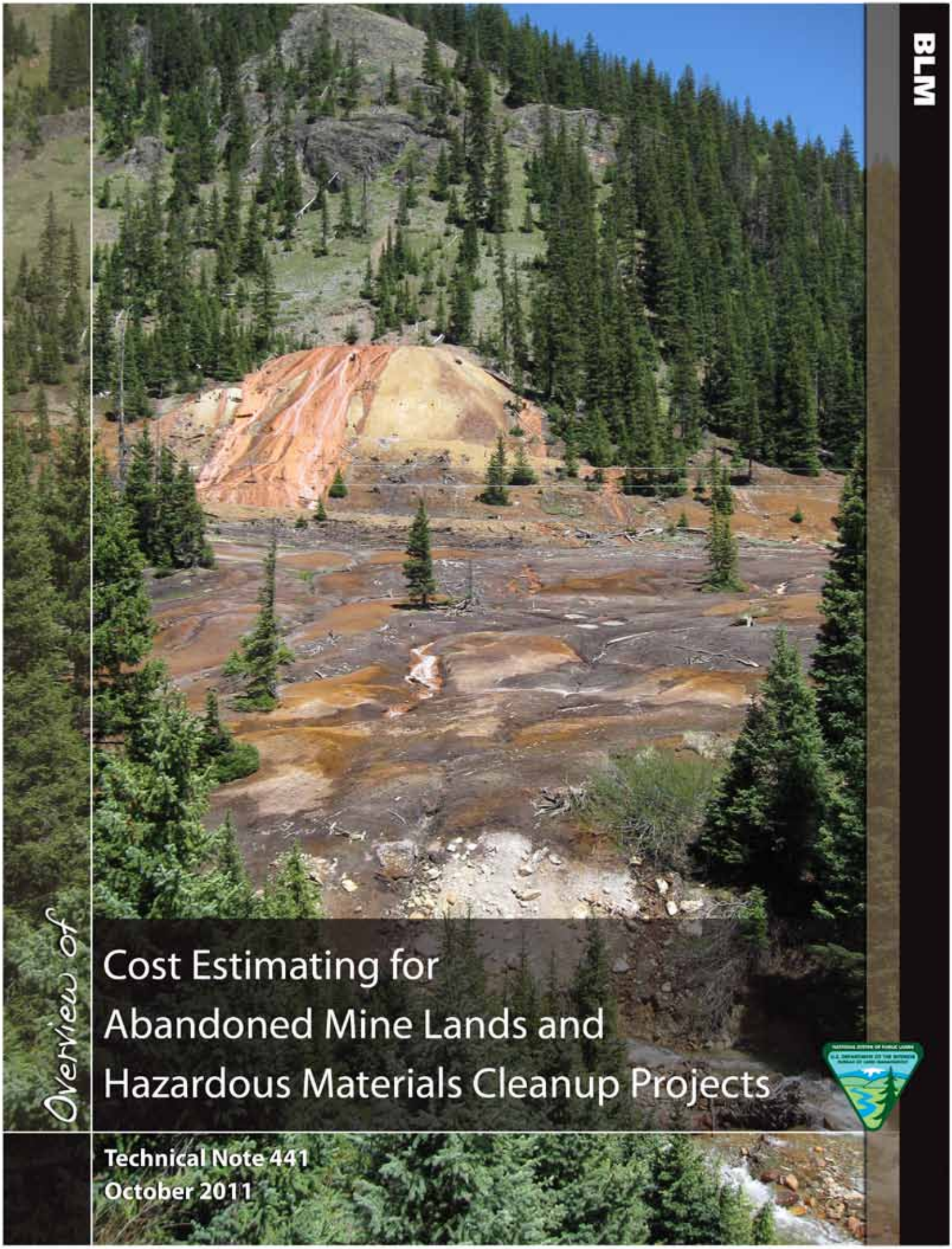

BLM

Overview of

Cost Estimating for Abandoned Mine Lands and Hazardous Materials Cleanup Projects

Technical Note 441
October 2011

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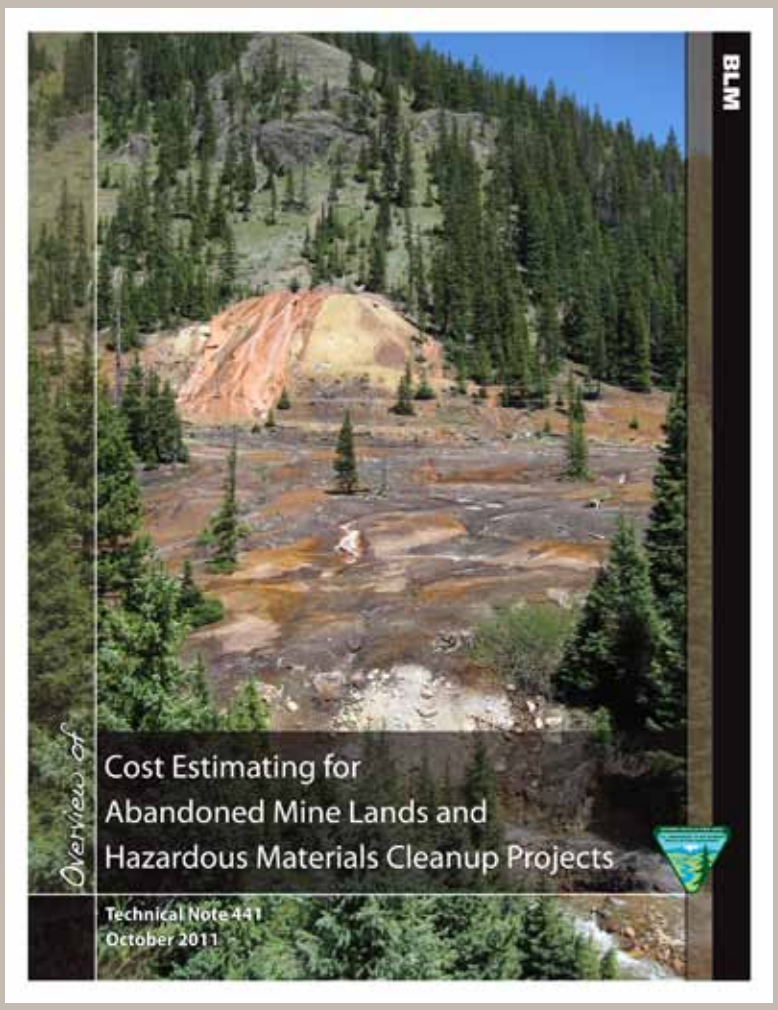

Overview of Cost Estimating for Abandoned Mine Lands and Hazardous Materials Cleanup Projects

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October 2011

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BLM environmental engineer Suzanne Buntrock and BLM construction cost estimator John Treacy conducted the final review of this technical note.

