

Optimization Program for the RCRA Corrective Action Facilities

Progress Report and Lessons Learned

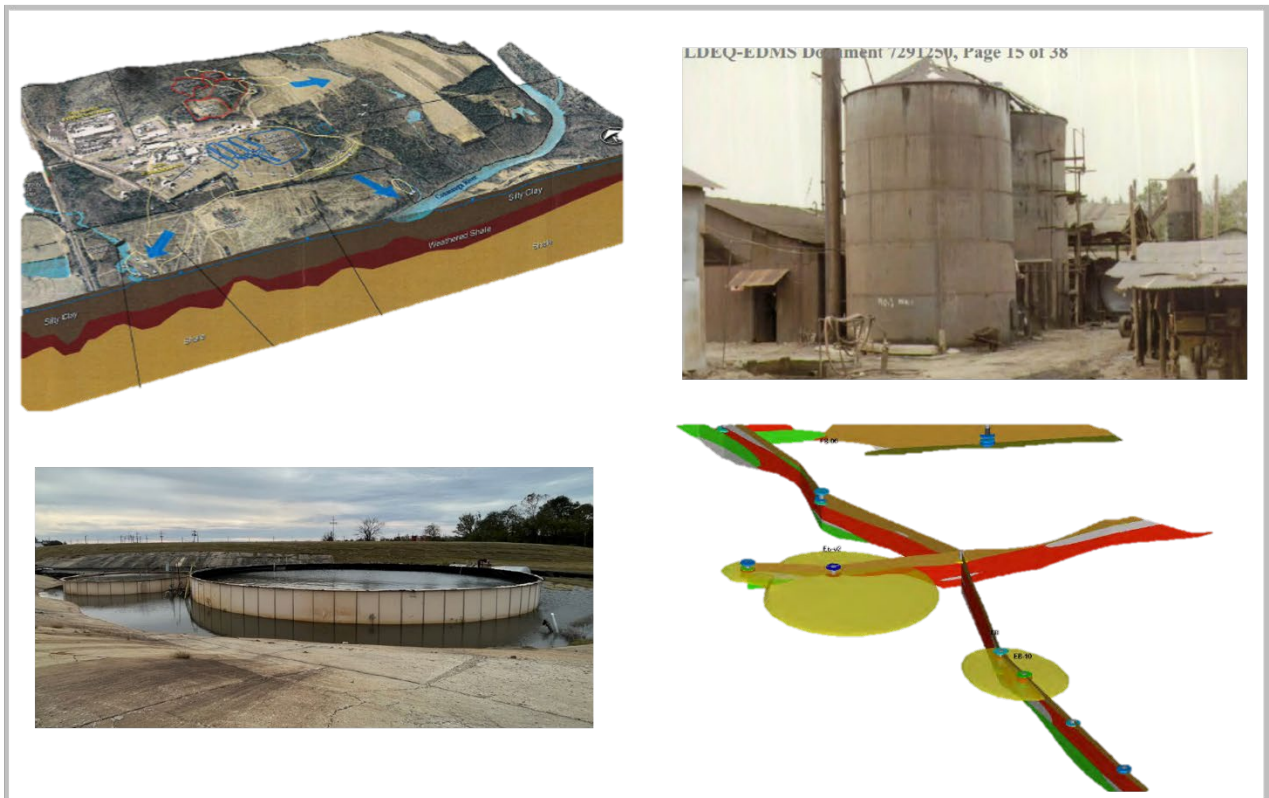


PHOTO CREDIT:

Top Left: Dow Chemical, Dalton. Georgia, Region 4. Figure from the 2024 Optimization Review.

Top Right: Standard Wood. Louisiana, Region 6. Figure from the 2023 Optimization Review.

Bottom Left: Exide. Louisiana, Region 6. Photo from the 2022 Optimization Review. Photo from the 2023 Focused Technical Review.

Bottom Right: Calumet Montana Refinery, LLC, Great Falls. Montana, Region 8. Figure from the 2020 Optimization Review.

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Notice and Disclaimer

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Executive Summary

The Optimization Program plays a key role in cleanup efforts managed by the RCRA Hazardous Waste Cleanup Program, helping to enhance cleanup efficiency to meet the strategic goals set for 2030. Since 2019, the RCRA Optimization Program has successfully completed 17 site-specific optimization reviews across various EPA regions. By providing independent technical assistance, the program aims to improve the effectiveness and protectiveness of remediation efforts and accelerate progress toward corrective action activity completion.

This report synthesizes insights from Fiscal Year 2020 to Fiscal Year 2025 technical reviews and identifies priority actions to strengthen program implementation within the RCRA cleanup community. Through these efforts, the RCRA Optimization Program continues to drive advancements in hazardous waste cleanups, ensuring the protection of communities and the environment by supporting the return of land to safe and productive use within a reasonable timeframe.

Program Overview and Impact

Optimization reviews, led by a team of independent subject matter experts, evaluate conceptual site models (CSMs), adequacy of site characterization efforts, monitoring network effectiveness, remedial system performance, and progress toward achieving RCRA Environmental Indicators (EIs) within a reasonable timeframe. Optimization reviews can strengthen remedy performance, improve monitoring strategies, refine CSMs, enhance long-term protectiveness, and identify cost savings and cost avoidance opportunities. These reviews also create opportunities to strengthen relationships and collaboration among EPA's RCRA Hazardous Waste Cleanup Program, EPA regions, State regulatory partners, facility owners/operators, and other stakeholders. Collectively, these efforts reinforce the importance of optimization reviews as a best management practice within the RCRA cleanup framework.

Since FY20, the RCRA Optimization Program has generated over 170 recommendations, with a median of about 8 recommendations per facility. These efforts have led to measurable progress in achieving RCRA EIs, enhancing monitoring efficiency, and informing remedy decisions at numerous facilities. For example, post-review data show fewer facilities with a "NO" status for RCRA EIs CA725 (Human Exposures Under Control) and CA750 (Migration of Contaminated Groundwater Under Control). This suggests that implementing optimization recommendations helped move facilities toward control of human exposures and groundwater migration. The most common recommendations focus on:

- Refining conceptual site models and site characterization
- Optimizing monitoring networks

RCRA Optimization Reviews: Key Benefits

RCRA optimization reviews aim to advance remediation measure efficiency, which in turn can protect communities and the environment, support ongoing site use, and help transition areas more quickly toward reuse.

Independent experts collaborate with the EPA, states, and site owners/operators to provide recommendations on various technical cleanup issues, including:

- Site characterization
- Refinement of conceptual site models
- Evaluation and optimization of monitoring systems
- Assessment of remedial system performance
- Support for achieving RCRA Environmental Indicators
- Identification of alternative remedies
- Addressing specific contaminant challenges

- Improving remedy performance

Key Technical Issues

Recurring issues that have been identified by the team and addressed during the optimization reviews include:

- *CSM and Data Gaps*: Oversimplified hydrogeologic interpretations, insufficient vertical delineation, outdated risk assessments, and limited visualization tools.
- *Monitoring Network Efficiency*: Opportunities to optimize well networks, refine analyte lists, adjust sampling frequency, and apply statistical trend analyses.
- *Remedy Engineering Improvements*: Optimization of pump-and-treat systems, adaptive scaling of remedies, enhanced dense non-aqueous phase liquid/light non-aqueous phase liquid management, and transition strategies to monitored natural attenuation.
- *Emerging Issues*: Consideration of per- and polyfluoroalkyl substances, vapor intrusion, and contaminant migration pathways not fully characterized in legacy site work.

These themes demonstrate that most optimization reviews prioritize strengthening technical foundations, particularly data quality and site understanding, before recommending significant remedy modifications, when appropriate.

