Moonlight Beach Urban Runoff Treatment Facility

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1.0 INTRODUCTION

Moonlight State Beach (Pacific Ocean) is the most popular coastal feature in the City of Encinitas and is one of North San Diego County's most famous recreation areas with over 2.5 million visitors in the year 2000. However, in the same year, there were over 90 days of beach postings/closures at Moonlight Beach, in addition to the year-round postings at the Cottonwood Creek outfall, which discharges onto the north shore of Moonlight State Beach. This number of postings/closures ranks fourth in San Diego County. Postings/closures negatively impact the coastal community that relies heavily on coastal tourism and recreation revenue. A recent study concluded that the economic value of the City of Encinitas beaches is $47 million per year. The Pacific Ocean at Moonlight State Beach is also listed by the State as an impaired water body for bacteria.

2.0 OVERVIEW OF WATERSHED

The Cottonwood Creek watershed, also referred to as Old Encinitas in City planning documents, is entirely within the jurisdictional boundary of the City of Encinitas. It is approximately three square miles (2,000 acres) and extends from the Encinitas Ranch Golf Course in the east to Moonlight Beach in the west. The watershed generally slopes gently westward towards the Pacific Ocean with the highest point at approximately 400 feet mean sea level (MSL) along the bluffs on the eastern boundary of the watershed. It is estimated that approximately ninety-five percent of the watershed is heavily urbanized including the largely commercial areas of old Encinitas.

Creek Flows

Cottonwood Creek is a perennial stream comprised of groundwater and urban runoff during the dry season. It also serves as a major storm drain channel for wet weather flows. The average dry weather flow has been approximated at 100 gallons per minute (GPM) near the mouth of Cottonwood Creek as it passes beneath Third Street. Continual flow monitoring was performed at this location for a one-week period in November of 2001 as part of a separate project. This monitoring measured an average dry-weather flow of approximately 65 GPM. No significant rainfall had occurred prior to the time of measurement. The flow data also indicated no diurnal pattern. A permanent flow monitoring station has been set up at 3rd and B, which indicates an average flow rate of 150 GPM. A strong diurnal pattern may be

indicative of urban runoff associated with early morning or evening over-irrigation. No diurnal pattern may suggest that groundwater makes up a significant portion of the creek flows. Groundwater expression on the slopes above the channel (along Highway 101) also suggests that groundwater is present in the creek (Pacific Southwest Biological Services 2000). However, at this point there is not enough data to make a firm determination of the amount of groundwater that contribute to creek flows.

Moving up the creek from the mouth, the flows taper off gradually. Most of the tributary flows at the upper sampling point had on the order of 5 GPM although the flow in Moonlight Creek is somewhat higher. At the eastern side of the watershed the creek dries up completely just below the new Encinitas Ranch development adjacent to Quail Gardens Drive. Other tributaries were also dry just upstream of their convergence with Cottonwood Creek. These include the open channel along the southeast side of Interstate 5 south of Encinitas Boulevard, located in the Requeza sub-basin, and Moonlight Creek along the west side of Interstate 5 north of Encinitas Boulevard. The other main tributary to Cottonwood Creek is the drainage along Encinitas Boulevard joining the Creek at the intersection of Encinitas Boulevard and Quail Gardens Drive. This tributary had very low flows where it daylights near the San Dieguito Union High School District Offices (SDUHSD), just west of Delphinium Street. Above that point the tributary is underground and the flow source can not easily be traced.

Water Quality

The City of Encinitas has monitored the dry weather water quality in the watershed for several years. In addition, the City, the State, and other nonprofit organization sample the water quality at Moonlight Beach at the mouth of Cottonwood Creek. This sampling often shows exceedences of enterococcus bacteria (failure to meet AB411 requirements). The City has determined that the source of bacteria is urban runoff from Cottonwood Creek. In addition to high bacteria levels, historical testing has shown high levels of nitrogen and ammonia in the creek.

