PLANNING AND EVALUATION CRITERIA

This chapter summarizes the criteria established for the development of the West Basin Municipal Water District's (West Basin) hydraulic model and for the analysis of the master plan facilities. The planning and evaluation criteria discussed in this chapter are separated into four subsections, including hydraulic criteria, water quality criteria, facility sizing criteria, and cost estimating criteria.

5.1 HYDRAULIC CRITERIA

The hydraulic criteria described in this section include model simulation requirements, peaking factors, delivery pressure, system losses, and pipeline velocity. While specific analysis criteria for each distribution system will be detailed in Chapter 7, Existing System Analysis, each of these criteria is discussed below in general.

5.1.1 Model Simulation Requirements

The recycled water system was evaluated using hydraulic models that were calibrated for hydraulic parameters measured in the field. With the exception of the Edward C. Little Water Recycling Facility (ELWRF) Brine Line, these models were developed to conduct 24-hour extended period simulation (EPS) analyses to allow the evaluation of the impact of demand variations on pipeline, pump station, and reservoir performance.

5.1.2 Peaking Factors

5.1.2.1 Average Day Demands

Average annual demands (AAD) for existing customers shall be based on historical customer water use data from the past five years, if available. Significant variations in average annual demands will be verified with West Basin staff to identify the reasons. These variations may result from limited usage throughout a year, or very dry and very wet years. The average demands will be determined with consideration of all the available data. Future average day demands for industrial users and the West Coast Barrier will be based on individual customer requests. Future average day irrigation demands will be based on existing potable water use by the potential customers.

5.1.2.2 Maximum Month Demands

Maximum month demand (MMD) depends on the type of user. MMD for existing customers shall be based upon the historical seasonal peaking factors for existing system analysis. For future system analysis of existing customers, historical seasonal peaking factors greater than 3.0 will be reduced to 3.0. For future customers, MMD shall generally be based on the following:

Irrigation Customers:	2.5 * ADD
Industrial Use:	1.3 * ADD
Mixed-Use:	1.7 * ADD
Barrier Water Injection:	1.0 * ADD

A more detailed description of peaking factors is provided in Chapter 3.

5.1.2.3 Peak Demand Factors

Peak demand factors are determined from a combination of maximum month peaking factors and diurnal curves, which describe the typical hourly demand variation of a customer type.

Hourly fluctuations in the demands are experienced due to variations in seasonal conditions, industry demands, and maintenance operations. The peak demand factors for the largest customers were determined individually based on field data. These diurnal curves were then evaluated to develop a set of generic diurnal curves that were applied to all remaining customers based on the water usage types listed in Chapter 3. The generic diurnal curves are shown in Chapter 3, while the 15 customer specific demand patterns are included in Appendix E.

5.1.3 Delivery Pressure

The Title 22 distribution system should typically be designed to provide a minimum service pressure of 65 pounds per square inch (psi). Under special circumstances, a higher service pressure may be required. For instance, the Anza Avenue Lateral services, located in the City of Torrance, require a minimum service pressure of 80 psi, because the existing irrigation systems at certain customer sites are old and need a minimum pressure of 75 psi to adequately irrigate these sites.

The pump station control discharge pressures for each of the remaining West Basin recycled water systems are summarized in Table 5.1.

**Table 5.1 Control Discharge Pressures
Capital Implementation Master Plan
West Basin Municipal Water District**

System Description	Control Discharge Pressure (psi)
Hyperion Secondary Effluent Pumping System	59
Barrier System	73
Chevron Industrial RO System	34
Chevron Industrial RO Ultra System	34
Chevron Nitrified Water System	100
bp Industrial RO System	50
bp Nitrified System	50
Title 22 Pump Station at ELWRF	87

5.1.4 System Frictional Losses

The pressure in the system at any given point for a particular flow is dependent on a number of variables including pipe size, roughness and length. These components all contribute to the magnitude of energy losses in the system and consequently, pressure. The system should be designed and operated to maintain system losses below 10 feet for each 1,000 feet of pipe length under any conditions, subject to satisfying all other criteria.

5.1.5 Pipeline Velocity

The distribution systems should be sized and designed to provide service at adequate pressures with the maximum day demands. To maintain adequate system pressures and prolong the life of the pipe, flow velocities should be limited. The system should operate at velocities of 1 to 3 feet per second (fps) normally, with a maximum velocity of 7 fps at intermittent peak flows.

