Ballona Freshwater Wetland System

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Constructed Wetlands Help Achieve Water Quality and Conservation Goals at Ballona

EDITH READ

The 51.1 acre Ballona Freshwater Wetland System was conceived in the early 1990's as part of the First Phase of the Playa Vista project, a residential and mixed use development located on a former airport and aircraft manufacturing facility to the west of Culver City. One goal of the project was to re-establish the freshwater habitat that had been lost with the channelization of Ballona and Centinela Creeks. A second goal was to help improve the quality of urban runoff into Ballona Creek and Santa Monica Bay. A third goal was to provide stormwater management and flood control. Phased construction of the wetland system began in 2001 and was completed in 2008 at a cost of more than $30 million. Monitoring results indicate rapid achievement of habitat and water treatment goals. Nesting bird species now include one State Species of Special Concern (the least bittern) and another species thought to have been extirpated from the Ballona Wetlands after 1902 (the Virginia rail). Comparisons of average modeled effluent concentrations versus measured effluent concentrations show the wetland system performing as well as, or better than, similarly designed treatment systems nationwide.

Background

It is important to recognize that the success of the Ballona Freshwater Wetland System is as much a product of its history and governance as of its design. Like other estuaries on the California coast, the Ballona estuary has a centuries-old history of watershed urbanization and loss of essential wetland functions. As part of constructing the Playa Vista project, the developer re-established a portion of the Ballona Wetlands, which had suffered from decades of neglect and inflows of urban pollutants, as a multi-function Freshwater Wetland System. Various land use permits, and approvals of the Playa Vista project, obligated the developer to construct the wetland and to ensure that the system is maintained in perpetuity.

The Freshwater Wetland System is managed and maintained by the non-profit Ballona Wetlands Conservancy, which is governed by a board with representatives from the Friends of Ballona Wetlands, the State of California, the City of Los Angeles, and the developer. Funding for the Ballona Wetlands Conservancy is entirely private and is derived from the Playa Vista community, thereby facilitating the "in perpetuity" obligation for wetland protection.

Design

There is a substantial body of research and numerous case studies regarding the design and effectiveness of treatment wetlands (e.g. Kadlec and Knight, 1996; Moshiri, 1993). The basic concept of a treatment wetland is to use natural wetland processes, such as uptake of nutrients by plants, to improve water quality. This concept is based on the premise that wetlands have a higher rate of biological activity than most ecosystems and can transform many common pollutants into harmless byproducts or even into

Figure 1. Overview of Ballona Freshwater Wetland System

essential nutrients (Kadlec and Knight 1996, 3). However, to achieve these functions without overloading the system with pollutants, the design of the treatment wetland must include (among other considerations) sufficient retention capacity, freshwater inflows, and upstream best management practices (BMPs) such as catch basins to prevent trash in storm runoff from reaching the wetland.

Additional design considerations for the Ballona Freshwater Wetland System included its location within the Ballona watershed and provision for a wildlife habitat. Conceived when all of the property was still under one private land owner, restoration plans for the freshwater wetland were designed with the adjacent Ballona Wetlands in mind. Since December 2003, the Ballona Wetlands have been owned by the State of California, which is currently planning restoration of the salt marsh and surrounding habitat.

The urbanized watershed that drains into the Freshwater Wetland System consists of about 1,040 acres, including 440 acres of the Playa Vista project and over 600 acres of off-site areas. The design of the Freshwater Wetlands System was intended to manage the amount and quality of freshwater flowing into the Ballona Wetlands salt marsh, and to enhance the quality of dry-weather and stormwater runoff into Ballona Creek and Santa Monica Bay. Figures 1 and 2 show hydrologic features of the Freshwater Wetland System, consisting of: 1) a 2-mile long, 25-acre riparian corridor along one of the historic flow lines of Centinela Creek, through which a minimum of one cubic foot per second (cfs) of treated groundwater is released to ensure freshwater supply to the system; 2) a 26-acre freshwater marsh connected to the riparian corridor through a box culvert under a major road; 3) within the freshwater marsh, a riparian corridor inlet as well as two additional storm drain inlets; 4) a primary outlet to manage water level and control releases into Ballona Creek; and 5) two secondary outlets (spillway and sluice gate) for freshwater overflow into the adjacent Ballona Wetlands Ecological Reserve. Treatment basins at the drain inlets to the Freshwater Marsh were expected to receive the brunt of pollutant inflows. Therefore, design of these basins focused on reducing inflow velocities and maximizing pollutant removal while keeping areas of intensive maintenance to a minimum (Figure 3).

Figure 2. Design Features of the Freshwater Marsh

Results

With more than 160 environmental parameters monitored over the past six years, only a few results can be summarized here. Details are in the latest annual monitoring report for the Ballona Freshwater Wetland System (Read and Strecker, 2009).

