5.0 Progress Since 2005 Five-Year Review (Completed 12/20/2007)

5.1 Protectiveness Statements from 2005 FYR

The protectiveness statements presented below are quoted from the 2005 FYR:

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

On-Post Operable Unit

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

Off-Post Operable Unit

> *The Army concludes that the remedy at the Off-Post OU is expected to be protective upon completion or is protective of human health and the environment, and in the interim, exposure pathways that could result in unacceptable risks are being controlled. All immediate threats have been adequately addressed in the form of IRAs and their continued effectiveness has been assured by transferring them administratively into specific, related remedial projects under the Off-Post ROD, as appropriate. Administrative controls to protect the public have been effective in their implementation. Groundwater contamination is being treated to Off-Post ROD remediation goals both at the RMA boundary as well as at the OGITS.*

5.2 Status of Recommendations and Follow-Up Actions from 2005 FYR

The EPA 2001 Five-Year Review Guidance (EPA 2001) states that "all issues that currently prevent the response action from being protective, or may do so in the future" should be documented as FYR issues in the FYRR. Such issues are to be documented along with follow-up actions needed to ensure the proper management of the remedy. The guidance also states the

FYRR should identify "early indicators of potential remedy problems." The 2005 FYRR identified 13 FYR issues for which recommendations for follow-up actions were provided. Table 5.2-1 lists and describes the issues and summarizes the recommendations, follow-up status, and actions taken for each. The issues and actions taken during this FYR period are further described in Sections 5.2.1 through 5.2.13. No other unresolved concerns from CDPHE, TCHD, the SSAB, Restoration Advisory Board (RAB), or other interested parties were identified.

Additional detail on how the water-related recommendations were addressed and implemented during this FYR period can be found in the FYSR.

Table 5.2-1. Status of Follow-Up Actions to Address 2005 FYR Issues

2005 FYR Issue	Description of Issue	Recommendation	Follow-Up Action
Leachate Volume at Basin F Sump	It was observed that the Cell #2 sump was not operating as designed. A larger volume of leachate was being collected in the secondary (LDS) sump than the primary (LCS) sump.	Soils beneath the secondary sump system of Cell #2 will be monitored for staining during the Basin F Wastepile Excavation project.	Observations during the remediation and results of post-excavation confirmatory sampling in March 2007 concluded that the secondary liner system in Cell #2 did not leak.
Monitoring Well Maintenance and Security	Monitoring wells just outside the relocated RMA perimeter fenceline were not repaired in a timely manner and did not have the locks required for off-post wells.	The Army will ensure that the well maintenance and security issues are corrected in accordance with Army policies and procedures in the next FYR period.	Repair/closure/lock installation completed in 1st Quarter of 2006. Well reviews will continue.
Extraction Well and Extraction System Shut-Off Criteria	The possible different interpretations of the ROD shut-off criteria, including starting point and what constitutes "hydraulic purpose."	More detailed and objective extraction well and system shut-off criteria will be proposed as part of the revisions to the 1999 LTMP.	The 2010 LTMP, issued March 9, 2010, documents the revised shut-off criteria that rely on the consultative process and no longer include the hydraulic purposes criterion or the monitoring of extraction well criterion. An ESD is under preparation to document the revised criteria as changes to the RODs.
Establishing Site-Specific PQLs	The existing process for determining PQLs/MRLs has been identified as an issue for the compounds for which the PQLs remain above the CSRGs in part because Army has used an MRL-based approach, which differs from industry practice.	PQL studies will be conducted in accordance with 40 CFR 136 Appendix B and soon-to-be published Colorado State PQL Guidance.	Although new PQLs have not yet been established, studies are in progress.The PQL study process therefore remains an issue. A fact sheet will be issued for public information after PQLs have been established. An ESD is under preparation to document revision to the PQL process as changes to the RODs.

Table 5.2-1. Status of Follow-Up Actions to Address 2005 FYR Issues (Continued)

2005 FYRR Issue	Description of Issue	Recommendation	Follow-Up Action
Bedrock Ridge Plume Capture	An additional well was installed to ensure plume capture.	Remedy performance will be monitored and assessed by the RMA Water Team during the next FYR period.	Remedy performance is addressed in this report, and plume capture is now occurring.
Shell Trenches Dewatering	The dewatering goal of achieving water levels below the bottom of the trenches had not been met at the end of the FYR period.	The trenches will be evaluated after both the RCRA-equivalent cover and adjacent soil covers have been installed at the Shell Disposal Trenches.	Dewatering goal documented in 2010 LTMP, issued March 9, 2010. By agreement between the RVO and the Regulatory Agencies the dewatering goal is not applicable until it is determined that cover vegetation is established (October 2, 2012). The 2010 LTMP incorporates a trigger to track the performance of the covers.
South Lakes Plume Management	The 2004 Groundwater Monitoring Report concluded that the goal of preventing the migration of contaminants into the South Lakes at levels exceeding the CBSGs has been met.	The RVO and Regulatory Agencies agreed that it was appropriate to remove the lake level maintenance requirement from the selected remedy in the On-Post ROD using an ESD that was approved by EPA.	Resolution of this issue is documented in the 2005 FYRR. The ESD was finalized March 31, 2006.
Off-Post Groundwater Intercept and Treatment System Performance Objectives Clarification	OGITS has been and will continue to be operated as a mass removal system in accordance with the design and ROD documentation.	The 2010 LTMP provides specific performance criteria for evaluation of system mass removal effectiveness to facilitate future system evaluation presented in the OARs and FYRs.	Mass removal performance criteria were developed as part of, and documented in, the 2010 LTMP, which was issued March 9, 2010.

Table 5.2-1. Status of Follow-Up Actions to Address 2005 FYR Issues (Continued)

2005 FYRR Issue	Description of Issue	Recommendation	Follow-Up Action
North Plants Fuel Release	Fuel contamination present as LNAPL was discovered in North Plants wells during the FYR period.	The LNAPL will be evaluated in accordance with applicable requirements during the next FYR period.	The LNAPL removal pilot study work plan was issued in March 2008 and the pilot study is ongoing as of March 31, 2010. [Note: The Final North Plants Pilot LNAPL Removal Action Evaluation Report was issued by URS Corporation in April 2011. This report presented the monitoring results from March 2009 through May 2010. An additional monitoring period was recommended by the RVO and agreed upon by the Regulatory Agencies, and monthly water level and LNAPL thickness measurements will continue through August 2011. A subsequent evaluation report for the additional monitoring period will be issued to the Regulatory Agencies, and will be used as the basis for determination of the further actions necessary to address the LNAPL plume.]
Changes in Monitoring Networks	Unexpected changes to the off-post monitoring networks along with the significant reductions in the extent of off-post contamination have resulted in a need to review and potentially revise the Off-Post Exceedance Monitoring Network.	All monitoring categories and containment and treatment systems identified in the 1999 LTMP and the Well Retention and Closure Program (FWENC 2003d) will be evaluated in the revised LTMP.	The monitoring networks have been revised through Regulatory Agency consultation and documented in the 2010 LTMP.
Operational Assessment Report (OAR) Schedule	The OARs were not developed within the RS/S time requirement and concerns were raised by the Regulatory Agencies that delays in issuing the OARs prevent timely review and evaluation of remedy effectiveness.	Army will ensure that the OAR schedule provided in the RS/S is adhered to, starting with the 2005 OAR.	The OARs have been issued according to the RS/S schedule every year during this FYR period.

Table 5.2-1. Status of Follow-Up Actions to Address 2005 FYR Issues (Concluded)

2005 FYRR Issue	Description of Issue	Recommendation	Follow-Up Action
SEO Well Notification Program (Off-Post Institutional Controls)	The SEO is not including the agreed-upon notification on all well permits issued in the notification area and copies of the permits are not routinely being transmitted to the RVO and Regulatory Agencies.	TCHD has agreed to review well application and permit data in the notification area quarterly under its current Memorandum of Agreement (MOA) with the Army.	The Army maintains responsibility for implementation of the program and provides evaluation as part of the annual land use control monitoring.TCHD is providing oversight of the SEO program and coordination with the Army for annual reporting.

5.2.1 Basin F Wastepile

As discussed in the 2005 FYRR, during the O&M phase of the Basin F Wastepile IRA it was observed that Subcell sump #2 was not operating as designed. A larger volume of leachate was being collected in the secondary (LDS) sump than the primary (LCS) sump. This discrepancy in the expected volume of leachate was identified as an issue described as follows in the 2005 FYRR:

> *The Basin F Wastepile is not operating as designed, as detailed in Section 7.2.3.13. Very little leachate is being collected in the primary system (leachate collection) of Cell #2 while larger volumes are collected by the secondary sump (leak detection) system. There is no evidence that the secondary sump system in Cell #2 is leaking, but soils beneath the secondary sump system will be monitored for staining during the Basin F Wastepile Excavation Project and reported in the CCR. Cells #1 and #3 are operating as expected. It should be noted that leachate volume currently being generated is dramatically less than it has been in the past due to the gradual dewatering of the waste. For those reasons, the issue is not affecting current protectiveness of the remedy.*

The 2005 FYR concluded**:**

> *The On-Post ROD requires the Basin F Wastepile to be excavated and placed in an on-site triple-lined landfill, which began in the spring of 2006. Placement of all Basin F Wastepile material is currently scheduled to be completed by October 2008. There is no evidence that the secondary sump system of Cell #2 is leaking, but soils beneath the secondary sump system of Cell #2 will be monitored for staining during the Basin F Wastepile Excavation Project and reported in the next CCR.*

Several actions were taken to address the issue discussed above. During the Basin F Wastepile Remediation, care was taken to ensure complete removal of Sump #2 and other sumps. Removal of Sump #2 was begun by detaching the primary and secondary liners from the sump box, and dewatering of the sump box and surrounding gravel. It was noted that the weld of the subcell

liner to the primary sump box had been separated, allowing leachate to flow directly into the secondary sump box that surrounded the primary sump box. The sump boxes, concrete pad, and gravel were removed and the clay sump liner was excavated. Soil beneath the clay sump liner was overexcavated, but only a few feet of overexcavation were required.

Observations of the final Sump #2 excavation surface did not indicate the presence of wet, discolored, or stained soil. Inspections of the subgrade soil beneath the secondary liner and compacted clay sump liner, removal of impacted soil, confirmatory sampling, and documentation of these activities provide assurance that removal of the Basin F Wastepile material as well as subcell liner components and sump structures was successfully accomplished in Subcell #2, Sump #2, and the remaining subcells and sumps.

Confirmatory samples were collected from beneath the secondary liner from all three subcells at pre-selected locations and post-excavation confirmatory samples were taken at the bottom of all three Basin F Wastepile subcell sump locations. Results from a confirmatory sample collected from the lowest final Sump #2 excavation surface did not exceed human health criteria. Observations during the remediation concluded that the secondary liner system in Subcell #2 did not leak.

5.2.2 Monitoring Well Maintenance and Security of Off-Post Wells

The 2005 FYRR identified the following issue related to well maintenance and security:

> *During FYR inspections, the team found that four monitoring wells, located off post east of the North Gate access to RMA and just outside the relocated RMA perimeter fenceline, were damaged and had not been fixed or replaced in a timely manner. Two of these wells were "orphan" wells that are not included in the current database. The primary reason these monitoring wells were not locked was that the recent fence relocation resulted in on-post wells (for which locks are not required) being located outside the secured perimeter fence. In addition, three other wells were identified which had previously been flagged in the database as requiring repair. Of the three wells, one was closed and replaced by a new well and the other two were repaired. The Army had scheduled these wells for repair prior to the FYR inspections and the repairs were completed after the site inspection was conducted. It is Army policy to lock all monitoring wells located outside the RMA perimeter fence, or outside off-post fenced-in well fields. Also, the Well Retention and Closure Program (TtFW, 2004) requires prompt notification and response for damaged wells and in this case response was delayed. This issue did not affect the protectiveness of the remedy.*

The 2005 FYRR included the following conclusion regarding follow-up on this issue:

> *The Army will ensure that the well maintenance and security issues are corrected in accordance with Army policies and procedures in the next FYR period. Inspections of off-post and on-post monitoring wells will be conducted and reported in accordance with the revised LTMP.*

During this 2010 FYR period, the Army continued to review the integrity of wells as part of the ongoing monitoring activities. This approach is consistent with that specified in the 2010 LTMP (TtEC and URS 2010c), which states that monitoring wells will be reviewed each time a well is used during scheduled monitoring events. When a review indicates that a retained well is damaged or that its condition has deteriorated, a decision will be made to repair the well, replace the well, or close it. Well protection needs are identified in the Well Networks Updates that have been issued monthly during the past FYR period. These updates include an annual summary update and are made available at the end of each year. A list of wells to be retained in addition to the LTMP wells will be developed during the next FYR period.

5.2.3 Extraction Well and Extraction System Shut-Off Criteria

The extraction well and extraction system shut-off criterion issue identified in the 2005 FYRR was as follows:

> *During the evaluation of how ROD shut-off criteria had been applied to past and planned extraction well and system shut-off, it became apparent that the existing ROD criteria leave room for interpretation. Two questions were identified related to the ROD shut-off criteria:*
>
> - *When can a well be turned off for hydraulic purposes; can this apply when the well has already met chemical shut-off criteria?*
> - *How long after an extraction well has been turned off for chemical purposes should shut-off monitoring start? (The ROD does not identify a timeframe for this action.)*

The possible interpretation differences of the ROD shut-off criteria have not affected the shut-off process during the past FYR period.

The 2005 FYR concluded:

> *Even though the Army concludes that this issue has not affected remedy protectiveness, more detailed and objective extraction well and system shut-off criteria will be proposed as part of the revisions to the LTMP. Different shut-off criteria will be considered for the systems based on whether they are containment or mass removal systems and whether they are boundary or internal systems.*

The current RODs do not specify an exact starting point for the shut-off monitoring, so the revised shut-off criteria, which are being formally modified through an in-progress ESD, specify that the ROD-required shut-off monitoring commence once the entire extraction system, or a discrete portion of an extraction system, has been shut off. There is no longer a distinction between shut-off for hydraulic and chemical purposes. Operational shut-off monitoring will be conducted from the time an extraction well is shut off until system shutdown to ensure that the operational and regulatory objectives of the system continue to be met.

The decision to shut off a system and develop and execute shut-off monitoring programs relies on a consultative process that includes the Regulatory Agencies in the decision–making process. Once an agreement that a system can be shut off has been reached, a pre-shut-off monitoring program may be conducted to confirm the decision with collection of additional data. Upon

confirmation, a minimum of 5 years of shut-off monitoring will be conducted for wells selected through the consultative process. Upon completion of the shut-off monitoring program and the final decision to shut off the system, a post-shut-off monitoring program will be performed for a period specified for each system.

5.2.4 Establishing Site-Specific PQLs

The 2005 FYRR identified the following issue regarding establishing site-specific PQLs for groundwater contaminants for which the CSRGs cannot be measured with available analytical methods:

> *The On-Post ROD identifies the site-specific PQL as "(c)urrent certified reporting limit or practical quantitation limit readily available from a commercial laboratory." The existing process for determining PQLs/MRLs has been identified as an issue for the compounds for which PQLs remain above the CSRGs/CBSGs in part because Army has used a MRL-based approach that differs from industry practice. The ongoing changes to the Army analytical programs and recent advancements in analytical technology suggest it would be beneficial to follow a standardized procedure to evaluate the analytical capabilities of several laboratories. Therefore, it has been determined necessary, during the next FYR period, to re-evaluate the current laboratory procedures and the procedure for establishing site-specific PQLs.*

ICs are in place to prevent exposure until the CSRGs/CBSGs are attained. The groundwater remedy as it currently exists is therefore protective.

The 2005 FYR concluded:

> *The Army recommends that the approach for establishing site-specific PQLs be revised and that a procedure for site-specific PQLs be developed. As of October 26, 2006, agreement has been reached with the Regulatory Agencies that PQL studies will be conducted in accordance with 40 CFR 136 Appendix B and soon-to-be published Colorado State PQL Guidance for compounds for which MRLs exceed CSRGs as outlined in decision document DD-RMAPQL-11. The site-specific PQLs determined from these studies will be implemented at RMA.*

The PQL Work Plan was finalized in December 2009 in accordance with state PQL guidance (CDPHE 2008) and the PQL study was conducted in early 2010.

5.2.5 Bedrock Ridge Plume Capture

The FYR issue related to plume capture at the Bedrock Ridge extraction system was described as follows in the 2005 FYRR:

> *As stated in the technical assessment, it was determined that a low volume of the Bedrock Ridge plume was not captured by the extraction system. To ensure that the ROD objective for this system was met, it was decided that the addition of an*

extraction well should be evaluated and tested. The additional extraction well was installed and its performance will be evaluated during the next FYR period.

While the need to improve plume capture was identified for the Bedrock Ridge System, the low volume of bypass did not affect remedy protectiveness due to site-wide remedy elements including downgradient groundwater treatment systems and ICs.

The 2005 FYR concluded:

Based on monitoring and pumping tests in the Bedrock Ridge area, the Army recommended the addition of an extraction well to the Bedrock Ridge Intercept system to capture the flow of contaminated groundwater previously not captured by the system. The additional extraction well was installed in FY 2005. Remedy performance will be monitored and assessed by the RMA Water Team during the next FYR period.

The additional extraction well successfully captures contaminated groundwater not previously captured by the system. The BRES has consistently met performance criteria during this FYR period.

5.2.6 Shell Disposal Trenches Dewatering Goals

The timeframe for achieving dewatering goals at the Shell Trenches had not been specified and the dewatering goals had not been met at the time of the 2005 FYRR since lowering of the water table at the Shell Trenches depends on the passive dewatering resulting from reduced infiltration after cover installation. This led to the identification of the following issue as described in the 2005 FYRR:

The ROD remedy for the Shell Disposal Trenches is described as "installing a soil cover and slurry wall to reduce movement of contaminants from the Shell Disposal Trenches in Section 36." Consistent with the assessment presented in the FYRR, the dewatering goal of achieving water levels below the bottom of the trenches had not been met at the end of the FYR period. The fact that water level measurements were not collected from the monitoring wells inside the slurry wall during part of the FYR period makes it difficult to verify that the remedy was functioning as intended. However, there is no impact to protectiveness due to site-wide remedy elements including downgradient groundwater treatment systems and institutional controls.

The 2005 FYR concluded:

The Army recommends that the dewatering goal of achieving water levels below the bottom of the trenches be evaluated after both the RCRA-equivalent cover and adjacent soil covers have been installed at the Shell Disposal Trenches. This will allow meaningful assessment of the reduction of infiltration and lowering of groundwater levels in the Shell Trenches slurry wall enclosure caused by the cover systems. Water level monitoring will be performed and documented.

The short-and long-term performance criteria for the Shell Trenches are specified in the 2010 LTMP (TtEC and URS 2010c), which also specifies the monitoring program for the Shell Trenches. Since the vegetation plays a critical role in the effectiveness of the cover, meeting the Shell Trenches performance goal will not be required until the vegetation has been established. For cover compliance, the vegetation is considered to be established 5 years after the cover has been completed and revegetated, at which time potential irrigation is assumed to end. Compliance with the dewatering goal will therefore not be required until the end of the 5-year period—once vegetation has been established and irrigation has ended. The final inspection for the cover revegetation was held on October 2, 2007, so achievement of the performance goal is expected to occur by October 2, 2012, after the 5-year period required to establish vegetation.

5.2.7 South Lakes Plume Management

The South Lakes monitoring program to determine if there was contaminant migration at levels exceeding CBSGs into Lake Ladora was completed during the 2005 FYR period. However, there was no documentation prior to the 2005 FYRR that removed the associated monitoring requirement from the On-Post ROD. An ESD was therefore issued during FYRR finalization to ensure the requirement was removed from the ROD. Since this issue was resolved before the Final 2007 FYRR was issued, the issue and its resolution were documented as follows in the 2005 FYRR:

> *The 2004 South Lakes Groundwater Monitoring Report concluded that there was no migration of contaminants into the South Lakes at levels exceeding CBSGs, and consequently, the goal of preventing the migration of contaminants into the South Lakes at levels exceeding the CBSGs has been met. As a result, the parties agreed that it was appropriate to remove the lake level maintenance requirement from the selected remedy in the On-Post ROD using an ESD which was approved by EPA on March 31, 2006.*

The 2005 FYR concluded:

> *The 2004 South Lakes Groundwater Monitoring Report concluded that there was no migration of contaminants into the South Lakes at levels exceeding CBSGs, and consequently, the goal of preventing the migration of contaminants into the South Lakes at levels exceeding the CBSGs has been met. As a result, the parties agreed that it was appropriate to remove the lake level maintenance requirement pertaining to plume management from the selected remedy in the On-Post ROD using an ESD. The ESD was approved on March 31, 2006.*
>
> *As a separate part of the remedy, the Institutional Control Plan has established lake level performance criteria for the future, but only for the HHE soil and aquatic ecosystems ROD requirements of maintaining a healthy aquatic ecosystem and preventing human exposure to potentially contaminated sediments, respectively.*

As noted, the ESD (TtEC 2006c) was approved in 2006. Groundwater monitoring will be conducted as part of the long-term monitoring program for groundwater to assess any change in future conditions.

5.2.8 Off-Post Groundwater Intercept and Treatment System Performance Objectives Clarification

Because of inconsistencies in terminology used in the two RODs and other documents, the need to clarify whether the off-post system was a containment or mass removal system was identified as a 2005 FYR issue and clarified as follows in the 2005 FYRR:

> *The OGITS is designed as and has been operated as a mass removal system. However, the use of containment terminology in descriptions of the system in several documents trigger comments regarding system performance and made it apparent that a clarification of system objectives was necessary The need to clarify the mass removal objective has not affected remedy protectiveness as the system has been operated as designed.*

The 2005 FYRR included the following clarification regarding follow-up on this issue:

> *This FYRR clarifies that the OGITS has been and will continue to be operated as a mass removal system in accordance with the design and ROD documentation. The revised LTMP will provide specific performance criteria for evaluation of system mass removal effectiveness to facilitate future system evaluation presented in the OARs and FYRs. The Army believes that the need to clarify the overall remedial objectives of the system has not affected the system operation or protectiveness of the remedy during the FYR period.*

The 2010 LTMP (TtEC and URS 2010c) includes detailed mass removal performance criteria for the OGITS and the Regulatory Agency performance notification triggers presented in the LTMP are based on mass removal effectiveness.

5.2.9 Northern Pathway System Modification

The property on which the NPS component of the OGITS is located was acquired by Amber Homes, Inc. Its plan for the property includes the development of a large retail center and residential areas that entail construction at the NPS location and its immediate surrounding area. The modifications to the OGITS affect the NPS extraction system and the associated recharge wells used for reinjection of treated groundwater are described in the Final Conceptual Design Document by Amber Homes, Inc. (George Chadwick Consulting 2005). The new NPS extraction wells will be operated concurrently with the original NPS extraction wells until the latter meet the shut-off criteria.

The system modification for the NPS was designed to meet or exceed the contaminant removal efficiencies of the original system. Also, the original system will continue to operate until shut-off criteria are met. The modification is therefore expected to have a positive impact on system effectiveness and maintain protectiveness. The construction of the NPS modification did not

begin until November 2005 and had no impact on remedy protectiveness. No additional follow-up action is required beyond the follow-up action identified for the OGITS.

The 2005 FYR concluded:

> *The Army proceeded with the modifications to the NPS part of the OGITS in 2005. It is anticipated that the modifications will increase the mass removal effectiveness of the system and expedite the cleanup of the Off-Post OU. The performance of the modified NPS will be monitored during the next FYR period.*

The Army proceeded with the modifications to the NPS part of the OGITS in 2005.

Monitoring of the NPS has continued during this FYR review period and the new system has been found to meet performance expectations of increased mass removal effectiveness. The system performance is discussed in greater detail in Section 4.1.1.1. A DCN that was issued after the new system became operational indicated that two more wells may be required in the vicinity of NE-13 (well 37817) and NE-14 (well 37818) to allow for the shutdown of the old system. The final DCN for the project clarified that a new well was not required in the area of DW-13, and that downgradient extraction wells 37809 and 37810 would continue to operate to intercept flow that bypasses NE-14 (well 37818).

5.2.10 North Plants Fuel Release

Fuel contamination present as LNAPL was discovered in North Plants wells during the 2005 FYR period. As of the end of the FYR period, the need to perform additional characterization and/or remediation of the fuel contamination was being evaluated.

The 2005 FYR concluded:

> *Fuel remains as LNAPL in the North Plants vicinity. The LNAPL will be evaluated in accordance with applicable requirements during the next FYR period.*

A pilot LNAPL removal pilot study was initiated in 2009, and is currently operating in accordance with the North Plants Pilot LNAPL Removal System Action Plan (URS Washington Division and TtEC 2008). The purpose of the study is to determine the extent to which removal of LNAPL is practicable using a well recovery skimming system. A total of 22 piezometers and 2 recovery wells have been installed in the North Plants LNAPL Plume. The pilot LNAPL removal system will be operated to the extent necessary to gather data in support of the final action, if any, for the North Plants LNAPL Plume (URS Washington Division and TtEC 2008). The recovery wells and piezometers were installed in February 2009, and monitoring began in March 2009. Through the end of the FYR period (September 30, 2009), no LNAPL had accumulated in the recovery wells.

5.2.11 Changes in Monitoring Networks

The 2005 FYR concluded:

> *A revised LTMP will be issued in 2007. All monitoring categories and containment and treatment systems identified in the 1999 LTMP and the Well*

Retention and Closure Program will be evaluated in the revised LTMP with regard to the following:

- *Groundwater well networks*
- *Surface water monitoring network*
- *Analytes*
- *Monitoring frequencies*
- *Statistical method applications*

The system objectives and monitoring criteria will be addressed for all on-post and off-post containment and treatment systems. Modifications to the existing well networks will be based on established performance criteria. The conformance monitoring network will be re-evaluated to address the individual and system performance criteria.

The long-term monitoring programs were revised to reflect the current remedy status as well as future remedy and post-remedy monitoring through an interactive process that involved a series of meetings and sharing of technical materials with the Regulatory Agencies. The 2010 LTMP incorporates agreements on monitoring networks and decision processes that were reached during this cooperative effort, which was implemented to ensure that the earlier agreements reached with the Regulatory Agencies during the resolution process for the 2005 FYRR were addressed.

The revised LTMP relies on a process-oriented approach in which objectives, criteria, and decision processes are used to make program-related decisions. A key component of the 2010 LTMP revisions is the development of performance criteria that were established to meet the specific objectives of each of the containment and mass removal systems. This resulted in the development of a performance monitoring category that incorporates the 1999 conformance category. Another important revision affects the shut-off criteria and shut-off monitoring; a consultative process will be employed for decisions related to the shut-off criteria and monitoring programs.

Because of large-scale development and construction activities in the Off-Post OU, some Army monitoring wells have been destroyed and could not be re-drilled in the same locations. These unexpected changes to the off-post monitoring networks along with the significant reductions in the extent of off-post contamination have resulted in a need to review and potentially revise the off-post Exceedance Monitoring Network that was last updated in 2003. The CSRG exceedance well network was reviewed and revised as part of the LTMP revision (TtEC and URS 2010c).

5.2.12 Operational Assessment Report Schedule

The RS/S for the Off-Post OU states that the Operational Assessment Reports (OARs) will be "published in the year following the reporting period" (HLA 1996a). The OARs were not developed within the Off-Post RS/S time requirement and concerns were raised by the Regulatory Agencies that delays in issuing the OARs prevent timely review and evaluation of remedy effectiveness. The OAR delays may affect the ability to conduct timely reviews, but the

delays did not affect remedy protectiveness as the information presented in the OARs is evaluated on a continuous basis by system operators and provided to the Regulatory Agencies in monthly status meetings.

The 2005 FYR concluded:

> *Even though the Army has concluded that this issue has not affected remedy protectiveness, the Army will ensure that the OAR schedule provided in the RS/S be adhered to, starting with the 2005 OAR. The 2005 OAR was issued in a timely fashion in September of 2006.*

The 2005, 2006, 2007, 2008, and 2009 OARs have been issued in a timely manner during the 2010 FYR period, with no schedule delays (PMRMA 2006b, 2007, 2008b, 2009b, 2010).

5.2.13 State Engineer's Office Well Notification Program (Off-Post Institutional Controls)

The 2005 FYRR identified the following issue related to the Well Notification Program:

> *The primary mechanism for implementing the institutional controls is a well notification program developed in conjunction with the State Engineer's Office (SEO) and the Army. The Army prepares updates to a notification map and provides the map to the SEO for its use in notifying well permit applicants of their proximity to RMA groundwater contamination. After evaluation, TCHD has concluded that the SEO is not including the agreed-upon notification on all well permits issued in the notification area and copies of the permits are not routinely being transmitted to all parties. The inconsistency in notification has not resulted in the use of contaminated drinking water wells in the notification area.*
>
> *While the Army has provided the SEO with all the necessary information to implement the off-post well notification program, the SEO has not been following the agreed-upon notification process. This issue needs to be addressed to ensure that this institutional control continues the "(p)revention of the use of the groundwater underlying areas of the Off-Post OU exceeding groundwater containment system remediation goals. The well permit notification program is not consistently operating as intended.*

The 2005 FYR concluded:

> *Based on TCHD findings that the SEO deviated from the agreed-upon notification process for well permits issued in the notification area, the following revised process is recommended:*
>
> - *TCHD has agreed to review well application and permit data in the notification area quarterly under its current MOA with the Army.*
>
> *Under this new recommended procedure the following will occur:*
>
> - *Four times per year (once per quarter), TCHD will make a formal request to the SEO office for copies of well permits issued in the notification area.*

- *TCHD will review each permit to determine if the appropriate notification has been placed on the well permit and evaluate if the well user is or may in the future be extracting and using groundwater that exceeds CSRGs. If notifications are not being placed on well permits issued in the notification area, TCHD in conjunction with the Army will work with the SEO to improve the notification process.*
- *TCHD will notify the RVO, EPA, and CDPHE if a well permit is issued near an existing plume. If so the well will be included in the next round of sampling, and Army will provide notification to the EPA, CDPHE and TCHD if the sample result exceeds CSRGs.*
- *When warranted, TCHD will make individual contact with the permit recipient to provide a detailed explanation of the nature and extent of groundwater contamination in the off-post area.*

The well notifications have occurred routinely during the FYR period.

