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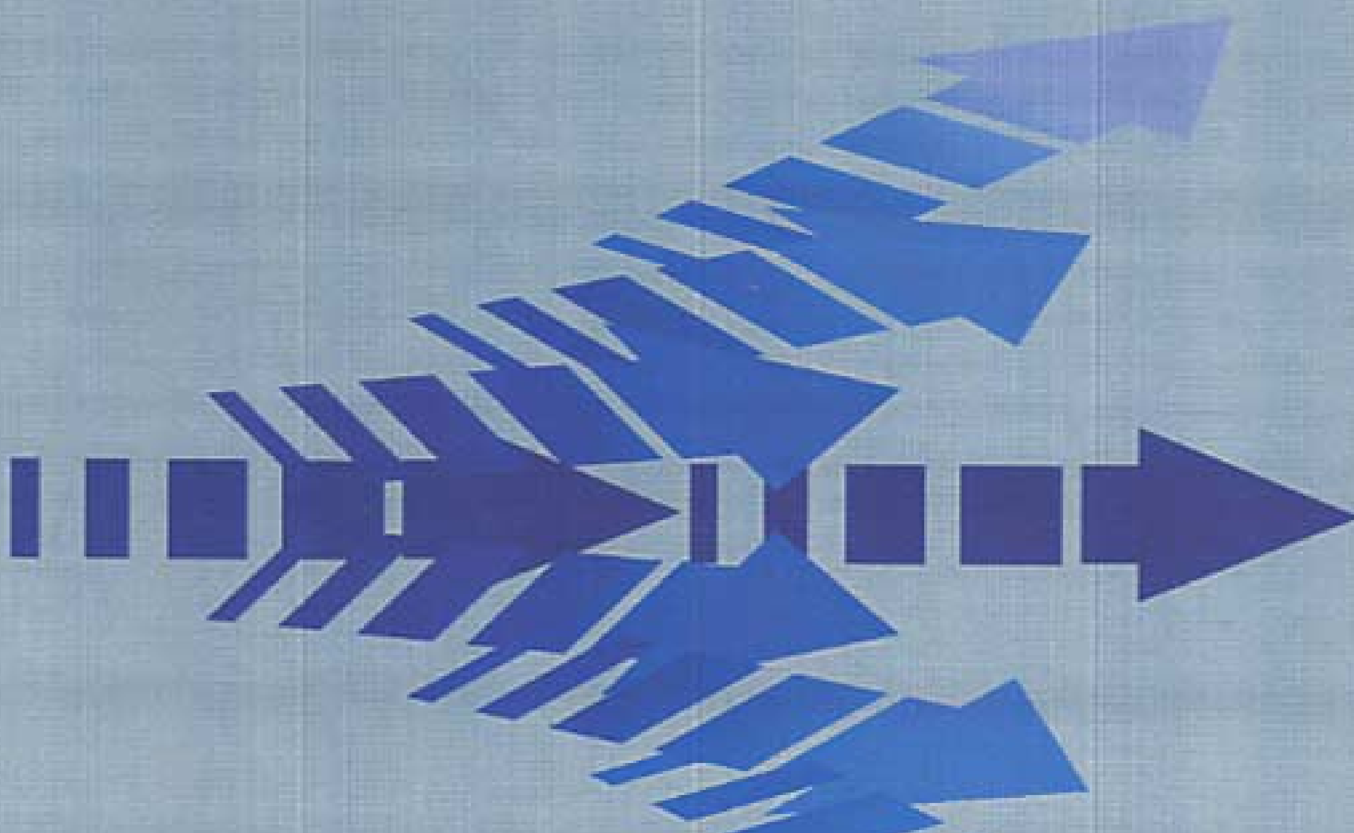
ANALYZING UNCERTAINTY IN THE COSTS OF ECOSYSTEM RESTORATION



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Preface

The work presented in this document was conducted as part of the Risk Analysis of Water Resources Investments Research Program, under the "Identifying and quantifying key sources of risk and uncertainty in production and costs related incremental analysis" work unit. The Program is sponsored by the Headquarters, U.S. Army Corps of Engineers and is assigned to the Water Resources Support Center, Institute for Water Resources (IWR). Mr. David Moser is the Program Manager at IWR. Mr. Harry Kitch, Planning Division, Mr. Jerry Foster and Mr. Earl Eiker, Engineering Division, and Mr. Harold Tohlen, Operations, Construction and Readiness Division, are the Headquarters Program Monitors. Field Review Group Members that provide overall program direction include: Mr. Martin Hudson and Ms. Pat Obradovich, Portland District; Mr. S.K. Nanda and Mr. Dale Rossmiller, Rock Island District; Ms. Pat Mutschler, Institute for Water Resources (formerly Baltimore District); Mr. Ken Cooper, Omaha District; Mr. Jerry Smith, Southwest Division; Mr. Gerald Melton, South Atlantic Division; Mr. Jim Crews, Northwest Division; Mr. Paul Wemhoener, Omaha District; and Mr. Franke Walberg, Kansas City District. The paper was prepared under the general supervision of Mr. Michael Krouse, Chief of the Technical Analysis and Research Division (TARD), Institute for Water Resources, and Mr. Kyle Schilling, Director of the Institute for Water Resources and Acting Director of the Water Resources Support Center. This paper was prepared by Dr. Ben Noble, Dr. Ron Thom, Mr. Tom Green and Ms. Amy Borde of Battelle. Ms. Joy Muncy of IWR is the Project Manager.

This document evolved from the contributions of the following personnel in completing the survey, providing more information during telephone conversations, or in providing material collected for the earlier reports used to support this study: Mr. Paul Kowalaczyk, Rock Island District; Mr. Bill Hicks, New Orleans District; Mr. Rick Hartman, NMFS; Ms. Barbara Kimler, Rock Island District; Mr. Randy Montgomery, New Orleans District; Mr. Steve Rothe, Omaha District; Mr. Leo Foley, Rock Island District; Mr. Don Powell, St. Paul District; Mr. Joey Dykes, New Orleans District; Mr. Darryl Clark, U.S Fish and Wildlife Service; Mr. David Gates and Mr. Tim Caldwell, St. Louis District; Mr. Gene Lilly, Tulsa District; Mr. Bill Hubbard, New England District; Ms. Dorie Bollman, Rock Island District; Mr. Leo Foley, Rock Island District; Mr. Terrell Roberts, Galveston District; Mr. Jerry Skalak, Rock Island District; Ms. Julie Marcy, Vicksburg District; Mr. Gary Polesh, St. Paul District; Mr. Steve Madrone, Redwood Community Action Agency; Mr. Ted Hauser, Charleston District; Ms. Renee Wright, Vicksburg District; Mr. Mike Thompson, St. Louis District; Mr. Michael Irlbeck, U.S. Dept. of Interior/Bureau of Reclamation; Mr. Lester Soule, Seattle; Mr. Gary Oates, Environmental Sciences Associates, San Francisco; Mr. Martin Cooley, Savannah; Mr. Curtis Tanner and Ms. Debbie Terrwiliger, U.S Fish and Wildlife Service; Ms. Britt Paul, Natural Resources Conservation Service; Mr. Wes McQuiddy, EPA.

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Section 1: Introduction

Planning and projecting components of environmental restoration measures is challenging, and so too is the estimation of associated financial costs. Recent experience has shown that the task of estimating costs for aquatic ecosystem restoration projects is subject to considerable uncertainty. Uncertainty is associated with many aspects of these projects including project design, equipment mobilization, land acquisition, and construction. This uncertainty often manifests itself in significant disparities between projected costs and actual expenditures, and in requests for additional funds to address these unexpected cost overruns.

Purpose

This report summarizes the findings of a preliminary effort to examine the factors that contribute to the differences between projected costs and actual expenditures, and to identify ways to reduce the uncertainty associated with the costs of habitat restoration projects. This work represents part of a general research and development program that is currently being funded by the U.S. Army Corps of Engineers (Corps). The goal of this program, titled the "Risk Analysis of Water Resources Investments", is to develop approaches for dealing with issues of risk and uncertainty that arise in water resources planning, engineering, and design. The program emphasizes the need to develop generalized techniques that can be applied in a variety of settings to address the challenges faced by a range of different Corps activities. It is hoped that the application of such approaches will improve decision making and respond to a need expressed by various study managers, project managers, engineers, water resource planners and other team members.

Scope

This work builds on previous research conducted as part of the Evaluation of Environmental Investments Research Program (EEIRP). Past efforts included detailed case-study assessments of individual restoration projects. These assessments specifically involved a review of project goals, estimated costs, and actual performance.[1] The current study builds on this work by expanding this analysis to include a comparison of estimated costs and actual project expenditures. In addition, data collection efforts were broadened to include additional examples and more recent projects.

The studies (projects) described in this report were conducted under several different legislative authorities, including Section 1135(b) of the Water Resources Development Act (WRDA), 1986, as amended; the Upper Mississippi River System-Environmental Management Program (Section 1103 of WRDA 1986), the Coastal Wetlands Planning, Protection, and Restoration Act (PL 101-646 and also known as the Breaux Bill), and a

[1] See (1) Shreffler, David K., Michael J. Scott, Katharine Wellman, and Mark Curran. *National Review of Non-Corps Environmental Restoration Projects*. IWR Report 95-R-12, 1995. And (2) Muncy, Joy D., J. Craig Fichenich, and E.A. Dardeau. *National Review of Corps Environmental Projects.* IWR Report 96-R-27, 1996.

Section 205 Flood Damage Reduction Project. In addition, non-Corps projects led by various state and/or local agencies were also included in our analysis.

The fundamental approach used to address the issue of uncertainty is a direct comparison between estimated and actual project expenditures. This comparison includes a quantitative analysis of the available cost data, as well as a more qualitative assessment of project costs that builds on observations of individual project managers. Both these elements are essential for better understanding the basic forces driving the cost uncertainty associated with restoration projects.

It is important to understand that this report was not designed to be a critique of these projects or to 'second-guess' the decisions made by project managers and field personnel. Instead, our goal was to draw on their experiences to better understand how cost uncertainties might be reduced in the future.

Organization of Report

This report is organized into six (6) separate sections. Following this introduction, Section Two describes the procedures used to gather the data underlying our analysis. Section Three follows with a general description of these data and a statistical summary of key findings. These quantitative findings are then explored in greater detail in Section Four. The report then shifts to a broader analysis of the 'lessons learned' in project implementation and managers' observations about what factors contribute most to the differences between estimated and realized costs. These results are presented in Section Five. The report then concludes with a brief summary of our findings and recommendations for areas of future study.

Section 2: Data Collection

2.1 Survey Process

The data required for this analysis were collected through a multi-step process. Project files kept by the Corps offered a list of potential examples and provided a detailed record of estimated costs for many of these candidate projects. Given this list, telephone surveys were used to solicit records of actual project expenditures and to gather more qualitative information about project implementation. In addition, the original set of candidate projects was expanded to include examples completed by agencies other than the Corps. When available, project managers were contacted directly and asked about various aspects of planning and implementation. If the original project manager could not be reached, questions were posed to other project participants or current agency staff.

In addition to providing the requested cost data, the respondents also offered valuable qualitative information about how the project had proceeded and explained how actual expenditures had evolved. A copy of the final survey instrument used during the interview process is provided in Appendix A. In total, data were collected for 47 separate projects.

2.2 Data Gathered from Both Corps and Non-Corps Projects

The primary focus of the analysis was on projects sponsored and implemented by the Corps, so data collection efforts were focused on these specific examples. Particular emphasis was given to projects for which detailed cost estimates or expenditure reports already existed. A variety of Corps restoration projects, from locations across the country, were identified as potential targets. While the projects were not drawn in a random manner and were not designed to be a statistically valid sub-sample, they are generally representative of recent Corps efforts in habitat restoration.