Lessons Learned

Over the past five years, the program has also gained valuable perspectives on how to improve and strengthen the optimization reviews moving forward. The key areas with brief recommendations are summarized in the table below.

Description	Insight
1. Scope Clarity and Owner/Operator Participation	Clearly define review objectives early to alleviate owner/operator concerns about optimization being a regulatory burden. Emphasize that optimization is a tool for technical assistance, not enforcement, to enhance engagement and collaboration.
2. Prioritization of Optimization Review Recommendations Support Short-Term Wins	Present recommendations in a prioritized framework to help owner/operators focus on critical actions to complete cleanup milestones, especially when the optimization review does not explicitly address cost considerations.
3. Data Management Challenges	Ensure early identification and digital accessibility of historical records to improve review efficiency and avoid delays.
4. Virtual Site Visit (VSV) Efficiency	Ensure all technical stakeholders understand the focus and scope before the VSV. Conduct document reviews and provide targeted questions before virtual meetings to focus discussions on key technical challenges.
5. Tracking and Follow-Up	Implement more structured follow-up to enhance understanding of long-term program impact, as tracking varies by facility and public documentation is limited.

Environmental Indicators Considerations

RCRA Optimization reviews frequently consider EI determinations and identify data gaps affecting CA725 (human exposure under control) and CA750 (migration of groundwater under control) status.

In some instances, these reviews clarified exposure pathways, such as vapor intrusion, or highlighted inadequate plume delineation. Post-optimization results indicate progress toward achieving control for both CA725 and CA750. This report emphasizes the importance of:

- Clearly documenting cleanup goals before the review.
- Explicitly assessing EI status at the beginning of each optimization.
- Identifying intermediate objectives that align with long-term cleanup milestones.

Acronyms and Abbreviations

3DVA	3-dimensional visualization and analysis
CA	Corrective Action
CA725	Corrective Action 725 (human exposure under control)
CA750	Corrective Action 750 (migration of groundwater under control)
COC	constituent of concern
CSM	conceptual site model
DNAPL	dense non-aqueous phase liquid
EIs	Environmental Indicators
EPA	Environmental Protection Agency
FY	fiscal year
HWCUP	Hazardous Waste Cleanup Program
ITRC	Interstate Technology Regulatory Council
LCRD	Land, Chemicals and Redevelopment Division
LNAPL	light non-aqueous phase liquid
LUST	Leaking Underground Storage Tanks
MNA	monitored natural attenuation
NDMA	N-Nitroso-dimethylamine
O/O	owner/operator
ORCR	Office of Resource Conservation and Recovery
PFAS	per- and polyfluoroalkyl substances
P&T	pump and treat
PRP	Potentially Responsible Party
RCRA	Resource Conservation and Recovery Act
RDX	high explosives (research department explosive / high melting explosive)
RSE	Remedial Site Evaluations
SEMS	An EPA data repository for site- and non-site-specific Superfund data
VOC	volatile organic compounds

1. Introduction to Optimization

EPA defines optimization as a systematic site review by a team of independent technical experts, at any phase of a cleanup process, to identify opportunities to improve remedy protectiveness, effectiveness and cost efficiency, and to facilitate progress toward facility remedy completion (EPA, 2025a). The EPA's Office of Resource Conservation and Recovery (ORCR) Hazardous Waste Cleanup Program has been successfully implementing the RCRA Optimization Program, as a site-specific technical assistance tool that supports EPA regions and States in addressing cleanup challenges and advancing progress to completion at facilities regulated under the Resource Conservation and Recovery Act (RCRA). **Figure 1** provides an overview of the roles and responsibilities for various participants in the RCRA Optimization Program.

Since 2019, the program has successfully completed seventeen RCRA optimization reviews, with two currently underway. At the facility-level, optimization reviews have helped EPA and State regulators and owner/operators (O/O) to make more confident and improved decisions through suggestions on improving the conceptual site model and operating remedies which move the facility toward more efficient cleanup in the clean-up process. Optimization reviews have a well-defined timeline, objectives, milestones, and products. Therefore, they are efficient tools to identify improvements, measuring and accelerating cleanup progress to protect public health through controlling human exposure to contamination, controlling the migration of contaminated groundwater, and having cleanup technologies constructed and operational to achieve long-term protection. Further, at the Agency level, the optimization reviews accelerate progress to achieving EPA Hazardous Waste Cleanup Program 2030 Goals 1, 2 and 3 for initiating and completing cleanup efficiently and expeditiously (EPA, 2025b).

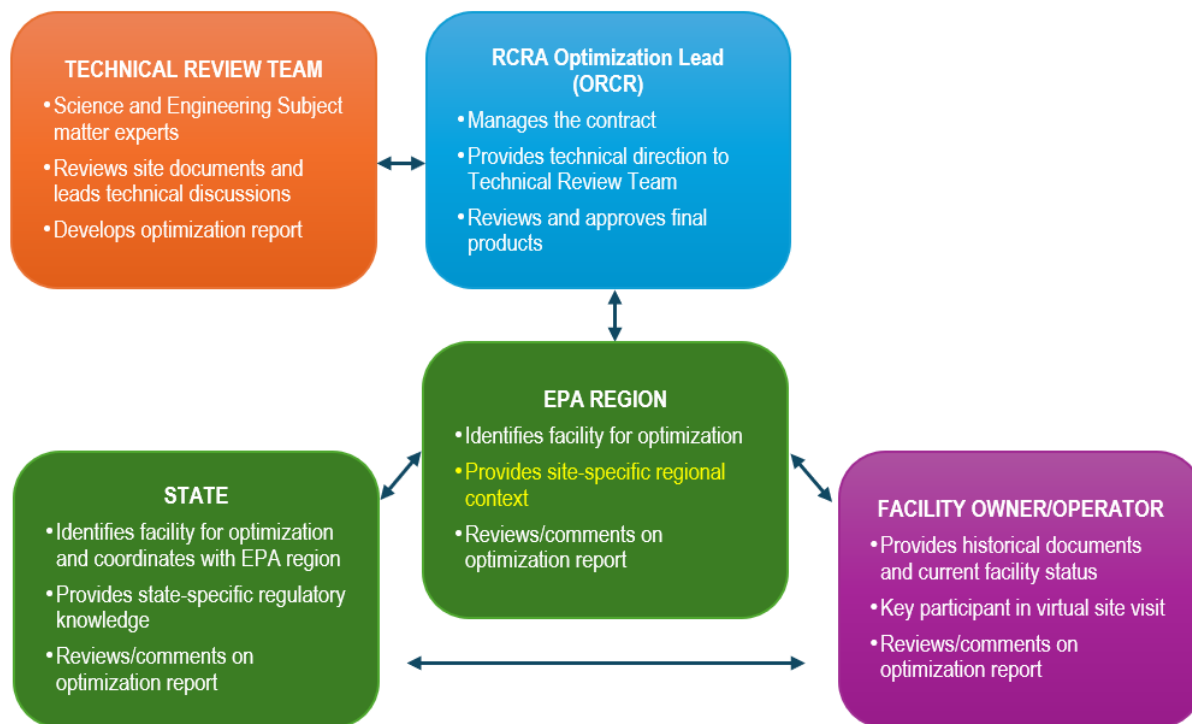


Figure 1. Summary of participant roles and responsibilities in the Optimization Program, illustrating how EPA, technical experts, state, and facility owners/operators contribute to optimization activities.