Contents

Abstract

This publication provides information on the procedures and activities associated with cost estimating for environmental response projects. Costs estimates are used to help define the magnitude of the project and accuracy of the total expense, depending on the stage of a project. This publication is intended to assist environmental professionals with determining the level of accuracy and detail required for each project estimate. The goals of this reference are to provide an understanding of the need for cost estimates, to improve the consistency of cost estimates developed in support of abandoned mine lands and hazardous materials site evaluations and remedy selections, and to establish classifications that define the level of confidence in the estimate at various stages within a cleanup project. Four different cost estimating methods are described for consideration. Utilization of this guidance will assist the environmental professional in developing a reproducible estimate appropriate for the phase of a project.

Introduction

A cost estimate can be defined as an evaluation of the expected costs to the government for the performance of an activity, either a service or construction task, or for the acquisition of an item. Cost estimating is the process of assembling and projecting the costs for the work to be performed on a project and should take all expected costs into consideration for any part of a project.

Since many factors can contribute to cost overrun, the typical project often overruns its original cost estimate. Overruns are common on government and commercial projects, even when changes in the design and varying field conditions are taken into account. The risk for potential overrun is increased due to the probability of unforeseen conditions whose costs exceed the estimated allocated contingency. In addition, contractor production rates are generally lower, while their indirect costs and risk/profit factors are higher than government estimates.

The purpose of this guidance is to provide information on the procedures and activities associated with cost estimating environmental response projects, such as abandoned mine lands and hazardous materials cleanup. Cost estimates are used to help define the magnitude and accuracy, depending on the stage of a project. This guidance is intended to assist environmental professionals with determining the level of accuracy and detail required for each project estimate.

The goals of this reference are to provide an understanding of the need for cost estimates, to improve the consistency of cost estimates developed in support of abandoned mine lands and hazardous materials site evaluations and remedy selections, and to establish classifications that define the level of confidence in the estimate at various stages within a cleanup project. Utilization of this guidance will assist the environmental professional in developing a reproducible estimate appropriate for the phase of a project.

In order to address the risk associated with the development of cost estimates for environmental cleanup projects, it has become necessary to provide a current reference within the Bureau of Land Management (BLM) for developing and documenting cost estimates. General classifications within this document can provide a range of confidence in the estimate. By following the basic principles of this guidance, the BLM will be able to apply a standard approach for risk analysis on environmental project life-cycle costs.

Why Cost Estimates Are Necessary

Cost estimates are a part of our everyday life. When we take a car into a repair shop, we ask for an estimate. When we are planning to buy or build a house, we estimate how much we can afford for monthly payments. Similarly, cost estimates are developed within the government for a variety of reasons.

PROJECT PLANNING/BUDGETING

All projects within the federal government require cost estimates to plan and budget the activities efficiently. Several estimates may be prepared sequentially throughout the life of a given project based on the estimator's confidence in the available information. A cost estimate will provide the basis for reserving funds for the contract as part of acquisition planning.

FEDERAL ACQUISITION REGULATIONS AND CONTRACTING

In accordance with the Federal Acquisition Regulation (FAR), an independent government cost estimate (IGCE) is a required element of a proper contract file for supplies or services over the simplified acquisition threshold ($100,000). The IGCE is the government's estimate of the resources and projected cost of the resources a contractor will incur in the performance of a contract. Most importantly, a cost estimate is necessary in the BLM for all requirements submitted through contracting.

Federal Acquisition Regulation

Part 36 - Construction and Architect-Engineer Contracts

36.203 Government estimate of construction costs.
(a) An independent Government estimate of construction costs shall be prepared and furnished to the contracting officer at the earliest practicable time for each proposed contract and for each contract modification anticipated to cost $100,000 or more. The contracting officer may require an estimate when the cost of required work is anticipated to be less than $100,000. The estimate shall be prepared in as much detail as though the Government were competing for award.

36.605 Government cost estimate for architect-engineer work.
(a) An independent Government estimate of the cost of architect-engineer services shall be prepared and furnished to the contracting officer before commencing negotiations for each proposed contract or contract modification expected to exceed $100,000. The estimate shall be prepared on the basis of a detailed analysis of the required work as though the Government were submitting a proposal.

IGCEs are developed to provide an assessment of the probable cost of supplies or services being acquired to ensure the BLM has adequate funds and to aid in determining the reasonableness of a contractor's proposed costs and understanding of the work. An IGCE consists of a breakdown of cost factors required for a contractor to complete a statement of work, including an estimate of technical staff labor categories, hours, and rates; direct material and supplies; subcontracting; consultant services; travel; indirect rates; and profit and fee.

CONTRACTS

IGCEs can be a valuable tool when evaluating contractor bids for a government request for proposal (RFP) or request for quotation (RFQ). With a well-written statement of work (SOW) and a detailed government cost estimate, the evaluation panel can examine costs for each bid item and develop a defensible assessment of the bidder's cost proposals. A well-constructed IGCE helps to ensure that the government receives the services requested at a fair and reasonable cost.

IGCEs can also verify the contractor understands the SOW. If contract bids are of extreme variability, further clarification to the scope may be necessary. Differences may, however, be a result of differences in the contractor's approach, quality of the proposal, or contract rates.

GOVERNMENT ACCOUNTABILITY OFFICE/OFFICE OF INSPECTOR GENERAL AUDITS

The Government Accountability Office (GAO) is the investigative arm of Congress and examines the use of public funds; evaluates federal programs and activities; and provides analyses, options, recommendations, and other assistance to help Congress make effective oversight, policy, and funding decisions.

The Office of Inspector General (OIG) is an independent office within the Department of the Interior (DOI) that helps the agency perform its functions/mission in a more efficient and cost-effective manner. The OIG consists of auditors, program analysts, investigators, and others with extensive expertise. Per the Inspector General Act of 1978, as amended, the Inspector General's mission is to:

- Conduct independent and objective audits, investigations, and inspections;
- Prevent and detect waste, fraud, and abuse;
- Promote economy, effectiveness, and efficiency;
- Review pending legislation and regulation; and
- Keep the agency head and Congress fully and currently informed.

Although a part of the DOI, Congress provides the OIG with separate funding to ensure its independence.

CERCLA ALTERNATIVE EVALUATION

The evaluation of removal and remedial alternatives in the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) process includes examining costs. During the early phases of these projects, information regarding cleanup options is highly conceptual and lacks detailed plans. This makes development of accurate cost estimates challenging.

