U.S. Army Corps of Engineers®

Corps of Engineers Harbor Projects:
Development of Tools, Measures and Organization of Data for Evaluating Performance
Volume I - Technical Report

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U.S. Army Institute for Water Resources
Navigation Analysis Program

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Development of Tools, Measures, and Organization of Data for Evaluating Performance

VOLUME I: Technical Report

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EXECUTIVE SUMMARY

The U.S. Army Corps of Engineers' Operations and Maintenance (O&M) Appropriation expenditures for harbor projects are subject to the same budgetary pressures exerted on all Federal government spending programs. As these pressures increase, the Corps is continuing to evaluate its navigation O&M activities to ensure that maximum benefits are obtained for the expenditures.

Under direction from Corps Headquarters' Office of Policy and Analysis, the Institute for Water Resources (IWR) initiated a number of efforts to determine the levels of navigation O&M funding supplied to each harbor project. The results of those efforts have given rise to this study. The goal of this study is to **develop a rational, performance-based analytical instrument that can be used by decision-makers to evaluate the performnace outputs of the several hundred harbor projects maintained by the Corps**.

Achieving this study's goals required that several objectives be attained:

- Performance measures must be identified. Developed by earlier Corps work, a performance measure is a criterion that uses one (1) or more harbor project activity data elements (e.g. O&M cost per ton of cargo, average annual cargo tons and cargo value) to measure the performance of a single project relative to a benchmark or relation to all other harbor projects.

- The recommended procedures must be national in scope, fit the Corps' existing O&M budget decision-making process, and utilize data generated by recent Corps harbor cost tracking efforts.

- Corps harbor project databases must be properly cross-referenced to access available data. A "bridge" must be created that equates harbor database codes that have been independently assigned to harbor projects by earlier database creation efforts.

- The resulting tool should be compatible with an updateable, user-friendly information management system such as the Corps' Operations and Maintenance Business Information Link (OMBIL) in order to enable Corps planners to quickly evaluate harbor performance using readily available data for a number of criteria.

This report represents the second phase in IWR's efforts to develop a rational, performance based tool that can be used to evaluate the economic performance of harbor projects maintained by the Corps. The first phase in this effort, also titled "Corps of Engineers Harbor Projects: Development of Tools, Measures, and Organization for Evaluating Performance" was completed in September 1997. Following the completion of Phase I, IWR decided to prepare a Phase II Report. The purpose of the second phase was to update the information used in Phase I by including additional data for the years 1995 and 1996. Phase II also represented an opportunity to apply lessons learned during the performance of Phase I, especially in developing additional performance measures that would more accurately evaluate the harbor projects. Throughout the remainder of this document Phase I refers to the report that was completed in September 1997 and Phase II refers to this current report.

Providing the information needed to evaluate harbor performance required the acquisition of a number of internal Corps project cost data and several large, public commodities databases. After reviewing several Corps cost analysis efforts, data were obtained from the Corps National Cost Recovery Database System for the years 1985-1996 for all of the 845 deep and shallow harbor projects that were not part of the Fuel-Taxed Inland Waterway System. Summary historical traffic tonnage in and out of harbors was obtained from the Corps for the period 1985-1996. Census Bureau data that track cargo weight and value for over 10,000 commodity classifications at the individual port level were also analyzed. In order to match the detailed traffic data recorded by the Corps' Waterborne Commerce Statistics Center (WCSC) to the Bureau of Census data, these commodities were reduced to 144 general classifications. Finally, WCSC data compiled on the United States Waterway Data CD-ROM was accessed to obtain for each harbor the tons of import, export, and domestic traffic for each commodity type that passed through the harbor between 1991 and 1996. This tonnage was applied to each commodity's unit value that was calculated from the Census Bureau database to derive the average annual cargo value.

Efforts performed during Phase I began by evaluating nine (9) potential performance measures. A potential set of fourteen (14) performance measures was then identified. This list was subsequently reduced to a set of six (6) performance measures that were used to evaluate and rank the projects during Phase I. The eight (8) performance measures were eliminated based on several factors, including data availability across the projects, low number of projects for which performance measure values could be calculated, ability to fairly measure project performance, and redundancy (i.e., several measures evaluated the similar aspects of harbor performance).

Phase II then proceeded began with the six (6) performance measures used during the earlier effort. Because more complete data were now available, a revised set of eight (8) performance measures was ultimately defined and used for this study. The principle improvements incorporated into this study were the availability of five (5) years of cargo value data, the ability to calculate performance measure values for more projects, the use of two (2) new performance measures that evaluated percent change in average annual cargo value and average annual O&M cost per cargo value, the use of real O&M costs for performance measures, a change in calculating domestic cargo value, a refinement in measuring percent change in average annual amounts, and a change in the ranking procedure for projects whose performance measures were equal or tied. The percent changes were calculated using the average annual data for 1985-1991 as compared to the period for 1992-1996. Analysis on data availability indicated that eight (8) of these measures could successfully be applied to most of the 845 harbor projects. The following eight (8) performance measures were used in Phase II:

1. Average Annual Real O&M Costs 1985 -1996
2. Average Annual Tons of Traffic, 1985-1996
3. Average Annual Cargo Value 1991-1996
4. Average Annual Real O&M Cost per Ton of Traffic, 1985-1996
5. Average Annual Real O&M Cost per Cargo Value 1991-1996

6. Change (%) in Average Annual Real O&M Costs, (1985-1991 to 1992-1996)

7. Change (%) in Average Annual Tons of Traffic, (1985-1991 to 1992-1996)

8. Change (%) in Average Annual Cargo Value, (1991-1993 to 1994-1996)

The eight (8) performance measures were applied to 720 active harbor projects, which represented all those projects that either incurred O&M costs and/or reported traffic during 1985-1996. The projects were then evaluated and sorted for each performance measure. Next, the average overall score of each individual project across all eight (8) performance measures was calculated. Finally, the 720 projects were re-sorted based on their average overall scores.

It must be emphasized that the intent of the evaluations is not to determine which projects are poor performers and should experience a reduction in O&M expenditures. Instead, the procedures presented in this report are intended to be used as a tool to provide a "first cut" evaluation of project performance from a national perspective, not a final evaluation from which budget decision can directly be made. It is possible to modify the ranking process and obtain different results by either changing the relative importance of the eight (8) performance measures, or by introducing new ones. Note also that many harbor projects have national benefits that can not be captured by the performance measures used in this study, including: commercial boat harbors, fish tonnages, through traffic and recreational navigation. The same reasoning applies to the several hundred harbor projects that reported no commerce in a given year, yet received funds for navigation maintenance. In virtually all of the cases it is likely that commercial use of the project did occur, but was not reflected in the data collected for a variety of reasons.

The research conducted in Phase II determined that the eight (8) performance measures can be useful tools for evaluating the relative efficiency of navigation O&M expenditures at the individual project level. Based on the information reviewed and the results of the database creation efforts, it is recommended that the following tasks be pursued:

- Further efforts should consider adding the data on percent and number of transits utilizing 80 percent or more of channel depth/clearance, initiated by the O&M Cost Reduction Task Force.

- A more thorough policy study is needed to verify the actual use of harbor projects where that use is not reported within national data sets.

- Develop a strategy/policy to obtain the necessary data/information for the harbors reporting no commerce, which describes the utilization and impacts of each harbor channel to enable the necessary determination of Federal continuation of maintenance. The primary burden for reporting should be on the ports desiring consideration.

- Continue and complete efforts to strengthen the retrieval of WCSC data by linking project CWIS (i.e., PWI) codes with WCSC waterway link codes so that project level waterborne commerce data can be assembled more rapidly and accurately in the future.

- Undertake a systematic analysis of the economic feasibility of continued maintenance of harbor channels which appear in the lowest quartile of priority ranking. An "acid test" strategy using current data on traffic and cost utilization should focus on the question, "does the channel provide enough transportation cost savings to justify continued levels of maintenance service?".

- Consider a systematic effort to partition project costs by channel segment and other parameters to enable reasonable approximations of incremental costs and benefits. This should lead towards a determination of a more accurate allocation of O&M outlays on an incremental basis for each project. Develop a strategy to help those harbors which are at the margin of budget priorities to identify potential state/local revenue sources which can increase non-Federal responsibility for O&M costs.

- Develop a strategy to help those harbors which are at the margin of performance benchmarks to identify the means for improving performance outputs.

- Develop a periodic report of the performance of Corps harbor projects. This document could increase the quality of data communicated between the Corps and the port industry, state/local project sponsors, and would help to clarify the issues of responsible stewardship of the Corps' harbor program.

Another product of the work performed under Phase II involved the improvement of IWR-HARBORVU, a user-friendly information management system that implements the analytical process developed in this report. The initial version of HARBORVU was developed during the earlier Phase I. Created using Oracle Personal Express, IWR-HARBORVU allows the user to quickly incorporate annual traffic cost and value data as they become available. Any or all of the eight (8) recommended performance measures can be used in a project ranking analysis. Different project sortings can be conducted, including: all projects, top/bottom projects, or sortings of projects by coasts, draft class (deep or shallow), Corps division, and Corps district. Finally, IWR-HARBORVU has the capability to weight the various performance measures, if future policy emphasis determines that some measures are more important than others. The software and the IWR-HARBORVU User's Guide are provided under separate cover.

1.0 INTRODUCTION

The goal of this study is to develop a rational, performance-based analytical instrument and accompanying software tool that can be used by analysts and decision-makers to evaluate and compare the performance of the Corps' 845 harbor projects, consisting of 720 active (maintained) and 125 inactive projects. These projects are listed in Appendix A. Such an instrument is intended for use by Corps planners or operators to evaluate the performance of harbor projects relative to the O&M outlays needed to maintain navigation. It should be noted that this tool will only provide a " first cut" of project performance from a national perspective, not a final evaluation from which direct budget decisions would be made.

The study required identifying measures that track the performance of Corps-maintained harbors. These performance measures, combined with a database of appropriate information, should provide a flexible tool for comparing harbors which can be updated as new information becomes available. Building this tool required that the following objectives be attained:

- Performance measures must be identified and evaluated. An acceptable measure is one that provides an objective criterion of project outputs or outcomes, is independent from other measures and utilizes existing data collected nationwide by the Corps or other Federal agencies.

- The overall process must be national in scope and fit the Corps' existing O&M budget decision-making process. Recent efforts conducted by IWR have greatly improved the quality of available harbor O&M information. This information, as well as cost data obtained from other ongoing efforts, must be integrated into the process.

- Corps projects must be properly linked to access available data. A cross-reference table must be created that assigns each harbor to the various identification codes that have been independently developed by several database creation efforts.

- A database management system such as OMBIL is needed so that Corps analysts can quickly evaluate harbor performance using the eight (8) performance criteria. Such database must be user-friendly and updateable as new data become available.

Section 1.2 describes the various efforts that the Corps has pursued in its efforts to improve the effectiveness of its Civil Works program. The remainder of this report describes the performance measure evaluation process, the data used to quantify the selected measures, and the performance measure results for each harbor.

1.1 Background

The Corps has utilized traffic and vessel movement data collected by the Waterborne Commerce Statistics Center (WCSC) over the years to assist the evaluation of harbor Operations and Maintenance programs. This information is furnished by vessel operators and published annually in Waterborne Commerce of the United States (WCUS). WCUS and other navigation databases from the U.S. Army Corps of Engineers, U.S. Department of Transportation, U.S. Coast Guard, U.S. Bureau of Census, Oak Ridge National Laboratory and Vanderbilt University are now available on CD-ROM entitled United States Waterway Data CD-ROM (BTS CD-18).

In recent years, the Corps has increased its efforts to monitor its O&M costs by instituting three (3) major O&M cost review programs. Beginning with the National O&M Program Plan of Improvement, a high visibility effort in 1991, the Corps has extensively revised its operating practices, standard organization structure of operations offices, and budget guidance for O&M projects. Other ongoing program reviews have begun defining performance measure concepts and identifying specific measures for allocating limited O&M budgets. The three (3) review programs are summarized as follows.

1.1.1 National O&M Program Plan of Improvement

Corps efforts in performance measurement intensified with the National O&M Program Plan of Improvement, which was started by the senior managers of the Operation and Maintenance program in June 1991. That effort was based on a high level of input provided by O&M field managers and staff. The initiative was guided by two (2) review groups: the Corps' regional division O&M chiefs, and the headquarter's O&M chiefs and staff. Support was provided by the Water Resources Support Center (WRSC), primarily by Institute for Water Resources (IWR) staff. A plan of study was proposed by five (5) committees of field, IWR and headquarter's staff in response to a thematic statement of objectives prepared by the Office of the Assistant Secretary of the Army for Civil Works (ASA/CW), which had considerable input from the Office of Management & Budget (OMB). This effort was begun because of the dominance of the O&M program budget in the Corps' Civil Works program budget, and the perception from top level budget managers that execution and funding of the O&M program could be improved.

The former Chief of CECW-O, Mr. John Elmore, concluded that the pressure was sufficient to undertake a major effort, relying on experienced O&M field managers to identify measures, policies and strategies to improve the program. The four (4) themes pursued were:

- Program Development and Budget Execution
- Organizational Structure
- Operating Procedures
- Performance Measurement

Each theme was investigated by a task force comprised of field O&M specialists/managers, supported by WRSC staff and a contractor who had considerable experience in the Corps' O&M work. These task forces worked for slightly more than a year to develop recommendations aimed at significantly improving the O&M program.

Study results were received in September 1992. The task forces concluded that projects operated and maintained by the Corps were generally in good condition from an engineering standpoint and confirmed a high standard of engineering and a high degree of professionalism throughout the O&M program. However, some management, operational, organizational, and budgeting problems were found. The levels of service provided at the project level were not always consistent due to 1) variations in the application of policies and procedures; 2) increasing top-down level of oversight and review; and 3) a cumbersome budget process. The program of reform centered on a concept that empowered the operations project manager and provided an increased measure of accountability.