The projects included in the analysis represent examples from a range of Corps programs including:

- Section 1135(b) of the 1986 Water Resources Development Act (WRDA) as amended;
- The Upper Mississippi River System-Environmental Management Program (Section 1103 of WRDA 1986); and
- Components of the Coastal Wetlands Planning, Protection, and Restoration Act (CWPPRA, Section 101-6464. Also known as the 'Breaux Bill').[2]

Although data collection mainly focused on Corps projects, an effort was also made to gather information about non-Corps restoration efforts. These included projects lead by state and local agencies, as well as other federal entities. 'Non-Corps' projects from

[2] CWPPRA includes projects led by both the Corps and various Non-Corps agencies.

CWPPRA were included among this group. Guidance from the Office of Management and Budget (OMB) limited the number of non-federal projects that could be directly surveyed, so only 10 projects sponsored by state or local governments were included in the final sample.

Although information could have been gathered for additional projects, the final sample of 47 projects included a wide-range of examples, and further investments in data collection would have distracted from the analysis goals identified at the project's outset.

2.3 Scope of the Data Collection Process

The major focus of the this report is to compare estimated costs and actual project expenditures, with an eye towards understanding what systematic factors contribute to the differences between the two. In particular, are cost differences driven by errors in estimating the costs of labor and/or materials? Or, are factors such as design difficulties and unanticipated site conditions most directly responsible? Given this goal, we initially established a preference for case studies where highly disaggregated data information about individual sub-tasks was available for both projected and actual costs. We expected that data broken out in this level of detail would offer insights beyond those available from aggregate summaries of total estimates and expenditures.

Estimated Costs

For most projects, the public bidding process guaranteed the availability of highly detailed cost estimates:

- Among the Corps projects, the Micro Computer Aided Cost Engineering System (MCACES) provided a standardized format for summarizing ex ante cost estimates. This system, used throughout the Corps, provides very specific estimates for various aspects of project engineering/design and implementation. Although MCACES reports were not available for the older Corps projects, some type of formal cost estimates were provided for most of these examples.
- For the non-Corps projects, estimates were available at varying levels of detail and aggregation. Some estimates matched the detail required by the MCACES, but many others only reported aggregated estimates for the project design and implementation phases. Ultimately, this level of detail proved to be sufficient for our analysis, but efforts were made to collect information at the finest degree of disaggregation possible.

In calculating total estimated expenditures for both Corps and non-Corps projects, any identified contingencies were included as part of the final cost estimates. Therefore, any overruns represent additions above and beyond those explicitly considered in original projections. In other words, we consider cases where the added expenditures exceeded the amount allotted for routine construction uncertainties. Many of the projects analyzed here included contingencies of roughly 10% to 15%, while cost overruns frequently ranged from 20% to 50%.

Actual Expenditures

As we began to collect data on actual expenditures, it became apparent that it would be difficult, if not impossible, to consistently match the detail available from MCACES:

- In many cases, the rigor used to develop the MCACES estimates was not matched by the effort to track actual project expenditures. Instead, when available, expenditure reports often included only summary-level expense data.
- Alternatively, some examples tracked actual costs at a high level of detail, but were aggregated in ways that did not map to the MCACES estimates. For example, actual expenditures on "plantings and grading" might be recorded in one category, while the estimated costs would group together "grading and berm construction".

Thus, there was no way to track each individual spending category. The discrepancy between both the level of detail and the aggregation of component costs can be attributed to several factors.

- Different individuals responsible for pre and post project accounting;
- Extended time interval between initiation and completion of projects;
- Projected costs assessed by Corps or other planners, while actual costs were often reported by contractors;
- Lack of a formal system for aggregating and inputting actual cost expenditure data; and
- Accounting not done with an eye toward this type of analysis.

Ultimately, the summary cost categories adopted by the Corps staff involved in the CWPPRA projects served as a model for our analysis. Although data for the CWPPRA projects were summarized at an aggregate level, cost categories were consistently defined for both ex ante and ex post costs. This consistency proved to be more valuable for our analysis than did the highly disaggregated information provided by the MCACES estimates.

Indeed, our original concern for gathering highly detailed data proved to be somewhat unfounded. As described in Sections 4 and 5, meaningful analysis did necessarily not require itemized comparisons of projected and actual expenditures.

2.4 Standardizing Cost Estimates

Once the cost data had been collected, a construction-cost index was used to convert all reported estimates and expenditures into 1999 dollars. The index used for this conversion was developed from the Corps' Civil Works Construction Cost Index System (CWCCIS).[3] Although separate indexes are available for specific types of projects (e.g. Reservoirs, Levees and Floodwalls, and Bank Stabilization), the historical cost data were scaled with the CWCCIS' overall composite index. The projects included in the final sample involved a variety of different construction activities, so a general index appeared

[3] Civil Works Construction Cost Index System, EM 1110-2-1304. U.S. Army Corps Engineers, September 1999. (In this index, estimates for 1999 year-end costs were developed based on Office of Management and Budget (OMB) projections of cost escalation.)

to be the most appropriate. A summary of the actual index values appears in Appendix B.

For projects that took several years to design and implement, the mid-point of the construction period was used as the basis for adjusting actual expenditures to current dollars. Most of the estimated costs included ‘fully-funded’ estimates which projected the actual appropriations needed to complete construction, after adjusting for the effects of inflation expected between planning and implementation. We adjusted these ‘fully-funded’ estimates to 1999 dollars using the construction cost index described above.

Furthermore, it is worth noting that our analysis focuses on the costs associated with project design and implementation, but does not specifically analyze expenditures related to monitoring and/or maintenance. Although the survey instrument did include some questions related to these costs, we were unable to gather a comprehensive set of quantitative data for many of the projects. Given our emphasis on relatively recent projects, many of the examples did not include a sufficient track record for analyzing monitoring and maintenance costs. In addition, on-going operational costs were often the responsibility of local agencies or other project partners and detailed data on these activities were not available from the sources contacted.

2.5 Supporting Information

In addition to requesting detailed reports on estimated and actual project costs, the survey instrument also included some general qualitative questions about project design, the procedures used to develop the original cost estimates, and project implementation. Particular emphasis was given to the issue of cost overruns, and the potential causes of unanticipated project expenses.

Respondents were asked to explain how such factors affected individual projects, but were also questioned about their general experience in overseeing complex project implementation. As the example questionnaire included in Appendix A shows, we were anxious to understand whether cost variances were most often linked to (1) inaccurate estimates of materials and/or labor costs, (2) shortcomings in preliminary design work, (3) unforeseeable natural forces, or (4) other issues.

While the questionnaire included a list of these potential factors, much of the qualitative information collected about each project was obtained from general discussions about how implementation had proceeded and the difficulties that were encountered along the way. The ‘lessons learned’ that were conveyed in these conversations underlie many of the general observations presented in Section 5.

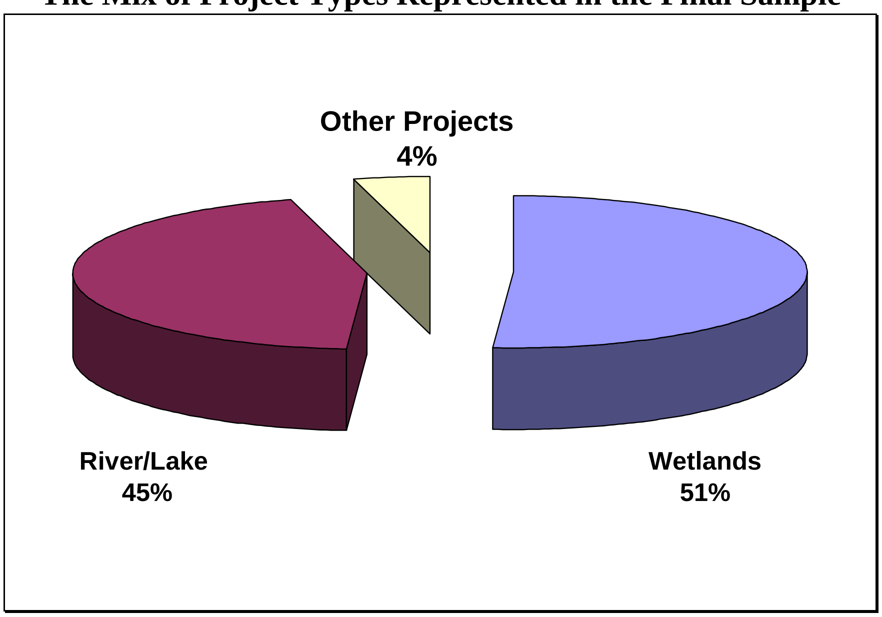
Section 3: Data Characterization

As noted above, a total of 47 projects were included in the final analysis sample. Data collection efforts were generally targeted at projects designed to create, restore, or enhance natural habitats. Within the sample we identified three broad types of examples: 1) Wetlands projects; 2) River/Lake projects; and 3) general habitat restoration projects. To some degree these distinctions were arbitrary, because many projects involved work within rivers or streams that was designed to establish or protect new and existing wetlands. In addition, many of the CWPPRA projects involved coastal shoreline protection aimed at preserving neighboring wetlands (therefore classified as wetland projects). Nonetheless, there was a group of projects targeted specifically at riverine habitats, involving, for example, redirecting flows to alter sedimentation patterns or improve habitat quality, or modifying river channels to return the riparian variation lost as a result of earlier channel straightening projects. Projects that were not directly related to wetland or river habitat were classified as 'general habitat restoration projects'. This category included projects that were designed to help improve habitat areas but did not involve active wetlands construction, instream dredging, etc. and instead were limited to such things as tree plantings or pipeline construction for the purpose of controlling flows.

3.1 Project Types

The total sample of 47 was divided almost evenly between the Wetlands and River/Lake projects. Only two projects were classified as general habitat restoration.

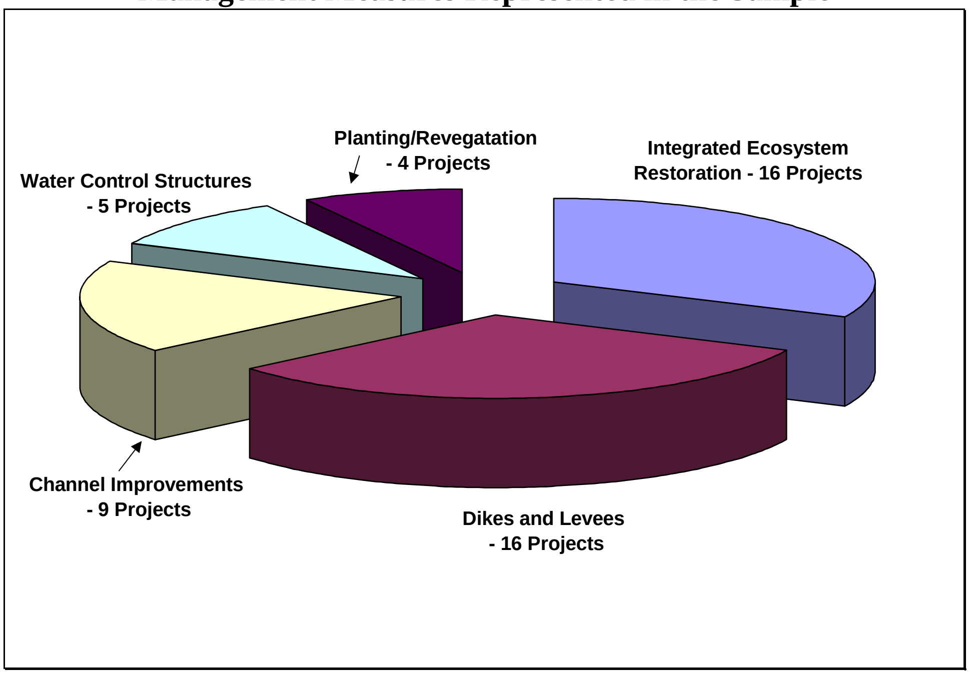
Exhibit 3-1
The Mix of Project Types Represented in the Final Sample



- Many of the River/Lake projects were drawn from the Upper Mississippi River System Environmental Management Program, but the final sample also included examples from other programs and on both the east and west coasts.
- The wetlands projects were gathered from across the country, and included projects funded through Section 1135, the CWPPRA program, and various state initiatives.