NON-TIME CRITICAL REMOVAL ACTIONS

Code of Federal Regulations

Title 40 – Protection of Environment

40 CFR 300.415 Removal action.
(b)(4) Whenever a planning period of at least six months exists before on-site activities must be initiated, and the lead agency determines, based on a site evaluation, that a removal action is appropriate:
(i) The lead agency shall conduct an engineering evaluation/cost analysis (EE/CA) or its equivalent. The EE/CA is an analysis of removal alternatives for a site.

The Environmental Protection Agency guidance on removal actions (Environmental Protection Agency 1993) specifies cost items to consider in the evaluation of removal action alternatives. The following items should be considered in the removal cost evaluations:

Direct capital costs
- Construction costs
- Equipment and material costs
- Land and site acquisition costs
- Relocation expenses
- Transport and disposal costs
- Analytical costs
- Contingency allowances
- Treatment and operating costs

Indirect capital costs
- Engineering and design expenses
- Legal fees and license or permit costs
- Startup and shakedown costs

Annual post-removal site control

- Operational costs
- Maintenance costs
- Auxiliary materials and energy
- Disposal of residuals
- Monitoring costs
- Support costs

REMEDIAL ACTIONS

Code of Federal Regulations

Title 40 – Protection of Environment

40 CFR 300.430 Remedial investigation/ feasibility study and selection of remedy. (e)(7)(iii) Cost. The costs of construction and any long-term costs to operate and maintain the alternatives shall be considered. Costs that are grossly excessive compared to the overall effectiveness of alternatives may be considered as one of several factors used to eliminate alternatives. Alternatives providing effectiveness and implementability similar to that of another alternative by employing a similar method of treatment or engineering control, but at greater cost, may be eliminated.

The National Contingency Plan (NCP) sets forth nine criteria for selecting remedial actions. The two most important criteria are overall protection of human health and the environment and compliance with federal and state environmental laws. These are considered threshold criteria, and remedial action remedies selected for a site must meet the two threshold criteria.

Potential remedial actions are also evaluated according to the five primary balancing criteria: long-term effectiveness and permanence; toxicity, mobility, or volume of waste; short-term effectiveness; implementability; and cost. These criteria are factors with which tradeoffs between alternatives are assessed so that the best option can be chosen for the site. The last two criteria are the modifying criteria of state and community acceptance.

Costs for remedial alternatives should be of sufficient detail to provide an accurate comparison of the cleanup options. The costs of construction and any long-term costs to operate, maintain, and monitor the alternatives shall be considered when comparing remedial action alternatives. Costs that are grossly excessive in comparison to the overall effectiveness of an alternative may be considered to eliminate excessive costs as an option. Alternatives providing effectiveness and implementability similar to that of another alternative by employing a similar method of treatment or engineering control, but at a greater cost, may also be eliminated.

The types of costs that shall be assessed include the following:

(1) Capital costs, including both direct and indirect costs;

(2) Annual operation and maintenance costs; and

(3) Net present value of capital and operation and maintenance costs.

Accuracy of cost estimates at the engineering evaluation/cost analysis (EE/CA) and remedial investigation/feasibility study (RI/FS) alternative analysis stage in the CERCLA process is highly conceptual and can be anywhere from 30 percent lower to 50 percent higher than the actual cleanup cost (ACOE and EPA 2000). Relative knowledge of the site can influence the level of confidence in the estimates.

Estimating Terminology

The following terms are used when discussing cost estimates, and some of the terms may be used interchangeably.

Capital costs are the total expenditures required to implement a cleanup action.

Contingency is an amount added to an estimate to provide some measure for the uncertainty of the design completeness or to mitigate the cost impact of unforeseen conditions. Generally, the contingency factor should decrease as the design documents are refined and the site investigation progresses. The costs are generally expressed as a percentage of the total direct and indirect costs and can range from 0 to 10 percent (100 percent design and completed site investigation) to in excess of 50 percent for preliminary design and investigation.

The ***Davis-Bacon Act of 1931*** is a United States federal law that established the requirement for paying prevailing wages on public works projects. The Wage and Hour Division of the U.S. Department of Labor determines prevailing wage rates to be paid on federally funded or assisted construction projects. It is the responsibility of the federal agency that funds Davis-Bacon covered construction projects to ensure that the associated wage rate determination is applied.

Direct construction costs are those costs directly associated with the project, including labor, material, equipment, and subcontractor costs, as well as design contingencies.

Direct labor charges are based on the total available man-hours per year (2,080 hours) and include costs for vacation, holidays, and sick leave. This is usually determined through published federal wage rate tables, which establish the minimum rate per hour and applicable fringe benefits in the geographic area of the proposed work.

Because the impact of inflation should be considered when developing your IGCE, ***escalation*** should be added to any cost estimate that includes work to be performed in the future. To forecast the out year(s) cost, appropriate escalation factors are applied to the cost elements to bring them up to realistic values. The Department of Labor Consumer Price Index (CPI) provides data and percentage of change in inflation/escalation factors and is available at ***www.bls.gov/cpi/***. However, an average factor between 2 and 4 percent each year would generally be considered "reasonable."

Labor burden includes payroll taxes, unemployment taxes and various forms of insurance, workmen's compensation, and employee benefits. Labor burden factors are fairly consistent with the acquisition policies and regulations for service contracting; therefore, they may be consolidated to form one line item expressed as a percentage of total cost. For general estimating purposes, this can be expressed as 50 to 60 percent of the direct labor costs.

General and administrative (G&A)/overhead costs include any management, financial, or other expenses incurred for the overall operation of a business, such as utilities, compensation packages, employee training, jury duty, business taxes, liability and other business insurances, and legal costs, as well as noncontract specific leases, equipment, and supplies. These costs are distributed equally across all contracts, government and private sector. Although G&A costs will vary based on the type of contract, ownership of facilities, location of work site, etc., 15 percent is typical unless more specific information is available.

General conditions are field-related tasks incurred by the contractor in the performance

of the work and include, but are not necessarily limited to the following (unless otherwise broken out as a specific estimate line item cost): site administration and supervision, bonds, permits, travel, subsistence/per diem, vehicles, trailers/ furnishing/office equipment, sanitary and health facilities, temporary construction, security, safety, power, telephone, water, waste disposal, quality control/testing/inspections, and surveying. General conditions have a usual cost range expressed as 4 to 20 percent of the sum total of direct costs (dependent on the project size, location, complexity, and other variables).

Mobilization costs include the direct costs associated with the transport of equipment, material, and personnel and the setup/teardown of equipment and support facilities associated with the performance of construction contract work. Mobilization is usually identified as a separate line item in an estimate and is dependent upon site access/location and associated transportation costs. For preliminary estimates (unless more specific site information is available) this amount can be expressed as 10 percent of the sum total of direct costs.

