

## **A WEB-BASED RI/FS AND RISK ASSESSMENT APPLICATION TO EXPEDITE DOE SITE CLEANUP AND CLOSURE**

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### **ABSTRACT**

Integrated Environmental Services, Inc. (IESI) has developed a web-based Environmental Data Management System (webEDMS) application which seamlessly integrates the components of the remedial investigation/feasibility study (RI/FS) process into a single application making the site cleanup and closure process faster, cheaper and easier.

Combining ESRI's Geographic Information Systems (GIS) development tools, computer data management, and 3-dimensional data display technologies, the webEDMS application allows the easy retrieval, analysis, and visualization in three-dimensions of the environmental (groundwater, surface water, soil, sediment, soil vapor, etc.), physical (hydrology, lithology, and subsurface remedial systems), and biological (human and ecological receptors) site data. The webEDMS application also links this data to project documentation (reports, photos, drawings, correspondence). The user can further analyze site data by any selected site object, geographical area of interest, and/or sampling period. In addition, the user can screen for remedial technologies based on United States Environmental Protection Agency (USEPA) guidance to efficiently identify the most applicable technologies to accelerate site cleanup. Most importantly, the user can automatically (within minutes) calculate the potential human health risk related to any selected area of interest.

The webEDMS application provides project team members with the means to query and analyze the nature and extent of site contamination, understand complex historical and current site conditions via three dimensional visualization, identify impediments to site closure, build consensus on a path forward, and achieve site cleanup and closure in a more cost-efficient and expeditious manner. The webEDMS application enables the project team to define the acceptable end state of a site early in the RI/FS process, and to study the what-if scenarios to devise a proactive approach. And since the application is web-based, it can be used by geographically displaced project team members to view project data together and expedite the decision making process.

### **INTRODUCTION**

The United States Department of Energy (US-DOE) Environmental Management (EM) Division in their February 2002 EM Program Review document identified a critical need to implement cleanup strategy reform. The focus of the reform is a fundamental change from a non risk-based to an accelerated risk-based cleanup strategy, and the primary goal is to achieve the greatest risk reduction to human health and the environment at an accelerated rate leading to site closure. These reforms include an accelerated risk-based cleanup strategy, the alignment of DOE's internal processes to support the approach of an accelerated risk-based clean up, and the

realignment of the EM program so its scope is consistent with an accelerated risk-based cleanup and closure mission. With these reforms, the US-DOE EM has estimated that it will complete its cleanup mission by the year 2035, almost 40 years ahead of the initial schedule.

Under this new initiative, contractors have to modify their approaches in conducting the RI/FS work to meet the DOE's accelerated clean up timeframe. Those that do not adopt new and innovative approaches to meet the DOE's aggressive schedules will find it difficult to be successful in the new performance-based contracting environment in which DOE is proposing. To satisfy the accelerated risk-based cleanup reforms, contractors must be able to integrate together massive amounts of site analytical data and health risk assessment capability. Multiple risk assessment scenarios must be evaluated prior to expensive site remediation in order to identify acceptable end state of the site and to identify the risk-based impediments to site closure. This information is then used to formulate path forward strategies that will expedite the closure process.

### **THE NEED OF A SEAMLESS INTEGRATED RI/FS MANAGEMENT SYSTEM**

For a large majority of environmental sites, responsible parties invest substantial financial resources to acquire environmental data for a variety of mediums including air, surface water, soil gas, soil, and groundwater. Unfortunately, in many instances, very little impetus is placed on how to organize and use this data in a manner that provides knowledge that leads to the efficient and expedited identification and solution of risk-based impediments to site closure. To meet the new DOE-EM mandate on accelerated site cleanup and closure, the capability to turn data into information and knowledge that provides accurate and time-tested solutions in a risk-based context is critical for program success.

In order to meet the DOE's new mandate on accelerated site closure via risk-based cleanup strategy, contractors will have to:

- Accurately and comprehensively characterize the nature and extent of site contamination as well as the fate and transport of contaminants in three major components of the environment (soil, groundwater and air)
- Define the acceptable end state of a site using site-specific data early in the RI/FS process and;
- Identify impediments to site closure prior to implementation of expensive and time consuming remediation in the field.

