieldrin[4a] (0.002 µg/L)	+	+	+	+	+	+	+	+		+	+	+	+			+		+	+	+	+	+
Endrin (2 µg/L)																						
Isodrin (0.06 µg/L)				+	+	+	+															

Table 3. Overview of FY14 CSRG Analyte Sampling for NWBCS Performance and Operational Wells (Concluded)

CSRG Analyte (The concentration in parentheses is the CSRG for the respective analyte)	Performance* and Operational Well Numbers																					
	*22008^{U}	*22015^{D}	*22043^{U}	*22053^{U}	*22081^{U}	*22505^{U}	22508^{D}	*22512^{D}	*27010^{C}	27091^{U}	*27500^{U}	*27516C	*27517^{U}	*27522^{D}	28031^{U}	28520^{U}	*28521^{C}	*37330^{D}	*37331^{D}	*37332^{D}	*37333^{D}	*37600^{D}
Chloroform (6 µg/L)	+		+																			
Trichloroethylene (3 µg/L)																						
N-Nitrosodimethyl-amine[4b] (0.007 µg/L)																						
Arsenic (2.35 µg/L)						+																

Notes: 1. Shading indicates that the respective well was not sampled for the indicated analyte or the data were not usable in FY14.
2. A plus sign (+) indicates that a reported concentration for a well sample was equal to or higher than the CSRG or PQL for the respective analyte.
3. Blank cells indicate that reported concentrations for the well samples were lower than the CSRG or PQL for the respective analyte.
4. Current certified reporting limit or PQL readily available from a certified commercial laboratory as listed in the Record of Decision:
[a] PQL = 0.013 µg/L [b] PQL = 0.018 µg/L
5. D = Downgradient well; U = Upgradient well; C = Cross-gradient well.

2.1.2 North Boundary Containment System (NBCS)

The NBCS treatment facility consists of a groundwater extraction system, monitoring wells, pre-filtration, carbon adsorption, post-filtration, ultraviolet (UV) oxidation, and a groundwater recharge system. The NBCS was designed to intercept contaminated groundwater from the upgradient side of the soil-bentonite barrier, treat it to remove the organic contaminants, and inject the treated water back into the alluvial aquifer on the downgradient side of the barrier. The treatment facility was originally designed as a pulse bed granular activated carbon adsorption system; however modifications to the treatment plant in May 1995 converted the plant to a down flow carbon adsorption system.

Additional modifications to the NBCS include the addition of UV oxidation treatment in the fall of 1997 in order to comply with additional remediation goals for n-nitrosodimethylamine (NNDMEA), and the addition of the South Channel well system in the fall of 2002 to extract groundwater upgradient of the NBCS in order to optimize NBCS operations.

The treatment system is designed to remove organic contaminants known to be present in the extracted groundwater to levels at or below the CSRGs established in the final ROD for the NBCS.
The results from CSRG-analyte sampling and water level monitoring at NBCS performance and operations wells are shown in Table 4 on page 26, in Appendix B, and in the attached data CD.

2.1.2.1 Operations

The NBCS operated at an average flow rate of 216 gpm and pumped a total volume of 114,570,012 gallons during FY14 (see Table 2 on page 3). Figure B-17 in Appendix B shows the locations of NBCS monitoring wells, extraction and recharge wells, the slurry wall, and the South Channel extraction wells.

The distribution of contaminants in performance wells upgradient and downgradient of the NBCS is shown for carbon tetrachloride, chloroform, chloride, DIMP, dieldrin, and NNDMEA in Figures B-11 through B-16 in Appendix B. The highest concentrations of these CSRG analytes were found

upgradient of the system in the vicinity of monitoring wells 23160, 24201 and 24101, near the middle of the system (see Table 4 on page 26).

The treatment plant influent and effluent concentrations for carbon tetrachloride, chloroform, chloride, DIMP, dieldrin, and NNDMEA are shown in Figures B-5 through B-10. The graphs indicate that treatment plant influent concentrations of dieldrin, and carbon tetrachloride exceeded the CSRG/PQL, and that influent concentrations of DIMP, chloroform, chloride, and NNDMEA were below the CSRG/PQL during FY14.

The moving averages for all CSRG analytes were below the CSRG/PQL in the plant effluent. See Table 2 in the "Treatment Plant Effluent Water Quality Data Report – Fourth Quarter FY14." A pdf of the effluent report is available on the attached data CD.

2.1.2.1.1 North Boundary Containment System (NBCS) Denver Unconfined Monitoring Wells

Reverse longitudinal hydraulic gradients across the slurry wall and upward vertical hydraulic gradients on the upgradient (south) side of the slurry wall are desirable in the Denver unconfined wells, but not required. Water levels were measured quarterly at seven well pairs adjacent to the NBCS slurry wall and screened in a Denver Formation sandstone that extends under the slurry wall at the western half of the NBCS. Reverse gradient graphs are shown in Figures B-3 and B-4 in Appendix B. The reverse gradient graphs have been consistent for the last several years. The well pairs, from west to east are as follows: 23536/23537, 23538/23539, 23138/23126, 23540/23541, 23194/23195, 23542/23543, and 23242/23243. Water levels in these well pairs show that a flat to reverse hydraulic gradient was present in all but well pair 23542/23543, which had a forward gradient for all four quarters in FY14. Wells 23542 and 23543 have contaminant concentrations consistently below the CSRGs, except for chloride or sulfate. Thus, the presence of a forward gradient in well pair 23542/23543 does not impact the effectiveness of the NBCS. These semi-confined sands in the Denver Formation limit the ability of the system to consistently maintain a reverse gradient in some areas.

Six Denver unconfined flow system (UFS) wells are sampled once-in-five years to monitor concentration trends upgradient and downgradient of the NBCS slurry wall. They are well pairs 23194/23195, 23540/24541, and 23542/23543 and were sampled for water quality in FY14. Two Denver UFS wells (23253 and 24191) located farther downgradient of the NBCS slurry wall were also sampled in FY14. They are former NBCS conformance wells, and are sampled to monitor the historical contaminant concentration trends in these two wells.

In wells 23193, 23194, 23542, and 23543, only chloride or sulfate were detected above the CSRGs. Well 23540 contained aldrin (0.0314 µg/L), chloride (530,000 µg/L), DIMP (601 µg/L), dieldrin (0.0416 µg/L), and isodrin (0.0768 µg/L) above CSRGs/PQLs. Well 23541 contained chloride (502,000 µg/L), DIMP 460 µg/L), and dieldrin (0.0413 µg/L) above CSRGs/PQLs. The DIMP concentrations in both wells have decreased steadily since monitoring of these wells started in 2000 when the DIMP concentrations were 2,700 µg/L (23540) and 1,500 µg/L (23541). The concentrations of the other analytes have been relatively stable. As discussed in previous ASRs, Five Year Summary Reports (FYSRs), and FYRRs, the contamination in wells 23540/23541 is not consistent with bypass or underflow and likely represents residual contamination present before the NBCS was installed. For example, the downgradient well (23540) contains more contaminants and the concentrations are higher than in the upgradient well (23541). Therefore, the contamination in these wells is not indicative of system performance.

Wells 23235 and 24191 are sampled for chloride and DIMP, and well 23235 is also sampled for 1,2-Dichloroethane (12DCLE). DIMP shows steadily decreasing trends in both wells, with well 23235 decreasing from 116 µg/L in FY12 to 32.4 µg/L in FY14, and well 24191 decreasing from 18.3 µg/L in

FY12 to 12.1 µg/L in FY14. 12DCLE in well 23235 also shows a decreasing trend, from 0.667 µg/L in FY12 to 0.404 µg/L in FY14. Chloride decreased slightly in well 24191, from 187,000 µg/L in FY12 to 182,000 µg/L in FY14, but increased in well 23235 from 537,000 µg/L to 1,240,000 µg/L in FY14. Compared to historical chloride concentrations in well 23235, the FY14 result seems questionable.

An upward vertical hydraulic gradient from the Denver unconfined zone to the overlying alluvium on the upgradient side of the slurry wall indicates hydraulic containment with depth. An upward gradient was present from the unconfined Denver wells to the adjacent alluvial wells during all four quarters in five of the seven well clusters on the extraction-well side of the slurry wall. The alluvial/Denver well pairs, from west to east are as follows: 23208/23537, 23207/23539, 23214/23126, 23533/23541, 23534/23195, 23535/23543, and 23212/23243. Well pair 23533/23541 is located at the bend in the slurry wall, and had flat to upward gradients during two quarters and downward gradients during two quarters. The downward gradients occurred during the third and fourth quarters, with head differentials of 0.11 and 0.27 feet, respectively. Well cluster 23534/23195 had a downward gradient with a head differential of 0.08 feet during the first quarter, and the gradient was upward during the other three quarters. All of the vertical hydraulic gradients in the well clusters on the north side of the slurry wall were downward or flat in FY14.

The FY14 hydraulic gradients in the Denver unconfined wells are consistent with expectations. The longitudinal hydraulic gradients indicate that underflow of contaminants likely is not occurring and the vertical gradients indicate hydraulic containment is being maintained.

2.1.2.1.2 North Boundary Containment System (NBCS) Denver Confined Monitoring Wells

The three CFS wells located downgradient of the NBCS slurry wall (wells 23161, 23200, and 24171) were sampled in FY14. The contaminant concentrations were below the CSRGs/PQLs in wells 23200 and 24171, and only sulfate was above the CSRG in well 23161. The sulfate concentration in well 23161 is stable. The FY14 and previous results indicate that UFS contamination is not migrating to the CFS.

2.1.2.2 Performance Evaluation

The primary performance requirement for the NBCS is to maintain a reverse hydraulic gradient across the system in the alluvium and to ensure plume-edge capture. Figures B-1 and B-2 in Appendix B show that the reverse hydraulic gradient was maintained across the system during all four quarters of FY14. Plume-edge capture at the NBCS can be verified by inspection of the water-table map in Figure B-18. Water-table contours indicate that groundwater flow is being captured at the edges of the system. Since both primary performance criteria were met, according to the criteria in the 2010 LTMP, the NBCS functioned as intended during FY14.

The secondary performance requirement is that downgradient performance wells are at or below the CSRGs/PQLs, or show decreasing trends. Table 4 on page 26 and Figures B-11 through B-16 and B-19.1 through B-23.2 in Appendix B show downgradient performance wells are either below detection or below the CSRG/PQL for most of the CSRG analytes. Only chloride, dieldrin, DIMP, fluoride, and sulfate were above the CSRGs/PQLs. The DIMP concentration was above the CSRG in one well (23405), which shows a decreasing trend. Dieldrin concentrations were above the PQL in eight downgradient performance wells (23405, 23434, 24004, 24006, 24415, 24418, 24421, and 24424). Dieldrin concentrations in six of the eight wells show decreasing trends using visual inspection and trend line regression. Two of the eight wells show an increasing trend (23434 and 24421), but the concentrations are below the previous MRL and there are only three uncensored data points. Thus, the long-term trend cannot be determined.

In FY13, well 37362 had an anomalous increase in the dieldrin concentration to above the PQL. In FY14, the dieldrin concentration in well 37362 was below the PQL, and similar to historical data. Well

24421 also had an anomalous increase in dieldrin in FY13. It was lower in FY14, but still above the PQL. At stated above, more data are needed to determine the dieldrin trend in well 24421. Four wells were above the chloride CSRG and two wells were above the sulfate CSRG. The CSRGs for chloride and sulfate in the downgradient wells are expected to be met by attenuation.

As discussed in previous ASRs, the downgradient detections of chloride, dieldrin, DIMP, fluoride, and sulfate are most likely caused by residual contamination and not representative of system effectiveness. The dieldrin concentrations are present above the PQL in more downgradient wells likely due to its lower solubility and more sorptive nature. Fluctuations in groundwater levels downgradient of the NBCS slurry wall caused by variations in the recharge trench flow rates and variable recharge from First Creek likely causes desorption of dieldrin from the aquifer sediments.

Prior to FY13, the NBCS downgradient former conformance wells were also sampled for comparison to the current downgradient performance wells. With agreement from the Regulatory Agencies, sampling of these wells was discontinued in FY13 according to Operations and Maintenance Change Notice (OCN) OCN-LTMP-2013-001. The former conformance wells were included on the time versus concentration figures to show the long-term trends, and they were shown as operational wells that were sampled in FY14 on Table 4 on page 26.

2.1.2.3 Compliance Evaluation

Compliance monitoring is water quality monitoring performed for all treatment system effluents at RMA. Each system has a list of compliance analytes for which CSRGs were developed in the On-Post and Off-Post RODs. The system effluent for the NBCS was analyzed quarterly using the routine CSRG- analyte list for the NBCS, described in Section 4.4.5 of the 2010 LTMP, and annually using the complete ROD CSRG lists.

As shown in Table 2 of the "RMA Treatment Plant Effluent Water Quality Data Report – Fourth Quarter FY14," the four-quarter moving averages for CSRG analytes at NBCS and the annual ROD CSRG samples had no exceedances during FY14. A pdf of the effluent report is available on the attached data CD.

2.1.2.4 Quality Assurance Review for NBCS

The purpose of the data review is to evaluate data quality with respect to the established DQOs. Components of the data review process include; evaluating the data against the data quality indicators precision, bias, representativeness, completeness, sensitivity, and comparability; review of field and laboratory QC results; and evaluating the data for suitability based on the intended use. The data review has determined that the data quality meets or exceeds the established DQOs and is of the correct type, quality, and quantity to support the intended use.

2.1.2.4.1 Precision

A total of 134 duplicate analyses were performed. The duplicate and investigative sample results exceeded the MRL in 66 of the analyses. The RPD was only calculated for the 66 analyses where the duplicate and investigative sample values were above the MRL.

The average RPD for the 66 analyses was 5.2 percent. All duplicate pairs were considered comparable with the exception of five pairs considered non-comparable. The non-comparable investigative and duplicate data will be assigned a "Z" data qualifier with the comment "Duplicate and investigative values are not comparable". The data are considered acceptable for their intended use and no additional action in addition to the data qualification is considered necessary. The duplicate pairs determined to be comparable and not comparable are included in Appendix I (Table I-2 and Table I-3, respectively).

2.1.2.4.2 Accuracy/Bias

The average recovery rate for the 185 MS analyses was 91.7 percent. Recovery rates outside the lower or upper limits were observed in 14 analyses; seven were below the lower limit and seven were above the upper limit. No discernible trends or QC issues were observed in the samples exceeding the specified limits. The data are considered acceptable for their intended use and no additional action is considered necessary.

The average recovery rate for the 186 LCS analyses was 98.0% percent. Recovery rates within the lower or upper limits with the exception of 26 analyses. No discernible trends or QC issues were observed in the sample exceeding the specified limits. The data are considered acceptable for their intended use and no additional action is considered necessary.

The percent recoveries were outside the evaluation limits for both the MS and LCS analyses for the chlorophenylmethyl sulfoxide (CPMSO) and chlorophenylmethyl sulfone (CPMSO2) analyses in analytical lot ACFV. No additional action is considered necessary based on the analyst's notes in the data package. Additional information related to these analyses is included in Appendix I (Table I-6).

2.1.2.4.3 Representativeness

A review of field and laboratory documentation determined that samples were collected and analyzed as specified. Field instruments utilized to collect field measurements were calibrated according to the respective instrument manual and recorded in the Groundwater Sampling Calibration Record database. As a result, the data appropriately reflects the operation of the NBCS.

2.1.2.4.4 Completeness

Completeness was calculated at 100 percent. The criterion for the completeness calculation to exceed 90 percent was achieved.

2.1.2.4.5 Comparability

Standard techniques were utilized to collect and analyze samples and the data was reported in the appropriate units. The analytical results reported are equivalent to data obtained from similar analyses and the MRLs met the project goals.

2.1.2.4.6 Sensitivity

Method blank samples were analyzed for each analytical lot. There was a single NNDMEA method blank detection above the MRL. Based on the method blank detection, associated investigative values above the MRL were qualified with a "B" flag code. Sensitivity is considered acceptable.

2.1.2.4.7 Field QC Samples

A total of 30 field blank analyses were performed with no analyses above the MRL. A total of 130 trip blank analyses were performed, also with no results above the MRL.

A total of 60 rinse blank analyses were performed with three results above the MRL. The results above the MRL are from wells 23119 (dieldrin) and 23160 (dieldrin and endrin). No qualification of the data is required as the investigative sample is greater than the blank value in all three cases. The data are considered acceptable for their intended use and no additional action is necessary.

2.1.2.4.8 Data Usability Evaluation

A data usability evaluation was conducted on 777 records. The evaluation identified four chloride analyses and one chloroform analysis as statistical outliers. Two of the identified outliers were not qualified as an insufficient amount of recent historical data exists to determine if the values are anomalous or consistent with an unidentified trend. Three of the analyses were qualified with a "Z" flag code and associated comment referring to identification as a statistical outlier by Dixon's Test.

The Mann-Kendall test for trends identified 32 decreasing analyte trends and 11 increasing analyte trends. A listing of the identified outliers and trends is included in Appendix I (Table I-13 and Table I-14, respectively). Complete data usability information is included on the attached data CD in the Data Usability subfolder.

The evaluation did not positively identify data quality issues, thus the data is considered to be of acceptable quality and meets or exceeds the established DQOs. The data is of the correct type, quality, and quantity to support the intended use.

2.1.2.5 Conclusions and Recommendations

In FY14, the NBCS met the performance criteria and objectives established in the 2010 LTMP. There were no CSRG-analyte exceedances of the four-quarter moving averages and annual ROD CSRG samples in the NBCS treatment system effluent in FY14. The reverse gradient was maintained. The concentrations in the downgradient performance wells were less than the CSRGs/PQLs or show decreasing trends over the previous five years in most of the wells. Dieldrin concentrations are above the PQL in eight of the 11 downgradient wells, but show decreasing trends in six of the eight wells. More data are needed to determine the long-term trend in the other two wells. The dieldrin concentrations above the PQL likely are caused by residual contamination that is not representative of system performance. According to the LTMP, the concentration trends for the performance criteria are determined over a minimum of the previous five years. Some of the wells have not been sampled for the previous five years because of the change in well networks in the 2010 LTMP. In some cases, the concentrations are below the former MRL, which changed in FY12. Thus, the trend over the previous five-year period cannot be determined.

The contaminant plumes were captured. There were no trigger events for NBCS during FY14. Although a few analytes are above CSRGs/PQLs in downgradient wells because of residual downgradient contamination, the NBCS is functioning as intended.

Table 4. Overview of FY14 CSRG Analyte Sampling from NBCS Performance and Operational Wells

CSRG Analyte (The concentration in parentheses is the CSRG for the respective analyte)	Performance* and Operational[6] Well Numbers																											
	*23119^{U}	*23160^{U}	23198^{D}	*23211^{U}	23253^{D}	*23405^{D}	*23434^{D}	*23436^{D}	*23438^{D}	*24004^{D}	*24006^{D}	*24101^{U}	*24105^{U}	*24106^{U}	*24114^{U}	*24117^{U}	24162^{D}	24166^{D}	*24185^{U}	*24199^{U}	*24201^{U}	*24415^{D}	*24418^{D}	*24421^{D}	*24424^{D}	37338^{D}	37339^{D}	*37362^{D}
Diisopropylmethyl phosphonate (DIMP) (8 µg/L)				+		+						+																
Aldrin[1a] (0.002 µg/L)																												
Dieldrin[1b] (0.002 µg/L)	+	+	+	+		+	+			+	+	+		+	+	+	+	+	+		+	+	+	+	+	+		
Endrin (2 µg/L)		+																										
Isodrin (0.06 µg/L)	+	+										+																
Atrazine (3 µg/L)																												
Malathion (100 µg/L)																												
1,4-Oxathiane (160 µg/L)																												
Chlorophenylmethyl sulfide (30 µg/L)																												
Chlorophenylmethyl sulfoxide (36 µg/L)																												
Chlorophenylmethyl sulfone (36 µg/L)																												
Dithiane (18 µg/L)																												
Benzene (3 µg/L)																												
Toluene (1000 µg/L)																												
Xylenes (1000 µg/L)																												
1,2-Dichloroethane (0.40 µg/L)	+	+										+																
1,2-Dichloroethylene (70 µg/L)																												
Carbon tetrachloride (0.30 µg/L)																+			+		+							
Chloroform (6 µg/L)																					+							
Methylene chloride (5 µg/L)																												
Tetrachloroethylene (5 µg/L)																												
Trichloroethylene (3 µg/L)																												
Dicyclopentadiene (46 µg/L)																												
Dibromochloropropane (0.20 µg/L)																												
n-Nitrosodimethylamine[1c] (0.007 µg/L)		+										+																
Arsenic (2.35 µg/L)																												
Chloride (250 mg/L)	+	+	+	+			+	+	+			+					+								+	+	+	
Fluoride (2 mg/L)	+		+	+			+					+									+						+	+
Sulfate (540 mg/L)	+	+		+			+	+				+		+							+						+	

Notes: 1. As a result of the 2012 PQL study, here is the current list of NBCS PQLs readily available from a certified commercial laboratory: [a] PQL = 0.014 µg/L [b] PQL = 0.013 µg/L [c] PQL= 0.018 µg/L
2. A plus sign (+) indicates that a reported concentration for a well sample was equal to or higher than the CSRG or PQL for the respective analyte.
3. Shading indicates that the respective well was not sampled for the indicated analyte or the data were not usable in FY14.
4. Blank cells indicate that reported concentrations for the well samples were lower than the CSRG or PQL for the respective analyte.
5. D = Downgradient well; U = Upgradient well.
6. Operational wells in this table are former downgradient conformance wells. These wells are now sampled twice-in-five years (2014 was a sampling event, except for well 23253).

2.1.3 Railyard Containment System (RYCS)

The RYCS is designed to capture the Railyard dibromochloropropane (DBCP) plume. When the MPS/ICS extraction systems were shut off, treatment of the remaining Railyard plume was moved from the ICS to the new RYCS in July 2001. Recharge of the treated water was also transferred from the ICS to the RYCS. Two RYCS extraction wells (03306 and 03307) located downgradient of the primary Railyard extraction well field were converted to recharge wells 03401 and 03402. The objective of the original RYCS, which applies to the current system, was to contain and intercept the DBCP plume.

The results from CSRG-analyte sampling at RYCS performance and operations wells are shown in Table 5 on page 30 and in Appendix C. There were no DBCP detections above the CSRG in FY14.

2.1.3.1 Operations

The RYCS operated at an average flow rate of 113.6 gpm and pumped a total volume of 59,786,431 gallons during FY14 (see Table 2 on page 3). Figure C-5 in Appendix C shows the RYCS monitoring wells, extraction and recharge wells.

The distribution of DBCP in performance wells upgradient and downgradient of the RYCS is shown in Figure C-4 in Appendix C. All DBCP concentrations in the upgradient and downgradient performance wells were below the CSRG. Also, all operational wells sampled at RYCS were below the CSRG for DBCP (see Table 5 on page 30).

The treatment plant influent and effluent concentrations for DBCP are shown in Figures C-1 through C-3 in Appendix C. The graphs indicate that the treatment plant influent and effluent concentrations of DBCP were below the CSRG for FY14.

