Ms. Rachel Woodfield
Merkel and Associates, Inc.
5435 Ruffin Road
San Diego, CA 92123

Subject: Bolsa Chica October 2010 Beach Profile Survey

Ms. Woodfield:

This letter report presents the methods and results of the Bolsa Chica October 2010 Beach Profile Survey. The survey represents the ninth such effort conducted in support of the Bolsa Chica Lowlands Restoration Project Beach Monitoring Program. The sections that follow provide an overview of the monitoring program, discuss the October 2010 beach profile survey, and present the results. Beach profile plots accompany this report in Attachment A.

The vertical datum used throughout this report is North American Vertical Datum of 1988 (NAVD88), with units expressed in meters. At the project site, NAVD88 lies approximately 0.06 m above National Ocean Service (NOS) Mean Lower Low Water (MLLW) and 0.79 m below NOS Mean Sea Level (MSL; NOS, 2011). In the case of the geo-referenced data, the horizontal positions are given in meters relative to California State Plane Zone 6, North American Datum of 1983 (NAD 83).

Overview

The objective of the beach monitoring program is to develop a quantitative understanding of changes in the condition of the beaches adjacent to the newly constructed Bolsa Chica Full Tidal Basin (FTB) entrance channel. The program, which commenced in January 2007, is comprised of semi-annual beach profile surveys and monthly beach width measurements at seven sites located along a 5.3 km section of coastline between Bolsa Chica State Beach and 17th Street in Huntington Beach. The beach profile surveys are conducted by Coastal Frontiers Corporation, while the beach width measurements are obtained by Moffatt and Nichol.

Figure 1 shows the locations of the beach profile transects used in the monitoring program. Two of these were established specifically for the monitoring program, and were first surveyed in January 2007. Five of the transects had been established previously, and were included in the Coast of California Storm and Tidal Waves Study for the Orange County Region (CCSTWS-OC) conducted by the U.S. Army Corps of Engineers.
October 2010 Beach Profile Survey

Field activities were conducted on 29 October 2010. The methods employed were similar to those used on previous Orange County surveys performed by Coastal Frontiers. In consequence, the results are directly comparable. The following sections discuss the data acquisition and reduction methods for the October 2010 Beach Profile Survey.

Beach Profile Data Acquisition

The wading and bathymetric portions of the survey were performed concurrently by two crews. Data were acquired along each transect from the back beach to a depth of approximately 14 m below NAVD88. At the time of the October 2010 survey, the wave heights were typically less than 1 m, while the wind speeds remained below 10 kts.
The beach and surf zone were surveyed using a total station and a survey rodman. The total station was used to determine the position and elevation of the beach at each location occupied by the rodman. Each transect was surveyed from the back beach seaward through the surf zone until the survey rod no longer protruded above the water surface when held erect. This location, typically in a water depth of 3.0 to 3.5 m below NAVD88, provided substantial overlap with the landward portion of the bathymetric survey.

Bathymetric data were collected with a digital acoustic echo sounder operated from a shallow-draft inflatable survey vessel. A dynamic motion sensor, which provides real-time corrections to the echo sounder for wave-induced vessel heave, also was utilized. A GPS receiver was used to determine the position of each sounding. To improve the accuracy of each position, differential corrections transmitted in real-time from U.S. Coast Guard beacons were utilized (DGPS). All systems were interfaced to a laptop computer using the Hypack Max survey package.

The boat traveled along each transect from the offshore terminus to the surf zone guided by DGPS navigation. Soundings were acquired on a continuous basis (approximately 3 soundings per second), while positions were recorded at 1-second intervals. The DGPS position data and sounding data were merged using the Hypack software, with interpolated positions being assigned to the soundings acquired between position fixes.

The calibration of the echo sounder was checked at periodic intervals during the survey using a standard “bar check” procedure. In addition, measurements of the speed of sound in sea water also were obtained at the offshore end of each transect using a recording conductivity, temperature, and depth (CTD) instrument.

**Beach Profile Data Reduction**

The data from the wading portion of the survey were processed using software developed by Trimble. The raw total station data were read by the software, and the coordinates and elevation of each data point were calculated and inserted into a CAD drawing.

The raw data from the bathymetric portion of the survey consisted of Hypack files containing the position data and heave-compensated soundings. These data were edited for outliers using the Hypack Single-Beam Processing Module. The dynamic motion sensor utilized during the survey removed the majority of the wave contamination from the record in real time. However, to further minimize the influence of wave-induced vessel motion on selected portions of two transects, a smooth line was faired through the echo sounder record prior to digitizing it with the Hypack software package.
Corrections for the draft of the transducer and the measured speed of sound in sea water then were applied to the measured depths. The speed-of-sound profiles were confirmed using the results of the “bar check” calibration procedure. Finally, the corrected soundings were adjusted to NAVD88 Datum using tide measurements made by the U.S. Department of Commerce, NOAA, at Los Angeles Harbor. To provide a more accurate representation of local tide conditions, the water levels recorded at Los Angeles Harbor were adjusted to the project site using the time and height differences published by NOAA (NOS, 2011).