5.2 WATER QUALITY CRITERIA

The water quality criteria described in this section are separated into irrigation guidelines and disinfection guidelines.

5.2.1 Irrigation Guidelines

Water quality guidelines for irrigation were developed by the University of California Committee of Consultants. These criteria are presented in Table 5.2. According to Salt-Affected Turfgrass Sites: Assessment and Management, the combination of high nitrogen levels and frequent irrigation has several adverse effects including:

- Excessive growth and mowing requirements;
- Reduced heat stress tolerance;
- Reduced cold and drought tolerances;
- Reduced wear-resistant turf;
- Increased opportunity for invasive plant infestation (e.g., *Poa annua*); and
- Increased disease and weed problems.

The successful long-term use of irrigation water depends more on rainfall, leaching, soil drainage, irrigation water management, salt tolerance of plants, and soil management practices than upon water quality itself.

Since salinity problems may eventually develop from the use of any water, the following guidelines are given, should they be needed, to assist water users to better manage salinity in either agricultural or community-based irrigation:

- Irrigate more frequently to maintain an adequate soil water supply.
- Select plants that are tolerant of an existing or potential salinity level.
- Routinely use extra water to satisfy the leaching requirements.
- If possible, direct the spray pattern of sprinklers away from foliage. To reduce foliar absorption, try not to water during periods of high temperature and low humidity or during windy periods. Change time of irrigation to early morning, late afternoon, or night.
- Maintain good downward water percolation by using deep tillage or artificial drainage to prevent the development of a perched water table.
- Salinity may be easier to control under sprinkler and drip irrigation than under surface irrigation. However, sprinkler and drip irrigation may not be adapted to all qualities of water and all conditions of soil, climate, or plants.

Table 5.2 Irrigation Water Quality Guidelines
Capital Implementation Master Plan
West Basin Municipal Water District

Key Irrigation Water Quality Parameter		Units	Established Criteria Degree of Use Restriction[(2) (3) (4)]		
			None	**Slight to Moderate**	**Severe**
Salinity	EC	DS/m	<0.7	**0.7-3.0**	>3.0
	TDS	mg/L	<450	**450-2000**	>2000
Permeability[(5)]				EC	
aSAR = 0-3 and EC			>0.7	0.7-0.2	<0.2
= 3-6 and EC			>1.2	1.2-0.3	<0.3
= 6-12 and EC			>1.9	**1.9-0.5**	<0.5
= 12-20 and EC			>2.9	2.9-1.3	<1.3
= 20-40 and EC			>5.0	5.0-2.9	<2.9
Sodium (Na)					
Surface		SAR	<3	**3-9**	>9
Sprinkler		mg/L	<70	**>70**	
Chloride (Cl)					
Surface		mg/L	<140	**140-355**	>355
Sprinkler		mg/L	<100	**>100**	
Boron (B)		mg/L	**<0.7**	0.7-3.0	>3.0
Bicarbonate		mg/L	<90	**90-500**	>500
PH		---		**6.5-8.4 (normal range)**	
Ammonia (NH_3)		mg/L		(see combined N values below)	
Nitrate (NO_3)		mg/L		(see combined N values below)	
Total Nitrogen (N)		mg/L	<5	5-30	**>30**

Notes:
(1) Adapted from University of California Committee of Consultants (1974), and Ayers and Westcot (1984).
(2) Method and Timing of Irrigation: Assumes normal surface and sprinkler irrigation methods are used. Water is applied as needed, and the plants utilize a considerable portion of the available stored soil water (50% or more) before the next irrigation. At least 15 percent of the applied water percolates below the root zone (leaching fraction [LF] > 15%).
(3) Site Conditions: Assumes soil texture ranges from sandy loam to clay with good internal drainage with no uncontrolled shallow water table present.
(4) Definitions of "The Degree of Use Restriction" terms:
None = Reclaimed water can be used similar to the best available irrigation water.
Slight = Some additional management will be required above that with the best available irrigation water in terms of leaching salts from the root zone and/or choice of plants.
Moderate = Increased level of management required and choice of plants limited to those which are tolerant of the specific parameters.
Severe = Typically cannot be used due to limitations imposed by the specific parameters
(5) Permeability is evaluated based on the combination of the adjusted sodium adsorption ratio (aSAR) and electrical conductivity (EC) values.

