

May 23, 2012

Mr. Ali Fayad, P.E. Senior Civil Engineer, Orange County Public Works 300 North Flower Street, Room 756 Santa Ana, California 92703-5000

Subject: Review of Water Quality Enhancement and Perched Water Buffer Components for

East Garden Grove - Wintersburg Channel (C05) Levee Improvements

Reference: Agreement D07-067 Work Order No. EF03531

Dear Mr. Fayad:

Please see attached summary report which presents the results of the third-party review of the BMP design for the East Garden Grove – Wintersburg Channel (C05).

Please review and contact me at 949-833-8388 ext 102 or lweber@wrcinc.net .

Sincerely,

WRC Consulting Services Inc.

Lan Weber, P.E., Ph.D., C35894

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Stephen Anderson, PG, CHG,551

# A THIRD PARTY REVIEW OF BMP DESIGN FOR THE EAST GARDEN GROVE-WINTERSBURG CHANNEL (C05) IMPROVEMENTS

WRC Consulting Services, Inc.

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# 1. Introduction

OC Public Works Flood Control Design Division is in the process of final design and construction bid preparation to construct sheet pile walls along the existing levees of the Garden Grove Channel (see Reference 1). The project begins at Station 6+34 (6,790 feet downstream of Graham Street near Station 74+00) and extends approximately 146 feet upstream of Warner Avenue (Station 100+00).

It is proposed to provide flood control protection along the levee channel with sheet pile walls. A single sheet pile on the southern bank from Station 34+00 to 53+20 is proposed, and only riprap stones are to be placed on the banks downstream. Upstream of Station 53+28, the existing levee on the southern bank is to be replaced with a double sheet pile wall sandwiched with soil cement slurry. A sheet pile wall of similar depth without the soil cement sandwich has been constructed recently from Station 37+00 to Graham Street. A new double sheet pile wall with a soil cement sandwich is to be placed to replace the levees on each bank from Graham Street to Warner Avenue.

Generally speaking, the sheet pile and soil cement wall is 15 feet wide and 15 feet above and 30 feet below the existing channel grade. The top of the sheet pile is relatively high compared to the existing home sites along the channel.

Under the project conditions, a 15-foot-wide maintenance road is to be located on the sheet pile/soil cement cap, leaving an additional 8-foot-wide unpaved strip from the landside of sheet pile wall to the right-of-way. The final design includes a BMP subdrain system along this 8-foot strip on each side of the channel, as documented in the draft "Construction and Post-Construction Stormwater Pollution Prevention Plan (SWPPP)" dated December 2011 (Reference 2).

The BMP subdrain system proposed along the centerline of the 8-foot strip stated above includes a linear horizontal cistern with its bottom near the proposed channel. EcoRain ER501 single tanks (each tank 16.06 inches wide by 17.72 inches high by 26.97 inches long) or equivalent are recommended for this cistern system, and additionally, Cypress trees (Leyland or approved equivalent) are proposed to be planted along the cistern from Station 53+00 to Station 99+38 at 20- to 30-foot intervals.

Downstream of Graham Street (Station 54+20 to Station 76+00), seven infiltration drainage units, Kristar–Filterra Bioretention System or equivalent (4 feet wide by 4.2 feet high by 4 feet long), are to be placed at 250 to 350 feet intervals. An additional EcoRain ER501 drainage cell (16.06 inches wide by 17.72 inches high by 26.97 inches long) is proposed adjacent to the drainage tank (linear cistern stated above) to bypass subdrain flows where the Filterra Bioretention System is not below the cistern.

Thirteen grate inlet skimmer boxes are proposed from Station 77+00 to Station 91+00 at 200-foot intervals. Each box includes a 12-inch-square filter screen which is Bioclean Environmental model GISB-12-12-12 or equivalent, a 4-inch diameter observation standpipe, and a grate with a Case II inlet per APWA standard plan 150-2).

