Sacramento Regional County Sanitation District

Interceptor Sequencing Study

Technical Memorandum 6
Life Cycle Cost Criteria for Interceptor Conveyance Facilities

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1.0 INTRODUCTION

Subtask 4.3 of the SRCSD Interceptor Sequencing Study scope of work includes a technical memorandum discussing the development and application of life cycle cost criteria for conveyance alternatives. The ISS effort is focused on a high level analysis of conveyance and non-conveyance alternatives to provide service to the existing SRCSD service area. In general, the life cycle costs will vary with the size of the facility and the operating condition assumptions. For the purposes of this analysis, it is assumed that facilities are operating at full build-out capacity for the entire life cycle due to the limited information regarding construction timing and ESD absorption rates.

2.0 PIPELINES

2.1 Gravity Pipe O&M Costs

Unlike smaller gravity pipes in the collection system, interceptor gravity pipes are relatively large and are designed to be self cleansing at normal flow conditions. If an interceptor is constructed prior to flows reaching minimum cleansing criteria, periodic cleansing costs should be considered. The ISS analysis is limited to build out conditions and therefore no O&M costs are assigned to gravity pipes for the purpose of life cycle analysis.

2.2 Force Main O&M Costs

Interceptor force main pipes generally do not require regular maintenance but the air release valves and the air/vacuum valves located at changes in force main slopes require regular maintenance to ensure proper operation. Based on conversations with Interceptor M&O staff the following guidelines were established:

- Number of ARVs per mile – 2 (4 if alignment in hills and valleys)
- ARV maintenance interval – 1 per month
- Cost per ARV maintenance - $150 ($1000 if in high traffic area)

Based on the above guidelines the following assumptions can be made for the ISS:

Table 6.1 ARV O&M Costs

Average ARVs per mile	3
ARV maintenance interval	1 per month
Average ARV maintenance cost	$575 (assume 50% are in high traffic areas)
Total annual cost	**$20,700 per mile**

3.0 PUMPING STATIONS

3.1 Pump Station O&M Costs

Operation and maintenance costs for SRCSD pump stations vary with facility size, average flow, and facility age. The size of a facility will impact the number preventative maintenance (PM) tasks due to the number and complexity of equipment. The average flow will impact the intervals that PM work is required due to equipment run times. The facility age will impact the overall maintenance costs due to equipment obsolescence and/or mortality.

SRCSD pump stations can be classified into 4 categories based on the physical characteristics that impact the operational costs:

Table 6.2 Pump Station Categories

PWWF Capacity	Structure Type	Odor Control
10-50 MGD	Wet well with wet submersible pumps	Carbon Scrubber
50-75 MGD	Wet well with dry well submersible pumps	Biological system with carbon scrubbers
75-100 MGD	Wet well with dry well pumps and motors direct couple or driveline	Biological system with carbon scrubbers
101+ MGD	Wet well with dry well pumps and motors direct coupled	Biological system with carbon scrubbers

3.1.1 Electricity

Cost to purchase from the local electric company. Costs can be calculated based on actual flow and unit prices for electricity using the following equations:

BHP=Q(H)s/3960(n)
Where BHP=Brake Horse Power
Q= ADWF (gpm) *Assume PWWF/2*
H=Average Head (ft) *Estimate based on Elevation difference plus head losses*
S=specific gravity (1.0)
N= Pump efficiency, *assume 65%*

EHP=BHP/n
Where EHP=Electric Horse Power
N= wire to shaft efficiency, *assume 90%*

kw=EHP(0.7457)
Where kw=Kilowatts
EHP= Electric Horse Power

kwh/yr=kw(365)24
Where kwh/yr=Kilowatt-Hours per year consumed

Electrical cost per year = KWH/yr($/kwh)
Assume $/kwh=$0.10 per kwh

3.1.2 Chemicals

SRCSD historically has relied on chemical addition but recent studies suggest that vapor phase treatment is orders of magnitude less expensive. This effort will assume chemical usage based on feed rates below for summer months only (4 months per year). 2010 bioxide cost: $1.98/gallon. ADWF will be used to determine volume of bioxide required.