5.2.2 Disinfection Guidelines

The California Code of Regulations, Title 22, Division 4, Chapter 3, Recycling Criteria, specify treatment processes for ensuring proper disinfection of recycled water. They also specify requirements for limiting public contact with recycled water to protect public health.

Disinfected tertiary recycled water means a filtered and subsequently disinfected wastewater that meets the following criteria:

- The filtered wastewater has been disinfected by either:
  - A chlorine disinfection process following filtration that provides a CT (the product of total chlorine residual and modal contact time measured at the same point) value of not less than 450 milligram-minutes per liter at all times with a modal contact time of at least 90 minutes, based on peak dry weather design flow; or
  - A disinfection process that, when combined with the filtration process, has been demonstrated to inactivate and/or remove 99.999 percent of the plaque-forming units of F-specific bacteriophage MS2, or polio virus in the wastewater. A virus that is at least as resistant to disinfection as poliovirus may be used for purposes of the demonstration.
- The median concentration of total coliform bacteria measured in the disinfected effluent does not exceed an MPN of 2.2 per 100 milliliters utilizing the bacteriological results of the last seven days for which analyses have been completed and the number of total coliform bacteria does not exceed an MPN of 23 per 200 milliliters in more than one sample in a 30 day period. No sample shall exceed an MPN of 240 total coliform bacteria per 100 milliliters.

According to *Water Reuse: Issues, Technologies, and Applications*, a minimum analysis criteria of 1.0 mg/L is recommended to limit the regrowth of microorganisms within the distribution system.

5.2.3 Barrier Water Quality

The State of California Regional Water Quality Control Board (RWQCB) for the Los Angeles Region has issued a permit to West Basin for injection of recycled water from the microfiltration/reverse osmosis/advanced oxidation process (MF/RO/AOP) at ELWRF into the West Coast Basin Barrier. This water has been shown to meet all the requirements of the California Drinking Water Primary and Secondary Standards and the Maximum Contaminant Levels (MCLs). However, the permit requires total Nitrogen of less than 5 mg/L as total nitrogen rather than the MCL of less than 10 mg/L for nitrate. Similarly, the maximum TOC concentrate allowed in the permit is less than 0.5 mg/L. It has also been shown that selected pharmaceutically active compounds and other toxic contaminants not included in the drinking water standards are removed or reduced to low levels in the product water.

5.2.4 Industrial RO and Industrial RO Ultra Water Quality

The contractual limits for the water quality of each of the Industrial RO and Industrial RO Ultra water demands supplied by the Chevron Low Pressure Boiler Feed, Chevron High Pressure Boiler Feed, EMWRF, and CRWRF are shown in Table 5.3.

Table 5.3 Water Quality Criteria RO Products
Capital Implementation Master Plan
West Basin Municipal Water District

System	Recycled Water Type	Product Water Quality Limits
Chevron Low Pressure Boiler Feed System	Industrial RO	Hardness <0.3 mg/L Silica < 1.5 mg/L TDS < 60 mg/L
Chevron High Pressure Boiler Feed System	Industrial RO Ultra	Hardness < 0.03 mg/L Silica < 0.1 mg/L TDS < 5 mg/L
bp Reverse Osmosis System (CRWRF RO Product Water)	Industrial RO	Calcium 1.0 mg/L Magnesium 1.0 mg/L Ammonia 4 mg/L Silica 1 mg/L TDS 35 mg/L
EMWRF RO Product Water	Industrial RO	Conductivity 50 µmho/cm TOC 0.7 mg/L Ammonia 1.9 mg/L Silica 1.0 mg/L

Notes:
Hardness as mg/L as $CaCO_3$
Individual ions where indicated are as the species.

5.2.5 Nitrified Water Quality

The water quality goals for the Nitrified water supplied by CRWRF and EMWRF are shown in Table 5.4.

At the current time there are no water quality goals in place for the Nitrified water supplied by the Chevron Nitrification Facility.