The concept of optimization reviews is not new. Early examples include United States Army Corps of Engineers (USACE) Remedial System Evaluations (RSEs) and Long-term Monitoring (Network) Optimization reviews in the late 1990s. EPA evolved the concept through a pilot containing more than 100 Superfund, RCRA, and Leaking Underground Storage Tanks sites, with the process being formalized via the 2012 National Optimization Strategy (EPA, 2012). Optimization reviews are a standard best practice considered throughout the Superfund cleanup process, incorporated into agency guidance, fundamental training, and remedial contracts. The RCRA optimization review process was informed by more than a decade's worth of lessons learned and best practices developed through the Superfund program. Additionally, optimization is performed as a best practice by other federal agencies including the USACE, the United States Navy, United States Airforce, and the Department of Energy (Federal Remediation Technologies Roundtable, <https://www.frtr.gov/optimization/default.cfm>); and is supported by States and industry with multiple optimization-related technical guidance documents developed by the Interstate Technology Regulatory Council (ITRC, 2004, 2022, 2023).

2. Report Objective

The objective of this report is to demonstrate how the RCRA Optimization Program, since its inception in 2019, has excelled as a site-specific technical assistance tool that has supported EPA regions and States in addressing cleanup challenges at RCRA facilities around the nation. RTI International (hereafter, RTI) reviewed existing documentation, including fact sheets, presentations, previously developed lessons learned, and all RCRA optimization reports prepared from 2019 to 2025, including four optimization reports developed by RTI in FY24 and FY25. Lessons learned from developing these optimization reports and recommendations to the RCRA optimization review program are also presented alongside relevant lessons and recommendations from previous reports developed by the Superfund Optimization Program and RCRA Optimization Pilot (EPA, 2025a; ICF, 2024; HGL, 2020).

3. Scope of Optimization

The optimization review is a technical assessment performed by independent subject matter experts (the technical team) contracted by the EPA. It involves reviewing facility documents and data, as well as engaging with site owners/operators, State representatives, and EPA regional staff to understand the site's current progress toward cleanup, challenges, data gaps, and other needs that may assist in achieving its cleanup goals and RCRA Environmental Indicators (EIs). **Figure 2** provides an overview of the RCRA optimization review process, timeline, and milestones.

3.1. Outreach

The RCRA Optimization Program Lead employs several channels to inform EPA regions and States about available funding and participation in the program, including the monthly National RCRA Hazardous Waste Cleanup Call, the annual "All-States" meetings led by individual EPA regions, and annual Association of State and Territorial Solid Waste Management Officials meetings.

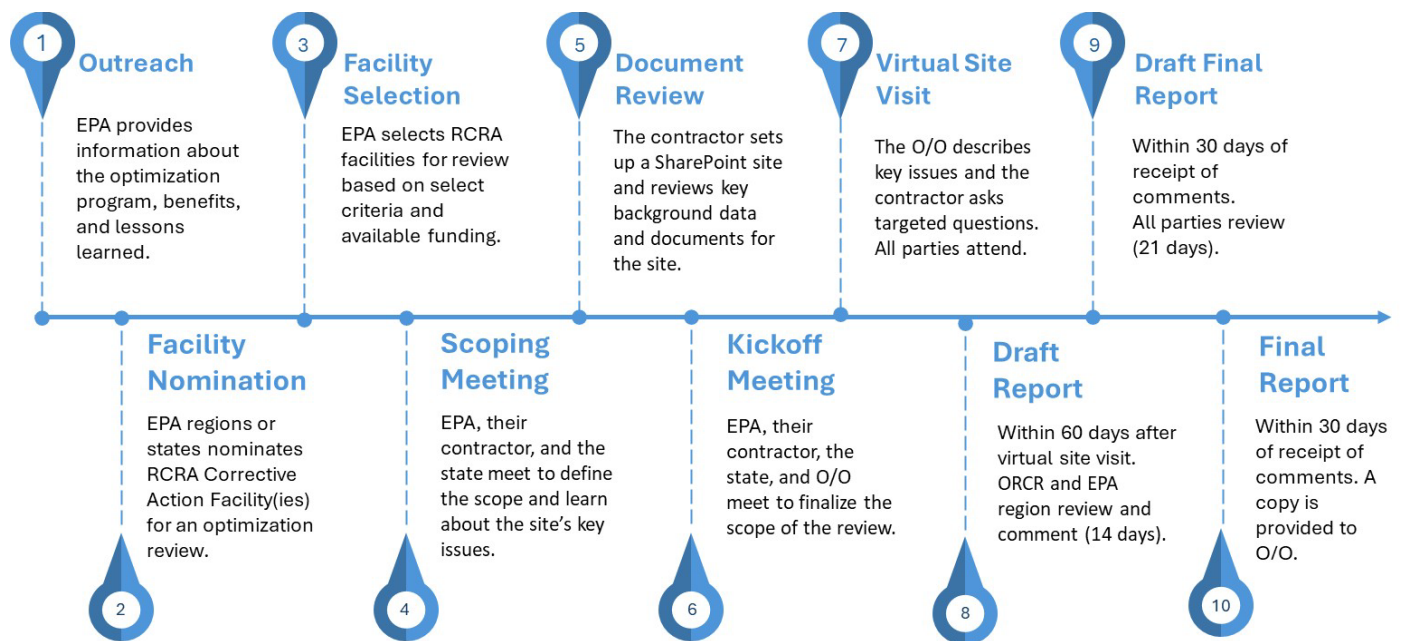


Figure 2. RCRA Corrective Action Facility optimization review process, including key milestones from outreach, facility nomination and initial review through technical evaluation, stakeholder input, and report development and finalization.

3.2. Facility Eligibility and Nomination

EPA regions and States can nominate a facility for an optimization review at any time. The sole eligibility criterion is that the facility must be a RCRA Corrective Action (RCRA CA) facility with a RCRA permit issued by EPA and/or authorized State or federal enforcement order. Any RCRA CA facility encountering challenges at *any stage of the cleanup process* is a suitable candidate. Regional and State RCRA Hazardous Waste Cleanup Program staff coordinate to nominate eligible facilities. Regional corrective action staff then coordinate with the RCRA Optimization Program Lead in ORCR to discuss nomination applications.

3.3. Facility Selection Process

The RCRA Optimization Program Lead selects four to five facilities for optimization review per fiscal year, depending on available budget and interest. The entire process, from facility nomination to completion of the optimization report, typically takes between six to twelve months, depending on site complexity, availability of documents and data supporting the CSM, and review duration.

3.4. Scoping, Technical Team Formation, and Understanding of Key Facility Issues

During the scoping phase, EPA and its contractor discuss the technical expertise required to review the facility and identify subject matter experts for the team. The regulator (EPA region or the State), with support from the RCRA Optimization Program Lead, develops the scope of the optimization review. The technical team then begins reviewing facility background documents to understand the facility's issues.

Key stakeholders, including the RCRA Optimization Program Lead, the technical team, EPA region and State regulators, and the owner/operator, meet virtually at three critical points: the scoping meeting, kick-off meeting, and virtual site visit. These meetings are essential for agreeing on the review scope and gaining insights into the facility's key issues.

The success of the virtual site visit relies on the owner/operator's providing pertinent photographs, videos, maps, and other materials that help visualize site conditions. The goal is to ensure a thorough understanding of technical issues and confirm the review scope. If deemed necessary, the optimization review experts and regulators may consider an in-person site visit, which can be particularly beneficial for regulators who have not previously visited the site.

3.5. Optimization Review and Recommendations

The technical team will present a list of recommendations and supporting explanatory text in a technical memorandum format that is provided to the regulators (EPA or State) for consideration. The recommendations are technically focused and may include filling data gaps in the CSM, filling gaps involving RCRA EI determinations, remedy implementation and operation, cost reduction, progress to cleanup completion (i.e., the exit strategy), and others depending on the scope. The optimization review reports are made available to the EPA team, State regulator, and O/O.

3.6. Post-Optimization Implementation

The recommendations in the optimization report are not requirements; rather, they are provided to the regulator for consideration. The regulator may try to encourage the O/O to consider optimization review recommendations during the review process itself. The regulator can require implementation of any of the optimization review recommendations, or the site O/O may choose to voluntarily implement recommendations after the optimization review process is complete. Regulatory support from the technical team is not in the scope of the optimization review.