The Plan of Improvement findings were organized by the previously mentioned four (4) major themes. An implementation task group was formed for each theme. The Program Development and Budget Execution efforts simplified and clarified the budget process. The number of budget line items was drastically reduced as the budget was ranked by the baseline (annually recurring functions) and variable (deferrable and non-deferrable) functions. The budget process subsequently went through a second generation of improvements that have aligned budget items by business functions.

The Organizational Structure effort eliminated a layer of management, reduced management positions, increased supervisor-to-employee ratios, and provided for accountability and responsibility on the part of the operations project manager. Operating Procedures efforts reduced the number of regulation pages from 1,600 to 300. The regulations now focus on key items needed to be done while not specifically identifying how they are to be accomplished. In addition, the Corps' national leadership identified customer satisfaction as a key result area. The Corps has committed itself to providing useful feedback to the field offices on project performance. The Performance Measurement effort is still underway and has evolved into a focus on all

Civil Works program, not just O&M. Within the O&M program performance measurement and database standardization were evaluated to determine the practicality of developing an automated information system that draws upon existing national-level databases from all O&M business functions. Current efforts are focused on finalyzing the development of a common O&M Business Information Link (OMBIL) as the means for accessing high level information to serve the needs of O&M managers. The implementation of data management is integrating a number of previously independent databases (hydropower, recreation, dredging, navigation, etc.), that are being analyzed, both technically and managerially.

1.1.2 Civil Works Performance Measurement Program

The Corps' O&M program improvement effort described above received the Hammer Award from Vice President Albert Gore as a model program in Reinventing Government. The O&M Program Plan of Improvement also served as the Corps' Performance Pilot under the Government Performance and Results Act of 1993 (GPRA). As the Corps' performance measurement prototype, it led to the application of performance measurement concepts to the full Civil Works Program process led by the Corps Headquarters' Chief of Programs and Project Management. This effort was supported by IWR and several contractors. Several documents are now available that discuss the process and structure of the effort and document Performance Measurement Philosophy and Process, which builds on values and customer needs in defining performance and results requirements within the Corps' functional programs and mission objectives. This framework offers an approach that integrates performance with achieving customer needs. Thus far, the framework documents do not report results of case or empirical studies. The work focuses on strategy, and several performance measures by product have been identified for navigation. The lead Corps Divisions for the navigation aspects of this initiative are the Ohio River Division (ORD) for inland waterways and the North Atlantic Division (NAD) for Deep and Shallow Draft Harbors.

Regarding seaports, where the "product" is defined to be "harbors", the following measures are being considered:

- Percent availability (percent time that a channel provides vessels with channel depth/width within authorized channel dimensions).
- Ratio of estimated total harbor project construction cost to actual total harbor project cost (effectiveness of construction management).
- Ratio of initial total harbor project construction time to actual harbor project time (effectiveness of construction management).
- Ratio of project benefits to operations and maintenance (O&M) costs.
- Percent transits with drafts greater or equal to 90 percent of authorized depth.
- Percentage of the world fleet that can use U.S. harbors (a response to frequent questions posed by U.S. Congressional Committees).

Worksheets have been developed which describe these performance measures. The worksheets define the measurement approach, identify the value demonstrated, indicate the preferred unit for measuring output, and identify the data sources.

1.1.3 The O&M Cost Savings Task Force

During FY 1996, the overall Federal strategy to achieve a balanced budget by 2002 was developed. Federal budget cuts were end loaded, with ceiling reduced for the budget year, but the most severe cuts occurring in later years. When this strategy was played out in the Corps' Civil Works budget, the size of the O&M program became a major concern, since the resulting ceilings would accommodate little, if any, room for funding of construction and planning activities. Thus, additional pressure for cost savings within the O&M program occurred.

The Corps' O&M Cost Savings Task Force completed a draft report, dated August 14, 1996, which evaluated deep draft navigation harbors, shallow draft harbors and inland navigation waterways. The report gave results of the following performance indicators:

- Deep Draft Harbors
  - Number of transits whose sailing draft exceeded 80 percent of maintained channel depth
  - O&M cost per ton of cargo
  - Indirect costs per O&M costs (a measure of overhead costs)

- Shallow Draft Harbors
  - O&M costs per ton of cargo
  - O&M costs per transit
  - Indirect costs per O&M costs (a measure of overhead costs)

- Inland Navigation Projects
  - O&M costs per ton-mile of cargo
  - O&M costs per lock
  - O&M costs per cut (each pass through a lock - some tows require multiple cuts)
  - Indirect costs per O&M costs (a measure of overhead costs)

A summary of the report is presented in Table 1-1.

The Task Force established a set of navigation costs by assigning each Feature Cost Account to a Corps Business Function for the years 1991 - 1995. In some cases, the costs were found to serve more than one (1) business function; these costs were prorated. In its analysis, the Task Force found that certain categories of data were missing for some projects.

Measures of O&M cost per ton of traffic were also developeded. Important aspects of the approach include the definition of relevant costs (why cost accounts that support purposes other than commercial navigation are included) and the availability of costs for individual features (such as locks in a segment or separable channels to serve individual ports in a multiple port project, such as the Columbia River, the San Francisco Bay project or the several ports in the Mississippi River below Baton Rouge to the Gulf). Tons or ton-miles were also used to measure the output of each project. The current study considered the recommendations from the three (3) Cost Reduction programs described above in defining the eight (8) performance measures applied in this study.

Table 1-1 O&M Cost Reduction Task Force Summary		
	Projects	
	Total #	# Tested
Deep Draft Harbor Projects	250	
Percent vessels exceeding 80% of maintained channel depth		186
O&M Cost per Ton		184
Indirect Costs per O&M Costs		225
Shallow Draft Harbor Projects	625	
O&M Cost per Ton		285
O&M Cost per Transit		285
Indirect Costs per O&M Costs		285
Inland Navigation Waterway Projects		
O&M Cost per Ton Mile		73
O&M Costs per Lock (lock only)		169
O&M Costs per Cut		158
Indirect Costs per O&M Costs		75

This report represents the second phase in IWR's program to develop a rational, performance based tool that can be used to evaluate and compare the economic performance of harbor projects maintained by the Corps. The first phase in this effort, also titled "Corps of Engineers Harbor Projects: Development of Tools, Measures, and Organization for Evaluating Performance" was completed in September 1997. The first phase consisted of the following products: 1) Volume I: Technical Report; 2) a software product IWR-HARBORVU for evaluating and ranking harbor projects; 3) a database containing information for individual harbor projects on historical cargo traffic, value, and O&M expenditures; and 4) Volume II: IWR-HARBORVU Users Manual. A previous version of IWR-HARBORVU was written in Oracle Personal Express Version 5.0. Phase I used information for the period 1985 through 1994. Following the completion of Phase I, the IWR decided to conduct Phase II. The purpose of this second phase was to update the information used in Phase I by including additional data for the years 1995 and 1996. Phase II also represented an opportunity to apply lessons learned during the performance of Phase I, especially in developing additional performance measures that would evaluate harbor projects in a more meaningful way. In order to minimize confusion on the part of the reader, throughout the remainder of this document Phase I refers to the report completed in September

1997 and Phase II refers to this report. Differences between the two (2) phases will be identified as appropriate.

2.0 CONCEPTUAL DESIGN

The context of performance measurement is already embodied in the IWR Report U.S. Army Corps of Engineers Civil Works Performance Measurement Program. The framework of values, customer satisfaction, and Corps programs and missions provide the intellectual basis for screening and evaluating the importance of harbors and ascertaining their need for continuing O&M expenditures.

2.1 Evaluation Framework

Performance indicators are used to evaluate O&M budget package requests, to assess program and project performance, and to increase accountability among Corps O&M managers. Decisions regarding the allocation of resources to projects should be driven by incremental costs and incremental benefits. In the same vein, the Corps' harbor navigation projects should ideally be viewed in terms of how much traffic they handle (effectiveness), the value to the national economy (NED output) from this traffic, and the costs required to enable this transport service (budget efficiency).

Detailed data on the tonnage and utilization of incremental harbor depth for projects with at least 250,000 tons per year of traffic per year is published by WCSC. Traffic, trip and draft data for projects with less than 250,000 tons must be requested from WCSC. These data may be analyzed to produce estimates of the transportation cost reduction benefits attributable to each increment of depth.

The incremental benefit analysis does not project future use, but is based on actual, recorded vessel sailing draft data, rather than on what was in planning or other decision documents. Data other than actual recorded use should not be permitted in actual performance measurements.

Related concepts that were considered include:

1. Maintain each harbor to provide equal incremental benefits to cost ratios across the system.

   Each harbor should be maintained to generate equal incremental benefits to cost ratios across the system at the margin, thus bringing equal managerial focus to these relationships for projects with high, medium, and low traffic and high, medium, and low costs. This emphasis can serve all levels of management in the Corps and provide a logical, coherent set of performance indicators.

2. Provide equal challenges to managers at all levels.

   Individuals at various levels of the organization have widely differing visions of what is important to the Corps now and in the future. Thus, a strategy that applies equal challenges to managers at all levels should be a desirable goal. The return on investment (ROI) concept can be utilized as an organizing concept, if the primary goal is to increase returns to continuing operation and maintenance outlays.

3. Identify willingness to pay.

   The performance measurement model should be equipped with procedures and data sources which report financial/economic measures of benefits minus costs for each project. This approach requires the ability to identify the "willingness to pay" or "actual payments" for each increment of project output and the costs of each increment of O&M. For outputs which are not easy to monetize, incremental costs to achieve incremental levels of output could provide a substantial source of information that identifies harbor productivity.

Supporting the above evaluation framework requires the development of data-intensive procedures for each harbor project. This would imply the implementation of a long-term program to acquire and/or track these project-level data. The following approach is suggested:

1. Identify incremental costs at the project level. Project cost data must be analyzed to identify the incremental costs of providing each additional foot of channel depth. When undertaking cost analysis, the structure of the Corps' accounting system facilitates identifying the costs directly attributed to dredging (studies, channel depth monitoring, dredging, disposal). Additional cost analysis would be required to identify incremental dredging costs for varying depths. A policy decision would be required to exclude or include costs other than navigation dredging and disposal from the basic performance indicator of incremental costs and benefits. In some cases, other costs may be substantial and significant.

2. Identify incremental benefits at the project level. There is a simple procedure for identifying incremental transportation cost reduction benefits for existing traffic. This method was developed by Richard Shultz, a former IWR navigation analysis specialist, now retired from the Corps. The procedure is as follows:

   a. Obtain the trips and drafts from WCUS. These data are published for all harbors with 250,000 or more tons of commerce annually. Data for harbors with less than 250,000 tons would have to be acquired by request to WCSC. The names of each vessel can also be obtained by request to WCSC.

   b. Obtain characteristics of each vessel using a harbor from a vessel database (such as Fairplay). These data should show the design load capacity for each ship and tons per inch (TPI) capacity data (additional sources may be required to obtain acceptable TPI estimates).

c. Using the TPI data, estimate the tonnage which would be eliminated if the available channel depth were reduced in one (1) foot increments.

d. Compute the trip cost for the vessels in the analysis from the IWR ship cost database. Trip costs will not vary substantially due to light loading, however, trip costs per ton increase substantially, due to light loading.

e. Compute trip cost per ton of eliminated tonnage and accumulate the costs by vessel and trips.

f. When all vessels are aggregated, the resulting increase in trip costs per foot of available channel depth can be developed.

3. Develop a methodology to calculate return on investment for Corps projects. The principal criterion for determining the Federal interest in any harbor project is that it provides an excess of transportation cost reduction benefits over costs, when measured by national efficiency assumptions and is environmentally acceptable. In addition, the recent establishment of financial managers at the top level of every Federal agency suggests a growing emphasis on the financial and economic performance of Corps projects. If the principal measure of performance were economic, financial and environmental returns on investment, the performance measures would be excellent for determining which projects to eliminate under funding constraints and as performance measures of managers at all levels of the Corps. Returns on investment are the principal basis for determining investment efficiency. The concept could as easily apply to projects which include environmental mitigation or habitat improvement. How much return in terms of habitat or transportation savings from a given investment in construction or O&M should be a desirable measure to judge managerial performance at all levels of the organization? Cost management may also be an effective measure of performance, since in the corporate world, it is the principal standard by which managers at many levels are graded.

Accepting the idea of incorporating economic efficiency analysis into O&M budget decisions will require education to overcome past business practices. A report prepared for IWR in December 1992 by The Greeley-Polhemus Group, Inc., entitled Development of Benefit-Cost Methodology for Evaluating O&M Projects emphasizes the need for marginal (benefit/cost) economic analysis in O&M budget decision-making. The report also documents the use of "engineering judgement" as a perceived superior technique to economic analysis.

Economic analysis can be tailored to fit the decision process, the environmental setting, and the schedules required to make timely decisions. When done well, economic analysis illuminates the consequences of various choices available to O&M managers at all level of the Corps.

2.2 Potential Performance Measures

To accomplish this move towards improved decision-making ultimately requires the acceptance of techniques and the realization that the analysis supports the usefulness of Corps budgets. The question should not be whether but when economic efficiency analysis should be applied to Corps program and project decisions. The management of the Corps' O&M program has initiated risk analysis and many other analytical procedures to enhance the Corps' ability to budget and manage the program. This study is a step in the direction of finding appropriate methods for measuring performance of harbor projects.

During Phase I, a total of nine (9) performance measures were initially evaluated, as required by the Scope of Work:

1. Navigation O&M Dollars per Ton of Traffic: Measures cost effectiveness, assuming that all commodities are equally important. IWR's Navigation O&M Cost Recovery Database was used to facilitate a longer run view of relevant costs. During this study, the Cost Reduction Task Force developed a different basis for defining navigation costs for the period 1991 to 1995. These data are also included in our database.