The adjusted soundings were thinned to a nominal interval of 3 m to produce a file size suitable for developing beach profile plots. The resulting x, y, z data (easting, northing, and elevation) were inserted into the CAD drawing containing the wading data. As indicated above, the field work was conducted in such a manner as to provide substantial overlap between the wading and bathymetric portions of the survey. The processed data were examined in this region to insure that the two data sets were compatible. Once this confirmatory inspection had been completed, only the more detailed data in the region of overlap were retained (typically the bathymetric data). The less detailed data were purged, after which the wading and bathymetric data were merged to create a single digital file.

Based on past experience, the vertical accuracy of the processed soundings is approximately ±15 cm. According to the Hemisphere GPS equipment specifications, the accuracy of horizontal positions obtained in the manner described above is less than 60 cm. The electronic total station used to conduct the survey is capable of measuring ranges to within ±15 cm and elevation differences to within ±3 cm. However, because the swimmer encountered waves and currents in the surf zone, the horizontal accuracy perpendicular to each transect (parallel to the shoreline) varied from minimal at short ranges to approximately ±5 m at the offshore end.

**Results**

The October 2010 beach profile data were used in conjunction with data from the historical surveys to create profile plots and compute changes in beach width. The beach profile plots developed from the survey data are provided in Attachment A, while the beach width changes are presented below. The range on each profile plot represents the distance in meters seaward of the transect origin. The CCSTWS-OC survey monument locations serve as the origin for the historical transects, while the survey markers are used for the newly-established transects. The elevations are given in meters relative to NAVD88.

The beach profile plots developed from the October 2010 survey data show those profiles obtained during the 5-year period from October 2005 to October 2010 as well as the envelope of all available profile data that preceded the opening of the Bolsa Chica entrance channel (May 1963 to March 2006). These plots also include two panels for each transect -
one isolating the nearshore region of the profile and another displaying the entire profile length.

The October 2010 beach profile data are included in a zip file attached to the electronic submittal of this report. The zip file contains ASCII files of: (1) range and elevation for each profile, and (2) northing, easting, and elevation triplets (n,e,z) for the entire survey. In the case of the geo-referenced data, the horizontal positions are in meters relative to California State Plane Zone 6, NAD 83. As indicated previously, elevations are given in meters relative to NAVD88.

A detailed assessment of beach changes will be provided in the annual report. General observations are offered, however, based on the profile plots (Attachment A) and the MSL beach width data presented in the tables and figures below. The MSL beach width data are reckoned from the landward extent of the sandy beach.

1.) **Beach Widths (Table 1, Figure 2):** At the time of the October 2010 Survey, MSL beach widths in the Bolsa Chica study area ranged from 20.8 m at Transect 378+29 to 113.3 m at Transect 423+89. As shown in Figure 2, the October 2010 beach widths at the two transects immediately north of the FTB entrance channel (318+30 and 311+22) each exceeds the range of historical Fall beach widths (1966-2005).

2.) **Seasonal Shoreline Changes (Table 2):** Shoreline advance and stability prevailed during the 2010 summer season (May through October) at Bolsa Chica-area beaches. During this time, the shoreline advanced at three sites, retreated at one location, and was essentially unchanged (3 m or less) at the remaining three sites. The greatest shoreline advance, 26.3 m, occurred at Transect 333+30. The average summer seasonal shoreline change over the entire study area was a gain of 5.2 m. The shoreline retreated only at Transect 249+30, a loss of 4.2 m.

3.) **Annual Shoreline Changes (Table 2):** During the one-year period between the October 2009 and October 2010 surveys, shoreline losses predominated in the Bolsa Chica area. The MSL shoreline retreated at five of the seven survey sites, advanced at one location, and was essentially unchanged (3 m or less) at the remaining site. The greatest shoreline retreat, a loss of 11.8 m, occurred at Transect 333+30. Transect 311+22 was the sole site of shoreline advance, measuring a modest 5.5 m.