The FAR describes ***other direct costs*** (ODCs) as costs not previously identified as a direct material cost, direct labor cost, or indirect cost. Any materials used in direct support of the contract, such as vehicles, computers, office furniture, travel, lease of equipment, per diem, etc., should be included in other direct costs. ODCs can generally be estimated at 2 to 4 percent of the total labor costs.

A ***price estimate*** is an estimate that is generally used for supplies, equipment, and simple services that are routinely available on the open market at competitive prices. A price estimate is not broken down into cost elements and is generally based on catalog prices or market information.

A ***profit or fee*** is the dollar amount over and above any allowable costs paid to a contractor for performance. The purpose of both is to compensate the contractor for risks assumed during contract performance and to stimulate efficient contract performance. In the absence of other data, a reasonable percentage for profit on fixed price contracts is approximately 5 to 10 percent for large businesses and 10 to 15 percent for small businesses, according to FAR 15.404-4 (GSA, DOD, and NASA 2005).

Surety bonds are a guarantee that the principal/ contractor will perform the obligation specified in the bond. Under the Miller Act, payment and performance bonds are required for general contractors on all U.S. federal government construction projects when the contract price exceeds $100,000. A ***performance bond*** guarantees the owner that the principal will complete the contract according to its terms including price and time. A ***payment bond*** guarantees the owner that subcontractors and suppliers will be paid the monies that they are due from the principal.

Methods of Estimating

Although government cost estimate documentation is a part of the government procurement cycle, there is no detailed guidance on how to prepare this estimate in statutes or regulations. Generally, the BLM project manager, engineer, or architecture-engineering contractor is responsible for developing the project cost estimate and keeping it up to date throughout the project development process. The project manager is responsible for reviewing and approving all project cost estimates. A government estimate should be developed independently and not based on a contractor's cost/price estimate. The following paragraphs describe some methods for developing cost estimates.

PARAMETRIC ESTIMATES

A parametric cost model is a group of cost estimating relationships used together to estimate entire cost proposals or significant portions thereof in the early planning stages. Parametric estimates primarily use historical data from projects of similar scope. This type of estimate is used for planning or budgeting purposes and is generally considered a "ballpark" approach to a cost estimate.

ASSEMBLY ESTIMATES

An assembly estimate is generally done in the conceptual stage of a project. The estimator gathers information on presumed work elements and creates the project from these elements. This allows the estimator to compare various combinations of elements to accommodate budget. Assembly estimates are primarily used for planning and budgeting purposes.

UNIT PRICE ESTIMATES

In developing a unit price estimate, the project is divided into significant work elements. The estimate is then based on standard pricing guidelines for the elements.

Table 1. Example of a unit price estimate for an environmental project

	Direct Labor	Subcontracts
Project Planning	$20,000	
Community Relations	$10,000	
Sampling and Analysis	$10,000	$50,000
Removal Action	$45,000	$250,000
Closeout Report	$20,000	
Total Project Cost	$405,000	

DETAILED ESTIMATES

A detailed cost estimate is developed by separating the project into basic work elements and examining the total effort to complete the work. This can be done by creating a work breakdown structure (WBS), which displays and defines the product or service to be developed or produced by finite elements and relates the work scope elements to each other and to the end product(s). The framework of the WBS defines all contractual authorized work. From the WBS, time estimates are applied to each discipline or type of equipment, and a cost estimate is produced. Specific elements should be considered, such as labor, project-specific equipment, field supplies (protective equipment, trailers, vehicles, generators, etc.), graphics/reproduction services, subcontractor services, and travel. Direct and indirect costs, including overhead and G&A costs, can be included in labor charges or added near completion of the estimate. For service contracts, a WBS is developed in terms of disciplines and experience levels. For construction contracts, a WBS is developed in terms of disciplines and equipment.

Figure 1 shows an example of a WBS. The task in this example is to develop a work plan for a site investigation. The task itself is broken down into progressively smaller pieces until it is a collection of manageable subtasks, and then the subtasks are assigned disciplines.

Example - Task 1.4 - Site Work Plan

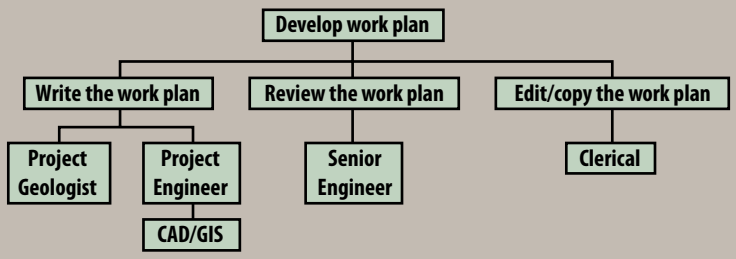

Figure 1. Work breakdown structure example

The project cost estimate is prepared using industry standards and/or historical information and contains well-documented backup information on how the estimate was developed. The estimate will represent the costs at the time it is dated, and the estimate can be valid for at least 2 years with escalation.

Table 2. Project cost estimate relating to the work breakdown structure in Figure 1

		Task 1.4 Work Plan	
Cost Description	Unit Cost	Est. Units	Cost
Direct Labor			
Principal	$100	1	$100
Project Manager	$90	4	$360
Senior Engineer	$75	10	$750
Project Engineer	$60	20	$1,200
Project Geologist	$55	40	$2,200
CAD/GIS	$45	10	$450
Support Staff	$40	10	$400
Total		95	$5,460

Cost estimates, in a sense, are never complete, and they have to be reviewed continually to remain current. A good estimate must begin with a complete understanding of the entire scope of the project's work. Errors in the cost estimate can result from commonplace reasons, such as omitting subtasks, design details, or simply human error. When preparing a construction estimate, care must be taken to identify not only labor and material costs for items shown on the plans and specification, but there are also labor and cost items that may not be reflected in the plans that are inherent to the contractor as a part of any project. To grasp a complete understanding of the work entailed, the estimator may consult with a project manager, engineer, field superintendent, or work crews.

ESTIMATING SOFTWARE

Several estimating tools are available to aid in the development of a cost estimate for a project. A majority of the estimating software, however, applies to the building or heavy construction industry and not to environmental cleanup projects.

Remedial Action Cost Engineering and Requirements (RACER) software is used to model and estimate the cost of remediation work. RACER software helps to quickly and accurately estimate costs for all phases of environmental remediation projects—from site discovery through long-term monitoring.

The Department of Energy Office of Environmental Management partnered with other agencies and the private sector to develop the ***Environmental Cost Element Structure (ECES)***. ECES provides methods for organizing environmental costs, serves as a model for project-specific WBSs, and tracks environmental project costs. ECES is commonly used for environmental restoration, waste management, and facility decommissioning and dismantling projects.