- 10-50 MGD PWWF 150gal/day
- 50-75 MGD PWWF 300gal/day
- 75-100 MGD PWWF 1000gal/day
- 101+ MGD PWWF 1500gal/day

3.1.3 Labor

Due to relatively recent organizational restructuring, and recent implementation of asset management SRCSD does not have well established labor costs for pump stations. The approach to estimating the cost of potential future pump stations was to gather existing data for analysis. Three sources of information were identified, each with its own strengths and weaknesses for use in the analysis.

Table 6.3 Labor Cost Information Sources

Source	Definition	Advantage	Issues
Maximo	SRCSD's asset register	All CM[1] and PM[2] work related to an asset is tracked	Interceptor system has only recently started using Maximo so no reliable cost history is available.
Budget	09/10 fiscal year budget	Reflects actual costs being spent	Only provide a lump sum number with no correlation to facility size or type.
Job plans	Schedule of PM[2] work (labor hours only)	Planned hours based on equipment manufacturer recommendations	Only provides PM hours scheduled. CM hours must be estimated. PM scheduled are not always done or required.

[1]Corrective Maintenance
[2]Preventative Maintenance

SRCSD currently operates 8 pump stations varying in PWWF capacity from 15MGD to 221MGD. For the 8 existing pump stations information was gathered and analyzed in an attempt to determine an appropriate range of labor costs based on established categories. The results are in the table below:

Table 6.4 Labor Cost Recommendation

Category	Station Name	2008 Labor Cost from Maximo	2009 Labor Estimate from Job Plans[1]	2009-10 FY Labor Budget	Reccomended value for life cycle cost analysis ($/yr)
10-50 MGD	N52 Power Inn N53 Van Maren S30 Natomas S33 Cordova	$138 $632 $59,702 $3,302	$55,692 $39,117 - $112,821	$2,155,330	$115,000
50-75 MGD	N40 Iron Point	$13,248	-		$150,000
75-100 MGD	-	-	-		$300,000
101+ MGD	N19 Arden N50 South River N51 New Natomas	$30,961 $14,936 $13,475	- $1,043,562 $1,082,458		$400,000

[1]Job plan labor estimated by following equation: (PM Hours)(WOBT)($/hr)+(PM Hours)(WOBT)(CM/PM Ratio)($/hr)= Total Labor
Where: WOBT = Wrench on Bolt Time = 50%
CM/PM Ratio = Ratio of CM to PM work = 30%
$/hr = Average labor rate of all crafts = $85

Because the inconsistency in the data from various sources, the Maximo and the Job Plan data was used as a guide for appropriating the current budget among the existing facilities. The recommended values for labor make the assumption that the current level of maintenance will continue as more facilities are added to the system (the PM backlog will not be allowed to grow).

3.1.4 <u>Materials</u>

Materials costs typically include all materials needed to perform PM and CM work activities. These generally include: backup generator maintenance supplies, odor control system supplies, lubricants, gaskets, tools, spare parts, etc. Similar to labor costs, SRCSD does not currently have a well established method to track or estimate materials usage by pump stations. For the 8 existing pump stations information was gathered and analyzed in an attempt to determine a appropriate range of material costs. The results are in the table below:

Table 6.5 Materials Cost Recommendation

Category	Station Name	2008 Materials Cost from Maximo	2009 Cost Estimate from Job Plans[1]	2009-10 FY Materials Budget	Reccomended value for life cycle cost analysis ($/yr)
10-50 MGD	N52 Power Inn N53 Van Maren S30 Natomas S33 Cordova	$66,528 $60,164 $13,668 $91,300	$13,923 $9,779 - $28,205	$679,728	$30,000
50-75 MGD	N40 Iron Point	$57,103	-		$50,000
75-100 MGD	-	-	-		$75,000
101+ MGD	N19 Arden N50 South River N51 New Natomas	$421,291 $399,823 $357,246	- $260,891 $270,615		$200,000

