

These costs apply to fund-lead activities; enforcement-lead removals, RI/FSs, and remedial designs cost less, sharing the same private-sector efficiency advantage assumed in each scenario for remedial actions.

Estimating the Costs of Remedial Action

Cleanup has been completed at too few NPL sites for observed costs to provide a good indication of average remedial action costs. Accordingly, CBO's analysis began instead with the estimated costs given

in the records of decision that EPA issues for its remedial cleanups. In using the RODs to explore average costs at NPL sites, three problems had to be addressed.

- o The ROD estimates are not always calculated on a consistent basis and often understate the actual costs that are ultimately incurred.
- o Many RODs only discuss cleanup of an operable unit (subsite), leaving the cost picture incomplete for the site as a whole.
- o The ROD estimates do not attempt to incorporate any private-sector efficiencies that would

Table 6.
Average Present-Worth Costs per Site for Fund-Lead Remedial Action, by Site Type (In millions of dollars)

	Base Case	Low Case	High Case
Mega-Sites			
Capital	107.6	102.6	112.7
Operations and maintenance ^a	<u>61.6</u>	<u>58.9</u>	<u>65.0</u>
Total	169.2	161.5	177.7
Major Sites			
Capital	33.0	28.9	37.0
Operations and maintenance ^a	<u>16.9</u>	<u>14.8</u>	<u>19.0</u>
Total	49.9	43.7	56.0
Minor Sites			
Capital	14.0	14.0	14.0
Operations and maintenance ^a	<u>6.9</u>	<u>6.9</u>	<u>6.9</u>
Total	20.9	20.9	20.9
Memorandum:			
Average Total Cost for All NPL Sites, Before Private-Sector Efficiency Advantage	28.5	28.9	31.2
NPL Average After Private-Sector Advantage	24.7	23.3	29.1

SOURCE: Congressional Budget Office.

NOTES: Site types are defined by cleanup costs as estimated in the records of decision. Estimated present-worth costs for mega-sites are \$50 million or more; for major sites, between \$20 million and \$50 million; and for minor sites, less than \$20 million.

See Appendix A for the differences in assumptions underlying the three cases.

NPL = National Priorities List.

a. Operations and maintenance costs are discounted at 7 percent.

Table 7.
Sensitivity of Present-Worth Cost Estimates to Assumptions About Remedial Action Costs (In percent)

	Base Case	Low Case	High Case
Effect of a 10 Percent Increase in Remedial Action Costs			
Mega-site	1.4	1.7	1.5
Major site	1.4	1.2	2.2
Minor site	4.2	4.3	3.7
All sites	7.0	7.2	7.4
Effect of a 5-Percentage-Point Increase in the Private-Sector Cost Advantage^a			
	-3.6	-3.9	-3.3

SOURCE: Congressional Budget Office.

NOTES: Site types are defined by cleanup costs as estimated in the records of decision. Estimated present-worth costs for mega-sites are \$50 million or more; for major sites, between \$20 million and \$50 million; and for minor sites, less than \$20 million.

See Appendix A for the differences in assumptions underlying the three cases.

a. This change affects the cost of enforcement-lead removals and studies, as well as remedial actions.

lower the costs of cleanups led by the responsible parties.

The starting point for CBO's analysis was the data set EPA uses to underpin its projections of future costs to Superfund. This data set contains estimates of capital costs from 273 RODs (not counting duplicate entries or those for federal facilities). However, problems of reliability and comprehensiveness limited the usefulness of the entries on mega- and major sites.¹⁹ For these sites, CBO relied instead on a review of individual RODs for all known or suspected mega-sites and a set of 34 major sites, updated with information from knowledgeable EPA staff.

Whenever possible, CBO obtained operations and maintenance costs for major and mega-sites from individual RODs. Where information on O&M costs was lacking, average shares of O&M costs in total costs, obtained from those RODs with complete detail, were applied as default values. These default

shares were calculated for different cost categories and ranged from 14 percent (for RODs with estimated capital costs above \$30 million) to 35 percent (for those with capital costs below \$20 million). For minor sites, a fourth ratio was derived from a data set developed by researchers at Resources for the Future; this ratio was based on the 184 RODs with capital costs below \$15 million. In all cases, O&M spending was assumed to occur in equal installments over 24 years, the average duration seen among all 214 RODs in the data set.

