APPENDIX O

Inlet Trafficability Memorandum

Memorandum

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To:	Cindy Kinkade, AECOM
From:	David Cannon, Everest International Consultants, Inc.
Copy to:	-
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Project Number:	P2183
Re:	BVLEP Supplemental Technical Studies
	Inlet Trafficability Analysis

1. OVERVIEW

The beach in the vicinity of the ocean outlet of Buena Vista Lagoon (see Figure 1) is currently dry much of the time, providing lateral pedestrian beach access (lateral access) between Oceanside and Carlsbad. The beach in this area is occasionally wet, with water depths and velocities that interrupt lateral access and sometimes create hazardous conditions. Various enhancement alternatives evaluated as part of the Buena Vista Lagoon Enhancement Project (BVLEP) would create a permanently open tidal inlet (inlet) at this location that would interrupt lateral access, potentially increasing the frequency of hazardous inlet crossing conditions. To better understand this potential impact, an inlet trafficability analysis was conducted to characterize lateral access under existing conditions and this analysis is summarized below.

Conditions in the sandy beach area where the Lagoon discharges to the Pacific Ocean (ocean outlet) were assessed to establish the level of lateral access under existing conditions at this location, which is also the location of a proposed tidal inlet for two of the BVLEP enhancement alternatives. The overall analysis consisted of three components: (i) analysis of field observations conducted by SANDAG between March 2013 and July 2016, (ii) analysis of Google Earth images, and (iii) analysis of prior fluvial modeling conducted as part of the BVLEP.

Figure 1. Project Location

2. ANALYSIS

2.1 SANDAG FIELD OBSERVATIONS

Twenty-three (23) field observations were conducted by SANDAG (2016) during three field visits made in 2013, two in 2014, ten in 2015, and eight in 2016. The first field visit was conducted on March 21, 2013 and the last on July 21, 2016. Field visits were authorized to identify potential inaccessible conditions so the observations tended to be conducted during high tide, high wave, and fluvial flood conditions. Observations consisted of photographs and notes documenting tide level estimates and wave height estimates as well as lateral access conditions at and near the ocean outlet.

The field observations are summarized in Table 1. The first columns in the table provide information on the date and time when field observations were conducted, followed by tide estimates and wave height estimates. It appears that the field observation documentation (SANDAG 2016) included predicted tides so those values were updated based on measured tides using data recorded at the same NOAA gage at San Diego Bay (Station No. 9410170). The updated (measured) tide data are presented in Table 1.

Precipitation data from the National Oceanic and Atmospheric Administration (NOAA) San Diego International Airport-Lindbergh Field (KSAN) station, located approximately 32 miles from Buena Vista Lagoon, was included in the field observation documentation (SANDAG 2016). To improve the accuracy of the precipitation data for the project location, available data from a closer weather station was substituted in place of the KSAN data. The selected rain gage is located at the NOAA McClellan-Palomar Airport (KCRQ) station, approximately five miles southeast of the Buena Vista Lagoon (see Figure 1). The updated rainfall data are summarized in Table 1.

Based on the field observation documentation, lateral access across the ocean outlet was characterized as easy access (*e.g.,* clear/dry or shallow water conditions), difficult/no access, or intermittent access (*i.e.,* between wave surges) for each field visit. Lateral access conditions were based on subjective interpretations made during brief field visits lasting from 3 to 50 minutes so it was sometimes challenging to clearly characterize the lateral access conditions. For example, the difference between "easy access" and "difficult/no access" events sometimes appear to be minimal based on the photo documentation. Nevertheless, difficult/no access events appear to be mainly triggered by a combination of precipitation causing water levels to overtop the weir as well as high tides and/or large waves. See Attachment 1 for photographic examples of lateral access conditions.