TCHD has continued to provide oversight over the SEO during this FYR period through quarterly reviews of well permit information and meetings at the SEO. There have been no deviations from established procedures. TCHD reported that there were 47 permits and 43 notices issues for monitoring wells, gravel pits, replacement wells, and new wells between September 15, 2005, and December 31, 2009, within the notification areas.

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6.0 Five-Year Review Process

6.1 General

The RMA FYR was conducted by the Army in accordance with Paragraph 36.3 of the FFA and CERCLA, Section 121(c). The following individuals participated in the review:

- Scott Ache, PMC Environmental Compliance
- Rick Beardslee, RMA, Remedy Execution, Team Leader
- Ron Bertram, EPA
- Kelly Cable, RMA, Remedy Execution
- Bob Charles, RMA, Water Group
- Leo Chen, RMA Remedy Execution
- Robert DiDonato, PMC Engineering
- Laura DiNorcia, RMCI
- John Edrich, PMC Air Group
- Wes Erickson, RMA, Chief Counsel
- Neville Gaggiani, U.S. Geological Survey (USGS) (RMA)
- James Green, RMA Remedy Execution
- Lou Greer, RMA, Remedy Execution
- Janie Griffin, RMA Quality Group
- Greg Hargreaves, EPA
- Dorothea Hoyt, Pacific Western Technologies, Inc. (PWT)
- Tom Jackson, USFWS
- Ellen Kaastrup, PMC, Water Group
- Mark Kearns, RMA, Project Controls
- Scott Klingensmith, RMA Risk Assessor
- Tony LaChance, RMA, Remedy Execution
- Bill Lutz, PWT
- Carl Mackey, RMA, Remedy Execution
- Tom Martella, TCHD
- Richard McPeek, PWT
- Melody Mascarenaz, TCHD
- Susan Newton, CDPHE
- Don Schild, USGS, Water Group

- John Schmuck, PMC Environmental Compliance
- Steve Singer, PWT
- Sherry Skipper, USFWS
- Cecil Slaughter, USGS, Water Group
- Vince Stewart, TCHD
- Andy Todd, PMC Engineering
- Ken Vogler, CDPHE
- Laura Williams, EPA

Volume 1 of this FYRR addresses only inspection findings that have the potential to affect the protectiveness of the remedy that were identified during the FYR inspections. These issues are reported in Section 8.0 of this report. Other less significant inspection findings will be acted upon by the Army or RVO during normal housekeeping and O&M of the remedy components that have inspection findings identified during the FYR.

As appropriate, specific documents were summarized in this review to illustrate the basis for conclusions of the FYR. On-site personnel responsible for all aspects of the remedy implementation were involved in developing the 2010 FYRR.

6.2 Community Involvement and Public Notification

The onset of the initial FYR public notification began on April 30, 2010, with public notices printed in the *Denver Post, Gateway News, Commerce City Sentinel,* and *Brighton Standard Blade,* officially announcing the review was underway. The notice announced the U.S. Army was seeking community input during this process and community members were encouraged to submit any concerns or issues they would like to see addressed during the review. The summary of the community interviews is presented in Appendix A of this report.

The majority of the interview respondents became aware of the site from living in proximity to it or from working with government and environmental officials during the beginning stages of the cleanup. All of the respondents lived or worked in the area during some phase of the environmental cleanup program. None of the respondents had any concerns about the cleanup. However, a few had general comments about the site.

RMA's RAB was briefed about the FYR at the May 13, 2010, board meeting.

Additionally, 10 community interviews were conducted by July 2010 as part of the FYR process. The interviewees were asked about any community concerns related to the cleanup, how the overall cleanup is functioning, and if they had any additional comments, questions, or suggestions regarding the cleanup.

The FYR public notice and fact sheet about the review were posted on the RMA Web site—www.rma.army.mil. Staff also provided information about the review at summer community outreach events.

6.3 Document and Data Review

A wide variety of documentation and data were reviewed while preparing this FYRR. A complete list of references is available at Section 12.

6.3.1 Groundwater

On-post and off-post groundwater monitoring programs not directly associated with the containment and treatment systems were evaluated by comparing site-wide monitoring results during the period FY05 through FY10 with the FY04 data, which represent the full data year in the previous FYR period. During this third FYR period, monitoring was conducted in accordance with the 1999 LTMP (FWENC 1999a) and the data evaluation was, to the extent possible, conducted in accordance with the criteria and definitions established in the 2010 LTMP (TtEC and URS 2010c). Implementation of the revised monitoring programs presented in the 2010 LTMP will start in FY10, which is the first year of the next FYR period.

The data evaluation in this section is presented for each of the monitoring categories and does not address monitoring associated with the groundwater containment and treatment systems discussed in Section 4.1.1.1 through 4.1.1.3. A more detailed evaluation and data presentation is provided in the FYSR. The monitoring categories are the following:

- **Water Level Tracking**: On-post water level monitoring used to track the effects of the soil remedy to groundwater in the On-Post OU. Water level tracking wells will be used to monitor water levels and track flowpaths between individual on-post remedies and the RMA boundary as well as off post. Water level tracking will be performed annually.
- **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. Water quality tracking is conducted either once or twice during each FYR period to track plume migration upgradient from the groundwater containment and intercept systems. These data are collected to evaluate long-term trends in the FYRR.
- **Confined Flow System (CFS) 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. CFS monitoring will be performed twice in 5 years.
- **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 ICs. Exceedance monitoring will be performed twice in 5 years.
- **Off-Post Water Level Monitoring**: Water level monitoring off post conducted in support of the exceedance monitoring to assess flow paths and contaminant migration in the exceedance areas. Water level monitoring will be performed annually. *(Separated from "Water Level Tracking" because it serves a different purpose.)*

The review was conducted in accordance with the following criteria outlined in the 1999 LTMP:

- Water level tracking will be conducted annually and summarized in the FYRR. The main purpose of the long-term monitoring program is to track changes in water levels and

flowpaths. A report will therefore be generated to include comparisons of new water level maps with baseline water level maps for each FYR period.

- Exceedance monitoring has separate reporting requirements in addition to its inclusion in the FYSR. Summaries of trends based on the exceedance mapping and the most recent exceedance maps will be presented in the FYRR.
- Confined flow system monitoring will be summarized in the FYRR, which will include an evaluation of any potential contaminant trends during that FYR period.

Conclusions from the site-wide data for these monitoring categories were used to evaluate project-specific impacts on groundwater. The conclusions of the on-post and off-post groundwater monitoring programs are summarized below.

6.3.1.1 Water Level Tracking

During the third FYR period, water level tracking was conducted in accordance with the LTMP objectives. Several soil remedies were completed during the second FYR period and their impact on groundwater was evaluated.

The On-Post ROD identified five plume groups consisting of 15 contaminant plumes on post. The on-post plume groups that were included in the water level tracking during the past FYR period are as follows:

- North Boundary Plume Group upgradient of NBCS
- Northwest Boundary Plume Group upgradient of the NWBCS
- Western Plume Group upgradient of the Irondale Containment System
- Basin A Plume Group upgradient of BANS
- South Plants Plume Group, which includes plumes emanating in the South Plants Central Processing Area

Source monitoring is conducted in the South Plants Central Processing Area, South Plants Balance of Areas, SPSA-2d Ditch, and Basin A to evaluate effectiveness of the remedies. The objectives of the source-monitoring component of on-post water level and quality tracking are as follows:

- Conduct water level monitoring to assess the impact of the on-post remedy implementation on water levels, flow, and contaminant migration pathways in plume source areas.
- Conduct water quality monitoring for key indicator compounds to support contaminant concentration tracking in source areas where human health exceedance soils are left in place.

Source and remedy areas addressed under the water level tracking program, include the following:

- Former Basin F/Basin F Wastepile
- Basin A

- Complex (Army) Disposal Trenches and Shell Disposal Trenches
- South Plants and South Lakes

Project-specific operational water level monitoring as specified in the respective design documents and the 1999 LTMP was also conducted at former Basin F, Basin A, Complex Trenches, and Shell Trenches. Under the 2010 LTMP, project-specific performance water level monitoring will also be conducted at Complex Trenches and Shell Trenches.

The monitoring results from the on-post water level tracking over the 5-year period show that the flowpaths are consistent with the previous review period. It should be noted that the water level tracking program described here addresses the site-wide remedy impacts and water level trends. Project specific details are addressed in the monitoring reports for the individual remedies that require monitoring.

The RVO collects water-level data annually during the fourth quarter (July through September) and uses the data to construct a water-table map of RMA. The water-table map is used for identifying changes in groundwater flow directions in the unconfined groundwater that could affect contaminant plume migration. Figure 6.3.1-1 shows a comparison between on-post water levels in FY04 and FY09 and reflects the overall changes in water levels during the FYR period.

Remediation activities, such as groundwater extraction and recharge systems as well as the slurry wall caps and covers affect groundwater levels in several areas. Precipitation events also affect water levels and are an important source of recharge to the shallow unconfined groundwater system at RMA. The RVO collects precipitation data from an on-site station (Met4a) along C Street, about one-third mile north of Seventh Avenue. If precipitation data are not available at that site, the RVO collects data from another on-site station (Met1a) along Seventh Avenue in the southern portion of Section 36, about one-third mile west of E Street.

The average annual water-year precipitation at RMA is 15.48 inches (TtEC 2009a). Annual precipitation data from 2004 through 2009 showed a variable trend ranging from a low of approximately 10 inches in 2008 to a high of approximately 17 inches in 2004.

For this FYRR (FY05 through FY09), water-level tracking data were evaluated by comparing water-level contours year-to-year beginning with the FY04 (the last year of the second FYR) through FY09. The RVO also compared water-level contours for FY09 to those in FY04 to compare the difference in groundwater flow direction and groundwater elevations in the final year of each FYR period. Precipitation events and remediation activities have caused some changes in groundwater levels at RMA over the past 5 years. Precipitation events at RMA generally result in increases in water level elevations while remedies, such as groundwater extraction and soil covers, have caused water levels to decrease over time. Overall, based on a year-to-year water level comparison for 2004 through 2009, groundwater flow directions and associated migration of contaminant plumes have not changed significantly. The year-to-year comparison also indicates that there were no changes in groundwater levels or associated flow patterns in the areas upgradient of the containment systems that could have affected the effectiveness of the systems during the FYR period. The FY09 water-level contours, which are compared to those generated in FY04 in Figure 6.3.1-1 show water levels that depict similar

groundwater flow directions. A more detailed evaluation of localized water level changes is presented in the FYSR.

Groundwater flow has not changed in the unconfined flow system (UFS) across most of RMA. Locally, groundwater flow has changed within areas where infiltration is now limited due to the installation of covers, caps, slurry walls and trenches within the vicinity of Basin A and (Section 36) and the South Plants area. Minor changes in groundwater flow have resulted, but flowpaths and associated plumes continue to migrate directly towards the containment systems. Within the South Plants area, the extent of the groundwater mound has decreased and evolved into two smaller mounds during the latter part of the FYR period. The overall groundwater flow directions have not changed, however.

6.3.1.2 Water Quality Tracking

Water quality tracking was conducted in areas upgradient of the containment systems to supplement the water level tracking data. A well network established in the 1999 LTMP was used to monitor changes in water quality and assess the influence of the soil remedies on groundwater contaminant levels and plume migration. Table 6.3.1-1 provides a list of water quality tracking wells with their respective indicator analytes for the specific source areas and boundary containment systems monitored under the LTMP.

The table is updated from the 1999 LTMP well network to include revisions made in the Well Networks Updates for WYs 2003 through 2009.

Table 6.3.1-1. Water Quality Tracking Wells and Indicator Analytes (1999 LTMP and Well Networks Update Revision)

Well ID	Sampling Frequency	Indicator Analytes
Upgradient of NWBCS		
03016	Twice in 5 years	Chloroform, dieldrin
27025	Twice in 5 years	Chloroform, dieldrin, DIMP, NDMA
27037	Twice in 5 years	Chloroform, dieldrin, DIMP
27072	Twice in 5 years	Chloroform, dieldrin, DIMP
27079	Twice in 5 years	Chloroform, dieldrin, DIMP
27082	Twice in 5 years	Chloroform, dieldrin, DIMP
27083	Twice in 5 years	Chloroform, dieldrin, DIMP
27500	Twice in 5 years	Chloroform, dieldrin, DIMP
27522	Twice in 5 years	Chloroform, dieldrin, DIMP
28520	Twice in 5 years	Chloroform, dieldrin, DIMP
28522	Twice in 5 years	Chloroform, dieldrin, DIMP
34020	Twice in 5 years	Chloroform, dieldrin
35058	Twice in 5 years	Chloroform, dieldrin
Basin A/Basin A Neck/Section 36 Bedrock Ridge		
25502	Twice in 5 years	Benzene, chloroform, DBCP, dieldrin, dithiane
25503 (36F07)	Twice in 5 years	1,2-Dichloroethane, benzene, carbon tetrachloride, chloroform, PCE, TCE, DDT, DIMP

Table 6.3.1-1. Water Quality Tracking Wells and Indicator Analytes (1999 LTMP and Well Networks Update Revision) (Continued)

Well ID	Sampling Frequency	Indicator Analytes
25504 (36F08)	Twice in 5 years	1,2-Dichloroethane, benzene, carbon tetrachloride, chloroform, PCE, TCE, DDT, DIMP
26006	Twice in 5 years	NDMA
26500	Twice in 5 years	Benzene, chloroform, DBCP, dieldrin, DIMP
35065	Twice in 5 years	Benzene, chloroform, DBCP, dieldrin, DIMP
35069	Twice in 5 years	Benzene, chloroform, DBCP, dieldrin, DIMP
36552	Twice in 5 years	1,2-Dichloroethane, benzene, carbon tetrachloride, chloroform, PCE, TCE, DDT, DIMP
36594	Twice in 5 years	1,2-Dichloroethane, benzene, carbon tetrachloride, chloroform, PCE, TCE, DDT, DIMP, atrazine
36629 (36093)	Twice in 5 years	Benzene, chloroform, TCE, DBCP, dieldrin, DIMP
36630 (36108)	Twice in 5 years	Benzene, chloroform, TCE, DBCP, dieldrin, DIMP
36631 (36109)	Twice in 5 years	Benzene, chloroform, TCE, DBCP, dieldrin, DIMP
36632 (36177)	Twice in 5 years	Benzene, chloroform, TCE, DBCP, dieldrin, DIMP
36633 (36599)	Twice in 5 years	Benzene, chloroform, TCE, DBCP, dieldrin, DIMP
South Plants/South Lakes		
01078	Twice in 5 years	Chloroform, dieldrin
01525	Twice in 5 years	Chloroform, dieldrin
01534	Twice in 5 years	Benzene, chloroform
02034	Twice in 5 years	Benzene, chloroform, dieldrin
(1999 LTMP and Well Networks Updates Revisions)02056	Twice in 5 years	Chloroform, dieldrin
02505	Twice in 5 years	Benzene, chloroform, dieldrin
02512	Twice in 5 years	Benzene, chloroform, dieldrin
02524	Twice in 5 years	Benzene, chloroform, dieldrin
02525	Twice in 5 years	Benzene, chloroform, dieldrin
Former Basin F		
26015	Annual	Chloride, chloroform, dieldrin, DIMP, NDMA
26017	Annual	Chloride, chloroform, dieldrin, DIMP, NDMA
26157	Twice in 5 years	Chloride, chloroform, dieldrin, DIMP, NDMA
26163	Annual	Chloride, chloroform, dieldrin, DIMP, NDMA
Upgradient of NBCS		
23095	Twice in 5 years	Chloride, chloroform, dieldrin, DIMP, NDMA
23096	Twice in 5 years	Chloride, chloroform, dieldrin, DIMP, NDMA
23142	Twice in 5 years	Chloride, chloroform, dieldrin, DIMP, NDMA
24092	Twice in 5 years	Chloride, chloroform, dieldrin, DIMP, NDMA
24094	Twice in 5 years	1,2-Dichloroethane, 1,1,1-trichloroethane, carbon tetrachloride, chloroform, dieldrin, DIMP

Table 6.3.1-1. Water Quality Tracking Wells and Indicator Analytes (1999 LTMP and Well Networks Update Revision) (Concluded)

Well ID	Sampling Frequency	Indicator Analytes
Rail Yard		
03503	Twice in 5 years	DBCP
03523	Twice in 5 years	DBCP
Western Plume		
33341	Twice in 5 years	TCE
North Plants		
25059	Twice in 5 years	1,2-Dichloroethane, 1,1,1-trichloroethane, carbon tetrachloride, chloroform, dieldrin, DIMP

Water quality tracking data were used to assess potential changes in water quality related to the on-post plume areas, in source areas, and in remedy areas for indicator compounds identified in the LTMP. The water quality tracking focuses on tracking changes in indicator analyte concentrations at plume source areas, along the edges of plumes, and across transects of major plumes. The water quality tracking results over this 5-year period show that the groundwater conditions remain consistent with the initial assumptions used at the time of remedy selection. Detailed information, including concentration trends for individual wells is provided in the FYSR.

Based on the evaluation of water quality data, the remedies have affected the levels of indicator analytes within each area. For the most part, the concentrations of indicator analytes are remaining stable or decreasing. In a few instances, there are observed concentration increases that require continued monitoring to verify the trend. For each area addressed in the FYR, a summary is provided below with additional details presented in the FYSR.

- Upgradient of the NWBCS: Concentrations of chloroform and DIMP demonstrate decreasing trends or were not detected in wells sampled under the LTMP. Dieldrin concentrations increased in a few wells, likely due to an increase in water levels, but were stable or decreased in other wells. Based on two sampling events, dieldrin in well 35058 showed a slight increase in 2009.
- Basin A/Basin A Neck/Section 36 Bedrock Ridge: Concentrations of benzene, chloroform, DBCP, dieldrin, dithiane, tetrachloroethylene (PCE), TCE, 1,2-dichloroethane, n-nitrosodimethylamine (NDMA), DIMP, carbon tetrachloride, and 2,2-bis(p-chlorophenyl)-1,1,1-trichloroethane (DDT) demonstrate stable or decreasing trends for the wells sampled in this area. DDT had an increasing trend in one well in Basin A Neck downgradient of the BANS, but this is a small-scale, short-term variation within a relatively stable long-term trend. TCE in well 36594, which is upgradient of the Bedrock Ridge system, shows a slight increase in concentration during the FYR period.
- South Plants/South Lakes: Although the concentrations of chloroform, benzene, and dieldrin indicate decreasing or stabilizing trends, there were a few increases indicated in specific wells. The concentration of dieldrin increased in well 01525 in 2007, but

subsequently decreased in 2009. Chloroform concentrations slightly increased in wells 02034 and 01534 during the FYR period.

- Former Basin F: Concentrations of chloride, chloroform, and DIMP were not detected or demonstrated decreasing trends in groundwater within the vicinity of the former Basin F. Only dieldrin and NDMA concentrations increased in groundwater in well 26157 sampled during the FYR period.
- Upgradient of the NBCS: Concentrations of chloride, chloroform, dieldrin, DIMP, and NDMA generally showed stable or decreasing trends in groundwater upgradient of the NBCS. The only increases noted during the FYR period were for well 23142 where chloride, chloroform, and dieldrin concentrations increased, and in well 23095, where only dieldrin increased in concentration.
- Rail Yard: DBCP concentrations decreased or remained stable in the two wells sampled during the FYR period within the Rail Yard area.
- Western Plume: TCE concentrations decreased to below the CSRG in well 33341 in 2004 and 2007 and sampling was discontinued. This plume originates south of RMA and migrates on post.
- North Plants: Concentrations of DIMP showed a decreasing trend in the single well sampled at the North Plants during the FYR period. Chloroform, carbon tetrachloride, dieldrin, 1,1-dichloroethane, and 1,1,1-trichlorethane were not detected in well 25059 during the FYR period.

6.3.1.3 Confined Flow System

The On-Post ROD provides the following specific component of the selected groundwater remedy for the confined flow system:

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

CFS monitoring is required by the On-Post ROD to identify vertical or lateral migration of contaminants to or within the CFS in the Basin A, Basin F, and South Plants areas.

Water level and water quality monitoring results were evaluated for the CFS wells. In addition to review of chemical data, this evaluation included comparisons of CFS water level data with UFS water level data to help address potential downward migration. The wells considered for the current FYR period were monitored in accordance with the 1999 LTMP. There are 19 on-post wells sampled for water quality in the on-post CFS well network. The CFS monitoring program was reviewed as part of the LTMP revision (TtEC and URS 2010c); the CFS well network and monitoring frequency were retained, and the indicator analytes were revised.

During this FYR period, organic indicator analytes and arsenic were not detected in several wells or were detected at low concentrations indicating decreasing trends within the CFS. As summarized below, increases in chloride levels within the CFS and the discrepancies between chloride levels detected in the CFS and UFS can be attributed to several conditions:

- The installation of soil covers and systems within Section 36 may or may not have a direct effect on chloride concentrations within the CFS, but continued monitoring will provide support for future evaluations.
- Increases in chloride concentrations in well 35067 were evaluated along with the hydraulic properties of the UFS and CFS in that area. The results indicate that vertical migration of groundwater is likely taking place in the vicinity of well 35067, but an effective aquitard may not exist and thus, confined conditions do not locally exist in this area.
- Substantial increases in chloride concentrations in well 35083 were evaluated along with the hydraulic properties of the UFS and CFS in that area. It is likely that a combination of vertical and lateral migration of groundwater is taking place in the vicinity of well 35083 and that the well integrity may have been adversely affected by the lack of a bentonite well seal, which may facilitate vertical contaminant migration in the well.
- West of Basin A, chloride concentrations remained relatively stable in well 35063 and increased slightly in well 36171 during the FYR period. Chloride concentrations are lower in these two wells compared to other CFS wells in the vicinity of Basin A, with consistent concentrations since the early 1990s. Arsenic was detected in both of these wells for the first time, with concentrations near the detection limit. Future sampling of wells 35063 and 36171 will confirm the presence of arsenic, whose presence is likely a function of decreasing detection limits over time rather than contamination within the CFS.

6.3.1.4 Off-Post Exceedance Monitoring

As stated in the Off-Post ROD, off-post water quality monitoring is conducted to assess contaminant concentration reduction and remedy performance and to support the IC component of the off-post remedy (HLA 1995):

> *[T]he preferred alternative includes long-term monitoring of offpost 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 RS/S (HLA 1996a) 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.*

The stated purpose is accomplished by monitoring water quality in a network of off-post monitoring wells and private wells. The regional monitoring category in the Off-Post RS/S is now called exceedance monitoring. Exceedance monitoring wells are sampled twice in 5 years. Water levels also are monitored annually in the monitoring wells.

Exceedance monitoring is also conducted in support of the IC component of the off-post remedy. The purpose of the ICs is to restrict the use of contaminated groundwater. This is accomplished by providing notification in areas where groundwater contaminants have the potential to exceed CSRGs and by providing alternate water supplies for wells that exceed CSRGs. The SEO notifies potential well owners of possible contamination. This notification is implemented in areas with contaminant levels that potentially exceed the CSRGs presented in Table 4.1.1-5. According to the Off-Post ROD, Appendix B (HLA 1995):

> *The Army has provided the Office of the State Engineer, State of Colorado, a map identifying areas in the Off-Post Study Area where groundwater could potentially exceed CSRGs. This map will be updated based on each sampling round.*

A summary of the CSRG exceedance monitoring results is as follows:

- DIMP is the RMA groundwater contaminant with the greatest extent off post. The DIMP CSRG of 8 µg/L is a state standard for human health and has no corresponding Federal standard. The EPA health advisory for DIMP is 600 µg/L. Figure 6.3.1-2 shows the DIMP exceedance areas for 2004, 2007, and 2009, and depicts the decrease in the size of the DIMP plume between 2004 and 2009. It should be noted that beginning in 2002 the maps are based on concentrations at or above the CSRG of 8 µg/L, while earlier maps were drawn based on concentrations at or above the reporting limit.
- DIMP concentration trends varied in individual wells within the analyte's exceedance area, but the total exceedance area has decreased over the FYR period, particularly downgradient of the FCS, where the plume is narrower than in WY04, and downgradient of the NPS, where the NPS Modifications appear to have reduced contaminated flow around the northeast end of the NPS. The size of the DIMP exceedance area upgradient of the NPS also decreased between 2004 and 2009, and the DIMP concentrations in all wells upgradient of the NPS in Section 12 are below the CSRG. The size of the DIMP exceedance area north of 96th Avenue, and northwest of the west end of the NBCS, also decreased in 2009. The downgradient extent of this exceedance area is based on an unconfined Denver Formation well (37379). The DIMP concentrations in the adjacent alluvial well (37374) have been below the CSRG for DIMP since 1994. The underlying unconfined Denver formation has lower permeability and is slower to clean up than the overlying alluvium.
- DIMP and carbon tetrachloride were the only organic contaminants that exceeded CSRGs downgradient of the OGITS. The DIMP and carbon tetrachloride concentrations downgradient of the NPS decreased to below the CSRGs in WY09, likely as a result of operation of the NPS Modifications.
- Most of the dieldrin exceedance areas were similar in 2007 and 2009, including a narrow exceedance area that extends from near the eastern end of the NBCS to the NPS. One of the dieldrin exceedance areas was larger in 2009 in the First Creek Pathway and western part of the Northern Pathway because of an increase in concentrations in three wells. Dieldrin concentrations decreased in most wells between 2007 and 2009.

- Chloroform, DBCP, NDMA, and PCE concentrations in wells evaluated in this review decreased during the current FYR period. DBCP and NDMA were not detected above the CSRG/PQL.
- The CSRG exceedance areas for chloride and sulfate did not change significantly during the FYR period. No definite trends were observed for chloride. Sulfate concentrations show a decreasing trend downgradient of the NBCS and an increasing trend in some wells near the FCS.
- The fluoride exceedance areas showed little change during the current FYR period.

An increase in DIMP concentrations downgradient of the FCS occurred in 2007 in one well, likely a result of a lateral change in the flow direction because of unusually high groundwater levels and extended flow in O'Brian Canal. Prior to 2007, the DIMP concentrations in well 37429 had been below the CSRG (since 1995). The DIMP exceedance areas had been interpreted to occur near, and to the east, of the well. In July 2007, the DIMP concentration in well 37429 was 23.8 µg/L. The well was sampled again in October 2007 to confirm the detection, and the concentration was 43.2 µg/L. In 2009, the concentration in well 37429 decreased to 13.6 µg/L. In 2007 and 2009, therefore, the DIMP exceedance area was interpreted to extend approximately 400 ft farther west (compared to 2004) to include this well.

The CSRG exceedance well network was reviewed and revised as part of the LTMP revision (TtEC and URS 2010c).

6.3.1.5 Private Well Network (#96)

In accordance with the 1997 Memorandum of Agreement (MOA) between TCHD and the Army (PMRMA 1997a), TCHD conducts sampling of private wells in the Off-Post OU. Samples are collected from off-post private wells to provide data to assist in refining the CSRG exceedance map, to determine the water quality of new off-post wells as required by the Off-Post ROD, to respond to citizen requests, and to determine whether CFS wells are acting as conduits for contaminant transport from the UFS to the CFS. Execution of the program depends on cooperation from the private well owners, and access to the wells is therefore not consistent. Approximately 30 wells are sampled for DIMP each year. No new wells were installed during the FYR period that required sampling by the Off-Post ROD.

The monitoring results for UFS private wells during the FYR period showed that DIMP concentrations have decreased steadily, and only one well (986A) contained DIMP concentrations at the CSRG of 8 µg/L in WY09 (8.03 µg/L in June 2009). All of the private wells sampled in WY07 and WY08 were below the CSRG. The off-post CSRG exceedance areas, based on monitoring well and private well data, are discussed in the previous section.

6.3.1.6 Hazardous Waste Landfill Groundwater and LCS/LDS Monitoring

The operational monitoring for the HWL commenced upon the initial placement of remediation waste in the HWL in 1999 and continued until the start of the closure period in September 2006. Closure monitoring was then performed until June 2009, when HWL cap construction was completed and post-closure monitoring began. Sampling procedures and frequencies and analytes evaluated remained the same throughout the operational, closure, and post-closure (to

date) periods. Some wells have been abandoned, as described below, and some analyte detection limits have been lowered during this FYR period.

Water quality results for indicator compounds were consistent during the operational, closure, and post-closure periods, except for lead. Lead was detected in upgradient and downgradient wells at concentrations ranging from 3.25 µg/L to 5.21 µg/L during the operational period and steadily increased to 15 µg/L in both downgradient (25087) and upgradient (25102) wells by the end of 2009.

A significant increase in carbon tetrachloride (6.41 µg/L) in well 25121 (an upgradient monitoring well) was reported in May 2007 (during the closure period) that exceeded the prediction limit. As a result, the prediction limit for carbon tetrachloride was raised to 6.41 µg/L. The prediction limit calculations are based on regression equations for each indicator compound. The calculation is based on the maximum reporting limit and the total number of samples for each compound. A comparison is made between the calculated prediction limit and the maximum concentration for each compound. If the maximum concentration is greater than the calculated prediction limit, the prediction limit is raised to the maximum concentration. If the calculated prediction limit is higher than any reported concentrations, then there is no change to the calculated prediction limit. Exceedances of the prediction limits are reported in annual groundwater reports.

In 2008 (during the closure period), seven HWL/Supplemental Operational Monitoring (SOM) wells were abandoned (25083, 25084, 25089, 25090, 25094, 25095, and 25103) because they were proximate to HWL construction activities and associated drainage channels. Five new wells (25183, 25189, 25194, 25195, and 25203) were installed as replacement wells. Wells 25084 and 25090 were dry and replacement of these two wells was deemed unnecessary (TtEC 2009i).

As expected, compounds associated with the North Plants/Bedrock Ridge contaminant plume (1,1,1-trichloroethane, 1,1-dichloroethylene, 1,2-dichloroethane, carbon tetrachloride, and chloroform) were reported during each annual sampling event in SOM wells 25089, 25091, and 25099. Upgradient HWL well 25121 appears to be impacted by the contaminant plume based on the contaminants detected, including carbon tetrachloride and chloroform. Given the contaminants detected in the upgradient HWL well, the Bedrock Ridge contaminant plume boundary has been expanded to include this HWL well. The concentration trends in the individual SOM wells were variable during the FYR period, with well 25089 showing increasing trends for most of the North Plants/Bedrock Ridge plume compounds, except carbon tetrachloride, which was stable. The concentrations in wells 25091 and 25099 were stable to decreasing. No North Plants/Bedrock Ridge contaminants were detected in well 25101, and well 25121 only had detections of carbon tetrachloride (increasing) and chloroform (stable). These variable trends are attributed to the variability of the plume in the transverse and longitudinal directions.