Because actual cleanup costs commonly exceed those estimated in a ROD, CBO analyzed preliminary data from an EPA survey of post-ROD changes in capital costs and gathered site-specific information from EPA staff. The survey of 226 cases found that the largest percentage increases in costs tended to occur at cleanup projects with the least expensive RODs: whereas the dollar-weighted average increase for the whole sample was 44 percent, RODs with estimated capital costs under \$13 million showed an

19. When CBO began its review in the summer of 1992, the data set included duplicate entries, entries that double-counted the costs of RODs covering two sites, entries that included the costs of operating and maintaining the remedy as well as the capital costs,

and many entries obtained from unreliable preliminary sources. (EPA has since taken steps to correct these problems.) Moreover, the limited sample did not provide complete data on the mega-sites, whose costs are particularly important to the overall average.

Table 8.
Scenario-Specific Assumptions About Remedial Action Costs (In percent)

	Base Case	Low Case	High Case
Default Scaling Assumptions Used for Sites with Cleanup Projects Not Yet Estimated			
Mega-sites over \$150 million	120	110	130
All other mega-sites	135	110	160
Major sites	160	120	200
Efficiency Advantage of Private Sector	20	30	10

SOURCE: Congressional Budget Office.

NOTES: Site types are defined by cleanup costs as estimated in the records of decision. For mega-sites, the estimated present-worth cleanup costs are \$50 million or more; for major sites, between \$20 million and \$50 million.

See Appendix A for the differences in assumptions underlying the three cases.

average increase of 80 percent.²⁰ This latter rate was assumed to apply to all RODs for minor sites. Where specific information was not available at the more costly sites, default values of 26 percent, 34 percent, and 12 percent were derived for projects with estimated capital costs above \$44 million, between \$20 million and \$44 million, and below \$20 million, respectively.²¹ In all cases, post-ROD growth of O&M costs was assumed to be half that of capital costs.

As noted earlier, sites may be divided into operable units that receive separate RODs; in fact, EPA estimates that the average site receives 1.8

RODs. CBO's analysis uses this ratio to convert from costs per ROD to costs per site at minor NPL sites. At the more expensive sites, however, evidence suggests that costs are not distributed evenly among a site's RODs and thus that smaller scaling factors should be applied to incomplete sites that already have a very expensive ROD. (Among 19 mega-sites with complete sets of RODs, the first ROD with costs in the mega-site range--or if none, the most expensive ROD--accounts for an average of 70 percent of total estimated capital costs.) The default scaling assumptions vary widely among scenarios, reflecting the great uncertainty surrounding this factor (see Table 8). Nonetheless, since the assumptions are used only where site-specific information is not available, they do not result in large differences in average RA costs or total Superfund expenditures.²²

Each scenario also assumes a cost advantage for private-sector studies and cleanups (see Table 8). Such advantages are widely thought to exist; various observers argue that responsible parties employ more

20. Because of the inverse correlation between a ROD's initial cost estimate and its subsequent percentage cost growth, the simple case-by-case average for the whole sample is 157 percent, much higher than the dollar-weighted average of 44 percent. These figures must be considered preliminary; at present, for example, the data contain both intermediate updates of estimated costs and actual observed costs.

Note that post-ROD cost growth is of interest here only in calculations of average actual cleanup costs. Additional experience might lead EPA to raise its ROD estimates in the future and thus reduce average cost growth, but that would have no effect on actual cleanup costs per site.

21. The apparent inverse relationship between ROD estimates and post-ROD cost growth is violated by the 12 percent average growth observed for RODs with estimated capital costs between \$13 million and \$20 million. This deviation from the pattern may result from small sample size: the data set of 226 cases included only 17 in the \$13 million to \$20 million range.

