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Focused Feasibility Studies: Streamlining the Process

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ABSTRACT

Conventional approaches to complete the CERCLA remedial action and RCRA corrective action processes at military bases scheduled for closure have encountered high costs and long schedules. These problems are due, in part, to the need to prepare voluminous feasibility studies (FSs) of remedial alternatives, backed up by extensive site investigations. These FSs have followed the long established tradition of starting with the universe of options and systematically narrowing the field through a seemingly endless repetitive process of proving why most of the options will not work. This unnecessary study and paperwork increases costs, slows down reviews, complicates the decisionmaking process, and delays the ultimate return of valuable base property to civilian use.

This paper illustrates a new approach utilized at a California closure base whereby the FS is streamlined and focused by starting with only a few remedial options which are judged likely to work based on experience as well as knowledge of the site and the contamination. The focused FS first ranks the complexity of each site, based on a group of rating factors adapted from accepted U.S. EPA guidance. Rating factors include exposure from and risk posed by the site, site surface complexities, magnitude and extent of contaminated media, and conditions of the waste. Next, a limited range of alternatives, perhaps one or two, are developed for less complex sites, while broader ranges of alternatives are developed as site complexity increases. The level of detailed analysis is also tailored to complexity: little or no modeling and analysis for uncomplex sites; more extensive modeling and analysis for complex sites. This methodology usually proves that most sites are not complex, despite initial perceptions, and thus the FS can be streamlined into a thinner document and the closure can proceed into getting on with cleanup.

INTRODUCTION

The Secretary of Defense established a commission to recommend military installations for realignment and closure. The United States Congress and the President endorsed this commission and its charter by implementing the Base Realignment and Closure Act (BRAC) and Defense Authorization Amendments. When the commission submitted its report to the Secretary of Defense in December 1988, 145 military installations were affected. Of these installations, 86 are to be closed, including Mather Air Force Base near Sacramento, California.

Closure activities at Mather AFB have been further complicated in that the base was placed on the Superfund National Priorities List (NPL) in July 1987. Since its listing on the NPL, 69 sites have been identified for remedial investigation. The challenge facing Mather AFB is how to accomplish environmental restoration under CERCLA within the funding and scheduling constraints of BRAC. To comply with BRAC, all remedial investigations and feasibility studies for all sites on the base must be completed by September 1995. This schedule is ambitious, especially considering that remedial investigations have either not yet been initiated or are still underway at many of the sites and feasibility studies at most of the sites have not yet begun.

RI/FSs conducted at Mather AFB thus far have encountered high costs and long schedules to comply with a complex system of requirements posed by CERCLA, RCRA, and State of California regulations. Changes must be identified and initiated if compliance with BRAC is to be achieved.

The paperwork requirements of the CERCLA decisionmaking process impose high costs and long schedules, especially those associated with FSs. CERCLA guidance prescribes a comprehensive methodology for conducting feasibility studies of remedial alternatives. Taken to its fullest extent, rigorous adherence to this guidance results in thick reports which are time-consuming and costly to prepare. Historically, regulatory agencies have had a tendency to require the same rigorous evaluations for simple sites involving few contaminants and little overall risk as those which are complex, involve multiple media and contaminants, and carry substantial risk. Thus, there is no credit given in the process for simple problems, i.e., all must follow the same rigorous FS approach. Further, the CERCLA FS methodology is inherently burdensome and redundant since too much of the effort is spent proving why most of the universe of technologies and process options will not work rather than proving why what is already known to work will work at the site in question.

