August 7, 2009

Mr. Thomas Barnes  
Environmental Science Associates  
707 Wilshire Boulevard, Suite 1450  
Los Angeles, California 90017

Subject: Morro Bay-Cayucos Sanitary District (MBCSD) Wastewater Treatment Plant  
         Flood Hazard Analysis

Dear Mr. Barnes:

We have completed the final version of the second phase of the Flood Hazard Analysis of the MBCSD Wastewater Treatment Plant. This phase of the report builds on the first phase by quantifying flood risks and presenting several alternatives to reducing these flood risks. As flood protection measures could have an impact on adjacent properties, the flood impact of these alternative improvements on neighboring properties is assessed. Recommendations for mitigating these impacts are also presented.

Sincerely,

WALLACE GROUP

[Signature]

Barry Rands, PE  
Senior Civil Engineer
MORRO BAY CAYUCOS SANITARY DISTRICT
WASTEWATER TREATMENT PLANT
FLOOD HAZARD ANALYSIS

TABLE OF CONTENTS

CERTIFICATION .............................................................................................................................. 1
  PROFESSIONAL ENGINEER ........................................................................................................... 1

LIST OF ACRONYMS AND TECHNICAL TERMS ............................................................................. 2

EXECUTIVE SUMMARY ..................................................................................................................... 3

INTRODUCTION ................................................................................................................................. 4

LOCATION ........................................................................................................................................ 4

EXISTING DRAINAGE SYSTEM ....................................................................................................... 4

HYDROLOGY ...................................................................................................................................... 5

PAST FLOOD STUDIES ...................................................................................................................... 6
  FEMA Flood Insurance Rate Map (FIRM) ..................................................................................... 6
  2001 Morro Bay Power Plant (MBPP) Flood Hazard Analysis .................................................... 7

CURRENT (2009) FLOOD ANALYSIS .............................................................................................. 8
  FIELD INVESTIGATIONS ............................................................................................................... 8
  FLOOD MODEL UPDATES .......................................................................................................... 9
  100-YEAR FLOOD EVENT SCENARIOS .................................................................................... 9
  RESULTS OF THE FLOOD EVENT SCENARIOS ..................................................................... 11
  DISCUSSION OF RESULTS ...................................................................................................... 13

FLOOD PROTECTION AND FLOOD REDUCTION METHODS ........................................................... 15

RECOMMENDATIONS ..................................................................................................................... 16

APPENDIX

Exhibit 1 – Location Map
Exhibit 2 – Existing Drainage System and Flooding Sources
Exhibit 3 – FEMA Flood Insurance Rate Map (FIRM)
Exhibit 4 – FLO-2D Flood Maps
Exhibit 5 – Photographs
Exhibit 6 - Recommended Plant Site Footprint
CERTIFICATION

Preparation of this report included efforts by the following persons:

Barry Rands, Project Manager
Craig Campbell, Principal (peer review)

Professional Engineer
This report was prepared by, or under the direction of the following Professional Engineer in accordance with the provisions of Section 6700 of the Business and Professions Code of the State of California.

Civil Engineer:

[Signature]
Barry Rands, Civil Engineer
PE 72929

Date
8-7-09

[Official Seal]
Registered Professional Engineer
No. 72929
Exp. 12-31-08
State of California
LIST OF ACRONYMS AND TECHNICAL TERMS

1% ANNUAL CHANCE FLOOD: Commonly known as the 100-year flood or the base flood, it is the flood that has a 1% chance of being equaled or exceeded in any given year. The boundaries and depths of this flood are shown on maps published by FEMA.

10% ANNUAL CHANCE FLOOD: Commonly known as the 10-year flood. Not shown on FEMA maps.

2% ANNUAL CHANCE FLOOD: Commonly known as the 50-year flood. Not shown on FEMA maps.

0.2% ANNUAL CHANCE FLOOD: Commonly known as the 500-year flood. Shown on FEMA maps for informational purposes.

ACOE: Army Corps of Engineers

BASE FLOOD: 1% Annual Chance Flood (see above)

CFS: cubic feet per second. This is a common unit of flow rate measurement in flood analysis.

FEMA: Federal Emergency Management Agency

FIRM: Flood Insurance Rate Map. The FIRM is an official map published by FEMA indicating boundaries and depths of flooding in a 1% chance (100-year) flood. Also referred to as the “FEMA map”.