Contractors' failure to satisfy requirements of state, federal and local regulatory agencies on the above three tasks have proved to be one of the major factors in the delays of DOE site closure and higher remedial costs. To overcome this hurdle, the contractors are best assisted by a user-friendly, intuitive data management system that integrates site information to various components of the RI/FS so that the user can retrieve, display and understand complex site conditions and the potential health risks related to each site condition that the user wishes to contemplate. This capability becomes even more crucial to the DOE contractor in light of DOE-EM's fundamental change from contract based to performance-based contracts. Efficient, timely

performance and utilization of the hard-earned and expensive data is crucial for surviving in this changing DOE-EM environment.

Integrated Environmental Services, Inc. (IESI), in managing large scale, complex site cleanup for private clients in the Aerospace & Defense, Oil & Gas, and Real Estate industries and government agencies recognized the need for such an all-in-one, intuitive and user friendly system many years ago. And as such, IESI worked with experts in GIS, 3D data visualization, health risk assessment, environmental engineering and computer programming fields and has developed a web-based Environmental Data Management System (webEDMS) application that is able to seamlessly integrate the components of the RI/FS process. The webEDMS application provides a cradle-to-grave data management solution for investigation and cleanup of DOE sites. The system stores and organizes project data (environmental, physical and biological data) and documents based on GIS technology so that project team can access and analyze project data from a location of a monitoring well, to an automated risk assessment for a specific region of interest (ROI) and finally estimating the cost of a selected remedial technology (Fig. 1).

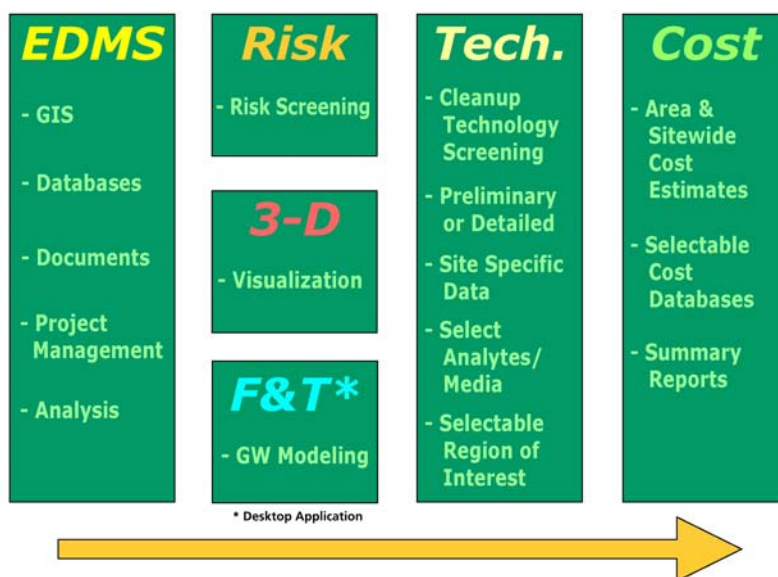


Fig. 1 The webEDMS application consists of the above modules to manage the RI/FS process. The site's spatial information, analytical data and project documents are stored in a central location and made available in the EDMS module of the webEDMS application (left column). The same information is passed to the risk screening module and 3D visualization module to perform risk calculations and visualize the site in 3 dimensions (second column from left). Based on the risk calculations, information is then passed to the remedial technology screening module to determine the appropriate remedial technologies (second column from right). Once the technology has been identified, its associated costs can be estimated from the cost estimation module of the webEDMS application. Thus, the RI/FS process can be managed from start to finish with one application (right column).

The application can therefore expedite the site cleanup and closure process, and is an asset in assisting DOE contractors in meeting the new DOE-EM accelerated risk-based cleanup mandates.

## **AN INTEGRATED APPROACH TO RI/FS & ACCELERATED RISK-BASED CLOSURE**

The webEDMS application provides project team members the ability to convert hard-earned massive amounts of site data to valuable information without searching through hardcopy libraries of project reports. The project team gains insight from the data by understanding the nature, extent and changes of site contamination over time via three dimensional visualization, identifying impediments to site closure, building consensus on a path forward, and achieving site cleanup and closure sooner and cheaper. All site information including laboratory, geological, and field monitoring data, CAD drawings, pictures, reports, correspondence, project schedules and budgets are linked and searchable through one single application. This wealth of information is available to all relevant project team members located throughout the country. In addition, the capability for a geographically displaced project team to have access to all of the site information at any time expedites the major decision making process.