During preparation of the HWL, LWTS, and ELF Annual Groundwater Monitoring Report for July 2005–June 2006 (TtEC 2007i) (during the operational period), PMC determined that 12 wells had been omitted from the April 2006 quarterly sampling program. The affected upgradient wells included HWL wells 25034, 25101, and 25121; SOM wells 25089, 25091, 25099, and

25103; and LWTS wells 26179, 26180, 26181, 26182, and 26183. The missing upgradient well data did not allow for the calculation of 2007 prediction limits. A detailed analysis completed for the missing well data presented in the 2005–2006 report concluded that there was little or no impact.

The HWL has two LCS sumps and two LDS sumps within each of the two cells. Each sump is constructed so the leachate from the LCS is removed separately from the liquid collected in the LDS. Leak detection water is defined as the liquid that is collected in the landfill LDS including any consolidation water draining from clay liners overlying the LDS.

As part of the Post-Closure Plan for both the HWL and ELF, the volumes of leak detection water generated are compared to the Action Leakage Rate (ALR) for each LDS sump. The ALR is the liquid flow rate that, when withdrawn from the secondary leak detection and LDS sumps, warrants follow-up actions. These rates and comparisons are reported in the Annual Covers Report for RCRA Caps.

The Annual Covers Report for RCRA Caps for 2009 (TtEC 2010a) and the Annual Covers Report for RCRA Caps for 2010 (TtEC 2010b) document that in all cases the average daily flow rates were much lower that the ALR and the non-routine action trigger level of 85 percent of the ALR. The performance standards and non-routine action trigger levels for leak detection liquids were not exceeded.

Water quality samples are taken quarterly from the sampling port on each LCS/LDS line when leachate/liquid is present. For three quarters (July, October, and January) these samples are analyzed for the indicator compounds, and for one quarter (April) per year, the samples are analyzed for the complete analyte list.

Water chemistry data from the operational groundwater monitoring wells are compared to compounds in the LCS and LDS to determine whether the water chemistry data are consistent with waste placed in the HWL. Trace concentrations of lead, DIMP, volatile organic compounds (VOCs), and OCPs were detected in the LDS leachate. The detections reported in the LCS have been consistent with the waste placed to date.

Arsenic, chloroform, chromium, dieldrin, lead, and DIMP were the indicator compounds detected in the HWL LDS. Lead was detected in all LDS sumps at concentrations ranging from 3.09 µg/L (2005) to 13.4 µg/L (2007). DIMP was detected in three of the LDS sumps at concentrations ranging from 0.889 µg/L (2009) to 7.73 µg/L (2007). Low concentrations of arsenic were detected in LDS1, LDS3, and LDS4 ranging from 1.02 µg/L (2007, 2009) to 1.38 µg/L (2006). Chloroform, dieldrin, and chromium have been detected in LDS4 at concentrations of 0.579 µg/L, 11.8 µg/L, and 0.0413 µg/L, respectively. Additional detections include, but are not limited to, aldrin, DCPD, isopropyl methylphosphonic acid (IMPA), NDMA, 2,2-bis(p-chlorophenyl)-1,1-dichloroethane (DDD), 2,2-bis(p-chlorophenyl)-1,1-dichloroethene (DDE), DDT, endrin, and isodrin.

Indicator compounds detected in the HWL LCS include 1,2-dichloroethane, arsenic, benzene, chloroform, chromium, DIMP, diedrin, and lead. Lead concentrations have increased from

concentrations of 3.03 µg/L (2005) to 11.9 µg/L (2009). DIMP was detected at concentrations ranging from 0.604 µg/L to 4.24 µg/L. Dieldrin was detected at concentrations of 0.0379 µg/L to 0.255 µg/L. Low levels of arsenic were detected at concentrations ranging from 1.01 µg/L to 2.09 µg/L. Concentrations of chloroform have decreased from 2005 (2.91 µg/L) to 2010 (0.245 µg/L). Benzene was last detected in 2007 in LCS2 at a concentration of 0.347 µg/L. A chromium detection of 29.7 µg/L occurred in 2010. A single detection of 1,2-dichloroethane occurred in 2005 (1.59 µg/L).

Additional compounds detected in the LCS sumps include, but are not limited to, aldrin, bicycloheptadiene, dichlorodifluoromethane, endrin, endrin ketone, endrin aldehyde, DCPD, IMPA, NDMA, PCE, TCE, chlordane (alpha and gamma), heptachlor epoxide, heptachlor, DDD, DDT, methoxychlor, and isodrin.

6.3.1.7 Enhanced Hazardous Waste Landfill Groundwater and LCS/LDS Monitoring

Preoperational monitoring was completed in April 2006, followed by operational monitoring from April 2006 through July 2008. Closure monitoring was performed until May 2010, when ELF cap construction was completed and post-closure monitoring began. Sampling procedures and frequencies and analytes evaluated remained the same throughout the pre-operational, operations, closure, and post-closure (to date) periods. Section 5.1.2.5 in the FYSR discusses the ELF monitoring data, which are summarized in the section below.

Lead was detected at low concentrations in upgradient and downgradient wells during the preoperational, operational, closure, and post-closure (to date) groundwater monitoring periods. Arsenic was detected at concentrations ranging from 4.88 µg/L to 11.5 µg/L in upgradient ELF wells for each quarterly monitoring event. Arsenic was detected during a single sampling event in downgradient ELF well 26099 (4.88 µg/L).

Detections of indicator compounds have been consistent during preoperational, operational closure, and post-closure (to date) groundwater monitoring. No prediction limits were exceeded.

The ELF has two cells, designated as Lime Basins cell and Wastepile cell. Each cell has two leak detection sumps, one for leak detection monitoring between the primary and secondary liners (LBLDS1 and WPLDS1), and the other between the secondary and tertiary liners (LBLDS2 and WPLDS2).

Leak detection water is defined as the liquid that is collected in the landfill LDS. Potential flow to the LDS sumps can include three sources. The first contributor is consolidation water released from the clay liner as the clay void ratio decreases due to increased load. The second contributor to the LDS sumps is potential leakage through the composite system. The last contributor is potential surface water that collects at the liner anchor trench. As discussed in Section 4.2.1.2, stormwater collected in the liner anchor trench during ELF cap construction in 2009 (before construction of the cap and internal drainage system components was complete) after a period of unusually high precipitation. With construction now complete, this situation is not likely to recur during the O&M period. However, a trench drain system was installed as part of the completed ELF cap that prevents the collection of stormwater in the liner anchor trench. The trench drain

system is monitored during ELF long-term operations and maintenance to ensure continued functioning. Liquids from the LDS are sampled quarterly for the complete analyte list.

As part of the Post-Closure Plan for both the HWL and ELF, the volumes of leak detection water generated are compared to the ALR for each LDS sump. The ALR is the liquid flow rate that, when withdrawn from the primary or secondary LDS sumps, warrants follow-up actions. These rates and comparisons are reported in the Annual Covers Report for RCRA Caps.

During the closure period for the ELF, in all cases the average daily flow rates were much lower than the ALR and the non-routine action trigger level of 85 percent of the ALR. The performance standards and non-routine action trigger levels for leak detection liquids were not exceeded.

Arsenic, benzene, chloroform, lead, dieldrin, DIMP, and 1,2-dichloroethane were the indicator compounds detected in the ELF LDS sumps. Arsenic was last detected in 2007 (WPLDSL). Benzene was detected during sampling events from 2006 through 2008. Lead was detected intermittently in the LDS sumps from 2007 through 2009. DIMP was detected in LBLDS2 during quarterly sampling events in 2007 through 2009. One time detections of DIMP occurred in WPLDS1 and WPLDS2. Beginning in 2008, chloroform was consistently detected in LBLDS1 and LBLDS2. Low concentrations of chloroform were also detected intermittently in WPLDS1 and WPLDS2. Beginning in 2007, dieldrin was detected in WPLDS2 in all quarterly sampling events. Low concentrations of dieldrin were detected in WPLDS1 and LBLDS2. A one-time detection of 1,2-dichloroethane occurred in 2008 in LBLDS2. Some additional compounds detected in the ELF LDS sumps include IMPA, NDMA, alpha chlordane, endosolfan, endrin, endrin ketone, gamma chlordane, hexachlorocyclopentadiene, and heptachlor.

Results from the April 2007 quarterly sampling event showed detections of several non-indicator compounds in the ELF LDS liquid. Although the results were reported in the 2006–2007 Annual Monitoring Report, notification of these detections was not made to the Regulatory Agencies when the data were initially available. In addition, the requirements in the ELF Operations Manual for follow-up of these detections were not implemented until the fall of 2008, in part because discussions with the Regulatory Agencies did not occur until that time. Those meetings resulted in the evaluation of the non-indicator compound detections and led to the conclusion that the likely source was consolidation water from the clay liners. Implementation of monthly sampling of the LDS liquid to monitor detections of non-indicator compounds occurred from November 2008 through March 2009. Concentrations of non-indicator compounds stabilized by the March sampling event and quarterly sampling resumed in May 2009.

The LCS sumps are sampled to support waste characterization required for off-post disposal. Chloroform was detected in the WPLCS and LBLCS sumps in 2006, 2008, and 2009. Single detections of dieldrin and lead were reported in each LCS sump. Detections of 1,2-dichloroethane were reported in LBLCS. One time detections of dieldrin and lead were detected in each LCS sump. Benzene was detected in 2009. Additional analytes detected include, but are not limited to, DCPD, DDT, IMPA, NDMA, and endrin ketone (LBLCS). TCE and DCPD were detected in the WPLCS.

6.3.2 Surface Water

6.3.2.1 On-Post Surface Water Quality Monitoring (#50a)

Surface water quality has been monitored by collecting and analyzing data from streams, ditches, lakes, and ponds at RMA since the late 1980s. This section summarizes the surface water data collected during the FYR period (WY05–WY09). Stream flow data were collected from 8 streams and ditches (except in WY06 when data were collected from 10 streams and ditches), stage/volume data were collected from 4 lakes, stage only data were collected from 1 lake, and water quality samples were collected from 6 on-post and 2 off-post sites, except in WY06 when the on-post Upper Derby Lake site and the off-post First Creek at Highway 2 site were not sampled because they were dry. Surface water quality and stream flow data are published in annual data summary reports by the USGS. Further details about the surface water monitoring programs are provided in Section 5.1.2.5 in the 2010 FYSR.

In 2004, the RVO discontinued water quality monitoring of surface water flowing onto RMA from the south because, in RVO's opinion, sufficient historical data had been collected from the south boundary sites, and data from these sites are not useful for assessing on-post contamination and remedy effectiveness. Additionally, the High Line Canal no longer was used to supply water to RMA. Accordingly, monitoring of First Creek (SW08003), Peoria Interceptor (SW11001), Havana Interceptor (SW11002), Uvalda Interceptor (SW12005), and High Line Lateral (SW12007) was discontinued. Water quality monitoring of the lakes and First Creek at the north boundary of RMA was continued. The Regulatory Agencies were not notified about the change in the monitoring program, and the lack of notification is identified as an issue in Section 8.0.

Monitoring of surface water occurred while remedial actions were being conducted. At the end of WY09, the soil contaminant remedy areas had clean backfill, subgrade, and intermediate or final cover on the surface, thereby eliminating movement of contaminated soil to surface water. Short-term confirmatory surface water sampling identified by RVO is to be conducted until the vegetation has been established in selected areas where borrow area soils had been placed and where revegetation has not yet been implemented.

There was only one detection of an organic analyte (dieldrin) in on-post surface water samples during the FYR period, which occurred in Upper Derby Lake (SW01004) on August 18, 2008. The concentration (0.037 µg/L) was below the aquatic life standards. Higher dissolved organic carbon and total organic carbon concentrations were observed in Havana Pond than in the lakes and First Creek during most of this FYR period, and this is consistent with urban runoff. However, higher concentrations were detected in First Creek above 96th Avenue in WY08.

The on-post surface water sampling program showed that very little inorganic contamination was present in the surface water bodies at RMA. Arsenic was detected at low concentrations consistent with background concentrations. Selenium was the only analyte detected at concentrations above an aquatic life standard. The detections were above the chronic standard, but below the acute standard and were intermittent, occurring in the two north boundary First Creek sites. Increasing concentrations of sulfate in First Creek likely are related to a combination of urban runoff south of RMA, upstream development, and groundwater discharge into First Creek.

Since contaminated soil excavation for the on-post remedy has been completed, an MCR for the On-Post ROD-required surface water monitoring will be prepared. Long-term on-post surface water quality monitoring will be discontinued with the FY10 implementation of the LTMP.

6.3.2.2 On-Post Surface Water Management (#50b)

The available supply and demand for surface water at RMA was documented in the annual Surface Water Management Plans during WY05 through WY09. An assessment of nonpotable water demands at the RMA was compared to water supplied to RMA through various sources. The nonpotable water demands included remediation projects, irrigation of permanently seeded areas, lake level maintenance (replacement of surface water lost to evaporation and seepage), wetland area filling, and fire protection and training.

RMA receives significant stormwater flows from upstream areas of the Irondale Gulch watershed located south and southeast of the southern boundary of RMA. On an average annual basis, this is the largest single water supply for the RMA lakes (USGS 2008). These flows are collected into a storm channel (interceptor) system that flows across the southern RMA boundary through the Havana, Peoria, and Uvalda Interceptors. Since this water flows as a result of storms, the timing and volume of flow is highly variable.

The more reliable source of nonpotable water comes from the Section 4 water supply wells and dechlorinated potable water from Denver Water. The Section 4 wells were the main nonpotable water supply at RMA for meeting the remediation and irrigation demands. A source of water available in WY08 to augment the Section 4 wells is the Denver potable water that is currently being delivered to Lake Ladora, where a dechlorination system was installed in the Lake Ladora Pump House to make Denver potable water suitable for discharge into the lake. The delivery of up to 800 acre-ft of Denver potable water is expected to be available during the period WY08–WY13.

For WY05–WY09, the anticipated supply of nonpotable water for RMA exceeded the estimated demand, so all nonpotable water requirements were met.

6.3.2.3 Off-Post Surface Water Monitoring (#50c)

Surface water monitoring was conducted in accordance with the Off-Post ROD to evaluate the effect of groundwater treatment on surface water quality. The Off-Post RS/S (HLA 1996a) specified sampling at two surface water monitoring stations, SW24004 and SW37001. Samples were to be collected annually at SW24004 and annually and after storm events at SW37001, dependent on the presence of water at the time of sampling. Stream stage and discharge measurements were to be collected at three stations: SW24002, SW24004, and SW37001. These locations are shown in Figure 6.3.2-1. The 2001 Surface Water Sampling SAP (FWENC 2001d) added site SW24002 for sampling, but deleted DIMP from the analyte list for this site. Further details about the surface water monitoring programs are provided in Section 5.2.4 in the 2010 FYSR.

Off-Post Areas Potentially Affected by DIMP

There is a small off-post area located near First Creek between the north boundary of RMA and Highway 2 where elevated DIMP concentrations in surface water are possible. Surface water in

this off-post area could be affected by DIMP contained in shallow alluvial groundwater that at times contributes flow into First Creek. Streams that receive groundwater discharge are gaining streams. First Creek is a gaining stream during portions of the year, and during those times DIMP and other contaminants may be detected. Downstream of gaging station SW37001, First Creek flows into the O'Brian Canal. While DIMP has been detected in First Creek upstream of its confluence with the O'Brian Canal at concentrations exceeding the CSRG/Colorado Basic Standards and Methodologies for Surface Water (CBSMSW) of 8 µg/L, the O'Brian Canal (when it is flowing) contains a much greater volume of water than First Creek. Although no new DIMP data have been collected for the O'Brian Canal since 1990**,** the 10 water quality samples analyzed for DIMP between 1985 and 1990 support DIMP concentrations from First Creek being significantly diluted by the flow in O'Brian Canal, and it is unlikely that DIMP would be detected above the CSRG or CBSMSW downstream of First Creek. The highest concentration of DIMP measured in the O'Brian Canal between 1985 and 1990 was only 0.532 µg/L on October 12, 1987.

Summary of Off-Post Surface Water Results

For most constituents, concentration and discharge often tend to have an inverse relationship, with higher concentrations observed with lower flow rates. There are many exceptions to this pattern, and concentrations during any given sampling event depend heavily on the streamflow conditions at the time of sampling, streamflow conditions preceding the time of sampling, and the groundwater elevations in the vicinity of the gaging station or sampling site, which help control groundwater/surface water interactions.

During this FYR period, the detection frequency for target analytes above CSRGs decreased for arsenic, was similar for chloride and sulfate, and increased for DIMP at station SW37001 compared to the past FYR period. Sulfate was detected above the CBSMSW more often at all three stations during this FYR period. The detection frequencies of sulfate above the CBSMSW at the three stations, and DIMP above the CSRG at SW37001, however, likely increased because sampling was conducted more often during low-flow conditions when groundwater is discharging into First Creek. The background groundwater concentration for sulfate was determined to be 540,000 µg/L when the CSRGs were developed for the RODs, which is higher than the CBSMSW of 250,000 µg/L. Although the frequency of detection above the CSRG increased for DIMP, because sampling during low-flow conditions was emphasized, the concentrations of DIMP decreased over the FYR period and are approaching the CSRG of 8 µg/L because treatment of groundwater is ongoing.

Surface water leaving RMA as measured at station SW24004 met applicable water quality standards for all of the target constituents. With the continuing removal of organic contaminants from the groundwater in the area, concentrations of the target suite of organic constituents in surface water at off-post station SW37001 are expected to continue to decrease. Attenuation of inorganic contaminants and treatment of organic groundwater contaminants at the NBCS and the OGITS appear to be having a positive effect on First Creek water quality. Accordingly, the remedy is performing in accordance with the Off-Post ROD.

6.3.3 Biota Monitoring

Long-term biomonitoring was conducted in accordance with the *Long-Term Contaminant Biomonitoring Program for Terrestrial Ecological Receptors at Rocky Mountain Arsenal* (BMP) (BAS 2006). The purpose of the BMP is to help evaluate the efficacy of the remedy in accordance with the requirements of Section 9.7 of the ROD, i.e., that "monitoring activities for biota will continue by USFWS in support of evaluating the effectiveness of the selected remedy."

Data from the first 2 years of the BMP were reported in 2009 (USFWS 2010). Habitat evaluation (prey base) was performed by the USFWS before each field season in areas specified in the BMP for starling nest box arrays. Eighteen areas had suitable prey base for starling monitoring in FY07 and FY08. Prey base in areas around the kestrel nest boxes was considered inadequate for the purposes of the BMP. A total of 72 brain samples from nestling starlings were collected and analyzed for dieldrin residues in 2007 and 181 brain samples were collected and analyzed in 2008. To this point, only one of the samples in one sampling season contained a dieldrin concentration above the evaluation criterion. The BMP specifies the collection of 10 samples from each nest box array (BAS 2006). Sample numbers in 2007 were lower than specified in the BMP. Adjustments were made to increase sample size for 2008. Based on the data collected thus far, it appears that the RMA remediation program has been successful in eliminating exposure pathways for terrestrial wildlife receptors.

The Long-Term Biomonitoring Program is ongoing. Starling samples were collected in 2009. Monitoring of kestrel nest boxes will begin in 2010. Additional starling samples from arrays not previously sampled due to remedial project activities will also begin in 2010.

6.3.3.1 Aquatic Ecosystem Monitoring

The selected remedy in the ROD states that water levels in Lake Ladora, Lake Mary, and Lower Derby Lake will be maintained to support aquatic ecosystems and that the biological health of the ecosystems will continue to be monitored.

The *Management Plan for Protection and Monitoring of Lake Ladora, Lake Mary, and Lower Derby Lake during RMA Remediation* (PMRMA 2006a) describes how the lake levels will be monitored. The plan outlines requirements for maintenance of lake levels (water quantity), surface water quality, and ecological monitoring that are applicable until EPA approves the CCR for the construction of the last cap or cover. Implementation of this plan will ensure that water levels will be maintained to support the desired aquatic ecosystems. Lake Ladora will be managed to support warm water recreational fisheries that support sustained populations of native and desirable naturalized game and forage fish species. The aquatic ecosystem of Lower Derby Lake will be managed to provide suitable habitat for water birds and shorebirds and to promote growth of aquatic and wetland vegetation through seasonal drawdowns in the spring and summer. This management will support accomplishment of the purposes, goals, and objectives of the Refuge through the completion of the remedy.

USFWS summarized data for water quality, fish populations, waterfowl use days, and lake levels for 2006 and 2007 in a single report (USFWS 2006).

Since 2007, when staffing and funding cuts to the RMA Refuge budget were initiated, no detailed water quality or aquatic biota monitoring activities have been conducted. The Refuge, in cooperation with the Colorado Division of Wildlife and the USFWS Region 6 Fish and Wildlife Assistance Office for Colorado, has conducted periodic fish sampling activities, however, to monitor general conditions of the fish populations in lakes Ladora, Lower Derby, and Mary. Growth, recruitment, and survival of the fish species most important to the RMA Refuge catch-and-release sport fishing program are focal points of the monitoring. Results from these fish population surveys are very encouraging and demonstrate excellent growth, survival, and recruitment of largemouth bass in all three lakes, of northern pike in Lake Ladora, and growth of bluegill in all lakes. Survival and recruitment of bluegill in each lake is purposely limited by significant and intentional predation pressure from largemouth bass in all lakes and from northern pike in Lake Ladora. Bluegills are used as a primary forage fish species in all lakes, and the Refuge periodically supplements the bluegill population in each lake by stocking bluegill fingerlings.

Based on results from generalized fishery management surveys in each RMA lake, the Refuge would classify all three lakes as healthy aquatic ecosystems based on the growth, survival, and recruitment of top predators in each lake. Top predators are an excellent general indicator of aquatic ecosystem conditions because their growth, survival, and recruitment are directly dependent on the supporting biotic and abiotic components and processes in such ecosystems. In addition, all three lakes support extensive stands of aquatic macrophytes that add structural, biological, and ecosystem functional diversity—another indication of healthy aquatic ecosystems.

6.3.4 Air Monitoring

Air monitoring results from the Site-Wide Air Quality Monitoring Program (SWAQMP) for the years 2005 through 2008 are detailed in annual air summary reports. Except for ongoing air monitoring for particulate matter less than 10 micrometers in diameter (PM-10), routine ambient air monitoring was completed at the end of 2008, with results presented and evaluated in the Air MCR (TtEC 2009a). Routine PM-10 air monitoring was completed as of May 1, 2010. A PM-10 addendum to the Air MCR is in progress. All air monitoring data collected during this FYR period and all previous years are maintained in the RMA Environmental Database (RMAED). Based on the results of the monitoring program that has been conducted during RMA remediation activities since the last FYR, ambient air quality impacts from the implementation of the On-Post ROD have been minimal; chronic and acute health risks have been managed within acceptable ranges.

Ambient air, dust, and odor sampling and monitoring activities were implemented and conducted in accordance with the SWAQMP Plan (TtEC 2006h), the Site-Wide Odor Monitoring Program (SWOMP) Plan (FWENC 1999b), and the Site-Wide PM-10 Monitoring Program Plan (TtEC 2008m). These activities included time-integrated ambient air sampling for RMA-designated COCs and particulate matter and real-time monitoring of odor and selected air quality and meteorological parameters. Additional air and odor monitoring activities were conducted specifically to support individual remediation projects such as the Basin F Wastepile and Basin F Principal Threat Soils Remediation Projects. In 2008 with the imminent completion of

contaminated soil intrusive remediation activities, the phase-out of routine ambient air monitoring commenced in accordance with the RMA Decision Document-Routine Ambient Air Monitoring Phase-Out Plan signed by the Parties on June 5, 2008.

The established criteria included fenceline acute and chronic health criteria that are designed to ensure that the community is not adversely affected by chemical exposures during remediation. The acute criteria are also applied at specific on-site locations to be protective of visitors to RMA. An air pathway analysis model was used to predict impacts from each remediation project. Results of the air pathway analysis were used to prescribe the level of air and odor monitoring conducted at any time. The air and odor monitoring programs were implemented in accordance with this plan.

Data evaluation protocols for assessing RMA impacts were established for the program through extensive interaction with the Regulatory Agencies and have been applied to all data during the SWAQMP. All ARARs established in the On-Post ROD relative to air and odor quality were met, and no federal or state ambient air quality standard was exceeded because of RMA remediation activity.

No exceedance of fenceline or on-site health-based acute RMA risk criteria was recorded during the SWAQMP. All individual carcinogens were below their individual chronic risk goal of 1.0×10^{-6} at the completion of air monitoring, except for DBCP. Estimated potential cancer risks for DBCP ranged from 1.3×10^{-5} to 3.4×10^{-5}, a range that is still well within the EPA acceptable risk envelope. An exceedance, as defined in the SWAQMP Plan, occurs when incremental COC levels, because of RMA impacts, exceed established criteria (for chronic, cancer, or acute values).

During the FYR period, air quality for airborne particulate matter was assessed through monitoring of total suspended particulates (TSP) and PM-10. Routine time-integrated sampling for PM-10, however, was not conducted between March 30, 2006, and June 5, 2008. PM-10 sampling was discontinued during that period due to an agreement to use TSP monitoring as a surrogate measurement for PM-10. PM-10 monitoring resumed again as part of the sampling reduction schedule to phase-out TSP sampling. Concentrations in several short-term PM-10 samples, as well as several surrogate TSP samples, approached RMA visitor location internal action levels during periods of high winds and dry soil conditions when regional dust was present, but no PM-10 ambient air quality standard was exceeded, and in each surrogate TSP sample event, no action levels were exceeded in subsequent PM-10 samples. Given these sample results, there was no impact to public health. The former National Ambient Air Quality Standard 24-hour Total Suspended Particulate standard was exceeded on two occasions. The first occurred in April 2006 at the east RMA fenceline. The exceedance was determined to be the result of weed control activity by the USFWS in immediate proximity to the sample location. The second occurred in April 2008 at the northwest RMA fenceline, which parallels Highway 2. The exceedance was determined to be the result of construction along the highway. Phase-out of PM-10 air monitoring began in August 2008 and was completed in May 2010. PM-10 sampling results obtained after December 2009 will be presented as an addendum to the Air MCR. Fugitive dust was occasionally observed from both contaminated and clean construction activities crossing an internal project boundary; however, there were no documented instances

where fugitive dust from on-site RMA remedy activities was observed crossing the RMA fenceline. Consequently, the goals related to dust outlined in the SWAQMP Plan were met.

The Odor MCR (TtEC 2009p) presents an evaluation of the results of odor monitoring conducted from 1999 to 2008 to support activities associated with the RMA Remedy. Odor monitoring activities were implemented during this FYR period in accordance with the SWAQMP Plan, the SWOMP Plan (FWENC 1999b), and annual monitoring plans. Project-specific monitoring plans were developed as a result of the need for intensive project-specific odor monitoring for the Basin F Wastepile Remediation project, Former Basin F Principal Threat Soil Remediation project, and ELF Operations. These activities included odor monitoring and meteorological monitoring.

During this FYR period, odor was frequently detected at and near internal project work boundaries and occasionally detected at the RMA fenceline during remediation of the Basin F Wastepile and the Basin F Principal Threat soils. When odors at internal monitoring locations exceeded management action levels, the odor was controlled on site. When occasional odors were detected at the fenceline, they were brief in duration and below the state nuisance odor standard action levels and resulted in no public complaints. Odor response protocols were followed during these events as a result of the detected odors. The odor response and control protocols established to mitigate potential problems were consistently followed and effectively continued to promote compliance with the ARARs.

From program implementation through review of the data, the objectives of the SWAQMP and SWOMP have been met during this FYR period. Monitoring data quality has been acceptable and useable for meeting project objectives. The Air Pathway Analysis and monitoring programs functioned as designed and met the objectives and requirements of the On-Post ROD. The SWAQMP and SWOMP collectively have demonstrated that they were effective in supporting remediation at RMA while supporting requirements and objectives designed to ensure the protection of public health and the minimization of nuisance odors.

Additional discussion related to site-wide air monitoring, air ARARs, and ROD compliance is included in Section 7.4.3.

6.3.5 RCRA-Equivalent Cover Monitoring

The RCRA-equivalent covers have been designed and constructed with the objective of isolating wastes and reducing percolation of moisture to minimize the migration of contamination to groundwater. These covers have a performance requirement not to exceed 1.3 mm/year of deep percolation and use a network of lysimeters to monitor deep percolation. Basin F has a total of five lysimeters and the ICS cover has a total of 15 lysimeters; 4 located on Complex Army Trenches, 4 located on Basin A, 3 located on South Plants, 1 located on Lime Basins, and 3 located on Shell Disposal Trenches. In addition, continuous soil moisture measurement is performed at each of the three Shell Disposal Trenches lysimeters. Soil moisture probes at these locations are used to monitor and demonstrate the formation of a functional capillary barrier at the interface between the soil cover moisture storage layer and the underlying materials. Soil moisture data are also intended to be used to assist in the selection of an appropriate corrective

action in the event that percolation in excess of the compliance criterion of 1.3 mm/year is measured in a lysimeter and to assess the effectiveness of corrective actions performed.

Monthly percolation and soil moisture measurements for the Shell Disposal Trenches began in 2007 and are ongoing. The soil moisture monitoring system will function for a minimum of seven consecutive spring seasons. Percolation measurements for the ICS and Basin F lysimeters began in December 2009 and are ongoing. Therefore all the RCRA-equivalent covers are in the Interim O&M period. The Interim O&M period is the period of time between completion of construction (i.e., after irrigation) and a determination that the cover is O&F, which is expected to be 5 years. Monitoring and maintenance is conducted during the Interim O&M period. However, performance standards are not enforceable during the Interim O&M period.

Percolation measurements are compiled and reported in the Annual Covers Report. During the Interim O&M period, these measurements are assessed to determine the overall trend in the amount of percolation compared to observations of vegetation and cover conditions. Soil moisture data are also collected at the Shell Disposal Trenches Cover and reported in Quarterly Soil Cover Moisture Monitoring System Data Evaluation Summaries. Starting in 2015, the RCRA-Equivalent Covers will be subject to enforcement of the performance standards. Data collected from monitoring activities will be used to support the O&F determination for the RCRA-Equivalent Covers.

Future FYRRs will discuss results of monitoring activities in the context of whether the performance standards have been met and the status of the O&F determination.