3.7. Post-Optimization Interviews and Tracking

Post-optimization activities include tracking implementation of the optimization review recommendations and post-optimization interviews with the technical team, EPA and State regulators. After the optimization review is completed and the report is finalized and transmitted, the RCRA Optimization Program Lead updates and maintains an internal spreadsheet to track implementation of recommendations for each facility. The tracker is updated every 1 – 2 years based on facility documents and/or communication with the regulator. Post-optimization interviews with the technical team may be conducted after the report to capture lessons learned, obtain a status update on implementation, and assess progress toward achieving or maintaining the Environmental Indicators (EIs). Not all facilities will be interviewed; interviews occur after the report is finalized – typically around two years later – but there is no fixed timeframe.

3.8. Benefits of Participating

The primary advantages of an optimization review are the inclusion of EPA, States and facility representatives and the prompt identification of cleanup impediments, which aids RCRA regulators in advancing their cleanup objectives to protect communities and the environment, support ongoing use, and expedite area reuse. The RCRA Optimization Program Lead encourages EPA regions and States to leverage this program to tackle technical cleanup challenges at RCRA CA facilities. The program advances strategy and partnerships, enabling candid dialogue with facility representatives, joint problem-solving, and a coordinated path to cleanup decisions and implementation.

4. Summary of Past Optimization Projects and Major Cleanup Issues

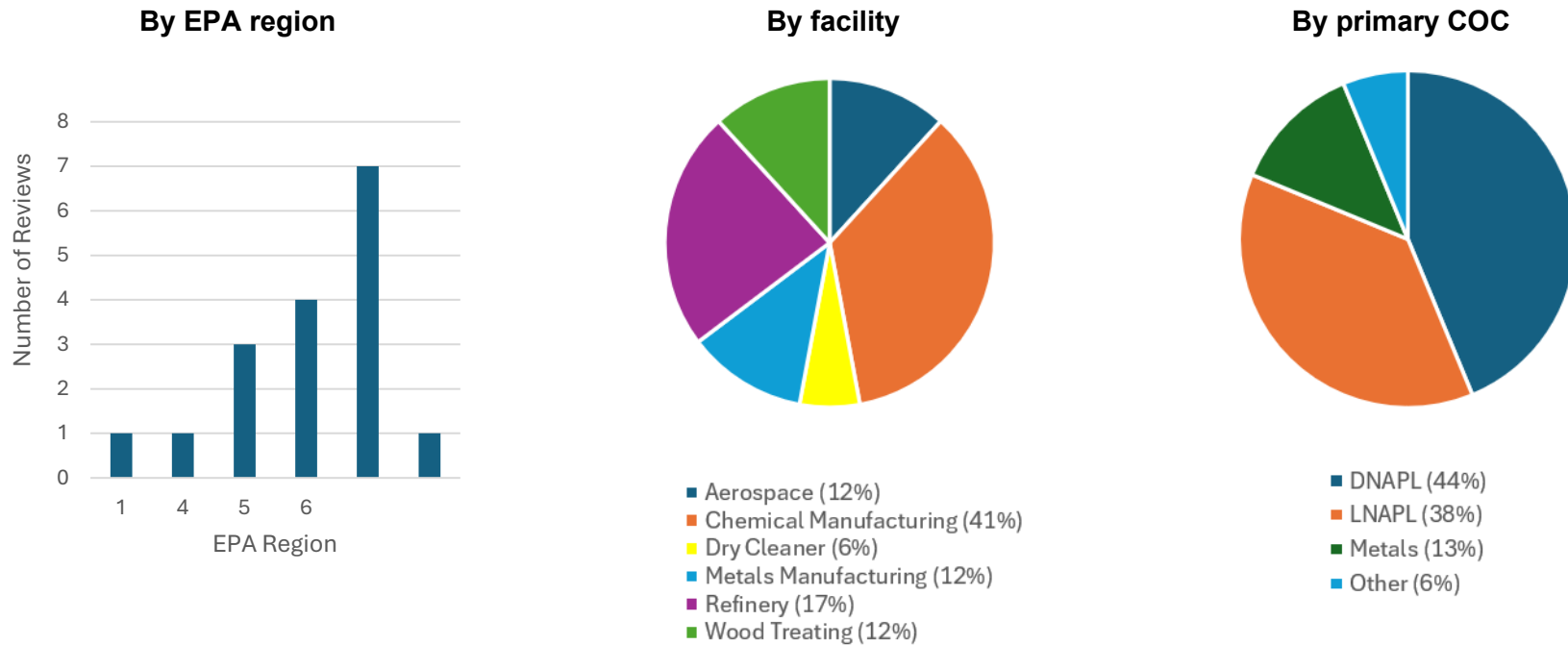
Seventeen (17) optimization reviews have been completed since FY20 across six EPA regions for a variety of facilities. Approximately two to four optimization reviews have been completed annually, with most optimization reviews completed at RCRA facilities in regions 5, 6, and 8. More optimization reviews have been completed at chemical manufacturing facilities and petroleum refineries and at sites with dense non-aqueous phase liquid (DNAPL) and light non-aqueous phase liquid (LNAPL) contamination (**Figure 3**). Chemical vapor intrusion is also considered in the optimization reviews, particularly for facilities where vapor intrusion has the potential to occur (e.g., dry cleaning facilities, wood preserving facilities, solvent manufacturing facilities). **Appendix A.1** presents key information for the 17 past optimization projects, including site name and location, type of facility, and scope of the optimization review.

4.1. Common Technical Issues of the Optimization Review Scopes and Key Drivers for Optimization Recommendations

The optimization review scopes and recommendations have typically fallen into different themes as described in **Table 1**. Opportunities for cost reductions and/or expediting characterization or cleanup timeframes are qualitatively incorporated into the scope of the review but are not always quantified. For example, as shown in **Table 1**, CSM improvements with new 3-dimensional visualization tools can provide a better, qualitative understanding of site contamination whereas remedy evaluation or a change in remedial approach may provide direct cost reductions that could be quantified.

The optimization reviews conducted to date included evaluating existing historical data to determine whether site-specific conditions and contamination have been adequately characterized; the adequacy of monitoring networks; and site characterization, including refinement of CSMs (**Figure 4a**). More than 170 combined optimization review recommendations were made across the 17 facility reviews completed to date, with a median of approximately eight recommendations per facility. The optimization review recommendations covered aspects ranging from improvements to site characterization and facility CSMs to meeting RCRA EIs and cleanup goals. Most optimization recommendations for the 17 facilities focused on improving site characterization and CSMs (48), remedy improvements (43), and monitoring improvements (39) (**Figure 4b**).

Including a review of the facility CSM and site characterization data was common to most facilities. For example, one facility specifically requested support to address PFAS contamination at the facility and downgradient of the facility (Suncor Energy Inc., Colorado), and the technical team recommended additional interior hotspot identification and characterization, additional boundary control monitoring, and general delineation for the interior portion of the Suncor refinery to support future interpretation of the nature and extent of PFAS contamination. At a chemical manufacturing facility (Kraton Polymers, LLC, Ohio), the technical team conducted a detailed analysis of the groundwater monitoring data and hydrogeology, and recommended a groundwater flow model to help refine the understanding of the site's hydraulic conditions and contaminant transport pathways.



Notes:

Other COCs include perchlorate, PFAS, RDX/HMX, NDMA, and 1,4-dioxane

DNAPL: dense non-aqueous phase liquid

LNAPL: light non-aqueous phase liquid

NDMA: N-Nitroso-dimethylamine

PFAS: per- and polyfluoroalkyl substances

RDX/HMX: research department explosive / high melting explosive.