22. Default values were used for 12 of 46 mega-sites and 9 of 34 major sites. Adopting the high-case assumptions in the base case would raise average present-worth costs from \$24.7 million to \$25.4 million per site and increase total discounted Superfund costs by 2.5 percent.

experienced project managers who can respond more creatively to situations encountered during cleanup, that government procurement regulations lead to costly delays or award jobs to low bidders who may be less efficient, and that certain efficient contractors choose not to bid on government projects. Although individual cases can be identified in which a private-sector cleanup cost as little as half the amount of a similar fund-lead project, no significant data are available on the overall impact of these advantages. In the absence of usable data, CBO identified savings rates of 10 percent to 30 percent as plausible estimates after consulting with experienced cleanup contractors, RP representatives, and EPA staff. As noted in Table 7, raising the assumed savings rates by 5 percentage points would reduce estimated present-worth costs for the program by 3.3 percent to 3.9 percent. Conversely, eliminating the 20 percent advantage assumed in the base case would increase total estimated costs by 14 percent.

Other Direct Response Costs

Direct costs for screening, removals, studies, and engineering designs account for 11 percent to 12 percent of discounted Superfund costs in the three scenarios. A 10 percent increase in any of the assumed unit costs would add no more than 0.6 percent to total costs in the base case.

Screening Costs. As noted earlier, CBO's analysis assumes an average of roughly \$46,000 per site in screening costs. This average has two components: each site placed in the inventory incurs \$10,000 in costs for a preliminary assessment, which is primarily a review of available documents concerning the site's history; and 55 percent of the sites are assumed to go on to receive a site inspection, involving collection and analysis of samples, at an average cost of \$65,000. Thanks to the large numbers of sites EPA has already screened, these unit costs are subject to less uncertainty than others in this study.

Removal Costs. Fund-lead removal actions at NPL and non-NPL sites are both assumed to cost \$600,000 each. Although this estimate is higher than EPA's budget-planning figure of \$525,000, EPA staff regard it as a reasonable estimate of future costs, given that average costs have risen over time as more

ambitious projects have been handled as removals rather than remedial actions. (EPA data show that the average fund-lead removal over the 1987-1992 period cost \$440,000, but that the average cost for 1992 alone was \$700,000.) Based on rough extrapolations of the evidence to date, CBO's analysis assumes that 45 percent of NPL sites receive at least one removal action and that 85 percent of these sites eventually get two. Also, 20 percent of non-NPL removal sites are assumed to get a second removal action.

Study Costs. The unit cost used in CBO's analysis for each fund-lead remedial investigation/feasibility study is \$1.2 million. This figure was derived by assuming that the typical RI/FS costs \$1 million and that 5 percent of cases (in all scenarios) are "mega-RI/FSs" that cost \$5 million. The EPA budget-planning estimate for a standard RI/FS is \$750,000; EPA staff note, however, that actual costs often exceed this target. The average NPL site is assumed to get 1.8 RI/FSs; this is essentially a restatement of the EPA estimate of 1.8 RODs per site, since every ROD except an amended one marks the completion of an RI/FS.

Remedial Design Costs. The unit cost used here is \$1 million per fund-lead remedial design--again, somewhat higher than EPA's budget-planning estimate of \$800,000, in recognition of increases in actual costs since the passage of the Superfund Amendments and Reauthorization Act in 1986. Major and minor sites receive an average of 1.8 designs per site; mega-sites, however, are assumed to receive 2.67 designs (and subsequent remedial actions) on average, based on an analysis of projects started or expected at 43 existing mega-sites. The latter assumption introduces a minor inconsistency: in principle, mega-sites should average 2.67 RI/FSs if they receive that number of designs.²³ Resolving the inconsistency would require tracking the mega-sites separately at the RI/FS stage. Given the relatively small number of such sites and the relatively

23. Another consequence of the assumption of 2.67 remedial projects per mega-site is that the NPL as a whole averages slightly more than 1.8 per site. The number of projects per major and minor site could be marginally reduced to attain an average of exactly 1.8 for the current NPL as a whole, but there is no reason to treat the rough EPA estimate with that level of precision.

minor cost of each RI/FS, the increase in complexity would have no noticeable impact on the results.

Assumptions About Transaction and Enforcement Costs

CBO estimates that the share of transaction and enforcement costs in total future spending will be 23 percent to 24 percent in the three scenarios, with private transaction costs (paid by responsible parties and their insurers) representing 18 percent (see Table 4 on page 17). These estimates assume that transaction and enforcement costs continue to maintain their current relationships to response costs; arguments could also be made for a wide variety of alternative assumptions.