The data were also categorized according to the management key management measures featured in each of the projects. To facilitate comparisons across management measures, the projects were grouped into five general categories. This distribution of projects is illustrated in Exhibit and 3-2 each category is described in greater detail below.

Exhibit 3-2
Management Measures Represented in the Sample



- **Integrated Ecosystem Restoration Projects:** This category includes larger projects that involved several measures such as dikes and/or levees (requiring dredging and/or excavation), water control structures, pumping stations and revegetation. The average cost of the 16 such projects included in the study sample exceeded $3.6 million.
- **Dikes and Levees:** Many of the projects designed to create new wetlands or protect existing wetland habitat involved the construction or rehabilitation of dikes and levees. While other measures were frequently included in these projects, dike or levee construction represented the most significant component of projects assigned to this category. Like the projects included first category, those represented here generally required major financial outlays; the 16 projects included in this category cost nearly $2.5 million on average.
- **Channel Improvements:** A significant share of the projects involved efforts to improve habitat in existing rivers or streams, or to create new channels in areas with

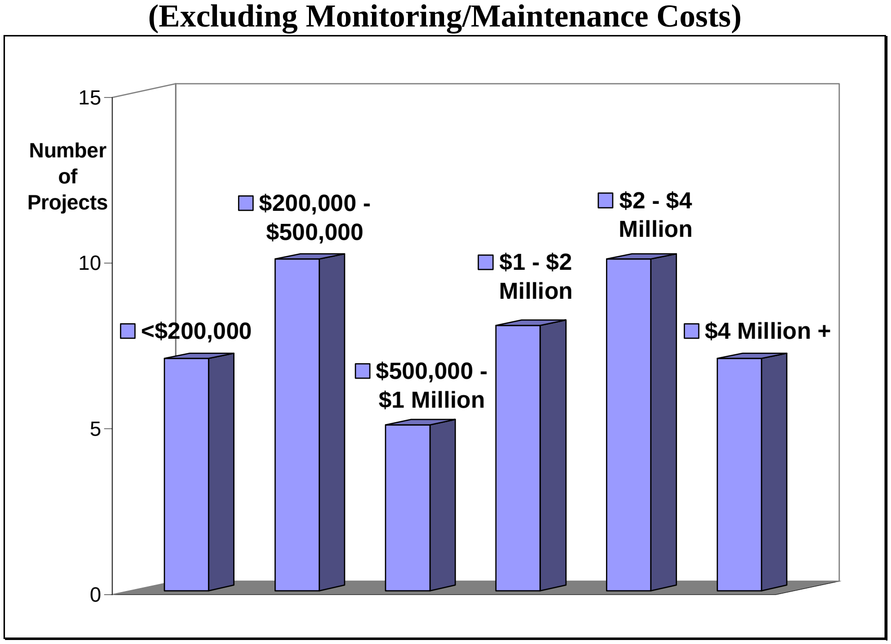
poor circulation. Typically, these projects included a series of integrated steps including bank stabilization, weir construction, rock placement, etc., but each example emphasized different specific measures. Nonetheless, they did all share the common goal of improving instream habitat or establishing new water circulation patterns. These projects were generally smaller in scope than those described above and had an average cost of roughly $650,000

- **Water Control Structures:** Efforts to enhance existing wetlands habitat frequently required installation of new water control structures designed to improve drainage or to enhance managers' control over wetland conditions. Culverts, stop-log devices, and tide gates are all examples of such structures. The 5 such projects included in our sample had an average cost of $800,000.
- **Revegetation/Plantings:** A small subset of the sample (4 projects) focused on enhancing habitat by planting native species in specifically targeted areas. The projects included in this category involved both terrestrial and aquatic planting programs. These projects were substantially smaller in scope than those included in the remaining categories and had an average cost of just under $275,000.

3.2 Project Costs

Although most of the projects involved expenditures of more than $200,000, the scope of projects represented in final sample varied considerably. Exhibit 3-3, which focuses on actual project expenditures, illustrates the wide range of project costs included in the final sample.

Exhibit 3-3
Range of Actual Project Expenditures
(Excluding Monitoring/Maintenance Costs)



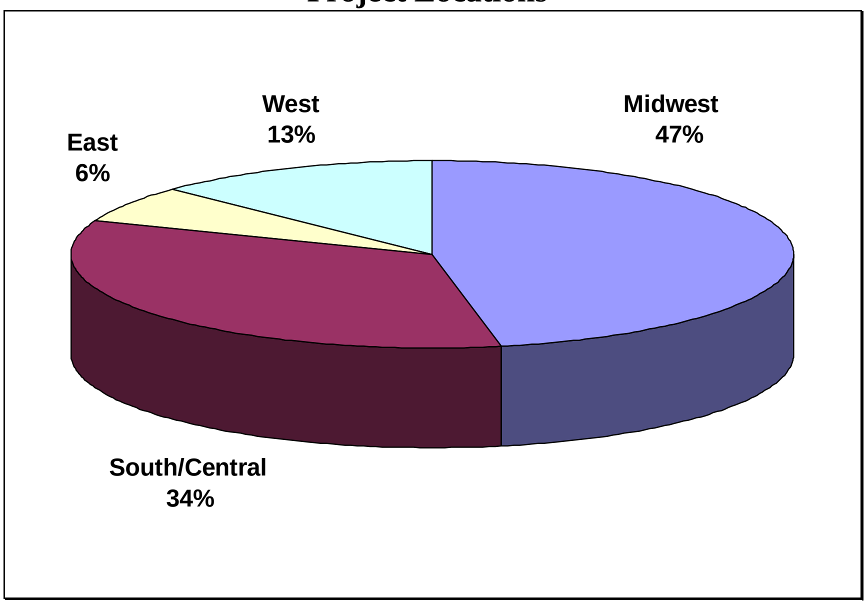
- Many of the less costly projects focused on revegetation or small drainage improvements. The larger projects, costing upwards of $2 to $3 million, included large multi-acre wetland restorations, major diking efforts, and other large construction efforts.

- Although this point is not illustrated above, wetlands projects were, on average, less costly than the river/lake projects (an average cost of $1.8 million for wetlands vs. $2.6 million for river/lakes).

3.3 Project Locations

The final sample also included projects from a broad geographic spectrum. Projects from the Upper Mississippi program provided examples from the Midwest, the CWPRAA initiative offered examples from the Southeast, and the Section 1135 program added examples from the central states as well as the east and west coasts.

Exhibit 3-4
Project Locations[4]



The geographic spread of the projects included in the current sample can also be demonstrated by considering their distribution across the various Corps Districts. Although Exhibit 3-5 focuses on only the Corps projects, it does show that projects were drawn from across the country.

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[4] East includes projects from South Carolina, Maryland, and Rhode Island;
West includes projects from California and Washington;
Midwest includes projects from Illinois, Iowa, Minnesota, Nebraska, Wisconsin, North Dakota, and Missouri; and
South/Central includes projects from Louisiana, Arkansas, Texas, and Georgia.

Exhibit 3-5
District Representation

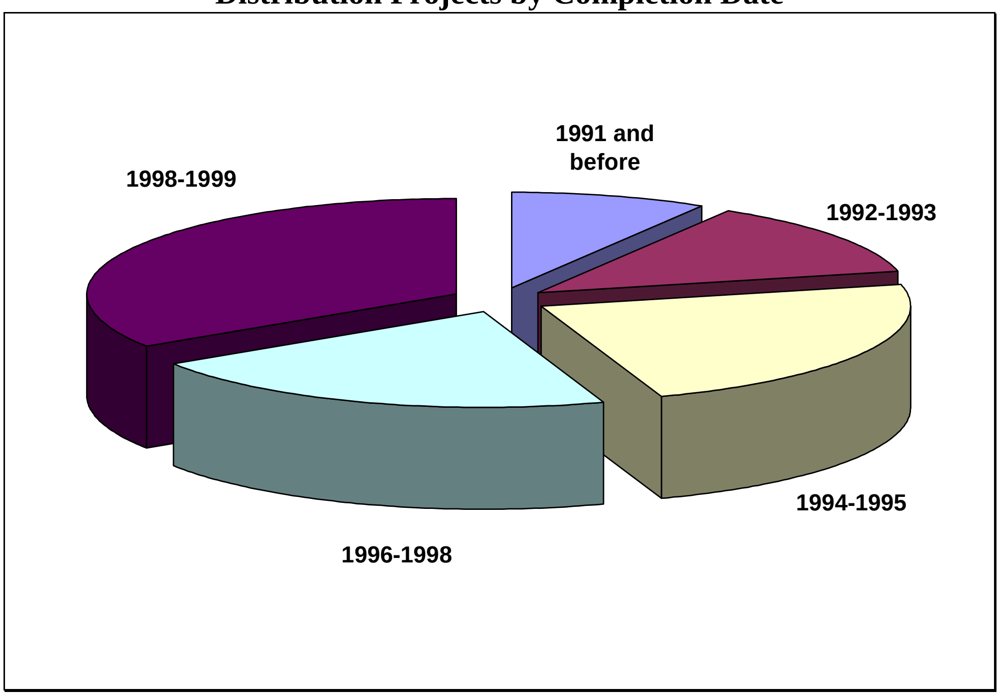
Corp District	Number of Projects
Rock Island District	10
New Orleans District	8
St. Paul District	6
St. Louis District	3
Vicksburg District	2
Baltimore District	1
Charleston District	1
Galveston District	1
Omaha District	1
New England District	1
Savannah	1
Seattle	1
Savannah	1
Total	**37**

The concentration of projects in the Rock Island, St. Paul and New Orleans Districts reflects the large number of examples taken from the Upper Mississippi and CWPPRA programs.

3.4 Project Timing

Most projects included in the final sample were completed some time within the last ten years. As shown in Exhibit 3-6, roughly 75% were completed after 1994 and more than half after 1996.

Table 3-6
Distribution Projects by Completion Date



Recognizing that habitat restoration is a relatively new and evolving area of emphasis, we were anxious to focus our analysis on relatively recent projects that reflect the practical knowledge gained from past restoration efforts.

3.5 Data Characterization: Summary

Overall, the sample included a wide mix of projects that seem to fairly represent the variety of restoration projects completed over the past few years. The selected projects were gathered from across the country and included both small and large undertakings. A list summarizing basic information about each of the 47 projects appears in Appendix C.

Section 4: Quantitative Results and Observations

Our analysis of the observed differences between estimated and actual costs began with a quantitative assessment of the data collected from the 47 case studies. The first step in this quantitative assessment involved aggregating all the available estimates to allow for consistent comparisons across projects. A methodology was then developed to identify examples where estimated costs and actual expenditures differed by a significant amount and to analyze the reasons underlying these differences. The procedures used to aggregate costs and to identify examples where estimated and actual costs diverged substantially are described below.

