

Modular Wetlands Impact on Water Quality in Oceanside Harbor

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Background

The location of Modular Wetland unit that the sampling and analysis was completed is the boat washing area in Oceanside Harbor in Oceanside, California. Oceanside Harbor is heavily used with dozens of boats being washed down daily in a small area where the septic tank disposal area is also located (fig. 1).



Figure 1: (top) Modular Wetlands Linear; (bottom) Oceanside Installation

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The wash water is typically potable water that is used to wash the boats, soap is not allowed but many waste products enter the wash off water and into the storm drains (figure 2), which is treated by the device being tested – Modular Wetlands Storm Water Filtration System(MWS)before being directly discharged into Oceanside Harbor.



Figure 2: Left posted signage, Right Washing area with soap being used.

The pollutants contained in the wash water can include sand, sewage waste, plant materials, oil grease, diesel, dead fish, paper products, soap products and petroleum products. Samples analyzed from 2007-2008 show multiple instances of Total Coliform above 1,600,000 MPN/100ml, Fecal Coliform above 18,755 MPN/100ml, and Enterococcus above 24,196 MPN/100ml, all of which are above the action level determined by the City of Oceanside. The action levels are 160,000 MPN/100m for Total Coliform, 18,755 MPN/100m for Fecal Coliform and 17,820 MPN/100m for Enterococcus for the City of Oceanside.

Before the Modular Wetlands Device was installed, the boat wash water was treated by StormCeptor vaults installed in 2003. After installation, bacteria levels still exceeded action levels. Further attempts to reduce bacteria levels resulted in a pilot study conducted by the City of Oceanside. According to the Bacterial Reduction Pilot Program – Oceanside Harbor, XTEX AM antimicrobial fabric filters were installed on the separator vaults in addition to more frequent cleaning of the boat wash out separation vaults and drains as part of the study.

While monitoring results showed an initial reduction in bacteria levels, the product did not display long-term effectiveness. The antimicrobial fabric showed a decrease in performance as sediment and hydrocarbon levels from run off increased.

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In response to the need for an all encompassing treatment device to deal with trash, debris (organic and non organic) solids, sediment, total suspended solids (“TSS”), metals (dissolved/particulate), nutrients (dissolved/particulate), oils, hydrocarbons, polycyclic aromatic hydrocarbons (“PAH”), and pathogenic bacterium contaminants, the City of Oceanside authorized the installation of the Modular Wetlands Device in April of 2008. The peak treatment capacity of the device is estimated to occur approximately six months from time of installation when the plants in the wetland chamber are mature.

Advanced Treatment Device Description

Introduction

Described as a structural/LID hybrid, the Modular Wetland System – Linear is a revolutionary stormwater treatment system. This treatment system utilizes an innovative combination of physically passive and natural biological treatment processes, including the use of a breakthrough filter media, BioMediaGREEN, which acts as a pre-treatment media filter for the enhanced 4th generation sub-surface flow wetland. These features combined with other various treatment and flow control technologies has lead to a system that maximizes pollutant removal and minimizes maintenance.

Testing Environment and Test Procedures

The Modular Wetlands device to be tested is located in a non typical situation. Unlike a storm event that typically contains higher concentration during the first 2 hours our site has a fairly consistent flow of wash water that is estimated to be consistent through out the day. For this reason, composite samples were taken over a two hour period. The intent of the sampling was to establish a composite pollutant sample. This was done by dividing all of the containers and bottles to be filled for testing into ten equal parts. The grab sample was taken and then the appropriate amount was measured and placed in each of the composite sample bottles. A total of 20 samples were taken over the course of 120 minutes, ten from the inlet located in the front chamber of the MWS (Figure 3) and 10 from the outlet located in the third cell or discharge area (Figure 4). This yielded two composite samples for each sampling event. To validate the event mean concentrations, flow data was obtained by a flow meter that measured gallons used in the entire boat wash area. The flow meter allowed use to accurately determine the amount of wash water flowing into the Modular Wetlands Device. The flow meter was not installed until approximately July 3 so no flow data was available prior to the installation. Electronic readings were taken for pH, TDS, Conductivity, Temperature, Oxidation Reduction Potential (ORP), and Turbidity. Bacteria was not anticipated to be effected until the plants roots had extended to the bottom of the MWS, that is why bacteria sampling was not started until July. Bacteria analysis for Fecal Coliform, enterococcus, and E.coli were conducted by Weston Solutions. Analysis for TSS, Copper, Lead, Zinc, N-Nitrates, and TPH were conducted by DTEK Laboratories. All of the samples where collected by Geosphere Consultants staff and who prepared a chain of custody for all samples.