AMDTreat, developed by the Pennsylvania and West Virginia Departments of Environmental Protection and the Office of Surface Mining Reclamation and Enforcement, estimates abatement costs for acid mine drainage and can assist in estimating costs to decrease water pollution.

CostWorks is software made available through RSMeans for construction projects, primarily building construction.

Micro-Computer Aided Cost Estimating System (MCACES) software is used for estimating construction costs. Generally, the user should possess indepth knowledge of construction practices to use this software.

Excel spreadsheets are used extensively in cost estimating since many estimating software packages are compatible with Excel. Unfortunately, most commercially available or government cost estimating software packages are not appropriate for estimating costs on abandoned mine and hazardous materials cleanup projects. However, some can be adapted to meet the requirements of BLM cleanup projects.

DATA RESOURCES

To produce an estimate, many cost data sources can be used. One of the most reliable methods of developing an estimate for a specific location is to contact local vendors or contractors, and ask them current market prices. This method is most commonly used when pricing materials or purchasing a specific item. Other data resources include published references such as RSMeans construction cost references, Richardson General Construction Estimating Standards, and manufacturer product price lists. Cleanup documentation or historical estimates from other IGCEs that apply directly to your site can be modified if they are available.

Preliminary cost information can be found at the Federal Remediation Technologies Roundtable Remediation Technologies Screening Matrix and Reference Guide, Version 4.0 website: ***www.frtr.gov/matrix2/top_page.html***. This website provides descriptive information on a multitude of available cleanup technologies and incorporates cost and performance data to the maximum extent available, focusing primarily on demonstrated technologies.

Developing Cost Estimates

Cost estimates are essential for contracting, budgeting, and general project management. Quoting a general dollar figure for a project estimate is no longer acceptable. Estimates must include sufficient backup material and references to document the development of the final figure. Additionally, estimators must follow an orderly process and a consistent routine when completing an estimate, thereby minimizing errors and omissions. The cost estimator needs to research, compare, and above all, use professional judgment to prepare a quality cost estimate.

ENVIRONMENTAL PLANNING AND ENGINEERING SERVICES CONTRACTS

Environmental planning and engineering services contracts are initiated at the site investigation phase. The scope of the work can include activities such as field sampling, document development, remedy selection, and design.

To develop a cost estimate for an environmental planning contract, a scope of work is required. The more detail that is supplied in the scope of work regarding tasks to be performed, the more accurate the cost estimate can become. To yield the most accurate cost estimate, projects can be organized and comprehended by breaking them into progressively smaller pieces until they are a collection of manageable subtasks. The cost estimates for service contracts are best developed using a WBS. A list of the labor categories that will be required in each task or step is then developed (e.g., clerical, engineer, research scientists, etc.). In a "level of effort" acquisition, the desired categories of expertise and the required training and experience for each category should be identified in as much detail as possible. An example of a service contract cost estimate is provided on the following page.

When a subcontractor is involved in a project, the project costs include the subcontractor fees plus their profit and the prime contractor management fees plus their profit. If possible, contracting specific work directly, rather than through a prime contractor, may be more cost effective.

Table 3. Service estimate example

Independent Government Cost Estimate													
				Task 1.0		Task 2.0		Task 3.0		Task 4.0		Task 5.0	
				Project Management		Health & Safety Plan		Sampling and Analysis Plan/Quality Assurance Project Plan		Field Sampling		Site Investigation Report	
Cost Description	Unit Cost	Total Units	Total Cost	Est. Units	Cost	Est. Units	Cost	Est. Units	Cost	Est. Units	Cost	Est. Units	Cost
Direct Labor													
Principal/Program Manager	$140.00	16	$2,240.00	16	$2,240.00		-		-		-		-
Project Manager	$100.00	133	$13,300.00	80	$8,000.00	1	$100.00	12	$1,200.00	20	$2,000.00	20	$2,000.00
Senior Engineer	$95.00	30	$2,850.00		-		-		-	30	$2,850.00		-
Senior Geologist	$95.00	130	$12,350.00		-		-	20	$1,900.00	80	$7,600.00	30	$2,850.00
Industrial Hygienist	$130.00	10	$1,300.00		-	10	$1,300.00		-		-		-
Toxicologist (Human Health Risk)	$129.00	20	$2,580.00		-		-		-		-	20	$2,580.00
Ecological Risk Assessor	$112.00	20	$2,240.00		-		-		-		-	20	$2,240.00
Public Relations Specialist	$109.00	0	-		-		-		-		-		-
Senior Chemist	$125.00	0	-		-		-		-		-		-
Chemist	$83.00	0	-		-		-		-		-		-
Biologist/Environmental Planner	$73.00	0	-		-		-		-		-		-
Archaeologist II	$89.00	0	-		-		-		-		-		-
Archaeologist I	$65.00	0	-		-		-		-		-		-
Project Engineer	$72.00	80	$5,760.00		-		-		-		-	80	$5,760.00
Project Geologist	$84.00	200	$16,800.00		-		-	30	$2,520.00	140	$11,760.00	30	$2,520.00
Staff Geologist	$63.00	180	$11,340.00		-		-	40	$2,520.00	100	$6,300.00	40	$2,520.00
CAD/GIS	$78.00	48	$3,744.00		-		-	24	$1,872.00		-	24	$1,872.00
Field Technician II	$53.00	0	-		-		-		-		-		-
Field Technician I	$30.00	0	-		-		-		-		-		-
Support Staff	$38.00	36	$1,368.00	20	$760.00	5	$190.00	4	$152.00	3	$114.00	4	$5,472.00
Subtotal- Direct Labor			$75,872.00	116	$11,000.00	16	$1,590.00	130	$10,164.00	373	$30,624.00	268	$27,814.00

Table 3. Service estimate example (continued)