[1]Job plan labor estimated by following equation: (Total Labor)(Materials/Labor Ratio) = Total Materials Cost
Where: Materials/Labor Ratio = 25%

4.0 REHABILITATION AND REPLACEMENT

All assets deteriorate over time. In addition to regular maintenance activities, assets require regular rehabilitation and replacement after the useful life has been depleted. Various types of assts deteriorate at different rates and have different service lives. Additionally, the rate of deterioration and the service life can be influenced by different maintenance and operation strategies. SRCSD has very little data on the cost of rehab and replacement of assets because interceptor system relatively new (approximately 30 years old). The following table contains assumptions on useful life and expected rehabilitation and replacement frequencies:

Table 6.6 Rehab/Replacement Schedule

Asset Type	Useful Life	Rehabilitation Frequency	Replacement Frequency
Gravity pipe	135	75	135
Manholes	135	75	135
Pressure pipe	90	45	90
ARV/Blowoffs	20	none	20
Pump station	80	-	-
Odor Control	30	5	30
Pumps	30	15	30
Electrical	30	none	30

4.1 Gravity pipes

SRCSD does not have extensive experience in rehabilitation of gravity pipes. Therefore general cost assumptions have been made for the purposes of lifecycle analysis. The basis for the recommended cost is based on information presented in the SRCSD 50 Year Funding Study and recent rehabilitation projects from other agencies. The recommended costs are based on CIPP rehabilitation techniques and include manhole rehabilitation and soft costs.

Table 6.7 Gravity Pipe Rehab/Replacement Costs

Size Range	2010 Rehab Cost ($/LF)	Rehab Schedule
33-39”	$495	75 years
40-50”	$640	
60-70”	$855	
72-80”	$980	
80-95”	$995	
Over 95”	$1,160	

4.2 Force Mains

SRCSD does not have extensive experience in rehabilitation of force main pipes. Therefore general cost assumptions have been made based on the information presented in the SRCSD 50 Year Funding Study and recent rehabilitation projects from other agencies. The recommended costs for this analysis are independent of pipe material and recommended costs include soft costs.

Table 6.8 Force Main Pipe Rehab/Replacement Costs

Size Range	2010 Rehab Cost	Rehab Schedule
8-18"	$65/ft	45 years
12"-33"	$100/ft	
33-48"	$125/ft	
48-72"	$200/ft	

4.3 Pump Stations

Pump station contain various major components that must be rehabilitated and replaced over time. The recommended costs are based on consultation with various SRCSD staff with knowledge in various fields such as odor control, mechanical, and electrical.

Table 6.9 Pump Station Rehab/Replacement Costs

Category	Equipment	Rehab Frequency	Rehab Cost	Replacement Frequency	Replacement Cost
10-50 MGD	Pumps	15	$100,000	30	$500,000
	Electrical	-	-		$300,000
	Odor Control	5	$16,000		$100,000
50-75 MGD	Pumps	15	$125,000		$700,000
	Electrical	-	-		$340,000
	Odor Control	5	$50,000		$120,000
75-100 MGD	Pumps	15	$200,000		$1,000,000
	Electrical	-	-		$460,000
	Odor Control	5	$75,000		$200,000
101+ MGD	Pumps	15	$350,000		$1,500,000
	Electrical	-	-		$630,000
	Odor Control	5	$125,000		$500,000

5.0 LIFE CYCLE DURATION

Life cycle refers to the number of years to be considered in the cost analysis. 40 year life cycle is the industry standard that has been adopted by SRCSD. Although most of the assets in an alternative will have a useful life greater than 40 years, using an analysis period greater than 40 years is not recommended due to the uncertainty in the assumptions beyond a 40 year time frame. ***It is recommended that the life cycle analysis for the ISS effort use a life cycle period of 40 years.***