2. Navigation O&M Dollars per Traffic Ton-Mile: Measures cost effectiveness for navigation channels which serve as throughways to several ports. Available data for those channels which met this definition were collected for the database.

3. Dredging Costs per Ton of Traffic: Similar to the first performance measure (O&M/Ton), except that this measure only considers the dredging portion of harbor maintenance costs. The intent of this measure is to identify those projects that are expensive to dredge.

4. Navigation O&M Costs per Traffic Value: Developed from the data on waterborne imports and exports available from the U.S. Bureau of Census. The data do not identify individual ports but permit estimation of average value for each commodity group in the waterborne traffic data reported in the Waterborne Commerce of the U.S. (WCUS). The value of domestic traffic was calculated as the weighted average of import and export values. Data for each commodity are available for each harbor that reported traffic in the latest available year (1994) when the prior phase was performed.

5. Dredging Costs per Traffic Value: Combines data developed for measures 3 (Dredging Cost per Ton of Traffic) and 4 (Navigation O&M Costs per Traffic Value). The intent here is to identify high-value harbors with low dredging requirements.

6. Navigation O&M Costs per Total Value of Imports and Exports: Calculated by comparing O&M costs to the sum of a project's import and export value. This measure eliminates domestic cargo from consideration, focusing instead on the higher value foreign trade cargoes subject to the Harbor Maintenance Tax.

7. Dredging Costs per Total Value of Imports and Exports: Combines data developed for measures 3 (Dredging Cost per Ton of Traffic) and 6 (Navigation O&M Costs per Total Value of Imports and Exports). Again, the intent is to identify high-value harbors (with Harbor Maintenance Taxable cargo) with low dredging requirements.

8. Navigation O&M Costs per Total Value of Exports: Similar to measure 6, except that only outbound cargo is considered. This measure can identify important export facilities.

9. Dredging Costs per Total Value of Exports: As with measures 3, 5, and 7, this measure only considers the dredging portion of O&M costs.

The potential performance measures listed above expand the range of cost to output relationships, which may add useful information to the evaluation of navigation projects. The first two (2) measures have been used in other Corps efforts. Phase II developed updated estimates for most of the nine (9) measures listed above based on the data now available, although eight (8) of the measures were combined into two (2) aggregate measures.

In addition, the total cargo value consisting of imports, exports, and domestic traffic through each harbor project, was estimated. These estimates reflect average prices between 1991 and 1996 for all U.S. Waterborne Imports and Exports by commodity group, applied to the annual traffic data for each project over this same period. Waterborne traffic tends to be relatively low-value bulk commodities, but its evolution is bringing rapid changes, such as containerized shipments of high-value commodities by carriers which provide regular service at relatively rapid transit speeds, greatly improved logistics, and impacts in loading, unloading and transhipment by surface carriers. Harbors are handling increasingly large quantities of these higher value commodities.

After evaluating the nine (9) required performance measures, Phase I determined that five (5) additional measures were needed to properly compare the projects. It was also concluded that some of the nine (9) required measures could be consolidated into a fewer number of more efficient measures. For example, only total navigation costs were considered, without including a specific breakout for dredging costs. Similarly, only the total value of cargo was measured, instead of having separate breakouts for exports and imports. The result of this effort was the identification of the six (6) performance measures used in the first phase of this study.

The second phase of this study presented in this document began with the six (6) performance measures used in Phase I. These six (6) performance measures were:

- Average Annual O&M Cost per Ton (1985 to 1994)
- Average Increase in O&M Costs (1985 to 1994)
- Average Annual O&M Costs (1985 to 1994)
- Average Annual Tons (1985 to 1994)
- Average Traffic Growth in Tons (1985 to 1994)
- Total Cargo Value (1994)

Based on the criteria discussed in Section 2.3.1, these six (6) performance measures were re-evaluated to see if they were still applicable. The availability of two (2) additional years worth of project level data for 1995 and 1996 made it possible to consider defining new performance measures, as well as to calculate percent changes between average annual figures for the 1985-1991 period compared to the 1992-1996 period. The result of the re-evaluation of six (6) existing performance measures was that a total of eight (8) performance measures were identified for use in this phase of the study. The primary improvement to the prior set of six (6) performance measures was the addition of two (2) that evaluated the percent change in average annual cargo value and average annual O&M cost per cargo value. Two (2) of the change measures (O&M costs, traffic) calculate percent changes between the average annual values for the 1985-1991 period and the average annual values for the 1992-1996 period, while changes for average annual cargo values are calculated for 1991-1993 compared to 1994-1996.

The following sections will evaluate these eight (8) performance measures, individually and in groups, to determine how effective they are and to judge the effort required to collect, maintain and update the data required to generate the measures. Because these performance measures are based on average rather than incremental costs, they serve as a preliminary step in the evolution of performance indicators.

2.3 Recommended Approach

Calculating the eight (8) performance measures used in this phase of the study necessitated the collection of three (3) basic types of data. Harbor maintenance cost data (total O&M including dredging costs) were needed for four (4) of the measures. The quantity of traffic in tons (for export, import, and domestic cargo) was needed for three (3) of the performance measures. Finally, traffic value was required for three (3) performance measures. (These figures sum to more than eight (8) because several performance measures used two (2) types of data, such as O&M cost per traffic value.) The following sections discuss the limitations of the data sources and the performance measures.

2.3.1 Performance Measure Evaluation Criteria

Meeting the objectives of this research requires analytical methods that address all projects uniformly (coverage) at a level of detail that considers resource inputs and project outputs (specificity). In addition, the analytical methods recognize the various defining characteristics, such as project, harbor, port, waterway pool, or segment (levels). Finally, methods and their data requirements for use now (availability) and in the future (perhaps with new databases) are factors in deciding how to proceed. Therefore, the four (4) criteria considered are:

1. Coverage. Project cost data are available from the Corps' financial accounting system. In recent years, the quality of reporting costs has improved due to command emphasis. A new accounting system is being implemented which promises improved financial data and better management information. The old Feature Cost Code system is being realigned to Corps business function (Flood Damage Reduction, Navigation, Hydropower, Environmental Stewardship, Recreation, and Multifunction). These cost data will generally be available for all projects. Traffic data availability by project is somewhat limited, although with the help of the WCSC organization, most necessary data were obtained.

2. Specificity. Contrary to the view that navigation project outputs are a deeper, wider channel, performance measurement requires the definition that navigation project outputs are transportation services which provide cost reduction for shippers. These are properly measured by the amount that shippers would pay for these cost reductions, which introduces an evaluation of the relevant risks,

costs, and quality facing the shippers in choices of route, carriers, and service quality.

3. Level. Deep draft harbor projects can often be evaluated independently, but in some cases, a multi-port analysis may have to be adopted, if a shipper can choose to ship or receive from several ports. This introduces land side cost and service analyses for the ports. For the purpose of performance measures, multi-port analysis will be less important than if a significant new investment for deeper, wider channels is at stake.

   Shallow draft harbors face greater competition than other ports. Therefore, it cannot be assumed that projects can always be evaluated independently. However, for the purposes of performance measures, this issue is less pressing.

4. Data "Availability". The performance measurement model now being implemented (discussed earlier in Section 1.1.2) is, primarily, an involvement effort which brings many levels of the Corps together in stages. Like all process models, the focus of measurement becomes confused by the lack of a clear conceptual model for development and use of performance indicators, the lack of applied cases which have been developed by clear criteria, and the tendency of participants to not clearly understand the relevance of measurement categories and the quality of the data which appear to be easily available. So, in the case of navigation projects, the Corps considered adopting the criterion of availability of structures and channels for service to navigation users as the primary measure of performance. (Availability is much more relevant to hydropower projects and value of power produced since the major advantage of hydropower over other sources of power is its ability to go online quickly and to modulate output in response to changes in loads.) However, availability is a very poor indicator of the economic efficiency of the costs incurred to operate and maintain harbor channel projects. Subsequent research documents show a shift to more direct measures of utilization and, in some cases, efficiency.

   The existing efforts of performance measurement show a tendency to reach for easily available data with the result that more logical and disciplined measures (which may take more time and resources to develop) are sometimes overlooked. The intent of this research project is to make use of available data to the degree that it can be used to screen the portfolio of projects and identify obviously poor performance.

The eight (8) performance measures used in this phase of the study are:

Performance Measure #1: Average annual real navigation O&M costs for the period 1985 through 1996.

Performance Measure #2: Average annual traffic (in short tons) for the period 1985 through 1996.

Performance Measure #3: Average annual cargo value for the period 1991 through 1996.

Performance Measure #4: Average annual real O&M cost per short ton of cargo for the period 1985 through 1996 (combination of measures #1 and #2).

Performance Measure #5: Average annual real O&M costs per $10,000 of cargo value for the period 1991 through 1996 (combination of measures #1 and #3).

Performance Measure #6: Percent change from the average annual real O&M costs for the period 1985-1991 to the average annual real O&M costs for the period 1992-1996.

Performance Measure #7: Percent change from the average annual traffic for the period 1985-1991 to the average annual traffic for the period 1992 to 1996.

Performance Measure #8: Percent change from the average annual cargo value for the period 1991-1993 to the average annual cargo value for the period 1994 to 1996.

2.3.2 Data Needs

Table 2-1 lists the data sources that were used to obtain the three (3) types of data needed to calculate the values of the performance measures. Each type of data is discussed in more detail below.

Table 2-1 Sources of Performance Measure Input Data

Item	Units	Time Series	Source	Use of Data
O&M Costs	Thousands of Constant 1992 Dollars	1985 - 1996	NCRDB	Average annual totals; used in performance measures 1, 4, 5, 6
Traffic	Thousands of Short Tons	1985 - 1996	WCUS	Average annual totals; used in performance measures 2, 4, 7
Commodity Value	Nominal Dollars per Ton	1991 - 1996	Census Bureau	Average annual totals; used in performance measures 3, 5, 8

Note: 1. Data extracted and provided by Institute for Water Resources staff.

2.3.2.1 O&M Costs

All data were taken from the cost accounting systems of the U.S. Army Corps of Engineers. Navigation projects serve objectives other than navigation, including: recreation, hydropower, flood control and environmental restoration. During the policy discussion in the 1980s dealing with cost recovery from users of the harbor and waterway systems, the Navigation Cost Recovery Database (NCRDB) was established by the Office of Policy in Corps Headquarters to include the O&M costs for all projects with navigation as an authorized purpose. A procedure was also developed to assign project costs to navigation, other non-navigation purposes, and joint costs shared by two (2) or more purposes. The NCRDB contains costs from

1977 to the present. The Corps of Engineers' Cost Reduction Task Force (CRTF) developed an estimate of navigation O&M costs for 1991 to 1995 with a slightly different set of assumptions. The task force developed cost allocations for all Corps O&M projects by assigning costs to Corps' business functions.

2.3.2.2 Traffic

All traffic data were taken from Waterborne Commerce of the United States (WCUS) published annually by the Waterborne Commerce Statistics Center, which is managed by the Navigation Data Center, WRSC, U.S. Army Corps of Engineers. The average annual traffic data series was furnished by the Corps IWR Navigation Division. The WCUS data for 1996 and earlier are available to the public in the form of the United States Waterway Data CD-ROM, which is available from the Federal government.[1]

2.3.2.3 Commodity Value

U.S. Bureau of Census data were used to develop commodity values.[2] These data contain all import and export transactions (weight and dollar value) between the U.S. and its trading partners. Since these data are organized by ten (10) digit Harmonized Commodity Codes, a conversion was required (see Section 3.4 for details) to match the four (4) digit commodity codes utilized by WCUS. Reported commodity quantities were converted from kilograms to short tons before being divided into the commodity values to obtain a value per ton.

2.3.3 Limitations

The performance measures that are evaluated in this report are derived from several large, national databases that have been maintained for as long as twenty (20) years. Any large database is inherently prone to errors, omissions, and format changes. Tracking commodities is even more difficult - the Corps and the Census Bureau use different breakdowns of commodities. These inconsistencies in data, along with outright

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[1] U.S. Department of Transportation, Bureau of Transportation Statistics and U.S. Army Corps of Engineers, BTS CD-18.

[2] The data are available on two CD-ROMs: U.S. Imports and Exports of Merchandise, International Harmonized System Commodity Classification by County by Customs District, December 1994; and U.S. Department of Commerce, Bureau of the Census, Data User Services Division, Washington, D.C.

data entry and transcription errors, affect all of the performance measures. Given the extremely large size and complex nature of the data, effective after-the-fact quality assurance cannot always be perfectly performed.

In particular, waterborne commerce data on fish tonnages are collected on a very limited basis. Currently, the WCSC collects fish landing information from a variety of sources, with the regional offices of the National Marine Fisheries Service (NMFS) being the primary source of fish statistics. The NMFS data are reported at the county level, and WCSC apportions these amounts to Corps locator codes in the WCSC database. WCSC also obtains data from three (3) state fish and game agencies (WA, OR, and CA) and from individual fish operators within seven (7) Corps districts. No enforcement by district or WCSC is pursued because the effort is problematic. Improving fish landing information should be a priority. Any evaluation of harbor performance should consider at least whether or not significant quantities of fish and shellfish are handled. Otherwise, harbors with low-commodity tonnages but significant commercial fishing fleets will exhibit a poorer performer.