2.1.3.2 Performance Evaluation

The Decision Rules for the RYCS are to demonstrate plume capture through visual evaluation of flow directions on potentiometric maps and to show that downgradient performance wells are at or below the CSRG, or show a decreasing trend. The water-table maps (Figures C-6 through C-9) indicate that the extraction wells in the RYCS system capture the upgradient groundwater. The interpretation of the water-table contours near the RYCS recharge wells was changed in FY14 compared to previous ASRs to more accurately depict the influence of the recharge well flows on the water table. The time versus concentration graphs in Figure C-10 indicate that DBCP concentrations are below the CSRG in all the performance and operational wells.

A review of RYCS analytes in the 2010 LTMP resulted in the elimination of trichloroethylene (TRCLE) from the routine CSRG-analyte list. DBCP was retained because it had two or more CSRG/PQL exceedances in the plant influent, extraction wells, or upgradient performance/shut-off monitoring wells and is the only analyte on the RYCS routine CSRG-analyte list. The treatment system effluent will continue to be analyzed for DBCP and TRCLE.

A RYCS pre-shut-off monitoring program was conducted during FY14. The results of the pre-shut-off program met the criteria for continuation of the shut-off process (Navarro 2015). The next steps will be preparation of a Decision Document and a Draft Shut-Off Monitoring SAP for review and approval by the Regulatory Agencies.

2.1.3.3 Compliance Evaluation

Compliance monitoring is water quality monitoring performed for all treatment system effluents at RMA. Each system has a list of compliance analytes for which CSRGs were developed in the On-Post and Off-Post RODs. The system effluent for the RYCS was analyzed quarterly, using the routine CSRG-analyte list (DBCP) for the RYCS described in Section 4.5.4 of the 2010 LTMP.

As shown in Table 5 of the "RMA Treatment Plant Effluent Water Quality Data Report – Fourth Quarter FY14," the moving averages for DBCP at RYCS did not exceed the CSRG during FY14. The annual effluent sample for TRCLE was below the CSRG of 5 µg/L with a result of less than (LT) 0.2 µg/L. A pdf of the effluent report is available on the attached data CD.

2.1.3.4 Quality Assurance Review for RYCS

The purpose of the data review is to evaluate data quality with respect to the established DQOs. Components of the data review process include; evaluating the data against the data quality indicators precision, bias, representativeness, completeness, sensitivity, and comparability; review of field and laboratory QC results; and evaluating the data for suitability based on the intended use. The data review has determined that the data quality meets or exceeds the established DQOs and is of the correct type, quality, and quantity to support the intended use.

2.1.3.4.1 Precision

A total of four duplicate analyses were performed. The duplicate and investigative sample results exceeded the MRL in two of the analyses. The RPD was only calculated for the two analyses where the duplicate and investigative sample values were above the MRL.

The average RPD for the two analyses was 10.9 percent. All duplicate pairs were considered comparable. The data are considered acceptable for their intended use and no additional action is considered necessary. The duplicate pairs determined to be comparable are included in Appendix I (Table I-2).

Field duplicate data was not collected for TRCLE at the RYCS due to the limited scope of volatile sampling in the RYCS treatment plant. Precision estimates for TRCLE are available based on field duplicate sample collection in other areas on the RMA.

2.1.3.4.2 Accuracy/Bias

The average recovery rate for the seven MS analyses was 111.2 percent. Recovery rates outside the upper limits were observed in two analyses. No recovery rates were observed outside the lower limit. The average recovery rate for the seven LCS analyses was 115.6 percent. Recovery rates outside the lower or upper limits were not observed. The data are considered acceptable for their intended use and no additional action is considered necessary.

2.1.3.4.3 Representativeness

Representativeness is a qualitative term achieved by evaluating whether measurements were made and samples were collected in a manner that the resulting data appropriately reflects the sampling unit. Field instruments utilized to collect field measurements were calibrated according to the respective instrument manual and recorded in the Groundwater Sampling Calibration Record database. A review of field and laboratory documentation determined that samples were collected and analyzed as specified.

2.1.3.4.4 Completeness

Completeness was calculated at 100 percent. The criterion for the completeness calculation to exceed 90 percent was achieved.

2.1.3.4.5 Comparability

Standard techniques were utilized to collect and analyze samples and the data was reported in the appropriate units. The analytical results reported are equivalent to data obtained from similar analyses and the MRLs met the project goals.

2.1.3.4.6 Sensitivity

Method blank samples were analyzed for each analytical lot. There were no method blank detections above the MRL. Sensitivity is considered acceptable.

2.1.3.4.7 Field QC Samples

Field blank samples specific to the RYCS were not collected as a considerable amount of QC samples were collected in conjunction with sampling programs such as water quality tracking and plume mapping. Trip blank collection was not required for the limited VOC analyses as those samples were shipped in coolers with trip blanks from other RMA sampling programs. No detections above the MRL were present in the three rinse blanks analyses performed. The data are considered acceptable for their intended use and no additional action is necessary.

2.1.3.4.8 Data Usability Evaluation

A data usability evaluation was conducted on 27 records. The evaluation identified no analyses as statistical outliers. The Mann-Kendall test for trends identified three decreasing analyte trends and no increasing analyte trends. A listing of the identified outliers and trends is included in Appendix I (Table I-13 and Table I-14, respectively). Complete data usability information is included on the attached data CD in the Data Usability subfolder.

The evaluation did not positively identify data quality issues, thus the data is considered to be of acceptable quality and meets or exceeds the established DQOs. The data is of the correct type, quality, and quantity to support the intended use.

2.1.3.5 Conclusions and Recommendations

In FY14 the RYCS met the performance criteria and objectives established in the 2010 LTMP. There were no CSRG-analyte exceedances of the four-quarter moving averages for DBCP and the annual TRCLE sample in the RYCS treatment system effluent in FY14. The water-table maps indicate that the plume was captured. The downgradient performance well chemical results were less than the CSRG. There were no trigger events for RYCS during FY14. The RYCS is functioning as intended.

A RYCS pre-shut-off monitoring program was conducted during FY14. The results of the pre-shut-off program met the criteria for continuation of the shut-off process (Navarro 2015). The next steps will be preparation of a Decision Document and a Draft Shut-Off Monitoring SAP for review and approval by the Regulatory Agencies.

Table 5. Overview of FY14 CSRG Analyte Sampling from Railyard Performance and Operational Wells

CSRG Analyte (The concentration in parentheses is the CSRG for the respective analyte)	**Performance* and Operational Well Numbers**												
	*03001[C4]	*03501[U]	*03503[U]	*03507[D4]	*03508[D3]	*03509[D4]	03523[U]	*03527[C4]	*03529[D]	*03530[D]	03534[U]	*03538[U]	*04506[D3]
DBCP (CSRG = 0.2 µg/L)													

1. Blank cells indicate that reported concentrations for the well samples were lower than the CSRG for the respective analyte.
2. Shading indicates that the respective well was not sampled for the indicated analyte in FY14.
3. Well is sampled biannually in odd years.
4. Well is sampled biannually in even years
5. D = Downgradient well; U = Upgradient well; C = Cross-gradient well.

2.1.4 Basin A Neck System (BANS)

The BANS was originally designed and constructed in 1989 to intercept contaminated groundwater originating from Basin A. Contaminated groundwater is removed from the upgradient side of a soil-bentonite barrier, treated by means of air stripping and granular activated carbon adsorption to remove the organic contaminants, and injected back into the alluvial aquifer through recharge trenches on the downgradient side of the barrier. Since the original plant was constructed, two additional extraction systems were added in 2000, and one additional system was added in 2011, all of which convey contaminated groundwater from different areas of the RMA to the BANS for treatment. These systems include the BRES, which extracts contaminated groundwater from an area in the north-central part of Section 36, the CADT dewatering system, which pumps contaminated groundwater from the Complex Trenches area in the southeast portion of Section 36, and the LB, which pumps contaminated groundwater from the southwest corner of Section 36.

The contaminated groundwater from the BRES and CADT systems requires pre-treatment by air stripping for removal of VOCs. In order to accommodate the increased flows, a new shallow tray air stripping system was installed in 2002 to replace the original packed bed air stripping system. In 2004, the air stripper was relocated to the headworks of the plant in order to process the entire plant flow. The Lime Basins Treatment Relocation Project, which directed groundwater from the Lime Basins extraction wells into the BANS treatment plant, was started in FY10 and was completed in FY11. A full description of the project can be found in Section 1.2.6 of the FY11 report.

The treatment system is designed to remove organic contaminants (and arsenic - with the modifications to the BANS treatment plant in FY11) known to be present in the extracted groundwater to levels at or below the CSRGs established in the final On-Post ROD for the BANS. For a diagram of the BANS plant operations, see Figure D-1 in Appendix D.

An overview of CSRG-analyte sampling at BANS/CADT/BRES performance and operations wells is shown in Table 7 on page 39 and in Appendix D, respectively.

2.1.4.1 Operations

The BANS operated at an average flow rate of 17.3 gpm and pumped a total volume of 9,099,741 gallons during FY14 (see Table 2 on page 3). Figure D-9 in Appendix D shows the BANS monitoring wells, extraction recharge trenches, and slurry wall.

The distribution of chloroform, dieldrin, and dithiane in performance wells upgradient and downgradient of the BANS is shown in Figures D-6 through D-8, in Appendix D. All chloroform concentrations in these upgradient performance wells were below the CSRG. All dieldrin concentrations were above the PQL in the upgradient performance wells. Dithiane concentrations in upgradient performance wells were above the CSRG at the middle of the system and below the CSRG at either end of the system.

The treatment plant influent and effluent concentrations for chloroform, dieldrin, and dithiane are shown in Figures D-3 through D-5, respectively. The graphs indicate that the treatment plant influent concentrations for all three analytes were above the CSRGs/PQL, and all effluent concentrations for the three analytes were below the CSRGs/PQL in FY14.

Performance criteria for BANS as required by the 2010 LTMP are to demonstrate effective mass removal for each CSRG analyte and demonstrate that concentrations in downgradient performance wells are below CSRGs/PQLs or are stable or decreasing.

2.1.4.2 Performance Evaluation, including BANS Mass Removal Estimates

One of the two performance criteria for the BANS is to demonstrate effective mass removal of each CSRG analyte.

Prior to FY10, there were no quantitative mass removal criteria for evaluating the performance of the BANS. Beginning in FY10, 75 percent mass removal was set as the goal in the 2010 LTMP (TtEC and URS 2010), pending further evaluation after collecting additional data for five years. As opposed to treatment system compliance with CSRGs, the mass removal criterion refers to removing at least 75 percent of the contaminant plume mass migrating toward the system during a specified time period (mass flux). Wells were included in the BANS upgradient performance well network in the 2010 LTMP to provide more data for estimating the mass flux and mass removal for future performance evaluations.

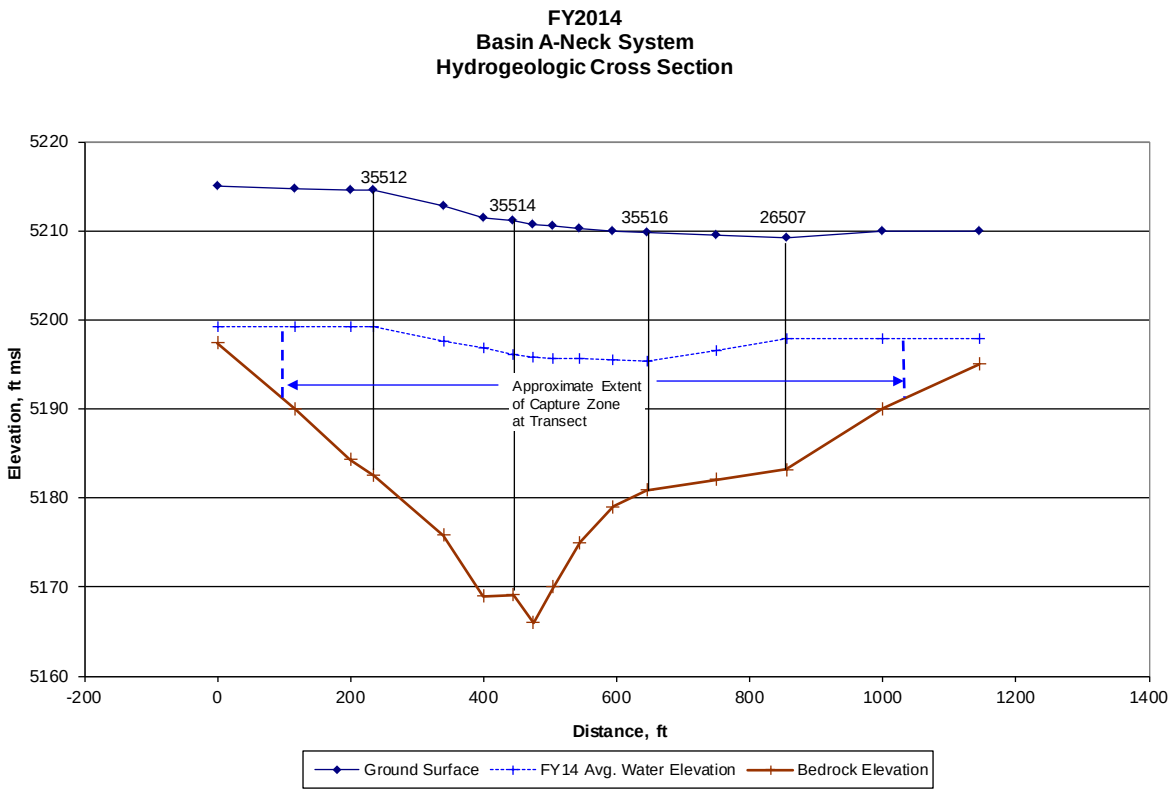
The majority of the contaminated groundwater flow is captured by the BANS extraction system, but not all of the groundwater flow is captured. The methodology in the 2010 LTMP was revised in OCN-LTMP-2012-002 such that the well capture method is used to estimate the mass flux within the system capture zone and the transect method is used to estimate the mass flux outside of the capture zone for the BANS. Since the extraction wells are used in the mass flux calculations for the BANS, they were re-designated as performance water quality wells in the OCN.

The BANS treatment plant treats the combined flow from the BANS, CADT, BRES, and LB (beginning in FY11). Thus, the treatment plant monitoring data are not BANS-specific. The mass removed by the BANS extraction system is calculated based on the difference between the annual average concentrations for the BANS extraction wells and the treatment plant annual average effluent concentrations, multiplied by the average annual flow rates for the extraction wells. The equivalent calculation also is done for the BANS extraction well influent (PADW1-7),

which is the combined flow from the extraction wells, for comparison to the sum of the individual extraction well data.

Four upgradient monitoring wells were selected in the 2010 LTMP to provide a cross section of the plume upgradient of the extraction system. Figure 1 shows the hydrogeologic cross section for the BANS and is located 250 feet upgradient of the BANS slurry wall. The cross section consists of the four BANS upgradient performance monitoring wells (26507, 35512, 35514, and 35516) and 12 additional bedrock elevation points based on the RMA bedrock contour map. The approximate FY14 capture zone for the BANS at the upgradient transect is shown in Figure 1 below.

Figure 1. BANS Hydrogeologic Cross Section



The annual average alluvial saturated thickness and available hydraulic conductivity data are used to estimate the annual mass flux outside the capture zone. Simplifying assumptions, such as uniform concentrations with depth, no flow in the bedrock (except for underflow at the slurry wall), uniform lateral concentrations to the mid-points between wells, etc., are used in the estimates. Contaminant concentrations obtained from the monitoring wells and extraction wells are representative of the alluvial groundwater flow from a mass flux perspective because they are flow-weighted concentrations. Where concentrations are below reporting limits, one-half the reporting limit is used in the mass calculations.

Mass flux was calculated based on a Darcy's Law approach where the contaminated flow is calculated using the following equation:

$$Q = Kia \times (7.48\ gal/ft^3 \div 1440\ min/day)$$

Where:

Q = Flow rate, gpm
K = Hydraulic Conductivity, ft/day
i = Hydraulic Gradient, ft/ft
a = area, ft^2

The mass flux outside the BANS capture zone is estimated adjacent to the BANS slurry wall where the aquifer lithologies, hydraulic gradients, and hydraulic conductivities are better defined than at the transect 250 feet upgradient. The alluvial saturated thickness past the ends of the slurry wall was based on the FY14 average saturated thickness in wells 26512 and 35549. The alluvial hydraulic conductivity was based on available data (i.e., from aquifer tests conducted near the slurry wall), the alluvial lithology, and the position in the bedrock channel, and ranged from 0.085 to 52 ft/day for aquifer test wells 26501, 26503, 35506, and 35509 (TtEC and URS 2010). The alluvium in the deeper, central portion of the Basin A-Neck channel has higher hydraulic conductivity than at the edges. The contaminant concentrations also are higher in the center of the channel.

The BANS slurry wall was keyed into the Denver Formation bedrock below the alluvium. Where there is a forward hydraulic gradient across the slurry wall and underflow may occur, the hydraulic conductivity of the Denver Formation bedrock was used in the calculations. Hydraulic conductivities from aquifer tests of wells 26063 and 35016, which are screened in the upper bedrock sandstone and are located near the BANS slurry wall, were used for this purpose. The saturated thickness of the bedrock used in the mass flux calculations for underflow was assumed to be 5 feet for clay/claystone and 10 feet for sandstone.

The calculations shown in Table 6 below were derived from BANS data in the "FY14 ASR BANS Mass Removal" Excel file on the attached data CD. The results of the BANS mass flux/mass removal analysis for FY14 using the 2010 LTMP methodology, as revised in OCN-LTMP-2012-002, are provided in the following table.

Table 6. FY14 BANS Estimated Contaminated Flow Rate, Mass Flux, and Mass Removed

Average Contaminated Flow Rate (gpm)	Contaminant Mass Flux Dewatering Wells/ PADW1-7 (lbs/year)	Average Extraction/ BANS Influent Flow Rate (gpm)	Extracted Mass - Dewatering Wells (lbs/year)	Extracted Mass Removed - Dewatering Wells (lbs/year)	Extracted Mass – BANS Influent (PADW1-7) (lbs/year)	Extracted Mass Removed - BANS Influent (PADW1-7) (lbs/year)
17.0 (total) 12.7 (Well capture method inside capture zone [CZ]) 4.3 (Transect method outside CZ)	15.7/17.4 (total) 14.8/16.4 (inside CZ) 0.94 (outside CZ)	12.7	14.8	13.6 (87%)	16.4	15.3 (88%)

The contaminated flow rate is estimated by adding the flow rates for the zones where there are reverse and forward hydraulic gradients. The capture zone is shown in Appendix D on Figure D-10 based on the presence of a reverse hydraulic gradient across the slurry wall. A small amount of the contaminated underflow may be occurring at the edges of the system beyond the ends of the recharge trenches where there is a forward hydraulic gradient across the slurry wall. Additionally, the FY14 water-table map (Figure D-10) indicates that the slurry wall may not extend to the edge of the saturated alluvium in the Basin A-Neck channel. Thus, the groundwater may flow around the ends of the slurry wall in the alluvium. However, the saturated alluvium is thinner in these areas, less permeable, and the concentrations are lower, so the mass flux is small.

The BANS average extraction flow rate shown in Table 6 on page 33 is 12.7 gpm. The estimated contaminated flow outside the capture zone (either underflow or flow around the slurry wall) is 4.3 gpm. Thus, the total contaminated groundwater flow approaching the BANS in FY14 is estimated to be 17.0 gpm.

Since not all of the groundwater flow in the Basin A-Neck channel is captured by the extraction system, the well capture method is used to estimate the mass flux that is captured by the system, and the transect method is used to estimate the mass flux outside the capture zone (i.e., where there is a forward hydraulic gradient or flow around the end of the slurry wall). Since the aquifer tests were conducted in wells near the slurry wall and the lithologies are known, uncertainties in the bypass estimates are minimal and accurate estimates of contaminated flow and mass flux may be obtained.

Forward gradients typically are present south of the end of Recharge Trench C and are calculated using well pairs 35520/35521, 35525/35526 and 35518/35519, and at well 35549. In FY14, the forward gradient extended to Recharge Trench B and well pair 35522/35523. The historically high groundwater levels after the unprecedented September 2013 precipitation/flood event and May 2014 rainstorms caused the BANS reverse hydraulic gradient to decrease to a smaller portion of the system than in FY13. An annual average gradient is calculated for each well pair using monthly water level data and three feet for the thickness of the slurry wall. The water-table contours are used to estimate the hydraulic gradient past the end of the slurry wall.

North of Recharge Trench A, the forward gradients are calculated using the FY14 water-table contours and at well pair 26511/26512, where a small forward gradient was present in FY14. The alluvial hydraulic conductivities range from 0.085 to 24.1 ft/day in the hydrogeologic zones in these areas. The upper Denver Formation (sandstone 1U) hydraulic conductivity ranges from 1.18 to 2.79 ft/day (geometric mean = 1.81 ft/day).

Table 6 on page 33 shows that 14.8 and 16.4 lbs/year of contaminant mass are estimated to be extracted based on the dewatering well and BANS influent (PADW1-7) data, respectively. There is a difference of 1.6 lbs/year for the estimated mass extracted. The samples for the BANS influent and dewatering wells were collected on different dates and the concentrations for some of the analytes were different. The same flow rate (12.7 gpm) is used for both estimates, so the plume concentration variability caused the difference in the mass extraction estimates.

The mass flux outside the capture zone is estimated to be 0.94 lbs/year. In FY14, the combined mass flux is 15.7 and 17.4 lbs/year, respectively for the dewatering wells and BANS influent. Five analytes (DIMP, CPMSO2, dithiane, 1,4-oxathiane, and arsenic) comprise approximately 91

and 93 percent of the mass flux for the two calculation methods (i.e., dewatering wells and the BANS influent). DIMP is not a BANS CSRG analyte, but is included in the mass removal performance evaluation because it has significant mass flux. The mass removal calculated using the dewatering well data is 13.6 lbs/year, and 15.3 lbs/year using the BANS influent (PADW1-7) data. Based on these data, the BANS mass removal is estimated to range from 87 to 88 percent of the mass flux during FY14, which exceeds the LTMP performance goal of 75 percent.

The reduction in the extent of the reverse hydraulic gradient in FY14 caused the estimated flow outside the capture zone to increase from 2.1 gpm in FY13 to 4.3 gpm in FY14, and the uncaptured mass flux increased from 0.18 lbs/year in FY13 to 0.94 lbs/year in FY14. However, for the BANS influent calculation, there was only a small decrease in the mass removal estimate (i.e., from 90 percent in FY13 to 88 percent in FY14).

The combined contaminant removal for BANS/CADT/BRES/LB is 242.7 lbs/year as shown in Table 2 on page 3. Subtracting the estimated contaminant removal for BANS, approximately 228 lbs/year of contaminant removal is from the groundwater extracted by the other systems, which is treated in the BANS treatment plant.