Figure 3. RCRA Facility Optimization Reviews have been completed for 17 facilities, primarily in EPA Regions 6 and 8, representing a range of facility types from small businesses like dry cleaners to large refineries and addressing a diverse set of constituents of concern including DNAPL, LNAPL, metals.

Table 1. Common Optimization Scope Themes

Common Optimization Scope Themes	Description
Conceptual Site Model Improvements	Improving a CSM can be achieved through additional characterization of sources and environmental media, such as groundwater, or by analyzing existing data with new tools, such as 3-dimensional visualization and analysis (3DVA). CSM improvements are best achieved through smart scoping (EPA, 2018a), the use of strategic sampling approaches (EPA, 2018b) and improved data management (EPA, 2018c). Contaminant-specific challenges (e.g., emerging contaminants such as PFAS) and confirmation of vapor intrusion pathways may also be considered.
Site Characterization Through Strategic Sampling	Specific strategic sampling approaches apply to several types of characterization activities conducted on various environmental media and help improve the technical understanding of site conditions. These approaches include high-resolution site characterization for groundwater and incremental sampling for contaminated soil for improved characterization of source volumes and locations. Strategic sampling approaches can often lead to other beneficial results such as CSM improvements, the use of combined remedies, and adaptively scaling remedies.
Streamlined or Improved Monitoring	Streamlined or improved monitoring involves adjustments to monitoring frequency, monitoring locations, chemicals of concern analyzed, as well as the analysis of monitoring results over time. Streamlined or improved monitoring also addresses data management practices.
Remedy Evaluation for Improved System Engineering	Improved system engineering includes modifying one or more engineered components of a remedial system to improve overall system performance. Improved system engineering can include adaptively scaling remedies or using a more targeted approach that applies technologies to a specific and well-defined area. Smart scoping (EPA, 2018a), strategic sampling approaches (EPA, 2018b), CSM improvement, and improved data management (EPA, 2018c) can facilitate adaptively scaling remedies.
RCRA Environmental Indicator (EI) Assessment	The technical team will evaluate the progress towards meeting RCRA EIs CA725 (human exposure under control) and CA750 (migration of groundwater under control). Some optimization review scopes specifically request an EI evaluation.
Remedy Identification or Change in Remedial Approach	Changes in remedial approach include adding or changing remedies to better address remaining contamination or newly identified areas of contamination. The recommendations provide improvements in remedy effectiveness, cost reductions, and the achievement of site closure in a shorter period of time.

This table was adapted from Table 1 of EPA, 2025a.

Many reviews evaluated remedial system performance, including capture zones and treatment efficiency. Evaluating attainment of RCRA EIs CA725 and CA750 and recommending actions needed to achieve compliance was a core part of the scopes. For example, at an El Dorado, Arkansas chemical manufacturing facility, the technical team recommended that EPA should revise the status of CA725 and CA750 from 'under control (YE)' to 'needs more information (IN)' due to existing data gaps and uncertainties based on current site conditions. The technical team also recommended updating the receptor well survey to identify public and private wells surrounding the site.

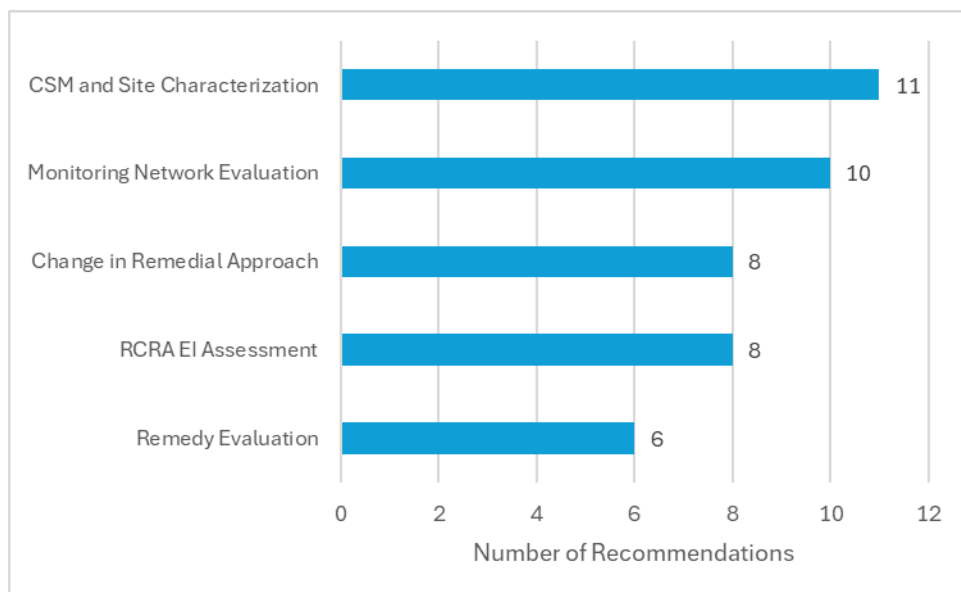
Review scopes also included offsite migration risks and protection of sensitive receptors. One facility (ArcelorMittal Indiana Harbor East, Indiana) specifically requested assistance in obtaining consensus on how best to achieve remediation for all site stakeholders because cleanup progress had stalled.

Of the 17 facility reviews completed to date, refineries and chemical manufacturing facilities are the most common (**Figure 3**). Key drivers for optimization recommendations at these facilities, included recommendations to improve characterization of contamination extents and proposed remedies.

Common reasons for recommending characterization improvements for these types of facilities include:

1. Oversimplified CSM (e.g., the CSM lacked details of the lithologies)
2. Lack of wells for vertical and/or horizontal delineations
3. Insufficient sampling frequencies, analytes, or media (especially surface water)
4. Missing visualizations of contamination
5. Potentially biased calculations of background concentrations
6. Outdated risk assessments.

4a. Common issues identified during facility scoping



4b. Optimization review recommendations by major category

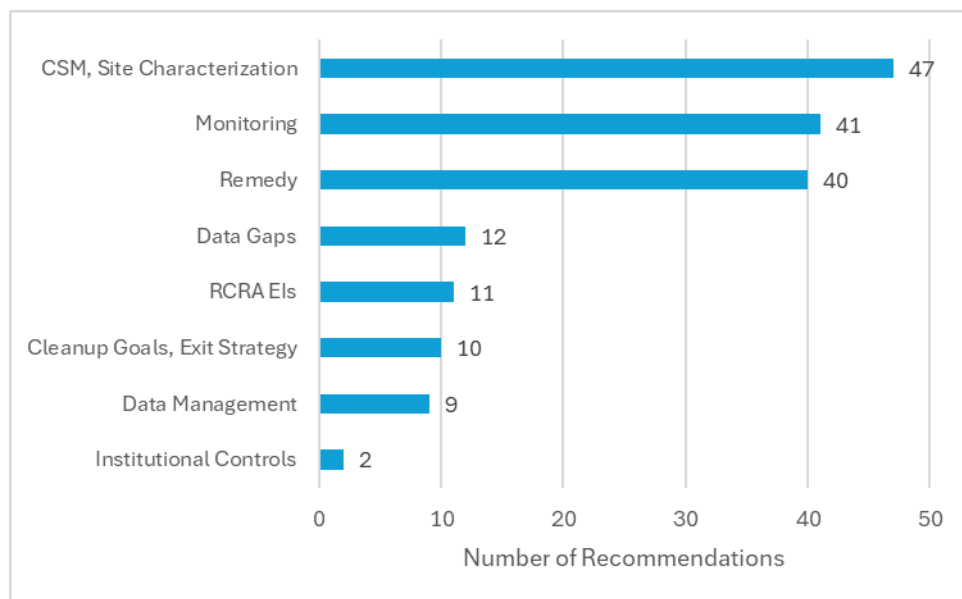


Figure 4. Summary of optimization review recommendations across 17 RCRA Corrective Action facility reviews completed since FY 2020.