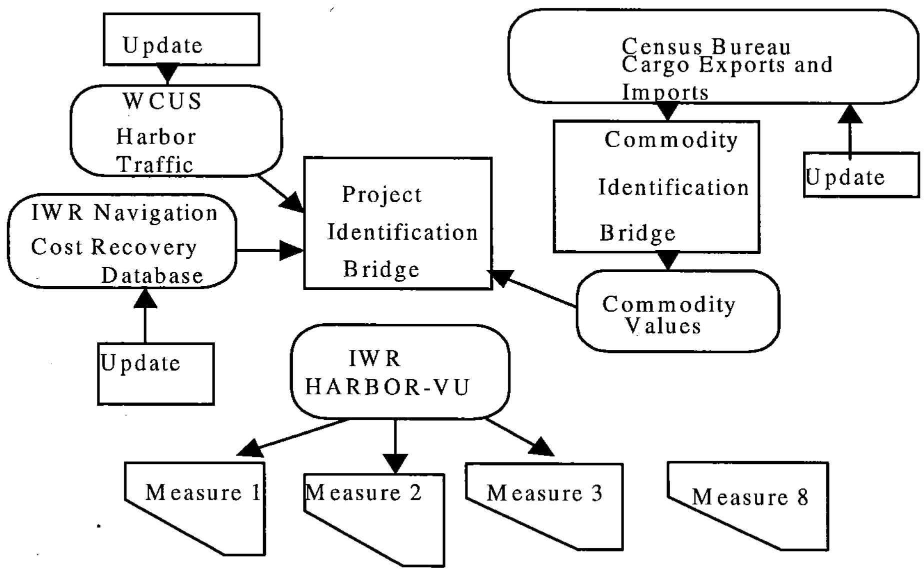
Two (2) additional limitations involve the cargo valuation process. First, values can only be calculated for those harbors that reported traffic in between 1991 and 1996.[3] This reduces the number of projects for which values can be calculated for performance measures #3 and #5. The second limitation involves the calculation of the unit value (i.e., $/ short ton) of a given commodity. While direct computations are made for import and export cargo, the unit value of domestic cargo is assumed to be equivalent to the unit value of export cargo in Phase II, in contrast to calculating a weighted average of import and export cargo values as was done in Phase I. Moreover, the unit cargo value calculation is based on only five (5) years of data due to the extremely large size of the dataset. Unit commodity values for exports and imports for the U.S. and for selected ports are presented in Appendices B1 through B8.

[3] The software tool developed under this effort has the capability of adding future commerce data to its harbor traffic database.

3. 0 DATA ORGANIZATION AND DEVELOPMENT

Quantifying performance measures required collecting and merging data from several large databases on O&M costs, traffic tonnage, and unit commodity values for each and every harbor project included in the study. Figure 3-1 illustrates the overall process of data analysis and performance measurement creation.

Figure 3-1: Performance Measure Analysis Information Flow



A unique key field was central to extracting, organizing, and merging data from several large databases. The project identifier code for each harbor was a natural selection to be the unique key field in this analysis. Unfortunately, the various databases used one (1) of two (2) identifier codes for (harbor codes): (1) Corps cost data used the Project Work Identification (PWI) code (formerly the Civil Works Identifier System (CWIS) code), while (2) traffic data collected by the Census Bureau and the Waterborne Commerce Statistics Center used the waterway (WTWY) code. A "bridge" file was needed to link the two (2) codes so that cost and traffic data could be properly assigned to its appropriate harbors.

3.1 Project Identification Bridge

For the waterborne commerce data used in this report, WCSC collected domestic traffic data at the location/dock level and obtained from the Bureau of the Census foreign traffic data at the location level, which was collected by the U.S. Customs Service. Subsequently, WCSC aggregated the domestic and foreign traffic data to the four (4) digit waterway code (WTWY) level. The Corps uses a five (5) digit PWI code to identify its navigation projects. Since O&M expenditures are recorded by PWI code, and traffic information is recorded by WTWY code, it was necessary to create a bridge that linked the WTWY code with the PWI code.

IWR has made several previous attempts to link the WTWY and PWI codes. These existing bridges were reviewed and combined into one overall Project Identifier Bridge that appears in Appendix A. The Project Identification Bridge contains, for each of the 845 projects, its WTWY code, PWI code, draft category (i.e., *D* for deep draft or *S* for shallow draft) Division, District, project name, and State.

As an outgrowth of this study, and other performance measurement efforts that have been hindered by the inability of users to access project related data, a joint effort between the WCSC and IWR has been initiated with the objective of improving the data retrieval process at the project level. The final product will be a WCSC database with project PWI (CWIS) codes assigned directly to the WCSC waterway link codes, and "maps" of Corps navigation projects overlaid with WCSC waterway links.

3.2 Navigation O&M Costs

Navigation O&M costs for this analysis were determined from the Navigation Cost Recovery Database (NCRD). Real O&M costs were calculated using the Gross Domestic Product chain price index, seasonally adjusted, where 1992=100. [4]

$$\text{Real O \& M Costs in Year}(x) = \left[\frac{\text{Price Level in Base Year (1992)}}{\text{Price Level in Year}(x)}\right] * \text{Nominal O \& M Cost in Year}(x)$$

4 Source: U.S. Department of Commerce, Bureau of Economic Analysis

The base year of 1992 was used because National Income and Product Account (NIPA) values are currently expressed in constant 1992 dollars. Real O&M costs, instead of nominal or current O&M costs, were used to calculate performance measures #1, #4, #5, and #6. O&M costs in the Phase II study were expressed in real (i.e., constant 1992 dollars) to correct for effects of inflation and real escalation. By comparison, in the Phase I study average annual costs were estimated using current dollar amounts. Converting current O&M costs to constant dollars is a more accurate way of calculating average annual costs from time series data because the figures for the different years are expressed in comparable terms. The resulting real average annual figure reflects only variations in the absolute magnitude of the navigation cost from year to year with the effects of inflation eliminated.

Appendix C1 presents times series data on annual navigation O&M costs in current or nominal dollars for the period 1985 through 1996 for each of the 845 projects. This appendix also presents the average annual nominal O&M cost for two (2) periods, 1985-1991 to 1992-1996, and the percent change in the average annual real O&M costs between these two (2) periods. Appendix C2 presents the same data in constant 1992 dollars. As a result, Appendix C2 presents a more accurate measure of the Corps' expenditure of scarce financial resources over time to support navigation at the project level as explained above.

3.3 Harbor Traffic

The amount of exports, imports, and domestic traffic (in tons) of each commodity type at or passing through each harbor project is another major piece of information that had to be collected for this study. The manuscript files from Navigation Data Center, the Water Resources Support Center, U.S. Army Corps of Engineers, contain data on commodities at the location code level. The manuscript files provided detailed traffic information for the years 1991-1996. Less detailed traffic information for the years 1985-1990 was obtained directly from the WCSC. Several project-level aggregations were required to ensure data consistency. Traffic for Los Angeles & Long Beach Harbors (WTWY 4101) is calculated as the sum of traffic for Long Angeles Harbor (WTWY 4120) and the traffic for Long Beach Harbor (WTWY 4110). Traffic for Gloucester Harbor & Annisquam River (WTWY 143) is the sum of traffic for Gloucester Harbor (WTWY 143) and

Annisquam River (WTWY 36). Finally, traffic for Weymouth Fore and Town Rivers (WTWY 162) is calculated as the sum of traffic for Weymouth Fore River (WTWY 162) plus traffic for Town River (WTWY 163). Appendix D contains historical harbor traffic data for the period 1985 to 1996.

3.4 Commodity Valuation

It was necessary to estimate unit values for each commodity in the four (4) digit WCSC classification list, in order to calculate cargo values for active projects. The Bureau of Census, Foreign Trade Division, annually publishes a database reporting all waterborne shipments between the United States and its trading partners. Export shipments are valued at the Free Alongside Ship (FAS) basis. Import shipments are recorded based on their Customs value (or cost) and the insurance and other freight charges (CIF).

There are two (2) basic limitations in using the Bureau of Census data to determine unit commodity values. First, while commodities analyzed in this study are aggregated to the four (4) digit WCSC list, the Bureau of Census value data are aggregated to a different ten (10) digit harmonized commodity description and coding system (HS). Second, data from the Bureau of Census are not specific to Corps harbor projects.

In order to use the Bureau of Census data to calculate unit commodity values, it was necessary to develop a link between the HS codes and the WCSC four (4) digit commodity classification list. First, the ten (10) digit harmonized codes were transformed into six (6) digit harmonized codes by deleting the four (4) digits used exclusively for statistical purposes in evaluating trade policies. Second, a series of links were made between: the six (6) digit HS and the SITC3 codes; the SITC3 codes and five (5) digit WCSC codes; and, finally, between the WCSC five (5) digit codes and the four (4) digit classification list. The result was the aggregation of over 17,000 HS codes into the 144 WCSC four (4) digit commodity classification list.

The first attempt to estimate unit commodity values consisted of determining the median value per ton of all shipments of a commodity between the United States and its trading partners. A preliminary evaluation of the results concluded that median values were inefficient estimators of unit commodity values. Major problems occurred due to the level of aggregation in the WCSC four (4) digit commodity classification lists. As a result, a commodity's unit value was calculated based on the weighted average of tons and values of waterborne shipments between the United States and its trading partners.

A comparison of the different results yielded by the two (2) approaches is illustrated in the following example. Suppose a hypothetical project handles three (3) shipments of commodity WCSC 7220 Aircraft & Parts.

Shipment 1: A ton of Aircraft Parts at $1,000,000 per ton
Shipment 2: Two (2) tons of Aircraft and Parts at $500,000 per ton
Shipment 3: Fifty (50) tons of Aircraft and Parts at $1 per ton

The median value equals $500,000 per ton. Using the median unit value, the total cargo value is calculated as 53 tons times $500,000 per ton, or $26,500,000. This is clearly inefficient, as the actual total value of this commodity is known to have been $2,000,050.

Using the weighted average, total cargo value is determined by multiplying 53 tons times $37,737, which is equal to the actual value of 2,000,050. The weighted average unit commodity value provides a much more accurate estimate of actual total cargo value handled at a project.

Because the import and export databases are very large (for example, the 1994 import database alone contains more than 1 million records), the calculation of a weighted average value for each commodity was a time consuming process despite the use of high-speed computers. The calculation process required the development of an Access SQL program to run a number of queries and perform a number of transformations and calculations. First, the program aggregated over 17,000 HS codes into the 144 WCSC four (4) digit commodity classification list. Second, it transformed the traffic weight contained in the Bureau of Census database from kilograms to short tons. Third, it calculated the value per ton for each shipment between the United States and its trading partners . Fourth, the program determined each shipment's weight as a percent of the weight of all shipments in the commodity group. Fifth, the program calculated the value for a single record as a proportion of the total value within a commodity group. Finally, the program summed the values for all records in a single commodity group to obtain the unit value for that commodity. Table 3-1 illustrates the calculation of unit commodity values for Machinery (WCSC 7110). The program calculated average unit values using data from 1991 through 1996. The unit commodity values for a single WCSC commodity type vary widely at an individual port level.

Table 3-1 Illustration of Weighted Average Calculation
1994 Import Value for Machinery (WCSC 7110)

SHIPMENT	WCSC4	HS	KG	VALUE	Short TONS	VALUE/TON	% TOTAL TONS	VALUE
1	7110	731511	144	$2,498	0.16	$15,737	3.33531E-06	$0.05
2	7110	731511	145,047	$1,671,312	159.89	$10,453	0.003359557	$35.12
3	7110	731512	42,460	$38,319	46.80	$819	0.000983452	$0.81
4	7110	731512	66,661	$84,786	73.48	$1,154	0.001543992	$1.78
5	7110	731512	17,101	$25,828	18.85	$1,370	0.000396091	$0.54
6	7110	731512	204	$8,940	0.22	$39,756	4.72502E-06	$0.19
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
56112	7110	870990	8,623	$31,325	9.51	$3,296	0.000199725	$0.66
56113	7110	870990	1,726	$7,692	1.90	$4,043	3.99773E-05	$0.16
56114	7110	870990	1,220	$14,131	1.34	$10,508	2.82575E-05	$0.30
56115	7110	870990	767	$3,468	0.85	$4,102	1.77651E-05	$0.07
			Total Short Tons:		4,759,193	Weighted Average Value Per Ton:		$6,409.54

Unit commodity values based on weighted averages were calculated using all shipments between the U.S. and its trading partners. Appendix B1 presents the national unit commodity values for the 144 WCSC list for U.S. exports. Appendix B2 presents the same information for U.S. imports. These national unit commodity values were used to derive project-specific estimates of total commodity values. Project-specific unit commodity values could not be calculated because the Bureau of Census data on international trade is port-specific and not project-specific. In order to directly import port-specific commodity values from the Bureau of Census in IWR-HARBORVU, it would be necessary to develop a bridge linking the District and port codes used in the Bureau of Census database to the waterway codes (WTWY) or to the project identification codes (PWI). This bridge is currently not available.

The calculation of national unit commodity values used data from all U.S. ports, including those that are not related to Corps projects analyzed in this study. For information purposes only, unit commodity values for imports and exports at Port of Baltimore, Port of Brunswick, and Port of San Francisco were also calculated. The information is contained in Appendices B3-B8 with separate tables for exports and imports at each port. An examination of port-specific data reveals that a large part of within-year variability in commodity values is due to the assignment of a large number of HS codes to a single WCSC code. Ports across the country handle a different mix of commodities within each commodity group; consequently, each port will have unique unit commodity values. If an effective bridge linking the district and port codes to waterway codes can be developed, port-specific unit commodity values should replace national unit values in order to reduce variability introduced by aggregation.

The Phase I report used a weighted average of import and export prices to estimate domestic unit commodity values. Export prices alone were used in this study to estimate domestic unit commodity values. This decision was justified on the grounds that export prices more accurately reflect the price of commodities produced domestically, while import prices reflect the price of commodities produced in foreign countries. Moreover, export shipments are valued at Free Along Ship (FAS) basis, thus reflecting domestic economic conditions and freight charges, while import shipments include the customs value (cost) plus insurance and other non-domestic freight charges (CIF).