Independent Government Cost Estimate (continued)														
				Task 1.0		Task 2.0		Task 3.0		Task 4.0		Task 5.0		
				Project Management		Health & Safety Plan		Sampling and Analysis Plan/Quality Assurance Project Plan		Field Sampling		Site Investigation Report		
Cost Description	Unit Cost	Total Units	Total Cost	Est. Units	Cost	Est. Units	Cost	Est. Units	Cost	Est. Units	Cost	Est. Units	Cost	
Other Direct Costs														
Materials (phone, fax, copies, etc.)*	0.03		$2,276.16								-			
Field Supplies	$50.00	20	$1,000.00							20	$1,000			
pH/EC/Temp Meter	$30.00	0	-								-			
XRF	$500.00	0	-								-			
Camera - Digital	$25.00	20	$500.00							20	$500.00			
Laptop	$22.00	0	-								-			
GPS - Professional Grade	$35.00	20	$700.00							20	$700.00			
Subcontractor Services														
Drilling	$1,000.00	10	$10,000.00							10	$10,000.00			
Test Pits	$75.00	24	$1,800.00							24	$1,800.00			
Well Abandonment	$200.00	0	-								-			
Mine Entry	$10,000.00	1	$10,000.00							1	$10,000.00			
Soil Testing		0	-								-			
Laboratory Analysis	$90,205.00	1	$90,205.00								-			
Subcontractor Handling Fee**	0.1		$11,200.50											
Field Vehicle	$65.00	10	$650.00							10	$650.00			
Meals and Incidental Expenses	$30.00	22	$660.00							22	$660.00			
Lodging	$95.00	22	$2,090.00							22	$2,090.00			
Subtotal			$206,953.66											
Contingencies	0.1		$20,695.37											
Total			$227,649.03											

* The Materials cost is 3 percent of the Subtotal - Direct Labor.
** The Subcontractor Handling Fee is 10 percent of the total of the Subcontractor Services.

DEVELOPING A CONSTRUCTION COST ESTIMATE

When developing a construction cost estimate, estimators should compile and analyze data on all of the factors that can influence costs, such as materials, labor, location, and special machinery requirements. Allowances for wasted materials, inclement weather delays, and other factors that may increase costs must also be incorporated in the estimate. Again, projects may be organized and comprehended by breaking them into progressively smaller pieces until they are a collection of manageable subtasks.

If the construction project is still in the conceptual phase, engineering and design costs must be included. The subtotaled capital cost of each alternative needs to be multiplied by 10 to 15 percent, depending on the complexity of the project, to estimate total capital costs including design.

For cleanup projects where the BLM will either hire or contract project management services, the estimated cost for this service should also be included. These costs include work such as inspection and quality assurance, as well as costs for the contract officer's representative and the contracting officer's time. This cost, whether performed by BLM staff, an architecture-engineering contractor, or an interagency agreement, is approximately 15 to 20 percent of the total estimated construction cost.

Table 4. Construction estimate example

Engineering Cost Estimate					
Bid Item	**Description**	**Units**	**Quantity**	**Unit Rate**	**Estimated Cost**
1	Mobilization, Demobilization, Bonding, and Insurance	LS	1	$29,000.00	$29,000.00 estimate
2	Project Management	LS	1	$65,000.00	$65,000.00 estimate
3	Site Preparation (including erosion control, clearing and grubbing, access ramps)	LS	1	$30,000.00	$30,000.00 estimate
4	Site Security	LS	1	$20,000.00	$20,000.00 estimate
5	Permitting and Documentation	LS	1	$20,000.00	$20,000.00 estimate
7	Limestone				
	Limestone, Delivered	Ton	1,710	$20.00	$34,200.00 quote
9	Waste Area 1 Removal				
	Excavate Tailings and Haul to Repository	CY	4,200	$7.12	$29,904.00
	Excavate Unimpacted Material - Backfill	CY	580	$2.37	$1,374.60
	Excavate Unimpacted Material - Mill Backfill	CY	750	$7.12	$5,340.00
	Place/Compact Backfill	CY	580	$1.43	$829.40
	Finish Grade Pond 2	SY	2,230	$0.15	$334.50
	Revegetation	AC	0.46	$827.00	$380.42
10	Central Waste Repository - Waste Area 2				
	Excavate Tailings and Regrade in Waste Area	CY	40	$2.37	$94.80
	Excavate Unimpacted Material - Backfill	CY	15	$2.37	$35.55
	Excavate Unimpacted Material - Cover	CY	1,105	$2.37	$2,618.85
	Place/Compact Waste from Area 1	CY	15,325	$1.43	$21,914.75
	Grade Waste Material	SY	4,170	$0.15	$625.50
	Place Limestone Layer	CY	456	$24.50	$11,172.00
	Place 2′ Cover Material	CY	2,800	$1.43	$4,004.00
	Finish Grade	SY	4,170	$0.15	$625.50
	Install Geotextile	SY	636	$2.55	$1,621.80 quote
	1′ Riprap Cover	CY	300	$51.00	$15,300.00
	Revegetation	AC	0.86	$827.00	$711.22
	Construction of Engineered Channel	LF	449	$11.72	$5,262.28
21	Placement of Limestone Cover on Waste Rock				
	Place High Visiblility Fencing	LF	1,000	$0.80	$800.00
	Placement of Limestone Cover on Waste Rock	CY	17	$24.50	$416.50
23	Borrow Area				
	Excavate Backfill Material	CY	3,600	$2.37	$8,532.00
	Screen Material for Riprap	CY	3,600	$1.72	$6,192.00
	Grade Waste Material	SY	2,760	$0.15	$414.00
	Place Limestone	CY	311	$24.50	$7,619.50
	Place 2′ Cover Material	CY	1,840	$1.43	$2,631.20
	Finish Grade Borrow Area	SY	2,760	$0.15	$414.00
	Revegetation	AC	0.57	$827.00	$471.39
	Subtotal Estimated Cost				$327,839.76
	City Cost Index Adjustment	LS	-1	$23,604.46	-$23,604.46
	Revised Subtotal Estimated Cost				$304,235.30
	Construction Surveying/Testing	LS	1	$15,211.76	$15,211.76
	Record Drawings	LS	1	$10,000.00	$10,000.00
	Contingencies	LS	1	$45,635.29	$45,635.29
	Total Estimated Cost				$375,082.36

AC = acres CY = cubic yards LF = lineal feet LS = lump sum SY = square yards (Balboni 2006; Spencer 2006)

PRESENT VALUE ANALYSIS

If the project is expected to last longer than 1 year, or if monitoring costs are included in the project cost estimate, a present value analysis should be conducted. This analysis helps to find the present value in "today's dollars" of the future net cash flow of a project. To convert future dollars to present dollars, net present value analysis uses a number called a discount rate.

Present Value Basics

The present value (PV) of a future payment is calculated using the following equation:

$$PV = \frac{x_t}{(1 + i)^t}$$

where x_t is the payment in year t (t = 0 for present or base year) and i is the discount rate. For example, suppose one needs to make a $1,000 payment in year 5. Using a discount rate of 5%, the present value would be:

$$PV = \frac{\$1{,}000}{(1 + .05)^5} = \$783$$

Therefore, $783 would need to be set aside or invested in year 0, at a discount or interest rate of 5%, in order to have $1,000 in year 5.

