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Subject: Full Scale SWRO Facility Operations and Construction Sequencing
MMWD Seawater Desalination Pilot Plant Program
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This technical memorandum summarizes and documents the expected operations and construction sequencing of a full scale MMWD desalination facility to permit conducting capital and operating cost modeling of the project. Parts of this memo would replace the expected facility operations Section 8.1.2 and be used in Section 10 of the Engineering Report.

Planned Desalination Plant Production Requirements

MMWD staff have projected potential future system water demands through the year 2020 to estimate the amount of desalination plant water that would be needed to meet those demands. The demand model projections incorporated use and supply factors based on normal rainfall years, low rainfall (dry) years and drought years. Based on these projections, in normal and dry years, the desalination plant would operate at lower production levels during the wet season (approximately December through April) and operate at increased production in the dry, summer season (approximately May through November). During droughts, the desalination plant would operate at full production levels all year or as required to meet water demands.

Based on MMWD staff projections, the potential operations scenarios for a full scale desalination facility would be as follows:

- Initial Operation:
  - In normal rainfall years: 4-MGD during the period May thru November; 1 MGD during the period December thru April.
  - In dry years: 10 MGD during the period April thru Nov; 4 MGD during the period December thru March.
  - In drought years: 10 MGD year round.

- Approximately 10 years later or about 2015
  - In normal rainfall years: 8 MGD during the period May thru November; 1 MGD during the period December thru April.
  - In dry years, 12 MGD during the period April thru November; 8 MGD during the period December thru March.

  - In drought years, 15 MGD year round.

- Approximately Year 2020 and beyond:
  - In normal rainfall years: 12-MGD during the period May thru November; 2 MGD during the period December thru April.
  - In dry years: 15 MGD during the period April thru November; 12 MGD during the period December thru March.
  - In drought years, 15 MGD year round.

The range of production in normal rainfall years reflects lower production in the wet season, winter months and higher production in the dry season, summer months. During the low production periods of operation, process units would operate at lower flow rates or units would be removed from serviced and placed into lay-up conditions. Low production period operations are discussed in more detail in Section 9 of this report.

Facility Capacity

The design capacity of the proposed full scale MMWD desalination facility is based on meeting the planned production requirements listed above under worst-case, dry-period source water conditions represented by higher salinity, lower turbidity/suspended solids and either low or high TOC depending on whether an algal bloom is present or absent in the Bay at or near the intake. To meet these requirements, MMWD is considering a phased construction approach. The initial phase could be 5 MGD with incremental expansion to 10 MGD and final expansion to 15 MGD. MMWD is also considering an approach that would call for initial construction of a 5 MGD facility that could be rapidly expanded to 10 MGD in a period of approximately 12 months, in response to a severe drought that would require production of desalinated water at greater than 5 MGD. The design features of a desalination plant necessary to permit rapid expansion are discussed in Section 10 of this report.

SWRO FACILITY OPERATIONS FOR COST MODELING

To estimate the annual operating costs of the SWRO system the CH2M HILL CPES cost model requires the following inputs: average annual plant flow, average annual SWRO feed pressures and plant on-line factor (fraction of days per year the plant is in operation). In addition, where a 2nd pass system is being utilized, the model needs to know the capacity and feed pressure of this system. Because MMWD is planning for different plant capacities during the year in non-drought condition, it is necessary to calculate a weighted average annual operating condition for non –drought or “average year” conditions that can be used in the cost model. Based on the planned production requirements described above, Kennedy/Jenks CH2M Hill had developed a weighted average and drought operating conditions for 5, 10 and 15 MGD capacities as described below:

- 5 MGD Plant – average year conditions
- 5 MGD Plant – drought year conditions
- 10 MGD Plant – average year conditions

- 10 MGD Plant – drought year conditions
- 15 MGD Plant – average year conditions
- 15 MGD Plant – drought year conditions

Tables 1, 2 and 3 present assumed values for the weighted average and drought conditions that will be used in the CPES cost model for a 5 MGD, 10 MGD and 15 MGD plant respectively. The dry and wet period TDS is based on the average source water conditions from the pilot study. The temperatures are based on the pilot study and have been adjusted lower to account for solar heating in the pilot tanks and piping that would not occur in a full scale facility. The RO feed pressures are based on average pressures over the life of the membrane with a typical fouling factor.