For the private sector, CBO assumes that transaction costs add 23 percent to responsible parties' direct costs for studies and cleanups, and that insurers' transaction costs nationwide are tied to those of the RPs in fixed proportions--1 to 1 in the base case, 1.15 to 1 in the low case, and 0.85 to 1 in the high case. The figures used in these assumptions come from the RAND data on five very large industrial firms and four insurance companies.²⁴ As noted in Chapter 1, the RAND study estimated that transaction costs represented 17 percent of the dollars spent by the five RPs at sites with costs exceeding \$100,000; subtracting the 8 percent of RP costs estimated to be repayments of government expenditures, the ratio of transaction costs to RP-lead cleanups and studies is $17/(100 - 17 - 8)$, or 23 percent.

CBO calculated the proportionality factors that relate insurer and RP transaction costs by dividing an estimated \$163 million in insurer transaction costs related to Superfund cleanups in 1989 (based on the RAND data) by estimated RP transaction costs in 1989. In turn, the RP transaction costs were calcu-

lated using the unit costs of the three scenarios for RP-lead cleanups and studies and an assumption that the 23 percent ratio of transaction costs to response costs is the nationwide average for all responsible parties.²⁵

Alternative assumptions are certainly possible, though difficult to quantify with current data. For example, a higher rate of RP transaction costs could be chosen on the theory that smaller firms not represented in the RAND study have relatively higher legal costs. The theory suggests that legal expenses have a high fixed component and thus that the transaction costs incurred by a smaller firm whose cleanup liability is \$200,000 may not be much less than those of a larger firm facing a liability of \$2 million. Conversely, lower rates could be chosen on the grounds that the RP data to date are biased because transaction costs occur earlier in the cleanup process. The assumptions about insurer transaction costs used here might turn out to be too low if new categories of litigation (such as insurer-versus-insurer or insurer-versus-reinsurer) become important; they might also be too high, if the courts gradually clarify the applicability of insurance policies to Superfund liabilities.

CBO's analysis modeled federal enforcement costs in more detail, assigning unit costs to site-level activities for RP searches and cost-recovery efforts and to project-level activities for negotiations and oversight. Site-level costs were estimated separately for fund-lead and RP-lead NPL sites and removal-only sites, and specific project-level costs were calculated for fund-lead and RP-lead removals, RI/FSs, and RAs (see Table 9). (Fund-lead projects do not incur enforcement costs for oversight, but many of them are preceded by negotiations between EPA and responsible parties over possible RP-lead

24. Jan Paul Acton and Lloyd S. Dixon, *Superfund and Transaction Costs* (Santa Monica, Calif.: RAND, 1992).

25. The RAND estimate of 1989 insurer transaction costs related to waste-hazard sites is \$410 million. The \$163 million used here subtracts 21 percent of the total for costs related to claims for bodily injury and property damage rather than cleanup and assumes that half of the remainder reflects costs for sites being addressed under state or federal programs other than CERCLA, or voluntarily. Taking into account the private-sector advantages in efficiency, the assumptions of the low, base, and high cases imply RP response costs in 1989 of \$623 million, \$734 million, and \$853 million, respectively--which in turn yield estimated RP transaction costs of \$143 million, \$169 million, and \$196 million.

responses.) EPA enforcement activities not included in these categories, such as developing policy and maintaining data bases, were viewed as indirect costs and modeled as fixed markups on the direct costs.

CBO's analysis broke down enforcement costs by federal office, including both headquarters and regional costs. The unit costs for the Office of Waste Programs Enforcement, the largest of the four sources, are based on EPA's budget-planning estimates, as are the RD/RA oversight costs of the Office of Emergency and Remedial Response. Costs for the Office of Enforcement were derived from expected outputs, work years, and subaccount budget totals in the 1993 operating plan. The Department of Justice costs are based on rough estimates obtained from department staff. None of these figures are

known with great precision; however, their relatively small contribution to total Superfund costs makes the uncertainties of secondary importance. For the same reason, moderate gains in efficiency resulting from the recently announced reorganization of EPA's enforcement activities would not have a major impact on total costs.