Table 5.4 Water Quality Goals for Nitrification Systems Capital Implementation Master Plan West Basin Municipal Water District		
Parameter	**EMWRF(1)**	**CRWRF(2)**
Conductivity, µmho/cm	3,000	1,000 (average) 1,350 (max)
Alkalinity, as $CaCO_3$	350	N/A
Sulfate, mg/L	600	N/A
Chloride, mg/L	450	N/A
Calcium, mg/L	80	60 (average) 100 (max)
Magnesium, mg/L	40	24 (average) 29 (max)
Hardness, as $CaCO_3$	360	N/A
Potassium, mg/L	20	N/A
Silica, mg/L	35	22 (average) 28 (max)
Ammonia, mg/L as N	1.6	0.1 (average) 0.1 (max)
Iron, mg/L	1.0	N/A
Phosphate, mg/L	15	N/A
Total Suspended Solids, mg/L	5	N/A
COD, mg/L	90	N/A

Notes:
(1) Listed limits for EMWRF are maximum concentrations
(2) CRWRF limits established by bp

5.3 FACILITY SIZING CRITERIA

The facility sizing criteria described in this section are separated into pump station sizing and storage requirements.

5.3.1 Pump Station Sizing

All pump stations should have flow meters, suction and discharge pressure gauges, and remote telemetry units. They should be tied to the central DCS system.

Pump stations should be constructed with fireproof materials. Power to the pump stations should be provided through underground service to minimize possibility of damage during fires.

5.3.1.1 Source of Supply Pump Station

Hyperion Secondary Effluent Pump Station (HSEPS) delivers secondary effluent from the Hyperion Wastewater Treatment Facility (HWWTP) to the ELWRF. HSEPS should have the capability to deliver the peak hour demands via one standby pump in an event the largest pump is out of service. The HSEPS shall also be equipped with back-up power connection and manual transfer switch or alternate power supply, in event there is a loss of main power supply.

5.3.1.2 Booster Pump Stations at ELWRF

The booster pump stations supplying recycled water from ELWRF include the Title 22 Pump Station, the Barrier Pump Station, the Low Pressure Boiler Feed Pump Station, and the High Pressure Boiler Feed Pump Station.

These pumping stations should be sized to deliver the peak hour demands via one standby pump in an event the largest pump is out of service.

The Title 22 Pump Station should be designed to deliver the expected overall peak hour demand with the largest pump out of service, because it pumps into a closed system. Back-up power should be provided to operate the pump station during commercial power outages.

The Barrier Pump Station should deliver the future maximum demand of 15.2 mgd with the largest pump out of service. Back-up power is not required because potable water is available through the Metropolitan Water District of Southern California's West Coast Feeder.

The Chevron Low Pressure Boiler Feed Pump Station should deliver the maximum day demand with the largest pump out of service. Back-up power is not needed for service to Chevron since there is an on site storage tank at the Chevron El Segundo Refinery. Under future maximum day demands, this tank would provide emergency storage for over 9 hours. However, back-up power requirement should be reviewed based upon the future service requirements at the El Segundo Power Plant.

The Chevron High Pressure Boiler Feed Pump Station should have the firm capacity to deliver the maximum day flow. Back-up power is not required because there is approximately 1.2 million gallons of emergency storage in the on-site storage tank at the Chevron El Segundo Refinery, which provides over 8 hours of storage under future maximum day demands.

5.3.1.3 Chevron Nitrified Water Pump Station

The difference between the future maximum day and maximum month demand is 0.83 million gallons, which is more than the available forebay storage at CNF. Therefore, this pump station should deliver the maximum day demand with the largest pump out of service. Because potable water connection from the City of El Segundo's distribution system is available to supply all the cooling towers, back-up power is not necessary.

5.3.1.4 Booster Pump Stations in Title 22 Distribution System

The pumping stations in the Title 22 Distribution System should be sized to deliver the peak hour demands with the largest pump out of service (one standby pump). Pump stations should be equipped with portable generator connections and manual transfer switches.

5.3.1.5 Booster Pump Stations at CRWRF

The future maximum day demands for RO industrial and nitrified water are significantly greater than the maximum month demands. Therefore, the bp RO and bp Nitrified Water Pump Stations should be designed to deliver the maximum day demands with the largest pump out of service.

West Basin will provide potable water back-up supply through an air gap at the CRWRF. If this capacity is sufficient for the maximum month demands of the future customers, no additional storage will be necessary. However, either portable power with manual transfer switches, or a secondary source of supply should be provided to operate the pump stations during an outage of the primary power supply.