Three out of the five "difficult/no access" events listed in Table 1 had precipitation larger than 0.5 inches one or two days prior to the observation dates. For the three years that field observations were conducted, it is likely that there were other rain events that may have caused difficult lateral access that were not observed. To supplement the field observations, KCRQ precipitation data was downloaded for the period from March 21, 2013 through July 21, 2016, which is the same timeframe during which field observations were conducted. Between March 21, 2013 and July 21, 2016, a total of ten days had recorded daily precipitation levels exceeding 0.5 inches. Excluding three of these dates, which coincided with dates where field observations were made, the remaining seven days (*i.e.,* approximately 2 days per year) shown in Table 2 were assumed to have included difficult/no access conditions. These seven dates were used to supplement the field observation data.

Table 1. Summary Table of Field Observations and KCRQ Precipitation Data

#	Date of Field Visit	Approximate Time of Field Visit	Tide (ft, MLLW)	Wave Height (ft)	Last Rain Event, Date*	Days Since Last Rain Event* (calculated)	Last Rain Event, Ppt* (in)	Lateral Access at Ocean Outlet (i) Easy (*e.g.*, clear/dry or shallow water), (ii) Difficult/not available, (iii) Intermittent (clear between wave surges)	Comments	Water Level Above/ Below Weir
1	3/21/13	9:50-10:40 am	1.29	1.5 -2.5	3/15/13	6	0.01	Easy (clear/dry)	--	Above
2	5/15/13	9:35-9:40 am	1.83	2-3	5/8/13	7	0.04	Easy (shallow water)	Users had to cross channel (appears easy to cross, due to very shallow flow & beach berm, based on photo documentation)	Below
3	12/3/13	8:30-9:00 am	7.71	1-2	11/29/13	4	0.15	**Difficult/Not available**	King Tide; Users had to wade through channel	Above
4	11/20/14	10:45-11:00 am	2.83	4-6	11/1/14	19	0.30	Easy (clear/dry)	Ocean was not connected to weir though tide lines indicate that recent water levels had breached the berm and reached the weir	Above
5	12/13/14	1:00-1:30 pm	4.12	6-8	12/12/14	1	1.49	**Difficult/Not available**	Channel connected ocean to weir, water moved both in and out; Users had to wade through channel	Above
6	1/22/15	9:20-9:40 am	6.83	3-4	1/11/15	11	0.43	Easy (clear/dry)	King Tide; Ocean was not connected to weir though tide lines indicate that recent water levels had breached the berm and reached the weir; Evidence of beach berm	Above
7	2/19/15	10-10:15 am	6.52	3-4	1/26/15	24	0.07	**Intermittent**	Channel connected ocean to weir during wave surges	Above
8	3/18/15	9:15-9:20 am	5.18	1.5-2.5	3/2/15	16	0.43	**Intermittent**	Channel connected ocean to weir during wave surges; Tides flowed over weir into lagoon	Above
9	4/11/15	2:00-2:15 pm	3.29	2.5	4/8/15	3	0.01	**Difficult/Not available**	Channel connected ocean to weir; field notes say "lateral access was not available" (though flow appears to be shallow in most locations, based on photo documentation)	Above
10	5/19/15	9:40-9:45 am	4.47	1.5-2	5/15/15	4	0.57	Easy (clear/dry)	Berm intact	Above
11	6/17/15	9:30-9:35 am	4.62	1	5/24/15	24	0.01	Easy (clear/dry)	No channel present, though tide lines indicate that recent water levels had breached the berm	Above