4.1 Aggregating Costs and Narrowing the Focus of Analysis

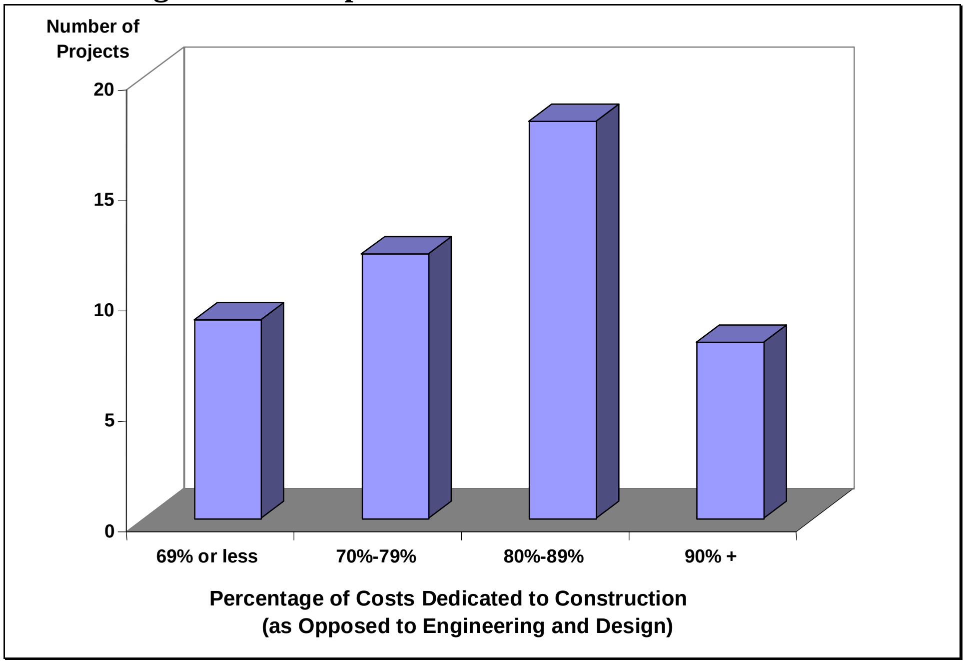
Originally, we had planned to examine costs at a very fine level of detail. Expecting that systematic errors in estimating both the quantity and price of labor and materials would be a likely source of cost variances, we had anticipated that very detailed data would be needed to identify these specific allocations.

However, as we moved forward, it become apparent that such an analysis would be neither possible nor particularly fruitful:

- As noted previously, when detailed cost records of both projected and actual costs were available, they were generally not reported in a comparable manner. Cost estimates grouped certain expenditures together, while the data on actual expenditures merged different categories;
- More importantly, the interviews we conducted as part of the data gathering process revealed that systematic errors in estimating specific project components were <u>not</u> the major cause of differences between projected and actual costs. For example, there was no evidence that labor hours or even hourly wages were being consistently underestimated. Nor did we find that the available estimates of per unit material costs were unrealistically low. Instead, as described in greater detail below, such differences were more directly related to a failure to follow prescribed planning procedures or to unanticipated events in project implementation.

Therefore, before proceeding with a quantitative analysis, both estimated and actual costs were aggregated at a summary level. The final aggregated data distinguished: 1) engineering and design; and 2) construction and construction management. As show in Exhibit 4-1, construction expenditures dominated the total costs for most projects. On average, more than 75% of total expenditures were directed towards construction, with just under 25% spent on engineering and design. This allocation was relatively stable; engineering and design expenses exceeded 30% of total project costs for only nine specific projects.

Exhibit 4-1
Percentage of Total Expenditures Directed Towards Construction



Construction costs included labor, materials, equipment mobilization, construction management, and real estate acquisition. Where budgets specifically listed the costs of completing final project reports, these expenditures were grouped with more general engineering and design costs.

Interviews with project staff revealed that estimates recorded at this level of detail would be sufficient to explore the major causes of differences between estimated and actual costs. Table 1 in Appendix C provides a complete list of the projects included in the analysis and reports both estimated and actual costs at this summary level of aggregation.

4.2 Projected vs. Actual Costs: The Frequency of Meaningful Differences

Even after aggregation, we found that rarely, if ever, did projected and actual costs match exactly. Therefore, before proceeding with a detailed analysis, it was necessary to establish a threshold that would identify examples where projected and actual costs differed by a ‘significant amount’. These examples could then be the focus of additional study.

The rules governing cost estimates for project modifications provided some basis for establishing a firm benchmark for our comparisons. Under current regulations, modifications and claims that exceed $100,000 require approval by the Chief Engineering Division or the Chief of the Construction Division. (Changes below $100,000 require an additional MCACES-based cost estimate, but only require approval from the Administrative Contracting Officer.)

This criterion was established as an initial 'cut-off', but it was apparent that using a fixed dollar-figure might lead us to ignore important variations in the costs of smaller projects. For example, a $200,000 project that suffered a $60,000 overrun would fall below the $100,000 threshold, even though the project cost 30% more than anticipated. Therefore, the selection criteria were expanded to include all projects where actual expenditures differed from projected costs by either $100,000 or by at least 20% of the original estimates. Although the 20% threshold is arbitrary, our review of the available cost data suggested it was a natural cut-off point.

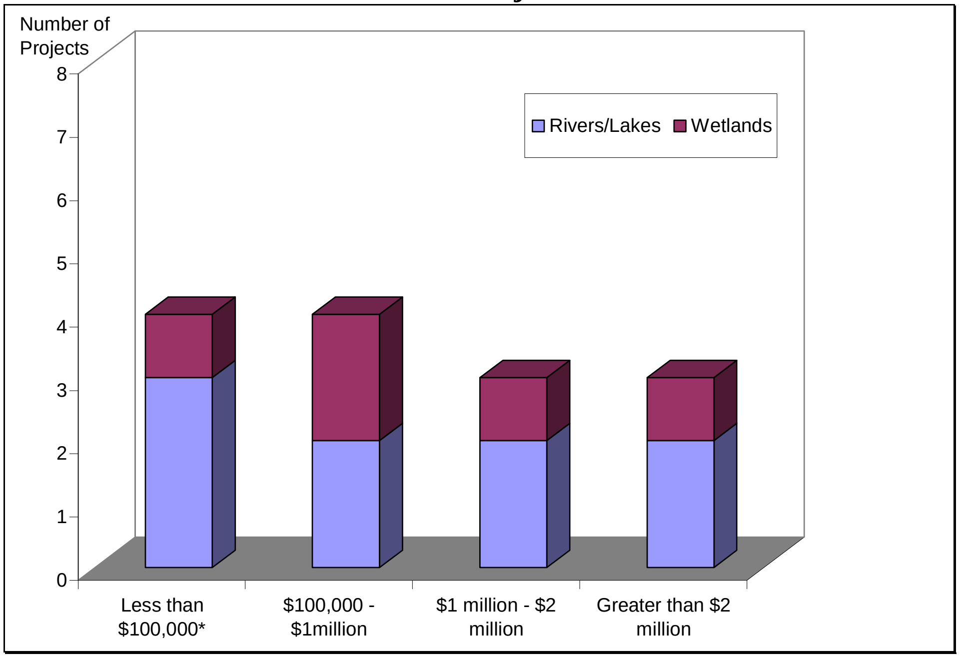
Because we were also interested in examples where actual costs fell *below* the original estimates, we used a symmetric criterion to address such situations. Thus, we identified the specific examples in which actual expenditures fell short of the projected costs by more than $100,000 or by more than 20% of the original costs.

In developing these thresholds, we also recognized some errors in estimating costs might not be seen as overruns. Given budgetary limitations, some of the projects facing possible overruns were likely scaled-back or reduced in scope to ensure that additional funding would not be needed. Unfortunately, we had no way to quantify the magnitude of any potential overruns for these examples and thus could not apply the classification procedure described above. Nonetheless, one should recognize that excluding these examples slightly understates the number of projects with significant overruns.

4.3 Quantitative Results

Overall, we found that for 14 of the 47 projects, or roughly 30% of our sample, actual expenditures exceeded projected costs either by $100,000 or by more than 20% of the original estimates. Although the discussion below shows that our quantitative analysis revealed some common links among these projects, this sub-set includes projects from across the country, with examples from each of the major Corps programs and representing a variety of different restoration efforts. As show in Exhibit 4-2, project overruns varied from less than $100,000, to more than $2 million.

Exhibit 4-2
Distribution of Project Overruns

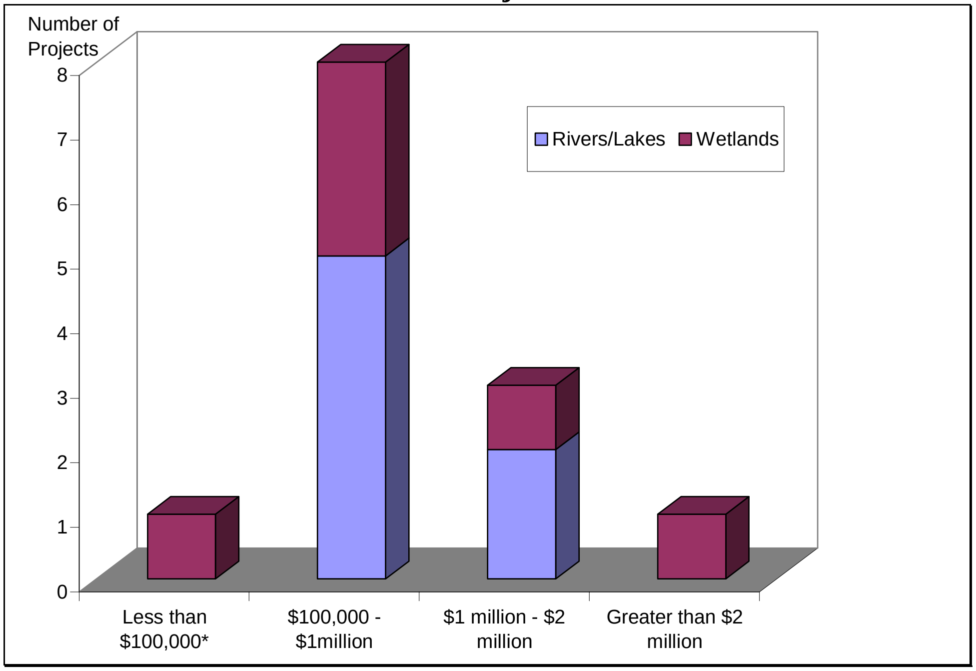


*Overruns of less $100,000 that represented at least 20% of estimated costs

From a technical perspective, the two basic criteria used to identify significant overruns were generally complementary and thus offered a robust method for focusing our more detailed analysis. For example, eight of the ten projects where actual expenditures exceeded estimated costs by more than $100,000 also involved overruns of more than 20%. However, we did identify four projects where overruns of less than $100,000 represented more than a 20% overrun. As expected these were smaller projects, with costs ranging from approximately $50,000 to $150,000.

A similar pattern of results was found among the projects that were completed for substantially less than the original budget. Project underruns ranged from less than $100,000 to more than $2 million:

Exhibit 4-3
Distribution of Project 'Underruns'



*'Savings of less $100,000 that represented at least 20% of estimated costs

In total, 13 of the 47 were found to be significantly 'under budget'. Of these 13 projects, seven projects met both criteria and involved underruns of more than $100,000 that also represented 20% (or more) of the original estimates. For the remaining six projects, actual expenditures were at least $100,000 below the original projections, *or* the observed 'savings' represented at least 20% of the cost estimates.