While the wetland system has met or exceeded conventional biological performance criteria such as habitat acreage, tree height, and dominance of native vegetation, there has been no greater surprise than the rapid return of bird species thought to have been extirpated at Ballona as breeding populations (Cooper 2006, 2008). One example is the least bittern (*Ixobrychus exilis*; Figure 4), a Species of Special Concern which was first observed nesting in the freshwater marsh in 2005, only two years after construction was completed. A more recent example is the Virginia rail (*Rallus limicola*), first observed nesting in the riparian corridor in 2009 and believed to be the first breeding record at the Ballona Wetlands since 1902 (Cooper 2009).

Figure 3. Sediment Basin at Jefferson Inlet

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Table 1. Predicted vs. Measured Wet-Weather Constituent Concentrations for the Ballona Freshwater Wetland System

Modeled Constituent	Units	Modeled Average Concentration[a]	Average (Range) of Wet-Weather Grab Samples, 2004-2009[b]	95% Confidence Interval of the Average Retention Pond Effluent Concentrations from International BMP Database (Oct. 2007)	Interquartile Range (25th - 75th percentiles) of Retention Pond Effluent Concentrations from International BMP Database (Oct. 2007)
Total Suspended Solids (TSS)	mg/L	10.2	20.5 (6-63)	22.1-29.2	4.3-28.3
Total Phosphorus (TP)	mg/L	0.06	0.23 (0.01-0.63)	0.28-0.56	0.06-0.28
Dissolved Phosphorus (DP)	mg/L	0.03	0.06 (0.002-0.24)[c]	0.08-0.12	0.04-0.12
Total Nitrogen	mg/L	0.56	1.39 (0.8-2.1)[d]	1.23-1.55[e]	0.77-1.57[e]
Nitrate (NO_3)	mg/L	0.23	0.15 (0.1-0.37)	0.37-0.70	0.11-0.63
Total Copper (TCu)	ug/L	8.17	5.65 (1.8-11)	8.9-12.2	3.1-9.0
Total Lead (TPb)	ug/L	23.86	1.2 (0.2-2.5)	11.4-16.0	1.0-15.8
Total Zinc (TZn)	ug/L	41.51	20.97 (3.5-50)	28.3-37.6	7.2-37.2

[a] Computed from modeled annual load and modeled annual runoff volume leaving the Freshwater Marsh as reported in Playa Vista Phase I Environmental Impact Report (EIR) (CDM, 1992)
[b] Detection limits were substituted for all non-detects prior to computing summary statistics.
[c] DP is not monitored, therefore orthophosphate (PO4-P), which is the most bioavailable form of phosphorus and typically the largest component of dissolved phosphorus, has been compared with the modeled dissolved phosphorus value.
[d] TN is not monitored, so the calculated sum of total Kjeldahl nitrogen (TKN), nitrate, and nitrite is compared to the modeled TN value.
[e] TKN reported from the BMP Database as TN was not summarized.
International BMP Database: www.bmpdatabase.org

Figure 4. Least Bittern

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Treatment wetlands have been evaluated in terms of percentage of pollutants removed, but for various reasons this "removal efficiency" method has been found to be inadequate for measuring BMP performance (U.S. EPA 2009). Instead, outflow (effluent) water quality is evaluated. Performance of the Ballona Freshwater Wetland System as a treatment wetland was evaluated by comparing average modeled versus average measured outflow concentrations (Geosyntec 2010) (Table 1). Average measured concentrations have been lower than predicted for total copper, total lead, total zinc, and nitrate. Other constituents such as total suspended solids and total phosphorus have been more variable, but compared to the range of outflow values reported in the International Best Management Practice Database, the system appears to be performing better than similarly designed treatment systems for dissolved phosphorus, nitrate, total copper, total lead, and total zinc (Geosyntec 2010). Despite extensive use of the wetland by wildlife, measured outflow densities of fecal indicator bacteria, such as total coliforms, have not exceeded 5,000 MPN/100 ml, and are more typically below 1600 MPN/100 ml. These values are in the lower end of the range of total coliform densities of 1,000 to 1,000,000 MPN/100 ml reported for tidal channels of the Ballona Wetlands and Ballona Creek (Dorsey 2006).

Overall, monitoring results indicate that the Ballona Freshwater Wetland System is performing better than predicted for biological and water quality parameters, thus serving as a model for other systems that may be contemplated for urban watersheds. However, in addition to the high construction costs, it should be noted that this system is not self-sustaining and is costly to maintain because of its position in a highly urbanized watershed. Accordingly, it is critical that other contemplated systems account for ongoing, dedicated maintenance funding.

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Ballona Freshwater Wetlands

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EDITH READ, *Ph.D., has managed and monitored the Ballona Freshwater Marsh since construction was completed in 2003. She has conducted numerous botanical surveys in the Ballona Wetlands over the past 17 years and serves as a technical advisor on the Board of Directors of Friends of Ballona Wetlands.*