6.4 Site Inspections and Interviews

6.4.1 Inspections

Site inspections were conducted on April 27–29, 2010, by representatives from the RVO, EPA, CDPHE, and TCHD. The purpose of the inspections was to visually assess the protectiveness of selected features and components of the On-Post and Off-Post RMA remedy. Per agreement, the field inspections focused on the groundwater remedy. Ongoing oversight and routine inspections of caps and covers, and the completed final inspections and CQAE reports for Basin F, HWL and ELF were deemed sufficient to establish the protectiveness of the surface remedies. The status of these remedy components, including revegetation, are captured in the project discussions in Section 4.

The inspected components of the groundwater remedy included

- Groundwater treatment systems and associated extraction, recharge, and monitoring wells
  - Groundwater mass removal systems at the South Tank Farm
  - Groundwater mass removal system for the Section 36 Lime Basins Slurry Wall
  - RYCS
  - CERCLA Water Treatment System
  - BANS/BRES
  - NWBCS

  - NBCS
  - OGITS (including Northern Pathway Modifications)

- Groundwater performance monitoring wells associated with
  - HWL
  - ELF
  - Basin F
  - North Plants LNAPL plume
  - Section 36 Lime Basins
  - Complex (Army) Trenches
  - Shell Disposal Trenches
  - Off-post Army groundwater monitoring wells
  - Private wells

Inspections also included the LWTS, plugged and abandoned sanitary sewer manhole markers, groundwater well protection in the Bison Pilot Area, and selected off-post private water wells.

During the inspections, groundwater treatment systems were observed for general condition and operational status of groundwater extraction and treatment facilities and equipment. Wells were inspected for the condition of protective features, such as pads, surface casings, caps and locks, and identification markings. The well inspection was also conducted to observe some wells that were identified as damaged or deficient in the 2005 FYR, and verify that repairs had been made in the current FYR period.

Table 6.4.1-1 (provided under Table tab) summarizes the observations made during the field inspection. Volume II of III contains a compilation of the completed inspection checklists used to document observations made by the EPA, CDPHE, and TCHD representatives conducting the inspections.

Deficiencies were noted during the inspections, as shown in Table 6.4.1-1. However, no issues were identified during the field inspections that affect the overall protectiveness of the remedy. For wells identified as damaged during the 2005 FYR, some were observed to have had repairs made since the last review, while wells without any identified monitoring purpose had not been repaired. Detailed status information for these wells is provided in Volume II of this report.

6.4.2 Interviews

6.4.2.1 Institutional Controls

Institutional Controls were evaluated on May 6, 2010, by visiting and interviewing the SEO to confirm that the RMA contamination notice was included in all groundwater well permits for which this is required during the FYR period. No well permit issues were identified through this review.

6.4.2.2 Laboratory Data Quality Assessment

A review was conducted by EPA and TCHD representatives from May 4 to May 12, 2010, to evaluate the performance of the RMA laboratory data quality assessment process and procedures. For this review, interviews were conducted with the PMC Lab Coordinator, the PMC Data Validation specialist, and the RVO Laboratory Database Manager. The PMC Chemical Quality Assurance Plan, Revision 4 (CQAP) (TtEC 2007h), the RVO CQAP, Revision 4 (RVO 2009a), and the RVO Post-Laboratory Water Quality Assessment Procedure (RVO 2007c), as well as internal PMC environmental data validation procedures were reviewed. The purpose was to understand the data quality processes in place for laboratory data at RMA. The focus of the interviews, and document and data reviews done in conjunction with this effort, was to establish the process by which laboratory results are provided by the contract laboratories to the RVO and subsequent data input, data checking, data quality assessment, and finalization of data results in the RMAED.

The review resulted in seven observations for consideration in the FYR. EPA's summary and observations from this review, along with the RVO's responses and clarifications are included in Volume II. The issues raised by the observations are considered to have no effect on the overall protectiveness of the remedy.

The RVO concurs with EPA's recommendation that a procedure be adopted to improve the laboratory data change control process, which includes a format for the documentation of data change requests, required justification and description of the change, and requirements for maintaining and archiving these documents.

6.5 Post-ROD Changes

This FYRR documents a minor ROD change to two treatment standards for the groundwater treatment systems. The RODs identify CBSGs as ARARs for the groundwater treatment systems. In some cases, when the ARAR values selected as CSRGs for RMA analytes could not be measured with the analytical methods available at the time, the ROD identified a PQL as the interim goal. During the 2010 FYR period, method reporting limits (MRLs) less than the ROD-identified PQLs and CBSGs have been achieved for carbon tetrachloride and 1,2-dichloroethane. As a result, the CSRGs have been modified to adopt the CBSGs for these contaminants. The revised CSRGs are reflected on the treatment system CSRG tables included in Section 4.1.1.1.

7.0 Assessment

The purpose of the FYR is to conduct a protectiveness level review to determine whether the remedies for RMA defined in the RODs remain protective of human health and the environment, and are functioning as designed, and whether required O&M is being performed, considering the changes in ARARs and TBCs that occurred during the FYR period.

It should be noted that projects with IRA status that have been incorporated into the final remedy are reviewed concurrently with the ROD project in which they have been incorporated.

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

Consistent with the EPA FYR guidance (EPA 2001) the following topics should be evaluated for projects under construction:

> Is the remedy being constructed in accordance with the decision documents and design specifications?
>
> Is the remedy expected to be protective when complete and will performance standards likely be met?
>
> Are access controls and ICs in place to prevent exposure during construction?

7.1.1 Hazardous Waste Landfill Cap Construction (#8)

The construction of the HWL final cap is complete and documentation of construction completion is being prepared. Construction was conducted in accordance with the decision documents and design specifications discussed in Section 4.2.1.1. A final inspection was completed and no further construction is required. Accordingly, the HWL is expected to be protective and performance standards will likely be met. Because the HWL cap was a clean construction project, prevention of exposure to COCs was not a concern. RMA site access restrictions and project-specific health and safety measures ensured the safety of workers and visitors during construction. As a containment facility, the HWL is subject to long-term O&M requirements. Long-term groundwater monitoring is being performed in accordance with the Hazardous Waste Landfill Post-Closure Groundwater Monitoring Plan (TtEC 2009j) and the 2010 LTMP (TtEC and URS 2010c). Monitoring results demonstrate that the cap is performing as expected (TtEC 2009i). Implementation of the recent revisions to the RMA ICs (PMRMA 2008a) continues to satisfy the Refuge Act and On-Post ROD requirements. No early indicators of potential remedy failure were identified. Approval of the CCR is expected in summer 2010.

7.1.2 Enhanced Hazardous Waste Landfill Cap Construction (#13)

The construction of the ELF final cap is complete and documentation of construction completion is being prepared. Construction was conducted in accordance with the decision documents and design specifications discussed in Section 4.2.1.2. A final inspection was completed and no further construction is required. Accordingly, the ELF final cap is expected to be protective and performance standards will likely be met. Because the ELF cap was a clean construction project, prevention of exposure to COCs was not a concern. RMA site access restrictions and project-specific health and safety measures ensured the safety of workers and visitors during construction. As a containment facility, the ELF is subject to long-term O&M requirements.

Long-term groundwater monitoring is being performed in accordance with the ELF Post-Closure Plan Groundwater Monitoring Plan (TtEC 2010d) and the 2010 LTMP (TtEC and URS 2010c). Implementation of the recent revisions to the RMA ICs (PMRMA 2008a) continues to satisfy the Refuge Act and On-Post ROD requirements. No early indicators of potential remedy failure were identified. Approval of the CCR is expected in fall 2010.

7.1.3 Integrated Cover System Part 1: Basin A Consolidation and Remediation Area (#15), South Plants Balance of Areas and Central Processing Area (#34), Complex (Army) Disposal Trenches Remediation Cover (#38), Shell Disposal Trenches 2-foot Soil Covers (#39), and Section 36 Lime Basins Cover (#47)

The construction of the ICS covers is complete and documentation of construction completion is being prepared. Construction was conducted in accordance with the decision documents and design specifications discussed in Section 4.2.1.3. Final inspections have been completed for each cover element and no further construction is required. Accordingly, the projects that comprise the ICS are expected to be protective and performance standards will likely be met. Because this project was a clean construction project, prevention of exposure to COCs was not a concern. RMA site access restrictions and project-specific health and safety measures ensured the safety of workers and visitors during construction. Because the covers serve as containment facilities, they are subject to long-term O&M requirements as presented in the LTCP (TtEC 2008i). Implementation of the recent revisions to the RMA ICs (PMRMA 2008a) continues to satisfy the Refuge Act and On-Post ROD requirements. No early indicators of potential remedy failure were identified. Approval of the ICS CCR—Part 1 is expected in summer 2010.

Following establishment of vegetation on the covers, a CCR—Part 2 will be completed that will document the O&F status of the covers. The ICS CCR—Part 2 and O&F determination are expected in 2015.

7.1.4 Miscellaneous RMA Structures Demolition and Removal Phase IV (#30)

The construction of the Miscellaneous RMA Structures Demolition and Removal Phase IV project consists of the demolition and removal of the CWTF (Structure 318), the remaining SQI building foundation, and the plugging of sanitary sewers in the SQI area, and is being conducted in accordance with the decision documents and design specifications discussed in Section 4.3.1.1. The project field work is expected to be completed in November 2010, with a CCR expected to be issued in early 2011. The Miscellaneous Structures Phase IV project is expected to be protective when complete and performance standards will likely be met. RMA site access restrictions and project-specific health and safety measures will ensure the safety of workers and visitors during construction. As a demolition project, long-term O&M is not relevant. However, the CWTF project area is located within the AMA surrounding the ICS covers and is subject to the O&M requirements specified in the LTCP (TtEC 2008i). Also, inspections of the plugged sanitary sewers, brass monuments, and warning system markers will be performed as part of the CERCLA FYR process. Implementation of the recent revisions to the RMA ICs (PMRMA 2008a) continues to satisfy the Refuge Act and On-Post ROD requirements.

7.1.5 Shell Disposal Trenches RCRA-Equivalent Cover Construction (#39)

The construction of the Shell Disposal Trenches cover is complete and a CCR—Part 1 has been completed. The project is in an interim O&M phase while vegetation is being established on the cover. Construction was conducted in accordance with the decision documents and design specifications discussed in Section 4.2.1.4. A final inspection was completed and no further construction is required. Following establishment of cover vegetation, the Shell Disposal Trenches cover is expected to be protective and performance standards will likely be met. Because this project was a clean construction project, prevention of exposure to COCs was not a concern. RMA site access restrictions and project-specific health and safety measures ensured the safety of workers and visitors during construction. Since the cover serves as a containment facility, it is subject to long-term O&M requirements as presented in the LTCP (TtEC 2008i). Implementation of the recent revisions to the RMA ICs (PMRMA 2008a) continues to satisfy the Refuge Act and On-Post ROD requirements. No early indicators of potential remedy failure were identified.

Following establishment of vegetation on the cover, a CCR—Part 2 will be completed that will document the O&F status of the cover. The CCR—Part 2 and O&F determination are expected in 2013.

7.1.6 Basin F/Basin F Exterior RCRA-Equivalent Cover Construction (Basin F Cover) (#46)

The construction of the Basin F cover is complete and documentation of construction completion is being prepared. Construction was conducted in accordance with the decision documents and design specifications discussed in Section 4.2.1.5. The final inspection has been completed and no further construction is required. During the establishment of cover vegetation, routine percolation monitoring, vegetation assessments, and cover maintenance activities are ongoing. No early indicators of potential remedy failure have been identified through these activities. Following establishment of cover vegetation, the Basin F cover is expected to be protective and performance standards will likely be met. Because the RCRA-equivalent cover was a clean construction project, prevention of exposure to COCs was not a concern. RMA site access restrictions and project-specific health and safety measures ensured the safety of workers and visitors during construction. Because the cover serves as a containment facility, the project is subject to long-term O&M requirements as presented in the LTCP (TtEC 2008i). Long-term groundwater monitoring is being performed in accordance with the Basin F Closure and Post-Closure Groundwater Monitoring Plan (TtEC 2006a) and the LTMP (TtEC and URS 2010c). Groundwater monitoring results during Basin F closure have been reported through 2008 and identify no early indicators of potential remedy failure (TtEC 2010c, 2009c). Implementation of the recent revisions to the RMA ICs (PMRMA 2008a) continues to satisfy the Refuge Act and On-Post ROD requirements. Approval of the CCR—Part 1 is expected in fall 2010.

Following establishment of vegetation on the cover, a CCR—Part 2 will be completed that will document the O&F status of the cover. The CCR—Part 2 and O&F determination are expected in 2015.

7.1.7 Section 36 Lime Basins Soil Remediation Slurry/Barrier Wall (#47)

The construction of the additional Section 36 Lime Basins Slurry Wall and Dewatering System was completed in accordance with the decision documents and design specifications discussed in Section 4.2.1.6 and documentation of construction completion is being prepared. RMA site access restrictions and project-specific health and safety measures ensured the safety of workers and visitors during construction. Implementation of the recent revisions to the RMA ICs (PMRMA 2008a) continues to satisfy the Refuge Act and On-Post ROD requirements.

As noted in Section 4.2.1.6, DNAPL was discovered in the project dewatering wells following the final inspection. The presence of DNAPL was not a known site condition during preparation of the design or construction of the system and represents a new source material for the Section 36 area. As a result, an RI/FS is underway to determine the nature and extent of the DNAPL contamination and is scheduled to be completed in February 2011. For that reason this project is an issue addressed in Section 8.0. The objectives of the on-going RI/FS identified in the Final RI/FS Work Plan (TtEC and URS 2010b) are as follows:

- Determine the nature and extent of DNAPL associated with the Lime Basins area
- Assess whether the following existing remediation projects in the vicinity of the Lime Basins are consistent with the presumptive remedy:
  - Section 36 Lime Basins Slurry/Barrier Wall project
  - Basin A Consolidation and Remediation project
  - Integrated Cover System project
- Assess whether the presumptive remedy is protective of human health and the environment and in compliance with ARARs in accordance with FS threshold criteria. The presumptive remedy, which was selected based on EPA guidance, consists of DNAPL source containment and DNAPL removal to the extent practicable (EPA 1992, 2009a).

Another objective of the RI/FS for the Lime Basins DNAPL project was to assess whether the DNAPL has had, or could have, a detrimental impact on the slurry wall integrity.

A CCR is being prepared for the Section 36 Lime Basins Soil Remediation project slurry/barrier wall construction. The CCR is expected to document that remedial actions under this project have been completed in accordance with the design requirements presented in the 100 percent design document (TtEC 2008l), that operation of the dewatering system indicates the system's ability to achieve the dewatering goals for the project, that the project has achieved the intent of the ROD to be protective of human health and the environment, and, having been inspected by the RVO and Regulatory Agencies, is functioning as intended. Approval of the CCR is expected in 2010.

7.1.8 Basin A Neck System—Lime Basin Groundwater Treatment Relocation and Basin A Neck Expansion (#59)

Modifications to the BANS to accommodate treatment of groundwater extracted by the Lime Basins dewatering system are underway and scheduled to be completed in November 2010.

Construction is being conducted in accordance with the design specifications presented in the 100 percent design document (URS Washington Division 2010), approved by the Regulatory Agencies on March 4, 2010. The modified system is expected to effectively treat the Lime Basins water to CSRGs and be protective upon completion.

7.1.9 North Plants Fuel Release

During the FYR period, water levels and thickness of LNAPL were monitored and LNAPL and groundwater sampling were conducted to characterize the LNAPL accumulation, assess potential groundwater impacts, and design a pilot LNAPL removal system. The results were reported in the *North Plants Soil Remediation Project Interim Free Product and Groundwater Characterization Data Summary Report* (TtEC 2007g). The groundwater results were compared to the Colorado Department of Labor and Employment Office of Public Safety Tier 1 Standards, which are the same as the Colorado Water Quality Control Commission (CWQCC) CBSGs. All results were below these standards. Reporting limits for certain analytes were above the standards; however, they were below the PQLs established for these compounds in the CWQCC PQL Guidance (CDPHE 2008).

A pilot LNAPL removal pilot study was initiated in 2009, and is currently operating in accordance with the Pilot LNAPL Removal System Action Plan (URS Washington Division and TtEC 2008). The purpose of the study is to determine the extent to which removal of LNAPL is practicable using a well recovery skimming system. A total of 22 piezometers and two recovery wells have been installed in the North Plants LNAPL Plume. The pilot LNAPL removal system will be operated to the extent necessary to gather data in support of the final action, if any, for the North Plants LNAPL Plume (URS Washington Division and TtEC 2008). The recovery wells and piezometers were installed in February 2009, and monitoring began in March 2009. Through the end of the FYR period (September 30, 2009), no LNAPL had accumulated in the recovery wells.

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

Consistent with the EPA FYR guidance, where relevant, the following topics are considered during the assessment:

Remedial Action Performance

Does the Remedial Action continue to be operating and functioning as designed?

Is the Remedial Action performing as expected and are cleanup levels being achieved?

Is containment effective?

Systems Operations/O&M

Will operating procedures, as implemented, maintain the effectiveness of the response actions?

Do large variances in O&M costs indicate a potential remedy problem?

Is monitoring being performed and is it adequate to determine protectiveness and effectiveness of remedy?

Implementation of Institutional Controls and Other Measures

Are access controls in place and preventing exposure (e.g., fencing and warning signs)?

Are Institutional controls in place and preventing exposure?

Are other actions (removals) to address immediate threats complete?

Opportunities for Optimization

Do opportunities exist to improve performance and/or costs of monitoring, sampling, and treatment systems?

Early Indicators of Potential Issues

Do frequent equipment breakdowns or changes indicate a potential risk?

Could other issues or problems place protectiveness at risk?

7.2.1 Operating Groundwater Remedial Actions in the On-Post OU

The on-post groundwater remedies are assessed against the criteria described above using the results and information presented in Section 4.1.1 and Section 6.3.1. Optimization of the operation of the groundwater containment and mass removal systems is ongoing under the individual system operations programs. Detailed evaluations of the groundwater containment, mass removal, and treatment systems are presented in the FYSR (TtEC and URS 2010a).

7.2.1.1 Shell Disposal Trenches Slurry Walls (Dewatering) (#17)

The Shell Disposal Trenches containment remedy includes a slurry wall encircling the disposal trenches in addition to the cover. Water levels are to be lowered below the disposal trench bottoms.

Consistent with the assessment presented in the 2005 FYRR, the dewatering goal had not been met at the end of the FYR period. The apparent rise in the water table during this FYR period likely is related to infiltration of precipitation before and during cover construction and irrigation after construction. As documented in the 2010 LTMP, however, it is not expected that the dewatering goal will be achieved until the RCRA-equivalent covers have been installed and the vegetation established. The Shell Disposal Trenches will be evaluated after both the RCRA-equivalent cover and adjacent soil covers have been installed at the Shell Disposal Trenches. By agreement between the RVO and the Regulatory Agencies the dewatering goal is not applicable until it is determined that cover vegetation is established. It is expected that the dewatering goal will be attained by October 2, 2012. Nevertheless, while the cover vegetation has not yet been established, the Shell Disposal Trenches remedy appears to be functioning as intended. Operations and maintenance plans are in place and the operating procedures, as implemented, are maintaining the short-term and long-term effectiveness of the action, and the monitoring being performed is adequate. No early indicators of potential issues have been identified.

7.2.1.2 Complex (Army) Disposal Trenches Slurry Walls (Dewatering) (#17)

The Complex Disposal Trenches slurry wall and dewatering system were installed in accordance with the On-Post ROD to lower groundwater levels below the disposal trenches. The Complex Disposal Trenches dewatering system had not attained the dewatering goal in one of the two compliance wells by the end of the FYR period. It is not expected, however, that the goal will be achieved until the RCRA-equivalent covers have been installed and the vegetation established. Optimization of operation of the dewatering system during this FYR period consisted of maximizing the pumping rate for the dewatering well. As of the end of FY09, the dewatering system was performing as expected in the ROD and design document. Operations and maintenance plans are in place and the operating procedures, as implemented, are maintaining the short-term and long-term effectiveness of the action, and the monitoring being performed is adequate. It is expected that the dewatering goal will be attained in both of the compliance wells by September 2014. Extracted water is treated at BANS, where concentrations were below CSRGs/PQLs in the BANS treatment plant effluent during the FYR period.

7.2.1.3 Bedrock Ridge Extraction System (#28)

The BRES was installed in accordance with the On-Post ROD to prevent contaminant migration from the Basin A area toward First Creek. A small amount of bypass in the center of the extraction system appeared to be occurring at the BRES during the previous FYR period. Consequently, a fourth extraction well was installed in FY05 and became operational in the fourth quarter of FY05. The bypass was eliminated in the fourth quarter of FY05 and plume capture has been maintained since then. Extracted water is treated at BANS. The CCR for this project was finalized in September 2008 (Washington Group International 2008) and the system was accepted as O&F by the EPA.

Based on criteria in the BRES design document, On-Post ROD, and 2010 LTMP, the BRES is functioning as intended in the decision documents. Concentrations were below CSRGs/PQLs in the BANS treatment plant effluent, plume capture has been maintained since the fourth quarter of WY05, and the contaminant concentrations are decreasing in the downgradient wells. Optimization of operation of the extraction system during this FYR period consisted of maximizing the pumping rates for the extraction wells. Operations and maintenance plans are in place and the operating procedures, as implemented, are maintaining the short-term and long-term effectiveness of the action, and the monitoring being performed is adequate. No early indicators of potential issues have been identified.

7.2.1.4 Railyard Containment System and Motor Pool Extraction System (#58)

The RYCS is designed as a capture system. When the Irondale and Motor Pool extraction systems were shut off, treatment of the remaining Railyard Plume was moved from the Irondale System to the new RYCS in July 2001. The Rail Yard and Motor Pool Systems were evaluated based on the performance data presented in the OARs and the FYSR (PMRMA 2006b, 2007, 2008b, 2009b, 2010; TtEC and URS 2010a). The Motor Pool extraction system was shut off in April 1998 and shut-off monitoring was conducted through December 2003 (PMRMA 2005). Approval of the CCR for the Motor Pool extraction system is anticipated in 2011.

Concentrations were below CSRGs in the RYCS treatment plant effluent, plume capture was maintained, and the contaminant concentrations were below the CSRG in the downgradient wells monitored during the FYR period. The RYCS performance water quality well network in the 2010 LTMP includes upgradient, cross gradient, and downgradient wells.

Based on criteria in the Railyard IRA Decision Document (MKE 1990), On-Post ROD, 1999 LTMP, and 2010 LTMP, the RYCS is functioning as intended in the decision documents and meets the protectiveness objectives for the system. Operating two of the five RYCS extraction wells during this FYR period has resulted in maximum optimization of the extraction system, while maintaining a conservative safety factor for achieving plume capture. Operations and maintenance plans are in place and the operating procedures, as implemented, are maintaining the short-term and long-term effectiveness of the action, and the monitoring being performed is adequate. No early indicators of potential issues have been identified.

The TCE concentrations in Motor Pool well 04535 have remained below the CSRG since shut-off monitoring ended in 2003, and they were well below the CSRG during the FYR period.

7.2.1.5 Basin A Neck System (#59)

The BANS is a mass removal system that treats water migrating through the Basin A area as well as water extracted by the Complex Trenches dewatering system and the BRES. The performance of BANS during the FYR period is described and evaluated in the OARs and in the FYSR (PMRMA 2006b, 2007, 2008b, 2009b, 2010; TtEC and URS 2010a).

All extracted groundwater was effectively treated and contaminant levels in reinjected water were below the CSRGs; the concentrations were below CSRGs/PQLs in the BANS treatment plant effluent; BANS mass removal improved the performance of the boundary systems by reducing contaminant loading; hydraulic gradients were acceptable; and the contaminant concentrations of most analytes were decreasing or below CSRGs in the downgradient wells. The concentrations of two less mobile compounds, dieldrin and DDT, are above the CSRGs/PQLs and are stable in the downgradient wells.

The BANS is functioning as intended based on criteria in the BANS IRA Decision Document (Army 1989), the On-Post ROD, and the 2010 LTMP (TtEC and URS 2010c), and meets the protectiveness objectives for the system. There are no quantitative interim mass removal criteria for the BANS, but 75 percent mass removal has been set as the goal in the 2010 LTMP (TtEC and URS 2010c), pending further evaluation when 5 years of additional data become available. Optimization of operation of the extraction system during this FYR period consisted of maximizing extraction well pumping rates. Potential future optimization includes evaluation of the addition of manganese pre-treatment to reduce the need for frequent replacement of the granulated activated carbon in the BANS adsorbers because of manganese accumulation and plugging. Operations and maintenance plans are in place and the operating procedures, as implemented, are maintaining the short-term and long-term effectiveness of the action, and the monitoring being performed is adequate. No early indicators of potential issues have been identified.

7.2.1.6 Northwest Boundary Containment System (#61)

The NWBCS is designed to prevent the off-post migration of contaminants and to treat groundwater contaminant plumes from the South Plants and the Basins A, C, and F areas to the RMA boundary. The performance of this system during the FYR period is described and evaluated in the OARs and the FYSR (PMRMA 2006b, 2007, 2008b, 2009b, 2010; TtEC and URS 2010a).

During the FYR period concentrations were below CSRGs/PQLs in the treatment plant effluent; the reverse gradient and plume capture were maintained; and the contaminant concentrations were below CSRGs/PQLs in the downgradient conformance wells.

Based on criteria in the On-Post and Off-Post RODs, Off-Post RS/S, and 2010 LTMP, the NWBCS is functioning as intended in the decision documents and meets the protectiveness objectives for the system. Optimization of the operation of the NWBCS during this FYR period consisted of periodic adjustments of the extraction well pumping rates and recharge well flow rates to maintain reverse gradient conditions. A potential optimization in the next FYR period may consist of evaluating extraction well pumping requirements relative to current plume conditions, which will consist of evaluating whether any extraction wells may be turned off according to the Operational Extraction Well Shut-off Procedure (RVO 2010). Potential future enhancements also include optimization of extraction well pump sizes relative to current flow rate requirements. Operations and maintenance plans are in place and the operating procedures, as implemented, are maintaining the short-term and long-term effectiveness of the action, and the monitoring being performed is adequate. No early indicators of potential issues have been identified.

7.2.1.7 North Boundary Containment System (#62)

The NBCS is located immediately south of the RMA north boundary in Sections 23 and 24. The system treats water from the North Boundary Plume Group as the plumes approach the north boundary of RMA. The North Boundary Plume Group includes the Basins C and F Plume and the North Plants Plume. The performance of the NBCS system during the FYR period is described and evaluated in the OARs and the FYSR (PMRMA 2006b, 2007, 2008b, 2009b, 2010; TtEC and URS 2010a). Extracted groundwater was effectively treated to contaminant levels below the CSRGs before reinjection, thereby meeting the effluent compliance requirements. According to the On-Post ROD, ARARs for chloride and sulfate at the NBCS will be achieved through attenuation as described in *Development of Chloride and Sulfate Remediation Goals for the North Boundary Containment System at the Rocky Mountain Arsenal* (MKE 1996).

The NBCS effluent concentrations were below CSRGs/PQLs in the treatment plant effluent, including chloride and sulfate. Both chloride and sulfate concentrations have consistently met CSRGs in the NBCS effluent since 2005, which is earlier than predicted in 1996, when the remediation goals for the NBCS were developed (MKE 1996) and the On-Post ROD was signed. The reverse hydraulic gradient was maintained except for a 55-day period in 2005 in one well pair. This period when the reverse gradient was not maintained was determined to not have an adverse effect with regard to plume capture and system protectiveness. The contaminant

concentrations were decreasing or were below CSRGs/PQLs in the downgradient conformance wells that are representative of system performance. Residual contamination in downgradient wells was still above CSRGs/PQLs in a few wells at the end of the FYR period, but these wells are not representative of current system effectiveness. The NBCS conformance wells were selected in the Off-Post RS/S (HLA 1996a) and the network was modified in the1999 LTMP to address widening of 96th Avenue and moving the RMA boundary fence. The conformance wells were initially selected to be representative of system effectiveness. However, it became apparent during subsequent monitoring of the wells that some of the conformance wells were not representative of system performance. This finding was related to the Regulatory Agencies during Water Team Status Meetings and documented in the 2005 FYRR (RVO 2007a). The 2005 FYRR determined that the NBCS well network was to be re-evaluated during the LTMP revision:

> *Concerns about the presence of elevated contaminant levels in downgradient conformance wells will be revisited when considering the performance monitoring well network in the revised LTMP.*

The revised LTMP (TtEC and URS 2010c) excluded the non-representative NBCS conformance wells in the downgradient performance well network. The 2010 FYSR re-examined the downgradient detections of contaminants in the NBCS conformance wells during the current FYR period and concluded that the concentration trends in the downgradient conformance wells observed during this FYR period are consistent with the evaluation in the 2005 FYRR, and no other explanations for the downgradient detections in the conformance wells (e.g., underflow or bypass) are feasible. Regardless, the concentrations are also decreasing in most of these wells. The concentration trends in the revised downgradient performance well network and the representativeness of the selected wells will be evaluated in future annual assessment reports and the 2015 FYR.

Based on criteria in the On-Post and Off-Post RODs, Off-Post RS/S, and 2010 LTMP, the NBCS is functioning as intended in the decision documents and meets the protectiveness objectives for the system. Optimization of operation of the NBCS during this FYR period consisted of periodic adjustments of the extraction well pumping rates and recharge trench flow rates to maintain reverse gradient conditions. A potential optimization in the next FYR period may consist of evaluating extraction well pumping requirements relative to current plume conditions, which will consist of evaluating whether any extraction wells may be turned off according to the Operational Extraction Well Shut-off Procedure (RVO 2010). Potential future enhancement also includes optimization of extraction well pump sizes relative to current flow rate requirements. Operations and maintenance plans are in place and the operating procedures, as implemented, are maintaining the short-term and long-term effectiveness of the action, and the monitoring being performed is adequate. No early indicators of potential issues have been identified.

7.2.1.8 South Tank Farm and Lime Basins Mass Removal (#60a)

The Groundwater Mass Removal Project (GWMRP) was implemented in accordance with the Resolution Agreement and *Explanation of Significant Differences for Groundwater Remediation and Revegetation Requirements* (TtEC 2006c). The groundwater extraction/recharge and monitoring systems were installed in accordance with the Final Design Document (Washington

Group International 2006b) and became operational in 2006. This project was a limited duration mass removal project implemented to reduce the contaminant mass within the respective plumes. Groundwater extracted from these systems was treated at the CWTF before it was decommissioned in 2010. Treated water regulated under the Underground Injection Control Program was reinjected in the South Tank Farm and Lime Basins areas under an exemption that allowed recharge of groundwater at concentrations that exceeded the CBSGs (Washington Group International 2005).