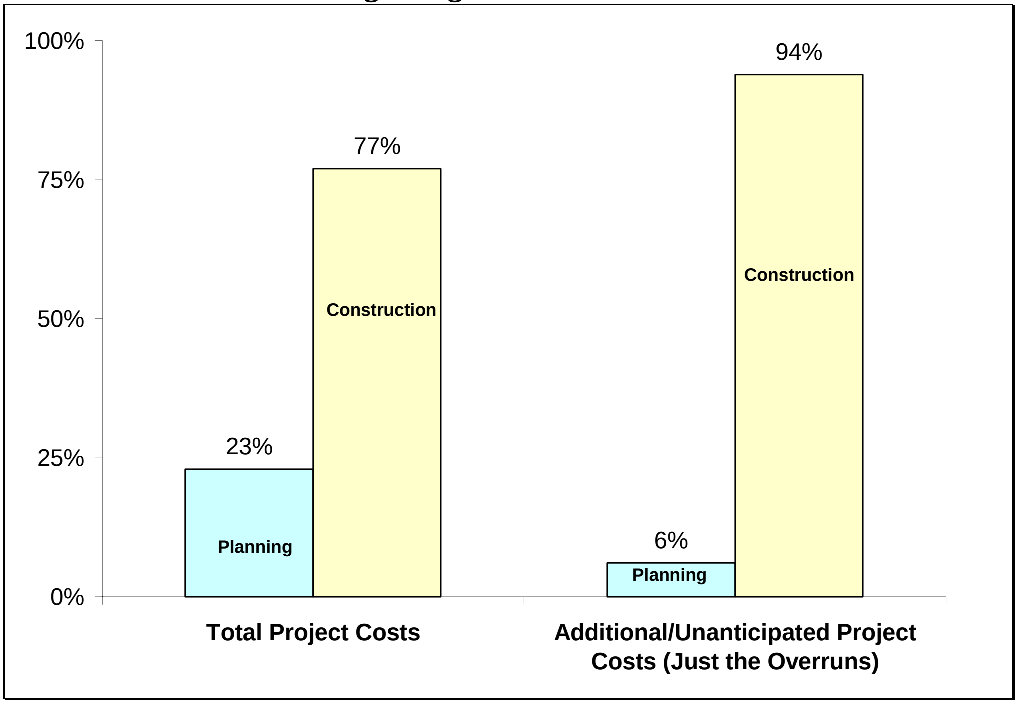
Overall, 27 of the 47 projects involved significant overruns or underruns, with nearly even numbers in these two categories (14 overruns vs. 13 underruns).

Where do Cost <u>Overruns</u> Occur?
Construction Costs vs. Engineering and Design

As described earlier, the available data generally distinguished between the costs associated with project engineering/design and those required for actual construction. Access to these data provided an opportunity to track unanticipated spending and identify which general categories absorbed most of the additional funding.

In comparing the relative impact of these two cost categories, we confirmed our expectation that construction related costs represent a larger share of the reported overruns. Among the overall sample,, construction costs represented roughly 77% of final project outlays, with the remaining 23% dedicated to planning and design. However, if one focuses on just the additional costs, those above and beyond planned contingencies, one finds that construction represented nearly 95% of these additional costs. Thus, a larger share of the additional spending is directed toward actual construction.

Exhibit 4-4
Distribution of Planning/Design and Construction Costs - Overruns



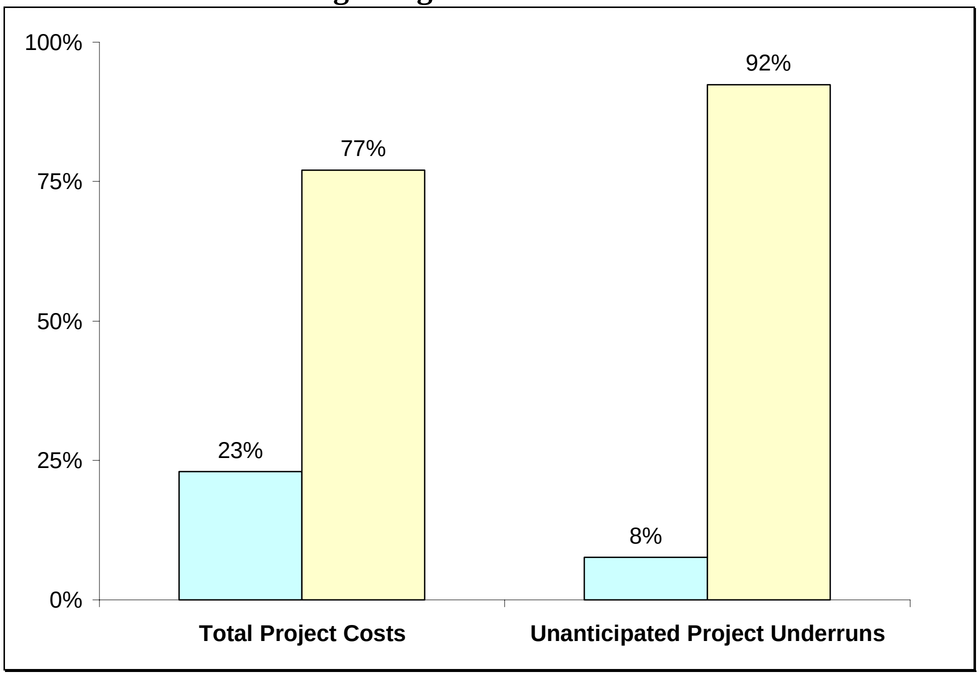
Thus, in most cases, project overruns involve some additional planning/design, but the required changes usually involve modifications to the original plans rather than an entire re-working. As a result, a larger share of the additional cost is directed towards actual construction.

However, these results should not be interpreted as indicating that planning/design does not have an important role in cost uncertainty. To the contrary, as we discuss in Section 5, a lack of thorough planning was consistently identified by project managers as an important cause of cost disparities. Managers often felt pushed by local partners to move projects head quickly and to advance toward implementation as rapidly as possible.

Where do Cost Underruns Occur?
Construction Costs vs. Engineering and Design

A similar analysis of projects involving significant underruns found that most overestimates are linked to construction rather than planning and design. As shown below, if one focuses specifically on cost underruns, 92% of the unexpended funds come from construction budgets rather than engineering and design.

Exhibit 4-5
Distribution of Planning/Design and Construction Costs – Underruns



Overall, construction typically absorbs 75% of the overall project budget, so clearly a disproportionate share of underruns can be attributed to construction.

Uncertainty Has Decreased with Cumulative Experience

Our interviews with individual project managers suggested that many of the past shortcomings in project design and implementation arose from a general lack of experience and recent projects have involved considerably less cost uncertainty (as defined by significant differences between estimated and actual costs). From an empirical perspective it is dangerous to draw broad conclusions from our relatively small sample, however, our analysis does suggest that the disparities between projected and actual costs have been narrowing in recent years.

- Only four of the twenty projects completed from 1997 to the present involved significant costs overruns. In contrast, ten of the twenty-seven projects completed between 1985 and 1996 (more than 35%) required significant additional funding.
- The results involving projects with unexpectedly low costs were comparable. Among the more recent group of projects, only five were completed for significantly less than the budgeted total. However, costs for eight of the twenty-seven earlier projects fell significantly below the original estimates.

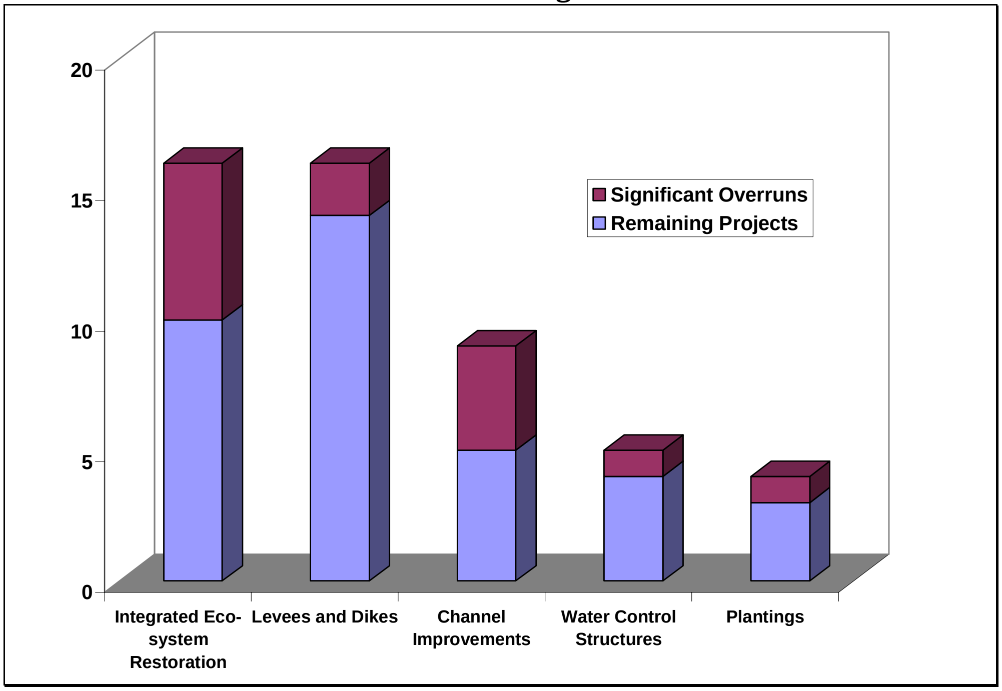
Thus, cost uncertainty has narrowed from both directions; tendencies to both over- and under-estimate project costs have been reduced over the past few years. As discussed in Section Five, these results likely reflect a growing body of experience with habitat restoration programs and an increased familiarity with the factors that drive costs for this type of work. This experience has reduced the frequency of both over- and under-estimated budgets.

Role of Management Measures

Quantitative analysis of the available cost data also showed that the distribution of cost overruns and underruns depended on the type of management measures featured in specific projects. As described above, our analysis of management measures focused on five broad categories of projects: (1) Integrated Restoration Efforts; (2) Levees and Dikes; (3) Channel Improvements; (4) Water Control Structures; and (5) Revegetation/plantings. Projects typically included more than one management measure, but were classified according to the principal project component. The 'Integrated Restoration' category was used to characterize projects that involved an integrated set of management measures.

Focusing first on cost overruns, our results revealed that significant additional expenditures were most frequently needed for the larger integrated projects and for those involving channel improvements. However, as shown in Exhibit 4-6, significant overruns did occur in all project categories. (In this exhibit, the height of each bar indicates the total number of projects in each category, while the shaded region highlights the share of these projects that involved significant overruns.)

