City of San José

San José/Santa Clara Water Pollution
Control Plant Master Plan

TASK NO. 6
PROJECT MEMORANDUM NO. 2
BASIS OF COST EVALUATION

FINAL DRAFT
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CITY OF SAN JOSÉ

SAN JOSÉ/SANTA CLARA WATER POLLUTION CONTROL PLANT MASTER PLAN

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BASIS OF COST EVALUATION

1.0 INTRODUCTION

Cost estimates are often prepared at various stages during project planning and design. The cost estimate is one of the most sensitive products prepared for a project. The level of accuracy that can be expected is directly proportional to the level of engineering effort completed. Each cost estimate must be carefully prepared from the conceptual level to the facilities plan level, through the preliminary design and the final engineer's estimate.

This project memorandum (PM) provides procedures and guidelines for estimating capital and operation and maintenance (O&M) costs for the San José/Santa Clara Water Pollution Control Plant Master Plan (Master Plan). These capital and O&M costs are the basis for developing both total annual and present worth (life cycle) costs.

2.0 SCOPE AND LEVEL OF ACCURACY

The Association for the Advancement of Cost Engineering International (AACE International, formally known as the American Association of Cost Engineers) has suggested levels of accuracy for five estimate classes. These five estimate classes are presented in the AACE International Recommended Practice No. 18R-97.

Table 1 presents a summary of these five estimate classes and their characteristics, including expected accuracy ranges.

The quantity and quality of the information required to prepare an estimate depends on the end use for that estimate. Typically, as a project progresses from the conceptual phase to the study phase, preliminary design and final design, the quantity and quality of information increases, thereby providing data for development of a progressively more accurate cost estimate. A contingency is often used to compensate for lack of detailed engineering data, oversights, anticipated changes and imperfection in the estimating methods used. As the quantity and quality of data becomes better, smaller contingency allowances are typically utilized. For the projects developed as a part of the Master Plan, cost estimates are developed following the AACE International Recommended Practice No. 18R-97 estimate classes 5 and 4.

Class 5 estimates are prepared for any number of strategic business planning purposes, including, but not limited to, project screening, evaluation of resource needs and budgeting, and long-range capital planning. Very limited information is available at the time when a Class 5 estimate is developed. Therefore, Class 5 estimates virtually always use stochastic estimating methods such as cost to capacity curves and various scaling factors. Subsequently, estimated costs have wide accuracy ranges. Typical accuracy ranges for

Table 1 Category of Cost Estimates[1]
San José/Santa Clara Water Pollution Control Plant Master Plan
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Estimate Class	Primary Characteristic	Secondary Characteristic			
	Level of Project Definition Expressed as % of complete definition	End Usage	Methodology Typical Estimating Method	Expected Accuracy Range Typical variation in Low and High Ranges[a]	Preparation Effort Typical degree of Effort Relative to Least Cost Index of 1[b]
Class 5	0% to 2%	Concept Screening	Capacity Factored, Parametric Models, Judgment, or Analogy	L: -20% to -50% H: +30% - +100%	1
Class 4	1% to 15%	Study or Feasibility	Equipment Factored or parametric Models	L: - 15% to -30% H: +20% - +50%	2 to 4
Class 3	10% to 40%	Budget, Authorization, or Control	Semi-Detailed Unit Costs with Assembly Level Line Items	L: - 10% to -20% H: +10% - +30%	3 to 10
Class 2	30% to 70%	Control or Bid/ Tender	Detailed Unit Cost with Forced Detailed Take-Off	L: - 5% to -15% H: +5% - +20%	4 to 20
Class 1	50% to 100%	Check Estimate or Bid/Tender	Detailed Unit Cost with Detailed Take-Off	L: - 3% to -10% H: +3% - +15%	5 to 100

Notes:

(1) Table 1.1 comes from the AACE International Recommended Practices and Standards, No. 18R-97

(a) The state of process technology and availability of applicable reference cost data affect the range markedly. The +/- value represents typical percentage variation of actual costs from the cost estimate after application of contingency (typically at a 50% level of confidence) for a given scope.

(b) If the range index value of "1" represents 0.005% of project costs, then an index value of 100 represents 0.5%. Estimate preparation effort is highly dependent upon the size of the project and the quality of estimating data and tools.