The California Regional Water Quality Control Board (RWQCB) listed the Pacific Ocean at Moonlight State Beach near the outlet of Cottonwood Creek as 303(d) impaired by coliform bacteria, in accordance with the EPA Clean Water Act. Heal the Bay's Summer 2000 Beach Report Card™ gave Moonlight Beach an “F” based on risk of adverse health effects to humans. They name the cause as Cottonwood Creek. The typical cause of beach postings/closures is enterococcus bacteria exceedences in the ocean (failure to meet Assembly Bill 411 (Wayne, 1997) requirements. The City and State have determined that the source of these harmful bacteria is urban runoff in Cottonwood Creek. Cottonwood Creek drains a 2,000 acre, highly urbanized watershed. Typical dry weather flows near the mouth of Cottonwood Creek are estimated to be in the range of 150 gallons per minute (gpm). Recent water quality assessments indicate that the average enterococcus levels are approximately 1,500 CFU/100ml in Cottonwood Creek. Though the bacteria becomes diluted in the surf zone sampling area, the creek bacteria levels are over an order of magnitude higher

than AB 411 single-sample standards of 104 CFU/100ml for enterococcus. Several years of upstream best management practices (BMPs) and heavy enforcement of urban runoff regulations appear to have improved water quality in the creek. However, bacteria standards are consistently exceeded, and beach postings/closures continue to plague the beach. Thus, a more aggressive contaminant treatment system was proposed.

The County of San Diego will post the beach within one to four days when one bacteria sample exceeds a sample. For instance, if a fecal coliform sample exceeds the sample the data will not be available until 4 days later. There is no geometric mean analysis or comparison with the other bacteria data.

Land Use

The Cottonwood Creek watershed is primarily a suburban area with over half of its area designated as residential. It is estimated that the watershed is approximately 95 percent developed. The next largest land use category is transportation corridors, making up 18 percent of the area. Public/semi public areas make up 14 percent of the watershed, and parks/open space make up approximately 2 percent. Only seven percent is commercial and light industrial, and four percent agricultural. **Table 1** provides a breakdown of the land use within the watershed.

TABLE 1
SUMMARY OF COTTONWOOD CREEK WATERSHED LAND USE

Land Use Category	**Percent of Watershed**
Residential (low, medium and high density)	55
Right-of-way and Transportation Corridor	18
Public/semi-Public	14
Ecological Resource, Open Space, Park	2
General Commercial/Light Industrial	7
Agricultural	4
Total	100

There are jurisdictional wetlands within the watershed that have been professionally mapped. These include areas along Cottonwood Creek from Moonlight Beach to Highway 101, and along Cottonwood and Moonlight Creeks adjacent to Interstate 5, just north of Encinitas Boulevard.

3.0 Causes of Degradation

Cottonwood Creek is ninety-five percent urbanized. The creek is underground for the majority of the conveyance channel. Strips malls with gas stations, restaurants, grocery stores sit directly on top of the creek. Anyone with a hose can change the water quality in the creek and the beach. The upper watershed consists of nurseries and residential communities.

The City of Encinitas has been known as the Flower Capitol. With that claim to fame also comes an elevated nitrogen, ammonia and bacteria level. Growers

characteristically use an abundant supply of water and have used their storm drains to discharge their waste stream. During numerous source control investigations the water quality evidence suggests pollutant loads generated from nurseries.

4.0 Source Control

The City of Encinitas has one of the most aggressive urban runoff programs in San Diego County. For years the City has investigated pollutant sources and methods for reducing beach closures at Moonlight Beach. Structural and nonstructural BMPs have been implemented throughout the watershed. Particularly, the City has issued hundreds of Notices of Violations to restaurants, gas stations, automotive and other businesses for storm water infractions. Two years of general source identification, upstream BMPs and enforcement within the watershed have improved water quality, specifically; testing has shown a decrease in turbidity, bacteria and pH.

The City has also performed an exhaustive water quality analysis along with a summary of Land Uses within the Cottonwood Creek watershed. Contaminate loading can be pinpointed to specific land uses within this watershed.

The City has also purchased a VAC-CON truck to vacuum debris out of the catch basin inlets. Each inlet has been cleaned out in order to reduce trash and debris from entering the storm drain conveyance channel. Site specific catchbasin inlets have also been retrofitted with filters to collect pollutants before they impact the water.

5.0 Location

The most important decision for the viability of the treatment facility was the choice of where the plant would be located. At 3rd and B Street, one block from the beach, is a sewer pump station. By locating the Urban Runoff Treatment Facility within an existing utility structure a number of aesthetics and environmental issues were eliminated. The community character was not a factor since the treatment facility is located within the footprint of an existing utility. A second consideration was how do we direct the flow from the creek without impacting the creek? This issue was resolved by drawing the water from an existing box culvert under 3rd Street and returning the flows into the box culvert.