# 2. Scope of Work Performed

At the request of Orange County OC Public Works, WRC Consulting Services, Inc., performed an evaluation of the proposed system, including the following work:

## Task 1: General Review and Field Investigation

Review the proposed levee and sheet pile improvements, subsurface and surface drainage, grading compaction, and other construction activities which may require short-term and long-term runoff and pollution control. Investigate the site to become familiar with the field conditions. Review of the District's draft Stormwater Pollution Prevention Plan (SWPPP) is to be completed by and implemented by the project construction contractor, including short-term construction impacts.

#### Task 2: Infiltration Cistern

The infiltration cistern, consisting of EcoRain tanks or an Engineer-approved equivalent, was proposed by District's Design team to reduce the barrier effect associated with sheet pile wall. WRC reviewed the efficacy of the infiltrating cistern for buffering of the perched water fluctuations during sheet pile insertion and post-sheet pile insertion. Further, on behalf of the District WRC reviewed any additional benefits of the cistern for buffering and preventing construction surface water pollution, if any, from reaching the groundwater aquifer. Recommendations were made as presented in this report.

#### Task 3: Review of Sink Holes

On January 11, 2011, the District's design team was informed of sinkholes that have formed in the vicinity of the Slater Pump station which were subsequently filled with concrete slurry. WRC reviewed the potential for sinkhole development and prevention.

#### Task 4: Letter Summary

WRC prepared a letter summary, as presented herein.

# 3. Review of Design Function

Review was conducted based on the 95% Plans titled "Construction of East Garden Grove - Wintersburg Channel, O.C.F.C.D. Facility No. C05, from Bolsa Chica Tide Gates to Upstream of Warner Avenue (from Station 6+34 to Station 102+02)" and its draft Storm Water Pollution Prevention Plan dated December 2011. In addition, Mr. Ali Fayad, Design Engineer of Record, provided a draft project design report (Reference 8) which details the design background and references for the underground cistern BMP system (Sheets 45 and 82 to 87, referred to as the BMP System). Based on our understanding, the design basis and function for this system are summarized as follows:

BMP for Groundwater Replenishment During Construction - Under the existing conditions, subsurface groundwater is expected to flow through the permeable layers under the levee toward landside. The BMP cistern volume was estimated based on the volume of the stated subsurface flow using the flow rate 2.07 cubic feet per day per linear feet as determined by MACTEC (Reference 3). The cistern is provided to help mitigate the immediate response of groundwater during sheet pile insertion.

BMP for Long-Term Groundwater Balance - For groundwater flow in the substrate, it was estimated that the length of the groundwater flow path from the river bottom to the land surface after sheet pile construction will be similar to the pre-construction condition. The existing groundwater movement near the levee was measured at a much higher flow rate in the horizontal direction than the vertical direction. In addition, upper soils piping under existing conditions, has been reported by some home owners. No additional consideration of the design is given to offset potential groundwater recharge imbalance.

<u>Stormwater Pollutioin Control</u> (SWPPP)- The BMP is designed to receive stormwater which may contain sediment and other pollutants. Since the receiving water is the sensitive Bolsa Chica wetland, the proposed BMP system will add excellent value to control the water quality of the flows leaving the construction site, if functioning properly.

<u>Flood Protection</u> - The BMP system was designed with voids capable of storing a 10-year flood from the 8-foot strip between the sheet pile and the right-of-way. It was intended that the flow will not overtop the street curb, avoiding flood-contribution to the residential tracts. In the event of potential overflow, the City of Huntington Beach has agreed to allow pumping of the excess surface flow to the Slater Pump Station (near Station 63+00). The pump system and drainage outlet to the pump were not part of this design.

<u>Maintenance Road Drainage</u> - The maintenance road was designed to be sloped toward the channel without increasing runoff to the landside during floods.

<u>Construction Modification</u> - OC Public Works intends to allow for BMP modification during construction as long as the contractor follows the plan for final construction.

