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Project Summary

Standardized Costs for Water Supply Distribution Systems

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Under the Safe Drinking Water Act (Public Law 93-523), the U.S. Environmental Protection Agency is responsible for collecting and making available information pertaining to the demonstration, construction, and application of acceptable water supply practice. Research, development, and demonstration activities are essential to the upgrading of existing water supply systems, planning and design of new systems, and prediction of system performance and cost. A primary feature of the Safe Drinking Water Act is that economics must be considered before Federal regulations are promulgated. The cost impact of regulations on large water utilities should be minor, but there may be potentially serious cost effects on small water utilities due to the high unit costs generally associated with small systems. The cost of distributing water to the final user after it has been treated is of growing concern as well as its quality. There are a significant number of distribution systems in the United States that are aging and/or deteriorating, which results in a potential threat to the future quality of drinking water. It would be quite useful to have a mechanism for examining the economics of various alternative solutions for handling problems affecting water quality within the distribution system. A cost data base and associated computer programs have been developed to aid the design engineer in this type of analysis.

This Project Summary was developed by EPA's Risk Reduction Engineering Laboratory, Cincinnati, OH, to announce key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering information at back).

Introduction

In support of the Safe Drinking Water Act, the U.S. Environmental Protection Agency (EPA) provides cost estimating information to the water utility field relative to construction and operation/maintenance of all aspects of drinking water acquisition, treatment, and distribution. The evaluation of cost is important to the EPA decision-making process when formulating new regulations and to water utilities as they implement these regulations. In prior research work, EPA has placed a great deal of emphasis on treatment techniques and treatment costs because those areas were of immediate concern to utilities in meeting the Interim Primary Drinking Water Regulations. A recent research effort focused on another area of importance: the costs of constructing, expanding, maintaining, and rehabilitating water supply distribution systems with associated pumping and storage facilities. Expenses related to distribution system problems often account for a large percentage of total water utility expenses.

This project was aimed at providing a cost data base to assist utilities in making decisions relating to replacement or rehabilitation of existing distribution systems. An associated computer program was also developed for accessing the data base in order to provide quick and easy cost esti-

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mates as well as displaying the computer output in a format that provides for an easy analysis of the results. The principal objectives of the project were to develop cost information for expansion and/or rehabilitation of existing facilities, to evaluate the potential impact of inadequate distribution facilities on treated water quality, and to provide a computer program to allow users to easily estimate costs for construction, operation, and rehabilitation of water distribution systems.

Sources of Cost Information

Various large utilities have extensive backgrounds in rehabilitation, repair, and replacement of existing facilities. A number of these utilities supplied this type of cost data from their files. The cost data base also includes information gathered from the literature. Frequent articles are published in the trade journals discussing the costs associated with new construction and rehabilitation of existing utilities. Other publications deal with construction bids received. Useful information was collected from the files of engineering firms, equipment manufacturers, state agencies, and construction contractors. Past EPA research project data also contributed to the effort. Hypothetical cost estimates based on engineering designs were used extensively. In order to verify the accuracy of the final cost data base, several examples were evaluated comparing actual costs to estimated. A procedure has been included so that cost estimates can be updated to reflect the influence of inflation. All cost data is presented in both tabular and graphical form in the final project report, and a user's guide for the computer program is also part of the report. Each construction cost curve is supplemented with design drawings and details. Operation/maintenance costs relate to the requirements of individual pieces of equipment. The cost data base that has resulted from this research project is accurate enough for preliminary planning purposes and flexible enough for cost-effectiveness studies.

Outline of Cost Information

The following is an outline of the specific cost information that is presented in graphical and tabular form and can be used by the design engineer to estimate the costs associated with water distribution systems:

I. Pipelines
  A. New pipelines, installed (pipe diameter vs. cost/ft)
    1. Base cost for mechanical only (purchase and lay pipe)
    2. Type of Material
      a. Ductile iron pipe
      b. Steel pipe
      c. Asbestos cement pipe
      d. Concrete cylinder pipe
      e. Thermoplastic pipe
    3. Class of pipe
  B. New pipelines, additive items
    1. Valves, fittings, hydrants (pipe diameter vs. cost/ft)
      a. Frequency
        i. Low
        ii. Average
        iii. High
    2. Trenching and excavation (pipe diameter vs. cost/ft)
      a. Depth range
        i. 3 to 6 ft
        ii. 6 to 8 ft
        iii. 8 to 10 ft
      b. Type of soil
        i. Sandy
        ii. Clay
        iii. Rocky
    3. Dewatering (pipe diameter vs. cost/ft)
      a. Conditions
        i. Moderate
        ii. Severe
    4. Sheet piling (pipe diameter vs. cost/ft)
    5. Boring or tunneling (pipe diameter vs. cost/ft)
    6. Bedding (pipe diameter vs. cost/ft)
      a. Classes of bedding
        i. Class A - arch encasement
        ii. Class B - first class bedding
        iii. Class C - ordinary bedding
    7. Backfill (pipe diameter vs. cost/ft)
      a. Compaction percentage
        i. 85%
        ii. 95%
      b. Type of material
        i. Native soil
        ii. Imported material
    8. Utility interferences (pipe diameter vs. cost/ft)
      a. Frequency
        i. Minimal
        ii. Moderate
        iii. Severe
    9. Pavement replacement (pipe diameter vs. cost/ft)
      a. Type of material
        i. Concrete
        ii. Asphalt
    10. Traffic control (pipe diameter vs. cost/ft)
      a. Conditions
        i. Moderate
        ii. Heavy
    11. Project length
      a. Multiplier for project size
        i. Small
        ii. Average
        iii. Large
    12. Household connection
      a. Cost for water meter and connecting pipeline
        i. Inner city
        ii. Suburban
        iii. Rural
  C. Existing pipelines, rehabilitation
    1. Cleaning (cost/ft cleaned)
    2. Install new cement mortar lining (pipe diameter vs. cost/ft)
    3. Install plastic liner (pipe diameter vs. cost/ft)
  D. Existing pipeline, preventative maintenance
    1. Valves (annual cost per valve)
    2. Fire hydrants (annual cost per hydrant)
    3. Corrosion inhibitors
      a. Component (chemical feed rate vs. cost component)
        i. Construction of facilities
        ii. Labor
        iii. Power
        iv. Materials
        v. Chemical costs
      b. Chemicals
        i. Polyphosphates
        ii. Sodium hydroxide
    4. Flushing (cost/ft flushed)