Table 1: Average Operating Conditions for a 5 MGD Desalination Facility for Cost Modeling

Parameter	Average Year Dry Period	Average Year Wet Period	Weighted Average	Drought Period
Operating Period (months)	7	5	--	12
First Pass SWRO Production, MGD	4	1	2.75	5.4
TDS, ppm	21,800	13,800	18,500	32,000
Temp, ^{o}C	15	10	13	13
SWRO Feed Pressure, PSIG	625	500	575	900
2nd Pass RO Production, MGD	None	None	None	3.3
2nd Pass RO Feed Pressure, PSIG	None	None	None	200
On-line Factor, %	95	95	95	95

Table 2: Average Operating Conditions for a 10 MGD Desalination Facility for Cost Modeling

Parameter	Average Year Dry Period	Average Year Wet Period	Weighted Average	Drought Period
Operating Period (months)	7	5	--	12
First Pass SWRO Production, MGD	8	1	5.1	10.7
TDS, ppm	21,800	13,800	18,500	32,000
Temp, ^{o}C	15	10	13	13

SWRO Feed Pressure, PSIG	625	500	575	900
2nd Pass RO Production, MGD	None	None	None	6.6
2nd Pass RO Feed Pressure, PSIG	None	None	None	200
On-line Factor, %	95	95	95	95

Table 3: Average Operating Conditions for a 15 MGD Desalination Facility for Cost Modeling

Parameter	Average Year Dry Period	Average Year Wet Period	Weighted Average	Drought Period
Operating Period (months)	7	5	--	12
First Pass SWRO Production, MGD	12	2	7.8	16.1
TDS, ppm	21,800	13,800	18,500	32,000
Temp, ^{o}C	15	10	13	13
SWRO Feed Pressure, PSIG	625	500	575	970
2nd Pass RO Production, MGD	None	None	None	10
2nd Pass RO Feed Pressure, PSIG	None	None	None	200
On-line Factor, %	95	95	95	95

CONSTRUCTION APPROACH FOR RAPID EXPANSION

MMWD is considering designing and constructing an initial 5 MGD desalination facility with the ability to rapidly expand to 10 MGD in a period of approximately 12 months to permit increased desalinated water production should a drought require more than 5 MGD of desalinated water. Where civil and process facilities must be installed as part of a desalination plant expansion, construction can take over 36 months and may take longer in the case of MMWD because of the site work required for pile supports at the Pelican Way site. Additional time is often involved in bidding the project and hiring a general contractor assuming that the design documents are completed and ready for bidding.

To complete an expansion from 5 to 10 MGD in an approximate 12-month period, Kennedy/Jenks-CH2M Hill recommend MMWD construct the major civil and process facilities for a 10 MGD facility during the initial plant construction, but only install major process equipment (pumps, RO trains, associated mechanical, electrical and instrumentation) for 5 MGD of desalinated water production. This approach would require constructing the structural, building, major site and process piping, residuals handling, chemical storage and tank facilities for 10 MGD during the initial phase. For expansion from 5 to 10 MGD, MMWD could contract with a RO system supplier to supply, install and start-up the process equipment to provide the additional 5 MGD of capacity. The same supplier could also supply, install and commission the second pass RO system if required during a drought.

Alternatively, MMWD could let two contracts, one for process equipment purchase and start-up assistance and a second contract to a general contractor for installation, commissioning and start-up. As the lead time for some process equipment (e.g., pumps, motors) can be up to six months, it is advisable to pre-qualify equipment suppliers and possible general contractors and have bid documents and purchase contracts prepared in advance so that bids can be obtained and contracts executed as quickly as possible.

The rapid capacity expansion approach would require a greater initial capital investment by MMWD compared to an initial-phase 5 MGD facility but would be less expensive than constructing a 10 MGD initial phase facility. The approach for expansion to 15 MGD would be the approach where space would be reserved on the site for the major civil and process facilities for the expansion.

cc: Project File