#	Date of Field Visit	Approximate Time of Field Visit	Tide (ft, MLLW)	Wave Height (ft)	Last Rain Event, Date*	Days Since Last Rain Event* (calculated)	Last Rain Event, Ppt* (in)	Lateral Access at Ocean Outlet (i) Easy (*e.g.*, clear/dry or shallow water), (ii) Difficult/not available, (iii) Intermittent (clear between wave surges)	Comments	Water Level Above/ Below Weir
12	7/16/15	9:50-10:05 am	4.92	1.5	6/30/15	16	0.05	Easy (clear/dry)	No channel present, though tide lines indicate that recent water levels had breached the berm; Evidence of a vehicle previously moving sand	Above
13	9/17/15	10:18-10:25 am	4.42	2-3	9/15/15	2	0.64	**Difficult/Not available**	Channel connected lagoon water to ocean; Lateral access was difficult water > 1.5' in depth	Below
14	11/16/15	10:28-10:36 am	5.74	3-4	11/15/15	1	0.01	Easy (clear/dry)	--	Above
15	11/25/15	7:58-8:14 am	7.78	3-4	11/25/15	0	0.11	**Intermittent**	King Tide; Channel connected only during wave surge	Above
16	1/8/16	7:38-7:54 am	7.00	5-8	1/7/16	1	0.90	**Difficult/Not available**	No lateral access. Ponding on beach to south. Water flowing to lagoon on wave surges and out of lagoon between surges.	Above
17	1/25/16	9:48-9:55 am	6.36	2-3	1/23/16	2	0.04	Easy (clear/dry)	--	Above
18	2/26/16	9:40-9:45 am	4.54	2-3	2/18/16	8	0.05	Easy (clear/dry)	--	Above
19	3/25/16	9:11-9:17 am	4.63	1-2	3/14/16	11	0.01	Easy (clear/dry)	--	Above
20	4/22/16	9:20-9:28 am	4.70	1-2	4/10/16	12	0.19	Easy (clear/dry)	--	Above
21	5/20/16	7:10-7:13 am	3.91	1-3	5/7/16	13	0.05	Easy (clear/dry)	--	Above
22	6/20/16	9:24-9:29 am	4.36	1-2	5/25/16	26	0.01	Easy (clear/dry)	--	Above
23	7/21/16	9:42-9:47 am	4.84	1-2	5/25/16	57	0.01	Easy (clear/dry)	--	Above

Sources: (SANDAG 2016), NOAA 2016a, NOAA 2016b

* Based on precipitation data from the NOAA McClellan-Palomar Airport (KCRQ) station

Table 2. Dates with Precipitation Levels Greater Than 0.5 Inches at KCRQ and No Field Observations Were Made (3/21/2013 - 7/21/2016)

DATE	PRECIPITATION (IN)
2/28/2014	0.93
3/1/2014	0.65
3/1/2015	1.00
5/15/2015	0.57
7/19/2015	0.55
1/5/2016	1.22
1/6/2016	0.66

Source: NOAA 2016a

It was assumed that difficult/not available access events would completely block access while intermittently available access events would block access half the time. Based on these assumptions, an analysis of the field observations and KCRQ precipitation data was conducted, and the results revealed that lateral access was impaired (difficult/not available and intermittently available) 28% of the observation days. This implies that inaccessible conditions occurred, on average, 103 days per year (28%) during this time period; however, this seems too high given the mechanisms (fluvial flood flows, high tides, high waves) that cause inaccessibility and the associated frequency of those mechanisms. Based on discussion with SANDAG staff, it was determined that field observation occurred to document higher tides as a basis for determining impairment of lateral access and as part of regional shoreline monitoring which is structured to go out monthly on higher tides. This means the field observation data will tend to be biased towards conditions leading to inaccessibility. Consequently, the analysis results will likely overestimate the percentage of time that lateral access across the ocean outlet was/is inaccessible.

It is recognized that lateral access would likely be impaired for a small duration of the days for which such impairment was observed so an estimate of the impairment duration was developed. Given the relatively short duration of storms and high tides in Southern California, it was assumed that difficult/not available/intermittently available events lasted, on average, two to four hours each day that such events occurred. Based on these assumptions and limitations, it was estimated that lateral access was difficult/not available/intermittently available 2% to 5% of the time between March 21, 2013 and July 21, 2016.