This paper presents a novel concept for overcoming the deficiencies associated with conventional FSs. The focused feasibility study (FFS) provides an effective methodology for tailoring the FS to the site complexity, focusing more effort on sites which are most complex. The key to successful implementation and acceptance of this approach by regulatory agencies requires some measurable means of evaluating site complexity. To meet this need, the Complexity Ranking System (CRS) has been developed which quantifies the subjective evaluation of site complexity based upon responses to several rating criteria. Application of the CRS allows the classification of sites as either uncomplex, average, or complex. Once the complexity of the site has been determined, the FS can be focused accordingly. Focusing includes the development and evaluation of alternatives that are likely to work and solve the problem. Further, the range of remedial alternatives developed is commensurate with the complexity classification for each site; i.e., a limited range of alternatives is developed for uncomplex sites, while broader ranges of alternatives are developed as site complexity increases. This streamlined FFS approach greatly reduces report preparation time, reduces costs, produces thinner reports which are less time-consuming for agencies to review, provides for less complicated decisionmaking, and reduces the time for return of the base property to civilian use.

FFS METHODOLOGY

Conventional CERCLA FSs begin by starting with the universe of remedial technologies/process options and then systematically eliminating options one-by-one with respect to implementability, effectiveness, and cost. This process of elimination justifies why each option is either likely to work or not likely to work until the technology spectrum is narrowed to a manageable list. From this narrowed list of technologies, remedial alternatives are developed to make a wide range of options, usually spanning the range of general response actions, available for analysis. Once the remedial alternatives have been assembled, a second screening of alternatives is initiated to further narrow the field. A third level of even more detailed analysis, often involving complex hydrogeologic and/or fate and transport modeling, is then conducted to provide decisionmakers with enough information to select a preferred alternative. The process is laborious and often requires several months for preparation followed by several additional months for regulatory agency reviews and document revisions. A typical FS generally approaches or exceeds one year for completion.

The FFS streamlines the FS process by limiting the starting point to those remedial technologies which are likely to work. Utilization of this approach results in the development of a few technology options which have succeeded in similar situations or related applications. This precept is backed by a large body of knowledge already gained from Superfund and other site remediations which indicate the specific technologies that work for specific contaminants and media. With few exceptions, most sites, especially those typically found on military bases, involve the same types of contaminants. While geology and hydrology may vary from site to site, the choice of remedial technologies generally correlate with the types of contaminants rather than with site conditions. It is already well accepted that few known, effective, and technically feasible remedial alternatives are currently available to address site problems. Further, Applicable or Relevant and Appropriate Requirements (ARARs) typically constrain the number of alternatives to be considered because not all of the technologies can offer the required level of protection.

Once the list of technologies and process options is established, justification is provided for each as to why it is technically feasible. Subsequently, the FFS process works with the list of known, workable, and justified technologies/options and constructs a more limited number of remedial alternatives for detailed analysis than would otherwise be developed by a conventional FS. Both the number of alternatives and the detail of their analysis is tailored to the complexity of the site under evaluation.

This FFS approach meets the legal and regulatory requirements of CERCLA. Focusing of the FS is consistent with the principles of streamlining as stated in the NCP [55 FR 8666 et seq.]

The FFS approach is also consistent with the U.S. EPA's directives for consideration of innovative technologies. Innovative technologies can be fed into the evaluation process if there is not only sufficient information to show that the innovative technology offers significant technical or economic incentives relative to conventional solutions, but also that the technology is sufficiently developed to offer a realistic chance of success. The qualified and experienced FS author will be knowledgeable regarding the history of development of applicable innovative technologies. That is, even though a technology may not ever have been applied at a site, if it has a realistic chance of being considered as a site remedy, its development history will already be well established and its development will be very advanced. Conversely, technologies which, are promising on paper but which are still laboratory curiosities are not realistic candidates within the needed time frame and therefore are not considered.

The following sections of this paper discuss some of the important details of the FFS methodology currently being applied at Mather AFB, including the cornerstone of the methodology, the Complexity Ranking System (CRS). The discussion describes the novelties of the approach, focusing on the principal differences relative to conventional FS practices.

COMPLEXITY RANKING SYSTEM

Paramount to the consistent application of the FFS approach is the definition of site complexity in measurable terms such that each site is appropriately categorized according to its relative complexity. Once this categorization is achieved, the FFS can efficiently tailor remedial alternatives and their analysis to a level which is commensurate with site complexity. The CRS has been developed to aid in this categorization.