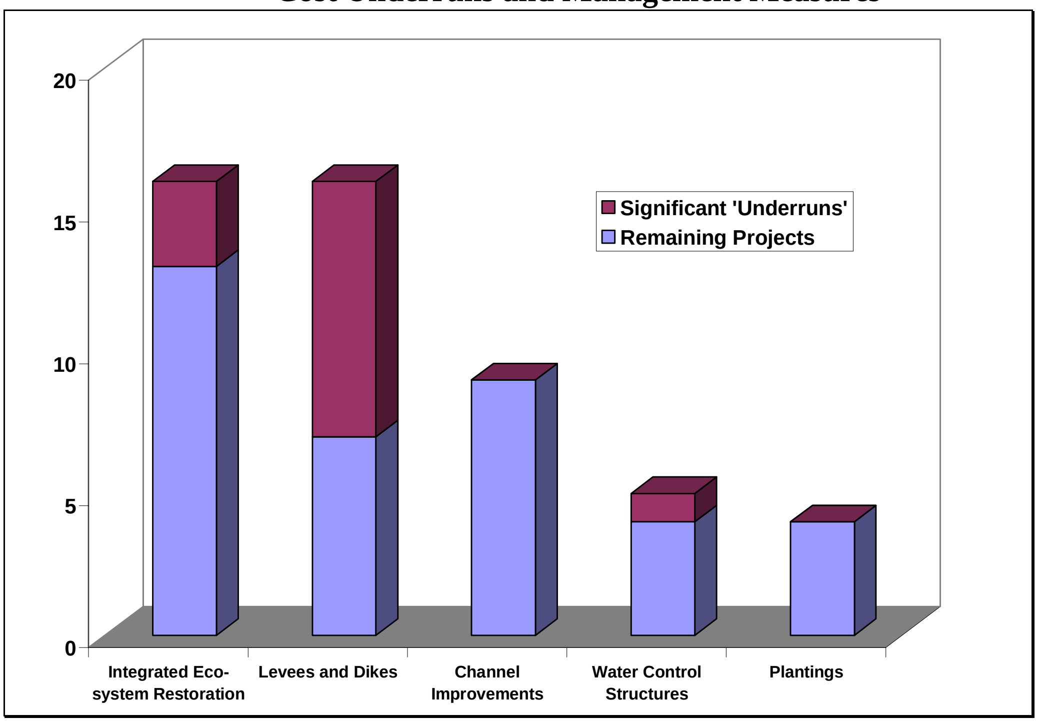
Exhibit 4-6
Cost Overruns and Management Measures



The frequency of overruns within the larger integrated projects likely reflects the complexity of these efforts and the challenges of managing the uncertainty inherent in specific aspects of the overall project. However, because we were unable to track project costs at an individual task level, we could determine whether particular components of these projects were most directly associated with cost overruns. Interestingly, the cost overruns that occurred among the channel improvement projects were almost exclusively limited to non-Corps projects; there were four projects with significant overruns and three of these were non-Corps efforts. Thus, there is no evidence that channel improvement projects are a major challenge, at least with regard to cost overruns, for the Corps of Engineers. Among the non-Corps projects, a general lack of experience apparently led to under-assessments of overall project scope and ultimately pushed costs beyond anticipated levels.

Shifting to an analysis of what role management measures had in determining the likelihood of significant cost underruns, our quantitative assessment revealed that significant underruns were most prevalent in projects involving traditional dike and levee construction. These findings are illustrated in Exhibit 4-7

Exhibit 4-7
Cost Underruns and Management Measures



Cost underruns in the Levee and Dike projects reflected the benefits of advantageous weather conditions, use of more efficient dredge/excavation technologies that had been anticipated, and adjustments in project scope. As we noted earlier projects are occasionally 'scaled-back' to ensure that the available funding will be sufficient to complete the targeted work. In at least three of the nine underruns involving dike and levee construction such reductions in project scope were identified as the key reason for the observed costs underruns. Thus, one should not rush to conclude that the costs of levee and dike projects are being systematically over estimated.

Project Type and Program-Specific Experiences

In an effort to better understand the factors underlying cost differences, we also compared experiences across the various different Corps initiatives represented in our sample (Upper Miss., Section 1135, and CWPPRA). We also did a separate analysis of the

Wetlands and River/Lake projects. It was more difficult to draw broad conclusions from these analyses because there were relatively few examples with any given sub-category. For example, although the overall sample includes 47 individual projects, the Upper Mississippi, Section 1135, and CWPPRA programs each contributed less than 17 projects to this total.

Acknowledging this important caveat, our results seem to indicate some differences between the River/Lake and Wetland projects, and these differences can explain some of the variation that is seen across the three major programs. Within our sample, significant cost overruns occurred more frequently among the River/Lake projects than the Wetland projects; nine of the fourteen projects with significant overruns were in the River/Lake category while only four were from the wetlands group.[5] Additional analysis suggest two general reasons that might explain this difference:

- First, the River/Lake category included a larger number of projects completed before 1997. And, as is noted above, a general lack of experience may have led to greater differences among these older projects.
- Second, our interviews with project managers revealed that some cost overruns were attributable to contractors unfamiliar with the difficult environmental conditions associated with restoration projects. In particular, the increased difficulties associated with working in river habitats may explain some of the observed disparities.

Whatever the cause, the cost overrun differences between these project categories also correlated to variations across the Corps initiatives included in the sample. To be specific, a larger share of overruns was found among the thirteen Upper Mississippi projects included in the sample than among either the Section 1135 or CWPPRA projects. But, by its very nature, the Upper Mississippi program included a large share of the River/Lake projects and the integrated restoration efforts. Thus, differences among the initiatives may reflect more about the types of projects funded and the measures employed than they do about overall program management.

4.4 Quantitative Results and Observations: Summary

Overall, we found that a similar proportion of projects had either experienced significant overruns or underruns. Among the Corps-led projects, differences between estimated costs and actual expenditures were most common among the larger, integrated restoration efforts. Large costs differences were also found among projects involving channel improvements, but the Corps did not lead those projects with the largest cost differentials. There was also some indication that differences were more frequent in the River/Lake projects, but in general we found that cost differences have been decreasing with increased experience in project implementation. As discussed in the following chapter, efforts to further reduce cost uncertainty will probably be best targeted at improving pre-construction site surveys and better implementing current planning and design procedures.

[5] Recall that the overall sample is divided roughly evenly between these two categories.

Section 5: General Conclusions and 'Lessons Learned'

The original methodology developed for this analysis was designed to track expenditures at a high level of detail. The approach was designed to separately consider expenses associated with labor, materials, equipment, etc., and to compare how estimated costs and actual expenditures differed for individual categories and for each project task. It was anticipated that systematic 'errors' in estimating certain types of expenditures would explain the observed differences between projected and actual expenditures, and that detailed data would be necessary to identify the source of these differences.

However, as the interview process proceeded and we were able to engage project managers in frank discussions about project design and implementation, it became apparent that cost uncertainty was more directly related to a broader set of design and implementation issues. Although these problems manifested themselves as additional expenditures for specific items such as labor and materials, the underlying causes had more to do with environmental conditions and other general challenges. As information was gathered from a survey of project managers, working in different areas, on a variety of different projects, we consistently heard that cost uncertainties were linked to many of the same concerns and problems:

- **Incomplete site surveys –** unexpectedly difficult working conditions increase costs. Planners understand that more detailed surveys can reduce uncertainty, but need to balance this benefit against the costs of such efforts.
- **Insufficiently detailed planning –** the need to redesign projects during construction can lead to significant cost overruns. Pushed by local partners, projects sometimes move toward implementation with insufficiently detailed engineering and design.
- **General project experience –** project managers, local agency staff, and private contractors have been gaining experience with restoration projects, but at first projects were new and unfamiliar.
- **Construction Window Constraints –** given the need to suspend work to protect habitat areas during critical periods (spawning, mating, etc.), scheduling can have large impact on total project costs.
- **Difficulties with land acquisition –** it can be hard to precisely estimate land values; and conflicts with individual property owners over appropriate compensation can delay project implementation.
- **Weather conditions –**regular weather variations are expected, but when working in and around aquatic environments, extreme conditions such as storms and prolonged flooding can dramatically alter schedules and increase costs. While weather conditions are a challenge for any outdoor construction, restoration projects can put equipment and personnel directly into the most affected areas.

As the list above and the discussions that follow demonstrate, some of these difficulties may be overcome as these types of projects become more common, but others suggest a need to re-evaluate certain planning and design practices.

5.1 On-Site Surveys

Incomplete information about site conditions was the most frequently cited explanation for significant cost overruns. Project managers explained that in some cases no site surveys were conducted and that in others surveys were incomplete or insufficient. These deficiencies led to a host of different problems: contractors expecting firm, stable soil encountered the opposite; dumping sites for dredge material proved to be too small; and proposed structures had to be relocated or redesigned. Although we did find one case where untested site conditions actually led to a significant cost savings, most of these examples involved additional expenditures on labor, materials, equipment, etc., and significant project delays. Even when projects involved basic activities such as dredge and fill, incomplete surveys led directly to considerable cost overruns.

It might seem obvious then to suggest that detailed surveys be required for all projects. However, it is important to recognize that surveys themselves are expensive and, when allocating resources for pre-construction surveys, managers faced a difficult trade-off. Uncertainty can be reduced, but only if one is willing to invest a substantial sum in soil testing, boring, land surveys, etc. In cases where little is known about the site, such expenses may well be justified, but the benefits of such expenses may be less obvious for areas where work has been done previously or where conditions are better understood. It may also be prudent to engage in detailed site surveys for larger and more technically demanding projects.

5.2 Better Implement Existing Planning Guidelines

Project managers also expressed a certain level of frustration with the project planning process and several specifically described some of the difficulties faced when working with less experienced state agencies and community stakeholders. The managers explained that these groups were generally interested in planning at a conceptual level, but not necessarily working out specific project details and agreeing on a final design. In general, the agency staff and local stakeholders were anxious to begin implementation and assumed that detailed design decisions could be made on-site. Or alternatively, they assumed that the project in question was sufficiently similar to other past efforts that site-specific issues would not be a critical factor in determining project costs. This approach may reflect past experience with smaller projects where project refinements can be easily implemented in the field.

Unfortunately, this push toward implementation is problematic for the large, complex restoration projects that characterize many habitat restoration efforts. Costs can increase quickly if the project must be reconfigured ‘on-site’ or if stakeholders suggest substantial redesigns late in the implementation process. The Corps staff we interviewed suggested that project managers need to better implement existing planning and design procedures and insist that detailed project specifications be developed before construction begins. This insistence on careful planning may be unpopular with some of those involved in the project team, but this is necessary to reduce the likelihood of unanticipated complications.

5.3 Lack of Project Experience

Although habitat restoration projects have become more common and are an increasing focus of Corps activities, considerable experience with this type of work has only been gained in recent years. Thus, a significant share of the differences between projected and actual costs for restoration projects can be attributed to inexperience in dealing with the specific challenges posed by these efforts.

Nearly all the project managers contacted for this study explained that in recent years they had improved the accuracy of cost estimates prepared for restoration projects. And as we showed in Section 4.3, the data collected for this study generally confirm this view. The number of cases where estimates were significantly under- or over-stated has generally decreased through time.

The staff we contacted also explained that local contractors have become more familiar with this type of work and have been able to better respond to the Corps' contract proposals. At a regional level, many contractors in the Midwestern states had not previously done extensive work in river and wetland environments and initially struggled to complete projects within budget. However, as the volume of this work has increased some have chosen to invest in the appropriate machinery and equipment, and at the same time they have built up valuable project experience.

Looking forward, this accumulated knowledge by Corps staff, state agency personnel, and local contractors should help reduce the uncertainty associated with cost estimation.

5.4 Habitat Protection and Project Scheduling

Sensitivity to natural habitats and potentially vulnerable species is obviously a major concern in many Corps projects. However, the need to minimize adverse impacts to the immediate local environment is paramount in habitat restoration projects. Projects often involve temporary disruptions to existing habitat areas and have the potential to adversely affect resident wildlife and/or disturb migratory species. Alternatively, construction has the potential to interfere with commercial harvest and/or wildlife management activities such as hunting and fishing. To avoid such adverse impacts, construction may be limited or completely prohibited during specific periods.