5.3.2 Storage Requirements

Storage for West Basin's recycled water systems is necessary for:

- Pump station forebay providing operational storage accommodating variations in water production and demand, and retention time for the product water.
- Emergency supply during interruption of treatment or primary supply source.
- Providing break tanks that separate CRWRF and EMWRF from the Title 22 System to minimize the transient pressures (surges) that result from the significant flow changes during the microfiltration backwash cycles.

Forebay storage should be evaluated for each pump station during the preliminary and final design stages.

Emergency storage for each system should be sufficient to allow West Basin transfer customers or treatment facilities to potable water. Potable water should be supplied through an air gap to minimize the required duration.

Break tanks should be sized to accommodate the variations in influent flows and backwash cycles.

5.4 COST ESTIMATING CRITERIA

The cost estimates presented in this Capital Implementation Master Plan (CIMP) are opinions developed from bid tabulations, cost curves, information obtained from previous studies, and Carollo Engineers, P.C. (Carollo) experience on other projects. The costs estimated for each recommended facility are opinions included in the CIP tables developed with this study. The tables are intended to be used to facilitate revisions to West Basin's CIP and ultimately to support determination of the user rates and connection impact fees. Recommendations for cost criteria of pipelines, pump stations, and reservoirs are also presented.

5.4.1 Capital Improvement Project Costs

Cost estimates presented in this master plan are based on the current Engineering and News Record (ENR) cost index for the Los Angeles metropolitan area of 9811 published in January 2009. In this report, the costs presented as Total Project Costs are present worth costs at this ENR number.

Total Project Cost estimates include estimated costs for construction, construction cost contingency, engineering, design, construction management, and miscellaneous cost, such as environmental fees.

5.4.2 Cost Estimating Accuracy

The cost estimates presented in the CIP have been prepared for general master planning purposes and for guidance in project evaluation and implementation. The actual costs of a project will depend on actual labor and material costs, competitive market conditions, final project scope, implementation schedule, and other variable factors such as: preliminary alignment generation, detailed utility surveys, and environmental and local considerations.

The Association for the Advancement of Cost Engineering (AACE) defines an order of magnitude estimate for master plan studies as an approximate estimate made without detailed engineering data. It is normally expected that an estimate of this type would be accurate within +50 percent to -30 percent. This section presents the assumptions used in developing order of magnitude cost estimates for recommended facilities.

For the development of the Capital Improvement Program (CIP), a construction cost contingency and other markups will be applied consistent with Table 5.5. The markups are intended to account for costs of engineering, design, administration and construction management. Separate percentages were used for contingency and markups for different types of projects, as detailed in Table 5.5.

Table 5.5 General Cost Estimating Assumptions Capital Implementation Master Plan West Basin Municipal Water District					
Description	**Treatment Facility**[(1)]	**Distribution System**[(2)]	**Condition Assessment**[(3)]	**Membrane Replacement**	**Land Acquisition**
Construction Cost	100.0%	100.0%	100.0%	100.0%	100.0%
Construction Cost Contingency	15.0%	30.0%	20.0%	0.0%	20.0%
Engineering and Design	12.5%	12.5%	0.0%	0.0%	0.0%
Public Outreach	0.0%	2.0%	0.0%	0.0%	0.0%
Project Administration	2.5%	2.5%	0.0%	0.0%	0.0%
Construction Management	10.0%	10.0%	0.0%	0.0%	0.0%
Total Project Cost[(2)]	**140.0%**	**157.0%**	**120.0%**	**100.0%**	**120.0%**

Notes:
(1) Applies to projects at treatment facilities ("inside the fence").
(2) Applies to projects outside treatment facilities ("outside the fence").
(3) Equipment replacement costs.

The cost estimates are based on current perceptions of conditions at the project locations. These estimates reflect Carollo's professional opinion of costs at this time and are subject to change as the project details are defined. Carollo has no control over variances in the cost of labor, materials, equipment, services provided by others, contractor's methods of determining prices, competitive bidding, or market conditions, practices, or bidding strategies. Carollo cannot, and does not, warrant or guarantee that proposals, bids, or actual construction costs will not vary for the costs presented herein.