The CRS adapts it fundamental principles from the U.S. EPA's *Scoper's Notes—An RI/FS Costing Guide* [U.S. EPA 1990] to provide a comparison of each site's characteristics to a group of rating criteria. The principal rating criteria include:

- Exposure from and risk posed by the site
- Site surface complexities
- Magnitude and extent of contaminated media
- Condition of the waste

The rating criteria have been assembled into a CRS Worksheet as shown in Figure 1. This worksheet provides a scorecard for each site which can be evaluated based on information compiled during the RI process. Note that each of the four principal rating criteria is comprised of multiple factors which are specific to the given criterion. Additional rating criteria can be introduced to address site peculiarities, if appropriate.

FACTORS	RANGE			SITE				
EXPOSURE RISK	L	M	H	1	2	3	4	5
Significant Closest Population	>1500m	500m	<100m					
Working Drinking Water Wells	No	--	Yes					
Off-Site Sensitive Areas	No	--	Yes					
Adjacent Agriculture Land Use	No	--	Yes					
Risk Assessment	<10-6	10-5	>10-4					
SITE SURFACE								
Site Area	small	medium	large					
Access (for equipment)	easy	aver.	hard					
Topographic Variation (in feet)	<5	5-20	>20					
Ponds or Lagoons	No	--	Yes					
On-Site Streams	No	--	Yes					
Soil Type	loam	sandy	rocky					
Rock Outcrops	No	--	Yes					
On-Site Vegetation	none	sparse	heavy					
Surface Settling/Cracking	none	sparse	heavy					
Evidence of Flooding	No	--	Yes					
CONTAMINATED MEDIA								
Soil Stains	none	few	many					
Odors	none	some	strong					
Wind Blown Particulate	none	little	much					
Buildings/Structures	none	few	many					
Water Table Depth (in feet)	>25	13-25	<13					
Off-Site Complaints (fishkills, etc)	none	few	many					
Discolored Sediment Deposits	none	few	many					
Annual Rainfall (inches)	<18	18-30	>30					
WASTE CONDITION								
Drums	none	few	many					
Storage Tanks	none	few	many					
Container Condition	good	aver.	poor					
Known High Hazard Substance	none	little	much					
Contaminants Present	few	--	many					
Refuse Present	No	--	Yes					
TOTAL SCORE								
Lows (L)								
Medium (M)								
High (H)								

Figure 1
CRS Worksheet

The first stage of the CRS procedure requires the FFS author to systematically respond to each of the rating criteria factors listed in the worksheet. For purposes of the CRS, responses to each factor are simply designated as high, medium, or low. Range criteria are listed next to each rating factor to aid in this designation. For example, the risk assessment factor (excess cancer risk) of the CRS Worksheet defines low risk as less than or equal to 10^{-6}, medium risk as 10^{-5}, and high risk as greater than or equal to 10^{-4}. Therefore, if the base line risk assessment of the RI determined that the excess cancer risk from Site 1 was $5.5x10^{-5}$, then the FFS author would record a medium response or M for the risk assessment factor for Site 1. This designation process is repeated until responses have been generated for each of the rating factors for every site.

Next, site scores in each column are tabulated by adding up the respective numbers of high, medium, and low responses. For example, if the number of medium responses for Site 1 adds up to 10, then the Total Medium score for Site 1 is simply recorded as 10. The totals are recorded in the appropriate spaces near the bottom of the worksheet.

Once the totals have been determined, the tabulated scores for both medium and high responses are plotted as "stacked column" graphs to allow site comparisons. Figure 2 is an example of the stacked column graph generated by the CRS for five sites from a particular operable unit. The graph depicts the relative complexity of a site, i.e., as the magnitude of the high and medium responses increase, site complexity increases. In the example of Figure 2, Site 3 is identified as the most complex of all sites, with 19 out of a possible 29 responses being either high or medium.

