City of Riverside

WASTEWATER COLLECTION AND TREATMENT FACILITIES INTEGRATED MASTER PLAN

VOLUME 4: WASTEWATER TREATMENT SYSTEM
CHAPTER 5: PRELIMINARY TREATMENT

FINAL
February 2008

Engineers...Working Wonders With Water™

10540 TALBERT AVENUE, SUITE 200 EAST • FOUNTAIN VALLEY, CALIFORNIA 92708 • (714) 593-5100 • FAX (714) 593-5101
H:\Client\Riversid_SAOW\7472A00\Rpt\Volume 04\Ch05.doc

City of Riverside

WASTEWATER COLLECTION AND TREATMENT FACILITIES INTEGRATED MASTER PLAN

VOLUME 4: WASTEWATER TREATMENT SYSTEM
CHAPTER 5: PRELIMINARY TREATMENT

TABLE OF CONTENTS

Page No.

LIST OF TABLES

LIST OF FIGURES

PRELIMINARY TREATMENT

5.1 PURPOSE

The purpose of this chapter is to develop a conceptual layout for a new headworks facility and estimate the overall capital cost using the conceptual layout. Alternatives for bar screens, screening conveyors and vortex grit basins are also evaluated. Final decisions about a specific layout and specific equipment type should be determined during the preliminary and final design.

5.2 CONCLUSIONS AND RECOMMENDATIONS

- The existing headworks facility is re-rated at a capacity of 37 mgd on an average daily flow basis. An additional separate headworks facility is planned for an average daily flow of 15 mgd.
- Based on the conceptual layout, the total project cost for the new headworks facility is estimated to be $9.89 million, based on an Engineering News-Record (ENR) value of 8,570 (Los Angeles, August 2006).
- Two mechanical bar screens (one duty and one standby) and one manual bypass bar screen are recommended for the new headworks.
- Climber-type and chain-and-rake-type are two alternatives for the bar screens. They should be further evaluated during preliminary design.
- A shaftless screw conveyor is recommended over a belt conveyor for screenings conveyance.
- A sloped-bottom vortex grit basin is recommended over a flat-bottom grit basin because the accumulation of settled grit can be minimized, and also because the equipment can be bid instead of sole-sourced.
- The headworks will be covered for odor control, and foul air will be continuously withdrawn and treated in a biofilter.

5.3 BACKGROUND

The current headworks facilities at the Regional Water Quality Control Plant (RWQCP) were built in 1999 based on an average daily flow of 50 mgd and a peaking factor of 2.0 (peak flow of 100 mgd). Table 5.1 lists the equipment included in the existing headworks facilities. There is a lack of redundancy, due to no standby grit chamber, and based on performance it appears that the grit chamber capacity is less than the manufacturer's rating of 50 mgd on an average daily flow basis. For this Integrated Master Plan, the grit chambers are re-rated at a more conservative capacity of 37 mgd for average daily flow. An average daily flow of 52 mgd and a wet weather peaking factor of 2.2 are used for the Integrated Master Plan. Based on the apparent capacity of the existing grit basins, it was decided at the project meeting on September 20, 2006 that the sizing for an additional separate headworks facility would be planned for an average daily flow of 15 mgd and a wet weather peak flow of 33 mgd for the Integrated Master Plan.

Table 5.1 Existing Headworks Facility
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

Equipment	Type	Qty	Note
Bar Screens	Climber	4	1/2-inch opening.
Raw Screenings Conveyors	Shaftless Screw	2	
Grit Screenings Conveyors	Shaftless Screw	2	
Grinders		2	
Washer/Compactors		2	
Grit Basins	Vortex (Sloped-Bottom Type)	2	20-foot diameter.
Grit Pumps	Centrifugal Recessed Impeller	2	250 gpm each, 45-foot head.
Grit Classifiers (Teacup)	Hydraulic Vortex	2	250 gpm each, 42-foot diameter.
Grit Dewatering Unit (Snail)		2	18-inch belt width.