Assumptions About Federal Program Costs

Federal program costs--those for activities other than direct response and enforcement--constitute the remaining 11 percent of estimated future costs in the

Table 9.
Assumed Unit Enforcement Costs, by Source (In thousands of dollars)

Site or Activity Category	EPA Office of Waste Programs Enforcement	EPA Office of Emergency and Remedial Response	EPA Office of Enforcement	Department of Justice	Total
Removal Site					
Fund-lead	56	n.a.	33	15	105
RP-lead	18	n.a.	5	n.a.	24
National Priorities List Site					
Fund-lead	503	n.a.	235	150	888
RP-lead	327	n.a.	97	60	484
Removal Action					
Fund-lead	2	n.a.	4	n.a.	7
RP-lead	74	n.a.	17	n.a.	91
Remedial Investigation/ Feasibility Study					
Fund-lead	53	n.a.	18	n.a.	72
RP-lead	604	n.a.	28	n.a.	632
Remedial Design/ Remedial Action					
Fund-lead	64	n.a.	56	10	131
RP-lead	134	500	109	240	983

SOURCE: Congressional Budget Office.

NOTE: EPA = Environmental Protection Agency; n.a. = not applicable; RP = responsible party.

base case, 12 percent in the low scenario, and 10 percent in the high scenario (see Table 4 on page 17). These costs cover a wide spectrum of support, research, and management activities: some are closely related to site-level cleanup, and others are highly centralized and administrative in nature.

Although data on current spending for program costs are readily available, assumptions about their future evolution are unavoidably speculative because the connection between such costs and the flow of sites through the Superfund pipeline is indirect. In some cases, CBO's analysis assumes that these costs rise or fall in strict proportion to certain measures of program activity. The remaining costs are assumed to be totally independent of other program activity--that is, they are fixed, real-dollar amounts over the life of the program.²⁶ These assumptions of full or zero proportionality are not intended to be individually accurate but merely simple rules of thumb whose biases partially compensate for each other.

Using unit costs based on EPA's budget-planning estimates or on extensions of recent experience, CBO makes several assumptions about program costs.

- o Annual personnel costs for EPA's nonenforcement staff are assumed to equal \$68,000 per NPL site, excluding sites at which remedial construction is complete. (With 1,500 "active" NPL sites in a given year, for example, total salary costs would be \$102 million.)
- o Removal support costs, including contracts for technical assistance and support of policy development, are assumed to be \$250,000 per fund-lead removal action.
- o Annual remedial support costs are assumed to equal \$750,000 per fund-lead RA started in that year plus a fixed component of \$40 million. Such costs include administrative costs of cleanup contractors, technical assistance grants to local communities, state grants, contracts for

mapping and support of policy development, and services of the Army Corps of Engineers and the Bureau of Reclamation.

- o Response management is assumed to cost \$44 million per year for services and equipment related to training, budgeting, planning, data management, policy development, dissemination of information on new technologies, and emergency preparedness.
- o General administration (including financial management, rent, and utilities), research and development, and interagency costs (primarily for the Agency for Toxic Substances and Disease Registry and the National Institute of Environmental Health Sciences) are assumed to be a fixed markup on all other federal costs except operations and maintenance costs. (O&M costs were excluded as a matter of convenience to avoid the need for separate spreadsheet columns for federal and state costs.) General administration expenses are both larger and harder to predict than the other types of program costs. Consequently, the markup factor varies among scenarios, from 20 percent in the low case to 22 percent in the base case and 24 percent in the high case.

Assumptions About the Discount Rate

Because the Superfund program can be expected under present policies to continue for many decades, the present values of its costs and benefits are sensitive to the assumed annual discount rate.²⁷ For

26. For this purpose, the end of the program is defined as the point at which remedial construction is complete at all NPL sites. Costs for operations and maintenance would continue to be incurred for another 24 years.

27. As noted earlier, CBO's analysis assumes that sites are added to the screening inventory for another 30 years in the low scenario, 35 years in the base case, and 40 years in the high scenario, and that operations and maintenance of each remedy last for 24 years. The time between a site's inclusion in the screening inventory and its proposed listing on the NPL is assumed to be four years, and the time it spends on the NPL before beginning its last O&M project is assumed to be 9, 12, or 15 years, depending on whether it receives one, two, or three remedial actions. Consequently, Superfund expenses continue for as many as 83 years (through 2075) in this analysis.