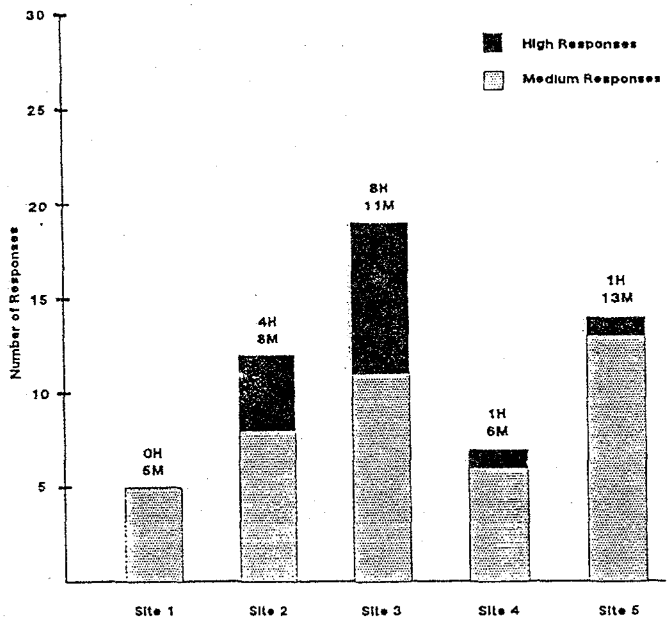

Figure 2
Stacked Column Graph of Complexity Scores

In general terms, based on the rating criteria, site complexity can be defined as follows:

UNCOMPLEX

- Site area is small in size and not located near populated areas or buildings.
- Little or no contamination is present and/or the potential for migration is low.
- Contamination is usually associated with some type of spill.
- Exposure is through direct contact with the contaminant(s).
- Contamination is limited to the unsaturated vadose zone and does not impact the groundwater.
- There is little variation in lithologic or hydrogeologic conditions.

AVERAGE

- Site area is average in size and is possibly located near populated areas and/or buildings.
- Contamination is present at the site and/or past history indicates disposal of contaminants; the potential for migration of the contamination exists.
- Contamination is usually the result of a spill and/or buried waste; some vapor phase odor may be noticeable.
- Exposure is through direct contact and/or ingestion of the contaminant.
- Contamination has impacted the underlying aquifer.
- Lithology and hydrogeology are somewhat variable.

COMPLEX

- Site area is large in size and is located near populated areas and/or buildings.
- The presence of contamination at the site is confirmed and usually involves an assortment of waste.
- Contamination is usually the result of a spill and/or buried waste.
- Exposure is through direct contact with the contaminant, inhalation, and/or ingestion.
- Drinking water wells show signs of contamination.
- Possible airborne contamination is detected from sampling.
- Contamination penetrates the vadose zone and causes contamination of the underlying aquifer or aquifers.
- Possible off-site impacts from migration of the contamination.
- Lithologic and/or hydrogeologic conditions are complex.

Other generalizations pertaining to site complexity could be added to reflect unique site features or unusual situations.

The final step of the CRS procedure designates the site(s) into the uncomplex, average, or complex categories. While this final categorization involves some degree of judgement and subjectivity, the complexity of a given site as it compares to another site or group of sites is relatively clear based on the magnitude of the complexity scores. As an example, evaluation of the stacked column graphs of Figure 2 could result in categorizing site complexities as follows: Site 3 is complex; Sites 2 and 5 are average; and Sites 1 and 4 are uncomplex. The author's judgement, which is graphically presented in Figure 3, is reflected in the establishment of the cutoff lines separating the three categories. While the positioning of these cutoff lines is a matter of judgement, the basic principle behind CRS holds true: as medium and high responses increase, the overall complexity of a site also increases, thereby correspondingly increasing the level of analysis in the FFS.