6.0 Treatment Options Proposed

The City had a number of options to choose from for treating the creek water:

Diverting to the sewer system
Chemical Treatment i.e., chlorine
Ozone generation
Ultraviolet Treatment

After discussing each option in detail the most logical, cost effective and least land intensive option was ultraviolet treatment.

7.0 PROCESS OVERVIEW

Pump Station

Water is withdrawn from Cottonwood Creek and diverted to a five-foot diameter circular concrete wet well. Water is collected via five (5) 4-inch diameter screened openings, discharging into a common 4-inch diameter PVC pipe connected to the wet well. Two 7.5 horsepower float controlled submersible pumps (one duty and one standby), each rated at 150 GPM at 60 feet total dynamic head (TDH), delivers water to the UV treatment facility via a 4-inch PVC pipeline. A check valve on each pump discharge line prevents reverse flow into the wet well. The level in the wet well is monitored with an ultrasonic level transmitter. A slide rail system with lifting chains was provided to allow the pumps to be removed from service for maintenance or repair.

Basket Strainers

After pre-screening at the wet well intake, a second stage of screening is provided by two (2) 3-inch diameter PVC basket strainers connected in parallel. The baskets entrap unwanted material that has passed through the first stage of screening, thereby improving the performance of the dual media filtration system, and protecting the UV units from damage.

Dual Media Filtration System

After screening, water is filtered through two (2) 30-inch diameter dual media (sand and anthracite) pressure filters manufactured by Yardney Water Management Systems. The filters are operated in parallel. Water enters the filter at the top of each filter vessel and flows, under pressure, through the media where solid particulate and suspended organic and inorganic solids are removed. The filters operate at 15.3 gallons per minutes per square foot (GPM/sf) at the design flow rate of 150 GPM. Filters are backwashed periodically to remove trapped material. The parameters used to determine the need for backwashing include effluent turbidity, filter head loss (differential pressure), and elapsed time of operation. Water for backwashing is obtained from the City's potable system and is metered through a 2-inch propeller flow meter. Through the use of a three-way valve, the flow through each tank can be reversed, causing a turbulent expansion of the media and the flushing of entrapped particulate matter. The backwash system is sized for a 95 GPM rate at 40 psi. The backwash (waste wash water) flow is discharged to the sewer.

UV Disinfection System

The UV disinfection system consists of two (2) Aquionics GSA4 UV Disinfection Chambers and two (2) Power/Control Modules installed in series. Each GSA4 unit consists of a Type 316 stainless steel chamber with integral 4-inch inlet and outlet flanges. Each unit consists of four (4) low-pressure, high intensity (160VIK) UV lamps installed in high purity quartz sleeves and contains a motor driven automatic cleaning mechanism for wiping the sleeves and a temperature sensor to shut down the unit in the event of overheating due to no flow conditions. Each Disinfection Chamber is approximately 48-inches in length and 8-inches in diameter, with an operational pressure rating of 100 psi (rated for 150 psi test pressure). The units

weigh 77 pounds when dry, and 132 pounds when flowing full. The required electrical supply is 220 volts at 60 Hz, consuming 510 watts at full power. The units are mounted horizontally.

The GSA4 Power/Control Module is equipped with a main switch, manual wipe push button, and various alarms. When placed into operation, the UV lamps take five (5) minutes to warm up. The automatic lamp wiper mechanism operates on a timed cycle basis from an operator adjustable timer mounted in the UV chamber Power/Control Module.

Instrumentation and Controls
The entire system is operated from a single Allen-Bradley Micrologix 1500 programmable logic controller (PLC). The unit is equipped with an Allen-Bradley Panelivew-600 touch screen color display. System controls are set to shut the entire system down on three operating conditions: high level in the wet well, high pump discharge pressure, and high effluent turbidity.

Flow Metering/Control
The flow treated by the facility is metered downstream of the UV units with a GF Signet insertion paddlewheel flow meter. The flow rate is controlled with an electrically operated, modulating butterfly valve. The flow meter signal is input directly into the PLC program to allow Average Daily Flow Rate (GPM), Total Daily Volume (Gallons), and Total Monthly Volume (Gallons) to be continuously monitored. The treated flow is returned to Cottonwood Creek via a 4-inch PVC pipeline.