The Lime Basins groundwater system of the GWMRP was shut down during RCRA-equivalent cover construction in 2008 and 2009 for a total of approximately 430 days, during which no contaminated groundwater was removed from the Lime Basins area. The protectiveness of the remedy was not adversely affected.

During operation of the South Tank Farm extraction system, free product that was confirmed to be primarily benzene was discovered in three of the seven wells within the high-concentration area of the plume. Two of the wells exhibited sufficient accumulation to allow for recovery of the free product that contributed to the contaminant mass extracted by the project.

Per the Resolution Agreement for the GWMR Project, a goal was established for the system to remove as much contaminant mass as possible and enhance in-situ biodegradation. With respect to the goal of maximizing mass removal, the system continues to be operated in a manner that achieves this objective. During the period covered by this FYRR, numerous instances can be cited where the GWMR Project has been operated to maximize mass removal including optimization of the existing treatment operations, and non-routine repairs that were implemented in a timely manner to restore operation to the system. However, it should be noted that the GWMR Project has not achieved the level of mass removal estimated by the final design package for the project. The actual flowrates that have been realized for both the South Tank Farm and Lime Basins Groundwater systems have been significantly less than the flowrates assumed in the design, constrained either by the capacity of the treatment system or the production and/or capacity of the extraction and recharge systems. Correspondingly, the mass extracted by both systems are also less than the design values assumed in the design.

With respect to the goal of enhancing in-situ biodegradation, irreversible loss of capacity of the recharge wells that was attributable to biofouling was observed during the first year of operation. Addition of a biodegradation enhancement agent to the treated water would further aggravate this biofouling. Consequently, the addition of a biodegradation enhancement agent has not been attempted on the project. The decision to forego this action represents a decision to maximize mass removal through groundwater extraction/treatment/recharge versus the mass removal that could be obtained through in-situ biodegradation. While not being actively enhanced, it should be noted that the ongoing biodegradation that is already occurring in the plume is still being enhanced through the decrease of benzene concentration over time that increases the bioavailability of benzene. Biodegradation is also unavoidably enhanced through the introduction of residual hydrogen peroxide and/or dissolved oxygen through treated water reinjection into the aquifer.

Based on criteria in the Resolution Agreement, Design Document (Washington Group International 2006b), and ESD (TtEC 2006c), the Groundwater Mass Removal project is functioning as intended in the decision documents. Optimizations of operation of the Groundwater Mass Removal project included utilization of exsitu biodegradation to more effectively treat benzene, removal of benzene free product, frequent cleaning of the South Tank Farm recharge wells to improve recharge capacity, and installation of recharge trenches in the South Tank Farm system to provide additional recharge capacity. Additional removal of contaminant mass after the project ended in 2010 is unnecessary because it would not benefit the performance of any boundary control system or the BANS. The South Tank Farm plume has been shown to be at steady state or receding, and is contained by biodegradation that has been confirmed and will continue to be verified through future monitoring. No early indicators of potential issues have been identified.

Within the primary objective of the GWMRP to remove contaminant mass, the project has also been focused on the operation of the South Tank Farm System to prevent the adverse migration of the high-concentration portion (>100,000 μg/L) of the contaminant plume. As stated in the design and project plans, such adverse migration would consist of the migration of the plume towards the lakes to the south of the project site. Monitoring of downgradient wells during the past FRR period to assess plume migration has indicated a decrease in the concentrations of benzene below historical maximum and baseline levels. Consequently, the South Tank Farm System has been operated during this period to prevent the adverse migration of the contaminant plume.

7.2.2 Operating Groundwater Remedial Actions in the Off-Post OU

7.2.2.1 Off-Post Groundwater Intercept and Treatment System (#94)

The OGITS is a mass removal system designed to extract and treat contaminated alluvial groundwater from the First Creek and Northern Pathway alluvial channels, downgradient of the NBCS, and return treated water to the alluvial aquifer. Modifications to the NPS extraction and recharge systems were made in 2006 to accelerate the cleanup of groundwater between Highway 2 and the Original NPS extraction system (George Chadwick Consulting 2005). Modifying the NPS was not required to meet ROD requirements, but was funded by the property owner to develop the property. However, the RVO has sole responsibility for operating the modified NPS to meet ROD requirements. In 2006, a draft Fact Sheet was issued by the Army to document the modifications made to the NPS. As of the end of the FYR period, this Fact Sheet has not yet been finalized. The performance of the OGITS during the FYR period is described and evaluated in the OARs and the FYSR (PMRMA 2006b, 2007, 2008b, 2009b, 2010; TtEC and URS 2010a). Groundwater extracted was effectively treated to contaminant levels below the CSRGs before reinjection, thereby meeting the effluent compliance requirements.

Chloride and sulfate concentrations exceeded CSRGs in the OGITS effluent, but these analytes are not treated by OGITS and are expected to meet CSRGs in the effluent by attenuation by 2026 and 2021, respectively, consistent with the On-Post ROD. Chloride and sulfate concentrations in the OGITS effluent have been relatively stable during the FYR period, averaging 304 mg/L for chloride and 507 mg/L for sulfate. Chloride was consistently above the CSRG of 250 mg/L, but sulfate was above the CSRG of 540 mg/L only twice. At the NBCS, the CSRGs for both chloride

and sulfate have consistently been met in the effluent since 2005, which is earlier than predicted in 1996, when the remediation goals for the NBCS were developed (MKE 1996) and the On-Post ROD was signed . Since the OGITS is downgradient of the NBCS, flushing of the aquifer between the two systems will eventually cause the OGITS effluent to meet the CSRGs as well. It is anticipated that the chloride and sulfate concentrations also will meet the CSRGs in the OGITS effluent earlier than the timeframes in the ROD. For the other CSRG analytes, except for one DIMP CSRG exceedance, the concentrations were below CSRGs/PQLs in the treatment plant effluent. The single DIMP exceedance was quickly corrected. The hydraulic gradients were acceptable, and increased pumping of NPS extraction wells in 2007 mitigated a temporary change in flow direction at the west end of the system that was caused by unusually high water levels.

A 75 percent interim mass removal goal for OGITS has been set in the 2010 LTMP pending further evaluation of 5 years of additional data. Mass removal estimates for the FCS could not be made during this FYR period because of data limitations, but were made for the NPS. The NPS Modifications commenced operation in September 2006. At least 63 percent of the contaminant mass flux was estimated to be removed by the new NPS Modifications extraction system, and at least 105 percent of the mass flux was removed by the combined NPS extraction systems in WY07, WY08, and WY09. The mass removed by the Original NPS extraction system has decreased since WY06 as the contaminant concentrations in the area between the two systems have decreased. Based on these calculations, the NPS would exceed the 75 percent mass removal criterion established in the 2010 LTMP. Additional data collected under the 2010 LTMP will help refine the mass removal estimates for both the FCS and NPS.

Except for chloride, sulfate, and arsenic, the contaminant concentrations either are decreasing or are below CSRGs/PQLs in the downgradient wells. Arsenic is sporadically detected above the CSRG in one well downgradient of the NPS. While the arsenic detected in the downgradient well may be related to the upgradient plume, other explanations suggest that the arsenic plumes are separate and different sources of arsenic may exist downgradient of the NPS extraction wells.

The NPS Modifications have met or exceeded expectations. Contaminant concentrations for most compounds have decreased to below CSRGs downgradient of the new system. DIMP and carbon tetrachloride concentrations in downgradient well 37009 have decreased to below CSRGs, so more DIMP and carbon tetrachloride mass has been removed than was expected, and the new system appears to have reduced the flow around the northeastern end of the NPS. Installation of an additional extraction well was specified in the NPS Modifications design document; however, the RVO will continue operating two Original NPS extraction wells instead of installing an additional well.

Five-year shut-off monitoring associated with shutdown of NPS extraction wells 37811, 37812, 37813, and 37814 in July 2004 was completed in September 2009 with no validated CSRG exceedances during the monitoring period. One reported DIMP detection above the CSRG occurred in well 37032 in August 2009, but was not confirmed by re-sampling, and subsequently flagged as questionable (Z) following the RMA Post-Laboratory Data Assessment Procedure (RVO 2007c). This procedure is applied infrequently to data that have been subject to laboratory validation when there is reason to question the result. The questionable sample from well 37032

was collected on August 10, 2009. The confirmation sample was collected on September 30, 2009. The flagged result was determined to be an outlier and not representative of groundwater conditions. A CCR/MCR will be prepared to document completion of the shut-off monitoring requirement.

Based on criteria in the Off-Post ROD, Off-Post RS/S, and 2010 LTMP, the OGITS is functioning as intended and meets the protectiveness objectives for the system. Optimization of operation of the OGITS during this FYR period consisted of periodic adjustments of the extraction well pumping rates and recharge trench flow rates relative to current plume conditions. Potential future enhancements include optimization of extraction well pump sizes relative to current flow rate requirements. Operations and maintenance plans are in place and the operating procedures, as implemented, are maintaining the short-term and long-term effectiveness of the action, and the monitoring being performed is adequate. No early indicators of potential issues have been identified.

7.2.2.2 Private Well Network (#96)

The Off-Post Private Well monitoring is conducted by TCHD for the Army. As described in Section 6.3.1, TCHD samples off-post private wells to provide data to assist in refining the CSRG exceedance map, to determine the water quality of new off-post wells as required by the Off-Post ROD, to respond to citizen requests, and to determine whether CFS wells are acting as conduits for contaminant transport from the UFS to the CFS. Execution of the program depends on cooperation from the private well owners, and access to the wells is therefore not consistent. Approximately 30 wells are sampled for DIMP each year. No new wells were installed during the FYR period that required sampling by the Off-Post ROD.

The monitoring results for UFS private wells during the FYR period showed that DIMP concentrations have decreased steadily, and only one well (986A) contained DIMP concentrations at the CSRG of 8 µg/L in WY09 (8.03 µg/L in June 2009). All of the private wells sampled in WY07 and WY08 were below the CSRG.

7.2.2.3 Off-Post Institutional Controls (#98)

TCHD continued to provide oversight of the SEO to ensure that requirements of the off-post well notification program were met. There were no deviations from the established procedure and no new wells installed within the notification areas. During the negotiations of the 2010 LTMP, the RVO and the Regulatory Agencies agreed to an expansion of the off-post institutional control program that will be documented in the Land Use Control Plan. The agreement included the following components (RVO 2009b):

- The Parties will jointly develop an expanded off-post IC area, with consideration of the 1994 DIMP plume footprint, 2007 off-post plume map, and the current Well Permit Notification Area.
- TCHD will develop/formalize access agreements with private well owners, as needed.
- The Parties agree to continue an Army/Shell-funded, private well monitoring program that is independently implemented by TCHD to ensure that an independent, funded

program continues. The private well monitoring program will continue until the Parties agree the program is not needed.

- The Army will incorporate the private well completion information and sample results supplied into the RMAED.

7.2.3 Other Operating Projects

7.2.3.1 Operation of Hazardous Waste Landfill Wastewater Treatment System (#10)

The operation of LWTS, described in Section 4.2.2.1 continues to operate and function as designed. While there were five separate events that required Regulatory Agency notification during this FYR period, the project is generally performing as expected and containment is effective. The one-time events, for which descriptions, formal notification letter source, and follow-up actions are provided in Table 7.2.3-1, were all addressed in a timely manner and did not affect remedy protectiveness.

7.2.3.2 Borrow Area Operations (#47a)

Based upon the status presented in Section 4.2.2.2, the Borrow Area Operations have been completed with the exception of final grading and revegetation and continue to operate and function as designed. The project is performing as expected. The operating procedures, as implemented, are maintaining the effectiveness of the action. RMA site access restrictions and project-specific health and safety measures have ensured the safety of workers and visitors. Implementation of the recent revisions to the RMA ICs (PMRMA 2008a) continues to satisfy the Refuge Act and ROD requirements. Opportunities for optimization are continually evaluated and a successful employee incentive program promotes that goal. No early indicators of potential issues have been identified.

7.2.3.3 Site-Wide Biota Monitoring (#48)

Although included in Table 2.0-2 as an operating project, this subject matter was more appropriately addressed as a topic for data review in Section 6.3.3. The Site-Wide Biota Monitoring Program was supplanted by the Long-Term Contaminant Biomonitoring Program. Based upon the status presented in Section 6.3.3, the Site-Wide Biota Monitoring in the form of the Long-Term Contaminant Biomonitoring Program continues to operate and function as designed. The activity is performing as expected. The operating procedures, as implemented, are maintaining the effectiveness of the action and the monitoring being performed is adequate. No early indicators of potential issues have been identified. Long-term biomonitoring will continue to be conducted at RMA.

Table 7.2.3-1. LWTS Notifications and Follow-Up

Date	Event/Letter Reference	Description	Corrective Action
05/02/05	Total Chromium Exceedance (RVO 2005a)	Total chromium concentration of 88.5 μg/L exceeded CCD 30-day average of 50 μg/L	Only one of four samples collected during the batch had a concentration greater than the detection limit. This was not representative of the quality of the treated water. Subsequent sampling did not reveal a source of the chromium and all further samples had concentrations less than the detection limit.
12/05/05	Total Recoverable Iron Exceedance (RVO 2005b)	Total Recoverable Iron concentration of 1,460 μg/L exceeded CCD 30-day average of 1,000 μg/L	Investigation revealed high turbidity in the plant influent coincident with pumping from HWL operations. The high turbidity was attributed to stirring up the sludge blanket in the influent basin, which caused suspended and colloidal materials, with iron and ammonia, to be carried over into the treatment plant influent. The influent basin was subsequently pumped to remove the sludge and the sludge was dewatered and transferred to the HWL. Ammonia and total recoverable iron were added to the analytical suite of the compliance confirmation samples and results verified to be compliant before discharge.
	Ammonia Exceedance (RVO 2005b)	Ammonia concentration of 132 μg/L exceeded CCD 30-day average of 100 μg/L	
12/27/06	Positive Whole Effluent Toxicity (RVO 2007b)	Acute toxicity confirmed for *Ceriodaphnia dubia* and *Pimephales promelas*	• Retested next treatment batch. • Instituted Toxicity Identification Evaluation and Toxicity Reduction Evaluation. • Identified High Total Suspended Solids suspected as cause for toxicity. • Reduced volume and high suspended solids at the ELF through changes to the decontamination process. • Replaced 20-micron first-stage filter bags with 5-micron filter bags and replaced 5-micron second-stage filter bags with 1-micron filter bags. • Added chitosan to influent sump to precoat filter bags for more efficient removal of colloidal particles.
09/02/08	Spill of leachate (RVO 2008)	Pipe break resulting in leachate spill	• Affected soil removed. • Communication plans between subcontractors implemented. • The isolation valve in the perimeter collection was eliminated. • Open stormwater collection lines were capped.

7.2.3.4 Site-Wide Air Monitoring (#49)

Although included in Table 2.0-2 as an operating project, this subject matter was more appropriately addressed as a topic for data review in Section 6.3.4. Except for on-going PM-10 air monitoring, routine ambient air and odor monitoring was completed by the end of 2008, with

results presented and evaluated in the Air MCR (TtEC 2009a) and the Odor MCR (TtEC 2009p). PM-10 air monitoring will be completed by May 2010, with results to be summarized in an addendum to the Air MCR. Based upon the status presented in Section 6.3.4, ongoing PM-10 particulate air monitoring continues to operate and function as designed. The activity is performing as expected. The operating procedures, as implemented, are maintaining the effectiveness of the action and the monitoring being performed is adequate. No indicators of potential issues have been identified.

7.2.3.5 Site-Wide Surface Water Monitoring

On-Post Surface Water Quality Monitoring (#50a)

There was only one detection of an organic analyte (dieldrin) in on-post surface water samples during the FYR period, which occurred in Upper Derby Lake (SW01004) on August 18, 2008. The concentration was below the aquatic life standards. Higher dissolved organic carbon/total organic carbon levels were observed in Havana Pond than in the lakes and First Creek, which is consistent with urban runoff.

The on-post surface water quality monitoring program showed that very little inorganic contamination was present in the surface water bodies at RMA. Arsenic was detected at low concentrations consistent with background levels. Selenium was the only analyte detected at concentrations above an aquatic life standard. The detections were above the chronic standard, but below the acute standard and were intermittent, occurring in the two north boundary First Creek sites. Increasing concentrations of sulfate in First Creek likely are related to a combination of urban runoff from south of RMA, upstream development, and groundwater discharge into First Creek.

The surface water quality monitoring program was conducted in support of the on-post soil remediation in accordance with the On-Post ROD requirements during this FYR period. Through the evaluation of monitoring networks conducted in the 2010 LTMP, it was determined that on-post surface water quality monitoring is no longer necessary because contaminated soil excavation for the on-post remedy has been completed. On-post surface water quality monitoring will be discontinued with the FY10 implementation of the LTMP.

As discussed in Section 6.3.2.1, surface water sampling at five on-site south boundary surface water locations was discontinued without modification of the SAP or notification to the Regulatory Agencies. The change was made in response to discontinuation of the High Line Canal as an RMA water supply source, and because these sites monitor surface water flowing onto RMA from the south. However, this change was not communicated to the Regulatory Agencies and no discussions took place to confirm agreement with the change. This lack of notification to the Regulatory Agencies is identified as an issue in Section 8.0.

Off-Post Surface Water Monitoring (#50c)

During this FYR period, the detection frequency for target analytes above CSRGs decreased for arsenic, was similar for chloride and sulfate, and increased for DIMP at station SW37001 compared to the past FYR period. Sulfate was detected above the CBSMSW more often at all three stations during this FYR period. The detection frequencies of sulfate above the CBSMSW

at the three stations, and DIMP above the CSRG at SW37001, however, likely increased because sampling was conducted more often during low-flow conditions, i.e., when groundwater is discharging into First Creek. During this FYR, low-flow sampling at SW37001 was conducted to better evaluate the effect of groundwater treatment on the surface water quality in accordance with the Off-Post ROD. The background groundwater concentration for sulfate was determined to be 540,000 µg/L when the CSRGs were developed for the RODs, which is higher than the CBSMSW of 250,000 µg/L. Although the frequency of detection above the CSRG increased for DIMP because sampling during low-flow conditions was emphasized, the concentrations of DIMP decreased over the FYR period and are approaching the CSRG because the treatment of groundwater is ongoing.

Surface water leaving RMA as measured at station SW24004 met applicable water quality standards for all of the target constituents. With the continuing removal of organic contaminants from the groundwater in the area, concentrations of the target suite of organic constituents in surface water at off-post site SW37001 are expected to continue to decrease. Attenuation of inorganic contaminants and treatment of organic groundwater contaminants at the NBCS and the OGITS appear to be having a positive effect on First Creek water quality. Accordingly, the surface water monitoring component of the off-post remedy is performing in accordance with the Off-Post ROD.

7.2.3.6 Site-Wide Groundwater Monitoring (#50)

Although included in Table 2.0-2 as an operating project, this subject matter is more appropriately addressed as a topic for data review in Section 6.3.1. Identified inconsistencies between the RMA groundwater program and the monitoring program established by the 1999 LTMP are described below.

On-Post Monitoring

Based on the data and discussions in Section 6.3.1 regarding the RMA groundwater monitoring program, the following inconsistencies with the planned monitoring program established by the 1999 LTMP have been identified:

On-post Water Level Tracking:

- Well 24063 was closed in June 2008 and was only monitored through 2007.
- Wells 36627, 36628, 36629, 36630, 36631, 36632, and 36633 were installed in 2007 and 2008 (to replace wells 36056, 36081, 36093, 36108, 36109, 36177, and 36599, respectively), but were only measured in 2009.

On-Post Water Quality Tracking:

- Well 35058 was not sampled in 2007 because the well was damaged. The well was subsequently rehabilitated and was then sampled in 2009.

Off-Post Exceedance Monitoring

There were only a few deviations from the planned sampling of the wells in the 1999 LTMP exceedance well network during the FYR period. Well 37318 was damaged and closed in 2005 and replaced by well 37328, which was sampled in WY07 and WY09. Wells 37040 and 37403

were closed in 2008 because of road construction and replaced by wells 37151 and 37150, respectively. Wells 37040 and 37403 were sampled in WY07, and wells 37151 and 37150 were sampled in WY09. Wells 37355, 37356, and 37357 were destroyed prior to implementation of the 1999 LTMP, so nearby private wells 995A, 548B, and 538A, respectively, were sampled in the areas of the destroyed wells during this FYR.

7.2.3.7 Unexploded Ordnance (UXO) Management (#51)

Based upon the status presented in Section 4.4.1.3, UXO Management continues to operate and function as designed. The activity is performing as expected and management of UXO and residuals is effective. The operating procedures, as implemented, are maintaining the effectiveness of the action and the monitoring being performed is adequate. RMA site access restrictions and project-specific health and safety measures have ensured the safety of workers and visitors. Implementation of the recent revisions to the RMA ICs (PMRMA 2008a) continues to satisfy the Refuge Act and ROD requirements. No early indicators of potential issues have been identified.

7.2.3.8 Operation of CERCLA Wastewater Treatment Facility (#60)

As described in Section 4.4.1.4, the CWTF has supported various RMA remediation projects and was used for treatment of water extracted under the Groundwater Mass Removal project (South Tank Farm and Lime Basins mass removal) and the Lime Basins Slurry Wall Dewatering project. Previous to demolition, water treated at the CWTF was reinjected in the South Tank Farm and Lime Basins areas under an exemption that allowed recharge of groundwater at concentrations that exceeded the CBSGs (Washington Group International 2005).

The CWTF has been meeting all applicable provisions of the On-Post ROD and applicable discharge requirements. All wastes generated have been properly disposed either on site in the HWL or off site in a fully permitted facility with CERCLA Off-Site Rule approval.

7.2.3.9 On-Post Institutional Controls (#99)

Land use restrictions and on-post ICs continue to be implemented successfully in accordance with the ICP as described in Section 4.4.1.5. The ICP includes primary land use restrictions identified in the FFA and ROD as well as access control requirements to limit access to certain on-post areas depending on the remedy activities being performed. In addition, the ICP incorporates controls for other specific areas, including additional ICs for the previously excavated lake sediments (SSA-3b), access restrictions for the covers, protection of groundwater remedy structures, and lake level maintenance.

Access restrictions and ICs have been implemented and revised as necessary. They have effectively prevented individuals from exposure to unacceptable levels of risk. There was one trespass incident reported in FY07 and two incidents reported in FY08. None of the trespasses threatened the integrity or effectiveness of the remedy, and none created any potential for exposure.

Annual monitoring of land use controls is required to ensure they remain effective and are protective of human health and the environment. Results of the monitoring are provided in an

annual monitoring report. In January 2010, a monitoring report was issued to document land use control monitoring activities for FY09. This report was subsequently revised to evaluate land use controls and monitoring activities for FY06 through FY09 and was reissued in June 2010 (TtEC 2010f). As a result of monitoring activities, two issues related to land use controls were identified resulting in three recommended corrective actions. Several markers installed during remedy activities along the abandoned sanitary sewer were damaged or missing. Also, review of the Commerce City Prairie Gateway PUD revealed a use-by-right included as "(p)ublic gardening and similar cultivation of land, nursery, and supplementary to the primary public use" for a parcel of the Prairie Gateway. This use appears inconsistent with the land use restrictions delineated in the Refuge Act, which prohibit non-remedy agricultural activities, although the Commerce City Planning Division stated that it believed the use would be interpreted consistent with the FFA and Refuge Act restrictions. In addition, the PUD process includes notification to adjacent landowners of proposed amendments to the PUD. However, the Army has not been included in the notification list. These findings are early indicators of potential issues and are discussed further in Section 8 of this FYRR.

During the land use control inspection of the sanitary sewer markers, an exposed section of pipe was observed in Section 35. The exposed pipe was also identified as an issue in the FY09 land use control monitoring report. Although not truly a land use control, the exposed section of the sewer is not consistent with the ROD requirements and could limit the effectiveness of the remedy. The exposed pipe is an early indicator of a potential issue and is discussed further in Section 8.0 of this FYRR.

It was also noted in the monitoring results that water levels in Lake Ladora and Lower Derby Lake were below the minimum elevations specified in the Interim Rocky Mountain Arsenal Institutional Control Plan (PMRMA 2008a) for a portion of FY06 and FY07 because of regional drought during those years. The minimum elevations were less than 0.25 feet below the specified minimum elevations for aquatic ecosystem protection, and there were no adverse impacts on the ecosystems. With the end of drought conditions in early 2007, the water levels were once again recorded above the minimum specified levels. As such, no corrective action was identified.

7.3 Question A: Are the completed remedial actions functioning as intended by the decision documents

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

- Remedial action activities have completed all construction items identified in the Scopes of Work and the Final Design Packages, as modified, for these projects.
- The RVO has certified that the projects have been completed in accordance with the appropriate ROD.
- The State of Colorado has concurred with the CCRs.
- The EPA has approved the CCR and accepted the projects as complete.

These completed projects were reviewed in more detail than were projects under construction. This reflects the added emphasis placed on completed ROD projects as stated in the EPA guidance on FYRs. Consistent with the EPA FYR guidance (EPA 2001) the following topics should be evaluated for completed projects:

Remedial Action Performance

Does the Remedial Action continue to be operating and functioning as designed?

Is the Remedial Action performing as expected and are cleanup levels are being achieved?

Is containment effective?

Systems Operations/O&M

Will operating procedures, as implemented, maintain the effectiveness of the response actions?

Do large variances in O&M costs indicate a potential remedy problem?

Is monitoring being performed and is it adequate to determine protectiveness and effectiveness of remedy?

Implementation of Institutional Controls and Other Measures

Are access controls in place and preventing exposure (e.g., fencing and warning signs)?

Are institutional controls in place and preventing exposure?

Are other actions (removals) to address immediate threats complete?

Opportunities for Optimization

Do opportunities exist to improve performance and/or costs of monitoring, sampling, and treatment systems?

Early Indicators of Potential Issues

Do frequent equipment breakdowns or changes indicate a potential risk?

Could other issues or problems place protectiveness at risk?

7.3.1 Section 26 Human Health Exceedance and Biota Exceedance Soils Removal (#5)

As noted in Section 4.2.3.1, the Section 26 HHE and Biota Soils Project has been completed and is protective. Subsequent to the initial project completion, it was noted that unbackfilled HHE excavations could pose a risk to biota. The issue was evaluated for all unbackfilled HHE excavation areas and additional sampling and excavation was performed. As a result, that early indicator of potential remedy failure has been addressed. The remedial action continues to function as designed and cleanup levels have been achieved. Because this was an excavation project, containment and O&M are not relevant to this project, but containment effectiveness will be tracked in conjunction with the O&M and monitoring of the CAMU and Basin A where the project wastes were disposed. RMA site access restrictions and project-specific health and

safety measures ensured the safety of workers and visitors. Implementation of the recent revisions to the RMA ICs (PMRMA 2008a) continues to satisfy the Refuge Act and ROD requirements. Because this excavation project has been completed, optimization is not relevant.

7.3.2 Operation of Hazardous Waste Landfill Cells 1 and 2 (#7)

As noted in Section 4.2.3.2, the HWL Operations project has been completed and is protective. HWL groundwater and LCS/LDS monitoring is discussed in Section 6.3.1.6. Though not completed during the FYR period, the HWL cap is described in Section 4.2.1.1. The operating procedures and monitoring, as implemented, were successful in maintaining remedy effectiveness throughout the operational period. Containment effectiveness will be tracked in conjunction with the monitoring of the HWL during long-term O&M. RMA site access restrictions and project-specific health and safety measures ensured the safety of workers and visitors. Implementation of the recent revisions to the RMA ICs (PMRMA 2008a) continues to satisfy the Refuge Act and ROD requirements. As a completed operations project, optimization is not relevant. Early indicators of remedy failure were not identified.

As discussed in Section 6.3.1.6, 12 wells were omitted from the April 2006 quarterly groundwater monitoring event. The missing upgradient well data did not allow for the calculation of 2007 prediction limits. A detailed analysis completed for the missing well data presented in the 2005–2006 groundwater monitoring report concluded that there was little or no impact. However, notification of the missed sampling was not provided to the Regulatory Agencies in a timely fashion. This lack of communication to the Regulatory Agencies is identified as an issue in Section 8.0.

7.3.3 Landfill Wastewater Treatment Addition of Ion Exchange (#9)

As noted in Section 4.2.3.3, the LWTS Ion Exchange project has been completed and is protective. The modifications to the LWTS were constructed in accordance with the approved DCN. This project, as part of the LWTS discussed in Section 7.2.3.1, continues to operate and function as designed. As a facility construction project, containment is not relevant to this project. RMA site access restrictions and project-specific health and safety measures ensured the safety of workers and visitors. Implementation of the recent revisions to the RMA ICs (PMRMA 2008a) continues to satisfy the Refuge Act and ROD requirements. As a completed construction project optimization is not relevant. Early indicators of remedy failure were not identified.

7.3.4 Construct Enhanced Hazardous Waste Landfill (#11)

As noted in Section 4.2.3.4, the Enhanced Hazardous Waste Landfill construction project has been completed and is protective. The facilities were constructed in accordance with the ROD, designs, and change documentation. Because this is a facility construction project, containment and O&M are not relevant to this project, but containment effectiveness will be tracked in conjunction with the monitoring of the ELF during long-term O&M. RMA site access restrictions and project-specific health and safety measures ensured the safety of workers and visitors. Implementation of the recent revisions to the RMA ICs (PMRMA 2008a) continues to satisfy the Refuge Act and ROD requirements. Because this construction project has been completed, optimization is not relevant. Early indicators of remedy failure were not identified.

7.3.5 Operation of Enhanced Hazardous Waste Landfill (#12)

As noted in Section 4.2.3.5, the ELF Operations project has been completed and is protective. ELF groundwater and LCS/LDS monitoring is discussed in Section 6.3.1.7. Though not completed during the FYR period, the ELF cap is described in Section 4.2.1.2. The remedial action continues to function as designed. The operating procedures and monitoring, as implemented, were successful in maintaining remedy effectiveness throughout the operational period. Containment effectiveness will be tracked in conjunction with the monitoring of the ELF during long-term O&M. RMA site access restrictions and project-specific health and safety measures ensured the safety of workers and visitors. Implementation of the recent revisions to the RMA ICs (PMRMA 2008a) continues to satisfy the Refuge Act and ROD requirements. Because this Operations project has been completed, optimization is not relevant. Early indicators of remedy failure were not identified.