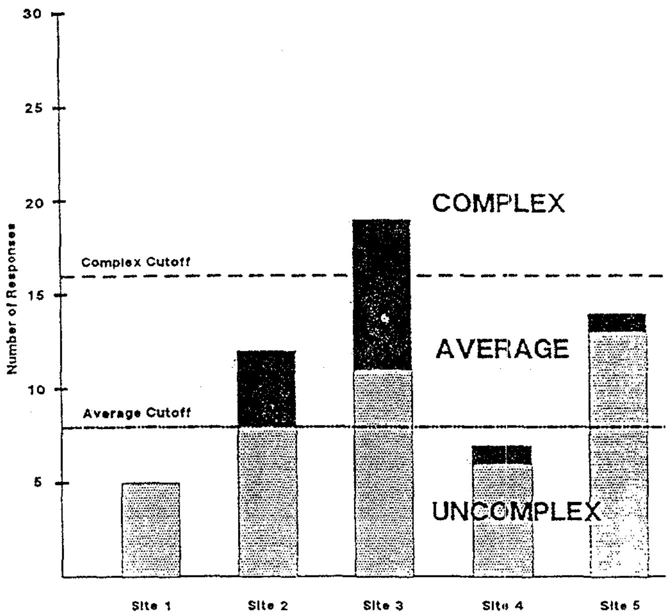

Figure 3
Complexity Determination

Interaction among all parties, including regulatory agencies, is important during the final categorization process because this process establishes the foundation for focusing available resources where they are needed the most, i.e., on the most complicated sites. The CRS Worksheet also provides an excellent summation of all pertinent information needed for the categorization exercise. Working primarily from the worksheet saves a lot of time in discussions with regulators.

REMEDIAL ALTERNATIVES DEVELOPMENT

Once complexities of the individual sites have been determined, the next step in the FFS process is the development of remedial alternatives. These alternatives are assembled from the pool of known remedies which have been applied at similar sites to handle similar contamination problems. Information is gleaned from numerous technical documents, including but not limited to government and private sector FSs and RODs, professional journals and publications, and other pertinent literature sources. With some exceptions, most contamination at military installations, including Mather AFB, is limited to fuels and solvents. Although the environments may differ significantly in terms of hydrology, geology, and source, significant information already exists to specify remedies for the contaminants typically encountered.

Innovative technologies are included for consideration during the FFS if both of the following two criteria have been met:

- Sufficient information exists which demonstrates significant performance or cost advantages relative to conventional solutions.
- The technology has been developed and/or tested to the point where success is likely if implemented.

It is the responsibility of the FFS author(s) to effectively evaluate existing technologies along with innovative technologies which meet the aforementioned criteria.

The following discussion illustrates general examples of how remedial alternatives are developed at a level commensurate with the complexity of a site; i.e., a limited range of alternatives for uncomplex sites, broader ranges of alternatives as site complexity increases.

For an uncomplex site, the range of remedial alternatives developed for evaluation during the FFS is likely to be limited to:

- A no-action alternative which is required in the NCP to provide a base line for comparison with other response actions
- An alternative which provides protection of human health and the environment by controlling and/or preventing exposure to the contaminated soil through the use of institutional/access controls or containment technologies.

The range of remedial alternatives developed for an average site is likely to include:

- A no-action alternative (as required by the NCP)
- An alternative that utilizes containment of the contamination to prevent potential exposure and/or reduce the mobility of contaminants to an acceptable level
- An alternative that removes and disposes of the contamination.

Complex sites will require the largest range of remedial alternatives. These remedial alternatives are likely to include:

- A no-action alternative (as required by the NCP)
- An alternative that utilizes in situ treatment of the contamination to reduce contamination to acceptable levels
- An alternative that utilizes removal and/or treatment with disposal of the contamination
- An alternative that combines technologies to provide both containment and active treatment.

While these ranges are typical and appropriate for most sites, they should by no means be considered inflexible. Some deviation may be warranted if justified by unique situations. Such deviation is discretionary on the part of the FFS author.