The second performance requirement is to demonstrate that concentrations in downgradient performance wells are below CSRGs/PQLs or stable or decreasing if they are above the CSRGs/PQLs. Table 7 on page 39 is an overview of the FY14 water quality results for the BANS performance wells. Figures D-6 through D-8 in Appendix D show the upgradient and downgradient performance well concentrations for chloroform, dieldrin, and dithiane. Time versus concentration graphs in the maps on Figures D-11 through D-14 show the concentrations for arsenic, DIMP, dithiane, and dieldrin, respectively. The concentrations of arsenic and chloroform are below CSRGs in the downgradient wells. Dieldrin concentrations are above the PQL in three of the four downgradient performance wells (26505, 35505, and 35525), but are decreasing in one of the wells (Figure D-14). Concentrations of 12DCLE, CPMSO2, dieldrin, and dithiane increased to above the CSRG/PQL in well 26505 in FY14, likely due to the decreased extent of the reverse gradient. The performance requirement does not apply to DIMP, but DIMP concentrations in well 35525 are above the CBSG of 8 µg/L. Although BANS has no performance requirements for DIMP, the DIMP concentrations in well 35525 have decreased steadily from 200 µg/L in FY10 to 12.5 µg/L in FY13, but increased to 19.6 µg/L in FY14 (Figure D-12). The CPMSO2 and dieldrin concentrations in well 35525 increased in FY14. Although short-term concentration increases occurred for several analytes in FY14, the long-term trends are not increasing, according to Mann-Kendall statistical tests.

Concentrations of one other analyte (PPDDT) has previously been above the CSRG in two downgradient performance wells (wells 35505 and 35525), but was below the CSRG in all four wells in FY14 (see Table 7 on page 39).

2.1.4.3 Compliance Evaluation

Compliance monitoring is water quality monitoring performed for all treatment system effluents at RMA. Each system has a list of compliance analytes for which CSRGs were developed in the On-Post and Off-Post RODs. The system effluent for BANS was analyzed quarterly using the complete On-Post ROD CSRG list.

As shown in Table 4 of the "RMA Treatment Plant Effluent Water Quality Data Report – Fourth Quarter FY14," the four-quarter moving averages for CSRG analytes at BANS did not exceed the CSRGs during FY14. A pdf of the effluent report is available on the attached data CD. Although DIMP is not required to meet a standard at BANS, the effluent concentrations of DIMP were below the CBSG of 8 µg/L during all four quarters of FY14.

2.1.4.4 Quality Assurance Review for BANS

The purpose of the data review is to evaluate data quality with respect to the established DQOs. Components of the data review process include: 1) evaluating the data against the data quality indicators precision, bias, representativeness, completeness, sensitivity, and comparability; 2) reviewing field and laboratory QC results; and 3) evaluating the data for suitability based on the intended use. The data review has determined that the data quality meets or exceeds the established DQOs and is of the correct type, quality, and quantity to support the intended use.

2.1.4.4.1 Precision

A total of 131 duplicate analyses were performed. The duplicate and investigative sample was above the MRL in 51 of the analyses. The RPD was only calculated for the 51 analyses where the duplicate and investigative sample values were above the MRL.

The average RPD for the 51 analyses was 20.8 percent. A total of 14 duplicate pairs were not considered comparable. The non-comparable investigative and duplicate data will be assigned a "Z" data qualifier with the comment "Duplicate and investigative values are not comparable". The data are considered acceptable for their intended use and no additional action in addition to the data qualification is considered necessary. The duplicate pairs determined to be comparable and not comparable are included in Appendix I (Table I-2 and Table I-3, respectively).

2.1.4.4.2 Accuracy/Bias

The average recovery rate for the 209 MS analyses was 98.6 percent. Recovery rates outside the lower or upper limits were observed in 14 analyses; five below the lower limit and nine above the upper limit. No discernible trends or QC issues were observed in the samples exceeding the specified limits. The data are considered acceptable for their intended use and no additional action is considered necessary.

The average recovery rate for the 312 MS analyses was 96.0 percent. Recovery rates outside the lower or upper limits were observed in 29 analyses; 18 below the lower limit and 11 above the upper limit. No discernible trends or QC issues were observed in the samples exceeding the specified limits. The data are considered acceptable for their intended use and no additional action is considered necessary.

2.1.4.4.3 Representativeness

A review of field and laboratory documentation determined that samples were collected and analyzed as specified. Field instruments utilized to collect field measurements were calibrated according to the respective instrument manual and recorded in the Groundwater Sampling Calibration Record database. As a result, the data appropriately reflects the operation of the BANS.

2.1.4.4.4 Completeness

Completeness was calculated at 100 percent. The criterion for the completeness calculation to exceed 90 percent was achieved.

2.1.4.4.5 Comparability

Standard techniques were utilized to collect and analyze samples and the data was reported in the appropriate units. The analytical results reported are equivalent to data obtained from similar analyses and the MRLs met the project goals.

2.1.4.4.6 Sensitivity

Method blank samples were analyzed for each analytical lot. There were no method blank detections above the MRL. Sensitivity is considered acceptable.

2.1.4.4.7 Field QC Samples

A total of 26 field blank analyses; 234 trip blank analyses and; nine rinse blank analyses were performed with no analyses above the MRL. The data are considered acceptable for their intended use and no additional action is necessary.

2.1.4.4.8 Data Usability Evaluation

A data usability evaluation was conducted on 1,121 records. The evaluation identified 16 analyses as statistical outliers. Ten analyses identified as outliers by Dixon's Outlier Test were qualified with a "Z" flag. The Mann-Kendall test for trends identified 89 decreasing analyte trends and 37 increasing analyte trends. A listing of the identified outliers and trends is included in Appendix I (Table I-13 and Table I-14, respectively). Complete data usability information is included on the attached data CD in the Data Usability subfolder.

The evaluation did not positively identify data quality issues, thus the data is considered to be of acceptable quality and meets or exceeds the established DQOs. The data is of the correct type, quality, and quantity to support the intended use.

2.1.4.5 Conclusions and Recommendations

In FY14, the BANS met the treatment plant compliance requirements established in the 2010 LTMP. As shown in Table 4 of the "RMA Treatment Plant Effluent Water Quality Data Report – Fourth Quarter FY14," there were no CSRG-analyte exceedances of the four-quarter moving averages in the BANS treatment system effluent in FY14. A pdf of the effluent report is available on the attached data CD.

In FY14, the BANS met both of the two performance criteria and objectives established in the 2010 LTMP. Therefore, the BANS functioned as intended in FY14. The BANS met the 75 percent mass removal goal for FY14, with mass removal estimated to range from 87 to 88 percent. The concentrations of most analytes are below CSRGs/PQLs in the downgradient performance wells (Table 7 on page 39). Dieldrin concentrations are above the CSRG/PQL in three of the four downgradient performance wells, and are decreasing in one of the wells. The concentrations of several analytes increased to above the CSRGs/PQLs in two downgradient performance wells (26505 and 35525) in FY14, but the long-term trends are not increasing based on Mann-Kendall statistical tests. The reverse hydraulic gradient was reduced due to historically high groundwater levels that were caused by the combined effects of the September 2013 flood event and May 2014 rainstorms.

When the increased concentrations in wells 26505 and 35505 were noted in October 2014, the status of the reverse gradient was evaluated. Although there are no performance requirements for the reverse gradient in the LTMP, the reduced extent of the reverse gradient negatively affected the contaminant concentrations in one of the downgradient performance wells. The dewatering well pumping rates were increased to attempt to increase the extent and magnitude of the reverse gradient.

The BANS total pumping rate has been increased from about 12 gpm at the end of FY14 to over 17 gpm in March 2015. The BANS reverse gradient improved during the first quarter of FY15 and was restored to its historical extent during the second quarter in response to the flow rate increase. Thus, no additional operational adjustments appear necessary.

The Regulatory Agencies were notified about the performance issue on April 2, 2015. The effects of the action taken will be evaluated further during FY15, and any additional measures will be implemented.

Table 7. Overview of FY14 CSRG Analyte Sampling from BANS/CADT/BRES Performance and Operational Well

CSRG Analyte (The concentration in parentheses is the current CSRG for the respective analyte)	BANS/CADT/BRES Performance* and Operational Well Numbers																								
	BANS															CADT	BRES								
	*26307[U]	*26501[D]	*26505[D]	*26507[U]	*35301[U]	*35302[U]	*35303[U]	*35304[U]	*35305[U]	*35306[U]	*35505[D]	*35512[U]	*35514[U]	*35516[U]	*35525[D]	36305	*36555[D]	36563[U]	*36565[U]	*36566[D]	*36567[U]	*36571[D]	*36572[D]	*36575[U]	*36578[U]
DIMP[6] (CBSG = 8 µg/L)	+		+		+	+	+	+	+			+	+		+	+					+				+
111Trichloroethane (200 µg/L)																									
11Dichloroethylene (7 µg/L)																					+				
12Dichloroethane (0.40 µg/L)	+		+			+	+	+	+				+			+		+		+	+				+
12Dichlorobenzene (600 µg/L)																									
13Dichlorobenzene (94 µg/L)																									
14Dichlorobenzene (75 µg/L)																									
Carbon tetrachloride (0.30 µg/L)																					+				
Chlorobenzene (100 µg/L)																									
Chloroform (6 µg/L)																+				+	+				+
Tetrachloroethylene (5 µg/L)																+				+	+			+	+
Trichloroethylene (5 µg/L)																+				+	+				
Dicyclopentadiene (46 µg/L)																									
Benzene (5 µg/L)																+									
Atrazine (5 µg/L)																									
Hexachlorocyclo-pentadiene (50 µg/L)																									
PPDDT (0.10 µg/L)	+								+			+													
Dieldrin[4] (0.002 µg/L)	+		+	+	+	+	+	+		+	+	+	+	+	+	+			+		+				+
Endrin (2 µg/L)																									
Chlorophenylmethyl sulfide (30 µg/L)																									
Chlorophenylmethyl sulfoxide (36 µg/L)													+												
Chlorophenylmethyl sulfone (36 µg/L)			+			+	+	+	+				+		+	+									
1,4-Oxathiane (160 µg/L)																									
Dithiane (18 µg/L)	+		+			+	+	+	+	+			+			+									
Arsenic (50 µg/L)																									
Mercury (2 µg/L)																									

Notes:
1. A plus sign (+) indicates that a reported concentration for a well sample was equal to or higher than the CSRG or PQL for the respective analyte.
2. Shading indicates that the respective well was not sampled for the indicated analyte or the data were not usable in FY14.
3. Blank cells indicate that reported concentrations for the well samples were lower than the CSRG or PQL for the respective analyte.
4. PQL for Dieldrin = 0.013 µg/L. Current certified reporting limit or PQL readily available during FY14.
5. D = Downgradient wells; U = Upgradient wells.
6. DIMP is not a BANS CSRG analyte, but the CBSG is provided for reference.

2.1.5 Bedrock Ridge Extraction System (BRES)

The BRES intercepts groundwater flowing northeast out of Basin A from the Complex Trenches area (see Figure D-18 in Appendix D for the well locations).

Four quarterly water-table maps (Figures D-19 through D-21) indicate that the groundwater was flowing northwest in the vicinity of the extraction wells.

2.1.5.1 Operations

Extraction water from BRES is piped to and treated at BANS. See Section 2.1.4 beginning on page 30 for an explanation of BANS Operations. The distribution of chloroform, DIMP, and tetrachloroethylene in performance wells upgradient and downgradient of the BRES is shown in Figures D-15 through D-17, in Appendix D. The concentrations of all three analytes are above the CSRGs in upgradient wells, with the highest concentrations occurring in well 36567. The tetrachloroethylene concentration in upgradient well 36575 increased and was above the CSRG in FY14, which is the only analyte above the CSRG/PQL in this well.

2.1.5.2 Performance Evaluation

The performance criteria for the BRES are to demonstrate plume capture through visual evaluation of flow directions on potentiometric maps and evaluation of water quality data from performance and operational monitoring wells, and show downgradient performance wells are at or below the CSRGs/PQLs, or show decreasing trends.

Water-table contours are shown in Figures D-19 through D-22 in Appendix D. The map contours indicate that during three of the four quarters, the flow lines, and therefore the plume, likely was captured, including in the middle of the system where bypass occurred previously. During three of the four quarters, contaminant plume capture also was indicated at the west and east edges of the plume. On Figure D-19, extraction well 36303 was not operating when the first quarter water levels were measured. Consequently, capture of the plume in the vicinity of well 36303 is not indicated by the contours. The water levels were measured on October, 15, 2013. Well 36303 was offline from 10/15/2013 to 10/16/13 while the pump was replaced. Because the well was only off for one day, bypass of the plume likely did not occur and plume capture would have been maintained. There were no significant changes in the groundwater flow directions in the BRES during FY14 compared to FY13.

Table 7 on page 39 shows the FY14 water quality results for the BRES performance and operational wells. The LTMP states that the downgradient wells will be monitored for five sampling events (FY10 through FY14) to assess the trends before any performance conclusions are drawn. Concentrations in three of the four downgradient performance wells have decreased to below the CSRGs. Figures D-15 through D-17 and D-23 through D-25 in Appendix D indicate that concentrations in downgradient performance wells 36555, 36571, and 36572 were below the CSRGs for chloroform, DIMP, and tetrachloroethylene. Concentrations in downgradient performance well 36566 were above the CSRGs for chloroform and tetrachloroethylene. Table 7 indicates that the concentrations of 1,2-dichloroethane and trichloroethylene were also above the CSRGs in well 36566. Over the five-year period, concentrations in well 36566 shows decreasing trends for carbon tetrachloride, DIMP, and chloroform and increasing trends for 12DCLE, tetrachloroethylene and trichloroethylene. All of these analytes are present upgradient of the system at much higher concentrations than in well 36566. Additionally, these six analytes have

similar distributions upgradient of the system. If bypass of the system were occurring, it seems that all six analytes would show similar concentration trends in well 36566, but they do not.

Plume capture is indicated on the water-table maps. Well 36566 is located downgradient of extraction well 36302 where the hydraulic gradient is much flatter than at the other downgradient performance wells. Therefore, the contamination in well 36566 would be expected to clean up much slower than in the other wells. Five years of data have now been collected, but this time frame may be too short for evaluating well 36566. Additional monitoring is needed to determine whether the well is appropriate as a downgradient performance well and whether the data from the well indicate system performance. The flow rates for the extraction wells have been relatively consistent and the water-table maps have shown similar configurations during the five-year period, which precludes a decrease in pumping rates as a possible explanation for the increasing concentrations for some of the analytes in downgradient well 36566.

2.1.5.3 Conclusions and Recommendations

In FY14, the BRES likely met the plume capture performance criteria and objectives established in the 2010 LTMP. The quarterly water-table maps indicate that the plume likely was captured both at the center and at the edges of the system. Three of the four downgradient performance wells were below the CSRGs. One well is above the CSRGs for 1,2-dichloroethane, chloroform, tetrachloroethylene, and trichloroethylene. Over the five-year period from FY10 through FY14, chloroform shows a decreasing trend in well 36566, and the other three analytes have increasing trends. A total of eight analytes are present above CSRGs/PQLs upgradient of the system. Four of these analytes have shown decreasing trends in well 36566 and four have shown increasing trends. Well 36566 is located downgradient of the extraction system where the hydraulic gradient is much flatter than at the other downgradient performance wells. Therefore, the contamination in well 36566 would be expected to clean up much slower than in the other wells. Additional data collected in the future will help clarify the issue. Therefore, Army/Shell believes the BRES is functioning as intended. There were no trigger events for BRES during FY14.

2.1.6 Complex Army Disposal Trenches (CADT) Dewatering System

The performance criteria for the CADT dewatering system are based on achieving water elevation goals (i.e., below the bottoms of the disposal trenches), not water quality or mass flux goals. Quarterly water level monitoring is conducted in 11 wells to monitor the hydraulic gradient across the slurry wall, and water levels inside the slurry-wall enclosure, to assess progress toward meeting the dewatering goals (see Figure D-26 for well locations). The groundwater pumped by the CADT dewatering system is treated at the BANS to meet CSRGs and reinjected in the BANS recharge trenches. Consultation trigger events for the Complex Trenches were established based on system compliance requirements, performance criteria, and non-routine operational events that might lead to performance or compliance issues. These triggers, along with notification requirements, type of consultation, and follow-up criteria are presented in Table 5.1-1 of the 2010 LTMP. The table also includes a list of operational trigger events that could potentially result in a compliance or performance issue.

2.1.6.1 Operations

Extraction water from CADT is piped to and treated at BANS. The CADT dewatering well is sampled for informational purposes and the FY14 water quality results are provided in Table 7 on page 39. See section 2.1.4 beginning on page 30 for an explanation of BANS Operations.

2.1.6.2 Performance Evaluation

The performance criteria for the CADT system are to demonstrate that water levels in compliance monitoring wells 36216 and 36217 are below the target elevations of 5226 feet and 5227 feet, respectively, and that the water levels inside the slurry wall are lower than the water levels outside the slurry wall (i.e., maintain an inward gradient). The target elevations correspond to the disposal trench-bottom elevations.

Figure D-2 shows that the FY14 quarterly water levels for well 36216 were below the target elevation for all quarters. FY14 quarterly water levels for well 36217 remained above the target elevation for all quarters, but are trending lower, with the elevation less than one foot above the target elevation during three of the four quarters. As shown in Figure D-2, the inward gradient across the CADT slurry wall was maintained where quarterly water levels were measured in well pairs 36218/36219 and 36220/36221 (see Figure D-26 for well locations).

For cover compliance, the vegetation is expected to be established five years after the cover is constructed and seeded. Consequently, the 2010 LTMP stated that achievement of the dewatering goals is expected to occur by September 9, 2014, after the five-year period required to establish vegetation. The unprecedented 500- to 1000-year storm event in September 2013 affected the groundwater elevations within the Complex Trenches slurry wall, such that the dewatering goals were not attained by September 2014. On September 29, 2014, the Regulatory Agencies were notified about the non-attainment of the dewatering goals. In well 36217, both the long-term water elevation trend and the trend over the five years since the Integrated Cover System was completed (FY10 - FY14) are decreasing, and indicate that progress toward meeting the dewatering goal in well 36217 is being made, even with the September 2013 and May 2014 storms. Consequently, no further action besides continued quarterly monitoring was proposed, and progress toward meeting the goals will be reported in the quarterly effluent reports and ASRs.

2.1.6.3 Conclusions and Recommendations

In FY14 the CADT system met some of the performance criteria and objectives established in the 2010 LTMP. The inward gradient was maintained across the slurry wall and the target water-level elevation goal was met in one of the two compliance wells. However, the water levels remained above the trench-bottom elevation in compliance well 36217. Since some of the dewatering goals have been met and progress toward meeting the remaining goal is being made, no actions besides continued quarterly water level monitoring are recommended. Attainment of the dewatering goals will be evaluated further in the 2015 Five-Year Review.

2.1.7 Shell Trenches

The performance criteria for the Shell Trenches are based on achieving water elevation goals (i.e., below the bottoms of the disposal trenches) (RVO 1997). Quarterly water level monitoring is conducted in 14 wells to monitor the hydraulic gradient across the slurry wall, and water levels inside the slurry-wall enclosure, to assess progress toward meeting the dewatering goals. Consultation trigger events for Shell Trenches were established based on system compliance requirements, performance criteria, and non-routine operational events that might lead to performance or compliance issues. These trigger events, along with notification requirements, type of consultation, and follow-up criteria, are presented in Table 5.2-1 of the 2010 LTMP. The table also includes operational trigger events that could potentially result in a compliance or

performance issue. The performance criterion established in the approved design document (RVO 1997) for the Shell Trenches is presented below.

2.1.7.1 Performance Evaluation

The performance requirement for Shell Trenches is to demonstrate that groundwater elevations are below the disposal trench-bottom elevations within the slurry-wall enclosure shown in Figure E-1 in Appendix E and Table 8 below. Table 8 lists the bores drilled through the disposal trenches where the trench-bottom elevations were determined. The elevation of the water level at each bore location was interpolated using the July 2014 water table and bore locations in Figure E-1. As shown in Table 8, the water elevations were below the bottom of the trenches in all of the bores except at Bore 3453 in July 2014. The July 2014 water elevation is estimated to be 0.4 feet above the trench-bottom elevation at Bore 3453.

The target goals were not required to be achieved until October 2, 2012, after the five-year period required to establish vegetation. The Regulatory Agencies were notified on October 3, 2012 that the goal was not met. The notification indicated that meeting the goal was expected to be achieved during calendar year 2013 based on the water elevation trends in the associated wells. The dewatering goal was first met in July 2013 and continued until October 2013. The September 2013 500- to 1000-year storm, followed by a wet period in May 2014, caused water levels to rise inside the Shell Trenches slurry wall. The water elevation at Bore 3453 was above the trench-bottom elevation in January, April, and July 2014. The Regulatory Agencies were notified that the dewatering goal was not met after the quarterly monitoring results were reviewed.

The September 29, 2014 notification stated that after the effects of the September 2013 and May 2014 storm events have passed, the water elevations inside the slurry wall should decrease and the dewatering goal will be re-attained. Thus, continued quarterly water level monitoring was proposed. Additional notifications will be discontinued and the status will be reported in the Quarterly Effluent Reports and ASRs.

Table 8. Shell Trenches Boring Water Elevations (July 2013) and Trench Bottom Elevations

Bore ID From Figure E-1	FY14 Bore Water Elevation (interpolated from Figure E-1) (feet)	Trench Bottom Elevation (feet)	Bore Water Level Above or Below the Trench Bottom
3178	5239.9	5242.0	Below
3444	5237.8	5244.1	Below
3445	5238.0	5240.5	Below
3446	5237.9	5240.6	Below
3453	5238.1	5237.7	Above
3457	5239.1	5240.8	Below

2.1.7.2 Conclusions and Recommendations

In FY14, the Shell Trenches system met the performance criteria and objectives established in the 2010 LTMP during the first quarter, but not during the subsequent quarters. The historic September 2013 precipitation/flood event and May 2014 storms affected groundwater levels within the Shell Trenches slurry wall, causing the groundwater elevation to be higher than one of the compliance borehole elevations during FY14. Three notifications were issued to the Regulatory Agencies. Attainment of the dewatering goal will be evaluated further in the 2015 Five-Year Review.

2.1.8 Lime Basins Slurry Wall Dewatering System (LB)

Prior to FY11, operation of the LB was reported in the GWMRP annual reports. The GWMRP was completed in FY10, and beginning in FY11, LB information is included in the ASR. Baseline water levels for the slurry-wall project wells were measured on March 25, 2009, and the system started up on March 30, 2009. Figure D-27 is the well location map for the LB area. Figure D-28 shows the reverse gradient plots for the northern and southern wells. Figure D-29 shows the water level trends for the wells inside the slurry-wall enclosure and the total flow rate for the six dewatering wells between March 2009 and September 2014. Figure D-29 also shows the shutdown periods for 1) evaluating DNAPL, 2) decommissioning the CERCLA Wastewater Treatment Facility, and 3) modifying BANS. FY12 was the first full year of operation of the LB. As discussed in Section 1.2.6 beginning on page 4, eight new monitoring wells (four well pairs adjacent to the slurry wall) were installed for the Lime Basins DNAPL Remediation Project in late FY12. FY13 and FY14 water quality data were collected to accommodate the LB and DNAPL Remediation Project monitoring objectives. Since the LB does not have water quality performance criteria, the data are discussed in Section 2.1.9 beginning on page 45.