As a result, managers need to be aware of how project schedules might be affected by the need to protect local species during sensitive periods or to avoid interference with commercial or recreational harvest. A short-term interruption to the project schedule may grow into a major delay, if construction must be suspended because the work cannot be fully completed before some critical period. We encountered specific cases where equipment had to be fully demobilized and construction suspended for several months due to some type of local restriction. Depending on the length of the delay, costs can increase rapidly and push budgets well beyond the initial project estimates. With appropriate planning and coordination, one should be able to identify periods of potential sensitivity well before construction begins. Contractors should then use this calendar to develop a schedule with enough flexibility to ensure that essential activities can be completed before any restrictions are imposed.

5.5 Land Acquisition

Real estate acquisition was the one specific line item that managers identified as having an important role in explaining the variation between projected costs and actual expenditures. Accurate assessments of the real estate market and land prices require very specific local knowledge and cannot be tracked as easily as labor rates, materials costs, and other expenditures. As a result, even if one relies on cost estimates from the same general area, there is no guarantee that one can accurately predict final acquisition costs.

Furthermore, depending on the scope of the project, opposition from a single landowner can affect overall project costs. While the need to pay individual landowners more than anticipated may have only a small impact on cost, the delays associated with negotiations and legal maneuverings can contribute to more significant overruns. Reliance on local appraisers, who have specific knowledge about the parcels required for the project, may help reduce the potential for such anticipated impacts. Additionally, key landowners should be approached as early as possible so as to resolve disputes before they can derail construction schedules.

5.6 Weather Conditions – Flooding and Storm Events

When working in river and wetland environments the threat of flooding represents an ever-present concern. Many of the projects covered in our survey, and particularly some of those in the Upper Mississippi program, were significantly affected by major flooding events and a major share of unanticipated costs were attributed to these events. While contingency budgets can include some additional funding to cover a share of these unexpected costs, project managers noted that one cannot realistically expect to fully anticipate the funding needs associated with major flooding events. The contingencies required to address such rare and potentially devastating events would easily represent a significant share of overall estimated project costs. Thus, even if planning and design efforts are improved and project experience translates into better cost estimation, there will still be other factors that contribute to uncertainty and lead to differences between projected and actual costs.

Section 6: Summary and Issues for Further Study

This report summarizes the results of an assessment designed to explore the differences between estimated and actual costs for a variety of habitat restoration projects. The survey data needed to support both a quantitative and qualitative examination of this issue were gathered from a representative group of 47 projects, implemented across the country. To help identify the factors most directly linked to cost uncertainty, estimated and actual expenditures were considered at a somewhat aggregate level and criteria were established for identifying examples where cost differences were truly significant.

6.1 Findings

The preliminary quantitative assessment of these data revealed several important and unanticipated results. First, cost differences are not generally linked to systematic errors in estimating the per-unit costs of labor and/or materials. At a quantitative level, we did find that cost uncertainties (particularly overruns) were more common in large, integrated restoration projects, but our interviews with project managers also revealed that specific problems in planning, design and implementation appear to drive the uncertainty associated with cost estimation.

In addition, we found that the frequency of significant cost differences has decreased over time. The experience gained in implementing restoration projects over the past several years has helped sharpen the ability of planners to accurately estimate costs. Moreover, when overruns do occur, most of the additional money required for project completion is used to cover actual construction rather than additional engineering and design work. Even in cases were the initial design work proved to be insufficient, significant investments (relative to overall construction costs) were not needed to cover the costs of redesign.

This observation was confirmed during our qualitative discussions with project managers. These interviews also corroborated our general findings with regard to cost uncertainty and helped us to identify the specific underlying factors outlined in the previous section. As noted there, our results suggest that differences between estimated and actual costs are most directly linked to: (1) incomplete on-site surveys; (2) insufficiently detailed planning; (3) lack of project experience; (4) difficulties in project scheduling; (5) problems in land acquisition; and (6) unanticipated weather conditions. Some of these factors such as inadequate surveys, insufficiently detailed planning and unrealistic scheduling can be addressed through specific program policies, but others represent issues that are inherent to habitat restoration efforts.

6.2 Suggested Future Research and Further Recommendations

Looking forward, a detailed consideration of the uncertainty associated with on-going operations and maintenance costs would be a valuable addition to this study. Maintenance and monitoring costs can be critical issues for large, long-term programs such as CWPPRA. As these programs develop a record of success and implement a growing number of projects, a significant share of annual funding will be directed towards on-going maintenance/monitoring rather than project construction. While these costs will not be borne by the Corps, the O&M expenditures could have a dramatic impact on the budgets of state and local partners. Therefore, the Corps may find it useful to take the lead in studying this aspect of restoration costs. In addition, O&M expenditures are obviously directly tied to overall project design and implementation, so the Corp actions have a direct impact on O&M expenses and could directly influence the uncertainty associated with these costs as well.

In addition, a more detailed examination of the Corps' larger, integrated restoration projects might help reveal what specific aspects of these undertakings lead to divergences between anticipated costs and actual expenditures. It may be that the challenge comes in coordinating many individual sub-tasks, but perhaps certain measures are particularly difficult to implement. With additional resources one might be able to develop a more detailed set of data on actual expenditures and better track each of the potential trouble points.

Whatever types of studies are pursued, our efforts also suggest that a more systematic system of reporting actual project expenditures may be needed to develop sharp quantitative results. If studies such as this one are to be made more effective, and if other financial accounting efforts are planned, the systems for estimating budgets and reporting expenditures should be more closely linked. This study was somewhat constrained in its scope because the cost categories included in the records of estimated and actual costs were not always comparable. The cost reporting system for tracking actual expenditures should be designed to map with the MCACES cost estimating systems, and project managers should routinely adhere to both systems.

Ultimately, these findings and recommendations may confirm what many project managers and habitat restoration experts have already discovered on an individual basis. However, this study has provided an opportunity to address important aspects of cost uncertainty in a formal manner that considered both quantitative and qualitative input from a wide group of planners and managers. This approach has allowed us to explore and document some of the most basic factors underlying the differences between estimated costs and actual expenditures for ecosystem restoration projects.

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Louisiana Department of Natural Resources, Coastal Restoration Division. *Coastal Wetlands Planning, Protection, and Restoration Act: Summary of Priority Project Lists 1-6.* CWPPRA Report Series No 2. November, 1997/

MCACES for Windows: User Manual for Version 1.2. Building System Design Incorporated, 1996.

Muncy, Joy D., J. Craig Fichenich, and E.A. Dardeau. *National Review of Corps Environmental Projects.* IWR Report 96-R-27, 1996.

Shreffler, David K., Michael J. Scott, Katharine Wellman, and Mark Curran. *National Review of Non-Corps Environmental Restoration Projects*. IWR Report 95-R-12, 1995.

Project Contacts:

Contact	Agency	District
Barbara Kimler	COE	Rock Island
Bill Hicks	COE	New Orleans
Bill Hubbard	COE	New England
Britt Paul	NRCS	Natural Resources Conservation Service
Debbie Terrwiliger	USFWS	U.S. Fish & Wildlife Service
Darryl Clark	USFWS	U.S. Fish & Wildlife Service
Tim Caldwell	COE	St. Louis
Don Powell	COE	St. Paul
Dorie Bollman	COE	Rock Island
Gary Oates	City of San Leandro	Environmental Sciences Associates
Gary Polesh	COE	St. Paul
Gene Lilly	COE	Tulsa
Jerry Skalak	COE	Rock Island
Joey Dykes	COE	New Orleans
Leo Foley	COE	Rock Island
Lester Soule	COE	Seattle
Martin Cooley	COE	Savannah
Michael Irlbeck	Bureau of Reclamation	U.S. Dept. of Interior/Bur. of Reclamation
Mike Thompson	COE	St. Louis
Paul Kowalaczyk	COE	Rock Island
Julie Marcy	COE	Vicksburg

Project Contacts (continued):

Randy Montgomery	COE	New Orleans
Renee Wright	COE	Vicksburg
Steve Madrone	Redwood Community Action	Redwood Community Action Agency
Steve Rothe	COE	Omaha
Ted Hauser	COE	Charleston
Terrell Roberts	COE	Galveston
Wes McQuiddy	EPA	EPA
Rick Hartman	NMFS	NMFS

Appendices

Appendix A:
Survey Instrument

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Cost Analysis Questionnaire

GENERAL INFORMATION:

Interviewed by: Interview Date:

Name of Contact/Interviewee: Affiliation:

Phone/Fax/Address:

Project Name and Location:

1. PROJECT CLASSIFICATION: *(If this information is already available, this section can be completed before the telephone call is made.)*

1.1 What type of project was this? *Circle, or otherwise indicate* ***(Add/subtract from this list as you think is appropriate)***

Wetlands Creation/Restoration/Enhancement
Stream/River Restoration/Enhancement
Forest Restoration/Enhancement

Restoration/Enhancement of Fish and Wildlife Habitat

Public Access
Damage Prevention – Erosion or Flood Control

***Other:*______________**

1.2 Why was the project done? *Was there a specific ecological goal(s) that motivated the project?*

1.3 How was the project done? *What were the major components/methods of the project to achieve stated goal(s)?*

1.4 Were future Operations and Maintenance Costs considered when selecting among project alternatives?

1.5 When did this project start (what year)? Finish?

2. Cost Classification:

2.1 Do you have (A) estimates that show the projected costs and/or (B) records that track actual expenditures?

2.2 We are particularly interested in distinguishing the following major cost categories:

- Planning and Design;
- Construction and Implementation (including key sub-tasks involved in implementation);
- Maintenance; and
- Monitoring.

2.3 Within these categories information that provides detailed expenditures related to labor, materials, and equipment would be ideal.

- *If this information is available, request that materials could be mailed or faxed.*
- *Alternatively, we have a spreadsheet that they could fill out (see attached). This could be delivered electronically (e-mailed) or in a hard-copy format (via fax or post).*

(As an alternative to questions 2.2 and 2.3, it may just be better to craft a letter that would sent as a follow-up to request this information, particularly for non-Corps projects.)

3. ANALYSIS OF COST DISCREPANCIES:

3.1 Were there specific tasks or project phases that cost more or less than expected? Which task/phases were these? (If not, follow up: even if total costs came in at budget, were the particular areas that proved more expensive that anticipated.)

3.2 Did your budgeting process include “contingency” factors for specific tasks? *(This will be true for (nearly?) all the Corps projects)*

IF THE ANSWER TO QUESTION 3.2 WAS 'YES' SKIP 3.3 AND PROCEED TO QUESTION 3.4. If 'N0' PROCEED WITH QUESTION 3.3.

3.3 How was the uncertainty in project costs dealt with in your estimates? Were attempts made to address potential overruns for specific tasks or the project as a whole? If not, what measures were taken to address uncertainty?

PROCEED TO QUESTION 3.5

3.4 How did you estimate contingencies – by specific task or overall? If costs were higher than expected, did these 'overruns' exceed the contingency budgeted?

3.5 What were the underlying reasons for any differences in projected versus actual costs? For example:

- Hourly wages higher than expected (not more hours, just higher wages per hour);
- Materials cost more expected than higher (not more materials, just more expensive per unit);
- The scope of the project budget was insufficient to meet the project goals (more work than expected.);
- Did the original approach or project design prove impractical/unworkable;
- Were there seasonal or weather impacts that contributed to costs increases;
- Were there site specific situations such as soil stability, river conditions, etc. that added to costs;

- Were there legal or administrative reasons for significant delays or changes to the project (private property disputes, endangered species concerns, overlapping regulatory jurisdictions, etc.)

- Was the local sponsor short on project funds?

- Did the local sponsor want to change the project?

- Was the difficulty in obtaining the type of equipment or materials that were needed? Special orders required?

- Did subcontractor's costs exceed their initial estimates?

Explain:

3.6 Were these factors considered when costs were estimated? *(In other words, was this issue foreseen, but the funds to address uncertainties insufficient to address the cost overrun.)*

In your opinion, could/should these factors have been foreseen?