Other recommendations were unique to a specific facility's remedy. For example, at the Exide facility (Louisiana), the technical team recommended separating the collected leachate from groundwater to repair stormwater containment features, and to avoid shutting down the leachate collection system prematurely. At Solvay (Montana), the review team identified the incorrect use of detection limits in the analytical methods used to assess cleanup progress.

Appendix A.2 presents each optimization review recommendation by facility and a status of implementation of each optimization review recommendation, where publicly available. A recommendation status update could not be found for 10 of 17 sites. No updates on the recommendations are expected for optimization reviews that were completed in the past one to two years (i.e., 2024 and 2025) to allow time for the facilities to make substantive progress towards implementation. Optimization reviews were completed in the last two years at six facilities. Some O/Os of the recently reviewed facilities, such as Solvay, however, have already begun implementing the surface water sample collection recommendation. Updated status of implementation progress for the recommendations should be obtained by directly contacting the relevant EPA or State site manager.

4.2. RCRA Environmental Indicators CA725 and CA750

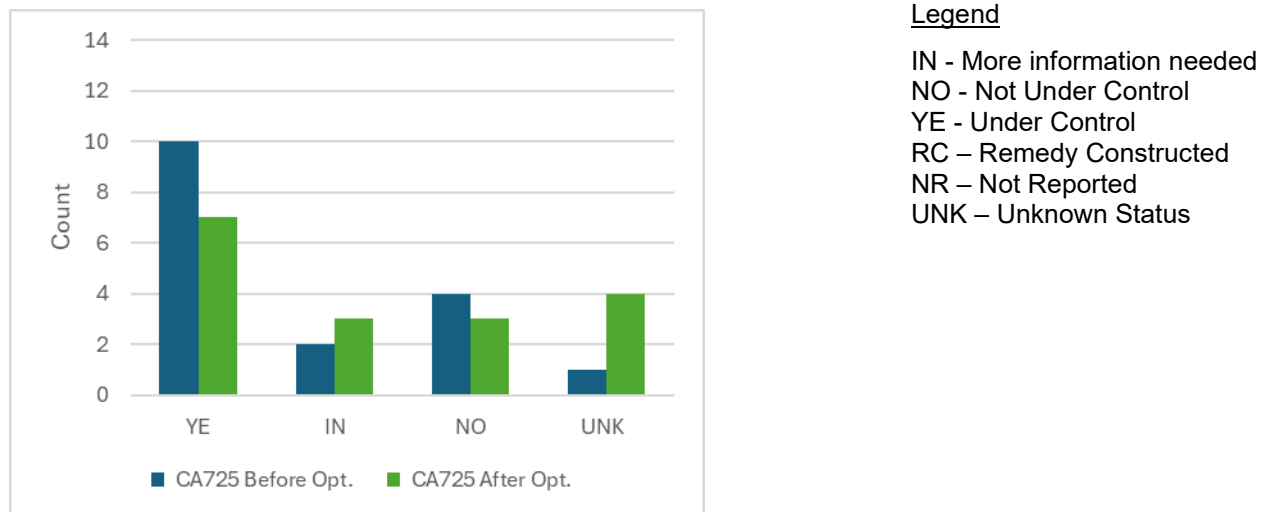
Evaluations of the progress towards meeting the RCRA CA725 (human exposure under control) and CA750 (migration of groundwater under control) EIs are included in the optimization reviews. Historically, RCRA cleanup activities were prioritized based on the need to issue permits (i.e., permit deadline established by Congress). In alignment with the EPA Hazardous Waste Cleanup Program's 2030 Goals, EPA is prioritizing achieving CA725 when assessing RCRA cleanups with more emphasis placed on facilities with higher exposure risk.

The 2024 RCRA optimization lessons learned report (ICF, 2024) recommended that three aspects be incorporated into the technical reviews, (1) to clearly document cleanup goals before the optimization review begins, (2) to explicitly evaluate whether EIs CA725 and CA750 have been achieved at the beginning of the review, and if not, to provide recommendations that, if implemented, will advance the cleanup towards those goals; and (3) to develop facility-specific short-term protection goals, intermediate performance goals and final cleanup objectives to achieve EIs as recommended in the Handbook of Groundwater Protection and Cleanup Policies for RCRA Corrective Action (EPA, 2004). Most of the optimization scopes for the 17 facilities included an evaluation of whether CA725 and CA750 were achieved.

Appendix A.3 presents a comparison of the status of meeting two RCRA EIs and three corrective action milestones by facility before and after each optimization review. **Figure 5** summarizes the results for two RCRA EIs: CA725 and CA750, and progress that has been made in meeting CA725 and CA750 after the optimization reviews:

1. 10 of the 17 facilities achieved a YE or IN status and fewer facilities (3 versus 4 facilities after the optimization review) reported NO for CA725 (human exposures under control).
2. 8 of the 17 facilities achieved a YE or IN status and fewer facilities (8 versus 5 facilities after the optimization review) reported NO for CA750 (migration of contaminated groundwater under control).

5a. Status of RCRA EI CA725 (Human Exposures Under Control)



5b. Status of RCRA EI CA750 (Migration of Contaminated Groundwater Under Control)

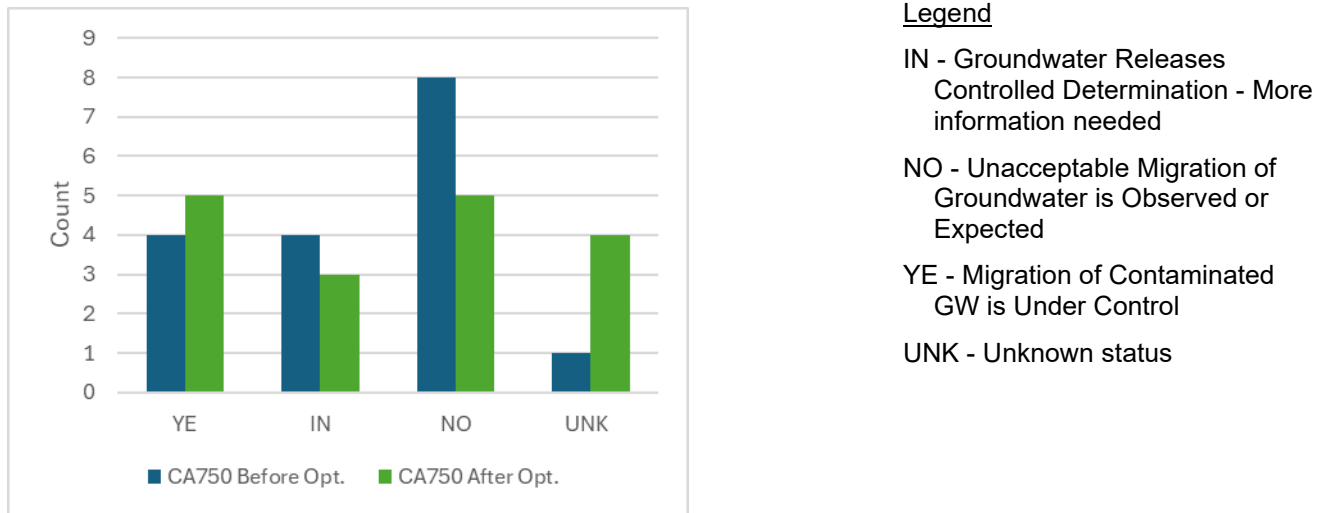


Figure 5. Status of Meeting RCRA EIs CA725 and CA750 across 17 RCRA Corrective Action facilities.