FIS: Flood Insurance Study. The FIS is a FEMA-sponsored study to determine flood risks in a given community or county. The results are published as maps (FIRMs) and as a report. FIS usually refers to the report.

FLO-2D: A hydraulic analysis program that uses a grid system to model flooding over unconfined surfaces.

HEC-RAS: A hydraulic analysis program used to model flows in river and open channel systems.

LOMR: Letter of Map Revision. An application for a LOMR is a formal process requesting a change to the official flood map (FIRM) published by FEMA.

MBCSD: Morro Bay - Cayucos Sanitary District (Joint owners of the WWTP)

MBPP: Morro Bay Power Plant


NGVD 29: National Geodetic Vertical Datum of 1929. This vertical control datum was established in 1929 for vertical control surveying in the US. It has been replaced by the NAVD 88, though elevations shown on many maps still reference the NGVD 29 datum. The NAVD 88 datum is generally the higher of the two, but the difference is not constant. In Morro Bay, the NAVD 88 datum is approximately 2.8 feet higher than NGVD 29.

USGS: United States Geological Survey

WWTP: MBCSD Wastewater Treatment Plant. Also referred to in the report as the “plant”.

EXECUTIVE SUMMARY

The MBCSD Wastewater Treatment Plant (WWTP) experiences both localized drainage problems and larger flooding problems. Flooding has occurred in the past at the plant, and the site is in a designated Flood Insurance Zone.

A flood analysis was performed for the WWTP site, based on two-dimensional flood modeling using FLO-2D software. This study shows that flooding at the WWTP site is in the range of 3 to 4.5 feet deep. The study also indicates that floodwaters have an outlet through the dunes to the north of the WWTP.

Examination of the current FEMA flood maps and reports show flood depths approximately 2.5 feet higher at the WWTP site than those determined with the above described FLO-2D model. The FEMA map shows about a third of the site as free from 100-year flooding and no flow outlet through the dunes. However, based on current topography, the entire site is below the 100-year flood elevation. Inconsistencies in the peak flow rates reported in the Flood Insurance Study (FIS) used to support the mapping were also discovered.

The FLO-2D model was originally developed by West Consultants for the Morro Bay Power Plant (MBPP) in 2001. To bring the flood analysis up to date, we obtained and revised the original FLO-2D files with current dune topography and analyzed the flood hazard under existing conditions. The updated analysis shows only a marginal increase in flood levels relative to the original study for the Power Plant. Ten flood risk reduction alternatives were also modeled to determine the impact on the WWTP and adjacent properties.

Results of the analysis of the alternatives and feedback from City and CSD staff lead to the following recommendations:

To address 100-year flooding issues:
- Construct the new WWTP facilities on higher ground. Construction on elevated fill provides the highest level of protection and least amount of operational inconveniences.
- Construct all or part of the new facilities on City owned land to the south of the current site that is already elevated, modeled in the analysis as MB10 through 12. Construction at this location will have the least adverse flood impact on neighboring properties.
- Reconstruct Atascadero Road with an inverted crown. This will reduce flooding for all properties along the road and nearly eliminate flooding at the high school for all but the most extreme storm events.
- The City floodplain management ordinance and funding agencies require that WWTP improvements be protected from flooding to the level of one foot above the 100-year flood elevation. Because of the potential reduction of flood levels relative to the current FIRM, we recommend that a Letter of Map Revision (LOMR) be applied for, including new hydrology and new hydraulic analyses. The LOMR process typically takes 3 to 6 months for complex situations such as this.

To address smaller, more frequent flooding:
- Drainage along Atascadero Road should be improved. Several options include:
  - Increasing the size of the 24 inch culvert through the dunes at the end of the street
  - Reestablishment of a surface flow path to the ocean through the dunes at the end of the street.
  - Reconstruction of Atascadero Road with an inverted crown will increase street capacity from a few cfs to approximately 150 cfs.
  - Atascadero Road could be managed as a flood conveyance facility with appropriate warning signs for traffic and parking limitations.
- Raising the WWTP site with fill will alleviate most of the inconveniences of smaller floods on the operation of the plant, but will not improve the flooding situation for neighboring
properties. We recommend that one or more of the measures to alleviate smaller flooding be implemented to mitigate the small impact that the new plant will have on the floodplain.