As discussed in Section 6.3.1.7, several non-indicator compounds were detected in the ELF LDS liquid in the April 2007 quarterly monitoring event. However, notification of the non-indicator compound detections was not provided to the Regulatory Agencies in a timely fashion. This lack of communication to the Regulatory Agencies is identified as an issue in Section 8.0.

7.3.6 Basin A Consolidation and Remediation Area Operations/Subgrade (#14)

As noted in Section 4.2.3.6, the Basin A Remediation and Operations project has been completed and is protective. The remedial action continues to function as designed. The operating procedures and monitoring, as implemented, were successful in maintaining remedy effectiveness throughout the operational period and subgrade construction. Containment effectiveness will be tracked in conjunction with the monitoring of the Basin A cover during long-term O&M. RMA site access restrictions and project-specific health and safety measures ensured the safety of workers and visitors. Implementation of the recent revisions to the RMA ICs (PMRMA 2008a) continues to satisfy the Refuge Act and ROD requirements. Because this operations project has been completed, optimization is not relevant. Early indicators of remedy failure were not identified.

7.3.7 Existing (Sanitary) Landfills Remediation Section 1 (#20)

As noted in Section 4.2.3.7, the Existing (Sanitary) Landfills Section 1 project has been completed and is protective. Subsequent to the initial project completion, it was noted that unbackfilled HHE excavations could pose a risk to biota. The issue was evaluated for all unbackfilled HHE excavation areas and additional sampling and excavation was performed. As a result, this early indicator of potential remedy failure has been addressed. The remedial action continues to function as designed and cleanup levels have been achieved. Because this was an excavation project, containment and O&M are not relevant to this project, but containment effectiveness will be tracked in conjunction with the O&M and monitoring of the CAMU and Basin A where the project wastes were disposed. RMA site access restrictions and project-specific health and safety measures ensured the safety of workers and visitors. Implementation of the recent revisions to the RMA ICs (PMRMA 2008a) continues to satisfy the Refuge Act and ROD requirements. Because this excavation project has been completed, optimization is not relevant.

7.3.8 Existing (Sanitary) Landfills Remediation Section 30 (#22)

As noted in Section 4.2.3.8, the Existing (Sanitary) Landfills Remediation Section 30 project has been completed and is protective. The remedial action continues to function as designed and cleanup levels have been achieved. Because this was an excavation project, containment and O&M are not relevant to this project, but containment effectiveness will be tracked in conjunction with the O&M and monitoring of the CAMU and Basin A, where the project wastes were disposed. RMA site access restrictions and project-specific health and safety measures ensured the safety of workers and visitors. Implementation of the recent revisions to the RMA ICs (PMRMA 2008a) continues to satisfy the Refuge Act and ROD requirements. Because this excavation project has been completed, optimization is not relevant. Early indicators of remedy failure were not identified.

As noted in Section 4.2.3.8, the ROD did not anticipate MEC at this project. Regardless, because the design evaluation indicated the possibility for MEC, UXO spotters were present during excavation activities in anticipation of the MEC and concomitant safety measures suggest that the remedy, as implemented through the RI/FS, ROD, design evaluation, design specifications, site procedures, and other change documentation is functioning as intended.

7.3.9 Munitions (Testing) Soil Remediation Parts II–IV (#25)

As noted in Section 4.2.3.9, the Munitions Testing Soil Remediation project has been completed and is protective. The remedial action continues to function as designed and cleanup levels have been achieved. Because this was an excavation project, containment and O&M are not relevant to this project, but containment effectiveness will be tracked in conjunction with the O&M and monitoring of the CAMU and Basin A, where the project wastes were disposed. RMA site access restrictions and project-specific health and safety measures ensured the safety of workers and visitors. Implementation of the recent revisions to the RMA ICs (PMRMA 2008a) continues to satisfy the Refuge Act and ROD requirements. As a completed excavation project optimization is not relevant. Early indicators of remedy failure were not identified.

As noted in Section 4.2.3.9, the ESA-4a boundaries were modified several times during project implementation and the DREZ was added to the project area. Clearly, the possible UXO in a number of medium groups and subgroups at RMA was anticipated when the ROD was developed, and the contemplated use of geophysical methods to locate and recover these items has been a reality. The boundary changes at ESA-4a and inclusion of the DREZ evidence a functioning, iterative remedy process.

The CERCLA process recognizes the ROD as one step in a long sequence of remedy activities. As new data became available, the prior ROD conclusions were challenged and, where appropriate, the ROD conclusions were modified. As a result of the boundary changes completed, this project, as implemented though the RI/FS, ROD, design evaluation, design specifications, site procedures, and other change documentation, is functioning as intended. Additional information about this project is provided in Sections 4.4.1.3 and 7.2.3.7.

7.3.10 Miscellaneous Northern Tier Soil Remediation (#26)

As noted in Section 4.2.3.10, the Miscellaneous Northern Tier Soil Remediation project has been completed and is protective. Subsequent to the initial project completion, it was noted that unbackfilled HHE excavations could pose a risk to biota. The issue was evaluated for all unbackfilled HHE excavation areas and additional sampling and excavation was performed. As a result, this early indicator of potential remedy failure has been addressed. The remedial action continues to function as designed and cleanup levels have been achieved. Because this was an excavation project, containment and O&M are not relevant to this project, but containment effectiveness will be tracked in conjunction with the O&M and monitoring of the CAMU and Basin A, where the project wastes were disposed. RMA site access restrictions and project-specific health and safety measures ensured the safety of workers and visitors. Implementation of the recent revisions to the RMA ICs (PMRMA 2008a) continues to satisfy the Refuge Act and ROD requirements. Because this excavation project has been completed, optimization is not relevant.

7.3.11 Miscellaneous RMA Structures Demolition and Removal Phases II and III (#30)

As noted in Sections 4.3.2.1 and 4.3.2.2, the Miscellaneous RMA Structures Demolition and Removal Project, Phases II and III, has been completed and is protective. The remedial action continues to function as designed and cleanup levels have been achieved. During Phase II, DCN-MSD2-013 (TtEC 2005d) was completed that reclassified a number of structures for "future use" that the ROD had identified for "no future use" (TtEC 2006e). As a demolition project, containment and O&M are not relevant, but containment effectiveness will be tracked in conjunction with the O&M and monitoring of the CAMU and Basin A, where the project wastes were disposed. RMA site access restrictions and project-specific health and safety measures ensured the safety of workers and visitors. Implementation of the recent revisions to the RMA ICs (PMRMA 2008a) continues to satisfy the Refuge Act and ROD requirements. Because this demolition project has been completed, optimization is not relevant. Early indicators of remedy failure were not identified.

7.3.12 South Plants Balance of Areas and Central Processing Area Soil Remediation Phase 2, Parts 1 and 2 (#34)

As noted in Section 4.2.3.11, the South Plants Balance of Areas and Central Processing Area Soil Remediation Phase 2, Parts 1 and 2 project has been completed and is protective. The remedial action continues to function as designed and cleanup levels have been achieved. Because this was an excavation and subgrade construction project, containment and O&M are not relevant to this project. However, long-term O&M is required for the South Plants RCRA-equivalent cover and 3-ft soil cover constructed as part of the ICS project (discussed in Sections 4.2.1.3 and 7.1.3). Containment effectiveness will also be tracked in conjunction with the O&M and monitoring of the CAMU and Basin A, where project wastes were disposed. RMA site access restrictions and project-specific health and safety measures ensured the safety of workers and visitors. Implementation of the recent revisions to the RMA ICs (PMRMA 2008a) continues to satisfy the Refuge Act and ROD requirements. As a completed excavation and subgrade construction project optimization is not relevant. Early indicators of remedy failure were not identified.

7.3.13 Sanitary Sewer Manhole Plugging Project Phase II (#35)

As noted in Section 4.2.3.12, the Sanitary Sewer Manhole Plugging project Phase II has been completed and is protective. During project activities, RMA site access restrictions and project-specific health and safety measures ensured the safety of workers and visitors. Because the project consisted of plugging existing manholes, containment and O&M are not relevant. Because this construction project has been completed, optimization is not relevant.

Land use controls in the form of aboveground markers to indicate the abandoned sewer location were included in the remedy. Subsequent to project completion, an inspection was conducted to confirm the presence of aboveground markers along the abandoned sanitary sewer line as part of the FY09 land use control monitoring effort. The inspection included segments of sewer addressed during Phase I (discussed in the 2000 FYRR) and Phase II of the project. Observations recorded during the inspection included missing or broken markers at several locations, lack of markers along one segment of abandoned sewer, and an exposed sewer pipe in Section 35. The FYR inspections confirmed these observations, as discussed in Section 6.4.

The lack of required markers and the presence of the exposed pipe are early indicators of potential issues and they are therefore identified as FYR issues in Section 8.0. However, implementation of access control and activity management systems identified in the RMA ICP (PMRMA 2008a) provide additional layers of protection against inadvertent access to the abandoned sewer, and no exposure has occurred. Corrective actions are being evaluated and will be tracked as part of the annual land use monitoring and reporting. These issues will be evaluated in the 2015 FYRR and are addressed in Section 8.0.

7.3.14 Section 36 Balance of Areas Soil Remediation Parts 1 and 2 (#36)

As noted in Section 4.2.3.13, the Section 36 Balance of Areas Soil Remediation project has been completed and is protective. The remedial action continues to function as designed and cleanup levels have been achieved. Because this was an excavation and subgrade construction project, containment and O&M are not relevant to this project. However, long-term O&M is required for the portion of the project area within the AMA as presented in the LTCP (TtEC 2008i). Containment effectiveness will also be tracked in conjunction with the O&M and monitoring of the CAMU and Basin A, where project wastes were disposed. RMA site access restrictions and project-specific health and safety measures ensured the safety of workers and visitors. Implementation of the recent revisions to the RMA ICs (PMRMA 2008a) continues to satisfy the Refuge Act and ROD requirements. Because this excavation and subgrade project has been completed, optimization is not relevant.

7.3.15 Secondary Basins Soil Remediation, NCSA-2d (Basin B Drainage Ditch) Contingent Soil Volume (#37)

As noted in Section 4.2.3.14, the Secondary Basins NCSA-2d Basin B Drainage Ditch CSV project has been completed and is protective. Subsequent to completion of the Secondary Basins Soil Remediation (discussed in the 2005 FYRR), an evaluation of soil along the banks of ditches was completed and additional HHE soil was identified and excavated. As a result, this early indicator of potential remedy failure has been addressed. The remedial action continues to function as designed and cleanup levels have been achieved. Because this was an excavation

project, containment and O&M are not relevant to this project, but containment effectiveness will be tracked in conjunction with the O&M and monitoring of the CAMU and Basin A, where the project wastes were disposed. RMA site access restrictions and project-specific health and safety measures ensured the safety of workers and visitors. Implementation of the recent revisions to the RMA ICs (PMRMA 2008a) continues to satisfy the Refuge Act and ROD requirements. Because this excavation project has been completed, optimization is not relevant.

7.3.16 Complex (Army) Disposal Trenches Remediation Subgrade Construction (#38)

As noted in Section 4.2.3.15, the Complex (Army) Trenches Subgrade Construction project has been completed and the remedial action continues to function as designed. A final inspection was completed and no further construction is required. Although O&M is not directly relevant to the subgrade construction, long-term O&M is relevant to future operation of the RCRA-equivalent cover constructed at this location under the ICS project (discussed in Section 7.1.3). Following establishment of cover vegetation, the Complex (Army) Trenches cover is expected to be protective and performance standards will likely be met. RMA site access restrictions and project-specific health and safety measures ensured the safety of workers and visitors. Implementation of RMA ICs (PMRMA 2008a) continues to satisfy the Refuge Act and ROD requirements. As a completed construction project optimization is not relevant. Early indicators of remedy failure were not identified.

7.3.17 Miscellaneous Southern Tier Soil Remediation, Sand Creek Lateral (#27) and Section 35 Soil Remediation, Sand Creek Lateral (#41)

As noted in Section 4.2.3.16, the Sand Creek Lateral Remediation project has been completed and is protective. Subsequent to completion of the Miscellaneous Southern Tier and Section 35 Soil Remediation projects (discussed in the 2005 FYRR), an evaluation of soil along the banks of the Sand Creek Lateral was completed and additional HHE and biota risk soils were identified and excavated. As a result, that early indicator of potential remedy failure has been addressed. The remedial action continues to function as designed and cleanup levels have been achieved. Because this was an excavation project, containment and O&M are not relevant to this project, but containment effectiveness will be tracked in conjunction with the O&M and monitoring of the CAMU and Basin A, where the project wastes were disposed. RMA site access restrictions and project-specific health and safety measures ensured the safety of workers and visitors. Implementation of the recent revisions to the RMA ICs (PMRMA 2008a) continues to satisfy the Refuge Act and ROD requirements. Because this excavation project has been completed, optimization is not relevant.

7.3.18 Basin F Wastepile Remediation (#43)

As noted in Section 4.2.3.17, the Basin F Wastepile Remediation project has been completed and is protective. The remedial action continues to function as designed and cleanup levels have been achieved. Because this was an excavation project, containment and O&M are not relevant to this project, but containment effectiveness will be tracked in conjunction with the O&M and monitoring of the ELF where the project wastes were disposed. Also, long-term O&M will be relevant to future operation of the RCRA-equivalent cover constructed at this location under a separate implementation project. RMA site access restrictions and project-specific health and safety measures ensured the safety of workers and visitors. Implementation of RMA ICs

(PMRMA 2008a) continues to satisfy the Refuge Act and ROD requirements. Because this excavation project has been completed, optimization is not relevant. Early indicators of remedy failure were not identified.

7.3.19 Former Basin F Principal Threat Soil Remediation (#44)

As noted in Section 4.2.3.18, the Former Basin F Principal Threat Soils Remediation project has been completed and is protective. The remedial action continues to function as designed and cleanup levels have been achieved. As an excavation project, containment and O&M are not relevant to this project, but containment effectiveness will be tracked in conjunction with the O&M and monitoring of the ELF, where the project wastes were disposed. Also, long-term O&M will be relevant to future operation of the RCRA-equivalent cover constructed at this location under a separate implementation project. RMA site access restrictions and project-specific health and safety measures ensured the safety of workers and visitors. Implementation of RMA ICs (PMRMA 2008a) continues to satisfy the Refuge Act and ROD requirements. Because this excavation project has been completed, project optimization is not relevant. Early indicators of remedy failure were not identified.

7.3.20 Basin F/Basin F Exterior Remediation Part 1/Phase I and Part 1/Phase II—Remaining Biota Soil (#45)

As noted in Sections 4.2.3.19 and 4.2.3.20, the Basin F and Basin F Exterior Soil Remediation Part 1/ Phases 1 and 2 projects have been completed and are protective. The remedial action continues to function as designed and cleanup levels have been achieved. Because this was an excavation project, containment and O&M are not relevant to the Basin F Exterior project. However, long-term O&M will be relevant to future operation of the RCRA-equivalent cover constructed at this location under a separate implementation project. RMA site access restrictions and project-specific health and safety measures ensured the safety of workers and visitors. Implementation of RMA ICs (PMRMA 2008a) continues to satisfy the Refuge Act and ROD requirements. Because this excavation project has been completed, optimization is not relevant.

Previously identified early indicators of remedy failure have been addressed. During project implementation, evaluation of soil data located at greater depths was performed. This effort identified soils exceeding acute site evaluation criteria that, in the absence of additional ICs, warranted remediation. This soil was excavated and disposed in the HWL and additional sampling was performed. No other indicators of potential remedy failure have been identified.

7.3.21 Residual Ecological Risk Soil Remediation (#47a)

As noted in Section 4.2.3.21, the Residual Ecological Risk component of the remedy has been completed and is protective. The remedial action continues to function as designed and cleanup levels have been achieved. Because this was an excavation project, containment and O&M are not relevant to this project, but containment effectiveness will be tracked in conjunction with the O&M and monitoring of the CAMU and Basin A, where the project wastes were disposed. RMA site access restrictions and project-specific health and safety measures ensured the safety of workers and visitors. Implementation of the recent revisions to the RMA ICs (PMRMA 2008a) continues to satisfy the Refuge Act and ROD requirements. Because this excavation project has

been completed, optimization is not relevant. Early indicators of remedy failure were not identified.

7.3.22 Medical Monitoring Program (#52)

All elements of the Medical Monitoring Program have been completed. An MCR is under preparation and is expected to be finalized in 2011. The program performed as expected. Based upon the status presented in Section 4.4.3.1, the Medical Monitoring Program operated and functioned as designed. No indicators of potential issues have been identified.

7.3.23 Basin F Wastepile Operations and Management (#65)

As noted in Section 4.2.3.22, the Basin F Wastepile Remediation project has been completed and is protective. Indicators of remedy failure, such as indications that contaminants of concern were released to the environment were not identified upon final excavation of the Basin F Wastepile during the remedy implementation. Protectiveness issues identified in the 2005 FYRR concerning the performance of the Basin F Wastepile Cell #2 have been resolved with the completion of the Basin F Wastepile Remediation. Continued O&M is no longer relevant to this project, but containment effectiveness will be tracked in conjunction with the O&M and monitoring of the ELF, where the project wastes were disposed. Also, long-term O&M will be relevant to future operation of the RCRA-equivalent cover constructed at this location under a separate implementation project. RMA site access restrictions and project-specific health and safety measures ensured the safety of workers and visitors. Implementation of RMA ICs (PMRMA 2008a) continues to satisfy the Refuge Act and ROD requirements.

7.3.24 Cost

The original estimate for the remediation of RMA was $2.2 billion in FY95 dollars. This total included approximately $750 million of cost that was incurred prior to the signing of the ROD; this total also included an estimated $91 million in post-remedy long-term monitoring/maintenance costs. The remaining $1.364 billion represents the baseline remediation-only estimate in FY95 dollars. The escalated estimate for this scope of activity, as shown in the RMA 1997 Report to the U.S. Senate Appropriations Committee, is $1.512 billion dollars. As of March 31, 2010, the RMA's current escalated estimate at completion for remediation cost is $1.397 billion dollars. Of that total, $1.322 billion dollars has been recorded as actual cost-to-date. Remediation at the RMA is estimated to be 94.6 percent complete with 94 percent of the current estimated budget consumed.

7.4 Question B: Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives used at the time of the remedy selection still valid?

This section includes a discussion of all ARARs and TBCs identified in the RODs, and exposure and toxicity assessment variables and risk assessment methods used to develop soil cleanup criteria (Ebasco 1994). There is one potential change to the assumptions used at the time of remedy selection that should be evaluated when determining whether the remedy remains protective: the discovery during the FYR period of DNAPL in the vicinity of the Lime Basins.

ARARs are standards-based criteria, such as federal and state standards for soil or groundwater. ARARs can be chemical-specific, action-specific, or location-specific. TBCs are risk-based criteria established through risk assessments conducted for the relevant media and exposure pathways. The primary routes for potential exposure are ingestion, dermal contact, and inhalation.

The changes to the LWTS ARARs involve a different circumstance because the LWTS Discharge Control Mechanism Document (CCD) (EPA 2006a) caused a minor change to the ROD.

For organizational purposes, the ARARs and TBCs are separated into four categories: water treatment system ARARs and TBCs, air ARARs and TBCs, soil ARARs and TBCs, and other media ARARs and TBCs.

7.4.1 Lime Basins DNAPL

DNAPL associated with groundwater was first discovered in the Lime Basins vicinity in 2009. The DNAPL is composed of 1,2-dichlorobenzene and 1,4-dichlorobenzene, which are not currently on the CSRG lists for the downgradient BANS or other treatment systems at RMA. Because DNAPL has been identified as new contamination that constitutes a principal threat, the discovery triggered the application of the CERCLA process. The Final RI/FS Work Plan was issued in March 2010 (TtEC and URS 2010b) and the RI/FS is scheduled to be completed in February 2011. The presumptive remedy is containment and removal to the extent practicable. As of March 2010, the RI conducted to determine the nature and extent of the DNAPL contamination was ongoing. The need to update ARARs for the Lime Basins remedy or downgradient systems will be evaluated in the FS where the compatibility of the DNAPL with the slurry wall will be addressed.

7.4.2 Water Treatment System ARARs, TBCs, and PQL/MRLs

This section addresses ARARs, TBCs, and associated PQLs relevant to the water treatment systems that have changed during this FYR period. The ARAR, TBC, and PQL/MRL changes addressed here will not be used to assess past system performance, but they will be considered for future application. Unless otherwise noted, the ARAR, TBC, and PQL/MRL changes are adopted, as appropriate, by the FYR team; follow-up requirements are documented in Section 9.0.

Water treatment ARARs were identified for the NWBCS, NBCS, Irondale Containment System, OGITS, BANS, CWTF, and LWTS. The ARARs are based on state and federal standards as well as risk-based values. Potential changes in ARARs and TBCs for the different treatment systems are addressed in the following subsections. Table 7.4.2-1 lists all the existing and potential new ARARs for the water treatment systems.

7.4.2.1 PQLs, Certified Reporting Limits, and MRLs

The On-Post ROD identifies the site-specific PQLs as "(c)urrent certified reporting limit or practical quantitation limit readily available from a commercial laboratory." This process for determining PQLs/MRLs was identified as an issue for the compounds for which the PQLs remain above the CSRGs in part because the Army has used an MRL-based approach that differs

from industry practice. The ongoing changes to the RMA analytical programs and advancements in analytical technology suggested that it would be beneficial to follow a standardized procedure to re-evaluate the PQLs. Accordingly, the Army recommended that the approach for establishing site-specific PQLs be revised and that a procedure for site-specific PQLs be developed. Agreement was reached with the Regulatory Agencies that PQL studies will be conducted in accordance with 40 CFR 136 Appendix B and CDPHE PQL guidance for compounds for which MRLs exceed CSRGs.

Table 7.4.2-1. Existing and Potential New ARARs for Water Treatment Systems (Excluding LWTS and CWTF)

Chemical	Existing ARAR (CSRG) (µg/L)	New Potential ARAR (CBSG) (µg/L)	2010 ARAR (CSRG) (µg/L)
Arsenic[1]	50	10	50
Cadmium	10		10
Chloride	250,000		250,000
Fluoride	2,000		2,000
Sulfate	540,000		540,000
Carbon tetrachloride	0.3		0.3
Chloroform[2]	6	3.5	6
1,2 Dichloroethane	0.4		0.4
1,2 Dichloropropane	0.52		0.52
Dibromochloropropane	0.2		0.2
Dieldrin	0.002		0.002
Hexachlorocyclopentadiene	42		42
Methylene chloride	4.7		4.7
NDMA[3]	0.00069		0.00069
Tetrachloroethylene	5		5
1,1,2-Trichloroethane	2.8		2.8
Vinyl chloride	2		2

Notes:

[1] EPA promulgated a new arsenic MCL of 10 µg/L on January 25, 2010. Risk is within the acceptable risk range for the existing ARAR (see Table 7.4.2-4); arsenic CSRG for the NBCS, NWBCS, and OGITS is 2.35 µg/L.

[2] The latest review of the 2009 CDPHE groundwater standard continues to be based on a technical error (5 Code of Colorado Regulations 1002-41, 27 CR 12, amended October 13, 2009, effective November 30, 2009). The original CSRG of 6 µg/L was retained for the 2010 FYRR because the EPA has determined that chloroform is not carcinogenic in humans at low doses. Accordingly, there is no adverse impact on protectiveness from use of this earlier CBSG value of 6 µg/L for chloroform.

[3] The CSRG of 0.00069 µg/L for NDMA, which is the current CBSG, represents a change from the ROD CSRG of 0.007 µg/L, which was a risk-based level from Integrated Risk Information System (OHEA-EPA 1995).

The PQL Study Work Plan (TtEC 2009w) for establishing PQLs for aldrin, dieldrin, and NDMA was finalized in November 2009 in accordance with state PQL guidance (CDPHE 2008) and the study was conducted in January 2010. The PQL values resulting from the PQL study will be

reported in a PQL study report and the change will be documented in a RMA decision document planned for issuance in 2011. Because establishment of PQLs for these analytes was an issue in the 2005 FYRR, and the project was not completed at the end of the 2005–2010 review period, so extension has been identified as a continuing issue in Section 8 of this report.

The CSRG of 0.03 µg/L for chlordane was achieved from 1998 through 2008. The gamma-chlordane method was recertified in May 2008 and the method could only be certified at 0.039 µg/L, which exceeds the CSRG. As a result, the potential impact of the elevated MRL during the latter part of the FYR period is identified as an issue in Section 8.0. The gamma-chlordane method is scheduled for recertification in May 2011. During the time that the chlordane CSRG was met (1998 through 2008), there were no chlordane detections in the OGITS plant compliance samples.

The updated PQLs for each of the water treatment systems are presented in Table 7.4.2-2.

Table 7.4.2-2. Updated PQLs for Water Treatment Systems

Chemical	Quantitation Limit	CSRG (µg/L)	2005 Quantitation Limit (µg/L)	2010 Quantitation Limit (µg/L)
NWBCS				
Dieldrin	PQL	0.002	0.05	0.05
NDMA	PQL	0.00069	0.033	0.033
NBCS				
Aldrin	PQL	0.002	0.037	0.037
Dieldrin	PQL	0.002	0.05	0.05
NDMA	PQL	0.00069	0.033	0.033
OGITS				
Aldrin	PQL	0.002	0.037	0.037
Chlordane	PQL	0.03	0.012	0.039[3]
Dieldrin	PQL	0.002	0.05	0.05
NDMA	PQL	0.00069	0.033	0.033
BANCS				
Dieldrin	PQL	0.002	0.1	0.05
CWTF[1]				
Aldrin	Colorado PQL	0.002	0.1	0.1
Carbon Tetrachloride	System-Specific PQL	0.3	1.0	1.0
DDE	Colorado PQL	0.1	0.1	0.1
1,2-Dichloroethane	System-Specific PQL	0.4	1.1	1.1
Dieldrin	System-Specific PQL	0.002	0.1	0.1
Vinyl Chloride	Colorado PQL	2	2	2

Table 7.4.2-2. Updated PQLs for Water Treatment Systems (Continued)

Chemical	Quantitation Limit	CSRG (µg/L)	2005 Quantitation Limit (µg/L)	2010 Quantitation Limit (µg/L)
LWTS[1]				
Mercury	Colorado PQL	0.01	No Colorado PQL listed, MRL = 0.2[2]	No Colorado PQL listed, MRL = 0.23[2]
Aldrin	Colorado PQL	0.000049	0.1	0.1
Acenaphthylene	Colorado PQL	0.0028	10	10
Atrazine	Colorado PQL	3	1	1
Benzo(a)anthracene	Colorado PQL	0.0038	10	10
Benzo(a)pyrene	Colorado PQL	0.0038	0.2	0.2
Benzo(k)fluoranthene	Colorado PQL	0.0038	10	10
3,4–Benzofluoranthene	Colorado PQL	0.0044	No Colorado PQL listed, MRL= 10[2]	No Colorado PQL listed, MRL = 10[2]
bis(2-chloroethyl) ether	Colorado PQL	0.03	1.0	1.0
Carbon Tetrachloride	Colorado PQL	0.23	1	1
Chlordane	Colorado PQL	0.0008	1	1
Chrysene	Colorado PQL	0.0038	10	10
DDD	Colorado PQL	0.00031	0.1	0.1
DDE	Colorado PQL	0.00022	0.1	0.1
DDT	Colorado PQL	0.00022	0.1	0.1
Dibenzo(a,h)anthracene	Colorado PQL	0.0038	10	10
Dibromochloropropane	Colorado PQL	0.2	0.5	0.5
1,2–Dichloroethane	Colorado PQL	0.38	1	1
1,1-Dichloroethene	Colorado PQL	7	1	1
2,4–Dichlorophenol	Colorado PQL	21	50	50
1,2–Dichloropropane	Colorado PQL	0.50	1	1
Dieldrin	Colorado PQL	0.000052	0.1	0.1
Endosulfan, Alpha	Colorado PQL	0.056	0.1	0.1
Endrin	Colorado PQL	0.036	0.1	0.1
Heptachlor	Colorado PQL	0.000078	0.05	0.05
Heptachlor Epoxide	Colorado PQL	0.000039	0.05	0.05
Hexachlorobutadiene	Colorado PQL	0.44	10	10
Hexachloroethane	Colorado PQL	0.4	10	10
Indeno(1,2,3-cd)pyrene	Colorado PQL	0.0038	10	10
Malathion	Colorado PQL	0.1	Colorado PQL = 0.2 by gas chromato-graph	Colorado PQL = 0.2 by gas chromato-graph
Methoxychlor	Colorado PQL	0.03	0.5	0.5
NDMA	Colorado PQL	0.00069	10	10

Table 7.4.2-2. Updated PQLs for Water Treatment Systems (Concluded)

Chemical	Quantitation Limit	CSRG (µg/L)	2005 Quantitation Limit (µg/L)	2010 Quantitation Limit (µg/L)
Parathion	Colorado PQL	0.013	No Colorado PQL listed, MRL = 0.259[2]	No Colorado PQL listed, MRL = 0.259[2]
Pentachlorophenol	Colorado PQL	0.27	1	1
1,1,2,2-Tetrachloroethane	Colorado PQL	0.17	1	1
Tetrachloroethylene	Colorado PQL	0.69	1	1
Vinyl Chloride	Colorado PQL	0.023	2	2

Notes:

[1] Colorado PQL values established in the previous PQL guidance document will be used until the LWTS and CWTF are shut down permanently in 2010.

[2] MRL used because no Colorado PQL was available.

[3] The MRL for gamma-chlordane was 0.012 µg/L in 2005 but was changed to 0.039 µg/L in 2008. The method will be recertified in 2011.

7.4.2.2 Water ARARs

There was only one potential ARAR change since the last FYR that is relevant to the water treatment systems: the maximum contaminant level (MCL) and CBSG for arsenic has been reduced from 50 µg/L to 10 µg/L.

As shown in Table 7.4.2-3, a change in the CSRGs to the new CBSG for arsenic is not required because the new requirements do not result in risk outside the acceptable risk range of 1×10^{-4} to 1×10^{-6} for carcinogens and a hazard index less than 1 for non-carcinogens. Consistent with 40 CFR 300.430(f)(1)(ii)(B)(1), ARARs modified after ROD signature do not have to be attained unless necessary to ensure the remedy is protective of human health and the environment.