Regulatory goals and conditions for termination of the Lime Basins dewatering system were established in the Amendment to the ROD (TtEC, 2005). The dewatering goals/standards are summarized as follows:

- Standard: Dewater as necessary to maintain a positive gradient from the outside to the inside of the slurry wall and maintain groundwater level below the level of the LB waste for as long as the surrounding local groundwater table is in the alluvium.
- Standard: Monitor to ensure that the dewatering standard is met. If the groundwater table drops below the level of the alluvium inside the slurry wall, monitor annually thereafter to check that the groundwater table remains below the alluvium inside the wall.
- Standard: Capture and treat contaminated groundwater to meet CSRGs as specified in the ROD. This standard applies to the dewatering system after the CERCLA Wastewater Treatment Facility is decommissioned, and the extracted groundwater is diverted to BANS for treatment. At this point, the contaminated groundwater will be treated to meet the BANS CSRGs.

Establishing an inward hydraulic gradient across the slurry wall is one objective of the dewatering system. Figure D-28 shows the water elevation data for the northern and southern well pairs during FY14. At baseline (March 25, 2009), an outward gradient was present at all six well pairs. The baseline average head differentials were 9.2 feet in the well pairs on the northern side, and 2.4 feet on the southern side. In the fourth quarter of FY12, an outward gradient was present at all the well pairs, and the average head differentials were 5.8 feet on the northern side and 1.3 feet on the southern side of the slurry-wall enclosure. In the fourth quarter of FY14 (September 18, 2014), an

outward gradient was present at all the well pairs on the northern side and, for the first time, an inward gradient was present in all well pairs on the southern side. The average head differentials were 4.5 feet (outward) on the northern side and -0.44 feet (inward) on the southern side of the slurry-wall enclosure. Thus, significant progress was made toward meeting the dewatering goal in FY14.

The second dewatering objective is to lower the water levels inside the slurry-wall enclosure below the bottom of the waste, which is at an elevation of 5,242 feet. The average water elevation inside the slurry-wall enclosure decreased from 5,247.6 feet at baseline, which is 5.6 feet above the base-of-waste elevation, to 5244.4 feet at the end of FY12, which is 2.4 feet above the bottom of the waste. In FY14, the average water elevation on September 18, 2014 was 5,242.5 feet, which is only 0.5 feet above the bottom of the waste. For the first time, the water elevation in one well (36232) was below the waste elevation. Thus, progress also was made toward lowering the water levels below the waste.

With modification of the BANS in FY11, the Lime Basins groundwater has been extracted and treated in batch mode. Figure D-29 shows the intermittent nature of the dewatering system flow rates. The LTMP for Groundwater and Surface Water (TtEC and URS 2010) established a time frame for meeting the Lime Basins dewatering goals based on the time required to establish cover vegetation. Although achieving the Lime Basins dewatering goals does not rely on installation of the Integrated Cover System, the associated revegetation and irrigation may affect the timeframe for meeting the dewatering goals. Due to a variety of factors, achievement of the dewatering goals did not occur by the target date of September 9, 2014, after the five-year period required to establish vegetation. The Regulatory Agencies were notified on September 29, 2014, and the corrective action is to operate the dewatering and treatment systems in a more continuous mode instead of batch mode. Attainment of the dewatering goals will be evaluated further in the 2015 Five-Year Review.

2.1.9 Lime Basins DNAPL Remediation Project

In August 2009, monitoring of the Lime Basins dewatering wells indicated the potential presence of DNAPL. A Remedial Investigation/Feasibility Study (RI/FS) was conducted and three suspected DNAPL source zones were identified in the Lime Basins area:

- at the northwest corner of the Lime Basins, near dewatering wells 36315 and 36320;
- at the northeast corner of the Lime Basins, near dewatering well 36319; and
- approximately 300 feet south-southwest of the southwest corner of the Lime Basins, near wells 36001, 36181, and 36182 (wells 36001 and 36182 are closed).

The DNAPL consists of mixtures of the following five compounds: 1,2-dichlorobenzene (12DCLB), 1,3-dichlorobenzene (13DCLB), 1,4-dichlorobenzene (14DCLB), chlorobenzene (CLC6H5), and dicyclopentadiene (DCPD). The selected remedy consists of DNAPL source containment, removal of DNAPL to the extent practicable, and DNAPL thickness and groundwater monitoring (Tetra Tech and URS, 2012). Operation of the Lime Basins dewatering wells will continue according to the goals and standards for the Lime Basins Slurry Wall Dewatering System (provided in Section 2.1.8 beginning on page 44). The groundwater will be treated at the BANS to meet CSRGs. Eight new monitoring wells (four well pairs adjacent to the slurry wall) were installed in late FY12, and data collection specified in the Design Analysis Report (DAR) (TtEC and URS 2012) began in FY13 and continued in FY14. The Lime Basins

DNAPL Remediation Project FY13 Monitoring Results, Conclusions, and Recommendations (Department of the Army 2015) were presented to the Regulatory Agencies on November 20, 2013. The FY14 results are summarized in this section.

Figure D-27 in Appendix D is the well location map for the Lime Basins area. Lime Basins DNAPL Remediation Project monitoring consists of DNAPL thickness measurements, water-level measurements, and sampling of the dewatering and monitoring wells.

In the Lime Basins DNAPL RI Summary Report (TtEC 2010), the PRAS of the DNAPL compounds was used as a screening tool to assess the potential presence of DNAPL source zones using water quality data. The PRAS is calculated by dividing the aqueous solubility of an analyte by the dissolved concentration of the analyte. A PRAS greater than or equal to 75 percent, either for an individual analyte or for the sum of the five analytes, was considered the threshold for potential DNAPL source zone presence. The results for FY14 are provided in Table 9 below. All of the FY14 Lime Basins water level, DNAPL thickness, and water quality data are provided in the attached data CD.

Table 9. Lime Basins DNAPL Remediation Project. FY14 DNAPL Thickness, PRAS, and DNAPL Removal

Well	**Maximum DNAPL Thickness, feet**	**Maximum Analyte, PRAS, % (≥75% bold)**	**Maximum Summed PRAS, % (≥75% bold)**	**DNAPL Removed, gallons. (date)**
Monitoring Wells				
36054	0	CLC6H5, 0.5	0.5	
36212	0.08 (9/18/14)	14DCLB, 24.0	38.1	
36231	0.17 (1/29/14)	14DCLB, 57.7	**95.6**	
36232	0	14DCLB, 67.1	**111.4**	
36233	0	14DCLB, 34.5	53.7	
36234	0	14DCLB, 12.0	16.8	
36235	0	DCPD, 26.7	55.0	
36236	0	14DCLB, 23.3	39.9	
36237	0	14DCLB, 14.0	21.6	
36238	0	All LT RL	All LT RL	
36239	0	All LT RL	All LT RL	
36240	0	14DCLB, 15.1	23.2	
36241	0	14DCLB, 5.6	6.9	
36242	0	14DCLB, 54.2	**85.1**	
36243	0	14DCLB, 71.1	**117.8**	
36244	0	14DCLB, 47.5	73.0	
36245	0	14DCLB, 38.1	56.6	
36246	0	14DCLB, 22.5	25.4	
36247	0	CLC6H5, 5.8	5.8	
36248	2.0 (4/8/14)	CLC6H5, 5.2	5.2	3.75 (4/22/14)
36249	0	All LT RL	All LT RL	
Dewatering Wells				
36315	0.67 (2/19/14)	14DCLB, 42.1	62.9	
36316	0	14DCLB, 3.7	4.4	
36317	0	14DCLB, 3.3	3.3	
36318	0	14DCLB, 8.1	8.1	
36319	1.5 (4/8/14)	DCPD, 23.3	50.7	2.08 (4/22/14)
36320	0.75 (3/13/14)	14DCLB, 6.17	**106.0**	

The observed presence of DNAPL, PRAS greater than 75 percent for individual compounds, and summed PRAS greater than 75 percent in the wells in Table 9 are consistent with the FY13 results, and indicate that additional suspected DNAPL source zones are present in the vicinity of some of the new monitoring wells. The suspected DNAPL source zone on the west side of the Lime Basins is larger than the RI/FS data indicated based on PRAS greater than 75 percent in new wells 36242, 36243, 36244, and 36245. Additionally, DNAPL was detected in new well 36248, which is located inside the slurry wall on the east slurry-wall segment. The data for the previously existing wells are consistent with the suspected DNAPL source zones characterized in the RI Summary Report. The suspected DNAPL source zones based on the FY13 data are shown on Figure D-30 in Appendix D.

Generally, the DNAPL-related compound concentrations were lower in FY14 than in FY13, with no wells above 75 percent PRAS for individual compounds (five wells were above 75 percent in FY13), and three fewer wells were above 75 percent for summed PRAS (eight wells were above 75 percent Summed PRAS in FY13).

The water quality data for the western DNAPL source zone are consistent with the composition of the DNAPL found in dewatering well 36320. In FY13, the DNAPL found in new well 36248 was analyzed and contained four of the five DNAPL-related compounds. Additionally, the concentrations were above 75 percent PRAS for benzene, ethylbenzene, toluene, tetrachloroethylene, trichloroethylene, and xylenes. The DNAPL composition in well 36248 is different than the DNAPL analyzed previously in dewatering wells 36319 and 36320. The FY14 Lime Basins analytical data are provided on the attached data CD.

DNAPL was not detected in the well adjacent to well 36248 that is located on the outside of the slurry wall (36249), and the concentrations of DNAPL-related compounds in well 36249 were below reporting limits in FY13 and FY14. Thus, future increases in concentrations of the DNAPL-related compounds in well 36249 potentially may be an indicator of impacts to the slurry wall from the DNAPL found in well 36248. Assessment of potential impacts to the slurry wall will also include evaluation of water level data according to the criteria in the DAR.

Figure D-31 in Appendix D is the Lime Basins water-table map for September 2014. The hydraulic gradient is very flat inside the slurry wall, ranging from 0.0022 to 0.0043 ft/ft. The maximum head differential from the southeast corner to the northwest corner has decreased from 1.86 feet in April 2009 to 1.43 feet in September 2014. There are no depressions in the water table other than those created by the dewatering wells. Additionally, there is no apparent deviation of water levels in the wells adjacent to the slurry wall that would indicate an impact to the performance of the slurry wall.

The water level data discussed above and in the previous section indicate that the slurry wall has not been impacted by DNAPL according to criteria in the DAR. Consistent head differentials across the slurry wall have been maintained for all the well pairs. Consequently, the Lime Basins DNAPL Remediation Project is functioning as intended. During FY14, a total of 5.8 gallons of DNAPL was removed in April 2014; 3.75 gallons was removed from monitoring well 36248, and 2.08 gallons was removed from dewatering well 36319. Modification of the Lime Basins DNAPL monitoring program for FY14 and subsequent years is documented in OCN-LTMP-2014-001.

2.1.10 North Plants Pilot LNAPL Removal Action

An LNAPL pilot removal system was implemented in 2008 to perform LNAPL removal for a historical release of fuel oil in the North Plants, and to gather operating data for the potential design of a full-scale LNAPL removal action. The design of the pilot removal action is presented in the North Plants LNAPL Removal System Action Plan (TtEC and URS 2009). A separate evaluation report was issued for the LNAPL Removal Action prior to FY12 (URS 2012). As discussed in the report, over two years of monitoring was conducted in the North Plants LNAPL recovery and monitoring wells without detection of sufficient quantities of LNAPL in these wells to support the removal of LNAPL. Quarterly monitoring for the remainder of the current Five-Year Review period will be conducted, and beginning in FY12, the North Plants data are presented in the ASRs (URS 2012).

Figure E-2 in Appendix E shows the well locations, July 2014 water elevations, and LNAPL extent during previous years. No measurable LNAPL was present in the wells during July 2014, so using corrected hydraulic heads to depict the water table, as done in previous years, was not necessary. The flow directions and hydraulic gradients in Figure E-2 are consistent with previous years.

As mentioned above, no LNAPL was measured in July 2014 and Figure E-2 shows the thickness and LNAPL extent for previous years (i.e., 2004, 2007, and 2010). As shown on the figure, the extent of LNAPL has decreased significantly over time.

Figures 2 and 3 on page 49 show the water elevation, LNAPL elevation, and LNAPL thickness in wells 25125 and 25134 since 2003. Wells 25125 and 25134 were selected for the graphs because they were the only wells containing LNAPL during the previous years (FY12 and FY13). The graphs show rising water levels and decreasing LNAPL thickness overall from 2004 to 2010. The water table was relatively stable from 2010 until 2012, and fell about 0.75 feet in 2012. The FY13 water levels were more stable and there was not an increase in LNAPL thickness following the 2012 lowering of the water table. The FY14 water levels show a rising trend, with a spike in well 25134 after the September 2013 flood. The water level data in these two wells are similar to the data in other wells presented in previous project reports. Consequently, graphs of the other wells are not included. All of the FY14 North Plants water level and LNAPL thickness data are provided in the attached data CD.

Except for an LNAPL thickness of 0.24 inch (0.02 feet) measured in well 25125 in October 2013, no measurable LNAPL was detected in the North Plants wells during FY14. A rising water table prior to and during the pilot study likely caused the apparent thickness and extent of LNAPL to decrease, and explains the lack of entry of LNAPL into the recovery wells. The thickness of LNAPL in the formation probably is insufficient to overcome the entry capillary pressure. A falling water table may cause the apparent thickness of LNAPL in the wells to increase if sufficient potentially mobile LNAPL is still present in the formation. Based on the previous data, a decrease in water elevations of a least one foot for six months or longer may be required for the apparent thickness of LNAPL in the wells to increase significantly (URS 2012). Since this scenario was approximated during 2012/2013, yet the LNAPL thickness did not increase appreciably, potentially mobile LNAPL may no longer be present. A minimum apparent thickness of six inches is needed in the recovery wells for bail-down testing to be conducted, which would precede recovery operations. The future of the LNAPL Removal Project will be evaluated during the 2015 Five-Year Review.

Figure 2. Chart for Piezometer 25125

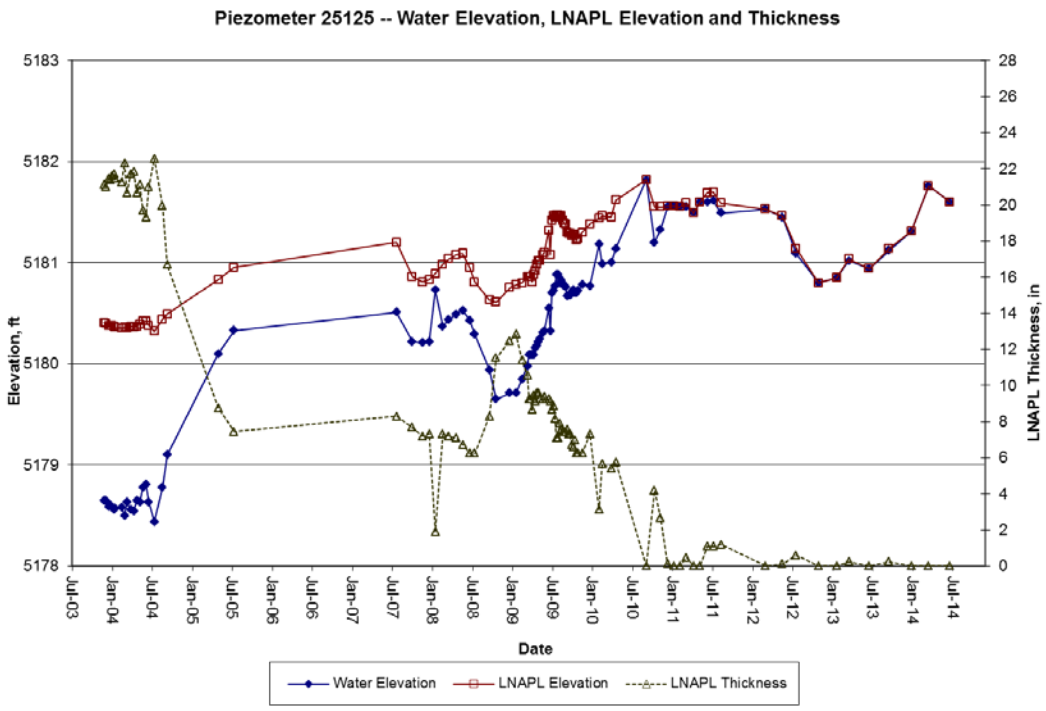
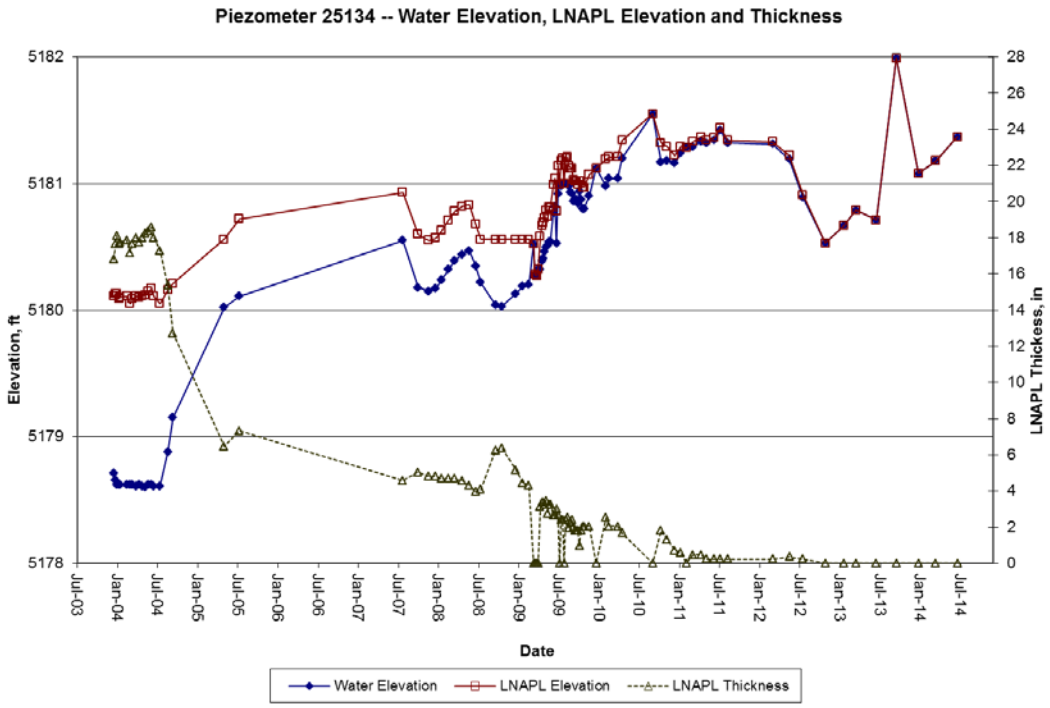


Figure 3. Chart for Piezometer 25134



2.2 Post-Shut-Off Monitoring

Post-Shut-Off monitoring was conducted for the GWMRP and MPS/ICS in FY14.

2.2.1 GWMRP

The GWMRP in the Lime Basins and STF was completed in 2010. Operations and monitoring for the Lime Basins Slurry Wall Dewatering System and DNAPL Remediation Project are ongoing. Consequently, no GWMRP post-shut-off monitoring for the Lime Basins was required.

Due to changes in the hydrology in the STF area caused by South Plants remediation and cover construction, a post-shut-off monitoring program was developed to monitor the STF benzene plume and assess potential impacts on Lower Derby Lake for a period of five years. This monitoring program is described in the GWMRP Post-Shut-Off Monitoring Sampling and Analysis Plan (URS 2012a) and summarized below. The data will be reported in the ASRs for Groundwater and Surface Water, and the long-term concentration trend will be evaluated in the Five-Year Groundwater Summary Reports. Consultation with the Regulatory Agencies will be conducted to discuss the monitoring results when the five years of post-shut-off monitoring is complete in 2016.

Monitoring wells 01600, 01670, and 01687 are to be sampled annually for five years, and extraction well 01312 is sampled twice-in-five years under the LTMP water quality tracking category (sampled in FY14). Benzene is the only Contaminant of Concern (COC) for the GWMRP post-shut-off monitoring. Figure E-3 in Appendix E is the well location map from the GWMRP SAP, and also shows September 2010 water-table contours and the 2009 high-concentration benzene plume (greater than 50 mg/L) for reference. The GWMRP post-shut-off water level network consists of fewer wells than in 2010 when the GWMRP was in operation, and includes wells in the 2010 LTMP water level tracking network, which are measured and mapped annually (Figure H-1 in Appendix H). The 2010 water-table contours are shown on Figure E-3 because the well network was larger, and it provides more detail on the flow directions under natural gradient conditions.

The FY14 water-table contours in the STF area (Figure H-1) are similar to those shown on Figure E-3 (September 2010). Water levels in the sampled wells were higher in FY14 compared to FY13 by a range of 4.0 to 9.3 feet. The higher water levels in FY14 were caused by the historic September 2013 rain/flood event, followed by a wet period during May 2014. No significant changes in flow directions are indicated, however.

The DQOs in the SAP specify that no additional action (besides continued monitoring per the SAP) is required if the benzene concentrations in monitoring wells 01600, 01670, and 01687 do not indicate an increasing trend above 80 percent of the historical maximum concentration for each well. These maximums and the FY14 benzene results are provided as shown Table 10 below.

Table 10. GWMRP Post-Shut-Off Benzene Results

Well	Sample Date during FY14	Historical Maximum Benzene Concentration, µg/L	FY14 Benzene Concentration, µg/L	Exceeds 80% of Historical Maximum
01600	9/9/2014	3.1	LT 0.2	No
01670	8/19/2014	3,040	LT 0.2	No
01687	8/20/2014	78.2 (1,170 in FY12)	LT 0.2	No
01312	9/22/2014	Not Applicable	1,320,000	Not Applicable
01049 (added in FY13)	8/20/2014	LT 2.7	LT 0.2	No

The benzene concentration in monitoring well 01687 exceeded the historical maximum in FY12. Consequently, monitoring well 01049 was added to the network in FY13 to monitor the area downgradient of well 01687. The benzene concentrations in all monitoring wells sampled in FY14 were below the MRL, which was LT 0.2. It is likely that the higher benzene concentrations in well 01687 in FY12 decreased to below detectable levels in FY14 due to naturally occurring biodegradation, which was previously determined to be occurring in the STF benzene plume. Former GWMRP extraction well 01312 is also sampled and monitored for water levels and the presence of benzene LNAPL. The benzene concentration of 1,320,000 µg/L was similar to previous concentrations. No LNAPL was detected in well 01312 in FY14.

These data indicate that the STF benzene plume is stable or receding and is not migrating toward the South Lakes.

2.2.1.1 Quality Assurance Review for GWMRP

The purpose of the data review is to evaluate data quality with respect to the established DQOs. Components of the data review process include: 1) evaluating the data against the data quality indicators precision, bias, representativeness, completeness, and comparability; 2) reviewing field and laboratory QC results; and 3) evaluating the data for suitability based on the intended use. The data review has determined that the data quality meets or exceeds the established DQOs and is of the correct type, quality, and quantity to support the intended use.

2.2.1.1.1 Precision

Due to the limited scope of the GWMRP sampling program, no duplicate analyses were performed.

2.2.1.1.2 Accuracy/Bias

There were two MS analyses in association with the GWMRP. The average recovery rate for the MS analyses was 83.1percent with no recoveries outside the evaluation limits. The average recovery rate for the two LCS analyses was 92.0 percent. Recovery rates outside the lower or upper limits were not observed. The data are considered acceptable for their intended use and no additional action is considered necessary.