5.4 CONCEPTUAL LAYOUT

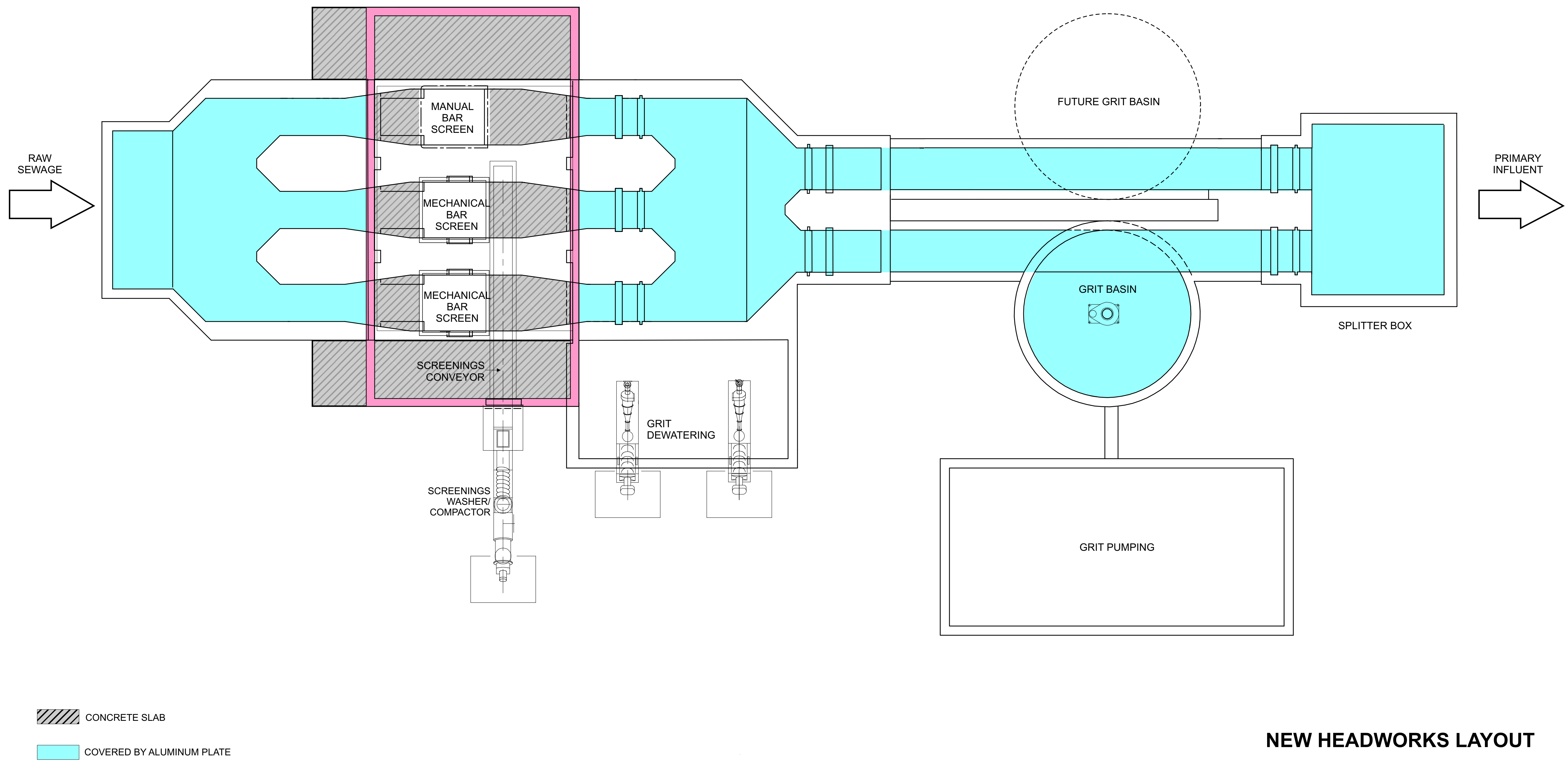
The conceptual layout for the new headworks with a wet weather peak flow of 33 mgd is shown in Figure 5.1.

The new headworks will have three channels for bar screens. Two mechanical bar screens are shown in two channels with one duty and one standby at peak flow, and one manual bar screen in a bypass channel for redundancy.

A conveyor will be required to convey screenings from the two automatic bar screens to the screenings washer and compactor for screenings disposal.