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Figure 3 Inflow chamber



Figure 4: Outflow

Testing Problems

Testing began on May 30, 2008 approximately eight weeks after the installation of the device. Plants being used in the system are Vetiver grass, a fast growing plant with large root bundles. The initial plants were only 8 to 10 inches high with about the same amount of root mass below the surface.



Photo taken April 8, 2008



Photo taken August 8, 2008



Photo taken September 29, 2008

This meant that the plants were doing little in the beginning to clean the inflow. In the beginning it was not known if the plants would survive such a harsh environment. But after five months the plants have proven that they are a plant well designed for this environment. Some benefits about these plants are that they produce no seed, have no rhizomes, and can only reproduce by physically moving a piece of the plant. At five months, the plants are three feet in height and the root systems are now reaching the bottom of the wetland chamber (see photos above).

Two key problems were identified that have a direct impact on test results. The first is, even though signs are posted, boat enthusiasts continually use soap products to clean their boats which goes directly into the inlet of the MWS. This will cause an increase in a variety of pollutants. The second problem is that the septic dump sites are directly above the inlet for the MWS. During testing, our staff observed, on several occasions, that septic waste was being discharged directly to the drain and into the MWS. Because of the improper use of the septic dumping sites we anticipated that the bacterial counts would have a high degree of variability. We had sufficient data from the City of Oceanside to show that bacteria levels were high, knowing that the MWS

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would not be effective against bacterial until the plants had matured. Plant roots were observed in the bottom of the MWS in early August and testing began August 15.

Summary of Test Results

The test results are provided at the conclusion of this report. A total of ten composite samples were taken over a four month period. The field measurements were taken on each of the grab samples that were used to make up the composite sample. The field data showed that the system had positive impact on pH and Turbidity. pH was consistently on the alkaline side ranging from 6.07 to 8.56 with an average of 7.64. In six of the nine tests, pH was reduced an average of 0.1 to 0.2 and where readings were on the acidic side at the inlet, the pH was increased after going through the MWS as much as 0.5 closer to neutral.

Turbidity entering the system averaged 23.3 ntu and was high as 48.4 ntu. Water exiting the system showed a marked improvement in clarity averaging 8.4 ntu and was low as 0.34 ntu. The MWS reduced the turbidity at an average of 62%.

Positive outcomes indicate the system is working very well in reducing copper, zinc, total suspended solids (TSS), and total petroleum hydrocarbons (TPH). It is anticipated that as the system matures the plants will play a larger role in reducing pollutants. Copper, lead and zinc levels were entering the system in very low concentration. Copper ranges from 0.06mg/l to 0.02 mg/l, Lead was < 0.10mg/l, and zinc ranged from 0.11 to 0.38. The outlet levels for copper ranged from <0.02 to 0.03, this is an average reduction of 52.7%. Lead was entering at concentration below the detectable limit of <0.10 mg/L and exiting the system at <0.10 mg/L, therefore no removal efficiency could be established. Zinc level was also low at the inlet ranging from 0.11 to 0.38. The zinc leaving the system was greatly reduced down to levels of <0.05 to a high of 0.06. Zinc reductions averaged 79%. TSS was significantly reduced by MWS. A particle size analysis was performed on the influent end of the system; 82% of the particles were less than 15 microns in size. TSS entered the inlet with levels ranging from 22 to 92 mg/L; the outlet levels ranged from 0.13 to 17. TSS reductions averaged 81.9%. TPH, which includes gasoline, diesel and motor oil, were present in the inlet water and could be visibly seen. Average reduction of gasoline was 42.5%. Reduction of diesel and motor oil was 100% during one sample; there were no influent concentrations during other sample periods. The nitrate-n seemed to have a significant reduction in the range of 69% to 83% in four out of the five test runs. Average nitrate-n reductions were 76.1%.

Testing was performed for three different bacteria: fecal coliform, e.coli, and enterococci. One set of samples were taken on 7/7/2008. The results are very promising with an 84% reduction in fecal coliform, 79% for enterococci, and 70% for E. coli. Overall there still appears to be a significant lowering of the bacteria levels due to the MWS. As the system matures, it is felt that bacteria levels should reduce even further.

Conclusion

With the testing that has been done to date we can show that the MWS has the ability to significantly reduce copper, zinc, total suspended solids (TSS), turbidity, and Total petroleum

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hydrocarbons (TPH), bacteria, and nutrients from Stormwater. It also has a positive impact on pH making the water more neutral. As the system's plants mature, it is anticipated these removal rates will stabilize.

8/1/2008

Particle Distribution	
Particle Size (Microns)	Particle Count/100ml
5-15	1,220,000.00
15-25	131,300.00
25-50	129,800.00
50-100	2,240.00
>100	360.00
	1483700.00

Particle Distribution	
Particle Size (Microns)	Percentage of Total
5-15	82.2%
15-25	8.8%
25-50	8.7%
50-100	0.2%
>100	0.0%