6.0 DISCOUNT RATE

Discount rate is used to represent the time value of money. In general, the greater the preference for immediate benefits or the greater the expected rate of return on alternative investments, the greater the discount rate. SRCSD generally performs a sensitivity analysis (3%, 5%, 7%) of the discount rate when preparing life cycle cost analysis for proposed near term projects. This analysis is appropriate when considering alternatives that will require funding in the near future and the value of money could impact SRCSD's rate and fee structure. The ISS effort is a study of potential alternatives to provide service at a point in time that is greater than 50 years in the future and therefore has little impact on near term rate and fee decisions. Therefore investigating the impact of varying discount rates will not contribute any value when comparing alternatives. *It is recommended that life cycle analysis for the ISS effort use a single discount rate of 5.0%.*

7.0 ESCALATION RATE

Escalation rates refer to the rate at which the cost of goods and services rise over time. This is typically different than inflation (using the consumer price index) which is a measure of general price increases across the whole economy. SRCSD typically uses a general escalation rate of 3.0%. Depending on the level of detail in the analysis, different escalation rates can be applied to different cost components of the alternative. Typical project components that can escalate at different rates include: construction costs, electricity costs, chemical costs, and labor costs. The ISS is a high level analysis and therefore it is recommended that the analysis only include the following cost component escalation rates:

- 3.0% - General, including construction and rehabilitation costs
- 5.0% - O&M costs

8.0 SALVAGE VALUE

Salvage value generally assumes that an asset can be sold at the end of the analysis period. Because SRCSD assets do not normally have a market value, Remaining Service Life (RSL) can be used to account for different asset lifetimes across alternatives. RSL can be determined based on project cost and the percentage of the useful life remaining at the end of the analysis period. The key difference between RSL and salvage value is that RSL only exists if the alternative will continue in operation after the end of the analysis period, whereas salvage value requires that the useful life of the asset has been exhausted.

RSL=C(RL)

Where RSL=Remaining Service Life

C= Capital Cost at year 0

RL=% of useful life remaining at end of analysis period

The RSL value represents the value of the investment at the end of the analysis period. The value must then be discounted back to year zero and presented as a present value that subtracts from the overall present value of the alternative.

9.0 RISK QUANTIFICATION

SRCSD does not currently have a uniform method for evaluating risk associated with project alternatives. Risk typically falls into two categories: quantitative and qualitative. Quantitative risks are those risks that can be identified in terms of cost and probability. Qualitative risks are those risks that can be identified but not enough is known about the cost or the probability to justify assigning a value to them.

SRCSD Asset Management is currently working on a template for use on all SRCSD PDPs and BCEs. It is recommended that the ISS effort utilize the draft risk template and further refine or modify it to fit the ISS needs.

10.0 SENSITIVITY (UNCERTAINTY) ANALYSIS

There are generally two main sources of error in life cycle analysis: variability and uncertainty. Variability reflects the natural variations in an estimate due to its properties or the forces acting on it. Uncertainty stems from a lack of knowledge about the true value of a specific variable. Variability and uncertainty can be addressed by evaluating the project outcomes based on a range of values rather than a single estimate. The ISS effort is a high level analysis and therefore the level of detail in the life cycle analysis is relatively low. Additionally, the facilities that are contemplated will not be required for 20 to 50 or more years. At a minimum the following analysis in recommended:

Table 6.10 Sensitivity Analysis Factors

Life Cycle Cost Input	Cost Estimate Variance	Escalation Rate Variance
Capital Costs	Vary by +/- 50%	3%, 5%, 7%
O&M Costs	Vary by +/- 50%	5%, 7%, 10%

Varying these key alternative inputs will help evaluate the merits of each alternative while considering the uncertainty of the alternative inputs.

Depending on initial cost estimate and life cycle cost results additional sensitivity analysis may be required. One example is varying the construction date of the projects within an alternative which would evaluate varying levels of population growth.