Another issue of concern is that the current version of IWR HARBORVU software does not calculate unit commodity values. As mentioned previously, unit commodity values in this study were calculated externally and imported into the IWR HARBORVU. GPG recommends that future versions of IWR HARBORVU software have the capability to use raw data from the Bureau of Census to calculate project-specific unit commodity values. The software should incorporate real Windows features, and it should be contained in a CD-ROM.

4.0 ANALYSIS OF DATA

This chapter presents the analysis of the Corps' 845 harbor projects using the eight (8) performance measures. First, however, economic performance of these projects between 1985 and 1996 is reviewed to identify trends in project performance. The three (3) types of data used to derive the performance measures are discussed.

4.1 Project Economics by Harbor Type

Using performance measures to evaluate Corps harbor projects requires that a project be active. An "active project" is defined as one that has historically generated traffic and/or incurred navigation O&M costs. Conversely, an "inactive" project is one that has had neither historical traffic nor O&M costs. A third group of projects, no commerce reported (NCR) projects, include those active projects with no commerce reported or zero traffic. NCR projects are defined as active because they had O&M costs. Traffic is recorded in thousands of tons; as a result, any project that handled less than 500 tons of traffic per year is listed as having zero traffic for that year. Table 4-1 shows the distribution of the 845 projects by draft and activity status. During the period from 1985 to 1996, 720 of the 845 projects (PWI codes) in the Corps' database were active, with 125 being inactive. Of these active projects, 239 were NCR projects.

Table 4-1 Harbor Projects

	Active	Inactive	Total
Deep Draft	277	115	392
Shallow Draft	443	10	453
Total	720	125	845

4.1.1 Average Annual O&M Costs

Table 4-2 summarizes O&M cost data for the 720 active projects. On average, total annual real O&M costs (1992 dollars) were approximately $416 million for all active projects between 1985 and 1996. This figure is derived by taking the average of the last "TOTAL" row in Appendix C2. Average annual real O&M costs for all active projects for the period 1992 to 1996 was 2.2 percent lower than between 1985 to1991 as shown in Table 4-2. The average annual O&M expenditures in real terms declined slightly from the first period to the second, with the largest percent decrease (3.6 percent) occurring for shallow draft projects, and the largest dollar reduction occurring at deep draft projects. Appendix C1 shows that the total navigation cost in 1996 in current dollars was $470.8 million.

The values in Appendix C2 were derived from those in Appendix C1 by converting current dollars to constant or real dollars using the GPD deflator. For example, the 1996 total O&M costs in current dollars of $470.776 million for all 720 active projects were multiplied by 1/GPD deflator of 1.0953 to derive the figure of $429.775 million shown in Appendix C2 for 1996. Similarly, the average annual real O&M cost of $415.920 million shown in Table 4-2 would be $462.852 million in current, third quarter, 1998 dollars.

Table 4-2 O&M Cost Analysis for Active Projects

	Number of Active Projects	Average Annual Real O&M Cost (1985-1996) (1992$ x 1,000)	Average Annual Real O&M Cost (1985-1991) (1992$ x 1,000)	Average Annual Real O&M Cost (1992-1996) (1992$ x 1,000)	Changes in Average Annual Real O&M Cost 1985-1991 to 1992-1996 (Percent)
Deep Draft	277	$350,019	$352,775	346,162	-1.9
Shallow Draft	443	$65,901	$66,915	64,483	-3.6
All Projects	720	$415,920	$419,688	410,645	-2.2

Note: Does not include fuel taxed inland waterway projects
Source: Navigation Cost Recovery Database

4.1.2 Average Annual Traffic

Table 4-3 summarizes traffic information. Over the twelve (12) year period, active harbor projects handled an annual average of 2.649 billion short tons of traffic. The average annual figures for all projects for 1985-1991 and 1992-1996 are found in the last row of Appendix D. The annual average traffic across all active projects for the period of 1992 to 1996 was 16 percent higher than annual average traffic for the period 1985 to 1991. The positive change in traffic, coupled with the decline in average annual real O&M costs, indicates gains in economic efficiency as measured by the decrease in O&M cost per ton of traffic. The average annual traffic increase for deep draft projects was more than double that for shallow draft projects (16.6 percent compared to 7.2 percent). The average deep draft project's traffic rose by over 385,000 tons compared to only about 12,000 tons for the average shallow draft project.

Table 4-3 Traffic Analysis for Active Projects

	Number of Active Projects	Average Annual Traffic (1985-1996) (Tons x 1,000)	Average Annual Traffic (1985-1991) (tons x 1,000)	Average Annual Traffic (1992-1996) (Tons x 1,000)	Changes in Average Annual Traffic 1985-1991 to 1992-1996 (Percent)
Deep Draft	277	2,480,819	2,320,094	2,705,833	+16.6
Shallow Draft	443	168,786	163,876	175,659	+7.2
All Projects	720	2,649,604	2,483,970	2,881,492	+16.0

Note: Does not include fuel taxed inland waterway projects
Source: Waterborne Commerce Statistics Center

4.1.3 Average Annual Cargo Value

Table 4-4 summarizes cargo value information for the period of 1991 to 1996. The unit commodity values per ton in Appendices B1 and B2 were applied to the traffic database contained in the manuscript files to obtain the average annual cargo values for all active harbor projects. Over the six (6) year period, all the active harbor projects handled an annual average cargo value of $1,172,810 million. Deep draft harbors handled about 96 percent of the total average annual cargo value, while shallow draft harbors handled the remaining 4 percent. The average annual cargo value for the period 1994 to 1996 for all active projects was 24.2 percent higher than annual average traffic for the period 1991 to 1993. However, shallow draft projects had the largest increase in average annual cargo value of 82.7 percent. A comparison of Tables 4-3 and 4-4 shows that the average annual value of cargo grew more rapidly than the amount of traffic, or 24.2 percent compared to 16 percent. The greater differential was for shallow draft projects, 82.7 percent compared to 7.2 percent.

Table 4-4 Cargo Value Analysis for Active Projects

	Number Active Projects	Average Annual Value of Cargo (1991-1996) (thousand of $)	Average Annual Value of Cargo (1991-1993) (thousand of $)	Average Annual Value of Cargo (1994-1996) (thousand of $)	Change in Average Annual Values of Cargo 1991-1993 to 1994-1996 (Percent)
Deep Draft	277	$1,125,089,099	$1,012,427,340	$1,237,750,857	+22.3
Shallow Draft	443	$ 47,721,296	$33,756,932	$61,685,660	+82.7
All Projects	720	$1,172,810,395	$1,046,184,272	$1,299,436,517	+24.2

Note: Does not include fuel taxed inland waterway projects
Source: Waterborne Commerce Statistics Center and Bureau of Census

4.1.4 Distribution by Project Draft

Table 4-5 presents the distribution of O&M cost, traffic, and cargo value according to harbor draft, based on Tables 4-2 through 4-4. Approximately 84 percent of all navigation O&M costs were all allocated to deep draft projects and 16 percent to shallow draft harbors. By contrast, deep draft harbors accounted for about 94 percent of total traffic, while shallow draft harbors handled only about 6 percent. As a result, O&M

costs per ton of cargo handled at shallow draft harbors were higher than O&M costs per ton of cargo handled at deep draft harbors. Using the figures for the period 1985 to 1996, average annual O&M costs were $145 per 1,000 short tons of cargo handled at deep draft harbors and $390 per 1,000 short tons handled at shallow draft harbors. At deep draft harbors, the O&M cost was about $3.11 per $10,000 of cargo value, while it was $13.80 per $10,000 of cargo value at shallow draft ports. Deep draft projects handle, on average, cargo with a slightly higher value per ton than do shallow draft projects.

Table 4-5 Distribution of O&M Cost, Traffic, and Cargo Value by Harbor Draft

	Number of Active Projects	O&M Cost Distribution Based on Avg. Annual Total (1985-1996)	Traffic Distribution Based on Avg. Annual Total (1985-1996)	Cargo Value Distribution Based on Avg. Annual Total (1991-1996)
Deep Draft	277	84%	94%	96%
Shallow Draft	443	16%	6%	4%
All Projects	720	100%	100%	100%

Note: Does not include fuel taxed inland waterway projects
Source: Navigation Cost Recovery Database and Waterborne Commerce Statistics Center

Table 4-6 presents information of O&M cost expenditures on NCR projects. Over the twelve (12) year period (1985-1996), NCR projects received about $227.7 million in O&M funding, an average of $19 million per year. Deep draft NCR projects received an average of $295,000 per year, while shallow draft NCR projects received an average of $157,000 per year.

The analysis of data in this section illustrates some important relationships among O&M costs, traffic, and cargo values broken down by deep draft and shallow draft harbors. This information is useful in evaluating general trends on navigation cost savings and gains in economic efficiency. However, the relationships are too general to evaluate the performance of individual harbor projects. The following section describes the use of the eight (8) performance measures in evaluating the performance of specific harbor projects.

Table 4-6 No Commerce Reported Harbor Projects with O&M Costs (1985-1996)			
Projects	Number Reporting	Average Annual O&M Cost 1985-1996 (Thousands of 1992$)	Average Annual O&M Cost per Project (Thousands of 1992$)
Deep Draft	8	$2,357	$295
Shallow Draft	106	$16,616	$157
All Projects	114	$18,973	$166

Note: Does not include fuel taxed inland waterway projects
Source: Navigation Cost Recovery Database and Waterborne Commerce Statistics Center

4.2 Selecting Performance Measures

The selection of performance measures to be used in any study evaluating the comparative suitability or economic performance of a set of projects, programs, or sites should be based on the following criteria:

- Identify measures that fairly and accurately assess performance or suitability.
- Use measures for which high quality, accurate data is available at a reasonable cost for as many projects as possible.
- Minimize the number of performance measures. This makes it easier to determine which ones determine performance or suitability. It also lessens the data gathering effort.
- Avoid having multiple measures that evaluate the same underlying issue. For example, it would not be necessary to have several measures addressing different aspects of cost (i.e., dredging costs vs. non-dredging navigation costs, or disaggregating commodity values into export, imports, and domestic shares) if they can be combined into one (1) aggregate measure.

These criteria were used in selecting eight (8) performance measures applied in this study.

The prior Phase I report considered an initial set of nine (9) performance measures that are described in Section 2.2 of this document. The first step taken in Phase I was to determine the number of projects for which values could be calculated for each performance measure. During this effort, it was discovered that values could be estimated for a large number of projects for only O&M costs per ton (performance measure #1 in Phase I). It also became apparent during Phase I that additional performance measures were needed to better assess the economic performance of projects. As a result, a decision was made to add measures evaluating average annual values for O&M costs, traffic, and cargo value; and also measures estimating changes in these variables over time. The five (5) additional measures expanded the initial set of nine (9) performance measures to fourteen (14). These five (5) additional performance measures were useful because they showed the direct traffic and cost demand for each project, as well as showing changes over time. In addition, the total cargo value by itself was useful because it rewards high-value harbor projects. The five (5) additional performance measures also enabled values to be calculated for a larger number of projects than was possible of most of the original set of nine (9) measures.

Based primarily on the availability of data and maximizing the number of projects for which values could be calculated, the expanded set of fourteen (14) measure were narrowed down to the six (6) applied in Phase I.

- O&M Cost per ton (1985-94)
- Average Increase in O&M Costs (1985-94)
- Average O&M Cost (1985-94)
- Average tons (1985-94)
- Average traffic growth (1985-94)
- Total cargo value (1994)

It was decided to initially carry these six (6) performance measures over into Phase II, and re-evaluate them as necessary. As noted in Section 2.3, the six (6) performance measures were modified and two (2) additional ones were added, yielding the eight (8) performance measures that could potentially be applied in this Phase II report. The two (2) performance measures added were average annual real O&M costs per cargo value, and change in average annual cargo value. Using the data presented in Section 3.0, the eight (8) performance measures were then calculated for each project. Since Phase II uses data from a longer time series (i.e., two (2) additional years for costs and traffic tons and five (5) additional years for cargo value), it was hoped that values could be estimated for a larger number of projects for each performance measure than was possible during Phase I.

Table 4-7 presents the number of projects for which data was available for each performance measure. In the case of measures #1, #2, and #3, data values, including zero indicating no activity in a single year, were available for all 720 active projects. Since the calculation of values for measures #4 and #5 required non-zero values in the denominator, values for these two (2) measures could not initially be estimated for all 720 projects. However, in order to derive values and ranks for all eight (8) performance measures across all the active projects, projects with missing data for a performance measure were assumed to have a value of "0" for that measure. For example, the 217 active projects for which data did not exist to calculate values for performance measure #5 were assumed to have a value of "0" for that measure.

As had been hoped, the availability of two (2) additional years of data provided data values for a larger number of projects within a single performance measure than had been possible during Phase I. For example, during Phase I, data values for average annual traffic and average growth in traffic were available for only 236 projects. In contrast, during Phase II, as shown in Table 4-7, values for these two (2) performance measures were available for 720 and 688 projects, respectively. The recommended performance measures for Phase II are presented in Table 4-8.

To further explore the relationships between the eight (8) recommended performance measures that can be used to prioritize harbor projects, a correlation analysis was performed. The results of this analysis are presented in Table 4-9. It should be noted that this correlation analysis examines the relationship between the performance measures, not the relationship between individual projects.

The results indicate that average annual real O&M cost (measure #1), O&M cost per traffic (measure #4), O&M cost per cargo value (measure #5), and change in O&M cost (measure #6) are all positively and highly correlated with each other. A low average annual O&M cost translates into low O&M cost per traffic and per cargo value. In addition, low average annual O&M costs also mean small annual changes in O&M costs. By contrast, there is a strong, negative correlation between both average annual traffic (measure #2) and average annual cargo value (measure #3), where higher values are preferred, and average O&M costs (measure #1), O&M costs per traffic (measure #4) and O&M costs per cargo value (measure #5). These negative correlations make sense, as they indicate that O&M costs are a smaller share of annual tonnage and commodity value at larger ports than at smaller ones. As expected, change in traffic (measure #7) and change in cargo value (measure #8) are positively and strongly correlated with each other (i.e., large increases in the amount of traffic handled large mean increases in the value of traffic). Finally, the correlation between O&M cost per traffic (measure #4) and O&M cost per cargo value (measure #5) suggests that average annual O&M costs are driven more by the volume of cargo handled than the value of cargo handled.