There are several reasons why more facilities changed their CA725 and CA750 status to IN (more information) after the optimization review. One reason is unaddressed or new exposure or migration pathways identified during the review. Another potential reason is that the designation of 'NO' and 'IN' can be unclear in some cases, particularly for facilities with unresolved issues and a long history of characterization. For example, as excerpted from ICF (2024), the shallow aquifer was impacted at one pre-2021 facility, but there was no information to determine if a deeper aquifer was impacted. The technical team initially assumed the CA750 designation should be 'IN' because there was no specific information that would indicate 'NO' but ORCR's technical expert commented that, in his opinion, an answer of 'NO' was more appropriate to raise the level of awareness, for the O/O and others, that delineation of the plume in the deep aquifer was still lacking. The need for vertical delineation of the contaminant plume was identified several decades earlier (since the early 1990's RFI Guidance), and there had never been adequate vertical delineation performed at this site. ORCR indicated this interpretation of 'IN' versus 'NO' remains somewhat of a judgment call, even though this issue was not addressed for decades. The report was modified per ORCR's suggestion, and language was added to indicate that it was in fact a judgment call.

Chemical vapor intrusion is an emerging issue at cleanup sites and recent technical review teams have considered the potential for vapor intrusion when evaluating achievement of CA725 and CA750. For example, the potential for vapor intrusion into a nearby neighborhood was included in the scope for the Standard Wood Preservers Inc facility (Louisiana). The technical team recommended adopting several institutional controls and coordinating with the local health authority to require a vapor intrusion mitigation system for new construction and existing residential homes with a subslab, performing vapor intrusion monitoring in the subslab and indoor air sampling in existing residences.

5. Lessons Learned

Lessons learned are documented to record insights from past projects – what worked, what didn't, and why – to improve program performance, strengthen the community of practice, facilitate technology transfer, and help EPA and state regulators address cleanup challenges and achieve cleanup goals at RCRA Corrective Action facilities under their oversight. Avenues to strengthen the community of practice and technology transfer include the development of this report, case studies presented during the monthly National RCRA Hazardous Waste Cleanup Call and providing program updates at All-States meetings.

This section documents successes and areas for improvement in the RCRA optimization review process. EPA and their technical team (RTI) have collected data for the past six years. Every RCRA CA facility can benefit from an optimization review, whether that be a holistic review or a targeted review of select areas or topics, including protectiveness concerns, technological challenges, data gaps in the CSM, uncertainties about remedy effectiveness, large annual costs of remedial activities, or interim remedies. EPA has found that RCRA project managers who are new to the role or to their assigned facility are particularly interested in optimization reviews. Additionally, some RCRA project managers have requested support for multiple facilities they manage, which underscores the ongoing need for – and value of – the RCRA Optimization Program in supporting cleanup at RCRA facilities. **Table 2** summarizes lessons learned from the past six years and recommendations to address them.

Table 2. Lessons Learned and Recommendations for the RCRA Optimization Review Process.

Lesson Type	Lessons Learned	Recommendations
Scope and O/O Participation	When a region nominates a facility for an optimization review, it typically signals unresolved questions about the remedy, system performance, or supporting data. Some facility O/Os may view the review as an added regulatory burden – though it is distinct from enforcement – and worry it could surface new liabilities or complicate current strategies, leading to defensiveness or reluctance to participate.	At the outset, clearly define the optimization review’s scope with the O/O (e.g., in the kickoff call and confirmed in writing) covering the purpose, key technical issues, applicable regulatory drivers, and the uncertainties that led to the nomination. EPA and the technical team should encourage the O/O to view the process as a platform to highlight cleanup efforts and use the virtual site visit to present site history, share performance results, and discuss lessons learned.
Scope and O/O Participation	Since FY24 (with a change in contractor) the optimization process has focused solely on technical findings and does not include a cost component. As a result, the technical team has recommended additional measures (e.g., installing new monitoring systems, updating existing remediation systems) without cost considerations. From the O/O perspective, these recommendations can increase operational costs and may be difficult to implement under constrained budgets. Although the optimization review is not a regulatory process and does not mandate implementation, cost remains a practical hurdle to adopting recommendations.	The technical team will present their recommendations in a prioritized framework, distinguishing between critical actions necessary to address regulatory concerns versus long-term actions to further enhance system effectiveness. This approach may also encourage the O/O to actively engage in the process, allowing them to share their perspectives and demonstrate the efficiency of the current system. The technical team will prioritize the evaluation of facility conditions (e.g., trend and statistical analysis, plume stability mapping) and remediation system performance using currently available data to help minimize the need for additional O/O activities to address data gaps (e.g., installation of additional monitoring wells, additional site characterization), thereby reducing potential cost burdens for the O/O.
Scope and O/O Participation	An O/O could be unresponsive or decline to participate in the optimization review process.	Ensure O/O participation in optimization reviews and avoid completing full reviews without O/O input except in narrowly defined circumstances (urgent protectiveness concern or a time-critical decision). If O/O is unresponsive after the initial invitation, send a follow-up within 14 days with alternative dates/times and a one-page “What to Expect”, and emphasize “no surprises” in the draft review process. If O/O declines to participate, the ORCR Optimization Lead will assist the Region/State in identifying alternative EPA site-specific technical assistance and plan for re-engagement.

Lesson Type	Lessons Learned	Recommendations
Virtual Site Visit Purpose	During the COVID pandemic, virtual site visits replaced in-person site visits. In some instances, a lot of time was spent during the kickoff / virtual site visit reviewing background documents that could have been better used to focus on the key issues of the optimization review. It is important to manage the agenda for the VSV to make the best use of limited time. In general, reserving significant time during the VSV for the O/O to present on their site has not provided the technical team with enough time to dig into the key issues. Note: this lesson learned was gained after RTI completed the optimization review for Solvay, and the recommendations provided here were implemented when completing the next three facility reviews (Stimson, Kraton, and Lanxess) in FY25.	Conduct the background document review before the virtual site meeting, then send the O/O a targeted list of questions on the key issues to focus the discussion. Ask the regional project manager to provide relevant background documents and figures at least seven business days before the virtual site meeting. Provide any additional documents identified during the kickoff call or virtual site meeting within 3 – 5 business days after the meeting. Share a brief agenda with suggested time blocks (e.g., site background, corrective action progress, key issues) to ensure sufficient time for priority topics. This process allows the technical team to complete a targeted review and use the virtual site meeting to address substantive issues. In past reviews, significant time was spent on general background, leaving limited time to discuss the optimization scope and key issues.
Rebranding	It is possible for the O/O to interpret the ‘virtual site visit’ literally as a virtual walk-through of the site.	Rename “Virtual Site Visit” to a title that emphasizes issue resolution and progress toward corrective action requirements. This will signal to the O/O that the meeting should focus on current challenges, decisions needed, and next steps—not a virtual site tour. The technical team generally does not need a virtual walkthrough unless specifically requested
Data Management	Data management refers to the strategy and methods for collecting, accessing, processing, evaluating, and communicating data. In some instances, historical documents and data were not compiled for the review team until after the optimization review began, or data sets needed to be digitized. This resulted in the review team spending unallocated resources to track down documents and digitize datasets, which reduced time for the technical review.	In some instances, the O/O owned documents that were not present in a facility’s record at the EPA or the State. To establish a complete baseline, EPA and the State should compile an inventory of documents in their records and request any missing, relevant materials from the O/O. This inventory and request should be completed within two weeks of the optimization kickoff.