IDENTIFICATION OF APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARs)

In a parallel effort to alternatives development, ARARs are identified for evaluation during the FFS. Identification of ARARs for the FFS closely follows conventional guidance for the FS in that action-specific, location-specific, and chemical-specific ARARs and pertinent To-Be-Considered (TBC) materials are identified and evaluated. However, resources expended in accomplishing ARAR definition for the FFS are usually decreased simply because fewer remedial alternatives are developed, thereby decreasing the number of action-specific ARARs and TBCs.

ALTERNATIVES ANALYSIS

The purpose of the detailed analysis is to provide decisionmakers with sufficient information to adequately compare the alternatives, select an appropriate remedy for the sites, and demonstrate fulfillment of the statutory requirements. The methodology for the detailed analysis in the FFS is much the same as in the conventional FS:

- An assessment of each remedial alternative is performed against the nine CERCLA evaluation criteria
- A comparative analysis is performed which focuses on the relative performance of each alternative against the CERCLA criteria

However, in the FFS, the level of detail at which alternatives are evaluated is commensurate with the complexity of the site. For example, computer modeling may be conducted to aid in alternatives comparison for both average and complex sites, but not for uncomplex sites. Further, the level of modeling sophistication would likely be greater for complex sites than for average sites. Available resources are focused to concentrate on complex problems where more thorough evaluations are often necessary to determine the effectiveness of an alternative.

As in the conventional FS, all remedial alternatives must meet the two threshold criteria: (1) overall protection of human health and the environment, and (2) compliance with ARARs. Alternatives that do not protect human health and the environment or do not comply with ARARs (or justify a waiver) will not meet statutory requirements for selection of a remedy and therefore will be eliminated from further consideration. The next five criteria are balancing criteria upon which the remedy selection will be based and include: (1) short-term effectiveness; (2) long-term effectiveness and permanence; (3) implementability; (4) reduction of toxicity, mobility, and volume; and (5) cost. CERCLA guidance for conducting feasibility studies lists appropriate questions to be addressed when evaluating an alternative against the balancing criteria. These same questions are applied during the FFS detailed analysis to provide a consistent basis for evaluation of each of the alternatives. The final two criteria which are evaluated during the review periods include: (1) state (support agency) acceptance and (2) community acceptance.

Once the alternatives have been described and individually assessed against the nine criteria, a comparative analysis is conducted to evaluate the relative performance of each alternative. The purpose of the comparative analysis is to identify the advantages and disadvantages of the alternatives relative to each other, so that key tradeoffs are identified for balancing by the decisionmaker.

CONCLUSION

The FFS provides an effective methodology for tailoring the FS to the site complexity, focusing more efforts on complex sites and less rigorous analyses on the less complex sites. Site complexity is determined by systematically replying to each of the rating criteria listed in the CRS Worksheet, tabulating the total number of high, medium, and low responses, and preparing the stacked column graph of complexity scores. The final step of the CRS procedure designates each site as either uncomplex, average, or complex.

Once complexities of the individual sites have been determined, the next step in the FFS process is the development of remedial alternatives. These alternatives are assembled from the pool of known remedies which have been applied at similar sites to handle similar contamination problems. The remedial alternatives are developed at a level commensurate with the complexity of a site; i.e., a limited range of alternatives is developed for uncomplex sites, while broader ranges of alternatives are developed as site complexity increases.

Finally, the level of detail at which alternatives are evaluated is also commensurate with the complexity of the site. The available resources are focused to concentrate on complex problems where more thorough evaluations are often necessary to determine the effectiveness of the alternative.

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Risk Assessment	<10-6	10-5	>10-4					
SITE SURFACE								
Site Area	small	medium	large					
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On-Site Streams	No	--	Yes					
Soil Type	loam	sandy	rocky					
Rock Outcrops	No	--	Yes					
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Evidence of Flooding	No	--	Yes					
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Contaminants Present	few	--	many					
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