II. Pump stations
  A. New pump stations, construction
    1. *Vertical turbine pumps (peak* flow vs. construction cost)
      a. Base cost for mechanical only (install pumps, piping)
      b. Pumping head
        i. Low
        ii. Medium
        iii. High
    2. Horizontal centrifugal pumps (peak flow vs. construction cost)
      a. Base cost for mechanical only (install pumps, piping)
      b. Pumping head
        i. Low
        ii. Medium
        iii. High
  B. New pump stations, additive items
    1. Wet well (volume vs. construction cost)
    2. Structure (area vs. construction cost)
      a. Type
        i. Average
        ii. Complex
    3. Sitework (area vs. construction cost)

a. Type
   i. Average
   ii. Extensive
4. Electrical/Instrumentation (peak flow vs. construction cost)
   a. Type
      i. Average
      ii. Complex
5. Standby Power (horsepower vs. construction cost)

C. Package pump stations, construction (peak flow vs. construction cost)
   1. Base cost for mechanical only (install pumps, piping)
   2. Pumping head
      a. Low
      b. Medium
      c. High

D. Expansion of existing pump stations, construction
   1. Vertical turbine pumps (peak flow vs. construction cost)
      a. Base cost for mechanical only (install pumps, piping)
      b. Pumping head
         i. Low
         ii. Medium
         iii. High
   2. Horizontal centrifugal pumps (peak flow vs. construction cost)
      a. Base cost for mechanical only (install pumps, piping)
      b. Pumping head
         i. Low
         ii. Medium
         iii. High

E. Expansion of existing pump station, additive items
   1. Wet well (additional volume vs. construction cost)
   2. Structure (additional area vs. construction cost)
      a. Type
         i. Average
         ii. Complex
   3. Sitework (additional area vs. construction cost)
   4. Electrical/Instrumentation (peak flow vs. construction cost)
      a. Type
         i. Average
         ii. Complex

F. Existing pump stations, operation and maintenance
   1. Labor (peak flow vs. manhours/yr)
   2. Power (average flow vs. kilowatt-hours/yr)
      a. Pumping head
         i. Low
         ii. Medium
         iii. High
   3. Natural Gas (average flow vs. therms/yr)
      a. Pumping head
         i. Low
         ii. Medium
         iii. High
   4. Material (average flow vs. annual cost)

III. Storage Reservoirs

A. New tanks, construction
   1. Steel
      a. Elevated (volume vs. construction cost)
      b. Ground level (volume vs. construction cost)
      c. Below ground (volume vs. construction cost)

B. New tanks, additive items
   1. Cathodic protection (volume vs. construction cost)
   2. Architectural treatment (volume vs. construction cost)
      a. Type
         i. Moderate
         ii. Extensive
   3. Sitework
      a. Ground level (area vs. construction cost)
         i. Average
         ii. Extensive
      b. Below ground (area vs. construction cost)
         i. Average
         ii. Extensive

C. Existing tanks, preventative maintenance
   1. Protective coating addition or renewal
      a. Labor (surface area vs. manhours/yr)
      b. Materials (surface area vs. annual cost)
   2. Cathodic protection addition or renewal
      a. Labor (volume vs. manhours/yr)
      b. Power (volume vs. kilowatt-hours/yr)
      c. Materials (volume vs. annual cost)
   3. Lining addition or renewal
      a. Labor (interior area vs. manhours/yr)
      b. Materials (interior area vs. annual cost)

Summary of Results

Many drinking water distribution systems in the United States, both large and small, are on the verge of disintegrating because of age and/or other physical factors that influence the useful life of the system. When it comes time to pay for the replacement or rehabilitation of these older systems, the effects of inflation on cost will be considerable and possibly prohibitive. This has not been a major problem in the past since most systems have held up well enough for a long time. Now a frequent decision that utilities must face is to determine if it is more economical to replace or repair a problem area within the distribution network. If the problem area is not corrected, water quality will deteriorate; if corrected, the cost of water supply will increase. Proposed and future federal regulations may require increased performance demands in addition to merely maintaining the present level of water service and quality provided by the utilities. Bringing all of the necessary cost information together, in order to establish a systematic method of cost estimating, represents a significant step toward a standardized approach of economically evaluating those alternatives available to water utilities for correcting problems within their distribution systems. The availability of a computer program for easy access to the cost data base provides the user with a large amount of cost information for decision making with a minimal amount of engineering effort and expense.

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The complete report consists of paper copy and diskette, entitled "Standardized Costs for Water Supply Distribution Systems:"

Paper Copy (Order No. PB92-141290/AS; Cost: $17.00, subject to change)
Diskette (Order No. PB92-501436/AS; Cost: $90.00, subject to change)
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The above items will be available only from:

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