For a stream or series of future payments, the total present value from 1 to n years would be calculated as:

$$PV_{total} = \mathbf{S}_{t=1}^{t=n} \frac{x_t}{(1 + i)^t}$$

If a $1,000 payment is needed for each of the next 5 years, then the total present value of these payments, at a discount rate of 5% would be:

$$PV_{total} = \mathbf{S}_{t=1}^{t=5} \frac{\$1{,}000}{(1 + .05)^t} = \$4{,}329$$

Therefore, $4,329 would need to be set aside in year 0 to make a $1,000 payment in each of the next 5 years.

(ACOE and EPA 2000)

SENSITIVITY ANALYSIS

A sensitivity analysis is a method for analyzing the uncertainty of a cost estimate by changing input variables and noting variations in the outcome. The uncertainties should be evaluated in terms of the effects of specific variables on the overall cost estimate. Variation in waste quantities, fuel cost, labor rates, material availability, and other factors contribute to the uncertainty in an estimate.

ESTIMATE CONTINGENCIES

Contingency is an integral part of the total estimated costs of a project and has been defined as a specific provision for unforeseeable elements of cost within the defined project scope. Previous experience has shown that estimating contingency is particularly important for environmental projects where unforeseeable events that increase costs often occur. Contingencies are applied to cost estimates to adjust for these unforeseen circumstances.

Factors influencing the contingency of an estimate include project or alternative complexity, market conditions (including fuel prices), availability of site specific information, and experience of the estimator. Project and operations estimates will always contain some amount of uncertainty and should be appropriately adjusted. However, inflating contingencies to account for significant schedule changes, congressional actions, unanticipated regulatory or public influence, and unprecedented force majeure should not be a standard practice.

BLM environmental projects consist of three main phases: site investigation, remedy selection, and site cleanup. The contingencies applied to government estimates may be affected by site conditions, but as a general rule, specific contingencies may be applied to each phase.

Generally, service contracts for field investigation, remedy selection, and design have a well-defined scope. Use of government or contractor estimates from projects of similar scope can increase

the level of confidence applied to the current estimate. Contingencies at this phase should generally be low, between 5 and 15 percent of the estimate.

Construction estimates for environmental cleanup are not as definitive. During the initial alternative screening stage in the EE/CA or feasibility study, cost estimates should be focused on relative, rather than absolute, accuracy. As the alternatives are further defined, contingency may be applied to the alternatives, but this is not necessary. In addition, contingencies should be similar for all alternatives. To represent the alternative more accurately to the public and management, when the final alternative is selected in the EE/CA or proposed plan, contingency should be discussed and applied. At this stage, adding up to 50 percent to the alternative may be appropriate.

Environmental cleanup projects have inherent and unusual problems. Even sites that have been thoroughly investigated will likely have anomalies that result in cleanup cost variations. When the scope of the construction work is provided in a definitive design but the cleanup contract has not yet been awarded, a 10 to 25 percent contingency should be included within the government estimated cost. These contingencies can be easily justified when considering varying weather conditions, unexpected economic changes, and unexpected site conditions.

The reference "Engineering Instructions: Construction Cost Estimates," developed by the U.S. Army Corps of Engineers, provides information on estimating costs for actions taken at hazardous, toxic, and radioactive waste sites (Army Corps of Engineers 1997). Table 13-3 in this reference specifically covers design contingencies for remedial action projects based on specific technologies. The contingencies range from 5 to 55 percent, depending on the phase of design and the complexity of the technology.

Estimate Classification for Environmental Projects

Environmental projects carry a certain amount of risk when considering cost estimates. The purpose of the estimate classification guideline presented below is to provide a standard approach to determining relative error boundaries for BLM environmental project estimates and to improve the understanding of applying these error boundaries in the project life cycle. To quantify a relative risk analysis for environmental project estimates, classes of estimates have been developed with a range of relative error applied to each.

CLASSES

The following classes should be considered and applied to environmental project estimates based on the phase of the project.

Class	Relative Error
Class A Estimate	-10 to +15%
Class B Estimate	-15 to +25%
Class C Estimate	-30 to + 50% *
Class D Estimate	-50 to +100%
Class E Estimate	Undefined. The estimate should be considered only preliminary at this phase.

* (ACOE and EPA 2000)

Class A Estimate. This estimate is based on a detailed and complete quantity takeoff from completed construction drawings, ready to advertise as a RFQ or RFP. These estimates reflect the highest level of accuracy an engineer/architect can make of the expected construction costs for removal or remedial actions. A detailed cost estimate for a clearly defined scope should be developed by experienced individuals, or an engineer's estimate should be provided with the final design for construction projects.

Class B Estimate. This estimate is based on actual design drawings that are under development, and the estimate should be of sufficient detail to demonstrate that the design will fulfill the functional and technical requirements of the projects. A design would be considered preliminary or conceptual, and a detailed cost estimate should be developed by experienced individuals at this point in the project.

Class C Estimate. This estimate is considered a conceptual-level cost estimate based on information provided during the removal site investigation or remedial investigation. These cost estimates are used for comparative analysis of alternatives in the EE/CA or feasibility study. Depending on the level of site information, a unit price or detailed cost estimate may be developed for the detailed analysis of the alternatives.

Class D Estimate. This estimate is based on tentative remedy possibilities. The project manager has a general idea of the scope of the work that will be needed for the project. At this point, only limited field work has been completed for the site, and an assembly or parametric estimate would be appropriate.

Class E Estimate. This estimate is conceptual, as the site has likely gone through the site verification process only. Field activities that provide information for development of estimates have not been completed. The estimator will likely rely on previous experience or similar projects, and the estimate at this point would be considered a parametric estimate.

Table 5. CERCLA project planning/budgeting stages flow diagram

Phase	Discovery	Verification	Investigation	Remedy Selection	Design	Construction	Closeout
Activities/ Documents	Discovery Documentation	Site Verification Report, National Response Center Notification (if required)	Health and Safety Plan, Sampling and Analysis Plan, Preliminary Assessment/Site Investigation, Potentially Responsible Party Search, Natural Resource Damage Assessment Documentation, Administrative Record	Engineering Evaluation/Cost Analysis, Action Memorandum, Remedial Investigation/ Feasibility Study, Proposed Plan, Record of Decision, Value Engineering Report	Design Report, Specifications, Drawings	Proposal(s), Construction Deliverables	5-Year Review, Closeout Report
Estimate Confidence Class	E	E	D	C	B	A	A

RELATIONSHIP TO THE ENVIRONMENTAL AND DISPOSAL LIABILITIES REPORT

The Department of the Interior "Environmental and Disposal Liabilities Identification, Documentation and Reporting Handbook v2.0" defines liability as "a future outflow or other sacrifice of resources (e.g., costs) as a result of past events or transactions for which the Department is responsible" (Department of the Interior 2008). All sites where a release of CERCLA hazardous substances has been identified and verified should be considered for placement on the environmental and disposal liability (EDL) report if cleanup cannot be achieved under operation and maintenance funds within a calendar year. Additionally, abandoned mine land sites should be considered for placement on the EDL report when environmental hazards occur on the site and will not be addressed within a reasonable timeframe (usually 1 year or less) or when long-term monitoring of the remedy will be required.