Table 7.4.2-3. Risk Evaluation for Potential New ARAR

Compound	Existing ARAR or Health-Based Concentration (µg/L)	Potential New ARAR (µg/L)	Risk at Existing ARAR or Health-Based Concentration using new ARAR risk calculation[1]	Existing ARAR Remains within acceptable risk range?
Arsenic	50	10	1×10^{-6} to 1.9×10^{-5}	Yes

Notes:

[1] The CSRG for the OGITS is 2.35 µg/L and the ARAR for the Basin A Neck System is 50 µg/L.

No other potential ARAR changes were identified as a part of this review.

Landfill Wastewater Treatment System

The LWTS is no longer operational and is scheduled for demolition in 2010. Therefore, no evaluation of potential revisions to LWTS ARARs was conducted for this FYR.

7.4.2.3 Groundwater TBCs

There were no reported changes to groundwater TBCs.

7.4.3 Air ARARs and TBCs

No air ARAR changes were identified over the FYR period that affected the protectiveness of the RMA remedy. The TBCs for the RMA site-wide air criteria were updated, agreed upon, and adopted yearly as documented in the Interactive Comprehensive Air Pathway Analysis. During the FYR period, changes to the TBCs for the chronic carcinogenic and chronic noncarcinogenic criteria were noted. No TBC changes were noted for the acute air criteria.

For the chronic carcinogenic criteria, updates to cancer slope factors published in Integrated Risk Information System and toxicity values documented by EPA Region 3 have resulted in changes to the TBC-based air criteria for two chemicals. These changes are listed in Table 7.4.3-1. For the chronic noncarcinogenic criteria, updates to the inhalation reference doses and reference concentrations are documented in Integrated Risk Information System.

Table 7.4.3-1. 2010 FYRR Toxicity Factor Evaluation

Chemical	Previous Cancer Slope Factor	Revised Cancer Slope Factor	Source
Carbon tetrachloride	Oral—0.13 mg/kg-day^{-1}	Oral—0.07 mg/kg/day^{-1}	IRIS 2010
Dibromochloropropane	Oral—1.4 mg/kg-day^{-1} Inhalation—0.694 mg/m^3	Oral—0.8 mg/kg-day^{-1} Inhalation—6.0 mg/m^3	EPA 2006b

In 2009, the EPA released new risk assessment guidance for Superfund sites (EPA 2009b) that replaced inhalation cancer slope factors with inhalation unit risks and inhalation reference doses with reference concentrations. The new guidance simplifies the calculation of cancer risk estimates by including adjustments for early-life risk in the derivation of the toxicity value. The inhalation unit risk and reference concentrations used to estimate potential cancer risks in the air monitoring program are listed in the Table 12.2-1 of the Air MCR. Generally, the effect of the supplemental EPA guidance was to lower cancer risk estimates by approximately 40 percent and chronic noncancer risks by a factor of two or more. However, this change in EPA guidance had no impact on the protectiveness of the remedy, since cumulative risks were within the acceptable risk range using either EPA risk assessment method.

7.4.4 Soil ARARs and TBCs

No changes to chemical-specific ARARs for soils were noted. Similarly, no changes to risk-based chemical specific TBCs (e.g., cancer potency factors of reference doses) in the Integrated Risk Information System for RMA soil COCs were noted beyond the changes to carbon tetrachloride and DBCP oral slope factors discussed in Section 7.4.3.

7.4.5 Other Media ARARs and TBCs

This section addresses ARARs and TBCs for all other chemical-, location-, and action-specific requirements beyond those listed in Sections 7.4.2 through 7.4.4 above.

Consistent with the federal RCRA regulations, on May 15, 2007, the Colorado RCRA regulations were revised to allow weekly inspections of hazardous waste tank systems that utilize leak detection systems to alert facility personnel to leaks. Prior to this rule, tank inspections were required each operating day. At the Leachate Containment Loadout System building, a leak detection system in the sumps, combined with an automatic call out system, allows real time notification of leaks. For that reason, weekly inspections will be conducted in accordance with this new rule.

No other ARAR changes were identified that could potentially affect the protectiveness of the remedy.

7.4.6 Changes in Exposure Assessment Variables

7.4.6.1 Demographics and Associated Exposure Scenarios

The demographics and associated exposure scenarios considered in the On-Post and Off-Post OU have not changed significantly since the signing of the RODs. The physical characteristics of the site (climate, vegetation, hydrology, and surface water) have remained relatively unchanged. Populations on and near the site have not changed significantly. Activity patterns and the presence of sensitive subpopulations have likewise not changed notably. While residential land development has occurred north of RMA during the FYR period, this does not alter the exposure scenario assumptions made in the RODs.

Exposure pathways were evaluated for contaminants in both OUs. The mechanisms of release in the On-Post OU and the Off-Post OU have not changed. Monitoring data described in this report indicate that no adverse changes in exposure concentrations were discovered. In most cases, concentrations have generally decreased, resulting in less risk over time. In the On-Post OU this decrease can be primarily attributed to the removal of source areas, while in the Off-Post OU the decrease can be attributed to effective groundwater intercept and treatment systems, as well as natural attenuation.

7.4.6.2 Seasonal Worker Use of RMA Bunkhouse

In 2009, the USFWS began using a trailer located in the administrative area of RMA as a bunkhouse for seasonal workers. Because occupational residential use on RMA was not specifically addressed in the FFA or the ROD, the USFWS requested a qualitative risk assessment from the RVO for this use in 2009, prior to allowing the seasonal workers to reside in the bunkhouse. This qualitative risk assessment, based in large part on results from the previous RMA baseline risk assessment (Ebasco 1994), identified no unacceptable potential health risks for the Biological Worker in the bunkhouse area (Klingensmith 2009). The 2009 qualitative risk assessment was an internal document within the RVO and was not provided for Regulatory Agency review. Occupational residential use was therefore approved by the RVO.

During the preparation of the 2010 Five-Year Review Report, the Regulatory Agencies have requested, and the RVO has agreed to perform, a quantitative risk assessment to provide additional information regarding the occupational residential exposure scenario before the 2012 field season. The quantitative risk assessment is identified in Section 9.0 as an issue for follow-up in the next Five-Year Review.

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

7.4.7 Changes in Toxicity Assessment Variables

There were changes in toxicity criteria for carbon tetrachloride and DBCP since the previous FYR. Specifically, the cancer slope factors for carbon tetrachloride and DBCP were revised as shown in Table 7.4.3-1. The oral cancer slope factors for both carbon tetrachloride and DBCP decreased, so there was no adverse impact on protectiveness for any aspect of the RMA remedy for the oral exposure route. The inhalation unit risk for DBCP increased by a factor of 10, but as discussed in Section 7.4.4, this increased potency did not result in hypothetical cancer risk estimates outside of the acceptable risk range (see Section 6.3.4).

In addition, CDPHE established a groundwater standard for 1,4-dioxane of 6.1 µg/l through March 21, 2012, and 3.2 µg/L from March 22, 2012. Although the 1,4-dioxane CBSG has not been identified as an ARAR for RMA, there is a small possibility that 1,4-dioxane may have been present in RMA groundwater. It was used as a stabilizer for 1,1,1-trichloroethane, an RMA analyte that has been detected at low concentrations in some wells on RMA. The need to evaluate whether 1,4-dioxane is present in RMA groundwater and should be included on the list of ARARs is identified as an issue in Section 8.0. As a follow-up action, existing and historical information, as well as additional groundwater samples, will be evaluated to determine whether 1,4-dioxane should be added to the RMA ARAR list.

7.4.8 Changes in Risk Assessment Methods

7.4.8.1 Mutagenic Carcinogens

There was a change in risk assessment methodology for mutagenic carcinogens made by the EPA to account for increased potential cancer risk from childhood exposure to these types of carcinogens. For this reason, the EPA now requires use of age-dependent adjustment factors for DBCP (EPA 2005). This change in methodology caused no change in the ARAR or CSRG for DBCP and the increased slope factor did not result in hypothetical cancer risk estimates outside of the acceptable risk range for the air monitoring program. There were no other changes in risk assessment methods or assumptions since the last FYR.

7.4.8.2 Vapor Intrusion

EPA performed a formal evaluation of the vapor intrusion pathway for off-post groundwater in 2004 and concluded that there were no unacceptable health risks from this pathway (EPA 2004).

The RVO has informally evaluated the vapor intrusion issue for on-post groundwater at RMA and concluded that vapor intrusion is not a pathway of concern for exposure to RMA contaminants. The only VOC-containing groundwater plume that is in the vicinity of public buildings is under the RMA Administration Area, which includes Buildings 112, 112A, 120, 121, 124, 128, 128A, 129, 130, 132, 133, 180, 181, NID35-1, NID35-2, and NID35-3. The only VOC contained in this plume is chloroform. The most recent chloroform concentration measured in this plume was 3.1 µg/L (USGS 1997). This concentration is well below the screening level contained in the vapor intrusion guidance document (80 µg/L; EPA 2002) and, as per the guidance, no further evaluation is necessary. The vapor intrusion pathway, therefore, is not a pathway of concern at RMA and no further follow-up action is required.

7.4.9 Worker Exposure Standards

Although worker exposure standards do not meet the definition of ARARs, these standards are included in the ROD as independently applicable requirements. Because they are not ARARs, a formal review is not required during the FYR process. However, a few isolated changes in worker exposure standards from the previous FYR were identified (e.g., arsenic, cadmium, and chromium). These changes had no effect on protectiveness of the remedy because they were automatically incorporated into worker protection and monitoring programs by the PMC and its subcontractors as they were promulgated by the Occupational Safety and Health Administration, NIOSH, or American Conference of Industrial Hygienists. These standards will not be reviewed in future FYRs.

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

7.5.1 Discovery of Non-Aqueous Phase Liquids in Groundwater

The discovery of DNAPL in the Lime Basins Area and discovery of benzene LNAPL in the South Tank Farm area during this FYR could call into question the protectiveness of the remedy. The August 2009 detection of DNAPL in Lime Basins dewatering wells indicated the potential presence of DNAPL. Subsequent sampling confirmed that DNAPL composed primarily of 1,2-dichlorobenzene and 1,4-dichlorobenzene was present in two of the six dewatering wells. Because DNAPL was identified as previously unreported contamination that could constitute a principal threat, the discovery triggered the application of the CERCLA process and performance of an RI/FS. The Remedial Investigation Summary Report summarizes the remedial investigation component of the RI/FS.

The presence of benzene contamination in the South Tank Farm area was documented during the RI, but LNAPL that was exclusively benzene had not previously been detected in recoverable quantities. The discovery of the benzene LNAPL does not adversely impact the protectiveness of the remedy because the benzene plume has been shown to be at steady state or receding, and is contained by biodegradation that has been confirmed and will continue to be verified through future monitoring. The LNAPL was found in the central portion of the South Tank Farm benzene plume that also has been shown to be extremely stable or receding. Additional removal of contaminant mass after the groundwater mass removal project ends in 2010 is unnecessary because of natural attenuation of the plume, and it would not benefit the performance of any boundary control system.

7.6 Technical Assessment Summary

According to the data reviewed, the documents reviewed, and the site inspections, the remedy is functioning as intended by the ROD and as modified by the ROD amendments, ESDs, and other administrative changes. There have been no changes in the physical conditions of the site that would affect current or future protectiveness of the remedy. Risk-based site evaluation criteria for soil presented in the ROD are being met. There have been no changes in the toxicity factors for the COCs that were used in the baseline risk assessment, and there have been no changes to the standardized risk assessment methodology that could affect the protectiveness of the remedy. There is no other information that calls into question the protectiveness of the remedy.

8.0 Issues

As stated in Section 5.2, the EPA FYR guidance identifies FYR issues as "all issues that currently prevent the response action from being protective, or may do so in the future" and "early indicators of potential remedy problems." This section identifies issues that meet these criteria in that they had not been addressed at the end of the FYR period. One-time problems and potential issues that occurred, but were addressed during the FYR period, are addressed as "events" in Sections 4 and 7 of this report.

Table 8.0-1. Issues Identified and Effects on Current or Future Protectiveness

Issue	Description	Currently Affects Protectiveness?	Affects Future Protectiveness?
1. DNAPL Discovery	Presence of DNAPL in the Lime Basins area.	No	No
2. Land Use Controls:	1) Annual monitoring and reporting not performed as required. 2) Markers installed during remedy activities along the abandoned sanitary sewer were damaged or missing. 3) Commerce City Prairie Gateway PUD includes "(p)ublic gardening and similar cultivation of land, nursery, and supplementary to the primary public use" for a parcel of the Prairie Gateway, which appears inconsistent with the land use restrictions in place.	No	No
3. Exposed Sanitary Sewer Pipe	Exposed section of pipe was observed in Section 35.	No	No
4. Regulatory Agency Notification	Lack of notification for events associated with HWL groundwater monitoring, ELF LDS monitoring, and surface water monitoring.	No	No
5. Gamma-Chlordane MRL	The gamma-chlordane method was recertified in 2008 and the new method could no longer achieve the CSRG of 0.03 µg/L.	No	No
6. Establishing Site-Specific PQLs	Establishing site-specific PQLs remains a continuing issue for the next FYR period as the PQL Study Report was not finalized and new PQL values were not established at the end of the 2005–2010 FYR period.	No	No

Table 8.0-1. Issues Identified and Effects on Current or Future Protectiveness (Concluded)

Issue	Description	Currently Affects Protectiveness?	Affects Future Protectiveness?
7. Potential Need to Include 1,4-Dioxane CBSG as ARAR	Although 1,4-dioxane has been a constituent of TCA wastes for decades, recent improvements to analytical methods have allowed its detection in the parts per billion range beginning in 1997. Analysis of 1,4-dioxane often must be specifically requested. The common practice of analyzing by a limited list of available methods for regulatory compliance has precluded detection of 1,4-dioxane. Although 1,1,1-TCA has been detected occasionally in RMA groundwater, the detections have been very limited in extent and very low in concentration, as is the case at the present time.	No	No
8. Seasonal Worker Residential Use	USFWS began providing temporary on-post housing for seasonal workers in 2009. Occupational residential use of RMA was not specifically addressed in the ROD, and a quantitative risk assessment of the potential health risks for this use was not performed.	No	No

8.1 Lime Basins DNAPL

DNAPL consisting of 1,2-dichlorobenzene and 1,4-dichlorobenzene was discovered in Lime Basins dewatering wells in August 2009. This finding constituted new principal threat contamination that requires further investigation according to CERCLA. Although potential remedial actions are being evaluated, there is no indication that protectiveness of the overall remedy has been compromised.

8.2 Land Use Control Monitoring

Pursuant to an amendment to the On-Post ROD completed in October 2005, annual monitoring of land use controls is required to ensure they remain effective and are protective of human health and the environment. The ROD amendment also specifies that results of the monitoring will be provided in an annual monitoring report. Land use control monitoring reports were not issued for FY06, FY07, or FY08. In January 2010, a monitoring report was issued for FY09. Subsequent discussions related to this first report resulted in a decision to modify the report to include discussion of land use controls for FY06–FY09 and the report was reissued in June 2010 (TtEC 2010f).

As a result of monitoring activities, two issues related to land use controls were identified that required corrective action. Several markers installed during remedy activities along the abandoned sanitary sewer were damaged or missing. Also, review of the Commerce City Prairie Gateway PUD revealed a use-by-right included as "(p)ublic gardening and similar cultivation of

land, nursery, and supplementary to the primary public use" for a parcel of the Prairie Gateway. This use appears inconsistent with the land use restrictions delineated in the Refuge Act, which prohibits non-remedy agricultural activities. However, the Commerce City Planning Division has stated that it believes the use would be interpreted consistent with the FFA and Refuge Act restrictions and that this use is not expected to affect protectiveness. In addition, the PUD process includes notification to adjacent landowners of proposed amendments to the PUD, although the Army has not been included in the notification list.

8.3 Exposed Sanitary Sewer Pipe

During the land use control inspection of the sanitary sewer markers, an exposed section of pipe was observed in Section 35. Although the sanitary sewer remedy only requires the plugging of manholes, the intent is to prevent access to the sewer and eliminate the sewer as a potential migration pathway for contaminated groundwater. The exposed section of the sewer is not consistent with the ROD requirements and could limit the effectiveness of the remedy. The FY09 land use control monitoring report included a recommendation to evaluate the exposed pipe and determine appropriate action. This evaluation was completed and the pipe was plugged and buried in September 2010.

8.4 Regulatory Agency Notification

There were several instances of poor communication with the Regulatory Agencies during the FYR period. Regulatory Agency notification was not made for events associated with HWL groundwater monitoring (Section 7.3.2), ELF LDS monitoring (Section 7.3.5), and surface water monitoring (Section 7.2.3.5). These events were instances of noncomformance with site plans; however, notification requirements were not well defined and the Regulatory Agencies were not notified in a timely fashion.

8.5 Chlordane PQL

Historically, analytical results for the OGITS system show chlordane has not been present above the CSRG. Chlordane results are obtained by adding the alpha and gamma isomers together; there is no single analytical method that can be used to test environmental samples. The gamma-chlordane MRL changed to a higher value during this FYR, in 2008, when the method was recertified. Currently the MRL for gamma-chlordane is above the CSRG and gamma-chlordane was not included in the new PQL study. Since the reported values continued to be below the MRL, the impact of the higher MRL on compliance reporting was not discovered until this review.

8.6 Establishing Site-Specific PQLs

The 2005 FYRR identified the following issue regarding establishing site-specific PQLs for groundwater contaminants for which the CSRGs cannot be measured with available analytical methods:

> *The On-Post ROD identifies the site-specific PQL as "(c)urrent certified reporting limit or practical quantitation limit readily available from a commercial laboratory." The existing process for determining PQLs/MRLs has been identified as an issue for the compounds for which PQLs remain above the CSRGs/CBSGs*

> *in part because Army has used a MRL-based approach that differs from industry practice. The ongoing changes to the Army analytical programs and recent advancements in analytical technology suggest it would be beneficial to follow a standardized procedure to evaluate the analytical capabilities of several laboratories. Therefore, it has been determined necessary, during the next FYR period, to re-evaluate the current laboratory procedures and the procedure for establishing site-specific PQLs.*

The 2005 FYR concluded:

> *The Army recommends that the approach for establishing site-specific PQLs be revised and that a procedure for site-specific PQLs be developed. As of October 26, 2006, agreement has been reached with the Regulatory Agencies that PQL studies will be conducted in accordance with 40 CFR 136 Appendix B and soon-to-be published Colorado State PQL Guidance for compounds for which MRLs exceed CSRGs as outlined in decision document DD-RMAPQL-11. The site-specific PQLs determined from these studies will be implemented at RMA.*

The Procedure for establishing site-specific PQLs was finalized in 2008 (*RVO SOP: RVOP.015.P* 2008). The PQL Work Plan was finalized in December 2009 in accordance with state PQL guidance (CDPHE 2008) and the PQL study was conducted in early 2010. However, "establishing site-specific PQLs" remains a continuing issue for the next FYR period as the PQL Study Report was not finalized and the new PQL values were not established at the end of the 2005–2010 FYR period.

8.7 Potential Inclusion of 1,4-Dioxane in RMA ARARs

The need to determine whether the 1,4-dioxane CBSG should be included in the RMA ARARs has been identified as a FYR issue. In recent years, regulators have become aware that 1,4-dioxane is likely to be present at sites where 1,1,1-trichloroethane (1,1,1-TCA, methyl chloroform) is a contaminant. Although 1,4-dioxane has been a constituent of TCA wastes for decades, recent improvements to analytical methods have allowed its detection in the parts per billion range beginning in 1997. Analysis of 1,4-dioxane often must be specifically requested. The common practice of analyzing by a limited list of available methods for regulatory compliance has precluded detection of 1,4-dioxane. Although 1,1,1-TCA has been detected occasionally in RMA groundwater, the detections have been very limited in extent and very low in concentration, as is the case at the present time. Accordingly, 1,4-dioxane levels are likely to be well below detection limits and therefore unlikely to be of any potential public health concern**.** Moreover, because there is no complete pathway for exposure to RMA groundwater contamination, there is no expected impact on remedy protectiveness even if 1,4-dioxane is present.

8.8 Seasonal Worker Residential Use

In 2009, the USFWS informed the Regulatory Agencies that it planned to provide on-site housing for a small number of seasonal USFWS workers. Because occupational residential use on RMA was not specifically addressed in the FFA or the ROD, the USFWS requested a qualitative risk assessment from the RVO for this use in 2009, prior to allowing the seasonal

workers to reside in the bunkhouse. This qualitative risk assessment, based in large part on results from the previous RMA baseline risk assessment (Ebasco 1994), identified no unacceptable potential health risks for the Biological Worker in the bunkhouse area (Klingensmith 2009). The 2009 qualitative risk assessment was an internal document within the RVO and was not provided for Regulatory Agency review. Occupational residential use was therefore approved by the RVO. The Regulatory Agencies have requested, and the RVO has agreed to perform, a quantitative risk assessment to provide additional information regarding the occupational residential exposure scenario before the 2012 field season.

8.9 Other Unresolved Concerns

No other unresolved concerns from CDPHE, TCHD, the SSAB, RAB, or other interested parties were identified.

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9.0 Recommendations and Follow-Up Actions

This section presents recommendation on how the issues identified in Section 8 will be addressed. The recommendations and associated milestones are summarized in Table 9.0-1.

Table 9.0-1. Recommendations and Follow-Up Actions

Issue	Recommendations/Follow-Up Actions	Operable Unit	Milestone
1. Presence of DNAPL in Lime Basins	Perform RI/FS to recommend remedy; prepare CECRLA Decision Document for remedy selection.	On-post	May 2011
2. Land Use Controls	Ensure that land use controls are monitored annually and that annual reports are issued. Implement the following corrective actions for the two specific issues identified during the FY09 land use control monitoring: • Repair or replace damaged and missing markers along the abandoned sanitary sewer line. • Obtain clarification from the Commerce City Planning Division on the use-by-right included in the Prairie Gateway PUD. • Request that the Army be included on the notification list for future changes to the PUD to improve notice of upcoming amendments.	On-post and Off-post	December 2010
3. Exposed Sanitary Sewer Pipe	Recommendation to evaluate the exposed pipe and determine appropriate action. Pipe plugged and buried as a result.	On-post	September 2010
4. Regulatory Agency Notification	Identify specific notification requirements in site plans.	On-post and Off-post	September 2011
5. Chlordane PQL	Recertify the method to meet the CSRG of 0.03 µg/L.	Off-post	May 2011
6. Establishing Site-Specific PQLs	Complete PQL Study Report and establish new PQL values for NDMA, aldrin, and dieldrin based on regulatory approval.	On-post and Off-post	December 2011
7. Potential Inclusion of 1,4-Dioxane in RMA ARARs	Evaluate existing and historical information, as well as additional groundwater samples to determine whether 1,4-dioxane should be added to the RMA ARAR list. Prepare a technical memorandum to document evaluation and decision.	On-post and Off-post	December 2012
8. Seasonal Worker Residential Use	Perform and prepare a quantitative risk assessment before the 2012 field season to provide additional information to the Regulatory Agencies regarding the occupational residential use exposure scenario.	On-post	March 2012

9.1 Lime Basins DNAPL

Upon the discovery of the DNAPL, the RVO notified the Regulatory Agencies and initiated a CERCLA process to assess the problem and evaluate potential remedies.

The basis for the regulatory approach to address the Lime Basins DNAPL is that portions of RMA, including all of Section 36, remain part of the NPL site. Administrative processes and cleanup activities are subject to the CERCLA, as amended by the Superfund Amendments and Reauthorization Act, the RMA FFA, and the On-Post ROD. The RVO is, therefore, conducting the DNAPL evaluation using an RI/FS approach.

The recommended approach, which is documented in the Lime Basins DNAPL RI/FS Work Plan (TtEC and URS 2010b), includes the following elements:

- Prepare RI/FS Work Plan.
- Execute RI activities.
- Prepare RI Summary Report.
- Prepare RMA Committee Decision Document.
- Prepare Supplemental RI Work Plan (if required).
- Execute Supplemental RI Activities (if required).
- Prepare Supplemental RI Summary Report (if required).
- Prepare RI/FS Report.
- Prepare RMA Committee Decision Document.
- Prepare CERCLA Decision Document.

The Final RI/FS Work Plan was issued in April 2010 and the RI is underway. The FS report and the CERCLA Decision Document are scheduled for completion in early 2011.

9.2 Land Use Control Monitoring

The land use control monitoring report issued for FY09 is being revised to include FY06 through FY09 to capture monitoring and reporting requirements in effect since the 2005 ROD amendment. The Army will ensure that land use controls continue to be monitored annually and that annual reports are issued as required.

The Army will repair or replace damaged and missing markers along the abandoned sanitary sewer line.

The Army will obtain clarification from the Commerce City Planning Division on the use-by-right included in the Prairie Gateway PUD. In addition, the Army will request to be included on the notification list for future changes to the PUD to improve notice of upcoming amendments. The Army has initiated discussions with the Planning Division regarding clarification of this issue. In September 2010, the Army transmitted a letter requesting clarification and also requesting inclusion on the notification list.

9.3 Exposed Sanitary Sewer Pipe

The FY09 land use control monitoring report (TtEC 2010f) included a recommendation to evaluate the exposed pipe and determine appropriate action. This evaluation was completed and the pipe was plugged and buried in September 2010.

9.4 Regulatory Agency Notification

Communication with the Regulatory Agencies could be improved by identifying well-defined parameters for notification and consultation in site plans. Plans completed during this FYR period have incorporated this concept by including specific notification triggers and consultation requirements based on potential events. Plans completed with notification requirements include:

- HWL Post-Closure Plan
- RCRA-Equivalent, 2-, and 3-Foot Covers Long-Term Care Plan
- Long-Term Monitoring Plan for Groundwater and Surface Water

Finalization of additional plans or revision to the existing plans will continue to include notification triggers to ensure that the Regulatory Agencies are informed of events related to RMA remediation. Additional plans requiring incorporation of notification triggers include:

- ELF Post-Closure Plan
- Basin F Post-Closure Plan
- Land Use Control Plan

9.5 Chlordane PQL

The gamma-chlordane MRL will be addressed as part of the laboratory recertification process in 2011. The new MRL is expected to be below the CSRG of 0.03 µg/L.

9.6 Establishing Site-Specific PQLs

The Army recommends that the PQL Study Report be completed and the PQL values for NDMA, aldrin, and dieldrin be approved and established in 2011.

9.7 Evaluation of 1,4-Dioxane as a Potential RMA ARAR

To confirm that 1,4-dioxane does not pose an unacceptable human health risk in RMA groundwater, existing and historical information, as well as potential additional groundwater samples, will be evaluated by the RVO and Regulatory Agencies to determine whether the 1,4-dioxane CBSG should be added to the RMA list of ARARs. A technical memorandum will be prepared during the next five-year review period to document this evaluation and the resulting decision.

9.8 Seasonal Worker Residential Use

To provide additional information regarding occupational residential use by USFWS seasonal employees at RMA, a human health risk assessment will be performed prior to the 2012 field season.

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10.0 Protectiveness Statements

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

10.1 On-Post Operable Unit

The Army concludes that the remedy at the On-Post OU is expected to be protective of human health and the environment upon remedy completion, and in the interim, exposure pathways that could result in unacceptable risks are being controlled. Placement of contaminated soils and debris in the HWL, ELF, and Basin A, which was central to the effective implementation of the remedy, has been completed with engineered cover systems in place. These sites have become part of the containment remedy with specific groundwater monitoring and ongoing cover O&M programs that monitor remedy effectiveness. Fences and signs are maintained around these areas and ICs prohibiting intrusive activities are in place to prevent exposure. All implementation projects are on schedule to be completed in 2010 and are in compliance with all elements of the On-Post ROD. Air, water, and biota monitoring programs are comprehensive in their design and were effective in their implementation during this FYR period. The long-term and operational groundwater and surface water monitoring programs effectively monitor contaminant migration pathways on post and ensure effective operation of the treatment systems as well as track off-post contamination trends. The long-term groundwater and surface water monitoring programs were revised during this FYR period to ensure contaminant migration is being adequately controlled. Risks to human health and the environment are also being controlled by a comprehensive worker protection and access control program and ICs. Monitoring of ICs to ensure protectiveness was implemented during this FYR period. Groundwater contamination is being treated to remediation goals at the RMA boundary as well as on post at the RYCS and BANS and operation and maintenance plans are in place to ensure short-term and long-term protection.

10.2 Off-Post Operable Unit

The Army concludes that the remedy at the Off-Post OU is expected to be protective upon completion or is protective of human health and the environment; in the interim, exposure pathways that could result in unacceptable risks are being controlled. Groundwater contamination is being treated to Off-Post ROD remediation goals at the RMA boundary as well as at the OGITS. Groundwater monitoring plans and system operation and maintenance plans are in place to ensure short-term and long-term protection. The required IC, notifying well permit owners of potential groundwater contamination, has been effective in its implementation.

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11.0 Next Five-Year Review

The FYR for RMA should be conducted in 2015 covering the period April 1, 2010, through March 31, 2015.

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TABLES

Table 2.0-2. RMA Remedial Project Status as of March 31, 2010

#	Project Name	Status	Forecast or Date of Final CCR or MCR EPA Approval and 2010 FYRR Cross Reference
1	Corrective Action Management Unit (CAMU)/Basin A Well Abandonment	Completed	CCR September 30, 1998; discussed in 2000 FYRR.
2	CAMU Soil Remediation	Completed	CCR September 30, 1998; discussed in 2000 FYRR.
	CAMU Soils Remediation Completion and Support	Completed	CCR September 29, 2000; discussed in 2005 FYRR.
3	Construction of Hazardous Waste Landfill Wastewater Treatment Unit	Completed	CCR September 27, 2000; discussed in 2005 FYRR.
4	Construct Hazardous Waste Landfill Cell 1	Completed	CCR September 27, 2000; discussed in 2005 FYRR.
5	Section 26 Human Health Exceedance and Biota Exceedance Soils Removal	Completed	CCR October 17, 2000; discussed in 2005 FYRR. Addendum March 30, 2006; discussed in Sections 4.2.3.1 and 7.3.1.
6	Construct Hazardous Waste Landfill Cell 2	Completed	CCR April 18, 2001; discussed in 2005 FYRR.
7	Operation of Hazardous Waste Landfill Cells 1 and 2	Completed	CCR April 8, 2008; discussed in Sections 4.2.3.2 and 7.3.2.
8	Hazardous Waste Landfill Cap Construction	Under Construction	CCR forecast mid-2010; discussed in Sections 4.2.1.1 and 7.1.1.
9	Landfill Wastewater Treatment Addition of Ion Exchange	Completed	CCR July 17, 2008; discussed in Sections 4.2.3.3 and 7.3.3.
10	Operation of Hazardous Waste Landfill Wastewater Treatment System	Operating	CCR forecast mid 2011; discussed in Sections 4.2.2.1 and 7.2.3.1.
11	Construct Enhanced Hazardous Waste Landfill	Completed	CCR January 29, 2007; discussed in Sections 4.2.3.4 and 7.3.4.
12	Operation of Enhanced Hazardous Waste Landfill	Completed	CCR May 5, 2009; discussed in Sections 4.2.3.5 and 7.3.5.
13	Enhanced Hazardous Waste Landfill Cap Construction	Under Construction	CCR forecast late 2010; discussed in Sections 4.2.1.2 and 7.1.2.
14	Basin A Consolidation and Remediation Area Operations/Subgrade	Completed	CCR September 3, 2009; discussed in Sections 4.2.3.6 and 7.3.6.