The screened wastewater will flow to a vortex grit basin. A bypass channel can be used if the grit basin needs to be bypassed. The space for a future grit basin is also included. The grit will be pumped to grit washers before disposal.

The new headworks will be covered for odor control. The bar screens will be enclosed in a building, and the channels and the grit basin will be covered by aluminum plate. The foul air will be continuously withdrawn and treated in a biofilter that is discussed in Volume 4, Chapter 6 - Primary Treatment.



NEW HEADWORKS LAYOUT

FIGURE 5.1

carollo
Engineers...Working Wonders With Water™

WASTEWATER COLLECTION AND TREATMENT FACILITIES INTEGRATED MASTER PLAN

CITY OF RIVERSIDE

20-Riverside2-08\Volume 4-F5.1-7472A00.cdr

Upstream of the headworks, a metering and flow splitting facility will be provided to split flow between the existing and future headworks.

Based on the conceptual layout, the total project cost for the new headworks facility is estimated to be $9.89 million, based on an ENR value of 8,570 (Los Angeles, August 2006).

The total cost estimate for the new headworks facility is summarized in Table 5.2.

Table 5.2 Total Cost Estimate of New Headworks Facility
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

Item	Percentage	Value	Subtotal
Subtotal Direct Costs			$3,120,000
Sitework	10%	$310,000	
Electrical and Instrumentation	15%	$470,000	$3,900,000
Contingency	30%	$1,170,000	$5,070,000
General Conditions	10%	$510,000	$5,580,000
General Contractor Overhead and Profit	15%	$840,000	$6,420,000
Sales Tax on Materials	7.75%	$200,000	$6,620,000
Bid Market Allowance	15%	$990,000	$7,610,000
Engineering Management and Legal	30%	$2,280,000	
Total Project Cost			**$9,890,000**

5.5 BAR SCREENS

The existing headworks facility has climber-type bar screens. Climber-type bar screens are a well-proven technology with many successful installations. The primary advantage of climber-type bar screens over most other screens is that all moving parts are out of the wastewater. For future expansion, chain-and-rake-type bar screen with multiple rake bars mounted onto chains could be considered as an alternative to the climber-type screens.

One option for a chain-and-rake-type bar screen is Mahr™, as shown in Figure 5.2. It has a lower profile than the climber-type bar screens, and requires less than 8 feet of headspace. Mahr™ is offered with a two-speed drive with automatic reverse ability to remove obstructions. Though the lower sprockets of Mahr™ are submerged in the wastewater, they have self-lubricated bearings and require no greasing.

Another option for a chain-and-rake-type bar screen is the Duperon® FlexRake, as shown in Figure 5.3. The chains (FlexLinks™) of the Duperon® FlexRake bend in only one direction providing both flexibility and rigidity. The design has no lower sprockets. The primary disadvantage of the Duperon® FlexRake is the limited number of long-term installations.

A summary and comparison of climber-type and chain-and-rake-type bar screens are presented in Table 5.3 and Table 5.4. The City of Riverside (City) should re-evaluate both alternatives during preliminary design, when chain and rake type screens have more experience.

Table 5.3 Summary of Climber- and Chain-and-Rake-Type Bar Screen Advantages/Disadvantages
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

Climber-Type Bar Screen Advantages	Climber-Type Bar Screen Disadvantages
• No moving parts in wastewater flow. • More installation experience.	• Height of equipment requires taller building. • Long cycle time for a deep channel. • Higher maintenance requirement.
Chain-and-Rake-Type Bar Screen Advantages	**Chain-and-Rake-Type Bar Screen Disadvantages**
• Reduced height of equipment above deck compared to existing climber-type unit. • Continuous operation and multiple rakes reduce cycle time. • Lower maintenance.	• Moving parts in wastewater flow. • Maintenance of bottom sprockets requires channel access (only for Mahr™). • Limited number of long-term installations.

Table 5.4 Comparison of Bar Screens
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

	Chain-and-Rake	Climber
Operating Experience	0/–(1)	+
Reliability	+/0(1)	+
Moving Parts in Wastewater	–/0(1)	+
Height of Equipment	+	–
Maintenance Access	–/0(1)	0
Maintenance Requirement	0	0
Equipment Cost	0	0
Capital Cost	0	–(2)
O&M Cost	0	–(3)

Notes:
(1) Varies by manufacturer (Mahr™/Duperon®).
(2) Requires the building to be taller.
(3) More foul air to treat.