2.2 GOOGLE EARTH IMAGERY

An additional avenue of inquiry utilized Google Earth imagery. Google Earth was queried to identify pertinent information related to the lateral access analysis. Google Earth contained 26 aerial photographs in the vicinity of Buena Vista Lagoon between May 31, 1994 and March 22, 2016 (22 years). Based on review of the 26 photographs there were eight photographs (1/3/2003, 3/10/2003, 12/31/2002, 1/31/2008, 2/29/2008, 4/24/2010, 10/27/2012, 11/2/2012) documenting conditions during which an outflow channel was present flowing from the Lagoon across the beach to the ocean. A simple ratio of these observations reveals that an outflow channel was documented on 31% of the days that observations (photos) were made. If it is assumed that each of these events represented inaccessible lateral access conditions, this percentage is representative of annual conditions, and the duration of each outflow event is 2 hours to 4 hours then this analysis reveals that lateral access across the ocean outlet was inaccessible 3% to 5% of the time between May 31, 1994 and March 22, 2016. This is similar to the results of the analysis of the SANDAG field observations.

2.3 PRIOR FLUVIAL MODELING

As part of the BVLEP, fluvial modeling was conducted for the following extreme flood flow events: 2-year, 5-year, 10-year, 50-year, and 100-year. The results revealed that all the extreme events analyzed would result in overtopping of the weir (El. +5.6 ft NGVD29) with the lowest event (2-year) overtopping the weir by 0.4 ft to 0.5 ft for the Freshwater Alternative and Existing Conditions, respectively. From these results it can be concluded that the ocean outlet would be inaccessible for lateral access on average once every two years. Although no modeling was conducted for the 1-year event, it is likely that the results would also show overtopping; hence, inaccessible lateral access on average once every year. Based on the assumption that each outflow event is 2 hours to 4 hours in duration suggests that lateral access across the ocean outlet would be inaccessible 0.02% to 0.05% of the time based on this analysis. This is far lower than the results of both the field observation and aerial imagery analyses. Since the fluvial modeling did not take into consideration high tides, wave runup, or channel opening by the City of Oceanside, it is highly likely that lateral access is impaired a greater amount of time than estimated from the prior fluvial modeling.

3. SUMMARY

In considering the results of the three analyses presented above, analysis of the prior fluvial modeling (Section 2.3) results likely under estimated the percentage of inaccessible conditions because it only considered extreme fluvial flow events. In addition, this analysis did not consider the effects of high tides, wave events, and beach berm elevation on lateral access. Even though the time period differed substantially, both of the analyses based on observations resulted in similar results with 2% to 5% for the SANDAG field observation analysis (Section 2.1) and 3% to 5% for the Google Earth imagery analysis (Section 2.2). The data associated with both of these analysis methods are very limited and the processes that affect lateral access are numerous and complex so there is a high degree of uncertainty in the results for both of these analyses. However, utilizing both of these analyses to establish an order of magnitude range of inaccessible lateral access conditions seems warranted to address the original question posed by this task: What is the percentage of time lateral access is unavailable across the existing ocean outlet at Buena Vista Lagoon? Based on the results of this analysis, it is estimated that lateral access across the existing ocean outlet at Buena Vista Lagoon is unavailable 2% to 5% of the time.

4. REFERENCES

SANDAG 2016. Time Series Photo Documentation of Buena Vista Lagoon. April 2016 and August 2016.

NOAA 2016a. History of Recorded Daily Precipitation at National Oceanic and Atmospheric Administration (NOAA) McClellan-Palomar Airport Station (KCRQ) in Carlsbad, California. Data accessed and downloaded from Weather Underground in June 2016 and July 2016. https://www.wunderground.com/history/airport/KCRQ/2016/06/27/DailyHistory.html?req_city=Carlsbad&req_state=CA&reqdb.zip=&reqdb.magic=&reqdb.wmo

NOAA 2016b. Tides/Water Levels at National Oceanic and Atmospheric Administration (NOAA) San Diego Bay Station (No. 9410170). Data accessed June 2016. http://tidesandcurrents.noaa.gov/waterlevels.html?id=9410170&units=standard&bdate=20140811&edate=20140811&timezone=LST&datum=MLLW&interval=6&action=data

Attachment 1: Examples of Lateral Access at Outlet

Easy Access

Intermittent Access

Difficult Access