2.2.1.1.3 Representativeness

A review of field and laboratory documentation determined that samples were collected and analyzed as specified. Field instruments utilized to collect field measurements were calibrated according to the respective instrument manual and recorded in the Groundwater Sampling Calibration Record database. As a result, the data appropriately reflects the operation of the GWMRP.

2.2.1.1.4 Completeness

Completeness was calculated at 100 percent. The criterion for the completeness calculation to exceed 90 percent was achieved.

2.2.1.1.5 Comparability

Standard techniques were utilized to collect and analyze samples and the data was reported in the appropriate units. The analytical results reported are equivalent to data obtained from similar analyses and the MRLs met the project goals.

2.2.1.1.6 Sensitivity

Method blank samples were analyzed for each analytical lot. There were no method blank detections above the MRL. Sensitivity is considered acceptable.

2.2.1.1.7 Field QC Samples

Due to the limited scope of the GWMR sampling program; no field QC samples were collected. The data are considered acceptable for their intended use and no additional action is necessary.

2.2.1.1.8 Data Usability Evaluation

A data usability evaluation was conducted on 13 records. The evaluation identified no analyses as statistical outliers. The Mann-Kendall test for trends identified no decreasing or increasing analyte trends. Complete data usability information is included on the attached data CD in the Data Usability subfolder.

The evaluation did not positively identify data quality issues, thus the data is considered to be of acceptable quality and meets or exceeds the established DQOs. The data is of the correct type, quality, and quantity to support the intended use.

2.2.2 MPS/ICS

In FY14, three wells were sampled for MPS/ICS post-shut-off monitoring (wells 04021, 04535, and 33081). Figure E-4 in Appendix E shows the well locations. Wells 04021 and 04535 are downgradient of the MPS and were sampled for TRCLE. Well 33081 is between the RYCS and former ICS, and was sampled for DBCP. The concentrations in all three wells were below the respective CSRGs (5 µg/L for TRCLE and 0.2 µg/L for DBCP). The TRCLE concentrations were 0.201 µg/L in well 04021 and 1.05 µg/L (1.06 µg/L duplicate) in well 04535. The DBCP concentration was LT 0.0198 µg/L in well 33081.

In the MPS/ICS Post Shut-Off Monitoring SAP (URS 2012b), the goals of the study are to determine if concentrations are above the CSRGs or are increasing or migrating offpost. The TRCLE concentration in well 04535 decreased from 2.16 µg/L in March 2013 to 1.06 µg/L in May 2014. Water levels were significantly higher in well 04535 (3.68 feet higher) in July 2014 than in July 2013. The water level and water quality data are included in the attached data CD. Since the SAP criteria were met, monitoring will continue according to the MPS/ICS SAP.

The water level in well 04048, which is closer to the historical Motor Pool TRCLE source than well 04535, is measured to distinguish potential regional and local changes, and to determine the hydraulic gradient between the source and well 04535. Only water level data are collected in well 04048, and both water level and water quality data are collected in well 04535. The historical difference in water elevations between wells 04048 and 04535 has been very consistent

over time, approximately 6 feet during 1998 through 2002, when both wells were last measured consistently. The wells were measured on the same date in FY14, and the water elevation difference between the wells was 5.74 feet. Thus, the hydraulic gradient between the two wells was very similar to the historical gradient, and with no apparent change due to local influences. Additionally, the gradient remained the same even though the water levels in the Motor Pool wells rose to historic highs after the September 2013 storm. The July 2013 to July 2014 water elevation increases were similar in wells 04048 (3.61 feet) and 04535 (3.68 feet). Thus, the water level trend in well 04535 appears regional.

2.2.2.1 Quality Assurance Review for MPS/ICS

The purpose of the data review is to evaluate data quality with respect to the DQOs. Components of the data review process include: 1) evaluating the data against the data quality indicators precision, bias, representativeness, completeness, sensitivity, and comparability; 2) reviewing field and laboratory QC results; and 3) evaluating the data for suitability based on the intended use. The data review has determined that the data quality meets or exceeds the established DQOs and is of the correct type, quality, and quantity to support the intended use.

2.2.2.1.1 Precision

A total of six duplicate analyses were performed. The duplicate and investigative sample results were above the MRL in one of the analyses. The RPD was only calculated for the single analysis where the duplicate and investigative sample values were above the MRL.

The RPD value for the single analysis was 0.9 percent. All duplicate pairs were considered comparable. The data are considered acceptable for their intended use and no additional action is considered necessary. The duplicate pairs determined to be comparable are included in Appendix I (Table I-2).

2.2.2.1.2 Accuracy/Bias

There were no MS or LCS analyses associated with the MPS/ICS. The data are considered acceptable for their intended use and no additional action is considered necessary.

2.2.2.1.3 Representativeness

A review of field and laboratory documentation determined that samples were collected and analyzed as specified. Field instruments utilized to collect field measurements were calibrated according to the respective instrument manual and recorded in the Groundwater Sampling Calibration Record database. As a result, the data appropriately reflects the operation of the MPS/ICS.

2.2.2.1.4 Completeness

Completeness was calculated at 100 percent. The criterion for the completeness calculation to exceed 90 percent was achieved.

2.2.2.1.5 Comparability

Standard techniques were utilized to collect and analyze samples and the data was reported in the appropriate units. The analytical results reported are equivalent to data obtained from similar analyses and the MRLs met the project goals.

2.2.2.1.6 Sensitivity

Method blank samples were analyzed for each analytical lot. There were no method blank detections above the MRL. Sensitivity is considered acceptable.

2.2.2.1.7 Field QC Samples

Field QC analyses consisted of one rinse blank analysis which was below the MRL. The data are considered acceptable for their intended use and no additional action is necessary.

2.2.2.1.8 Data Usability Evaluation

A data usability evaluation was conducted on two records. The evaluation identified no analyses as statistical outliers. The Mann-Kendall test for trends identified a single site ID/analysis as exhibiting a decreasing trend. A listing of the identified outliers and trends is included in Appendix I (Table I-13 and Table I-14, respectively). Complete data usability information is included on the attached data CD in the Data Usability folder.

The evaluation did not positively identify data quality issues, thus the data is considered to be of acceptable quality and meets or exceeds the established data quality objectives. The data is of the correct type, quality, and quantity to support the intended use.

2.3 Site-Wide On-Post Monitoring

The site-wide on-post monitoring evaluation includes data from water level tracking, water quality tracking, and CFS monitoring. Water level monitoring for water level tracking is performed annually and a water level contour map is used to present the results. The site-wide water level map (Figure H-1 in Appendix H) is included in the ASRs. The 2015 FYSR for Groundwater and Surface Water will include an assessment of the water level contours over the five-year review period that will identify any issues and possible recommendations for changes in network or monitoring approach. The twice-in-five year and once-in-five year water quality tracking and the twice-in-five year CFS monitoring well networks were sampled in FY14. The FY14 data collected for these networks can be found in the attached data CD at the back of this report. The results of these monitoring programs will be evaluated in the 2015 FYSR, which will provide information for the 2015 FYRR.

2.3.1 Water Level Tracking

Water level tracking, which includes measuring on-post and off-post water levels and determining groundwater flow directions, is the primary means of tracking the effects of remedy activities. Water levels were measured in both on-post and off-post water-level wells in FY14. These water levels were used to produce a site-wide water-table contour map shown in Figure H-1 in Appendix H. A pdf of the full-sized, site-wide water-table map, with the water elevation data plotted, is included in the attached data CD.

2.3.2 Water Quality Tracking

The Water Quality Tracking network, shown in Figure H-2 in Appendix H, was sampled in FY14. Wells scheduled to be sampled once-in-five years (at the contaminant source areas) were sampled in FY12, but were sampled again in FY14 under a separate 2014 On-Post Plume Mapping task. The results of the chemical analyses are listed on the attached data CD. The Water Quality Tracking and On-Post Plume Mapping results will be discussed in the 2015 FYSR.

2.3.2.1 Quality Assurance Review for Water Quality Tracking Wells

The purpose of the data review is to evaluate data quality with respect to the established DQOs. Components of the data review process include: 1) evaluating the data against the data quality indicators precision, bias, representativeness, completeness, and comparability; 2) reviewing field and laboratory QC results; and 3) evaluating the data for suitability based on the intended use. The data review has determined that the data quality meets or exceeds the established DQOs and is of the correct type, quality, and quantity to support the intended use.

2.3.2.1.1 Precision

Field duplicates were collected in the field at the time of investigative sample collection and were analyzed by the laboratory. A total of 38 duplicate analyses of tracking analytes were performed. The duplicate and investigative sample results were above the MRL in 24 of the analyses. The RPD was only calculated for the 24 analyses where the duplicate and investigative sample values were above the MRL.

The average RPD for the 24 analyses was 6.1 percent. All duplicate pairs were considered comparable with the exception of six analyses. The non-comparable investigative and duplicate data will be assigned a "Z" data qualifier with the comment "Duplicate and investigative values are not comparable". The data are considered acceptable for their intended use and no additional action in addition to the data qualification is considered necessary. The duplicate pairs determined to be comparable and not comparable are included in Appendix I (Table I-2 and Table I-3, respectively).

2.3.2.1.2 Accuracy/Bias

The average recovery rate for the 29 MS analyses of water quality tracking analytes was 67.4 percent. Recovery rates outside the lower or upper limits were observed in eight analyses; four below the lower limit and four above the upper limit. The average recovery rate for the 25 LCS analyses was 99.3% percent. Recovery rates were within the lower or upper limits with the exception of five analyses; one below the lower limit and four above the upper limit.

The percent recoveries were outside the evaluation limits for both the MS and LCS analyses for the diisopropylmethyl phosphonate (DIMP) analyses in analytical lots ACES and ABUT. Lot ABUT (DIMP) was recommended for rejection by the laboratory. The affected samples were re-collected within approximately one month from the original sample date. Based on the laboratory recommendation, Lot ABUT was placed in the Rejected table of the RMAED. The analyst noted low surrogate recoveries associated with Lot ACES (DIMP) for samples collected from well 23095 and the MS for the lot. Based on the analyst's comments, the affected samples was qualified with a "Z" flag indicating low surrogate recoveries. No additional action is considered necessary based on the analyst's notes in the data package. Additional information related to these analyses is included in Appendix I (Table I-6).

No discernible trends or QC issues were observed in the remaining samples exceeding the specified limits. The data are considered acceptable for their intended use and no additional action is considered necessary.

2.3.2.1.3 Representativeness

A review of field and laboratory documentation determined that samples were collected and analyzed as specified. The data are representative of contamination concentrations in and downgradient of source areas within the identified plumes.

2.3.2.1.4 Completeness

The criterion for the completeness calculation to exceed 90 percent was achieved. Completeness was calculated at 99.6 percent. A single water quality tracking analysis was rejected due to no method target analytes present in the LCS or MS. Rejected samples are listed in Appendix I (Table I-8).

2.3.2.1.5 Comparability

Standard techniques were utilized to collect and analyze samples and the data was reported in the appropriate units.

2.3.2.1.6 Field QC Samples

A total of 15 field blank analyses were performed with no analyses above the MRL. The data are considered acceptable for their intended use. A total of 13 trip blank analyses were performed with no results above the MRL. A total of 28 rinse blank analyses were performed with 3 results above the MRL. No further action is required as the investigative value is less than the rinse blank value in all three cases.

2.3.2.1.7 Data Usability Evaluation

A data usability evaluation was conducted on 433 records. The evaluation identified five analyses as statistical outliers. Four of the values were qualified with a “Z” flag and identified as statistical outliers in the associated comment. The remaining value was not qualified as an insufficient amount of historical data exists to positively identify the value as an outlier.

The Mann-Kendall test for trends identified 25 decreasing trends and five increasing analyte trends. A listing of the identified outliers and trends is included in Appendix I (Table I-13 and Table I-14, respectively). Complete data usability information is included on the attached data CD in the Data Usability subfolder.

The evaluation did not positively identify data quality issues, thus the data is considered to be of acceptable quality and meets or exceeds the established DQOs. The data is of the correct type, quality, and quantity to support the intended use.

2.3.3 Confined Flow System Monitoring

The CFS monitoring well network, shown in figure H-3 in Appendix H, was sampled in FY14. This network is sampled twice-in-five years. The analyte concentrations from the FY14 sampling are listed in the attached data CD. The results of the FY12 and FY14 sampling events will be discussed in the 2015 FYSR.

2.3.3.1 Quality Assurance Review for Confined Flow-System Monitoring

The purpose of the data review is to evaluate data quality with respect to the established DQOs. Components of the data review process include: 1) evaluating the data against the data quality indicators precision, bias, representativeness, completeness, and comparability; 2) reviewing field and laboratory QC results; and 3) evaluating the data for suitability based on the intended use. The data review has determined that the data quality meets or exceeds the established DQOs and is of the correct type, quality, and quantity to support the intended use.

2.3.3.1.1 Precision

Field duplicates were collected in the field at the time of investigative sample collection and were analyzed by the laboratory. A total of eight duplicate analyses of CFS analytes were performed. The duplicate and investigative sample results were above the MRL in five of the analyses. The RPD was only calculated for the five analyses where the duplicate and investigative sample values were above the MRL.

The average RPD for the five analyses was 2.5 percent. All duplicate pairs were considered comparable. The data are considered acceptable for their intended use and no additional action is considered necessary. The duplicate pairs determined to be comparable are included in Appendix I (Table I-2).

2.3.3.1.2 Accuracy/Bias

The average recovery rate for the eight MS analyses of CFS analytes was 88.7 percent. Recovery rates outside the lower or upper limits were not observed. The average recovery rate for the eight LCS analyses was 89.2% percent. Recovery rates were within the lower or upper limits with the exception of two analyses; both below the lower limit.

2.3.3.1.3 Representativeness

A review of field and laboratory documentation determined that samples were collected and analyzed as specified. The data are representative of contaminant concentrations in the CFS.

2.3.3.1.4 Completeness

The criterion for the completeness calculation to exceed 90 percent was achieved. Completeness was calculated at 100 percent.

2.3.3.1.5 Comparability

Standard techniques were utilized to collect and analyze samples and the data was reported in the appropriate units.

2.3.3.1.6 Field QC Samples

A total of two field blank; three trip blank and; three rinse blank analyses were performed with no analyses above the MRL. The data are considered acceptable for their intended use. A total of 13 trip blank analyses were performed with no results above the MRL. A total of 28 rinse blank analyses were performed with three results above the MRL. No further action is required as the investigative value is less than the rinse blank value in all three cases.

2.3.3.1.7 Data Usability Evaluation

A data usability evaluation was conducted on 45 records. The evaluation identified a single analysis as a statistical outlier. The value was not qualified as the historical samples had been filtered and present methodology does not require filtering. The Mann-Kendall test for trends identified two decreasing and no increasing trends. A listing of the identified outliers and trends is included in Appendix I (Table I-13 and Table I-14, respectively). Complete data usability information is included on the attached data CD in the Data Usability subfolder.

The evaluation did not positively identify data quality issues, thus the data is considered to be of acceptable quality and meets or exceeds the established DQOs. The data is of the correct type, quality, and quantity to support the intended use.

2.3.4 Surface Water Monitoring

An On-Post Short-Term Surface Water Sampling program was implemented in FY12 and continued in FY13 to confirm that surface water quality is not adversely impacted by cover soils during the establishment of cover vegetation and that groundwater plumes are not migrating into the lakes. The surface water sampling locations are shown on Figure H-4 in Appendix H. The sample locations include:

- Borrow Area 5 Pond Outlet (SW24005),
- Former Basin E Pond Outlet (SW26002),
- North Plants (SW25101 or SW25102),
- Lake Ladora (SW02020, SW02021, and SW020009), and
- Lower Derby Lake (SW01006).

The seven sites were not sampled in FY14, but selected sites will be sampled in FY15, dependent on sufficient volume for sample collection.

3.0 Off-Post Operations Monitoring Programs

3.1 Off-Post Groundwater Intercept and Treatment System (OGITS)

The OGITS consists of the First Creek Pathway System (FCS) and the Northern Pathway System (NPS) and a treatment plant that treats the combined extracted water from both systems with carbon adsorption. The FCS consists of five extraction wells, two of which have been shut down since early FY04, and six recharge trenches (see Figure F-17 in Appendix F). The NPS is located near Highway 2, north of 104th Avenue, and is bisected by Peoria Street (see Figure G-1 in Appendix G). The NPS consists of 15 extraction wells (one of which was shut down in FY04), 18 recharge wells, and five recharge trenches. There are pipelines from both systems for conveyance of extracted water to the treatment plant at Peoria Street and for conveyance of treated water from the treatment plant to the recharge wells and recharge trenches at the NPS and the recharge trenches at the FCS. The FCS began operation in January 1993 and the NPS began operating in May 1993. Both the groundwater contaminant concentrations and the areal extent of groundwater contamination have significantly decreased since operation of the OGITS began.

3.1.1 OGITS Operations

The OGITS operated at an average flow rate that was reported as 209.3 gpm, but was found to be approximately two percent too high because of constricted flow in the FCS and NPS pipes that affected the accuracy of the flow meters. The FY14 average flow rate was corrected to be 204.8 gpm based on flow testing in FY14. Inspection and cleaning of the meters and annual flow testing was implemented beginning in FY13 to calibrate the flow meters. Additionally, gears in the FCS and NPS influent flow meters were replaced in FY13 based on the testing to more accurately match the actual flow rate. Using the corrected flow rate, a total volume of 107,663,904 gallons was pumped during FY14 (see Table 2 on page 3). The flow at the OGITS treatment system is taken from extraction wells at the FCS and the NPS. Figure F-17 in Appendix F (for the FCS) and Figure G-1 in Appendix G (for the NPS) show the OGITS monitoring wells, extraction wells, recharge wells, and recharge trenches.

One way to illustrate the CSRG analytes approaching the two systems in the shallow groundwater is to look at the distribution of arsenic, chloroform, chloride, DBCP, dieldrin, DIMP, n-nitrosodimethylamine (NNDMEA), and tetrachloroethylene (TCLEE) in performance wells upgradient of the FCS and NPS as shown on graphs in Figures F-9 through F-16 in Appendix F. The figures also show the downgradient performance wells. All arsenic concentrations (Figure F-9) were below the CSRG. All chloroform concentrations in the upgradient performance wells (Figure F-10) were below the CSRG. Chloride concentrations (Figure F-11) were above the CSRG in four of the six upgradient FCS performance monitoring wells and the three extraction wells, and four upgradient NPS performance wells. All DBCP concentrations (Figure F-12) were below the CSRG. Dieldrin concentrations (Figure F-13) were above the PQL in three upgradient performance wells at the FCS and in seven of the upgradient NPS wells, located at the west end and center of the NPS. DIMP concentrations (Figure F-14) were above the CSRG in four upgradient performance wells in the northern part of the FCS, and in the three extraction wells. DIMP concentrations were below the CSRG in all the NPS wells. NNDMEA and TCLEE concentrations (Figures F-15 and F-16) were below the PQL/CSRG at all upgradient performance wells.

The OGITS treatment plant influent and effluent concentrations for arsenic, chloroform, chloride, DBCP, dieldrin, DIMP, NNDMEA, and TCLEE are shown in Figures F-1 through F-8. Except for chloride, the graphs indicate that the treatment plant effluent concentrations were below the CSRGs/PQLs in FY14. The FY14 four-quarter average for chloride was below the CSRG, however. The sulfate concentrations in the OGITS effluent were below the CSRG during all four quarters. The inorganic standards for chloride and sulfate at OGITS were expected to be met by attenuation consistent with the On-Post ROD and were met for the first time in FY14.

For FY14, an overview of CSRG-analyte sampling in wells at the FCS and NPS are summarized in Tables 12 through 15 on pages 69 to 73. Table 12 lists the First Creek Pathway performance and operational wells, and Tables 13, 14, and 15 list the Northern Pathway performance, operational, and extraction wells, respectively.

The 2010 LTMP updated the performance criteria for OGITS. These criteria are: to demonstrate effective mass removal of each organic CSRG analyte, and to demonstrate that concentrations in downgradient performance wells are below CSRGs/PQLs or are stable or decreasing.

3.1.2 Performance Evaluation, including OGITS Mass Removal Evaluation

One performance criterion for the OGITS is to demonstrate effective mass removal of each organic CSRG analyte. As discussed previously for the BANS, prior to FY10, there were no quantitative mass removal criteria for evaluating the performance of the OGITS. Beginning in FY10, 75 percent mass removal was set as the goal in the 2010 LTMP (TtEC and URS 2010), pending further evaluation after collecting additional data for five years. This evaluation period may be reduced to fewer than five years, however. As opposed to treatment system compliance with CSRGs, the mass removal criterion refers to removing at least 75 percent of the contaminant plume mass migrating toward the system during a specified time period (mass flux). Wells were included in the FCS and NPS upgradient performance well network in the 2010 LTMP to provide more data for estimating the mass flux and mass removal for future performance evaluations.

The performance criterion is to compare upgradient mass flux to the mass extracted by the extraction wells and removed by the treatment plant. The majority of the contaminated groundwater flow is captured by the FCS extraction system, but not all of the groundwater flow is captured. Thus, the well capture method will be used to estimate the mass flux within the system capture zone and the transect method will be used to estimate the mass flux outside of the capture zone for the FCS. The methodology in the 2010 LTMP was revised for the FCS in OCN-LTMP-2012-002 (2013). Since the extraction wells are used in the mass flux calculations for the FCS, they were re-designated as performance water quality wells in the OCN. The transect method was retained for estimating the NPS mass flux.