The webEDMS application is based on GIS technology to organize and streamline the RI/FS study process. User defined map layers (Fig. 2, top left) are displayed in the main display window (Fig. 2, top center) and objects within the map layers can be identified and comparison of analytical results to regulatory standards and general historic trending analysis can be conducted for the entire site or for specific user defined regions (Fig. 2, bottom). This allows the project team to focus quickly on potential impediments to site closure.

Advanced three-dimensional data display technologies allow the user to display a wide variety of site data including environmental (e.g. groundwater, surface water, soil, sediment, soil vapor, etc.), physical (hydrology, lithology), and biological (human and ecological receptors). This information can be queried as a function of both time and space (user defined temporal and spatial regions of interest) so that visualization of both pre- and –post remediation conditions can be communicated. Figures 3a-c illustrate the three-dimensional display capabilities of the webEDMS application.

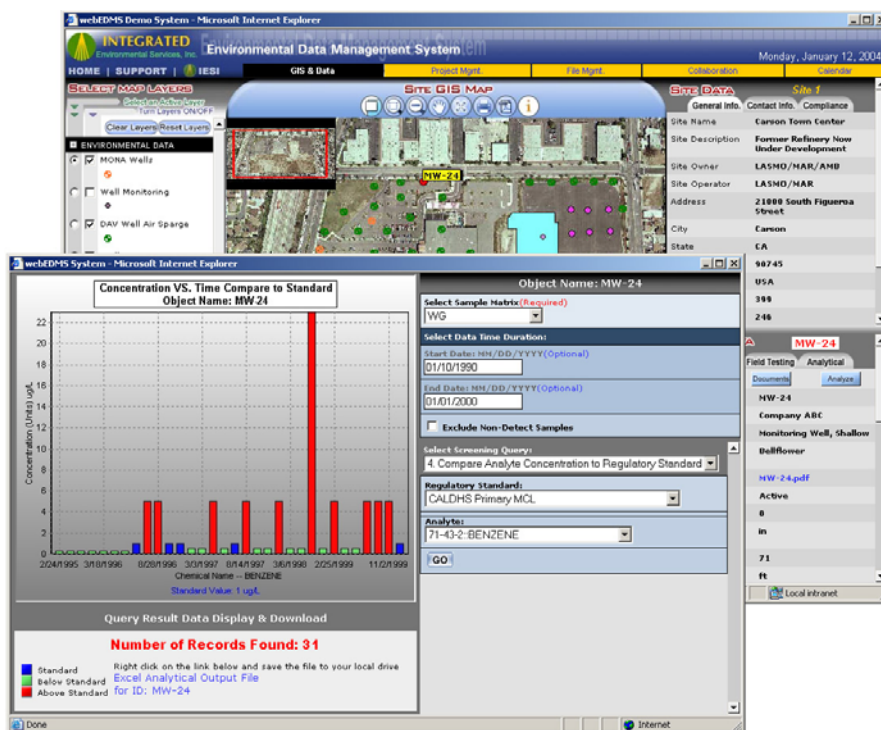


Fig. 2. Main display window showing user defined map layers (top left) and the GIS display window (top center). Data trending analysis allows for a visual interpretation of site conditions in comparison to user defined or regulatory mandated screening criteria (bottom). The trending plot and data is directly downloadable to Microsoft Excel for easy report preparation.