4.) **Bolsa Chica Monitoring Period Shoreline Changes (Table 2, Figure 3):** During the 5-year period (October 2005 to October 2010) encompassing the construction of the Bolsa Chica Lowlands Restoration Project, the MSL shoreline tended to advance north of the FTB entrance channel and retreat south of the entrance channel. The greatest shoreline gain, 28.0 m, occurred at Transect 311+22. The greatest shoreline loss, 15.3 m, occurred at Transect 378+29.
Table 1. MSL Beach Widths Derived From Profile Data

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>249+30</td>
<td>85.9</td>
<td>71.2</td>
<td>86.8</td>
<td>84.7</td>
<td>91.0</td>
<td>74.5</td>
<td>87.1</td>
<td>86.1</td>
<td>83.8</td>
<td>81.7</td>
<td>77.5</td>
</tr>
<tr>
<td>311+22</td>
<td>63.4</td>
<td>64.6</td>
<td>70.3</td>
<td>76.2</td>
<td>85.5</td>
<td>86.3</td>
<td>87.1</td>
<td>83.0</td>
<td>85.9</td>
<td>92.3</td>
<td>91.4</td>
</tr>
<tr>
<td>318+30</td>
<td>70.5</td>
<td>64.1</td>
<td>85.9</td>
<td>86.1</td>
<td>82.7</td>
<td>93.5</td>
<td>93.5</td>
<td>97.2</td>
<td>104.1</td>
<td>97.3</td>
<td>97.3</td>
</tr>
<tr>
<td>333+30</td>
<td>79.3</td>
<td>67.5</td>
<td>66.6</td>
<td>61.9</td>
<td>72.3</td>
<td>46.8</td>
<td>80.5</td>
<td>72.2</td>
<td>78.7</td>
<td>40.6</td>
<td>66.9</td>
</tr>
<tr>
<td>350+71</td>
<td>62.1</td>
<td>53.6</td>
<td>54.1</td>
<td>48.9</td>
<td>54.8</td>
<td>42.6</td>
<td>57.2</td>
<td>47.6</td>
<td>59.8</td>
<td>46.5</td>
<td>50.6</td>
</tr>
<tr>
<td>378+29</td>
<td>36.1</td>
<td>22.3</td>
<td>23.9</td>
<td>27.8</td>
<td>41.1</td>
<td>21.3</td>
<td>26.4</td>
<td>25.1</td>
<td>30.7</td>
<td>10.0</td>
<td>20.8</td>
</tr>
<tr>
<td>423+89</td>
<td>120.2</td>
<td>111.3</td>
<td>110.5</td>
<td>106.9</td>
<td>113.3</td>
<td>108.8</td>
<td>106.6</td>
<td>103.2</td>
<td>111.9</td>
<td>112.7</td>
<td>113.3</td>
</tr>
</tbody>
</table>

Notes:
(1) MSL lies 0.79 above NAVD88 datum.
(2) MSL beach width reckoned from the landward extent of the sandy beach.
(3) October 2005 and March 2006 beach profile data generated from LIDAR with a TIN model, topography only.
Figure 2. October 2010 MSL Beach Widths
Table 2. MSL Shoreline Changes Derived From Beach Profile Data

<table>
<thead>
<tr>
<th>Transect</th>
<th>Annual</th>
<th>Summer Seasonal</th>
<th>Bolsa Chica (1) Monitoring Period</th>
</tr>
</thead>
<tbody>
<tr>
<td>249+30</td>
<td>-6.3</td>
<td>-4.2</td>
<td>-8.4</td>
</tr>
<tr>
<td>311+22</td>
<td>5.5</td>
<td>-0.9</td>
<td>28.0</td>
</tr>
<tr>
<td>318+30</td>
<td>-6.8</td>
<td>0.0</td>
<td>26.8</td>
</tr>
<tr>
<td>333+30</td>
<td>-11.8</td>
<td>26.3</td>
<td>-12.4</td>
</tr>
<tr>
<td>350+71</td>
<td>-9.2</td>
<td>4.1</td>
<td>-11.5</td>
</tr>
<tr>
<td>378+29</td>
<td>-9.9</td>
<td>10.8</td>
<td>-15.3</td>
</tr>
<tr>
<td>423+89</td>
<td>1.4</td>
<td>0.6</td>
<td>-6.9</td>
</tr>
</tbody>
</table>

Note:
(1) October 2005 beach profile data generated from TIN model of LIDAR data, topography only.
Figure 3. Bolsa Chica Monitoring Period Shoreline Changes, October 2005 to October 2010
We have sincerely appreciated the opportunity to assist Merkel and Associates, and look forward to continued participation in the Bolsa Chica Lowlands Restoration Project Beach Monitoring Program. Please do not hesitate to contact us if you have any questions or require additional information.

Sincerely,
Coastal Frontiers Corporation

Brady Richmond, P.E.
Project Engineer

Attachments: (A) Beach Profile Plots

References

Attachment A

Beach Profile Plots