#### 4. Potential Performance Evaluation

The proposed BMP system is essentially a linear shallow horizontal cistern (EcoRain drainage tanks and cells) with enhanced filtration (skimmer box, Filterra Bioretention tree box, and tree-planting). It serves to retain rainwater and infiltrate to the shallow subsurface groundwater after rain events. The following performance evaluation was compared to the intended design function described above for confirmation or further recommendations.

BMP for Groundwater Replenishment During Construction - The MACTEC computation for levee seepage is based on a sand layer 10 feet thick. However, the sand thickness is probably quite variable and horizontally discontinuous. This is typical of river channel deposits that are highly variable in grain size and laterally and vertically discontinuous. Hence, predicting the recharge of groundwater by the BMP is problematic.

Previous groundwater measurements occur under the existing levee conditions in which there is a significant pressure difference in the water head from the tidal and flood channel toward the floodplains. The high pressure head causes significant groundwater movement through sand layers immediately under the levee below the channel invert elevation. Along the southern levee, the groundwater elevations were consistently measured at approximately minus one foot mean sea level (msl) near the south levee which are generally three feet lower than the ground surface and two to four feet higher than the channel invert elevations. Along the northern levee, the groundwater elevations were measured at minus 3 feet msl which are three feet lower than the ground surface and nearly at the channel invert elevations. The upper reach has less groundwater concern because the ground rises relative to the water level and channel invert.

Away from the channel, the groundwater gradient gradually drops toward the floodplain except for the areas influenced by pumping activities (see contour maps in References 6 and 7). The consistency of the groundwater patterns indicate that the channel has been a reliable water supply resulting in wet and saturated soil conditions. Since the horizontal movement of groundwater relies on this supply, the water level should be properly monitored and maintained especially in the low lying areas relative to the channel invert and where home owners stated existing problems (e.g. south of Graham Street). The insertion of the sheet pile may cause temporary groundwater depression. It is anticipated that the soils will remain wet during replenishment of the groundwater. The reestablishment of the groundwater supply, however, should be ensured and verified.

The proposed BMP with water storage and infiltration capacity is simply a management tool selected to add a water supply and reduce localized groundwater depression, if needed, during and after sheet pile insertion. The uncertainty of the infiltration capacity (which can vary with soil moisture, siltation, and groundwater level), may not provide the water volume needed for replenishment. Additional monitoring and other measures may be required as shown in Section 6 during and shortly after sheet pile insertion.

<u>BMP for Long-Term Groundwater Balance</u> – As a tool of management, the proposed BMP may benefit the project in reducing groundwater imbalance between the two sides

of the sheet pile wall. The effectiveness of recharge through this shallow cistern, however, depends on the factors mentioned above for short term construction. It is also highly dependent on the horizontal and vertical permeability of the various lithologic units (see groundwater characterization description in the following section).

It was noted in Item 4 of the WRC's January 30, 2009, report (Reference 4) that "One important factor to consider for this monitoring plan is to provide some data for properly designing a subdrain system along the sheet pile wall." As the sheet pile wall will definitely disrupt groundwater flow at the levee bottom and the lithology is likely to be inhomogeneous, it is critical to continue observing water changes after construction and recharge the monitoring wells as necessary to maintain the existing "horizontal movement" as well as "vertical connection" with groundwater at the sheet pile tip and behind the sheet pile wall.

Stormwater Pollution Control – Given construction water, the filtration and retention units of the proposed BMP system will be clogged with debris, coarse sediments and fine particles, eliminating the future value of BMP. The porosity of filtration and volume of retention of the proposed BMP system can be guarded against debris and coarse sediments using the traditional BMPs for storm drain protection. However, this preventive measure against sediment-laden construction water will defeat the objective of stormwater pollutant and sediment control during construction. Further, it is not feasible to prevent fine particles discharging into the proposed BMP units using cost-effective traditional BMPs. Unfortunately, fine particles will significantly reduce the lifetime of the units which will limit the use of this BMP for water storage and infiltration.