4.3 Performance Measures for Harbor Projects

The limited nature of society's resources requires efficiency-based decisions in order to improve the standard of living of a nation. The main objective of this section is to describe eight (8) performance-based indicators that can be used as tools to help allocate resources to navigation projects. These performance- based indicators are programmed into the IWR HARBORVU software to calculate the materials in Appendices F1, F2, F3, G1, and G2.

The estimation, application, and significance of the eight (8) performance measures used in this study are described below.

Table 4-7 Number of Projects with Data for Each Performance Measure	
Performance Measure	# of Projects
1. Average annual real navigation O&M costs (1985-96)	720
2. Average annual traffic (in short tons) (1985-96)	720
3. Average annual cargo value (1991-96)	720
4. Average annual real O&M cost per 1,000 short tons of cargo (1985-96)	606
5. Average annual real O&M costs per $10,000 of cargo value (1991-96)	503
6. Percent Change in average annual real O&M Costs (1985-91 to 1992-96)	69
7. Percent Change in average annual traffic (1985-91 to 1992-96)	688
8. Percent Change in average annual cargo value (1991-93 to 1994-96)	685

(Note: The number of projects with data includes those projects with a "0" value for an individual performance measure in a single year.)

Table 4-8 Recommended Performance Measures
Performance Measure
1. Average annual real navigation O&M costs (1985-96)
2. Average annual traffic (in short tons) (1985-96)
3. Average annual cargo value (1991-96)
4. Average annual real O&M cost per 1,000 short tons of cargo (1985-96)
5. Average annual real O&M costs per $10,000 of cargo value (1991-96)
6. Percent Change in average annual real O&M Costs (1985-91 to 1992-96)
7. Percent Change in average annual traffic (1985-91 to 1992-96)
8. Percent Change in average annual cargo value (1991-93 to 1994-96)

(Note: The number of projects with data includes those projects with a "0" value for an individual performance measure in a single year.)

Table 4-9 Correlation Analysis of the Eight Selected Performance Measures

	Average Annual Real O&M Cost	Average Annual Traffic	Average Annual Cargo Value	O&M Cost per Traffic	O&M Cost per Cargo Value	Change in O&M Cost	Change in Traffic	Change in Cargo Value
Average Annual Real O&M Cost	1.0000	-0.0870	-0.0728	0.9296	0.7790	0.8252	-0.0394	-0.0743
Average Annual Traffic	-0.0870	1.0000	0.9862	-0.0591	-0.1316	-0.0428	0.7782	0.8771
Average Annual Cargo Value	-0.0728	0.9862	1.0000	-0.0494	-0.1101	-0.0363	0.7873	0.9238
O&M Cost per Traffic	0.9296	-0.0591	-0.0494	1.0000	0.7489	0.8548	-0.0282	-0.0537
O&M Cost per Cargo Value	0.7790	-0.1316	-0.1101	0.7489	1.0000	0.4602	-0.0592	-0.1125
Change in O&M Cost	0.8252	-0.0428	-0.0363	0.8548	0.4602	1.0000	-0.0210	-0.0359
Change in Traffic	-0.0394	0.7782	0.7873	-0.0282	-0.0592	-0.0210	1.0000	0.8362
Change in Cargo Value	-0.0743	0.8771	0.9238	-0.0537	-0.1125	-0.0359	0.8362	1.0000

4.3.1 Performance Measure #1: Average Annual Real O&M Cost

The average annual real O&M cost for the period 1985 to 1996 was calculated for each project. Historical O&M cost values at current dollars were taken from the Navigation Cost Recovery Database. Real O&M costs were obtained with the use of the Gross Domestic Product chain price index, seasonally adjusted, 1992=100. The year 1992 was selected as the base year because national accounting values are currently expressed in 1992 dollars. Historically, total average annual O&M expenditures for all the deep draft projects have been more than five (5) times higher than the total average O&M expenditures for all the shallow draft projects. For instance, during the period of analysis, the average annual real O&M cost at shallow draft harbors was $149,000 per project, while it was $1,264,000 per project at deep draft harbors. As a result, shallow draft projects should generally perform better (rank higher) than deep draft projects for this measure. This difference argues that it may generally be appropriate to compare only shallow draft projects with each other, and deep draft projects with each other since they are fundamentally different facilities.

This performance measure improves on performance measure #3 - O&M cost per ton from Phase I in several ways. First, performance measure #1 is based on two (2) additional years of data, increasing the significance and the reliability of the average values. Second, performance measure #1 is expressed in real dollars to eliminate the effects of inflation. Calculating an average annual cost in constant dollars more accurately measures the long-term trend in expenditure levels.

4.3.2 Performance Measure #2: Average Annual Traffic

The average annual number of short tons of cargo handled between 1985 to1996 was calculated for each project. This performance measure ranks projects with large annual traffic flows higher than those with low average flows. Deep draft harbors handled an average of 8,697,400 tons per year per harbor project, while shallow draft harbors handled an average of 381,000 tons per harbor project. This information was derived from the data in Appendix D. The traffic data is based on the tons moved through a project, rather than just the cargo handled (i.e., loaded on or loaded off) at a project. As a result, for projects that are primarily channels, as opposed to conventional harbors, the annual average traffic figure will over estimate the amount of cargo moving through the local economy.

This performance measure is an improvement over performance measure # 4 – average annual tons from the Phase I report because measure it includes two (2) additional years of data.

4.3.3 Performance Measure #3: Average Annual Cargo Value

The average annual value of cargo handled between 1991 to 1996 was calculated for each project using tons and unit commodity values for commodities aggregated to the four (4) digit WCSC commodity classification list. Unit commodity values for imports and exports were estimated as a weighted average based on tons and values of waterborne shipments between the United States and its trading partners. Unit commodity values for exports were used as estimates for unit commodity values for domestic cargo. Harbors with higher annual cargo values will receive higher ranks than those with lower annual values. The average annual cargo value for deep draft harbors was $4,062 million per project, while the mean annual cargo value for shallow draft projects was $107 million per project. The average cargo value data is also based on cargo that moved through a project, as opposed to only cargo handled.

Historical cargo values for all active harbors are presented in Appendix E1 for 1991 through 1996. Appendices E2 and E3 present traffic and commodity values for imports, exports, and domestic cargo handled in 1996. Appendix E2 presents both the total amount of traffic and the value of that traffic for each project during 1996. This Appendix also presents the 1996 traffic and commodity values for each project disaggregated by imports, exports, and domestic traffic. Appendix E3 presents the project rank based on the total value of cargo for a port in 1996. Finally, Appendix E4 presents the 1996 traffic and commodity value data for all the projects that had trade with Canada.

The traffic figures in Table 4-3 and Appendix D and the cargo value figures in Table 4-4 and Appendix E accurately present the total amount and value of cargo that moves through the 720 active harbor projects when the activity at each individual project is added up. However, the figures in these two (2) tables and the accompanying appendices may contain some unavoidable double counting of domestic cargo. The total figures in these two (2) tables consist of 1) domestic cargo (i.e., cargo sent to or received from another U.S. project); 2) exports sent to foreign ports; and 3) imports received from foreign ports. Because of the way the project-specific tonnage commodity data are collected, a domestic shipment sent from one U.S. project to another may be included in both ports' statistics. For example, a shipment sent from Los Angeles to San Francisco will likely show up in the tonnage and value statistics for both ports so that a single domestic shipment is counted twice. The amount and value of domestic cargo may be over-estimated by about a factor of two (2).

As shown in the last line of Appendix E2, in 1996 total foreign exports from the 720 active projects had a value of approximately of $403.8 billion, while imports into these projects had a total value of approximately $370.6 billion, with the difference being the merchandise trade deficit. The combined value of the exports and the imports was about $774.4 billion. Subtracting this figure from the total traffic value of $1,350.1 billion indicates that domestic shipments between U.S. ports had a total value in 1996 of approximately $575.7 billion, which is shown in the last row and the last column of Appendix E2. The actual value of the domestic trade would be about half this value since this is where the double counting occurs. Note that the total cargo value figure for 1996 presented in the last row of Appendix E1 is the same as total cargo value figure shown on the last pages of Appendices E2 and E3.

Performance measure #3 in this study is superior to the corresponding performance measure #6 – total cargo value from Phase I for several reasons. First, performance measure #3 is based on 5 years of data as opposed to data from a single year – 1994 – that was available in Phase I. As noted in the Phase I Study, the availability of additional years worth of data would increase the number of projects for which this performance measure could be calculated. The ability to calculate an average from five (5) years of data means that performance measure #3 more accurately measures an individual project's performance over time as the rankings are not dependent upon a single data point. Since cargo values can fluctuate widely from year to year, especially at shallow draft projects, basing rankings on a single data point does not accurately measure a project's performance over time.

One of the major limitations recognized in the Phase I study was that cargo valuation data was available only for 1994, so that values could be calculated for only 386 projects. By contrast, cargo value data was available for 503 projects in Phase II. Another advantage of Phase II is that it used weighted averages to more accurately estimate the underlying unit commodity values that were used to derive the project-specific values for performance measures #3, #5, and #8. Finally, performance measure #3 improved on the Phase I study by using the unit commodity values of the exports to estimate the value of imported cargo.

4.3.4 Performance Measure #4: Average Annual Real O&M Cost Per Traffic

The average annual real O&M cost per 1,000 short tons of cargo during the period 1985 to 1996 was calculated combining the data in Appendices C2 and D. This indicator measures cost effectiveness per weight of cargo handled, assuming that all commodities are equally important. This performance measure ranks projects with low values above projects with high values (i.e., more efficient use of navigation O&M costs per amount of traffic). During the period of analysis, the real annual O&M cost averaged $141 per

1,000 tons for deep draft harbors up to $390 per 1,000 tons for shallow draft harbors. The average across all 720 projects was $157 per 1,000 tons.

This performance measure improves on performance measure #1 – O&M cost per ton from the Phase I study because measure #4 is based on two (2) additional years of data. Measure #4 also presents the costs in real dollars, removing the effects of inflation, and enabling the long-term trends in unit O&M costs to be more accurately measured at the project level. In the Phase I study, data for this performance measure were available for only 532 projects, while in Phase II it was available for 606 active projects.

4.3.5 Performance Measure #5: Average Annual Real O&M Cost Per Cargo Value

The average annual real O&M cost per $10,000 of cargo value was calculated for the period of 1991 to 1996. Average annual real O&M costs for 1991-1996 were used. It combines the data in Appendices C2 and E1. This performance measure shows the cost effectiveness of navigation O&M expenditures per value of cargo handled at specific harbor projects. The average O&M cost per $10,000 of cargo value was $3.11 per deep draft project and $13.81 per shallow draft project. This performance measure ranks projects with low values (i.e., low O&M expenditure per value of cargo) above projects with high values. The average O&M unit across all active projects was $3.55 per $10,000 of cargo value.

This performance measure is a significant improvement to the Phase II study because there was no comparable performance measure used in the Phase I study due to data limitations. Performance measure #5 enhances the Phase II rankings because it measures the cost effectiveness of O&M expenditures in unit terms of real dollars of expenditure per value of cargo.

The significant difference between deep and shallow draft projects in terms of average annual real O&M costs per ton and per cargo value shows that navigation O&M funds can be used more efficiently at deeper, larger projects. This higher efficiency is likely due primarily to economies of scale that exist at the larger, deeper projects. What is interesting is that the difference between deep and shallow projects is greater for O&M costs per cargo value (4.4 to 1) than it is for O&M costs per ton of traffic (2.8 to 1), providing further confirmation that deep draft projects generally handle more valuable commodities. This would indicate that, if the sole basis for allocating scarce navigation O&M funds is maximizing economic efficiency, then they should be directed toward deep draft projects.

4.3.6 Performance Measure #6: Percent Change in Average Annual Real O&M Cost

The Phase II study calculated the percent change from a project's average annual real O&M cost for the period 1985 to 1991 to its average annual real O&M cost for the period 1992 to 1996. Appendix C2 presents this data. The advantages in calculating the percent change in the average annual values for the two (2) multi-year periods are presented above in Section 4.1.

The results indicate possible trends in real O&M costs. As illustrated in Table 4-2, average real O&M expenditures for all active projects for the period 1992 to 1996 were 2.2 percent lower than average real O&M costs for the period 1985 to 1991. During the same two (2) periods, average real annual O&M expenditures at shallow draft harbors decreased by 3.6 percent while they decreased by 1.9 percent at deep draft harbors. This performance measure ranks projects with low values above projects with high values.

This measure is superior to performance measure #2 from the Phase I study because measure #6 is based on the change in average annual values between a seven (7) year period (1985-1991) and a five (5) year period (1992-1996). Calculating percent changes in this way for measures #6, #7, and #8 in the Phase II study more accurately evaluates the change in a project's performance by avoiding the bias that can occur when percent changes use only two (2) values – the first and last years of an analysis period. In contrast, in the Phase I study the percent change in O&M costs and traffic was calculated for each of the nine (9) intervals (i.e., 1984 to 1985, 1985 to 1986, etc.) and the average across all nine (9) values was then calculated.