Ratings:
+ = Positive comparative characteristic.
– = Negative comparative characteristic.
0 = Neutral comparative characteristic.

5.6 SCREENING CONVEYORS

Shaftless screw conveyors are currently used at the RWQCP. A belt conveyor is compared as an alternative as requested at the project meeting on September 20, 2006. A typical belt conveyor and shaftless screw conveyor are shown in Figure 5.4 and Figure 5.5, respectively.

A summary and comparison of the two conveyor alternatives are presented in Table 5.5 and Table 5.6. Based on the discussion in the October 18, 2006 meeting, a shaftless screw conveyor is preferred for the new headworks.

Table 5.5 Summary of Belt and Shaftless Screw Conveyor Advantages/Disadvantages
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

Belt Conveyor Advantages	Belt Conveyor Disadvantages
• Can convey large objects.	• Can be messy (significant housekeeping requirements). • Not well suited for very wet material (with free water). • Spillage/carryover can generate additional odors. • Large number of rollers and idlers require frequent maintenance.
Shaftless Screw Conveyor Advantages	**Shaftless Screw Conveyor Disadvantages**
• Clean. • Suitable for wet material (with free water). • Few components.	• May have difficulty conveying large objects. • Conveying abrasive material will reduce the liner life.

Table 5.6 Comparison of Belt Conveyor and Shaftless Screw Conveyor
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

	Belt	Shaftless Screw
Cleanliness	–	+
Maximum Incline	0	+
Large Object Conveyance	+	–
Very Wet Material Conveyance	–	+
Number of Components	–	+
Maintenance Requirements	–	+
Odor Control Covers	–	+

Ratings:
+ = Positive comparative characteristic.
– = Negative comparative characteristic.
0 = Neutral comparative characteristic.

A life-cycle cost analysis is performed for the two conveyor alternatives. As shown in Table 5.7, the life-cycle cost of the shaftless screw conveyor is slightly lower than the belt conveyor.

Table 5.7 Life Cycle Cost Analysis of Conveyors
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

	Belt	**Shaftless Screw**
Capital Cost	$58,000	$50,000
Replacement Frequency	Every 10 years	Every 4 years
Replacement Cost	$1,600(1)	$3,800(2)
Monthly Maintenance Cost(3)	$100	$0
Semi-Annual Maintenance Cost	$100	$100
Life Cycle Cost(5)	**$84,000**	**$67,700**

Notes:
(1) Belt cost of $800 plus labor of two people for 1 day at $50/hour.
(2) Liner cost of $3,000 plus labor of two people for 1 day at $50/hour.
(3) Grease bearings: 2-hour labor.
(4) Oil change: 2-hour labor.
(5) As present value, assuming life-cycle period of 19 years, discount rate of 6 percent, and escalation rate of 6 percent for the first 5 years and 4 percent thereafter.

5.7 SCREENINGS WASHER/COMPACTOR

A screenings washer/compactor that achieves washing and dewatering would be used in the new headworks. A typical one that would be evaluated during preliminary design is shown as Figure 5.6.

5.8 GRIT BASINS

It was decided the new headworks would include vortex grit basins at the project meeting on September 20, 2006. Typical sections of sloped-bottom and flat-bottom grit basins are shown in Figures 5.7 and Figure 5.8, respectively. These two alternatives are compared in Table 5.8. Carollo Engineers recommends sloped-bottom vortex basins because they minimize the accumulation of settled grit at the bottom, and also because they are non-proprietary, so they can be competitively bid.

Table 5.8 Comparison of Flat- and Sloped-Bottom Vortex Grit Basins
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

Characteristic	Flat-Bottom	Sloped-Bottom
Proprietary Equipment	–	+
O&M Requirements (Due to Grit Buildup on Basin Bottom)	–	+
Capital Cost	+	+
Required Land Area	+	+
Grit Removal	0	0
Odor Control Requirements	+	+
Reliability	0	0
Flow Turn Down	–	0
Hydraulic Head Loss	+	+

Ratings:
+ = Positive comparative characteristic.
– = Negative comparative characteristic.
0 = Neutral comparative characteristic.