5.4.3 Unit Construction Cost

The construction cost estimates presented in this report are based on the unit construction costs listed in Table 5.6. Construction costs for recycled water system pipelines include pipe material, valves, appurtenances, excavation, installation, bedding material, backfill material, transport, and paving where applicable. While no pipe material is specified in the unit construction costs, pipe materials used in comparable bid tabs for diameters through 12 inches were PVC and DIP is assumed for larger pipelines. The costs of acquiring easements for pipeline construction are not included in this estimate.

Table 5.6 Unit Construction Cost
Capital Implementation Master Plan
West Basin Municipal Water District

Category	Unit Construction Cost
Pipelines	**$/lineal ft**
4-inch diameter	165
6-inch diameter	200
8-inch diameter	240
10-inch diameter	275
12-inch diameter	310
14-inch diameter	350
16-inch diameter	390
18-inch diameter	420
20-inch diameter	460
24-inch diameter	530
30-inch diameter	650
36-inch diameter	750
54-inch diameter	1,100
72-inch diameter	1,400
Special Pipeline Construction(1)	**Markup (%)**
Arterial Street (A)	125% of standard unit cost
Jack-and-Bore Crossings (F, R)	200% of standard unit cost
Booster Pumping Stations – New Construction	**$/hp**
<100 hp	$10,000
100-500 hp	$7,500
500-3,000 hp	$6,500
3,000-5,000 hp	$3,200
> 5,000 hp	$3,000
Booster Pumping Stations – Pump Replacement	**$/hp**
<100 hp	$3,000
100-500 hp	$2,500
500-1,000 hp	$2,250
1,000-2,500 hp	$2,000
>2,500 hp	$1,750
Storage	**$/gallon**
< 1 MG	$2.00
1-2 MG	$1.75
2-5 MG	$1.50
> 5 MG	$1.25
Treatment Capacity	**$/gallon/day (gpd)**

Table 5.6 Unit Construction Cost Capital Implementation Master Plan West Basin Municipal Water District	
Category	**Unit Construction Cost**
From Secondary Effluent to Title 22 (conventional treatment)	$2.00/gpd
From Secondary Effluent to Title 22 (with MF/RO for TDS reduction)	$6.00/gpd
From Title 22 to Nitrified Water (Nitrification)	$1.05/gpd
Single Pass RO (treating Title 22 water with MF/RO)	$2.25/gpd
Double Pass RO (treating Single Pass RO feedwater)	$4.50/gpd
Barrier (treating Secondary Effluent with MF/RO/UV)	$6.25/gpd
Backup Power	**$/site**
ELWRF (on-site generating station; 95,000 kWh at 66,000 volts)	$8.0 million
CRWRF (on-site generator; 3,600 kWh at 480 volts)	$1.8 million
HSEPS (secondary feed)	$1.8 million
CNF (on-site generator for product water PS)	$0.5 million
EMWRF (on-site generator for product water PS)	$0.5 million
Miscellaneous	**$/unit**
Enclosure Structures	$300.00 $/sf
PRV (in pre-existing vault)	$50,000.00 $/valve
Cleaning Access Ports	$100,000.00/port
Disinfection Stations	$280,000.00/station
Surge Tank	$500,000.00 $/tank
Surge Protection at ELWRF	$1,500,000.00/site
Surge Protection at CRWRF	$1,750,000.00/site
Pumping Station building	$300.00/sft
Potable Water Backup Connection	$250,000.00/site
Land Acquisition	$2,000,000.00/acre

Notes:
(1) Abbreviations in parenthesis apply to the CIP. A or ART: Arterial street requiring significant additional temporary traffic control or alternate construction hours; F or FWY: Freeway crossing requiring jack and bore construction; R or RR: Railroad crossing requiring jack and bore construction.

As shown in Table 5.6, markups have been included for special construction considerations. A 200 percent markup is included for jack and bore construction, to be considered for improvements crossing the freeway or a railroad. A 125 percent markup is also included for construction in arterial streets, to account for the increased costs of temporary traffic control, reduced construction hours, and alternate construction phasing associated with working on arterial streets.

For booster pumping stations (PS), different unit costs are included based on the required horsepower and whether the project involves a new PS requiring new piping and all associated appurtenances or simply the replacement or addition of a pump to an existing PS. Unit costs are estimated per horsepower of design size.

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