The FCS FY14 quarterly water-table maps are Figures F-18 through F-21 in Appendix F, and show the capture zone each quarter. In FY14, the manner in which the water-table contours are drawn near the inactive recharge trenches (i.e., RT-1 and RT-2) was changed. The trenches are gravel-filled and have higher hydraulic conductivity than the adjacent formation. Consequently, when the trench is not receiving flow, the groundwater elevation is flat within the trench. When a water-table contour intersects RT-1 or RT-2, the contour is drawn around the downgradient end

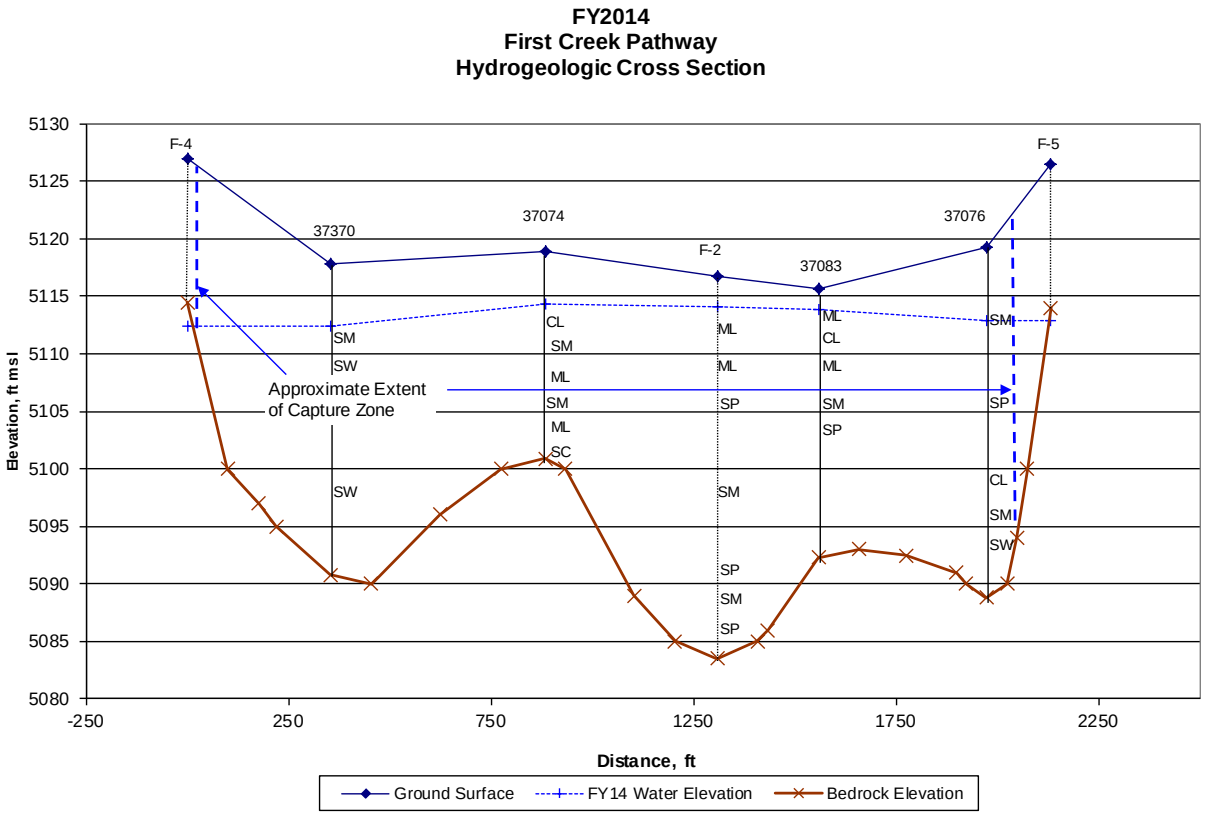
of the trench. The trench piezometer data supports this approach. Figures F-18 and F-21 illustrate this concept.

Since the OGITS treatment plant treats the combined flow from the FCS and NPS, the treatment plant monitoring data are not FCS- or NPS-specific. Thus, the mass removed by the FCS and NPS is calculated separately based on the difference between the annual average concentrations for the FCS and NPS extraction wells and the OGITS treatment plant annual average effluent (PPEFEF) concentrations, multiplied by the average annual flow rates for the extraction wells. The equivalent calculations are done for the FCS and NPS influents (PPINFC and PPINNP) for comparison to the sums of the individual extraction well data for the FCS and NPS. The mass removed for the combined flow from the FCS and NPS also is calculated for OGITS (Table 2 on page 3) and is discussed in Section 3.1.2.3 on page 67.

Figures 4 and 5 on pages 62 and 63 show the hydrogeologic cross sections for the FCS and NPS, respectively. The cross sections consist of the upgradient FCS and NPS performance wells and additional FCS bedrock elevation points based on the RMA bedrock contour map. The approximate capture zone for the FCS is shown on the corresponding figure.

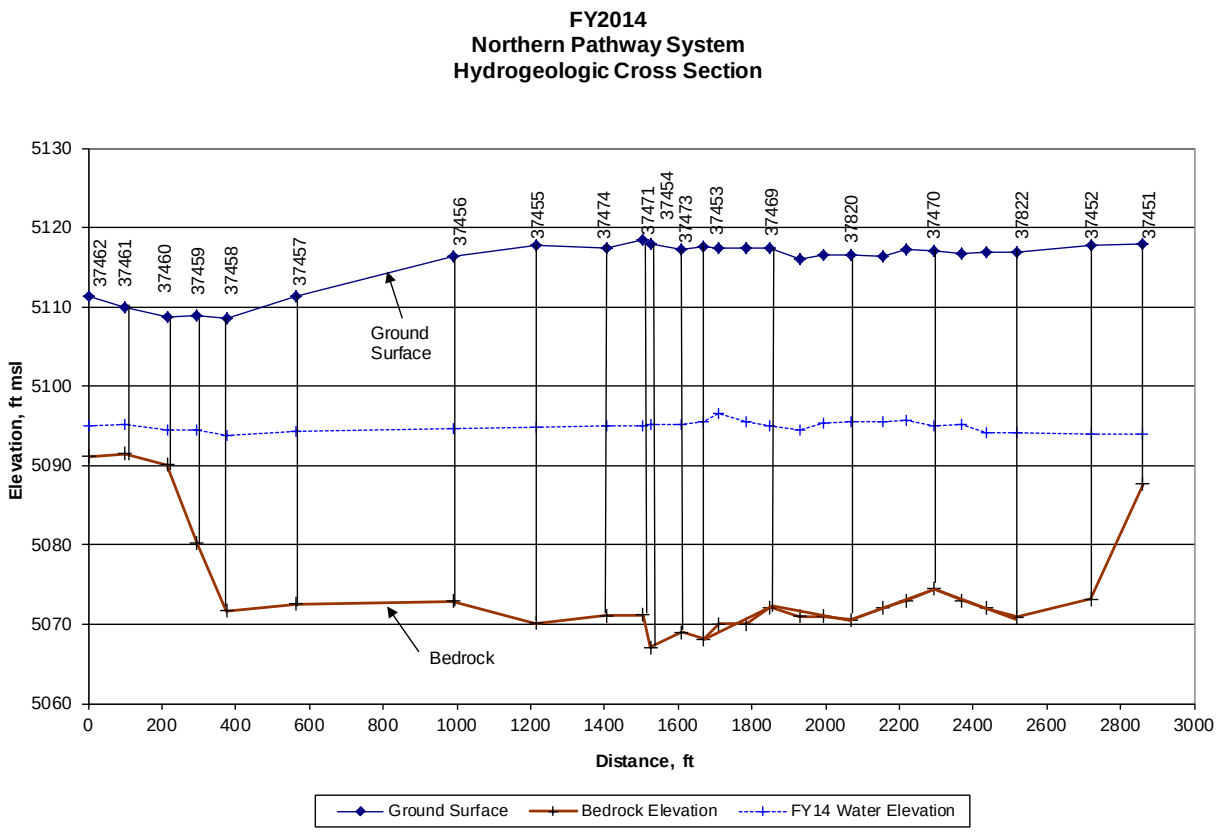
For the FCS cross section shown below in Figure 4, locations F-2, F-4, and F-5 are boreholes that were drilled to determine the bedrock depth in the First Creek Pathway. Borehole F-2 is projected onto the cross section from 210 feet upgradient (i.e., southeast). The borehole lithologies are shown on the First Creek Pathway cross section. The FY14 water elevation shown on the figure is the FY14 average based on quarterly data in the performance wells and interpolated for the additional bedrock points. The average hydraulic gradients for the transect outside the capture zone were calculated using the FY14 quarterly water-table contour maps (Figures F-18 through F-21) and water elevations for FCS well 37076. In July 2012, FCS recharge trench RT-1 was turned off to improve the mass removal performance. The FY14 capture zone shown on Figure 4 is larger than in FY12 and extends closer to borehole F-5, likely because of this operational change.

Figure 4. FCS Hydrogeologic Cross Section



The NPS cross section is shown in Figure 5 on page 63. The transect method is used for estimating the NPS mass flux because more wells and more hydrogeologic data are available along the line of transect. The FY14 average hydraulic gradients were calculated using the FY14 quarterly water -table contour maps (Figures G-2 through G-5) and water elevations for the following NPS wells or well pairs: 37095/37459, 37458, 37457, 37080/37488, 37456, 37455, 37395, 37474, 37471, 37454, 37473, 37453, 37469, 37404, 37470/EPA-4, 37094, and 37452. The hydraulic conductivity for the FCS and NPS was based on available aquifer test data, the alluvial lithology, and the position in the bedrock channels, and ranged from 22 to 182 ft/day.

Figure 5. NPS Hydrogeologic Cross Section



For the extraction wells, average annual flow rates and concentrations are used in the calculations. The upgradient monitoring wells were selected to provide a cross section of the plume upgradient of the extraction and recharge systems. The annual average alluvial saturated thickness, available hydraulic conductivity data, average hydraulic gradient, and contaminant concentration data are used to estimate the annual mass flux. Simplifying assumptions, such as uniform concentrations with depth in the saturated alluvium, no flow in the bedrock, uniform lateral concentrations to the mid-points between wells, etc. are used in the estimates.

Contaminant concentrations obtained from monitoring wells and extraction wells are representative of the alluvial groundwater flow from a mass flux perspective because they are flow-weighted concentrations. Historical plume distributions in the NPS are used to limit the lateral extent of plumes in the calculations. Adjacent to the NPS plumes and in the FCS, where concentrations are below reporting limits, one-half the reporting limit is used in the mass calculations.

Mass flux was calculated based on a Darcy's Law approach where the contaminated flow is calculated using the following equation:

$$Q = Kia \times (7.48\ gal/ft^3 \div 1440\ min/day)$$

Where:

Q = Flow rate, gpm
K = Hydraulic Conductivity, ft/day
i = Hydraulic Gradient, ft/ft
a = area, ft^2

The calculations shown in Table 11 below were derived from OGITS data in the "FY14 ASR OGITS Mass Removal" Excel file on the attached data CD. The table shows the estimated contaminated flow rate, mass flux, and mass removed for the FCS; four combinations of the NPS (NPS Combined, Original NPS, NPS Modifications, and NPS Modifications plus two Original NPS extraction wells [37809 and 37810]); and the combined OGITS treatment plant (from Table 2 on page 3).

Table 11. FY14 OGITS Estimated Contaminated Flow Rate, Mass Flux, and Mass Removed

System	Average Contaminated Flow Rate (gpm)	Contaminant Mass Flux[1] (lbs/year)	Average Extraction Flow Rate (gpm)	Extracted Mass Dewatering Wells (lbs/year)	Extracted Mass Removed Dewatering Wells (lbs/year)	Extracted Mass (PPINNP or PPINFC) (lbs/year)	Extracted Mass Removed (PPINNP or PPINFC) (lbs/year)	Mass Removed (lbs/year) (% of Mass Flux Removed)
FCS Well capture method (inside capture zone [CZ]) Transect method (outside CZ)	52 (total) 50.5 (inside CZ) 1.54 gpm (outside CZ)	4.9-6.1 (total) 4.6-5.8 (inside CZ) 0.3 (outside CZ)	88.5[2] gpm (Extraction wells) 88.5[2] gpm (PPINFC)	5.8	5.5	4.6	4.4	4.4-5.5 (90%) Analytes above CSRGs (91-92%)
NPS Combined (Original NPS and NPS Modifications) Transect method	98.4	1.1 Analytes above CSRGs/PQLs (0.024)	124.9[3] (Extraction wells) 116.3[3] (PPINNP)	1.35	1.05	1.27	0.9	0.9-1.05 (82-95%) Analytes above CSRGs (83%)
Original NPS	-	1.1 Analytes above CSRGs/PQLs (0.024)	86.7	0.93	0.68	-	-	0.68 (62%) Analytes above CSRGs (63%)
NPS Modifications	98.4	1.1 Analytes above CSRGs/PQLs (0.024)	48.2	0.41	0.37	-	-	0.37 (34%) Analytes above CSRGs (23%)
NPS Modifications + Original wells 37809, 37810	98.4	1.1 Analytes above CSRGs/PQLs (0.024)	80.9	0.66	0.53			0.53 (48%) Analytes above CSRGs (63%)
Summed FCS and NPS	150.4	6.0-7.2 Analytes above CSRGs/PQLs (4.76-5.56)	213.4 (wells) 204.8[3] (PPINFC + PPINNP)	7.2	6.6	5.9	5.3	5.3-6.6 (88-92%) Analytes above CSRGs (91-92%)
OGITS Treatment Plant (Table 2 on p. 3)	150.4	6.0-7.2 Analytes above CSRGs/PQLs (4.76-5.56)	204.8[2,3]					5.9 (82-98%) Analytes above CSRGs 5.3 (95-111%)

Notes: [1] The Mass Flux ranges for the FCS are based on the extracted mass calculated for the extraction wells and for the FCS influent (PPINFC) within the FCS capture zone added to the mass flux outside the capture zone.

[2] The reported extraction well and PPINFC flow rates were 93.7 and 89.6 gpm, but were found to be high because of constricted flow in the piping and were reduced by 5.5 and 1.2 percent to 88.5 gpm for both based on flow testing.

[3] The reported extraction well and PPINNP flow rates were134.9 and 127.3 gpm, but were found to be high because of constricted flow in the piping and were reduced by 7.4 and 8.7 percent to 124.9 and 116.3 gpm based on flow testing.

3.1.2.1 FCS Mass Flux and Mass Removal Estimates

The FCS contaminated flow rate is estimated by adding the estimated flow rates inside and outside the capture zone and subtracting the recharge flow pumped by the extraction wells. The FCS average extraction flow rate in the Table 11 is 88.5 gpm and the estimated flow outside the capture zone is 1.54 gpm (90 gpm total). The FCS recharge trenches are upgradient and/or within the area of influence of the FCS extraction wells. Thus, the FCS extraction wells also pump some of the treated water from the recharge trenches. Based on the FCS water-table maps, the component of recharge flow that is pumped is estimated to be approximately 38 percent of the total recharge flow of 99 gpm, which is 38 gpm in FY14. The estimated portion of the recharge flow from each recharge trench that is pumped by the dewatering wells is apportioned as follows based on the fourth quarter FCS water-table map (F-21) [RT-3 = 44 percent (15.8 gpm), RT-4 = 58 percent (10.2 gpm), RT-5 = 44 percent (1.8 gpm), and RT-6 = 25 percent (10.4 gpm)]. Using this approach, the FCS estimated contaminated flow rate is 88.5 gpm + 1.54 gpm - 38 gpm = 52 gpm.

Since not all of the groundwater flow in the First Creek Pathway is captured by the extraction system, the well capture method is used to estimate the mass flux within the system capture zone and the transect method is used to estimate the mass flux outside of the capture zone. The flow outside the capture zone is north of recharge trench RT-1. With shutting down of RT-1 in FY12, the edge of the capture zone in FY13 and FY14 has been farther north and is north of well 37076. The alluvial saturated zone in well 37076 contains approximately 9.2 feet of silty sand (K is assumed to be 10^{-3} cm/sec or 2.8 ft/day), 2.2 feet of clay (K is assumed to be 10^{-6} cm/sec or 0.0028 ft/day), and 13.7 feet of SP/SW sand (K = 5.4 x 10^{-2} cm/sec or 153 ft/day based on the average of K in wells 37427 and 37802). These data yield an average hydraulic conductivity of 84.5 ft/day for well 37076, which is used in the contaminated flow and mass flux calculations. As mentioned above, the contaminated flow outside the capture zone is estimated to be 1.54 gpm. The mass flux for the flow outside the capture zone is estimated to be 0.3 lbs/year.

The FY14 average FCS flow rates were reported in the RMA database as 93.7 gpm for the extraction wells and 89.6 gpm for the FCS influent (PPINFC). Beginning in FY13, annual flow testing has been conducted to correct flow meter discrepancies. Based on the FY14 flow testing, the FY14 average flow rates were corrected to 88.5 gpm for the wells and influent, which were used in the FCS mass removal calculations.

Table 11 on page 64 shows that 5.8 and 4.6 lbs/year of mass are estimated to be extracted based on the dewatering well and FCS PPINFC calculations, respectively. The mass flux for the remaining flow outside the capture zone is estimated to be 0.3 lbs/year. The combined mass flux is 4.9 lbs/year and 6.1 lbs/year for the two methods in FY14. The mass removal calculated using the extraction well data is 5.5 lbs/year and 4.4 lbs/year for PPINFC. Thus, the FCS mass removal is estimated to be 90 percent in FY14, which exceeds the LTMP goal of 75 percent. In FY12, the FCS mass removal was less than 75 percent; thus, the operational change made during the fourth quarter of FY12 was successful in improving the FCS performance in FY13 and FY14. The higher calculated mass extracted for the extraction wells compared to PPINFC in FY14 likely is caused by variations in the plume. Due to sampling schedule differences, the FCS influent and extraction wells were not sampled contemporaneously. The FCS extraction wells were sampled on February 18, 2014 and PPINFC was sampled on July 8, 2014. Contemporaneous sampling is not a requirement, and the differences in the calculations are not significant enough to adjust the schedule to sample at the same time.

Upgradient of the FCS, only DIMP and dieldrin concentrations were above the CSRGs/PQLs in the extraction wells and PPINFC in FY14. If only the analytes above CSRGs/PQLs are used in the calculations, the FCS mass removal is estimated to be 91 to 92 percent.

Regarding the contaminated flow outside the FCS capture zone, all the contaminant concentrations, except chloride and sulfate, have been equal to or below the CSRGs/PQLs in the downgradient wells sampled in the potentially affected areas in the northeast part of the system (wells 37084, 37342, 37396, and 37407) since 2009. The downgradient performance well data are evaluated further in Section 3.1.3 beginning on page 67.

3.1.2.2 NPS Mass Flux and Mass Removal Estimates

The transect method is used to estimate the contaminated flow and mass flux for the NPS because the hydraulic conductivity data were obtained from wells within the transect, and the alluvium is more homogeneous. In Table 11 on page 64, the NPS average extraction flow rate is 124.9 gpm, which is approximately 127 percent of the estimated contaminated flow rate of 98.4 gpm. Greater than 100 percent extraction of the plume is possible because multiple extraction wells (original NPS and NPS modifications) are located within the same groundwater pathways. It should be noted that the contaminated flow rate estimate is for contaminants detected at concentrations above the reporting limits, not detected above CSRGs/PQLs, which would be a lower flow rate.

The FY14 average extraction well and NPS influent site (PPINNP) flow rates were reported as 134.9 gpm and 127.3 gpm, respectively, in the RMA database, and corrected to 124.9 gpm and 116.3 gpm, respectively, based on flow testing.

The total contaminant mass flux approaching the NPS is estimated to be 1.1 lbs/year in FY14. Of the estimated mass flux of 1.1 lbs/year, 1.076 lbs/year or 98 percent of the total mass flux consists of analytes that have concentrations below CSRGs/PQLs in the upgradient performance and operational wells. The mass flux of analytes above the CSRGs/PQLs is estimated to be only 0.024 lbs/year. Of the organic CSRG analytes, only carbon tetrachloride and dieldrin concentrations were above the CSRG/PQL in upgradient wells in FY14. The LTMP mass removal performance criteria for OGITS did not distinguish between CSRG analytes above and below the CSRG/PQL, but only discussed a comparison of the total mass flux approaching the system and the total calculated mass removed for the CSRG analytes. An OCN to the LTMP may be needed to address this issue, and it will be evaluated further during the 2015 Five-Year Review. For FY14, the NPS mass removal is calculated two ways; using the total mass flux and the mass flux of analytes above CSRGs/PQLs.

Table 11 on page 64 shows that approximately 82 to 95 percent of the NPS total mass flux is estimated to be removed. For analytes above the CSRGs/PQLs, 83 percent of the mass flux is estimated to be removed. Therefore, the combined NPS exceeded the 75 percent mass removal goal in FY14 for the total mass flux and for the mass flux of the analytes above CSRGs/PQLs.

The mass removal for different configurations of the NPS are provided in Table 11 on page 64 for comparison purposes. For total mass flux, the mass removal for the Original NPS was 0.68 lbs/year (62 percent), the NPS Modifications was 0.37 lbs/year (34 percent), and the NPS Modifications and Original NPS wells 37809 and 37810 was 0.53 lbs/year (48 percent). For the analytes above CSRGs/PQLs, the corresponding mass removal was 63 percent, 23 percent, and 63 percent. As upgradient concentrations and mass flux decrease, some of the Original NPS extraction wells may be able to be shut down.

Since Army/Shell decided to operate extraction wells in both NPS systems for dieldrin plume mass removal, a comparison of the dieldrin mass extracted/removed and the mass flux for the two systems is provided. The dieldrin mass flux approaching the NPS is estimated to be 0.013 lbs/year in FY14, which is 24 percent less than in FY13 (0.017 lbs/year). The total mass extracted by both NPS systems is estimated to range from 0.0141 to 0.018 lbs/year (108 to 138 percent of the mass flux) and the mass removed is estimated to range from 0.0129 to 0.016 lbs/year (99 to 123 percent). Thus, the total mass removal for dieldrin also exceeded the 75 percent mass removal goal.

In previous ASRs, concerns about decreasing extraction-well capacity and decreasing mass extraction/mass removal for dieldrin were discussed (e.g., 76 percent mass removal in FY13). The capacity of NPS Modifications well 37818 has declined over the years, primarily due to biofouling, and pumps a smaller percentage of the dieldrin plume mass (i.e., 56 percent in FY10, 37 percent in FY11, 21 percent in FY12, 12 percent in FY13, and 11.5 percent in FY14). However, as the paragraph above states, the mass removal for dieldrin was estimated to be almost 100 percent or greater in FY14. The increased dieldrin mass removal in FY14 is explained by lower upgradient dieldrin concentrations, lower dieldrin mass flux, and higher pumping rates in extraction wells other than well 37818.

3.1.2.3 OGITS Mass Flux and Mass Removal Estimates

As shown in Table 11 on page 64, the summed FCS and NPS mass removal was 5.3 to 6.6 lbs/year, or 88 to 92 percent of the combined total mass flux of 6.0 to 7.2 lbs/year. For analytes above CSRGs/PQLs, the combined mass flux is estimated to be 4.76 to 5.56 lbs/years and the summed FCS and NPS mass removal ranges from 91 to 92 percent. The contaminant mass removal by the OGITS treatment plant (using the combined plant influent [PPININ] and effluent [PPEFEF]) in Table 2 on page 3 was 5.9 pounds, which is 82 to 98 percent of the combined FCS and NPS total mass flux. For analytes above CSRGs/PQLs, the OGITS treatment plant mass removal was 5.3 pounds (95 to 111 percent). Using these various methods, the OGITS mass removal was estimated to exceed the goal of 75 percent of the mass flux. Additionally, the mass removal estimates using the various methodologies are comparable and produce similar results.

3.1.3 Performance Evaluation, including CSRG Concentrations in Performance and Operational Wells

The second performance criterion for OGITS is to demonstrate that concentrations of CSRG analytes are below the CSRGs/PQLs or are stable or decreasing in downgradient performance wells.

3.1.3.1 First Creek Pathway Performance Evaluation

CSRG analytes above or below the CSRs/PQL concentrations in downgradient performance wells (37084, 37110, and 37343) sampled in FY14 are shown in Table 12 on page 69, and in Figures F-10 through F-16 in Appendix F. Concentration trends for CSRG analytes chloride, DCPD, and DIMP are shown in time verses concentration graphs in Figures F-22 through F-24 in Appendix F. All FCS downgradient performance wells (wells 37084, 37110, and 37343) were below the OGITS CSRGs/PQLs for the organic analytes, except dieldrin in well 37343. The dieldrin concentration in well 37343 increased from below the PQL in FY13 to 0.0163 µg/L in FY14. The increase likely was caused by a rise in water levels and potential mobilization of dieldrin downgradient of the FCS capture zone. The overall dieldrin concentration trend in well 37343 is downward since 2010, however, which meets the secondary performance requirement. The Regulatory Agencies were notified of this concentration increase in well 37343 on May 8, 2014.