3.7 In general, are some costs (or cost categories) significantly more difficult to estimate or project than others? Which areas?

Follow-up Questions:

- (For Corps projects only) Where you comfortable with the procedure used to estimate Mobilization and Demobilization costs?
- Did you have access to bids prepared for similar projects?
- Did you have access to the other reference materials you needed (estimates of per unit costs and required labor hours)?

3.8 In what specific areas were the additional costs incurred. *(In other words, where was additional budget actually spent.)*

- Planning;
- Labor;
- Materials; or
- Other (specify)

(Depending on the response to question 3.3, the answer may be obvious and this question may be unnecessary)

4. FOLLOW UP AND DOCUMENTATION:

4.1 Are there any printed references, project descriptions or studies, or other reports published or not, that could be sent to us?

4.2 Who are the relevant contacts to obtain further information?
Name:

Address:

Phone:

Appendix B:
Civil Works Construction Cost Index

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Civil Works Construction Cost Index*
(Composite Index)

Year	Raw Index	Standardized to 1999
1984	349.63	1.40
1985	354.31	1.39
1986	356.24	1.38
1987	361.43	1.36
1988	374.45	1.31
1989	388.68	1.26
1990	398.68	1.23
1991	406.78	1.21
1992	415.22	1.18
1993	427.83	1.15
1994	439.45	1.12
1995	452.31	1.09
1996	462.31	1.06
1997	472.17	1.04
1998	478.05	1.03
1999	490.96	1.00

* Civil Works Construction Cost Index System, EM 1110-2-1304. U.S. Army Corps Engineers, September 1999.

Appendix C:
Data Summary

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Projected and Actual Project Costs
(Costs Expressed in 1999 Dollars)

Project Type	Corps or Non-Corps	Location	Project Category	Year Completed	Projected Costs Planning/ Design	Construction	Total w/o Monitoring
Rivers/Lake	C	Maryland	Section 1135	1996	$399,446	$425,197	$824,643
Wetland	C	Missouri	Upper Mississippi	1994	$331,075	$1,209,014	$1,540,088
Wetland	C	Louisiana	CWPPRA	1994	$473,470	$3,315,558	$3,789,028
Wetland	NC	Louisiana	CWPPRA	1998	$570,688	$6,551,736	$7,122,424
Wetland	C	Iowa	Upper Mississippi	1994	$125,522	$1,129,577	$1,255,099
Rivers/Lake	C	Missouri	Section 205/Flood Control	1992	$30,633	$389,895	$420,527
Rivers/Lake	C	Nebraska	Section 1135	1993	$331,644	$2,213,641	$2,545,285
Rivers/Lake	C	Iowa	Upper Mississippi	1992	$435,938	$3,102,057	$3,537,996
Rivers/Lake	C	Iowa	Upper Mississippi	1996	$388,120	$1,969,426	$2,357,546
Wetland	C	Louisiana	Section 1135	1993	$28,689	$223,774	$252,463
Wetland	NC	Louisiana	CWPPRA	1994	$67,033	$1,151,111	$1,218,144
Wetland	C	Illinois	Section 1135	1999	$122,104	$870,079	$992,183
Wetland	C	Louisiana	CWPPRA	1997	$234,729	$294,467	$529,195
Rivers/Lake	C	Louisiana	CWPPRA	1997	$512,358	$2,413,449	$2,925,807
Rivers/Lake	C	Kansas	Section 1135	1999	$49,296	$222,860	$272,156
Rivers/Lake	C	Minnesota	Upper Mississippi	1994	$219,928	$762,654	$982,582
Wetland	C	Rhode Island	Section 1135	1998	$383,372	$1,626,940	$2,010,312
Wetland	C	Iowa	Section 1135	1995	$55,861	$248,022	$303,882
Wetland	C	North Dakota	Section 1135	1994	$14,918	$27,082	$42,001
Wetland	C	Texas	Section 1135	1998	$31,859	$303,724	$335,583
Rivers/Lake	C	Illinois	Upper Mississippi	1999	$710,459	$4,231,957	$4,942,416
Rivers/Lake	C	Arkansas	Section 1135	1995	$79,658	$354,841	$434,499
Wetland	C	Minnesota	Section 1135	1996	$23,126	$51,280	$74,406
Rivers/Lake	NC	California		1985	NA	NA	$34,652
Other Restoration Projects	C	Iowa, Illinois	Section 1135	1998	$48,851	$345,141	$393,991
Wetland	C	Louisiana	CWPPRA	1999	$210,243	$121,080	$331,323
Wetland	C	South Carolina	Section 1135	1998	$213,158	$266,188	$479,345
Other Restoration Projects	C	Arkansas	Section 1135	1998	$47,831	$52,302	$100,132
Wetland	C	Minnesota	Section 1135	1997	$58,095	$185,458	$243,553
Rivers/Lake	C	Illinois	Upper Mississippi	1997	$625,640	$4,088,112	$4,713,752
Rivers/Lake	C	Missouri	Upper Mississippi	1991	$602,494	$2,826,379	$3,428,873
Rivers/Lake	C	Wisconsin	Upper Mississippi	1993	$473,121	$1,285,876	$1,758,998
Wetland	C	Illinois	Upper Mississippi	1996	$610,181	$4,361,727	$4,971,908
Rivers/Lake	NC	California		1985	NA	NA	$86,118
Wetland	C	Iowa	Upper Mississippi	1998	$759,770	$2,628,725	$3,388,496
Wetland	NC	Texas		2000	$750,326	$370,646	$1,120,972
Rivers/Lake	C	Washington (State)	Section 1135	1994	$89,377	$338,516	$427,893
Wetland	NC	California		1995	$200,808	$1,097,390	$1,298,198
Rivers/Lake	C	Georgia	Section 1135	1992	$494,247	$3,360,407	$3,854,654
Wetland	NC	Washington (State)		1994	$177,183	$442,384	$619,567
Rivers/Lake	C	Illinois	Upper Mississippi	1999	$940,316	$6,051,704	$6,992,020
Rivers/Lake	C	Illinois	Upper Mississippi	1998	$1,053,755	$3,352,413	$4,406,168
Rivers/Lake	NC	California		1988	$0	$61,501	$61,501
Wetland	NC	Louisiana	CWPPRA	1996	$25,594	$95,577	$121,171
Rivers/Lake	C	Louisiana	CWPPRA	1996	$378,492	$1,447,289	$1,825,781
Wetland	C	Louisiana	CWPPRA	1998	$753,335	$4,819,934	$5,573,269
Wetland	NC	Louisiana	CWPPRA	1998	$611,504	$7,175,122	$7,786,626

Projected and Actual Project Costs
(Costs Expressed in 1999 Dollars)

Project Type	Actual Costs			Discrepancy		
	Planning/ Design	Construction	Total w/o Monitoring	Planning/ Design	Construction	Total w/o Monitoring
Rivers/Lake	$408,672	$412,916	$821,588	$9,226	-$12,281	-$3,055
Wetland	$693,360	$2,036,299	$2,729,659	$362,285	$827,285	$1,189,571
Wetland	$450,624	$3,229,876	$3,680,500	-$22,846	-$85,682	-$108,528
Wetland	$436,774	$9,821,826	$10,258,600	-$133,915	$3,270,091	$3,136,176
Wetland	$125,522	$757,630	$883,152	$0	-$371,947	-$371,947
Rivers/Lake	$96,493	$377,123	$473,616	$65,860	-$12,771	$53,089
Rivers/Lake	$298,365	$2,538,400	$2,836,765	-$33,279	$324,759	$291,480
Rivers/Lake	$320,237	$2,255,719	$2,575,956	-$115,701	-$846,338	-$962,039
Rivers/Lake	$580,952	$3,176,950	$3,757,901	$192,831	$1,207,524	$1,400,355
Wetland	$26,968	$271,398	$298,365	-$1,721	$47,624	$45,902
Wetland	$63,178	$1,013,505	$1,076,683	-$3,855	-$137,606	-$141,461
Wetland	$148,534	$1,033,036	$1,181,570	$26,430	$162,958	$189,387
Wetland	$214,538	$306,322	$520,859	-$20,191	$11,855	-$8,336
Rivers/Lake	$488,873	$2,341,747	$2,830,621	-$23,484	-$71,702	-$95,187
Rivers/Lake	$49,296	$178,596	$227,893	$0	-$44,264	-$44,264
Rivers/Lake	$391,377	$1,317,204	$1,708,581	$171,449	$554,550	$725,999
Wetland	$398,239	$1,245,692	$1,643,932	$14,868	-$381,248	-$366,380
Wetland	$54,725	$230,019	$284,743	-$1,136	-$18,003	-$19,139
Wetland	$18,516	$15,695	$34,211	$3,598	-$11,387	-$7,790
Wetland	$67,973	$251,240	$319,213	$36,114	-$52,484	-$16,370
Rivers/Lake	$1,713,766	$12,152,192	$13,865,958	$1,003,307	$7,920,235	$8,923,542
Rivers/Lake	$91,728	$269,148	$360,876	$12,069	-$85,693	-$73,623
Wetland	$27,229	$59,387	$86,616	$4,103	$8,107	$12,210
Rivers/Lake	$3,047	$39,172	$42,219	NA	NA	$7,568
Other Restoration Projects	$48,504	$328,939	$377,444	-$346	-$16,201	-$16,548
Wetland	$171,482	$62,169	$233,652	-$38,761	-$58,911	-$97,672
Wetland	$218,357	$338,589	$556,946	$5,199	$72,401	$77,600
Other Restoration Projects	$47,831	$54,589	$102,420	$0	$2,288	$2,288
Wetland	$117,471	$155,321	$272,792	$59,376	-$30,136	$29,239
Rivers/Lake	$949,799	$3,707,408	$4,657,207	$324,159	-$380,704	-$56,546
Rivers/Lake	$392,837	$1,169,891	$1,562,728	-$209,657	-$1,656,489	-$1,866,146
Rivers/Lake	$627,610	$2,165,778	$2,793,388	$154,489	$879,902	$1,034,391
Wetland	$711,926	$2,612,269	$3,324,195	$101,744	-$1,749,458	-$1,647,714
Rivers/Lake	$10,999	$99,724	$110,723	NA	NA	$24,605
Wetland	$795,187	$2,648,450	$3,443,638	$35,417	$19,725	$55,142
Wetland	$750,326	$365,511	$1,115,837	$0	-$5,135	-$5,135
Rivers/Lake	$97,645	$389,205	$486,850	$8,267	$50,689	$58,957
Wetland	$255,081	$1,118,014	$1,373,095	$54,273	$20,624	$74,896
Rivers/Lake	$494,247	$2,013,117	$2,507,364	$0	-$1,347,290	-$1,347,290
Wetland	$60,038	$814,436	$874,474	-$117,145	$372,052	$254,907
Rivers/Lake	$1,203,447	$4,998,220	$6,201,668	$263,131	-$1,053,483	-$790,352
Rivers/Lake	$1,099,235	$5,356,588	$6,455,824	$45,480	$2,004,175	$2,049,656
Rivers/Lake	$0	$107,149	$107,149	$0	$45,648	$45,648
Wetland	$36,367	$128,141	$164,508	$10,773	$32,564	$43,337
Rivers/Lake	$355,816	$1,275,565	$1,631,381	-$22,676	-$171,724	-$194,399
Wetland	$612,758	$4,580,041	$5,192,799	-$140,577	-$239,893	-$380,470
Wetland	$457,194	$5,214,505	$5,671,699	-$154,309	-$1,960,617	-$2,114,926