<u>Flood Protection and Maintenance Road Drainage</u> - To capture the BMP function and maximize the benefit of investment, reversing drainage of the roadway toward landside may be considered. The BMP will best serve as a long-term BMP to the Bolsa Chica tidal zone for dry weather and first flash flood pollution control. We understand the concerns of the District regarding flood protection; however, the maintenance road area is relatively small compared to the entire surface drainage contributing to the south levee.

### 5. Groundwater and "Sinkhole" Evaluation

WRC Consulting Services, Inc., completed a report titled "A Third Party Opinion Groundwater Impact Evaluation of the East Garden Grove-Wintersburg Channel (C05) Improvements" dated September 8, 2008 (Reference 5). Conclusions and recommendations in the report relevant to the current report are restated below:

- The project area contains generally silt, clay, sand, silty sand, sandy silt, silty clay, and some gravel in the lower stratum, with inhomogeneous distribution of these soil layers both horizontally and vertically.
- With sheet pile insertion, the seepage path becomes more complicated and is likely to be altered depending on:

- Soil lenses at the interlock locations;
- o Potential of local disruption of some of the minor impermeable layers; and
- Potential of seepage through the interactive area of soil and sheet pile surface.
- With the interplay of the permeable and impermeable zones, it is difficult to completely characterize the seepage flow hydrology and hydraulics through the existing earthen levees.
- Continuity of the recharge flows from the tidal channel to the adjacent ground and passage of the existing subsurface flows under the sheet pile wall seem to be the primary concerns of the stakeholders. Seepage through the soils and wall is an interim process (not the end result) and the focus should be on the overall perched groundwater elevations and flow directions within the floodplain.
- Perched groundwater baseline conditions should be assessed (as to both quantity and quality) and attention should be focused on the overall downstream perched groundwater surface elevations within the floodplain. A well planned monitoring well network will provide the existing shallow groundwater information. These wells can be used to monitor the post-construction condition of the perched groundwater. The data will provide stakeholders with long-term results of changes to groundwater elevations relative to baseline and support defense against future liability.

Subsequent to WRC's recommendation, the District has installed and monitored groundwater monitoring wells within the floodplain south of the leveed channel. HAI has prepared groundwater contour maps based on the monitoring results (Reference 6). The results are interpreted by WRC as follows:

- Relatively consistent shallow groundwater flow patterns exist from the channel toward the floodplain along each side of the bank.
- In addition to the direction of flow, the elevation contour elevations from different monitoring events appear to be similar.
- The 2011 winter groundwater elevations seem to be slightly higher than the 2010 monitoring results, probably as a result of heavy precipitation in early 2011 (Reference 6).
- Groundwater occurs in sands separated by saturated impervious clays (aquicludes). The
  groundwater depths measured during monitoring events show a steep gradient of
  approximately 0.7/100 feet away from the channel towards the floodplain.
- The groundwater contour maps show several depressions in the groundwater table on both sides of the levee. The largest depression was consistently shown on the contour maps at the Slater Channel Pump Station that discharges the Slater Channel flow to the Garden Grove - Wintersburg Channel, C05. This was not shown in the periods when the wells near the pump station were not measured.

In January 2011, subsidence of soil occurred near the Slater Channel Pump Station. The largest sinkhole measured 3 by 2 feet in area and 3 feet deep, exposing the fence post and the underside of the Slater Channel wall. These sinkholes were subsequently filled with cement slurry by the City maintenance staff. This depression may reflect subsidence related to sediment removal from around the pump bore following many years of pumping. This is probably a localized occurrence, and subsidence may repeat with continuing pumping without the proposed sheet pile project. However, the relatively consistent measurements of the perched groundwater may indicate saturation in the soils, and more-serious ground subsidence could occur if the existing groundwater saturation conditions are not maintained due to a lack of groundwater supply from the tidal channel during and following construction.