The downgradient performance wells exceeded the CSRGs for chloride and sulfate, but the inorganic standards for chloride and sulfate at OGITS will be met by attenuation consistent with the On-Post ROD. Downgradient performance well 37343 shows a decreasing chloride trend over the last five years, and well 37084 has been relatively stable (Figure F-22). The chloride concentration in well 37110 increased in FY14. Sulfate concentrations have been stable in wells 37084 and 37110, and decreased to below the CSRG in well 37343. Downgradient well 37110 historically has contained fluoride concentrations above the CSRG, including in FY14. The fluoride concentrations in well 37110 have been relatively stable overall since 2007. The fluoride concentrations in this well are higher than in upgradient wells and the groundwater near this well may be more stagnant, such that the fluoride concentrations do not appear representative of system performance.

Other FCS performance and operational wells are also shown in Table 12 on page 69 and in Figures F-22 through F-24 in Appendix F. All the wells sampled were below the CSRG for DCPD (Figure F-23). Dieldrin concentrations in upgradient performance wells 37074 and 37075 decreased to below the PQL in FY14. The dieldrin concentrations in wells 37083, 37370, and 37373 increased. The DIMP concentrations in most upgradient wells decreased in FY14 and/or show decreasing trends. The DIMP concentration in well 37075 increased from 8.9 µg/L in FY12 to 33 µg/L in FY13, likely in response to turning off recharge trench RT-1 in FY12. The FY14 DIMP concentration in well 37075 was lower (25.2 µg/L). An increase in DIMP concentrations is not problematic because well 37075 is located within the FCS capture zone. Five out of 13 wells sampled at FCS in FY14 showed fluoride concentrations equal to or above the CSRG (seven wells were above the CSRG in FY13).

Table 12. Overview of FY14 CSRG Analyte Sampling from OGITS First Creek Pathway Performance and Operational Wells

CSRG Analyte (The concentration in parentheses is the CSRG for the respective analyte)	First Creek Pathway Performance* and Operational^ Well Numbers												
	^37065^{U}	*37074^{U}	*37075^{U}	*37076^{U}	*37083^{U}	*37084^{D}	*37110^{D}	*37343^{D}	*37370^{U}	*37373^{U}	*37800^{U}	*37801^{U}	*37802^{U}
Diisopropylmethyl phosphonate (DIMP) (8 µg/L)	+		+	+	+					+	+	+	+
Aldrin[2a] (0.002 µg/L)													
Chlordane (0.03 µg/L)		+											
PPDDE (0.10 µg/L)													
PPDDT (0.10 µg/L)													
Dieldrin[2b] (0.002 µg/L)					+			+	+	+	+		
Endrin (2 µg/L)													
Hexachlorocyclopentadiene (0.23 µg/L)													
Isodrin (0.06 µg/L)	+												
Atrazine (3 µg/L)													
Malathion (100 µg/L)													
1,4-Oxathiane (160 µg/L)													
Chlorophenylmethyl sulfide (30 µg/L)													
Chlorophenylmethyl sulfoxide (36 µg/L)													
Chlorophenylmethyl sulfone (36 µg/L)													
Dithiane (18 µg/L)													
Benzene (3 µg/L)													
Ethylbenzene (200 µg/L)													
Toluene (1000 µg/L)													
Xylenes (1000 µg/L)													
1,2-Dichloroethane (0.40 µg/L)	+		+										
1,3-Dichlorobenzene (6.50 µg/L)													
Carbon tetrachloride (0.30 µg/L)													
Chlorobenzene (25 µg/L)													
Chloroform (6 µg/L)													
Tetrachloroethylene (5 µg/L)													
Trichloroethylene (3 µg/L)													
Dicyclopentadiene (46 µg/L)													
Dibromochloropropane (0.20 µg/L)													
n-Nitrosodimethylamine[2c] (0.007 µg/L)													
Arsenic (2.35 µg/L)													
Chloride (250 mg/L)	+		+	+	+	+	+	+	+		+	+	+
Fluoride (2 mg/L)		+		+	+		+				+		
Sulfate (540 mg/L)	+		+	+	+	+	+		+		+	+	+

Notes:
1. Shading indicates that the respective well was not sampled for the indicated analyte or the data were not usable in FY14.
2. As a result of the 2012 PQL study, here is the current list of OGITS PQLs readily available from a certified commercial laboratory:
   [a] PQL = 0.014 µg/L [b] PQL = 0.013 µg/L [c] PQL = 0.018 µg/L
3. A plus sign (+) indicates that a reported concentration for a well sample was equal to or higher than the CSRG or PQL for that analyte.
4. Blank cells indicate that reported concentrations for the well samples were lower than the CSRG or PQL for the respective analyte.
5. D = Downgradient well; U = Upgradient well.

3.1.3.2 Northern Pathway Performance Evaluation

Concentrations of CSRG analytes in performance wells sampled in FY14 can be found in Table 13 on page 71 and in Figures F-9 through F-16 in Appendix F. Analytes above or below CSRGs/PQLs in Northern Pathway performance wells are shown in Table 13 on page 71, and trends for CSRG analytes carbon tetrachloride, chloroform, chloride, DIMP, dieldrin, and TCLEE are shown in time verses concentration graphs in Figures G-6 through G-11 in Appendix G. In FY14, except for chloride in two wells (37009 and 37010) and sulfate in one well (37010), all NPS downgradient performance wells (37008, 37009, 37010, 37011, 37012, and 37013) were below the OGITS CSRGs/PQLs. The chloride concentrations are decreasing in both wells and the sulfate concentration in well 37010 is stable. The inorganic standards for chloride and sulfate in the downgradient performance wells at OGITS are expected to be met by attenuation consistent with the On-Post ROD.

CSRG analytes above the CSRGs/PQLs in OGITS NPS performance wells, operational wells, and extraction wells can be found in Tables 13, 14, and 15 on pages 71, 72, and 73, respectively. DBCP, chloroform, DIMP, and TCLEE were not detected above the CSRG in any performance, operational, or extraction wells. DIMP concentrations at the NPS have been below the CSRG since 2009. Carbon tetrachloride (in one well) and dieldrin are the only organic analytes detected above the CSRG/PQL in FY14.

Arsenic was found above the CSRG in operational well 37464 and extraction well 37809 in FY14. Dieldrin was above the PQL in upgradient performance wells 37095, 37395, 37457, 37458, 37471, 37473, and 37474, operational wells 37034, 37035, 37103, and 37464, and extraction wells 37809, 37810, 37816, and 37818. Beginning in FY12, dieldrin was detected in upgradient wells in the western part of the NPS (e.g., wells 37095, 37458, 37816, and 37817). Dieldrin was detected in an additional upgradient well in the western part of the NPS in FY14 (37457). These dieldrin detections in the western part of the NPS are below the previous MRLs/PQLs, but above the current values.

Table 13. Overview of FY14 CSRG Analyte Sampling from OGITS Northern Pathway Performance Wells

CSRG Analyte (The concentration in parentheses is the CSRG for the respective analyte)	Performance Well Numbers																			
	37008[D]	37009[D]	37010[D]	37011[D]	37012[D]	37013[D]	37027[C]	37039[C]	37094[U]	37095[U]	37395[U]	37404[U]	37452[C]	37457[U]	37458[U]	37469[U]	37471[U]	37473[U]	37474[U]	EPA-4[U]
Diisopropylmethyl phosphonate (8 µg/L)																				
Aldrin[2a] (0.002 µg/L)																				
Chlordane (0.03 µg/L)																				
PPDDE (0.10 µg/L)																				
PPDDT (0.10 µg/L)																				
Dieldrin[2b] (0.002 µg/L)										+	+			+	+		+	+	+	
Endrin (2 µg/L)																				
Hexachlorocyclopentadiene (0.23 µg/L)																				
Isodrin (0.06 µg/L)																				
Atrazine (3 µg/L)																				
Malathion (100 µg/L)																				
1,4-Oxathiane (160 µg/L)																				
Chlorophenylmethyl sulfide (30 µg/L)																				
Chlorophenylmethyl sulfoxide (36 µg/L)																				
Chlorophenylmethyl sulfone (36 µg/L)																				
Dithiane (18 µg/L)																				
Benzene (3 µg/L)																				
Ethylbenzene (200 µg/L)																				
Toluene (1000 µg/L)																				
Xylenes (1000 µg/L)																				
1,2-Dichloroethane (0.40 µg/L)																				
1,3-Dichlorobenzene (6.50 µg/L)																				
Carbon tetrachloride (0.30 µg/L)																	+			
Chlorobenzene (25 µg/L)																				
Chloroform (6 µg/L)																				
Tetrachloroethylene (5 µg/L)																				
Trichloroethylene (3 µg/L)																				
Dicyclopentadiene (46 µg/L)																				
Dibromochloropropane (0.2 µg/L)																				
n-Nitrosodimethylamine[2c] (0.007 µg/L)																				
Arsenic (2.35 µg/L)																				
Chloride (250 mg/L)		+	+				+	+		+	+			+	+					
Fluoride (2 mg/L)							+													
Sulfate (540 mg/L)			+				+			+					+			+		

Notes:
1. Shading indicates that the respective well was not sampled for the indicated analyte or the data were not usable in FY14.
2. As a result of the 2012 PQL study, here is the current list of OGITS PQLs readily available from a certified commercial laboratory:
   [a] PQL = 0.014 µg/L [b] PQL = 0.013 µg/L [c] PQL = 0.018 µg/
3. A plus sign (+) indicates that a reported concentration for a well sample was equal to or higher than the CSRG or PQL for the respective analyte.
4. Blank cells indicate that reported concentrations for the water samples were lower than the CSRG or PQL for the respective analyte.
5. D = Downgradient well; U = Upgradient well; C = Cross-gradient well.

Table 14. Overview of FY14 CSRG Analyte Sampling from OGITS Northern Pathway Operational Wells

CSRG Analyte (The concentration in parentheses is the CSRG for the respective analyte)	Operational Well Numbers																	
	37028[U]	37029[U]	37034[U]	37035[U]	37037[U]	37038[U]	37080[U]	37102[U]	37103[U]	37368[U]	37460[C]	37463[U]	37464[U]	37465[U]	37472[C]	37494[U]	37495[U]	37496[U]
Diisopropylmethyl phosphonate (8 µg/L)																		
Aldrin[2a] (0.002 µg/L)																		
Chlordane (0.03 µg/L)																		
PPDDE (0.10 µg/L)																		
PPDDT (0.10 µg/L)																		
Dieldrin[2b] (0.002 µg/L)			+	+					+				+					
Endrin (2 µg/L)																		
Hexachlorocyclopentadiene (0.23 µg/L)																		
Isodrin (0.06 µg/L)																		
Atrazine (3 µg/L)																		
Malathion (100 µg/L)																		
1,4-Oxathiane (160 µg/L)																		
Chlorophenylmethyl sulfide (30 µg/L)																		
Chlorophenylmethyl sulfoxide (36 µg/L)																		
Chlorophenylmethyl sulfone (36 µg/L)																		
Dithiane (18 µg/L)																		
Benzene (3 µg/L)																		
Ethylbenzene (200 µg/L)																		
Toluene (1000 µg/L)																		
Xylenes (1000 µg/L)																		
1,2-Dichloroethane (0.40 µg/L)																		
1,3-Dichlorobenzene (6.50 µg/L)																		
Carbon tetrachloride (0.30 µg/L)																		
Chlorobenzene (25 µg/L)																		
Chloroform (6 µg/L)																		
Tetrachloroethylene (5 µg/L)																		
Trichloroethylene (3 µg/L)																		
Dicyclopentadiene (46 µg/L)																		
Dibromochloropropane (0.2 µg/L)																		
n-Nitrosodimethylamine[2c] (0.007 µg/L																		
Arsenic (2.35 µg/L)													+					
Chloride (250 mg/L)										+								
Fluoride (2 mg/L)																		
Sulfate (540 mg/L)																		

Notes:
1. Shading indicates that the respective well was not sampled for the indicated analyte or the data were not usable in FY14.
2. As a result of the 2012 PQL study, here is the current list of OGITS PQLs readily available from a certified commercial laboratory:
   [a] PQL = 0.014 µg/L [b] PQL = 0.013 µg/L [c] PQL = 0.018 µg/L
3. A plus sign (+) indicates that a reported concentration for a well sample was equal to or higher than the CSRG or PQL for the respective analyte.
4. Blank cells indicate that reported concentrations for the water samples were lower than the CSRG or PQL for the respective analyte.
5. U = Upgradient well; C = Cross-gradient well.

Table 15. Overview of FY14 CSRG Analyte Sampling from OGITS Northern Pathway Extraction Wells

CSRG Analyte (The concentration in parentheses is the CSRG for the respective analyte)	**Northern Pathway Extraction Well Numbers**													
	37805[U]	37806[U]	37807[U]	37808[U]	37809[U]	37810[U]	37815[U]	37816[U]	37817[U]	37818[U]	37819[U]	37820[U]	37821[U]	37822[U]
Diisopropylmethyl phosphonate (8 µg/L)														
Aldrin[4a] (0.002 µg/L)														
Chlordane (0.03 µg/L)														
PPDDE (0.10 µg/L)														
PPDDT (0.10 µg/L)														
Dieldrin[4b] (0.002 µg/L)					+	+		+		+				
Endrin (2 µg/L)														
Hexachlorocyclopentadiene (0.23 µg/L)														
Isodrin (0.06 µg/L)														
Atrazine (3 µg/L)														
Malathion (100 µg/L)														
1,4-Oxathiane (160 µg/L)														
Chlorophenylmethyl sulfide (30 µg/L)														
Chlorophenylmethyl sulfoxide (36 µg/L)														
Chlorophenylmethyl sulfone (36 µg/L)														
Dithiane (18 µg/L)														
Benzene (3 µg/L)														
Ethylbenzene (200 µg/L)														
Toluene (1000 µg/L)														
Xylenes (1000 µg/L)														
1,2-Dichloroethane (0.40 µg/L)														
1,3-Dichlorobenzene (6.50 µg/L)														
Carbon tetrachloride (0.30 µg/L)														
Chlorobenzene (25 µg/L)														
Chloroform (6 µg/L)														
Tetrachloroethylene (5 µg/L)														
Trichloroethylene (3 µg/L)														
Dicyclopentadiene (46 µg/L)														
Dibromochloropropane (0.20 µg/L)														
n-Nitrosodimethylamine[4c] (0.007 µg/L)														
Arsenic (2.35 µg/L)					+									
Chloride (250 mg/L)	+		+	+		+	+	+	+					
Fluoride (2 mg/L)														
Sulfate (540 mg/L)			+	+			+		+					

Notes:
1. A plus sign (+) indicates that a reported concentration for a well sample was equal to or higher than the CSRG or PQL for the respective analyte.
2. Blank cells indicate that reported concentrations for the well samples were lower than the CSRG or PQL for the respective analyte.
3. Shading indicates that the respective well was not sampled for the indicated analyte or the data were not usable in FY14.
4. As a result of the 2012 PQL study, here is the current list of OGITS PQLs readily available from a certified commercial laboratory:
   [a] PQL = 0.014 µg/L [b] PQL = 0.013 µg/L [c] PQL = 0.018 µg/L
5. U = Upgradient well

3.1.4 Compliance Evaluation

Compliance monitoring is water quality monitoring performed for all treatment system effluents at RMA. Each system has a list of compliance analytes for which CSRGs were developed in the On-Post and Off-Post RODs. The system effluent for OGITS was analyzed quarterly using the routine CSRG-analyte list, as shown in Section 4.8.5 of the 2010 LTMP. The complete ROD CSRG list, as listed in the previous three tables, was analyzed once per year.

As shown in Table 1 of the "RMA Treatment Plant Effluent Water Quality Data Report – Fourth Quarter FY14," the four-quarter moving averages for CSRG analytes and annual ROD CSRG samples at OGITS did not exceed the CSRGs/PQLs during FY14. Three quarterly samples were slightly above the CSRG for chloride. For the first time, the four-quarter moving average for chloride was below the CSRG, and the sulfate concentrations were below the CSRG during all four quarters of FY14. The inorganic standards for chloride and sulfate at OGITS will be met by attenuation consistent with the On-Post ROD, but the concentrations of both have decreased to below the CSRGs in the moving averages. A pdf of the effluent report is available on the attached data CD.

3.1.5 Quality Assurance Review for OGITS Water Quality Monitoring

The purpose of the data review is to evaluate data quality with respect to the established DQOs. Components of the data review process include; evaluating the data against the data quality indicators precision, bias, representativeness, completeness, sensitivity, and comparability; review of field and laboratory QC results; and evaluating the data for suitability based on the intended use. The data review has determined that the data quality meets or exceeds the established DQOs and is of the correct type, quality, and quantity to support the intended use.

3.1.5.1 Precision

A total of 181 duplicate analyses were performed. The duplicate and investigative sample was above the MRL in 39 of the analyses. The RPD was only calculated for the 39 analyses where the duplicate and investigative sample values were above the MRL.

The average RPD for the 39 analyses was 6.4 percent. A total of four duplicate pairs were not considered comparable. The non-comparable investigative and duplicate data will be assigned a "Z" data qualifier with the comment "Duplicate and investigative values are not comparable". The data are considered acceptable for their intended use and no additional action in addition to the data qualification is considered necessary. The duplicate pairs determined to be comparable and not comparable are included in Appendix I (Table I-2 and Table I-3, respectively).

3.1.5.2 Accuracy/Bias

The average recovery rate for the 455 MS analyses was 84.8 percent. Recovery rates outside the lower or upper limits were observed in 10 analyses; eight below the lower limit and two above the upper limit. The average recovery rate for the 482 LCS analyses was 95.6 percent. Recovery rates outside the lower or upper limits were observed in 33 analyses; 13 below the lower limit and 20 above the upper limit.

No discernible trends or QC issues were observed in the samples exceeding the specified limits. The data are considered acceptable for their intended use and no additional action is considered necessary.

3.1.5.3 Representativeness

A review of field and laboratory documentation determined that samples were collected and analyzed as specified. Field instruments utilized to collect field measurements were calibrated according to the respective instrument manual and recorded in the Groundwater Sampling Calibration Record database. As a result, the data appropriately reflects the operation of the OGITS.

3.1.5.4 Completeness

The criterion for the completeness calculation to exceed 90 percent was achieved. Completeness was calculated at 99.9 percent. The single rejected sample was arsenic from the OGITS plant effluent (PPEFEF) collected on 1/8/2014. The sample was rejected due to arsenic contamination in the sample container. The source of the contamination is unknown. The rejected sample is included in Appendix I (Table I-8).

3.1.5.5 Comparability

Standard techniques were utilized to collect and analyze samples and the data was reported in the appropriate units. The analytical results reported are equivalent to data obtained from similar analyses and the method reporting limits met the project goals.

3.1.5.6 Sensitivity

Method blank samples are analyzed for each analytical lot. There were no method blank detections above the MRL. The data are considered acceptable for their intended use.

3.1.5.7 Field QC Samples

A total of 63 field blank and 59 trip blank analyses were performed with no detections above the MRL. A total of 317 trip blank analyses were performed with a single result (toluene) above the MRL. No action is required as the associated investigative result is less than the MRL. The data are considered acceptable for their intended use and no additional action is considered necessary.

3.1.5.8 Data Usability Evaluation

A data usability evaluation was conducted on 1,761 records. The evaluation identified a single analysis (sulfate in the First Creek System influent) as a statistical outlier. The sulfate value was not qualified due to insufficient historical data to determine if the value is anomalous or consistent with an unidentified trend. The Mann-Kendall test for trends identified 93 decreasing and 17 increasing analyte trends. A listing of the identified outliers and trends is included in Appendix I (Table I-13 and Table I-14, respectively). Complete data usability, including Mann-Kendall trend information, is included on the attached data CD in the Data Usability subfolder.

The evaluation did not positively identify data quality issues, thus the data is considered to be of acceptable quality and meets or exceeds the DQOs. The data is of the correct type, quality, and quantity to support the intended use.

3.1.6 Conclusions and Recommendations

In FY14, the OGITS system met the performance criteria and objectives established in the 2010 LTMP. Thus, the OGITS is functioning as intended.

The concentrations of most CSRG analytes have decreased to below CSRGs/PQLs in upgradient wells in both the FCS and NPS. The 2010 LTMP OGITS mass removal performance criteria did not distinguish between calculating the mass flux of CSRG analytes below or above CSRGs/PQLs. Thus, an OCN to the LTMP appears necessary to clarify this issue, and to develop an approach where the mass flux/mass removal of only CSRG analytes present at concentrations above CSRGs/PQLs in upgradient wells are evaluated. This issue will be evaluated further in the 2015 Five-Year Review.

At the end of FY12, an operational change was made to improve the FCS performance (i.e., recharge trench RT-1 was turned off). The FY13 and FY14 monitoring data indicate that the FCS estimated mass removal was increased from 70 percent in FY12 to 90 percent in FY13 and FY14.

In previous ASRs, concerns about decreasing extraction well capacity and decreasing mass extraction/mass removal for dieldrin in the NPS were discussed. The capacity of NPS Modifications well 37818 has declined over the years, primarily due to biofouling, and pumps a smaller percentage of the dieldrin plume mass (i.e., from 56 percent in FY10 to 11.5 percent in FY14). Although the capacity of well 37818 has continued to decline, the deceasing trend in dieldrin mass removal was reversed in FY14. The mass removal of dieldrin in the NPS increased from 76 percent in FY13 to almost 100 percent or greater in FY14. The increased mass removal in FY14 is explained by lower upgradient dieldrin concentrations, lower mass flux, and higher pumping rates in extraction wells other than well 37818.

3.2 Site-Wide Off-Post Monitoring

The following sections describe the RMA and TCHD off-post monitoring programs.

3.2.1 Off-Post Exceedance Monitoring

Off-Post Exceedance Monitoring was conducted in FY14 and the results will be published in the FY14 Off-Post CSRG Exceedance Map (in progress) and will be evaluated in the 2015 FYSR.

3.2.1.1 Quality Assurance Review for Off-Post Exceedance Monitoring

The purpose of the data review is to evaluate data quality with respect to the DQOs. Components of the data review process include: 1) evaluating the data against the data quality indicators precision, bias, representativeness, completeness, and comparability; 2) reviewing field and laboratory QC results; and 3) evaluating the data for suitability based on the intended use. The OGITS CSRG-analyte list is used for the exceedance water quality analyte list for the purpose of the quality assurance review. The data review has determined that the data quality meets or exceeds the established DQOs and is of the correct type, quality, and quantity to support the intended use.

3.2.1.1.1 Precision

A total of 80 duplicate analyses were performed. The duplicate and investigative sample was above the MRL in 43 of the analyses. The RPD was only calculated for the 43 analyses where the duplicate and investigative sample values were above the MRL.

The average RPD for the 43 analyses was 8.0 percent. A total of five duplicate pairs were not considered comparable. The non-comparable investigative and duplicate data will be assigned a "Z" data qualifier with the comment "Duplicate and investigative values are not comparable". The data are considered acceptable for their intended use and no additional action in addition to the data qualification is considered necessary. The duplicate pairs determined to be comparable and not comparable are included in Appendix I (Table I-2 and Table I-3, respectively).