Water Quality Monitoring
Effluent from each UV disinfection chambers is monitored with a single Hach 1720D process turbidimeter. The range of the unit is 0-100 nephelometric turbidity units (NTU).

Piping and Valves
Schedule 80 PVC pipe and fittings were used to assemble the entire treatment system. PVC true union ball and butterfly valves were used throughout to provide isolation, shut-off, and control, as required.

Facility Enclosure
The entire UV disinfection facility was assembled as a package system by Clear Creek Systems, Inc., and installed by Falcon General Engineering Inc. of Vista, CA. The system is housed in a 24 foot long by 10 foot high by 10 foot wide steel prefabricated steel enclosure. The enclosure was painted sea foam green inside and out.

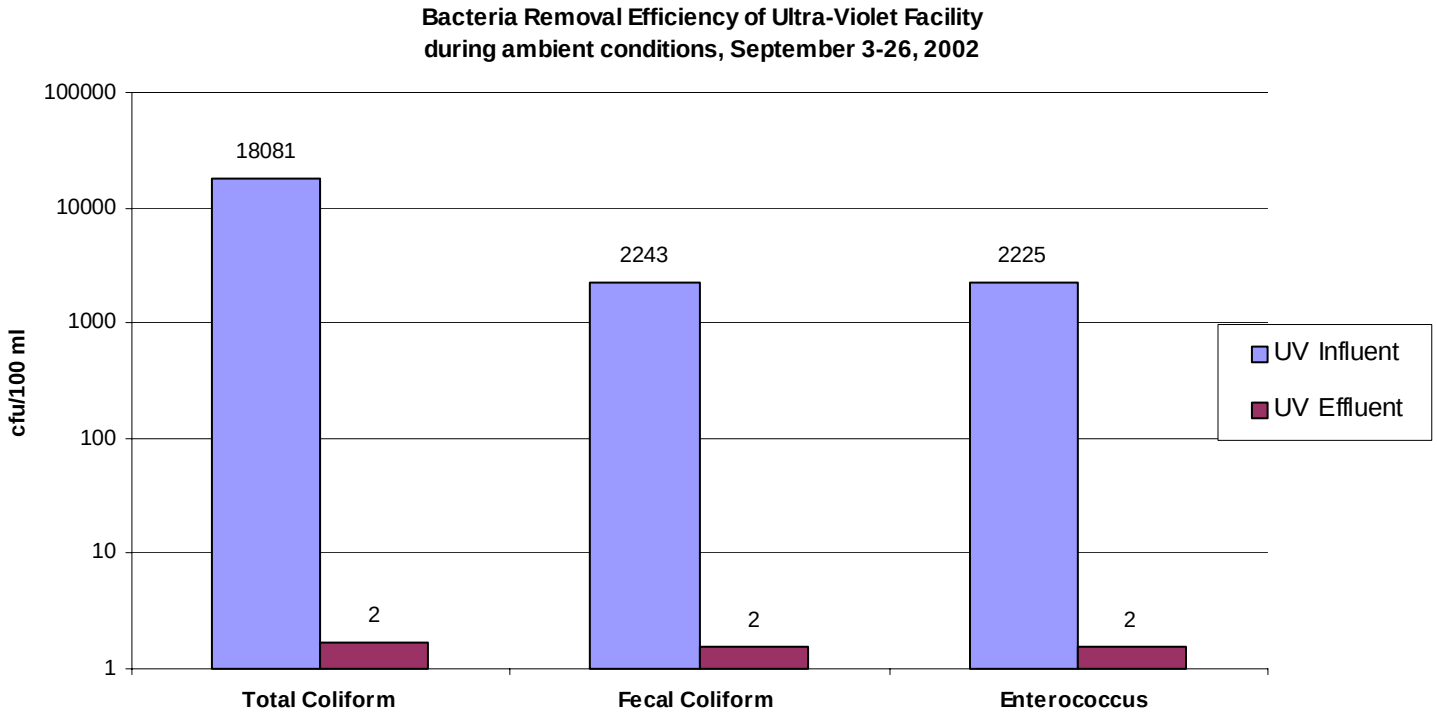
Design Criteria Summary
Key design criteria for the City of Encinitas facility are summarized in the table below:

City of Encinitas Moonlight Beach UV Disinfection Facility		
Description	Number	Design Values
Flow Rate	-	150 GPM
Wet Well	1	5 foot diameter
Submersible Pumps	2	7.5 horsepower each @ 150 GPM @ 60 feet TDH
Discharge Piping	-	4-inches
Basket Strainers	2	3-inch diameter
Dual Media Filtration System ½-inch x ¾-inch crushed rock 1.45 mm garnet 0.35 mm garnet 0.75 mm anthracite Filtration rate Backwash rate	2 - - - - - -	30-inch diameter 2.5 cubic feet 2.5 cubic feet 7.5 cubic feet 7.5 cubic feet 15.3 GPM/sf 75 GPM @ 40 psi 15.3 GPM/sf
UV Disinfection Chambers Construction Inlet and Outlet Size Lamps Size Pressure Rating	2 - - 4 - -	Aquionics GSA4 Type 316 SS 4-inches (flanged) 160VIK lamps 48-inches long x 8-inches diameter 100 psi (operational) 150 psi (test)
Controller	1	Allen-Bradley Micrologix 1500 PLC
Flow Meter	1	GF Signet insertion paddlewheel
Turbidimeter	1	Hach 1720D
Facility Enclosure	1	24 foot long x 10 foot high x 10 foot high painted steel

8.0 Construction Schedule

Contract awarded on April 10, 2002
Construction began on June 10th, 2002
Facility completed August 29th, 2002
Ribbon cutting ceremony September 20th, 2002

9.0 Monitoring Results



Biological Monitoring

The City hired a biological consultant, MEC Analytical Systems, Inc to prepare a biological report to characterize existing habitats, terrestrial wildlife and aquatic resources in the project area. Due to past practices it appears only species with moderate to high tolerance ranges survive.

10.0 Operation and Maintenance

San Elijo Joint Powers Authority and the City of Encinitas have taken over the Operations and Maintenance of the Urban Runoff Treatment Facility as of September 20, 2002. The City has been experiencing equipment failures due to the speed of the installation of the project. Each contractor and subcontractor has responded and replaced any malfunctioning unit. The system is under warranty for one year therefore, any malfunction is at the cost of the subcontractor.

The system has been set up to reduce the turbidity to the maximum extent practicable to help reduce the bacteria to the highest level. The cost to replace specific parts are as follows:

UV Lamp - $427.00
Quartz Sleeve - $419.00
O-Ring – (2 per sleeve) - $6.15
Wiper ring – (1 per sleeve) - $27.70
Ballast - $461.00
Multi-media chamber - $1,835.00

The multi-media chambers must be backwashed on a routine basis and therefore requires water to flush the chambers. The system can be set for a timed interval or by a differential pressure system. The water intake has increased the cost of the project until a pressure differential pressure system has been established.

11.0 Project Reflections

The overall project has been a true success. The City has reduced the bacteria levels entering the Pacific Ocean at Moonlight State Beach. The public can feel secure that their health has been protected to the maximum extent practicable.

Project improvements would include a better screening system needed to keep aquatic organisms out of the pumps and wet well. Plus, a improved 15% by-pass system still needs to be addressed. Richard Brady and Associates are designing a new by-pass system that will be in place by April.

12.0 Teamwork

This project was a complete success because of teamwork, cooperation and partnerships. We would like to acknowledge and thank the following agencies, companies, and environmental groups that made this possible.

Governor Gray Davis and the State Resources Control Board
Encinitas City Council – Mayor Christy Guerin, Deputy Mayor James Bond, Jerome Stocks, Maggie Houlihan and Dennis Holz
Contractor - Falcon General Engineering, Inc.
Construction Manager - Richard Brady and Associates
Contract Management - Ashford Engineering, Inc.
Operations and Maintenance - San Elijo JPA
UV Supplier - Clear Creek Systems
Project Designer - PBS&J
Biological Monitoring - MEC Analytical Systems, Inc.
Environmental Support – Baykeepers
City Staff – Kipp Hefner, Paul Hartman, Matt Chirdon, Kathy Weldon