Lesson Type	Lessons Learned	Recommendations
Data Management	There were frequent issues where data and documents were not digitized or were missing. Receiving site data and documents in digital format can significantly reduce the time required for data conversion. Additionally, ensuring that all relevant documents are submitted without omissions is essential for conducting a more accurate and comprehensive evaluation of the site.	Historical data should be available in a readily accessible format for data analysis (Microsoft Excel or another program). Most of the data are likely already digitized and/or available to the O/O. Depending on the level of O/O engagement, having the lead regulator (Regional EPA or State) directly contact the O/O to obtain the necessary data is recommended to ensure timely access to complete and accurate datasets for the optimization review.
Jurisdiction	Potential conflicts between the RCRA corrective action guidance and state regulations may surface during the optimization review. Note: this lesson learned was identified in the 2024 lessons learned memo (ICF, 2024) and was not relevant for the reviews completed by RTI.	The technical team would benefit from raising the general differences between RCRA and State guidance and regulations during the site kickoff calls, and, if applicable, provide access to regulatory experts within EPA and the relevant State agency. This would allow the technical team to focus on providing technical findings and recommendations versus interpreting EPA RCRA corrective action guidance or State regulations.

6. Post-Optimization Interviews

In 2024, post-optimization interviews were completed at two facilities and documented in the 2024 lessons learned memo (ICF, 2024). These facility interviews were selected because the optimization was recent enough (within the last 5 years) and had allowed sufficient time (2 to 5 years) for EPA and stakeholders to determine whether and how to implement the recommendations (ICF, 2024). The interview summaries are excerpted below.

6.1. ArcelorMittal Facility, Indiana, Region 5

Optimization Final Report Date: May 22, 2020

Lessons Learned Interview Date: September 13, 2024

The ArcelorMittal facility is located in East Chicago, IN. The optimization focused on the slag filled peninsula portion of the facility. In addition to updating the CSM, the optimization report included 14 recommendations, of which five were implemented, two are in progress, one is planned, one is under consideration, and five were deferred to the State or O/O. A summary of the recommendations and a description of the progress toward the recommendations is included in an appendix to ICF (2024).

Prior to the optimization, the ArcelorMittal facility had difficulty in establishing appropriate criteria for discharge of groundwater contamination to surface water, which delayed the RFI process and prevented development of a CSM. Part of this difficulty arises from the challenging setting of the ArcelorMittal facility on a man-made peninsula in Lake Michigan historically constructed from slag and authorized disposal of dredge spoils. Other difficulties resulted from the various regulations, rules, or guidance that seem to govern the development of such criteria. For example, the O/O cited NPDES and EI guidance, but this guidance conflicted with the default state regulations and federal Great Lakes regulations. The technical team did not recommend which guidance to follow but instead recommended that stakeholders meet to discuss cleanup criteria. This issue has still not been resolved.

More progress was made on other optimization recommendations, notably those related to facility investigation. For example, the facility has implemented the recommendations to complete additional investigation of sources of groundwater contamination discharging near Outfall 18, reduce the list of analytes to priority contaminants, and consolidate various monitoring reports into a single annual report.

6.2. GE Aircraft Engines, Ohio, Region 5

Optimization Final Report Date: September 16, 2022

Lessons Learned Interview Date: September 13, 2024

The GE Aircraft Engines facility is located along Mill Creek in southwestern Ohio. In addition to updating the CSM, the optimization report included 10 recommendations, of which five were implemented, three are in progress, and two are under consideration. A summary of the recommendations and a description of the progress toward the recommendations is included in an appendix to [the ICF, 2024 memorandum].

This facility has made significant progress since the optimization. Prior to the optimization, the primary issue of disagreement between the O/O and regulators was delineation of the groundwater plume downgradient. The optimization team recommended installation of additional wells on the facility property as well as downgradient of the facility. As of the date of this memorandum, a portion of the wells have been installed, with the remaining wells to be located and installed following sampling of the newly installed wells. In addition, the optimization team's recommendation that the building southeast of PMW-3VP be investigated for vapor intrusion. This investigation was completed, and the investigation was later expanded to encompass other buildings. Other optimization recommendations related to the transition from pump and treat (P&T) to monitored natural attenuation (MNA) remediation and a capture zone analysis for the P&T system were also implemented or are in the process of being implemented.

7. Future of the RCRA Optimization Program

The RCRA Optimization Program has consistently shown that the optimization review process provides tangible value to facilities, project managers, and stakeholders, evidenced by implementation of tailored, site-specific recommendations and post-optimization feedback. This report and the post-optimization review process identify several opportunities to standardize and strengthen the program. To maximize the return on investment and ensure consistent national impact, the RCRA Optimization Program Lead can take targeted steps to improve consistency, transparency, integration, and follow-through across EPA regions and States.

The RCRA Optimization Program has demonstrated that systematic, independent technical review can meaningfully improve remedy effectiveness, efficiency, and protectiveness. By standardizing best practices, strengthening implementation tracking, and enhancing knowledge transfer across the RCRA Corrective Action community, EPA can shift optimization reviews from a valuable supplemental activity to a core element of long-term corrective action management. With continued leadership commitment from ORCR and specific improvements to standardization, implementation tracking, training, and O/O engagement, the program can continue to drive cost-effective environmental protection while accelerating progress toward facility closure and long-term stewardship objectives.

Recommendations to Improve the RCRA Optimization Program include:

Establish Optimization Reviews as a Standard Practice for Addressing Cleanup Barriers

Embed optimization reviews as a go-to technical assistance tool to respond promptly to cleanup challenges at RCRA Corrective Action facilities when significant performance issues arise. In addition, EPA and state project managers would benefit from guidance to screen Corrective Action work plans and flag facilities that may warrant an optimization review.

Increase State and Stakeholder Engagement

Where corrective action is implemented under State authority, stronger coordination between EPA and State programs can promote consistency in optimization practices and decisions. Early engagement with facility owners/operators, responsible parties, and community stakeholders can improve transparency and increase acceptance of recommended changes.

Strengthen Tracking and Implementation of Recommendations

While optimization reviews generate actionable recommendations, tracking implementation is often time-consuming. Establish a standardized tracking system – e.g., a brief questionnaire and a shared implementation tracker – that would allow EPA to:

- Monitor implementation status
- Quantify cost savings and environmental benefits
- Identify recurring technical themes
- Measure long-term program impact

Schedule routine follow-ups 12–24 months after the review to increase accountability and ensure recommendations translate into tangible improvements. In addition, improve coordination with regions on post-review follow-ups, ask each ORCR regional liaison to incorporate regular check-ins for their assigned facilities, and track those facilities in the implementation tracker so they are flagged for biennial oversight meetings. This routine keeps recommendations moving forward and ensures visibility into progress.

Promote Knowledge Sharing and Lessons Learned

Optimization reviews surface recurring cleanup themes – conceptual site model refinement, groundwater-monitoring network adequacy, system performance tuning, closing data gaps, and data management. Establish structured dissemination through webinars and a searchable case-study repository so owners/operators and regulators can apply lessons more broadly. Collect short testimonials during post-optimization interviews to encourage participation by other facilities and regulators. Use existing forums (e.g., the monthly National RCRA Hazardous Waste Cleanup Call) to share resources and invite nominations for additional facilities.

8. References

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9. RCRA Optimization Review Technical Team

The optimization review technical team (technical team) included independent, third-party technical personnel from RTI International (RTI) who collaborated with representatives of EPA Headquarters (HQ), Office of Land and Emergency Management (OLEM), Office of Resource Conservation and Recovery (ORCR), Office of Superfund and Emergency Management (OSEM). **Table 1** lists the members of the technical team.

Table 1. Technical Team (all listed attended kickoff and virtual Site visit calls)

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Individuals from EPA HQ that contributed to the optimization review process and participated in the kickoff call on August 1, 2024, and meetings on October 31, 2024, and January 7, 2025, are listed in **Table 2**.

Table 2. Other Optimization Review Contributors

Name	Organization	Title/Role
Klara Crincoli	EPA ORCR	Environmental Scientist/RCRA Optimization Project Lead
Michael Adam	EPA OSRTI	RCRA Optimization Project Lead Support