Table 10.
Present-Worth Costs at Alternative
Discount Rates (In billions of dollars)

Discount Rate	Base Case	Low Case	High Case
10 Percent	52	32	80
7 Percent	74	42	120
4 Percent	112	59	197
2 Percent	156	78	292
0 Percent	228	106	463

SOURCE: Congressional Budget Office.

NOTE: See Appendix A for the differences in assumptions underlying the three cases.

example, at a discount rate of 10 percent, the present worth of estimated costs in the base case would be \$52 billion rather than the \$74 billion obtained at 7 percent; in contrast, a 2 percent discount rate would imply present-worth costs of \$156 billion (see Table 10). Although economists agree that future effects should be discounted in policy analyses, there is less agreement about the proper discount rate to use in a given case.

Much of the ambiguity surrounding the choice of a discount rate arises because income from capital is taxed, which implies that private-sector investments must provide a before-tax rate of return higher than the rate at which investors are willing to trade present and future gratification in their consumption patterns (called the pure rate of time preference). Because of this tax wedge, the discount rate used to analyze a particular policy should ideally be higher the more the policy is financed at the expense of private-sector investment rather than household consumption. In practice, however, the ultimate incidence of the policy's costs is generally unknown, and a simpler rule of thumb must be used.

The 7 percent real discount rate chosen here is the standard rate used by executive branch agencies in analyzing regulations and public investments. In

support of this policy, the Office of Management and Budget (OMB) argues that 7 percent "approximates the marginal pretax rate of return on an average investment in the private sector in recent years."²⁸ The argument most commonly made against the OMB policy is that some share of the funds used for a public policy is likely to come out of consumption rather than investment and thus that the 7 percent rate is too high.

CBO analyzed the sensitivity of present-worth costs in the base, low, and high cases to alternative discount rates between zero and 10 percent--a range chosen to span the set of plausible values (see Table 10).²⁹ Base-case costs vary from \$52 billion at 10 percent to \$228 billion at zero percent (that is, without discounting); similarly, the low-case estimates vary from \$32 billion to \$106 billion, and the high-case costs range from \$80 billion to \$463 billion.

Although using a 7 percent discount rate results in a much lower estimate of present-value costs than would be obtained at zero or 2 percent, it does not suggest that Superfund is a better "bargain"--if anything, the argument cuts the opposite way. A thorough cost-benefit analysis of the program re-

28. Office of Management and Budget, "Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs," Circular A-94, revised (October 29, 1992), p. 9.

29. The 10 percent rate was the OMB standard before October 1992. At the other end of the range, the zero rate provides a useful benchmark in undiscounted dollars and can be defended as a plausible estimate of the consumer rate of time preference, given the real interest rates now being paid on savings accounts. The 2 percent rate is based on the real interest rate on Treasury securities; in recent years, CBO's analyses of public investments have used this rate, on the basis of macroeconomic evidence that government spending was crowding out neither consumption nor investment in the short term, but rather leading to increased borrowing abroad. Finally, the 4 percent rate is included simply as a point between 2 percent and 7 percent, equally far below the primary assumption of 7 percent as 10 percent is above it.

The present study follows OMB's rule of thumb rather than CBO's on the grounds that in the incidence of its costs, Superfund is more like a pure regulation than a standard public investment. Over half of the estimated costs (before discounting) are incurred directly by the private sector. Moreover, most of the federal costs are funded from dedicated taxes on business that might not be retained if the Congress were to cancel the program and whose incidence, again, is probably closer to that of typical regulatory costs than that of the average federal dollar.

quires that its benefits also be discounted, after they are converted to dollar equivalents.³⁰ To the extent that the benefits of cleanup are spread over a longer period of time than the costs are, a higher monetary discount rate tends to reduce the present value of benefits more sharply, leading to a lower ratio of benefits to costs. In general, higher discount rates

favor less investment, whether public or private, and more consumption.

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30. Such an analysis might assume that the dollar equivalents of the benefits increase over time, on the theory that continued economic growth will raise the monetary value that individuals place on good health and a clean environment, but the assumed rate of increase would be the same for any discount rate.