- Not Yet Begun
- Under Construction
- Operating
- Completed during this FYR period.
- Completed and Documented in 2000 or 2005 FYRR.

Table 2.0-2. RMA Remedial Project Status as of March 31, 2010 (Continued)

#	Project Name	Status	Forecast or Date of Final CCR or MCR EPA Approval and 2010 FYRR Cross Reference
15	Integrated Cover System, Basin A Consolidation and Remediation Area	Under Construction	CCR Part 1 forecast mid-2010; discussed in Sections 4.2.1.3 and 7.1.3. CCR Part 2 (O&F determination) forecast mid-2015.
16	Sanitary and Chemical Sewer Manhole Plugging Phase I	Completed	CCR September 30, 1998; discussed in 2000 FYRR.
17	Shell Disposal Trenches Slurry Walls (Construction)	Completed	CCR June 8, 2001; discussed in 2005 FYRR.
	Shell Disposal Trenches Slurry Walls (Dewatering)	Operating	Dewatering goals to be evaluated and documented with Shell Disposal Trenches RCRA-Equivalent Cover Construction (#39); discussed in Sections 4.1.1.3 and 7.2.1.1.
	Complex (Army) Disposal Trenches Slurry Walls (Construction)	Completed	CCR July 3, 2001; Addendum September 30, 2002 O&F determination; discussed in 2005 FYRR
	Complex (Army) Disposal Trenches Slurry Walls (Dewatering)	Operating	Dewatering goals to be evaluated and documented with Integrated Cover System Complex (Army) Disposal Trenches Cover (#38); discussed in Sections 4.1.1.3 and 7.2.1.2.
18	Post-ROD Removal Actions for Structures—Administrative Areas Asbestos Remediation Projects	Completed	CCR September 30, 2003; discussed in 2005 FYRR.
	Post-ROD Removal Actions for Structures—Exterior Piping Chemical-Related Activities	Completed	CCR September 30, 1998; discussed in 2000 FYRR.
	Post-ROD Removal Actions for Structures—Interior Building Chemical Related Activities for South Plants	Completed	CCR September 29, 2000; discussed in 2005 FYRR.
19	Toxic Storage Yards Soil Remediation	Completed	CCR June 20, 2000; discussed in 2005 FYRR.
20	Existing (Sanitary) Landfills Remediation Section 1	Completed	CCR February 29, 2000; discussed in 2000 FYRR. Addendum March 30, 2006; discussed in Sections 4.2.3.7 and 7.3.7.
21	Existing (Sanitary) Landfills Remediation Section 4	Completed	CCR May 25, 2000; discussed in 2005 FYRR.

- Not Yet Begun
- Under Construction
- Operating
- Completed during this FYR period.
- Completed and Documented in 2000 or 2005 FYRR.

Table 2.0-2. RMA Remedial Project Status as of March 31, 2010 (Continued)

#	Project Name	Status	Forecast or Date of Final CCR or MCR EPA Approval and 2010 FYRR Cross Reference
22	Existing (Sanitary) Landfills Remediation Section 36	Completed	CCR July 15, 2004; discussed in 2005 FYRR.
	Existing (Sanitary) Landfills Remediation Section 30	Completed	CCR August 16, 2005; discussed in Sections 4.2.3.8 and 7.3.8.
23	Lake Sediments Remediation	Completed	CCR April 20, 2000; discussed in 2005 FYRR.
24	Burial Trenches Soil Remediation Part I	Completed	CCR September 25, 2002; discussed in 2005 FYRR.
	Burial Trenches Soil Remediation Part II	Completed	CCR September 30, 2004; discussed in 2005 FYRR.
25	Munitions (Testing) Soil Remediation Part I	Completed	CCR July 15, 2004; discussed in 2005 FYRR.
	Munitions (Testing) Soil Remediation Parts II–IV	Completed	CCRs—April 8, 2008, March 26, 2008, and May 14, 2009, respectively; discussed in Sections 4.2.3.9 and 7.3.9.
26	Miscellaneous Northern Tier Soil Remediation	Completed	CCR April 20, 2000; discussed in 2005 FYRR. Addendum March 30, 2006; discussed in Sections 4.2.3.10 and 7.3.10.
27	Miscellaneous Southern Tier Soil Remediation	Completed	CCR July 14, 2000; discussed in 2005 FYRR. Addendum March 30, 2006
	Miscellaneous Southern Tier Soil Remediation, Sand Creek Lateral	Completed	CCR September 2, 2008; discussed in Sections 4.2.3.16 and 7.3.17.
28	Bedrock Ridge Extraction System	Operating	Interim CCR September 30, 2008; discussed in Sections 4.1.1.1 and 7.2.1.3; final CCR forecast to be determined.
29	South Plants Structures Demolition and Removal Phase 1	Completed	CCR September 29, 2000; discussed in 2005 FYRR.
	South Plants Structures Demolition and Removal Phase 2	Completed	CCR July 2, 2002; discussed in 2005 FYRR.
30	Miscellaneous RMA Structures Demolition and Removal Phase 1	Completed	CCR September 30, 2002; discussed in 2005 FYRR.
	Miscellaneous RMA Structures Demolition and Removal Phase II	Completed	CCR March 30, 2006; discussed in Sections 4.3.2.1 and 7.3.11.
	Miscellaneous RMA Structures Demolition and Removal Phase III	Completed	CCR December 8, 2009; discussed in Sections 4.3.2.2 and 7.3.11.
	Miscellaneous RMA Structures Demolition and Removal Phase IV	Under Construction	CCR forecast early 2011; discussed in Sections 4.3.1.1 and 7.1.4.

- Not Yet Begun
- Under Construction
- Operating
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Table 2.0-2. RMA Remedial Project Status as of March 31, 2010 (Continued)

#	Project Name	Status	Forecast or Date of Final CCR or MCR EPA Approval and 2010 FYRR Cross Reference
31	Buried M-1 Pits Soil Remediation	Completed	CCR July 18, 2002; discussed in 2005 FYRR.
32	Hex Pit Soil Remediation	Completed	CCR July 21, 2004; discussed in 2005 FYRR.
33	South Plants Balance of Areas and Central Processing Area Soil Remediation Phase 1	Completed	CCR September 24, 2002; discussed in 2005 FYRR.
34	South Plants Balance of Areas and Central Processing Area Soil Remediation Phase 2, Parts 1 and 2	Completed	CCR January 19, 2010; discussed in Sections 4.2.3.11 and 7.3.12.
	Integrated Cover System, South Plants Balance of Areas and Central Processing Area	Under Construction	CCR Part 1 forecast mid-2010, discussed in Sections 4.2.1.3 and 7.1.3. CCR Part 2 (O&F determination) forecast mid-2015.
35	Sanitary Sewer Manhole Plugging Project Phase II	Completed	CCR February 17, 2009; discussed in Sections 4.2.3.12 and 7.3.13.
36	Section 36 Balance of Areas Soil Remediation Parts 1 and 2	Completed	Part 1 CCR May 5, 2009 and Part 2 CCR February 22, 2010; discussed in Sections 4.2.3.13 and 7.3.14.
37	Secondary Basins Soil Remediation, Phase I and II	Completed	CCR July 15, 2004; discussed in 2005 FYRR.
	Secondary Basins Soil Remediation, NCSA-2d (Basin B Drainage Ditch) Contingent Soil Volume	Completed	CCR June 11, 2009; discussed in Sections 4.2.3.14 and 7.3.15.
38	Complex (Army) Disposal Trenches Remediation Subgrade Construction	Completed	CCR July 17, 2008; discussed in Sections 4.2.3.15 and 7.3.16.
	Integrated Cover System, Complex (Army) Disposal Trenches Remediation Cover	Under Construction	CCR Part 1 forecast mid-2010; discussed in Sections 4.2.1.3 and 7.1.3. CCR Part 2 (O&F determination) forecast mid-2015.
39	Shell Disposal Trenches RCRA-Equivalent Cover Construction	Under Construction	CCR January 5, 2009; discussed in Sections 4.2.1.4 and 7.1.5. CCR Part 2 (O&F determination) forecast mid-2013.
	Integrated Cover System, Shell Disposal Trenches 2-foot Soil Covers	Under Construction	CCR Part 1 Forecast mid-2010; discussed in Sections 4.2.1.3 and 7.1.3. CCR Part 2 (O&F determination) forecast mid-2015.

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Table 2.0-2. RMA Remedial Project Status as of March 31, 2010 (Continued)

#	Project Name	Status	Forecast or Date of Final CCR or MCR EPA Approval and 2010 FYRR Cross Reference
40	North Plants Soil Remediation Free Product Removal—pilot	Not yet begun	Pilot study in progress.
41	Section 35 Soil Remediation	Completed	CCR July 15, 2004; discussed in 2005 FYRR.
	Section 35 Soil Remediation, Sand Creek Lateral	Completed	CCR September 2, 2008; discussed in Sections 4.2.3.16 and 7.3.17.
42	North Plants Structure Demolition and Removal	Completed	CCR September 30, 2004; discussed in 2005 FYRR.
43	Basin F Wastepile Remediation	Completed	CCR June 11, 2009; discussed in Sections 4.2.3.17 and 7.3.18.
44	Former Basin F Principal Threat Soil Remediation (formerly known as Former Basin F Solidification)	Completed	CCR July 16, 2009; discussed in Sections 4.2.3.18 and 7.3.19.
45	Basin F/Basin F Exterior Remediation Part 1/Phase I	Completed	CCR September 21, 2006; discussed in Sections 4.2.3.19 and 7.3.20.
	Basin F/Basin F Exterior Remediation Part 1/Phase II—Remaining Biota Soil	Completed	CCR December 8, 2009; discussed in Sections 4.2.3.20 and 7.3.20.
46	Basin F/Basin F Exterior RCRA-Equivalent Cover Construction (Basin F Cover)	Under Construction	CCR Part 1 forecast late 2010; discussed in Sections 4.2.1.5 and 7.1.6. CCR Part 2 (O&F determination) forecast mid-2015.
47	Section 36 Lime Basins Soil Remediation Slurry/Barrier Wall, including Lime Basins Dewatering Wells	Under Construction	CCR Forecast mid-2010; dewatering goals to be evaluated and documented with Integrated Cover System Section 36 Lime Basins Cover; discussed in Sections 4.1.1.3, 4.2.1.6 and 7.1.7.
	Integrated Cover System, Section 36 Lime Basins Cover	Under Construction	CCR Part 1 Forecast mid-2010; discussed in Sections 4.2.1.3 and 7.1.3. CCR Part 2 (O&F determination) forecast mid-2015.
47a	Borrow Areas Operations	Operating	Discussed in Sections 4.2.2.2 and 7.2.3.2.
	Residual Ecological Risk Soil Remediation	Completed	Part 1 CCR March 30, 2006 and Part 2 CCR September 3, 2009; discussed in Sections 4.2.3.21 and 7.3.21.

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Table 2.0-2. RMA Remedial Project Status as of March 31, 2010 (Continued

#	Project Name	Status	Forecast or Date of Final CCR or MCR EPA Approval and 2010 FYRR Cross Reference
48	Site-Wide Biota Monitoring	Operating	MCR forecast mid 2011; discussed in Sections 4.4.1.1 and 7.2.3.3.
49	Site-Wide Air Monitoring	Operating	MCR for Odor Monitoring June 11, 2009, MCR for Air Monitoring April 7, 2010, Addendum for PM10 December 13, 2010; discussed in Sections 4.4.1.2 and 7.2.3.4.
50	Site-Wide Groundwater Monitoring	Operating	Discussed in Sections 6.3.1 and 7.2.3.6.
50a	On-Post Surface Water Quality Monitoring	Operating	MCR forecast mid 2011; discussed in Sections 6.3.2.1 and 7.2.3.5.
50b	On-Post Surface Water Management	Operating	Discussed in Section 6.3.2.2.
50c	Off-Post Surface Water Monitoring	Operating	MCR forecast to be determined; discussed in Sections 6.3.2.3 and 7.2.3.5.
51	Unexploded Ordnance (UXO) Management	Operating	Discussed in Sections 4.4.1.3 and 7.2.3.7.
52	Medical Monitoring Program	Operating	MCR forecast early 2011; discussed in Sections 4.4.3.1 and 7.3.22.
53	Western Tier Parcel (deletion)	Completed	Deletion occurred on January 21, 2003; discussed in 2005 FYRR.
54	Trust Fund	Completed	No CCR required; discussed in 2005 FYRR.
55	South Adams County Water Supply	Completed	No CCR required; discussed in 2000 FYRR.
56	Henderson Distribution	Completed	CCR September 30, 1999; discussed in 2000 FYRR.
57	Confined Flow System Well Closures	Completed	CCR September 27, 2000; discussed in 2005 FYRR.
58	Irondale Containment System Main Well field Treatment Shutdown	Completed	CCR May 21, 2003; discussed in 2005 FYRR.
	Motor Pool Area Extraction System	Operating	CCR forecast mid-2010; discussed in Sections 4.1.1.1 and 7.2.1.4.
	Railyard Containment System	Operating	CCR forecast mid-2016; discussed in Sections 4.1.1.1 and 7.2.1.4.

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Table 2.0-2. RMA Remedial Project Status as of March 31, 2010 (Continued)

#	Project Name	Status	Forecast or Date of Final CCR or MCR EPA Approval and 2010 FYRR Cross Reference
59	North of Basin F Groundwater Plume Remediation System	Completed	CCR September 28, 2005; discussed in 2005 FYRR.
	Basin A Neck System	Operating	CCR forecast to be decided; discussed in Sections 4.1.1.1 and 7.2.1.5.
	Basin A Neck System—Lime Basin Groundwater Treatment Relocation and Basin A Neck Expansion	Under Construction	CCR forecast early 2011; discussed in Sections 4.4.2.1 and 7.1.8.
60	Operation of CERCLA Wastewater Treatment Facility	Operating	CCR for demolition covered under Misc. Structures Phase IV forecast early 2011; discussed in Sections 4.4.1.4 and 7.2.3.8.
60a	South Tank Farm and Lime Basins Mass Removal Project	Operating	CCR forecast mid-2011; discussed in Sections 4.1.1.1 and 7.2.1.8.
61	Northwest Boundary Containment System	Operating	CCR forecast to be decided; discussed in Sections 4.1.1.1 and 7.2.1.6.
62	North Boundary Containment System	Operating	CCR forecast to be decided; discussed in Sections 4.1.1.1 and 7.2.1.7.
63	n-Nitrosodimethylamine (NDMA) Monitoring and Assessment	Completed	CCR September 30, 1998; discussed in 2000 FYRR.
64	South Lakes Plume Management	Completed	ESD finalized March 31, 2006; discussed in 2005 FYRR.
65	Basin F Wastepile Operations and Management	Completed	No CCR; discussed in Sections 4.2.3.22 and 7.3.23.
66	Off-Post Groundwater Intercept and Treatment System (IRA)	Incorporated in RA: see #94	Not applicable.
67	Improvement of North Boundary Containment System and Evaluation of All Existing Boundary Systems (IRA)—North Boundary Containment System Improvements	Incorporated in RA: see #62	Not applicable.
68	Improvement of North Boundary Containment System and Evaluation of All Existing Boundary Systems (IRA)—Irondale Containment System	Incorporated in RA: see #58	Not applicable.

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Table 2.0-2. RMA Remedial Project Status as of March 31, 2010 (Continued)

#	Project Name	Status	Forecast or Date of Final CCR or MCR EPA Approval and 2010 FYRR Cross Reference
69	Improvement of North Boundary Containment System and Evaluation of All Existing Boundary Systems (IRA)—Northwest Boundary Containment System	Incorporated in RA: see #61	Not applicable.
70	Groundwater Intercept and Treatment North of Basin F (IRA)	Incorporated in RA: see #59	Not applicable.
71	Closure of Abandoned Wells at RMA (IRA)	Completed	Completed October 1989; discussed in 2000 FYRR. For additional identified work see #95.
72	Basin A Neck Containment System (IRA)	Incorporated in RA: see #59	Not applicable.
73	Basin F Liquid, Sludge, and Soil Remediation (IRA) Element One, Basin F Wastepile	Incorporated in RA: see #63 and #40	Not applicable.
74	Basin F Liquid, Sludge, and Soil Remediation (IRA) Element Two, Basin F Liquid	Completed	Completed May 1996; discussed in 2000 FYRR.
75	Building 1727 Sump Liquid (IRA)	Completed	Completed November 1987; discussed in 2000 FYRR.
76	Closure of the Hydrazine Facility (IRA)	Completed	Completed July 1992; discussed in 2000 FYRR.
77	Fugitive Dust Control (IRA)	Completed	Completed May 1991; discussed in 2000 FYRR.
78	Sanitary Sewers Remediation (IRA)	Completed	Completed September 1992; discussed in 2000 FYRR.
79	Asbestos Remediation (IRA)	Incorporated in RA: see #18	Not applicable.
80	Remediation of Other Contamination Sources (IRA)—Motor Pool Area, Soil Vapor Extraction	Completed	Completed October 1993; discussed in 2000 FYRR.
81	Remediation of Other Contamination Sources (IRA)—Motor Pool Area, Groundwater Remediation	Completed	Completed October 1993; discussed in 2000 FYRR.

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Table 2.0-2. RMA Remedial Project Status as of March 31, 2010 (Continued)

#	Project Name	Status	Forecast or Date of Final CCR or MCR EPA Approval and 2010 FYRR Cross Reference
82	Remediation of Other Contamination Sources (IRA)—Rail Classification Yard	Incorporated in RA: see #58	Not applicable.
83	Remediation of Other Contamination Sources (IRA)—Lime Settling Basins	Incorporated in RA: see #47	Not applicable.
84	Remediation of Other Contamination Sources (IRA)—South Tank Farm Plume	Completed	Completed October 1993; discussed in 2000 FYRR.
85	Remediation of Other Contamination Sources (IRA)—Army (Complex) Disposal Trenches	Incorporated in RA: see #17, #38, #39, and #50	Not applicable.
86	Remediation of Other Contamination Sources (IRA)—Shell Section 36 Trenches	Incorporated in RA: see #17, #38, #39, and #50	Not applicable.
87	Remediation of Other Contamination Sources (IRA)—M-1 Settling Basins	Incorporated in RA: see #31	Not applicable.
88	Pretreatment of CERCLA Liquid Wastes (IRA)—Wastewater Treatment System	Incorporated in RA: see #60	Not applicable.
89	Pretreatment of CERCLA Liquid Wastes (IRA)— Element One, Waste Management	Incorporated in RA: see #30	Not applicable.
90	Pretreatment of CERCLA Liquid Wastes (IRA)—Element Two, Polychlorinated Biphenyls (PCBs)	Completed	Completed May 1996; discussed in 2000 FYRR.

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Table 2.0-2. RMA Remedial Project Status as of March 31, 2010 (Concluded)

#	Project Name	Status	Forecast or Date of Final CCR or MCR EPA Approval and 2010 FYRR Cross Reference
91	Pretreatment of CERCLA Liquid Wastes (IRA)— Element Three, Waste Storage	Incorporated in RA: see #30	Not applicable.
92	Chemical Process-Related Activities (IRA)	Incorporated in RA: see #27, #29, and #42	Not applicable.
93	Deep Disposal Well Closure (IRA)	Completed	Discussed in 2000 FYRR.
99	On-Post Institutional Controls	Operating	Discussed in Sections 4.4.1.5 and 7.2.3.9.
Off-Post OU			
94	Off-Post Groundwater Intercept and Treatment System	Operating	CCR forecast to be decided; discussed in Sections 4.1.1.1 and 7.2.2.1.
95	Off-Post Well Abandonment	Completed	CCR September 30, 1999; discussed in 2000 FYRR.
96	Private Well Network	Operating	Discussed in Sections 6.3.1.5 and 7.2.2.2.
97	Off-Post Tillage Task	Completed	CCR September 30, 1998; discussed in 2000 FYRR.
98	Off-Post Institutional Controls	Operating	Discussed in Sections 5.2.2, 5.2.13, and 7.2.2.3.

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Table 6.4.1-1. 2010 Five-Year Review Field Inspection Summary

Location/Inspection Item	Well ID	Observations
Complex Army Trenches	36305	Well in AMA. Extraction well properly operating and in good condition. Well marked appropriately. Well was extended during cover construction and no signs of settling observed.
Complex Army Trenches	36219	Well in AMA. Water level well inside slurry wall. Marked adequately and in good condition.
Shell Trenches	36226	Well in AMA. Water level well outside slurry wall. Found to be in acceptable condition.
Shell Trenches	36535	Well in AMA. Water level well inside slurry wall. Found to be in acceptable condition.
ELF and HWL	26099	Well in AMA. Found in acceptable condition with pads, protective casing, cap and well cover in place, and ID tag intact.
ELF and HWL	25092	Well in AMA. Found in acceptable condition with pads, protective casing, cap and well cover in place, and ID tag intact.
ELF and HWL	25203	Well in AMA Found in acceptable condition with pads, protective casing, cap and well cover in place. Well ID is on inside of cap.
ELF and HWL	25102	Well in AMA. Found in acceptable condition with pads, protective casing, cap and well cover in place, and ID tag intact.
North Plants LNAPL	25301	LNAPL recovery well. Found in good condition with pad, protective casing, and well cover in place.
North Plants LNAPL	25139	Water level/LNAPL recovery well. Found in good condition. Has cap but no protective casing, no ID markings or tag.
Basin F	26157	Well in AMA. Found in acceptable condition. Well was extended and has an ill-fitting cover.
Basin F	26015	Well in AMA. Found in good condition with cap, cover, and casing intact and well tag in place.
On-Post Wells—General	24105	Severe damage to protective casing and has not changed since 2005 FYR. Well not included in any monitoring program during the FYR period, but was identified as a performance water quality monitoring well in the 2010 LTMP. A commitment was made to repair or replace the well.
On-Post Wells—General	27091	New pad in place (2005 FYR showed pad was damaged).
On-Post Wells—General	02522	No protective casing and polyvinyl chloride (PVC) casing found broken during 2005 FYR. A PVC casing piece and a cap have been added, however the casing stickup piece is wobbly.
On-Post Wells—General	04026	The well was found with the 2-inch casing loose at the surface and had no protective casing.
On-Post Wells—General	04027	The well was found with the 2-inch casing broken and had no protective casing.
On-Post Wells—General	04029	During the 2005 FYR the well was found broken off at ground surface and had no protective casing. No PVC has been added to the well, which was found cut off cleanly with a cap placed on. The well is not marked.
On-Post Wells—General	34014	Well in Bison Pilot Area. Found in good condition with protective cover on ground suggesting it was dislodged by bison.

Table 6.4.1-1. 2010 Five-Year Review Field Inspection Summary (Continued)

Location/Inspection Item	Well ID	Observations
On-Post Wells—General	34015	Well in Bison Pilot Area. Found in good condition with protective cover on ground suggesting it was dislodged by bison. Pad is cracked.
Off-Post Wells	37349	Off-post Army well. Found in good condition. During the 2005 FYR the well was found with a damaged protective casing and cover. Casing and cover are now found to be repaired and locked.
Off-Post Wells	37347	Off-post Army well. Found in good condition. Well was buried during road construction, but was found to have been repaired with a manhole in the new roadway for access.
Off-Post Wells	37327	Off-post Army well. Found in good condition. During the 2005 FYR the well was found with no protective casing and a broken PVC inner casing. The well has now been fixed and a protective casing installed. The well is locked.
Off-Post Wells	37374	Off-post Army well. Found in good condition. During the 2005 FYR the well was found with a broken casing. The well now has a flush mount cover bolted in place.
Rail Yard / Motor Pool Extraction System—General Plant		Treatment plant found to be clean and operating, and in good condition. Active sampling ports are marked. Tour guide did not point out sample port locations. O&M manual not present.
Rail Yard / Motor Pool Extraction System—Wells	03001	Top of casing found to be grooved and uneven. No protective casing.
Rail Yard / Motor Pool Extraction System—Wells	03527	Found in good condition.
CERCLA Water Treatment System—South Plants Tank Farm Groundwater Mass Removal System		Treatment plant and metering building found to be in good/acceptable condition. An O&M manual was not located in the treatment building.
CERCLA Water Treatment System—South Plants Tank Farm Groundwater Mass Removal Extraction Wells	01604	Monitoring well found to be in good condition.
CERCLA Water Treatment System—South Plants Tank Farm Groundwater Mass Removal System Extraction Wells	01685	Monitoring well found to be in good condition.
CERCLA Water Treatment System—Lime Basins Slurry Wall Groundwater Mass Removal System		Lime Basins metering building found to be in a neat and clean acceptable condition. Some encrustation noted on valves indicating minor leakage.
CERCLA Water Treatment System—Lime Basins Slurry Wall Groundwater Mass Removal System Wells	DW-10 (36320)	Problems currently encountered with Extraction Well DW-10 concerning corrosion of PVC piping. At time of inspection the pump was removed from well and lying on the ground unsecured. Surface casing is in good condition.

Table 6.4.1-1. 2010 Five-Year Review Field Inspection Summary (Continued)

Location/Inspection Item	Well ID	Observations
CERCLA Water Treatment System—Lime Basins Slurry Wall Groundwater Mass Removal System Wells	DW-9 (36319)	Odor of DCPD upon opening the well cover. Well found in good condition.
CERCLA Water Treatment System—Lime Basins Slurry Wall Groundwater Mass Removal System Wells	36210	Monitoring well found in good condition. Well number marked on casing.
CERCLA Water Treatment System—Lime Basins Slurry Wall Groundwater Mass Removal System Wells	36212	Monitoring well found in good condition. Well number marked on inner casing cap.
Basin A Neck Containment and Treatment System / Bedrock Ridge Extraction		BANS treatment plant found to be in good condition. A current O&M manual was present in the treatment building.
Basin A Neck Containment and Treatment System / Bedrock Ridge Extraction Wells	35516	BANS upgradient monitoring well. Well found in good condition with pads, protective casing, cap and well cover in place, and ID tag intact. Well ID tag was found lying on ground.
Basin A Neck Containment and Treatment System / Bedrock Ridge Extraction Wells	35512	BANS upgradient monitoring well. Well found in good condition with pads, protective casing, cap, and well cover in place, and ID tag intact.
Basin A Neck Containment and Treatment System / Bedrock Ridge Extraction Wells	36567	Bedrock Ridge monitoring well. Well condition is acceptable.
Basin A Neck Containment and Treatment System / Bedrock Ridge Extraction Wells	36566	Bedrock Ridge downgradient monitoring well. The well is covered up to the outer casing lid by soil but does not appear to be damaged.
Landfill Wastewater treatment System		LWTS Treatment plant found to be in good condition. Most recent version of O&M manual present on site.
North Boundary Containment System		NBCS Treatment plant found to be in good condition. Most recent version of O&M manual present on site. Effluent sample port tubing appeared stained with possible organic growth.
North Boundary Containment System Wells	24101	Upgradient monitoring well, found with no protective casing. Well cap and ID tag are in place.
North Boundary Containment System Wells	23119	Upgradient monitoring well, found with protective casing, pad, cap and outer cover in acceptable condition. Well number is on inside of cap.
Northwest Boundary Containment System		NWBCS Treatment plant found to be in acceptable condition. Most recent version of O&M manual present on site. All valve vaults for extraction and recharge wells are in good condition with doors closed but not locked.
Northwest Boundary Containment System Wells	22053	Upgradient monitoring well, found with protective casing, pad, inner cap and outer cover in acceptable condition. Well number is on inside of cap.

Table 6.4.1-1. 2010 Five-Year Review Field Inspection Summary (Concluded)

Location/Inspection Item	Well ID	Observations
Northwest Boundary Containment System Wells	22081	Upgradient monitoring well, found with protective casing, pad, inner cap and outer cover in place and in good condition. Well ID number painted on casing.
OGITS Treatment System		Some extraction and recharge well vaults show the effects of differential settling but wells are operational. The treatments system appeared to be in good condition. A draft (not final) version of O&M manual present on site.
OGITS Treatment System First Creek Extraction Wells	37075	Upgradient monitoring well, found with protective casing, pad, inner cap and outer cover in acceptable condition. Well is tagged with well number.
OGITS Treatment System First Creek Extraction Wells	37076	Upgradient monitoring well, found with protective casing, pad, inner cap and outer cover in acceptable condition. Well is tagged with well number.
OGITS Treatment System Northern Pathway Modifications		Metering building appeared in good condition. Extraction wells were all properly operating and in acceptable condition except as noted for well 37821.
OGITS Treatment System Northern Pathway Modifications Wells	37821	Extraction well has evidence of soil subsidence which has resulted in the well pad elevated 2-3 inches above ground surface.
OGITS Treatment System Northern Pathway Modifications Wells	37469	Upgradient monitoring well found in good condition, locked, pad and protective casing acceptable, and well identification in place.
OGITS Treatment System Northern Pathway Modifications Wells	37452	Upgradient monitoring well found in good condition, locked, pad and protective casing acceptable, and well identification in place.
Sanitary Sewer Markers		Inspected five sanitary sewer manhole locations in the Bison Pilot Area. Found concrete, signage and markers to be intact on all. EPA supplemental inspection of additional sanitary sewer manhole locations identified markers missing from manhole numbers 26, 28, 46, 48, 50, and 9 (within Section 26), as well as 392-1 and 393-4 as reported by RVO. Exposed pipe was observed north of manhole 49, as reported by the RVO. Numbers 29, 35, and 79 were verified to be buried by new access roads. Numbers 67A–67D and 58–60 were not located due to lack of GPS. In addition, within Sections 3 and 4 markers were missing from numbers 25, 27, 43, 44, 45, 46, 47, 48, and 50, while number 9 has a broken marker that will not stay upright.