Class 5 estimates are –20 percent to –50 percent on the low side, and +30 percent to +100 percent on the high side, depending on the technological complexity of the project, availability and accuracy of appropriate reference information, and the inclusion of an appropriate contingency determination. Capital costs for the Master Plan improvements that are not needed within 5 to 7 years are prepared based on Class 5 estimates.

Class 4 estimates are prepared for any number of strategic business planning purposes including, but not limited to, detailed strategic planning, confirmation of economic and/or technical feasibility, and preliminary budget approval or approval to proceed to next stage.

Limited information is available at the time when a Class 4 estimate is developed. Therefore, Class 4 estimates virtually always use stochastic estimating methods such as parametric or other modeling techniques, and various factors. Subsequently, estimated costs have fairly wide accuracy ranges. Typical accuracy ranges for Class 4 estimates are –15 percent to –30 percent on the low side, and +20 percent to +50 percent on the high side, depending on the technological complexity of the project, availability and accuracy of appropriate reference information, and the inclusion of an appropriate contingency determination. Capital costs for the Master Plan improvements that are needed within 5 to 7 years are prepared based on Class 4 estimates.

3.0 BASIS OF COST EVALUATIONS

The costs presented in the Master Plan are based on preliminary layouts, preliminary unit process sizes, and conceptual alternative configurations. Construction costs are estimated from unit costs developed from past San José construction contracts, estimating guides, preliminary quantity takeoffs, unit prices, and construction costs of similar facilities and configurations at other locations.

Where cost information for similarly sized and configured facilities is not available, and where cost curves are available, the cost curve approach will be utilized. The cost curve approach is the use of historical project cost data to estimate planning level costs for capital improvement projects. In this approach, historical project cost data are used to develop plots of total cost versus process capacity, or “cost curves”, for a given unit process. In the development of the cost curves, the project locations and dates of costs are accounted for with the application of “location factors” (R.S. Means Location Factors), and ENR values (Engineering and News Records). The location factors are based upon the R.S. Means national average construction costs. City-to-City location adjustment factors may be accurately derived by dividing the published factor for one location by the factor for another. By accounting for location factors and ENR values, the cost curves are plots of “locationless” costs and in today’s dollars. Given a known required capacity for a capital improvement project, the estimated cost is extrapolated from the cost curve.

The project cost data behind the cost curves were partitioned from final project costs and contractors’ schedules of values. The cost curves were plotted based upon the fractionated costs and the unit process sizing criteria. Project costs of smaller capacity jobs were not considered in the cost curves because these data tend to skew cost curves due to the “economies of scale” relationship. However, smaller project costs are archived so that they are available for reference should the need arise to develop costs of small projects. The cost curves include cost data of projects completed later than 1986. Project costs prior to 1986 do not provide reliable, predictive costs due to code and design approach differences.

O&M costs are based on historical operating costs, estimated manpower needs, resource requirements, and equipment replacement and maintenance needs.

A summary of the economic criteria to be used for estimating costs is presented in Table 2.

Table 2 Economic Criteria
San José/Santa Clara Water Pollution Control Plant Master Plan
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Item	Assumption
Costs in Time and Place	Base estimate costs are based on August 2009 costs in San José, California.
Estimating Contingency(1)	Total of 15 percent
Escalation in Cost	The cost escalation is 3% per annum.
Construction Contingency(2)	Total of 25 percent, which includes the following: • Contractor's overhead and profit • Construction costs associated with unknown conditions • Construction change orders • Compensation for estimation oversights and slight changes to the project
Project Cost Factor(3)	Total of 30 percent, which includes the following: • Engineering design fees • Construction management fees • Project management costs • Program management costs • Other legal and administrative costs and fees
Real Interest Rate(4)	2 percent for amortization purposes
Amortization Period	30 years

Notes:
(1) Per Carollo Cost Curves Manual, Estimating Contingency of 15-25% is advised. 15% is assumed.
(2) Per Carollo Cost Curves Manual, Construction Contingency of 15-25% is advised. 25% is assumed.
(3) Per Carollo Cost Curves Manual, engineering, legal, and administrative costs are assumed to range between 16-46%. 30% is assumed.
(4) Inflation is estimated at 1-3%; assume 3%. The typical capital borrowing rate is 3-5%; assume 5% on the bond market. Therefore, for amortization calculations, assume the real interest rate is 2% (the difference between 5% and 3%).