3.2.1.1.2 Accuracy/Bias

The average recovery rate for the 157 MS analyses was 88.7 percent. Recovery rates outside the lower or upper limits were observed in three analyses; one below the lower limit and two above the upper limit. The average recovery rate for the 213 LCS analyses was 91.0 percent. Recovery rates outside the lower or upper limits were observed in eight analyses; six below the lower limit and two above the upper limit.

No discernible trends or QC issues were observed in the samples exceeding the specified limits. The data are considered acceptable for their intended use and no additional action is considered necessary.

3.2.1.1.3 Representativeness

A review of field and laboratory documentation determined that samples were collected and analyzed as specified. As a result, the data is appropriate for use in assessment of contaminant concentration reduction and remedy performance.

3.2.1.1.4 Completeness

The criterion for the completeness calculation to exceed 90 percent was achieved. Completeness was calculated at 100 percent.

3.2.1.1.5 Comparability

Standard techniques were utilized to collect and analyze samples and the data was reported in the appropriate units.

3.2.1.1.6 Field QC Samples

A total of 18 field blank and 52 trip blank analyses were performed with no results above the MRL. A total of 55 rinse blank analyses were performed with two fluoride results above the MRL. The investigative value is greater than blank value in both cases, so no data qualification is required. The data are considered acceptable for their intended use and no additional action is considered necessary.

3.2.1.1.7 Data Usability Evaluation

A data usability evaluation was conducted on 205 records. The evaluation identified three results as statistical outliers. One of the values was qualified with a "Z" flag and identified as a statistical outlier in the associated comment (well 37320, dieldrin). The other two outliers (37374, fluoride;

37150, carbon tetrachloride) had insufficient historical data to quality them. The Mann-Kendall test for trends identified no decreasing and four increasing analyte trends. A listing of the identified outliers and trends is included in Appendix I (Table I-13 and Table I-14, respectively). Complete data usability information is included on the attached data CD in the Data Usability subfolder.

The evaluation did not positively identify data quality issues, thus the data is considered to be of acceptable quality and meets or exceeds the established DQOs. The data is of the correct type, quality, and quantity to support the intended use.

3.2.2 Surface Water Monitoring

In order to continue to evaluate the effect of groundwater treatment on surface water quality off-post of RMA, sampling is conducted during low-flow or base-flow conditions when groundwater is most likely to be discharging into First Creek. Surface water quality monitoring will continue at SW24004 (First Creek at the north fence line) and off-post site SW37001 (First Creek at Highway 2). An upstream sampling location (SW08003), where First Creek flows onto RMA, was added in FY13 to provide data to compare to the two downstream sites (see FigureH-4 in Appendix H for the LTMP surface water locations). Annual surface water quality samples will be collected at these sites when there is low flow in First Creek. Typically, this occurs during the spring or summer. The target analyte list includes aldrin, arsenic, chloride, dieldrin, DIMP, NNDMEA, and sulfate. The requirements for sampling can be found in the 2010 LTMP, Section 6.3. However, in FY13 several changes were implemented, including the addition of the upstream monitoring location, field parameters for sample collection, and the sample analyte list (OCN-LTMP-2014-001). Sampling in FY14 was conducted in accordance with the Long-Term Monitoring Plan for Groundwater and Surface Water Sampling and Analysis Plan (Navarro 2014a).

Sites SW08003, SW24004, and SW37001 were sampled once in FY14 (June 30, 2014). No analytes were detected at concentrations above the off-post CSRGs/PQLs in the investigative samples at the three sampling sites.

Arsenic was detected above the CSRG in the duplicate sample for downstream site SW37001, but the precision with the duplicate was poor and the investigative/duplicate results are not considered comparable.

3.2.3 Surface Water Monitoring

3.2.3.1 Quality Assurance Review for Surface Water Monitoring

The purpose of the data review is to evaluate data quality with respect to the established DQOs. Components of the data review process include: 1) evaluating the data against the data quality indicators precision, bias, representativeness, completeness, sensitivity, and comparability; 2) reviewing field and laboratory QC results; and 3) evaluating the data for suitability based on the intended use. The data review has determined that the data quality meets or exceeds the established DQOs and is of the correct type, quality, and quantity to support the intended use.

3.2.3.1.1 Precision

A total of nine duplicate analyses were performed. The duplicate and investigative sample was above the MRL in six of the analyses. The RPD was calculated for the six analyses where the duplicate and investigative sample values were above the MRL.

The average RPD for the six analyses was 12.2 percent. One duplicate pair was considered not comparable. The non-comparable investigative and duplicate data will be assigned a "Z" data qualifier with the comment "Duplicate and investigative values are not comparable". The data are considered acceptable for their intended use and no additional action in addition to the data qualification is considered necessary. The duplicate pairs determined to be comparable and not comparable are included in Appendix I (Table I-2 and Table I-3, respectively).

3.2.3.1.2 Accuracy/Bias

The recovery rate for the single MS analysis was 64.2 percent. The recovery rate was within the evaluation limits. The recovery rate for the single LCS analysis was 94.0 percent, also within evaluation limits. No discernible trends or QC issues were observed and the data are considered acceptable for their intended use and no additional action is considered necessary.

3.2.3.1.3 Representativeness

A review of field and laboratory documentation determined that samples were collected and analyzed as specified. Field instruments utilized to collect field measurements were calibrated according to the respective instrument manual and recorded in the Groundwater Sampling Calibration Record database. The data are representative of contaminant concentrations in surface water.

3.2.3.1.4 Completeness

Completeness was calculated at 100 percent. The criterion for the completeness calculation to exceed 90 percent was achieved.

3.2.3.1.5 Comparability

Standard techniques were utilized to collect and analyze samples and the data was reported in the appropriate units. The analytical results reported are equivalent to data obtained from similar analyses and the method reporting limits met the project goals.

3.2.3.1.6 Sensitivity

Method blank samples were analyzed for each analytical lot. There were no method blank detections above the MRL. Sensitivity is considered acceptable.

3.2.3.1.7 Field QC Samples

Due to the limited scope and nature of surface water sampling, field QC sample collection was limited to six field blank analyses. There were no detections above the MRL. The data are considered acceptable for their intended use.

3.2.3.1.8 Data Usability Evaluation

A data usability evaluation was conducted on 21 records. The evaluation identified no analyses as statistical outliers. The Mann-Kendall test for trends identified four increasing analyte trends. Information on trends is included in Appendix I (Table I-14). Complete data usability information is included on the attached data CD in the Data Usability subfolder.

The evaluation did not positively identify data quality issues, thus the data is considered to be of acceptable quality and meets or exceeds the established DQOs. The data is of the correct type, quality, and quantity to support the intended use.

3.2.4 Tri-County Health Department Off-Post Groundwater Monitoring for FY14

The Private Well Monitoring Program is administered by TCHD via a 1997 Memorandum of Agreement with the Army and summarized in the 2005 FYRR (Department of the Army 2006). Under this program, TCHD samples private wells and surface water sources in the off-post study area. The program is separate and independent from the off-post monitoring program administered and conducted by the Army. Private well monitoring provides water quality data to address community health concerns and communicate the effectiveness of the remedy to the public, related to off-post groundwater contamination. Data from TCHD's private well monitoring program will be used to help delineate the CSRG exceedance area. In addition, TCHD will collect samples from newly installed private wells within the CSRG exceedance area and from off-post CFS wells that may act as conduits for contaminants to migrate from the shallower UFS to the CFS.

Fifteen off-post private wells and two surface-water sites were sampled for DIMP by TCHD in FY14 (see report in Appendix J). None of the wells or sites contained DIMP values above the CSRG of 8 µg/L. The surface water sites were located in storage impoundments owned by Denver Water northwest of RMA. The surface water discharges into the South Platte River and it did not contain DIMP above 8 µg/L. Fourteen private wells and two surface-water sites were also sampled for 1,4-dioxane in FY14. One well was above the 2013 State standard of 0.35 µg/L for 1,4-dioxane. The surface water samples for 1,4-dioxane were non-detect. The results of the FY14 off-post private well sampling can be found in Appendix J.

3.2.5 Annual Well Networks Update for FY14

The Annual Well Networks Update Summary (see Appendix K) is included in this ASR as required by the 2010 LTMP. The FY14 Annual Well Networks Update Summary includes information on newly installed wells, closed wells, damaged/repaired network wells, and updates to the following tables in the RMAED: the mapfile, wellinfo, wellextra, and well_networks_2 tables from October 2013 through September 2014.

4.0 Conclusions and Recommendations

All of the groundwater containment and mass removal systems discussed in this FY14 report met the objectives identified in the On-Post and Off-Post RODs and are functioning as intended, except possibly the NWBCS, as discussed below. The September 2013 500- to 1000-year storm event, followed by an extremely wet period during May 2014 affected the water levels and performance of some of the groundwater systems and projects during FY14. For example, the performance of the NWBCS and BANS may have been adversely affected. The Shell Trenches dewatering goal was met during the first quarter of FY14, but lost in one of six compliance boreholes during the subsequent quarters. This was caused by a rise in water levels directly related to the storm events. The dewatering goals have not yet been attained at the Complex Trenches and the Lime Basins Dewatering Project, but progress is being made toward meeting the goals. The storm events affected the water levels at the Complex Trenches, but the effects were not significant at the Lime Basins.

At the NWBCS, effluent water quality requirements were met in FY14. The NWBCS had no CSRG-analyte exceedances of the four-quarter moving averages in the treatment system effluent in FY14. The NWBCS appears to be functioning as intended, but additional monitoring data are needed to confirm that all the performance criteria are being met. The primary performance requirement (a reverse hydraulic gradient across the system) was met during all quarters. The secondary performance requirement was also met with CSRG-analyte concentrations in all downgradient performance wells below CSRGs/PQLs, except dieldrin. Dieldrin concentrations were slightly above the new PQL in all five of the Original System downgradient performance wells and in two Northeast Extension downgradient performance wells. The secondary performance criterion is met if the concentrations in the downgradient performance wells are above CSRGs/PQLs, but the concentrations are decreasing based on the previous period of at least five years. Since the concentrations were below the previous PQL and MRL, which changed in FY12, additional dieldrin data from analytical methods with lower MRLs are needed for determining the trend and evaluating the secondary performance criterion. Thus, it is premature to draw conclusions about the FY14 performance based on the downgradient well data. The dieldrin treatment effectiveness and downgradient well detections above the PQL will be evaluated further during the 2015 Five-Year Review.

At the NBCS, effluent water quality requirements, including for chloride and sulfate, were met in FY14. The primary performance requirement is to maintain a reverse hydraulic gradient across the system and to ensure plume-edge capture. Both requirements were met during FY14. Thus, the NBCS is functioning as intended. The secondary performance criterion (downgradient performance well concentrations are at or below the CSRG/PQLs, or show decreasing trends) applies if the primary criteria are not met. Downgradient performance well concentrations were below CSRGs/PQLs or showed generally decreasing concentration trends. Thus, the secondary criteria also were met.

The RYCS is effectively capturing and treating the DBCP plume. The primary performance requirement is to demonstrate plume capture through groundwater flow directions and DBCP concentrations in performance wells. Water-table maps indicate that the plume is captured and concentrations of DBCP were below the CSRG in all performance wells sampled in FY14. A RYCS pre-shut-off monitoring program was successfully completed in FY14, and the shut-off

process will proceed to the next phase. A Decision Document and draft Shut-Off Monitoring SAP will be prepared for review and approval by the Regulatory Agencies in 2015.

At the OGITS, all four-quarter moving averages for the CSRG analytes in the effluent were below the CSRGs/PQLs, including chloride and sulfate in FY14. The OGITS met its ROD objective as a mass removal system in FY14. An operational change was made during the fourth quarter of FY12 that improved the FCS performance in FY13 and FY14 to exceed the mass removal goal. An OCN to the LTMP OGITS mass removal performance criteria may be needed to clarify how the mass removal evaluation is conducted when CSRG analytes are present at concentrations below the CSRGs/PQLs. This issue will be addressed during the 2015 Five-Year Review. Flow meter inspection and calibration procedures were implemented in FY13 to improve the accuracy of the flow meter readings, which are used in the mass removal calculations. The mass removal of dieldrin in the NPS had been declining (83 percent in FY11 to 76 percent in FY13), but increased to nearly 100 percent in FY14. The second performance requirement is to demonstrate that concentrations of CSRG analytes are stable or decreasing in downgradient performance wells. All downgradient performance wells in the FCS and NPS were below the OGITS CSRGs/PQLs except dieldrin in one FCS well and chloride, fluoride, and sulfate. These analytes showed stable or decreasing trends. The inorganic standards for chloride and sulfate at OGITS are expected to be met by attenuation consistent with the On-Post ROD.

All four-quarter moving averages for the CSRG analytes in the BANS effluent were below the CSRGs/PQLs for FY14. Also, the BANS met its ROD objective as a mass removal system in FY14. The BANS met the 75 percent mass removal goal for FY14, which satisfies one of the performance requirements. The second performance requirement is to demonstrate that concentrations in downgradient performance wells are below CSRGs/PQLs or are stable or decreasing. This is the generally the case for the four downgradient performance wells. However, the concentrations of several analytes increased to above CSRGs/PQLS in two wells in FY14. Historically high water elevations were experienced in FY14, which were caused by the 500- to 1000-year storm event in September 2013, followed by an extremely wet period during May 2014. The high water levels caused the extent and magnitude of the reverse hydraulic gradient to decrease in FY14. Although the concentrations of several analytes increased in FY14, the long-term trends are not increasing. Therefore, the BANS functioned as intended in FY14. Actions were taken in October 2014 that appear to have corrected the short-term reverse gradient issue, and will be evaluated further during FY15.

The CADT dewatering system was effective in lowering the water table to levels below the dewatering goal in one of the two compliance wells. The dewatering goal in the second compliance well was not attained by the 2010 LTMP-established date of September 2014, after the RCRA-equivalent cover vegetation is established. Water levels inside the Complex Trenches slurry wall were affected by the September 2013 and May 2014 storms. However, progress is being made toward meeting the goals, even with the recent storm events. Thus, continued water level monitoring is the proposed action. Attainment of the dewatering goals will be evaluated further during the 2015 Five-Year Review.

The BRES water-table contours and water quality monitoring data likely indicate that the plume was captured during all quarters of FY14. In FY14, five sampling events for the performance wells have occurred and the trends in the downgradient wells can be used to evaluate the performance. However, this time frame may be too short for evaluating one of the wells.

Concentrations in one of the four BRES downgradient performance wells are still above CSRGs. Some analytes in the downgradient performance well show decreasing trends and some show increasing trends. This well is located where the hydraulic gradient is much flatter than at the other performance wells and it may be expected to clean up more slowly. Additional data are needed to evaluate this well. Thus, based on available information, the BRES appears to be functioning as intended.

The Shell Trenches system met the dewatering goal in the first quarter of FY14. The September 2013 and May 2014 storms caused water levels inside the Shell Trenches slurry wall to rise above the trench-bottom elevation at one of the six compliance boreholes during the last three quarters of FY14. Once the effects of the storms have passed, the water levels inside the slurry wall are expected to fall and the dewatering goal will be re-attained. Thus, continued water level monitoring is the proposed action. Attainment of the dewatering goal will be evaluated further during the 2015 Five-Year Review.

The objectives of the Lime Basins Dewatering Project are to establish an inward hydraulic gradient across the slurry wall and to lower the water level inside the slurry-wall enclosure to below the bottom of the waste. The dewatering goals were not attained by the 2010 LTMP-established date of September 2014, after the RCRA-equivalent cover vegetation is established. At the end of FY14, the water elevation was below the waste elevation in one well, and is steadily approaching the goal in the other wells. An inward hydraulic gradient has been achieved in the southern well pairs and the difference in water elevation in the northern wells is decreasing. From 2009 to FY14, the average outward hydraulic gradient (head differentials) were reduced from 9.2 feet to 4.5 feet on the north side. Thus, progress toward meeting the goals is being made. A corrective action has been taken to improve the system performance, which involves changing the dewatering well and treatment operations from batch mode to more continuous operation. Attainment of the dewatering goals will be evaluated further during the 2015 Five-Year Review.

In August 2009, monitoring of the Lime Basins dewatering wells indicated the potential presence of DNAPL. A RI/FS was conducted and three suspected DNAPL source zones were identified in the Lime Basins area. Eight new monitoring wells (four well pairs adjacent to the slurry wall) were installed in late FY12, and data collection specified in the DAR began in FY13. In FY13, the observed presence of DNAPL and the water quality data indicated that the suspected DNAPL source zones were larger than characterized in the RI Summary Report. The FY14 data showed similar results, however the DNAPL-related compound concentrations were lower in many wells than in FY13. The water-level data indicate that the slurry wall has not been impacted by DNAPL. During FY14, a total of 5.8 gallons of DNAPL was removed from one dewatering well and one monitoring well. The FY14 data indicate that the Lime Basins DNAPL Remediation Project is functioning as intended.

The North Plants LNAPL pilot removal system was implemented in 2008 to perform LNAPL removal for a historical release of fuel oil in the North Plants, and to gather operating data for the potential design of a full-scale LNAPL removal action. During the pilot study, two years of monitoring was conducted in the North Plants LNAPL recovery and monitoring wells without detection of sufficient quantities of LNAPL in these wells to support the removal of LNAPL. Beginning in FY12, quarterly monitoring for the remainder of the current Five-Year Review period has been conducted. During FY14, the groundwater flow directions and hydraulic gradients were consistent with previous years. The LNAPL thicknesses and extent have continued to decrease since 2008, and only 0.02 feet of LNAPL was measured in one piezometer

during one quarter. No other LNAPL was detected. The amounts of LNAPL since 2008 have been less than the minimum thickness required for testing/recovery to begin. Future monitoring and project status will be evaluated in the 2015 Five-Year Review.

Post-shut-off monitoring for the GWMRP was conducted in the STF area in FY14. In FY12, the benzene concentration in one of the three monitoring wells sampled exceeded its historical maximum. Consequently, a fourth well was added in FY13 and FY14. Since FY12, the benzene concentrations have decreased, likely due to naturally occurring biodegradation, and benzene was not detected in the four wells sampled in FY14.

Post-shut-off monitoring for the MPS/ICS was conducted in FY14 and the contaminant concentrations were below CSRGs.

The site-wide on-post monitoring in FY14 included water level tracking, water quality tracking, and CFS well monitoring. These data will be evaluated during the 2015 Five-Year Review.

An on-post short-term surface water sampling program was implemented in FY12 and continued in FY13 to confirm that surface water quality is not adversely impacted by cover soils during the establishment of cover vegetation and that groundwater plumes are not migrating into the lakes. The seven sites were not sampled in FY14, but selected sites will be sampled in FY15 as conditions allow.

The off-post exceedance monitoring well network was sampled for water quality in FY14 and the FY14 Off-post CSRG Exceedance Map is in progress.

Off-post surface water sampling was conducted in First Creek during FY14 at two downstream sites, one near 96th Avenue and one near Highway 2 and at an upstream First Creek site located near Buckley Road. No analytes were detected at concentrations above the CSRGs/PQLs in the investigative samples at the upstream and downstream First Creek sites.

Fifteen off-post private wells and two surface-water sites were sampled for DIMP by TCHD in FY14. None of the wells or sites contained DIMP above the CSRG of 8 µg/L. The surface water sites were located in former storage impoundments owned by Denver Water northwest of RMA. The surface water discharges into the South Platte River and it did not contain DIMP above 8 µg/L. Fourteen private wells and two surface-water sites were also sampled for 1,4-dioxane in FY14. The result from one well was above the 2013 State standard of 0.35 µg/L for 1,4-dioxane. The surface water samples for 1,4-dioxane were non-detect.

5.0 References

Department of the Army, Rocky Mountain Arsenal Commerce City, Colorado, 2006, *Final 2005 Five-Year Review Report for Rocky Mountain Arsenal Commerce City Adams County, Colorado,* December 2006.

Department of the Army and Shell Oil Company, 2015, *Rocky Mountain Arsenal Annual Summary Report for Groundwater and Surface Water, FY13*, Revision 1, March 2015).

Department of the Army and Shell Oil Company, 2015, *RMA Treatment Plant Effluent Water Quality Data Report – Fourth Quarter FY14*, February 2015.

Foster Wheeler Environmental Corporation, 1996, *Record of Decision for the On-Post Operable Unit,* Final, June 1996.

Harding Lawson Associates, 1995, *Rocky Mountain Arsenal Offpost Operable Unit Final Record of Decision Rocky Mountain Arsenal Commerce City, Colorado*, December 19, 1995.

Harding Lawson and Associates, 1996, *Remediation Scope and Schedule for the Offpost Operable Unit Rocky Mountain Arsenal Commerce City, Colorado,* September 25, 1996.

Navarro Research and Engineering, Inc., 2015, *Railyard Containment System Pre-Shut-Off Monitoring Report,* Revision 0, March 2015.

Navarro Research and Engineering, Inc., 2014, *Sampling Quality Assurance Project Plan*, Revision 0, January 2014.

Navarro Research and Engineering, Inc., 2014a, *Long-Term Monitoring Plan for Groundwater and Surface Water Sampling and Analysis Plan,* Revision 0, June 2014.

Remediation Venture Office, 1997, *Complex Trenches and Shell Trenches Groundwater Barrier Project, 100 Percent Design Package, Rev. 1.* November 1997.

Tetra Tech EC, Inc., 2010, *Rocky Mountain Arsenal Lime Basins Dense Non-Aqueous Phase Liquid (DNAPL) Remedial Investigation Summary Report,* Final, September 2010.

Tetra Tech EC, Inc., 2005, *Amendment to the Record of Decision for the On-Post Operable Unit, Rocky Mountain Arsenal Federal Facility Site, Section 36 Lime Basins Remediation, basin F Principle Threat Soil Remediation,* Revision 0. October 2005.

Tetra Tech EC, Inc. & URS Corporation, 2012, *Rocky Mountain Arsenal Lime Basins Dense Non-Aqueous Phase Liquid Remediation Project, Design Analysis Report,* Final, August 2012.

Tetra Tech EC, Inc. & URS Corporation, 2010, *Rocky Mountain Arsenal Long-Term Monitoring Plan for Groundwater and Surface Water,* Final, March 2010.

Tetra Tech EC, Inc. & URS Corporation, 2009, *North Plants Light Non-Aqueous Phase Liquid Removal System Action Plan,* Revision 1, February 2009.

URS Corporation, 2012, *Railyard Containment System Sampling and Analysis Plan, Revision 0*, Final, September 2011.

URS Corporation, 2012, *Rocky Mountain Arsenal North Plants Pilot Non-Aqueous Phase Liquid Removal Action 2010- 2011 Evaluation Report*, Final, March 30, 2012.

URS Corporation, 2012a, *Rocky Mountain Arsenal Groundwater Mass Removal Project Post-Shut-Off Monitoring Sampling and Analysis Plan*, Revision 0, February 2012.

URS Corporation, 2012b, *Rocky Mountain Arsenal Motor Pool System Irondale Containment System Post Shut-Off Monitoring Sampling and Analysis Plan*, Revision 0, September 2011.

URS Corporation, 2013, *Surface Water Monitoring Report (FY1996 through FY2011)*, Final, February 2013.