One of the cost-related functions of the EDL report is to provide information on sites where the total cleanup costs are unknown and only an estimated cost of studies to evaluate possible removals or remedies is available. Estimate classes should be considered when both providing and reviewing the cost assigned to projects on the EDL report.

VALUE ENGINEERING

Value engineering (VE) is a systematic, creative study process conducted by engineers, scientists, and technicians to obtain optimum value for every dollar spent on a project. The significance of VE has been recognized by the Office of Management and Budget through its issuance of Circular A-131. This circular requires federal departments and agencies to use VE as a management tool, where appropriate, to reduce program and acquisition costs. The policy goes further to state that "Federal agencies shall use VE as a management tool, where appropriate, to ensure realistic budgets, identify and remove nonessential capital and operating costs, and improve and maintain optimum quality of program and acquisition functions."

VE uses creative thinking to develop innovative ideas and emphasizes improving project quality, eliminating unnecessary cost, and reducing overall life-cycle cost. VE techniques can be applied at any stage of a project: planning, conceptual design, preliminary design, detailed design, bid documents, construction, or operations and maintenance. Specific to environmental cleanup projects, a VE study may be used to perform a preliminary evaluation of alternatives after the site inspection is complete. Once an EE/CA is complete, a VE study may be used to reconsider

modifications to the preferred option or re-evaluate several options. Finally, a VE study may be necessary after the decision has been made to optimize the design.

A VE study is a systematic multistage plan typically broken down into seven stages (Mandelbaum 2006). Depending on the application, the number of steps can be reduced. According to Jay Mandelbaum's "Value Engineering Handbook," a typical VE study includes:

- ***Selection*** – Identify candidate projects for the VE study, and select specific projects to achieve maximum value, quality improvements, resource savings, and other benefits, such as a shorter construction schedule. Selecting VE study team members is an important part of this phase. If money is available, an independent third-party engineering consulting firm may be the best option at this point, as the disciplines available can accommodate multifaceted projects.

- ***Investigation*** – Acquire knowledge of the design to be studied; determine basic functions; and assess major functions, cost, and relative worth. Gather all types of information from the best sources possible. The team determines what they know about the project from readily available information and what they need to know in order to really define and solve the problem. In this phase of the VE study, identify the elements that have the greatest potential for value improvement. The investigation phase immediately brings to light the three fundamental concepts of VE (function, cost, and worth).

- ***Speculation*** – The team should brainstorm functions of design elements isolated by the investigation phase and develop a number of alternatives for each function. Brainstorming techniques force people to be creative and are applied to develop good alternatives to the current project design. Often, one idea triggers other ideas or thoughts through similar or like ideas, contiguous or adjoining ideas, or contrasting or opposite ideas. The VE study team should apply creativity to functional statements which it has selected from the cost/worth estimates.

- ***Evaluation*** – List the advantages and disadvantages of each remaining alternative. If the disadvantages far outweigh the advantages of any alternative, the alternative should be dropped at this point. Each advantage and disadvantage should be described in general terms. The team can perform a weighted matrix analysis to determine which alternative is best based upon the relative importance of each of the desirable criteria that must be addressed.

- ***Development*** – Once the team selects the best alternative, the alternative should be fully developed through sketches, cost estimates, validation of test data, and other technical work to determine if any assumptions made during the study are valid. The final step before presenting the team's recommendations to management is to formulate an implementation plan which describes the process that the agency must follow to implement any recommendations.

- ***Presentation*** – Present recommended alternatives to decisionmakers clearly and in sufficient detail for their consideration and potential approval.

- ***Implementation*** – Ensure approved recommendations are rapidly and properly translated into action in order to achieve the savings of project improvements that were proposed.

The use of VE techniques can result in recommendations that add needed value; reduce initial, annual, and total life-cycle costs; confirm design criteria and decisions; and achieve a quality project.

Summary

An IGCE is required for every new acquisition that exceeds the simplified acquisition threshold. By developing a detailed statement of work, a project manager can evaluate the labor categories and level of effort needed, material/equipment requirements, and other costs needed to assist in creating a reasonable estimate. Recognizing contingency and error are an important part in providing estimates to the customer.

References

Army Corps of Engineers. 1997. Engineering Instructions: Construction Cost Estimates. EI 01D010. Engineering Divisions, Directorate of Military Programs, Directorate of Civil Works, Washington, DC.

Army Corps of Engineers (ACOE) and Environmental Protection Agency (EPA). 2000. A Guide to Developing and Documenting Cost Estimates During the Feasibility Study. EPA 540-R-00-002.

Balboni, B., ed. 2006. RSMeans Heavy Construction Cost Data. RSMeans Co., Houston, TX.

Code of Federal Regulations. 2009. National Oil and Hazardous Substances Pollution Contingency Plan. Title 40, Part 300.

Code of Federal Regulations. 2010. Federal Acquisition Regulations System. Title 48, Part 15.

Department of the Interior. 2008. Environmental and Disposal Liabilities Identification, Documentation and Reporting Handbook v2.0.

Environmental Protection Agency. 1988. Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA. EPA/540/G-89/004. Office of Emergency and Remedial Response, Washington, DC.

Environmental Protection Agency. 1993. Guidance on Conducting Non-Time Critical Removal Actions under CERCLA. EPA540-R-93-057. Office of Solid Waste and Emergency Response, Washington, DC.

Environmental Protection Agency. 1996. The Role of Cost in the Superfund Remedy Selection Process. EPA 540/F-96/018. Office of Solid Waste and Emergency Response, Washington, DC.

General Services Administration (GSA), Department of Defense (DOD), and National Aeronautics and Space Administration (NASA). 2005. Federal Acquisition Regulation 15.404-4.

Mandelbaum, J. 2006. Value Engineering Handbook. IDA Paper P-4114. Institute for Defense Analyses, Alexandria, VA.

Office of Management and Budget. 1993. Circular A-131. www.whitehouse.gov/omb/circulars_a131/.

Rast, R.R. 1997. Environmental Remediation Estimating Methods. RSMeans Co.

Spencer, E., ed. 2006. RSMeans Site Work & Landscape Cost Data: 25th Annual Edition. RSMeans Co.

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