3.1 Capital Costs

Capital costs for the Master Plan improvements are based on Class 5 and Class 4 estimates.

While the estimated construction costs represent the average bidding conditions for many projects, variations in bidding climate at the time the facilities are constructed can affect actual construction costs. Further, the size of the facilities may be refined during preliminary design based on the most current operational information available. For these reasons, the

actual construction costs may be lower or higher than originally estimated. Thus, an estimating contingency of 15 percent will be added to account for the above uncertainties. As mentioned earlier, Class 4 and Class 5 estimates are not as accurate as estimates prepared in conjunction with preliminary or final design.

Construction costs have historically escalated with time. This trend is expected to continue in the future. To record these trends in rising costs, several indices have been established for various fields of construction. The standard indicator of changes in heavy construction prices is the ENR Construction Cost Index (ENRCCI). Where construction costs are developed from construction projects in previous years and/or different locations, the base estimate costs for the Master Plan improvements will be adjusted to 2009 costs for San José, California, using the 20-Cities average ENRCCI of 8564 and a location factor.

As the financial analysis is developed, the estimated costs will be escalated to the projected time of construction. The estimated escalation rate is 3 percent based per annum. This escalation rate, inflated to the mid-point of construction, will be used to adjust capital cost estimates for the financial analysis. The construction cost will then be adjusted to include a 25 percent construction contingency.

Finally, costs to the owner, such as engineering, legal, administrative, project contingencies, and construction management costs, are added to the construction costs to arrive at total project costs.

An example illustrating the process for estimating capital costs is summarized in Table 3.

3.2 O&M Costs

O&M unit costs are presented in Table 4. The unit costs presented will be used in developing O&M costs for each alternative.

3.3 Total Annual Costs

When project alternatives are analyzed for cost-effectiveness, it is necessary to compare both capital and O&M costs. Alternatives are then compared on a combined total annual cost basis. Capital costs are amortized over a 30-year period using an interest rate of 2 percent. Total annual cost is the sum of the amortized capital cost and the annual O&M cost.

Table 3	**Example of Process for Estimating Project Costs** **San José/Santa Clara Water Pollution Control Plant Master Plan** **City of San José**	
Item	**Percentage**	**Example of Estimated Cost**
	Subtotal	**$10,000,000**
Demolition costs (if applicable)	10%	$1,000,000
Yard piping, sheeting, shoring, piles, coatings, and other miscellaneous costs (if applicable)	15%	$1,500,000
Electrical and instrumentation (if applicable)	20%	$2,000,000
	Subtotal	**$14,500,000**
Estimating contingency	15%	$2,175,000
	Subtotal	**$16,675,000**
Construction contingency	25%	$4,169,000
	Construction Cost (today)	**$20,844,000**
Escalation to midpoint of construction (3% per annum to 2025)	45%	$9,380,000
	Escalated Construction Cost (midpoint of construction)	**$30,224,000**
Project cost factor	30%	$9,067,000
	Total Project Cost	**$39,291,000**

Table 4	**O&M Unit Costs** **San José/Santa Clara Water Pollution Control Plant Master Plan** **City of San José**
Item	**2009 Cost**
Labor (average)	$50/hour
Energy	
Electricity	$0.105/kWh(1)
Natural Gas	$0.93/therm(2)
Chemicals	
Sodium Hypochlorite (12.5%)	$0.7745/gallon
Sodium Bisulfite (25%)	$0.8625/gallon
Methanol	$1.00/gallon
Polymer	$1.70/pound

Note:

(1) Average price paid by San José/Santa Clara Water Pollution Control Plant (SJ/SC WPCP) for electricity from July 2007 through June 2008.

(2) Average price paid by SJ/SC WPCP for natural gas from January 2008 through June 2009.

3.4 Present Worth Costs

Present worth cost represents the value in current dollars of the total cash flow occurring over the life of a project. It includes both capital and O&M costs. As a result, present worth cost represents the life cycle cost of an alternative.

It should be noted that when O&M costs are prepared, the O&M costs that are common among the alternatives are usually not included. Capital, O&M, total annual and present worth cost estimates will be developed for the recommended master planned facilities.