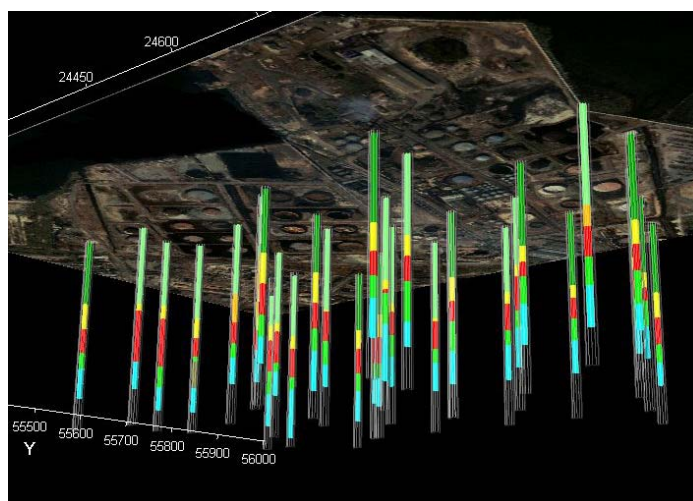


Fig. 3a. A subsurface view (looking up toward the bottom of the ground surface) of the site lithology for user defined boring logs. The color display represents the soil type, red signifying least permeable (e.g. clay) and blue signifying most permeable (e.g. clean sand). Based on a user-defined region of interest (ROI), the visualization application automatically links to the database to display only the data within the specified ROI. This process is completed “on the fly” for any user-defined area.

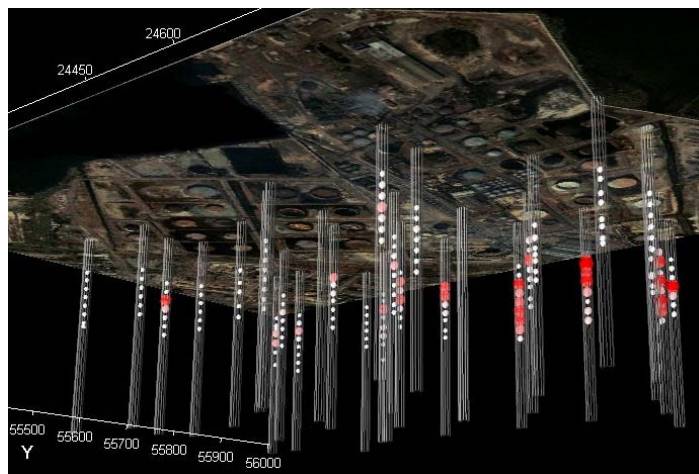


Fig. 3b. A subsurface view (looking up toward the bottom of the ground surface) of the soil boring mesh (white vertical lines) showing the analytical sample concentrations (white spheres signify non-detects and red spheres signify detects, and the sphere radius is proportional to the concentration value). Based on a user-defined region of interest (ROI), the visualization application automatically links to the database to display only the data within the specified ROI. This process is completed “on the fly” for any user-defined area of the site. The results can also be specified for a user-defined time frame in order to compare pre- and –post remedial site conditions.

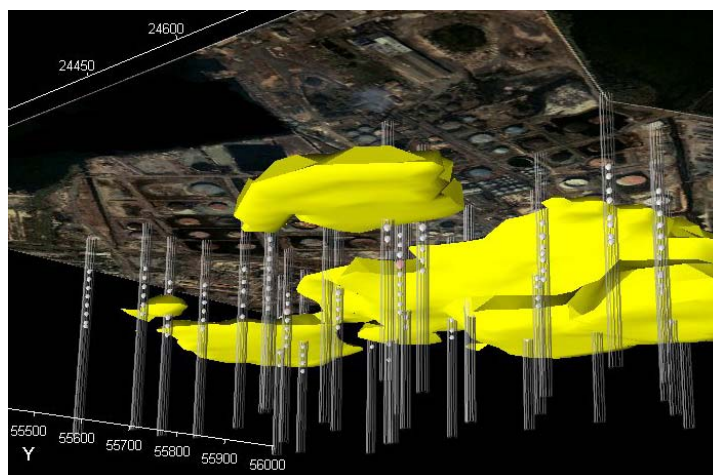


Fig. 3c. A subsurface view (looking up toward the bottom of the ground surface) of the contaminant plume for the data that is displayed in Fig. 3b. Based on a user-defined region of interest (ROI), the visualization application automatically links to the database to display only the data within the specified ROI. This process is completed “on the fly” for any user-defined area of the site. The results can also be specified for a user-defined time frame in order to compare pre- and –post remedial site conditions.