The problem with the Phase I approach, especially for shallow draft ports where the absolute values of O&M costs, tonnage, and cargo value can fluctuate widely, is that very high or very low percent changes can occur from year to year. These high or low values can then skew the nine (9) year average figure, resulting in ranking projects either too high or too low. This approach could either penalize or reward shallow draft projects that are more likely to have large yearly percent changes. The method used in Phase II of calculating percent changes between average annual values for two (2) sequential, multi-year periods avoids this bias and more accurately captures long-term trends. The Phase II study is therefore able to better measure the changes in the three (3) primary parameters used in this study: real O&M costs, traffic volume, and cargo values. The availability of these three (3) change measures also enables the Phase II study to more comprehensively evaluate and rank individual projects based on trends in their long-term growth or decline. The following equation was used to calculate this performance measure:

$$\text{Change (\%) O \& M Cost} = \left[\frac{\text{Average O \& M Cost 1992} - \text{1996 less Average O \& M Cost1985} - 1991}{\text{Average O \& M Cost 1985} - 1991}\right] * 100$$

4.3.7 Performance Measure #7: Percent Change in Traffic

The Phase II study calculated the percent change from a project's average annual traffic during the 1985 to 1991 period to its annual average during the 1992 to 1996 period. The following equation was used:

$$\text{Change (\%) Traffic} = \left[\frac{\text{Average traffic 1992} - \text{1996 less Average traffic 1985} - 1991}{\text{Average traffic 1985} - 1991}\right] * 100$$

This performance measure identifies possible trends in changes in the amount of traffic handled at harbors over time. The percent changes in traffic are presented in Appendix D. As illustrated in Table 4-3, the average annual traffic for the period 1992 to 1996 was 16 percent higher than average annual traffic for the period 1985 to 1991. During the period, the average annual traffic for deep draft harbors increased by 16.6 percent while the average annual traffic for shallow draft harbors increased by 7.2 percent. This performance measure ranks projects with high values above those with low values.

This measure more accurately and fairly measures the change in traffic handled than performance measure #5 – average traffic growth used in the Phase I study because measure #7 uses the percent calculation approach described above.

4.3.8 Performance Measure #8: Percent Change in Cargo Value

The percent change of a project's average cargo value for the years 1991to1993 to its average cargo value for the years 1994 to1996 was calculated and is presented in Appendix E1. The following equation was used

$$\text{Change (\%) Cargo Value} = \left[\frac{\text{Average Cargo Value 1994} - \text{1996 less Average Cargo Value 1991} - 1993}{\text{Average Cargo Value 1991} - 1993}\right] * 100$$

This performance measure evaluates trends in the change in the value of cargo handled by individual projects. Cargo value for all active projects increased by 24.2 percent from 1991-1993 to 1994-1996 as shown in Table 4-4. For the same period, the average annual cargo value for deep draft harbors increased by 22.3 percent, while the increase at shallow draft projects was 82.7 percent. This performance measure ranks projects with high values above those with low values.

This measure is a significant enhancement to Phase II because no similar performance measure could be calculated for the Phase I study due to data limitations. As noted above, cargo value data in the Phase I study were available only for 1994. Measure #8 was also calculated using the revised method for estimating percent changes described above.

4.4 IWR-HARBORVU: The Harbor Performance Database Analyzer

The performance of individual harbor projects has been analyzed with IWR-HARBORVU software. IWR-HARBORVU is a user-friendly, menu-driven database application that enables users to quickly generate harbor project rankings based on some or all of the eight (8) performance measures. It also allows users to view the various input data used to create the rankings, and to update the database as new traffic and cost information becomes available. To fulfill the demands of this analysis, IWR-HARBORVU version 1.0 was updated with additional programs and functions to analyze the new performance measures and to produce a variety of new reports.

The IWR-HARBORVU software is programmed in Oracle Personal Express®, a powerful multidimensional database system that integrates data management, a comprehensive set of analytical tools, and a fourth generation programming language that allows the building of menu-driven interfaces. Personal Express was selected over other software for compatibility, efficiency and ease of updating. First, IWR has used Personal Express on other projects, and several staff have formal training in its application. Second, Personal Express is designed to work efficiently with extremely large data sets. Its dimensional setup eliminates tables that consume storage resources. Finally, Personal Express is typically used to transfer data from mainframes. It has tools that are capable of reading only the data needed for the specific application.

A complete description of the software and its procedures is contained in User's Manual: IWR-HARBORVU Version 1.1.

4.5 Ranking Based on Performance Measures

The 720 active projects were ranked from first to last for each performance measure, so that a high rank (i.e., a small number) indicates that an individual project performs well for that measure. In order to rank each project, IWR-HARBORVU software sorted average traffic, average cargo value, change in traffic, and change in cargo value in descending order; it sorted the remaining measures in ascending order. The procedure therefore, assigned high ranks to high absolute levels of traffic, cargo value, increases in traffic, and increases in cargo value. Conversely, it gave low ranks to projects with large positive percent increases in O&M costs, high levels of O&M costs, and high values of O&M costs per traffic and cargo value. Projects with NA are ranked last when the performance measures are sorted in ascending order and first when the performance measures are sorted in descending order. Rankings were determined by conducting sorts within each performance measure. Two (2) or more projects with the same value for a given performance measure received the same ranking. The presence of duplicate values within a single performance measure for two (2) or more projects did not affect the ranks of subsequent numbers. For example, if two (2) projects had a value of 120 for a given performance measure, and received a rank of 49, then a project with a value of 121 for that measure was assigned a rank of 50. Finally, an average score-rank was calculated for each project as the mean of its ranks for all eight (8) performance measures. All active harbor projects were sorted in ascending order of the average score-rank to arrive at the final project ranking.

Table 4-10 presents the median ranks for each performance measure by type of project. The median ranks for shallow and deep draft projects confirm the data presented in Tables 4-2 through 4-5. As expected, since shallow draft projects have low average annual O&M costs, the median rank for these projects is lower (i.e., they were ranked higher) than the median rank of the deep draft projects for this performance measure. In contrast, and as expected, deep draft projects have lower median ranks for average annual traffic and average cargo value. Similarly, given the economics of scale at deep draft projects, they have lower median ranks for O&M cost/traffic and O&M cost/cargo value than do the shallow draft projects. As a result, deep draft projects have on average better overall performance than do shallow draft projects as shown by their median rank of 187 in Table 4-10.

Table 4-10 Median Rank Values for Performance Measures									
Draft	O&M Cost	Traffic	Cargo	O&M Cost/Traffic	O&M Cost/Cargo Value	Change O&M Cost	Change Traffic	Change Cargo Value	Average Score Ranking
Deep	297	163	167	127	133	230	217	224	187
Shallow	97	426	461	275	322	230	226	242	278
All	151	357	360	180	226	230	226	242	240

Appendix F1 contains an IWR-HARBORVU printout of performance measure values for all active projects. Appendices F2 and F3 contain IWR-HARBORVU printouts of ranks for each performance measure, for all active projects. Appendix F2 lists the projects alphabetically, while Appendix F3 lists them in descending order based on overall rank score.

Table 4-11 shows the 20 highest and 20 lowest sorted harbors generated by IWR-HARBORVU using all eight (8) performance measures. It confirms the better overall performance of deep draft projects shown in Table 4-10. Sixteen (16) of the top twenty (20) are deep draft projects. Appendices G1 and G2 contain the complete project rankings. No analysis can be applied to projects that have neither traffic nor O&M costs (i.e., inactive projects).

4.6 Additional Analyses

IWR-HARBORVU has the ability to perform rankings on a variety of subsets of all active projects, such as:

- Deep draft harbors
- Shallow draft harbors
- "Coast" (i.e., East, West, Gulf and Great Lakes)
- Corps Division or District

Table 4-11 Illustrative Sorting of Harbor Project Performers

TOP 20 PERFORMERS				BOTTOM 20 PERFORMERS			
RANK	DRAFT	PROJECT NAME	ST	RANK	DRAFT	PROJECT NAME	ST
1	D	Mystic River	MA	570	D	Grand Marais Harbor	MN
2	S	Bayou Lafourche And Lafourch	LA	575	S	St. Augustine Harbor	FL
3	D	Calcasieu River And Pass	LA	571	S	Folly River	SC
4	D	Port Everglades Harbor	FL	572	S	Shinnecock Inlet	NY
5	D	Oregon Slough (North Portlanc	OR	577	S	Yaquina River	OR
6	D	Ponce Harbor	PR	573	S	Willoughby Channel	VA
7	D	York River	VA	574	S	Bullocks Point Cove	RI
8	D	Miami Harbor	FL	574	S	Fox River	WI
9	D	Ketchikan Harbor	AK	576	S	Knapps Narrows	MD
10	D	Kahului Harbor, Maui	HI	578	D	Port Allen Harbor, Kauai	HI
11	D	Kodiak Harbor	AK	579	S	Fire Island Inlet	NY
12	D	Kawaihae Harbor	HI	580	S	Trinity River Channel To Libert	TX
13	S	Hammersley Inlet	WA	581	S	Depoe Bay	OR
14	D	Grays Reef Passage	MI	582	S	Perdido Pass Channel	AL
15	D	Bridgeport Harbor	CT	583	S	Pagan River	VA
16	D	Penobscot River	ME	585	S	Waterway on the Cost of Virgir	VA
17	S	East Pearl River	MS	584	S	Allegheny River, Open Channe	PA
18	S	Bayou Teche And Vermilion Ri	LA	586	S	East Pass Channel From The	FL
19	D	Weymouth Fore and Town Riv	MA	587	S	Old Harbor	AK

IWR-HARBORVU can also generate two (2) special project lists: Appendix H contains the inactive projects, defined as those that reported neither traffic nor O&M costs during the period 1985-1996. Appendix I contains a list of the No Commerce Reported (NCR) projects during the same period of analysis. An NCR project is one that did not report any traffic during the period 1985-1994, but incurred O&M costs.

Tables 4-12 and 4-13 list the top ten (10) and bottom ten (10) scoring projects sorted by deep draft and shallow draft. Table 4-14 lists the top five (5) scoring projects sorted by "coast". Since Tables 4-12, 4-13, and 4-14 used smaller subsets of the active projects, the top and bottom ranked projects shown in each of them will necessarily be different than the top and bottom ranked projects appearing in Table 4-11. However, the same four (4) top-ranked deep draft East Coast projects appearing in Table 4-11 (e.g., Mystic River Port Everglades, Ponce Harbor and York River) should also be the first four (4) deep draft projects appearing in the East Coast portion of Table 4-14. A glance at Table 4-14 shows this to be so.

All rankings presented in this analysis assumed equal weights for all performance measures. The IWR-HARBORVU software allows users to apply different weights to the various performance measures. The importance weight of one or selected performance measures could be increased when the underlying issues are known to be important for a particular policy decision.

IWRHARBOR-VU also allows the user to select a subset of the eight (8) performance measures to evaluate projects for specific issues. For example, if a user wishes to evaluate the economic efficiency of O&M expenditures, he or she could select only measure #1 – annual O&M costs and measure #4 – annual O&M costs per cargo value. The program also allows users to select projects based on channel depth (e.g., all projects, shallow draft, or deep draft) and geography (e.g., East or West Coast, Great Lakes, Mississippi Valley/Gulf Coast, by Corps District). Because of this built-in flexibility, users can both select a set of performance measures to address a specific issue, and then apply them to a particular geographic area. Continuing with the example above, a user could evaluate the economic efficiency of only deep draft projects located on the East Coast.

Presented below are examples of different scenarios that a user may wish to analyze using IWRHARBORVU and the performance measures that should be applied.

- Comprehensive Scenario: All active projects and all eight (8) performance measures.
- Geographic Scenario: East Coast projects for the eight (8) performance measures. This scenario could also be applied to West Coast, Great Lakes, or Mississippi Valley/Gulf coast projects.
- Draft Scenario: Only deep draft projects for the eight (8) performance measures. This scenario could also be limited to a specific unit of geography.
- Economic Efficiency: measure #3 – annual cargo value and measure #5 – annual O&M costs per cargo value. Measure #4 – annual O&M cost per ton of cargo could also be used in place of measure #5 as they measure related aspects of economic efficiency.
- Amount of Activity: measure #2 – annual traffic or measure #3 – annual cargo value.
- Cost Minimization: measure #1 – annual O&M costs and measure #4 – annual O&M costs per ton. This scenario could be applied to only deep draft projects, shallow draft projects, or even to deep draft projects located on the East or West Coasts.
- Growth: measure #7 – percent change in annual traffic or measure #8 – percent change in annual cargo value.
- Economic Efficiency and Growth: measure #3 – annual cargo value; measure #5 – annual O&M costs per cargo value; and measure #8 – percent change in annual cargo value. These performance measures could also be applied only to deep draft projects, shallow draft projects, or even deep draft projects located on the East or West Coasts.

In designing a scenario, the user must select the performance measures that most directly evaluate the issues of concern. Possible scenarios that could be analyzed include: amount of annual activity (tons or value); economic efficiency; high or low growth; level of real O&M expenditures, etc. The user should be careful not to use two (2) performance measures that evaluate similar aspects of the same underlying issue. For example, performance measures #7 and #8 both measure change in activity, but address related aspects: the tons of cargo handled and the value of that cargo. If a user wants to identify projects showing high growth in the amount of cargo handled, then only measure #7 should be used, and vice versa. Similarly, measures #2 and #3 each evaluate related aspects of annual activity (i.e., tonnage and value) at a project.

Users must also be careful about using two (2) performance measures where high values for one measure receive a high rank, and low values for the other measure receive a low rank. For example, using only measure #1- annual O&M costs where lower values are preferred, and either measure #2 or #3 (tonnage or cargo value), where high values are preferred, could produce ambiguous results as the ranks for the two (2) measures for a single project could cancel each other out. The canceling effect is minimized by using all eight (8) measures. In contrast, measure #1 and either measure #4 or #5 (unit O&M costs) could be used together as lower values are preferred for these measures. Using these two measures together would select projects that have both low annual total O&M costs and low unit O&M costs (i.e., high economic efficiency).