One concern reflected in WRC's previous and current evaluation is groundwater disturbance near the sheet pile during construction. Note that the Environ well ENV-1, located within the steep gradient area of the levee seepage flow, showed significant drop in this well after sheet pile insertion (see Reference 7). Where it is critical in maintaining a minimum water level during construction, the water supply from the stored water in the cistern may not be sufficient.

#### 6. Recommendations

The proposed BMP system has its merit for runoff control and water retention and infiltration as long as it is maintained and clear and free from debris, sediments, and especially fines (clay and silt). It is recommended not to install the cistern system including infiltration and retention units by EcoRain and Kristar or equivalent until construction is nearly completed or the sediment laden construction water and other debris are properly filtered. Other traditional BMPs can serve to control on site sediment and other construction pollutants. Unless the sand layers are continuous, the proposed BMP may not be reliable in prevention of groundwater depletion due to sheet pile insertion.

The District should focus on groundwater monitoring near the levee and within the floodplain prior to, during and following sheet pile wall insertion. During construction, groundwater depths should be intensively measured and compared to the baseline conditions.

It is difficult to predict the groundwater change at the time of sheet pile insertion especially with significant interference by the adjacent pumping activities (see the 2010 and 2011 monitoring contour maps with and without pumping station measurements). The area of concern remains in the lower reach where homes are at low elevations compared to the channel invert and the groundwater is subject to pumping effect from the Slater Channel Pump Station. There are three monitoring wells with two at the upstream and downstream ends and only one in the middle reach which is located by the Slater Pump Station.

We hope that the "cone of depression" is temporary and water moisture in the soils is maintained until groundwater conditions stabilize on both sides of the sheet pile. To ensure that there are no negative impacts to the homes within the critical groundwater path, monitoring wells can be placed at 300 ft. min. apart (total 6 wells in addition to B-8, B-9, and B-10) If these wells are built with 6-inch diameter PVC screen and conductor casing, it can be filled with water

and complement the horizontal BMP system in supplying the needed water to fill the groundwater depression caused by insertion of the sheet pile.

The recharge wells will increase subsurface flow movement through localized impervious clay units between the proposed BMP and underlying saturated sands, thus enhancing the intended percolation enhancement. The reaches which require additional wells and specific well locations should be strategically determined to provide as needed data for future defense against other factors influencing the ground stability as well as to enhance the groundwater connectivity and stabilization between the two sides of the sheet pile.

# 7. References

- 1. "East Garden Grove-Wintersburg Channel (C05) Improvements 95 % Plans and Design Report", prepared by OC Public Works, April 2012.
- 2. "SWPPP for East Garden Grove-Wintersburg Channel (C05) Improvements", prepared by OC Public Works, Dec. 2011.
- "Draft Report of Geotechnical Investigation Proposed East Garden Grove Wintersburg Channel C05 Improvement, Southwest of Graham Street From Station No. 48+00 to Station No. 74+25 Huntington Beach, California", prepared by MACTEC Engineering and Consulting, Inc., June 2004.
- "Letter Report: Review of HAI Groundwater Well Proposal, East Garden Grove-Wintersburg Channel (CO5) Southern Levee Improvements", prepared by WRC Consulting Services, Inc., Jan, 2009.
- 5. "A Third Party Opinion Groundwater Impact Evaluation of the East Garden Grove-Wintersburg Channel (C05) Improvements", prepared by WRC Consulting Services, Inc., September 8, 2008.
- 6. "Groundwater Contour Maps", prepared by HAI, 2009 to current.
- 7. "Monthly Ground Water Level Report" prepared by Environ International Corporation. March 2008.
- 8. "Draft Design Report (C05-DR-623-10202)", Section 1.9 and Appendix I, prepared by Ali Samih Fayad. May 2012.