The automated risk assessment (algorithm based on the USEPA risk assessment protocol) allows the user to conduct human health risk assessments (and if needed, ecological risk assessments) for the entire or for any portion of a site in just a few clicks of the mouse. When a user defines a region of interest (ROI), only the data specific to that ROI is automatically passed to the risk assessment application. The user can choose the appropriate media type (groundwater, soil, air, soil vapor) and the contaminants of concern (drop down menu automatically created based on the

ROI selected). The user also has the option of choosing Federal or State-specific toxicity criteria, specific receptors (e.g. onsite commercial worker, construction worker, onsite resident child, onsite resident adult, offsite resident child, offsite resident adult), associated with the land use scenarios (e.g. commercial, industrial, residential) along with the applicable exposure pathways (e.g. dermal contact, ingestion, inhalation of indoor air, inhalation of outdoor air) (Fig. 4). The health risk assessment module of the webEDMS is designed based on USEPA default parameters; however, modifications to these parameters, if necessary, are allowed. The user can conduct risk assessments that result in site specific Health Based Remedial Goals (HBRGs) or calculate the site-specific cumulative incremental lifetime cancer risk (Table I) for any user defined region of interest (Fig. 5). Once the calculations are conducted, a complete transaction log is prepared and the results downloadable to Microsoft Excel for easy report preparation.

Fig. 4 A snapshot of the risk assessment parameter selection page. The risk assessment application queries the database for the data only within the user define region of interest and calculates cumulative incremental lifetime cancer risk or health based remediation goals.

Table I representative example of risk-assessment output for region of interest defined in Fig. 5.

Receptor	Compound	Cumulative HQ Summary				
		Ingestion	Dermal	Outdoor Air	Indoor Air	All Pathways
Residential Child	BENZENE	9.90E-03	9.90E-04	3.90E-02	3.5	3.6
Residential Child	ETHYLBENZENE	9.40E-04	9.70E-05	3.90E-04	0.02	0.02
Receptor	Compound	Cumulative ILCR Summary				
		Ingestion	Dermal	Outdoor Air	Indoor Air	All Pathways
Residential Child	BENZENE	2.90E-06	1.60E-07	6.80E-06	6.10E-04	6.20E-04
Residential Child	ETHYLBENZENE	3.60E-07	3.60E-08	4.40E-07	2.20E-06	2.30E-05



Fig. 5 User defined region of interest (yellow shaded geometry) for representative risk assessment calculations shown in Table I

The webEDMS application approach to accelerated risk based site cleanup is by helping transform incoherent site data to useful information which improves the overall knowledge of the site for developing better solutions. By building solutions that work, DOE contractors will earn the trust of the regulatory agencies. The site data can be displayed in 3D with the webEDMS application in order for the project team to understand complex site conditions, build a consensus, agree upon a path forward and avoid costly mistakes. Figure 6 provides a schematic of this approach. The project team can define the acceptable end state of a site using the site-specific data early in the RI/FS process using the webEDMS application to identify and address impediments to site closure. This can be done prior to the implementation of expensive and time consuming remediation work in the field. Site closure approval can be expedited when the regulatory agencies trusts the RI/FS work that DOE has conducted. The RI/FS process becomes seamless and transparent for all stakeholders including state, federal and local regulatory agencies with the use of a tool such as the webEDMS application.

There are several ways in which the webEDMS application can help DOE contractors achieve DOE's goals of accelerated risk based site cleanup, which in turn, will save time and money for DOE.

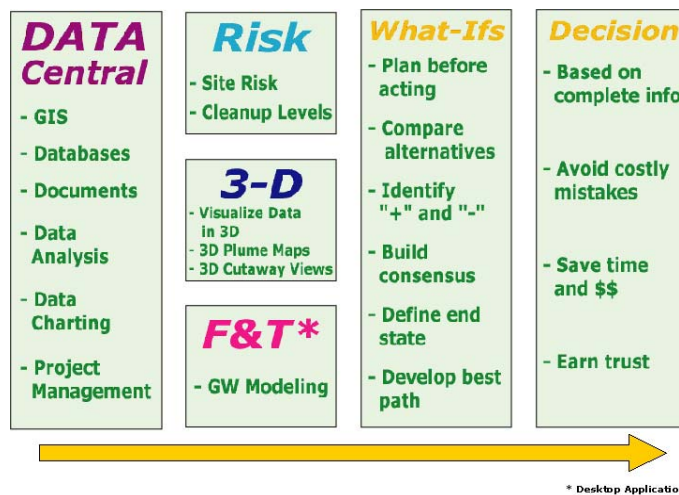


Fig. 6 The webEDMS application approach on accelerated risk-based DOE site cleanup



Specifically, the project information is available over the web therefore it can be shared with project team members who are geographically dispersed which enable the team to query, analyze and view site data in 3D to understand complex site conditions. Risk calculations can be performed on the entire site and on selected regions of interest to identify the major impediments to site closure. Once the site impediments have been identified, multiple scenarios can be conducted to develop a cost-effective solution prior to the start of any field activities. By recognizing what the nature and magnitude of potential health risk associated with a particular site condition, the project team is able to be more proactive in their approach to the regulatory agencies.