Table 4-11 Illustrative Sorting of Harbor Project Performers

TOP 20 PERFORMERS				BOTTOM 20 PERFORMERS			
RANK	DRAFT	PROJECT NAME	ST	RANK	DRAFT	PROJECT NAME	ST
1	D	Mystic River	MA	570	D	Grand Marais Harbor	MN
2	S	Bayou Lafourche And Lafourcl	LA	575	S	St. Augustine Harbor	FL
3	D	Calcasieu River And Pass	LA	571	S	Folly River	SC
4	D	Port Everglades Harbor	FL	572	S	Shinnecock Inlet	NY
5	D	Oregon Slough (North Portlanc	OR	577	S	Yaquina River	OR
6	D	Ponce Harbor	PR	573	S	Willoughby Channel	VA
7	D	York River	VA	574	S	Bullocks Point Cove	RI
8	D	Miami Harbor	FL	574	S	Fox River	WI
9	D	Ketchikan Harbor	AK	576	S	Knapps Narrows	MD
10	D	Kahului Harbor, Maui	HI	578	D	Port Allen Harbor, Kauai	HI
11	D	Kodiak Harbor	AK	579	S	Fire Island Inlet	NY
12	D	Kawaihae Harbor	HI	580	S	Trinity River Channel To Libert	TX
13	S	Hammersley Inlet	WA	581	S	Depoe Bay	OR
14	D	Grays Reef Passage	MI	582	S	Perdido Pass Channel	AL
15	D	Bridgeport Harbor	CT	583	S	Pagan River	VA
16	D	Penobscot River	ME	585	S	Waterway on the Cost of Virgir	VA
17	S	East Pearl River	MS	584	S	Allegheny River, Open Channe	PA
18	S	Bayou Teche And Vermilion Ri	LA	586	S	East Pass Channel From The	FL
19	D	Weymouth Fore and Town Riv	MA	587	S	Old Harbor	AK

Table 4-12 Illustrative Results of Deep Draft Project Performances

TOP TEN HARBOR PERFORMANCES				BOTTOM TEN HARBOR PERFORMANCES			
RANK	DRAFT	PROJECT NAME	ST	RANK	DRAFT	PROJECT NAME	ST
1	D	Mystic River	MA	525	D	Grand Marais Harbor (Harbor (	MI
3	D	Calcasieu River And Pass	LA	525	D	Great Sodus Bay Harbor	NY
4	D	Port Everglades Harbor	FL	532	D	Manistique Harbor	MI
5	D	Oregon Slough (North Portlan	OR	533	D	White Lake Harbor	MI
6	D	Ponce Harbor	PR	548	D	Hudson River, NY Citiy to Wat	NY
7	D	York River	VA	558	D	Chicago Harbor	IL
8	D	Miami Harbor	FL	558	D	Siuslaw River	OR
9	D	Ketchikan Harbor	AK	559	D	Michigan City Harbor	IN
10	D	Kahului Harbor, Maui	HI	570	D	Grand Marais Harbor	MN
11	D	Kodiak Harbor	AK	578	D	Port Allen Harbor, Kauai	HI

Table 4-13 Illustrative Results of Shallow Draft Project Performances

TOP TEN HARBOR PERFORMANCES				BOTTOM TEN HARBOR PERFORMANCES			
RANK	DRAFT	PROJECT NAME	ST	RANK	DRAFT	PROJECT NAME	ST
2	S	Bayou Lafourche And Lafourc	LA	579	S	Fire Island Inlet	NY
13	S	Hammersley Inlet	WA	580	S	Trinity River Channel To Libert	TX
17	S	East Pearl River	MS	581	S	Depoe Bay	OR
18	S	Bayou Teche And Vermilion F	LA	582	S	Perdido Pass Channel	AL
22	S	Bayou Bonfouca	LA	583	S	Pagan River	VA
28	S	Kelleys Island	OH	584	S	Allegheny River, Open Channe	PA
29	S	Rappahannock River	VA	585	S	Waterway on the Cost of Virgir	VA
32	S	Petit Anse, Tigre and Carlin B	LA	586	S	East Pass Channel From The	FL
34	S	Bayou Terrebonne	LA	587	S	Old Harbor	AK
35	S	St. Johns River Jacksonville to	FL	588	S	Savannah River Below August	GA

Table 4-14 Illustrative Results of Regional Coastal Project Sorting

Coast	RANK	WTWY	PWI	DRAFT	DIV	DIST	PROJECT NA	ST	AVG SCORE
East Coast	1	153	431	D	NAD	NAE	Mystic Rive	MA	51.38
	2	2163	76031	D	SAD	SAJ	Port Evergl	FL	58.88
	3	2151	75007	D	SAD	SAJ	Ponce Hart	PR	70.63
	4	648	73803	D	NAD	NAO	York River	VA	72.63
	5	2164	10140	D	SAD	SAJ	Miami Harb	FL	78.63
Great Lakes	1	3802	74160	D	LRD	LRE	Grays Reef	MI	91
	2	3210	11111	S	LRD	LRB	Kelleys Isla	OH	106.63
	3	3222	5060	D	LRD	LRB	Dunkirk Ha	NY	108.88
	4	3401	2940	D	LRD	LRE	Channels Ir	MI	113
	5	3008	13130	D	LRD	LRB	Ogdensbur	NY	119.88
Gulf Coast	1	2070	2310	S	MVD	MVN	Bayou Lafo	LA	56.75
	2	2254	9	D	MVD	MVN	Calcasieu F	LA	57.63
	3	2209	5200	S	MVD	MVN	East Pearl I	MS	94.5
	4	2064	1160	S	MVD	MVN	Bayou Tecl	LA	96.25
	5	2230	155	S	MVD	MVN	Bayou Bont	LA	100.13
West Coast	1	4634	66005	D	NWD	NWP	Oregon Slo	OR	67
	2	4800	72798	D	POD	POA	Ketchikan I	AK	83.63
	3	4410	8660	D	POD	POH	Kahului Ha	HI	84.13
	4	4934	72753	D	POD	POA	Kodiak Har	AK	89.5
	5	4405	990	D	POD	POH	Kawaihae I	HI	90.5

5.0 SUMMARY

The objective of this Phase II report was to develop a tool that could help the Corps of Engineers determine the efficiency of its navigation O&M program. Several national cargo traffic and commodity databases were acquired to estimate for each Corps harbor project the average annual tonnage and average annual value (in both real and nominal terms) of all import, export and domestic cargo handled by the harbor. Corps data on historical navigation O&M costs were obtained for each project. The resultant data set was used to derive for each harbor a value for each performance measure. Based on an evaluation of the six (6) performance measures applied in Phase I, a revised list of eight (8) performance measures was developed for use in Phase II. The eight (8) revised performance measures calculated over the analysis period a project's average annual O&M cost, traffic, and cargo value; estimated the changes in average annual real O&M costs, traffic, and cargo value; and also cost per ton of cargo and cargo value. The eight (8) performance measures are presented in Table 4-7.

All eight (8) performance measures were calculated for 720 active projects. An ordinal □ranking□ was determined for each project for each performance measure. Projects having the same value for a given performance measure all received the same ordinal rank. The eight (8) ranks were averaged for each project to obtain an overall "rank average" for that project, and all the projects were then sorted on their □rank averages□.

The system of performance measures and their underlying data are subject to several limitations. Projects reporting no commerce <u>may</u> provide outputs which are relevant to the Corps' definition of the national interest but are not now measured. Many harbors serve recreational boating, sport fishing, commercial fishing, serve as refuge from storms, and other uses which attract people to water. Many of these projects may have handled commercial traffic at some point, and probably the authorizing reports projected some waterborne commerce. Projected recreational boating and sport fishing benefits are frequently used in the partial economic justification of many harbors, and have been found to be a legitimate Federal interest by the Corps, based on the 1945 Water Resources Development Act.

The degree to which waterborne commerce (shipments of commodities and people) is a necessary criterion for continued funding of O&M in the Federal interest is at issue. There is a long history of policy decisions based on the balance of recreational benefits versus other water resources benefits of Corps projects in determining the Federal interest. A long-standing policy has been that recreation benefits should not exceed 50 percent of total benefits. The policy for funding a continued Federal interest in harbors that produce no commercial traffic should be reviewed and revised, if necessary.

No matter how the policy is revised, there will be a compelling need to obtain specific data on the recreational and sport fishing outputs from Corps harbors and improved data on commercial fishing. Perhaps, with continued pressure to reduce Federal outlays, there is a sufficient reason to require ports to collect and report the data to the Corps. It would be reasonable to use some Corps resources to develop a partnership with the port industry to develop the criteria for measurement and procedures for recording and reporting to the Corps. If pressure to further reduce O&M funds continues, it must be remembered that more than $50 million is currently spent on harbors that report no traffic. It is certain that the need for continued Federal outlays for these projects will be challenged.

A more important challenge will come from the need to manage navigation O&M costs for the larger, more expensive harbor projects. The need for additional expenditures to support navigation will rise as the cost of dredged material disposal increases. Thus, Corps managers will face the continuation of pressure for higher outlays while, at the same time, facing pressure to reduce outlays. This analysis questions the need to further deepen scores of ports in the race to insure interport competitive equity. The work of the Cost Reduction Task Force in using available vessel draft/channel depth utilization represents a primary step forward, even if the final criteria adopted seems overly cautious. Channel depth should be highly utilized or Corps O&M outlays should be reduced. As an example, the ten (10) most expensive harbors required an average of over $141.0 (constant 1992 dollars) million to maintain navigation during the period 1985 to 1996. Maintenance costs decreased an average of $0.334 million each year (-0.3 percent) over this period. Although traffic at these harbors averaged over 963 million tons during this period, annual traffic growth averaged only 8.5 million tons (less than 1.3percent) per year. Several of the projects actually showed significant declines in traffic over the period.

In Section 2.1 Evaluation Framework, we argue that marginal cost, marginal benefit analysis will be necessary to manage O&M costs. Under a budget constraint, net benefit maximization should be rigorously sought, then the costs reduced further to account for the budget constraint. Net benefit maximization without a budget constraint is not the same criterion with a budget constraint. Steps in this direction will have to be taken.

Other improvements in the data collected on costs and traffic deserve early consideration. There are several groups of navigation channels with separate project authorization and cost accounting which serve more than one (1) port or project. For example, several different channels serve the various port areas in the New York and New Jersey port complex. The entrance channel to the Galveston Harbor project serves traffic which moves to Texas City, the Houston Ship Channel, and other ports in Galveston Bay. A similar condition exists in the San Francisco area and the Columbia River area. The Corps should develop a systematic cost accounting process which tracks O&M costs by channel segments (smaller than the authorized project) and a process to identify costs which are part of one (1) authorized project but serve other projects. Such a system would facilitate division of costs among various projects. Traffic data would have to be maintained in a way that allows it to be aggregated or disaggregated. Entrance channel maintenance costs should be distributed among all projects served. The first step in performance measurement should be an evaluation strategy which rolls up all of the costs and traffic from several projects in a port complex. Each individual port could then be evaluated on its share of overall costs and traffic.

Based on the preceding discussion and analyses, it is recommended that the follow-up tasks listed below be pursued:

- Continue the basic structure of the database as an analytical tool begun here. The software to update the data supplied with this report will reduce the time and cost of updates.

- Consider adding the data on percent and number of transits utilizing 80 percent of channel depth/clearance or more, initiated by the Cost Reduction Task Force.

- Conduct the necessary policy determination/studies to determine the Federal interest in harbor projects reporting no commerce.

- Proceed as quickly as possible to strengthen the process by which WCSC data is retrieved electronically, linking project CWIS (i.e., PWI) codes with WCSC waterway link codes so that project level data can be assembled more rapidly and accurately in the future.

- Develop strategy/policy to obtain the necessary data/information from the ports reporting no commerce, which characterizes the utilization and impacts of each harbor channel to enable the necessary determination of Federal continuation of maintenance. The primary burden for reporting should be on the ports desiring consideration.

- Begin a systematic analysis of the economic feasibility of continued maintenance of harbor channels with low performance characteristics. An "acid test" strategy using current data on traffic and cost utilization should focus on the question "Does the channel provide enough transportation cost savings to pay for continued levels of maintenance service?".

- Begin a systematic effort to partition project costs by channel segment and other parameters to enable reasonable approximations of incremental costs and benefits. This should drive towards a determination of priority O&M outlays on an incremental basis for each project. The process should add capability to the Corps' O&M managers to control costs and increase the returns to limited budgets.

- Develop a strategy to help those ports which are at the margin of budget priorities to identify potential local revenue sources which can increase privatization of O&M costs.

- Develop a periodic report of the performance of Corps Harbor Projects similar in content to the Inland Waterway Review. This document could increase the quality of discourse between the Corps and the port industry and clarify the issues of responsible stewardship of the Corps' harbor program.

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13. ABSTRACT (Maximum 200 words)

The goal of this study is to develop a rational, performance-based analytical instrument that can be used by decision-makers to evaluate, compare, and update the value of several hundred projects maintained by the Corps. Eight performance measures were identified. A performance measure is a criterion that uses one or more harbor project activity data elements (e.g. O&M cost per ton of cargo) to measure the performance of a single project relative to that of all other harbor projects. The eight performance measures were applied to 720 active harbor projects, which represented all those projects that either incurred O&M cost and/or reported traffic during 1985-1996. The projects were then sorted and ranked for each performance measure. Next, the average overall rank of each individual project across all eight performance measures was calculated. Finally, the 720 projects were resorted based on their average overall ranks, resulting in a final ranking. It must be emphasized that the intent of this ranking is not to determine which projects are poor or good performers. Instead, the procedures presented are intended to be used as a tool to determine which projects should be investigated further with regard to continuing expenditures of navigation O&M funds. The structure of this evaluation program is flexible enough to accommodate various scenarios. This report consists of three volumes: Volume I - Technical Report; Volume II - Appendices; Volume III - User's Manual, IWR-HARBORVU Version 1.1.

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