The webEDMS application can help expedite the site closure process by performing risk based calculations which provide the ability to negotiate with agencies from a proactive rather than a reactive position. The calculations can be completed in a matter of minutes by accessing the environmental data and spatial information in the central database. If the risk calculations for the entire site exceed the screening criteria, the calculations can be repeated for selected areas based on defined regions of interest. Furthermore, the names of chemicals as well as the areas where they are present that drive the exceedances can be quickly identified and appropriate remedial action designed and implemented.

The project team is able to define regions where risk numbers are acceptable and obtain signoff from the regulatory agency to commence redevelopment work at those areas. This will allow portions of the project site to be redeveloped while other areas of the site continue with the remediation process. This approach will help the project move forward instead of being placed on hold and waiting for all site wide impediments to be resolved.

The ability to conduct multiple landuse and receptor exposure scenarios for post- and pre-remediation risk assessment is necessary to meet the new DOE-EM mandate of accelerated risk-based cleanup. The webEDMS application is able to provide such capability. By performing multiple scenarios of post- and pre-remediation risk assessment on multiple regions of interest, the project team can develop appropriate remediation strategies. For example, if an area has been determined as a site impediment, the current risk numbers for that area can be calculated. Using the central database and the GIS component of the webEDMS application, the contaminants of concern can be identified. The depth of the contaminants of concern can also be established from the central database and visualized in three dimensions. The project team can conduct a number of different scenarios by excluding certain contaminants of concern from the risk calculations and obtaining a new risk number that will meet the regulatory agencies criteria. The project team can also determine how deep they would need to excavate the site to reach a favorable risk number by excluding the contaminants of concern within that depth in the risk calculations. The above analysis and assessments can be conducted over the internet and more importantly, performed before remedial activities begin, saving valuable time and money.

By having the ability to calculate the risk to human health in a matter of minutes under each defined site landuse and receptor exposure condition with the webEDMS application compared to traditional methods, the project team is able to screen all probable combination of site conditions in order to make better decisions on how to redevelop their site. In doing so, the project team will be better informed and can take a more proactive role when it comes to

regulatory agency negotiations. The team will be able to improve its position to respond to the agencies' concerns and questions. The risk numbers generated from the calculations will be able to lead them to different redevelopment alternatives to meet the risk criteria set forth by the regulatory agencies. This method will expedite site closure and mutually benefits both the stakeholders and the regulatory agencies, and contribute in meeting the new DOE-EM accelerated risk-based cleanup mandates.

## **REMEDIAL TECHNOLOGY SCREENING & COST ESTIMATION**

To complete the discussions of how the webEDMS application supports the RI/FS process, the webEDMS application also employs a remedial technology and cost estimating module based on the Federal Remediation Technologies Roundtable *Remediation Technologies Screening Matrix and Reference Guide, Version 4.0* from the U.S. Army Environmental Center. The user can screen for applicable remediation technologies (over 40 technologies are included) using generally available site data such as media (groundwater or soil) and contaminant type, or the user can conduct a screening which incorporates site specific data including chemical and physical parameters. The application ranks technologies from 2 – most applicable to 0 – least applicable to quickly identify the most applicable technologies for the specific site conditions.

## **FINAL COMMENTS**

With the new DOE-EM mandates of accelerated risk-based site cleanup and closure, conversion of hard-earned site data to information and to knowledge so that impediments to site closure can be identified is critical to the success of the expedited closure schedules. The webEDMS application described in this paper includes a health risk assessment function that automatically calculates, on the fly, the potential health risk associated with a user-defined region of interest. The system, therefore, provides the users the capability to run numerous risk assessment screening scenarios and select an end state site condition that will be acceptable to agencies before the implementation of expensive site remediation in the field. All of this leads to expedited approval of site closure and significant savings on cost and schedule. The webEDMS application can provide a proven solution to help the DOE-EM accomplish the accelerated risk-based cleanup and closure mission.