INTRODUCTION

The MBCSD Wastewater Treatment Plant (WWTP) occupies a 6-acre parcel in Morro Bay at the west end of Atascadero Road, and only a few hundred feet from the Pacific Ocean. It experiences both localized drainage problems and larger flooding problems. Flooding has occurred in the past at the WWTP, and the site is in a Special Flood Hazard Zone. With the proposed upgrade of the WWTP, there is need to investigate the sources of flooding, quantify the flood risk, and assess several alternatives to reduce the risk of damage to the plant due to flooding. The impact of flood protection alternatives on neighboring properties also requires evaluation. This report seeks to address these flood related issues.

LOCATION

The WWTP is in a topographic depression, situated between higher ground to the east and a narrow swath of sand dunes to the west. Nearby developments include Morro Bay High School to the north, Hanson Aggregates directly to the east and Morro Dunes RV Park to the south and west. Other business nearby include two motels and another RV park on Atascadero Road to the east. Morro Creek flows to the ocean approximately 600 feet south of the WWTP, and is separated from the WWTP by high ground occupied by the Morro Dunes RV Park. The WWTP’s low-lying location aggravates the flooding problem, as the only stormwater drainage outlets for the site are subject to blockage and backwater. A location map is shown in Exhibit 1.

EXISTING DRAINAGE SYSTEM

The existing drainage system is comprised of five principle components: three underground storm drain systems for smaller flows and two surface routes to the ocean. They are described in more detail below. Exhibits 2 and 5 provide a map and photos of these facilities.

- **Underground storm drain to the ocean**: A 24-inch diameter storm drain captures runoff from the north portion of the WWTP and conveys it to the beach, just beyond the littoral dunes. Its full-flow capacity is 8 cfs, though sand accumulation at the outlet frequently reduces the effective capacity. Periodic maintenance to clear the outlet of sand is necessary. A catch basin in Atascadero road also contributes flow to this drain.

- **Underground storm drain to Morro Creek**: A 24-inch diameter storm drain captures runoff from the south portion of the WWTP and conveys it to Morro Creek. The outlet is capped by a flap gate to prevent high flows in the creek from backing up into the plant. The drain has a full-flow capacity of 11 cfs, but the capacity will be greatly diminished during high flows in Morro Creek.

- **Internal Stormwater Recapture System**: Approximately half of the WWTP site drains to a stormwater recapture system. This system captures runoff from the central part of the site and redirects it to the plant headworks were it enters the wastewater treatment process for eventual ocean discharge. Flows in excess of the capacity of this system are conveyed to Morro Creek in the 24-inch drain described above.

- **Surface drainage through the dunes at Atascadero Road**: Historic photos of the coastline (see Exhibit 5.3) show that there was once a fairly large gap in the dunes at the west end of Atascadero Road. It likely served as a primary surface outlet to the ocean for flood flows from the floodplain on the north side of Morro Creek. Over the years, this gap has diminished in width and increased in height to the point that it no longer serves as a free outlet for flood flows. It should be noted that the reduction in width is due primarily to encroachment from non-native vegetation (ice plant), which also likely contributes to the accumulation of windblown sand.
• **Surface drainage through the dunes to the north:** The dunes between the high school and the beach are well vegetated with a trough running parallel to the coastline. This trough serves as a surface path to the ocean for floodwaters on the north side of Morro Creek. The entrance to the trough at the south end is adjacent to a dirt parking area at the end of Atascadero Road. The outlet is 1,700 feet to the north where it crosses a pedestrian walkway and drops into a creek that leads to the ocean. The elevation drop across the 1,700 feet is only 1 foot with many depressions and hillocks along the way. Consequently, flow through along this path rather slow. This path conveys approximately 5% of the 100-year flood flow to the ocean. This portion of the dunes is owned and managed by the State Park system.

**HYDROLOGY**

Our scope of work included a review of existing hydrology studies and analysis of the flood hydraulics using flows from these existing studies. Our review indicates that an independent verification of flows is warranted, however, we do not anticipate major conclusions to be effected.

The WWTP is situated on the floodplain and near the mouth of Morro Creek, which drains a reported 24 square mile watershed to the east of the plant. Two major hydrology studies have been conducted for Morro Creek by FEMA and the Army Corps of Engineers (ACOE). The findings of these reports are discussed below.

Because of inconsistencies in the hydrology studies reviewed, two peak flow values have been used for flood modeling through the plant site. A high flow value corresponds to the 14,900 cfs reported in the FIS and a lower value which represents the 11,668 cfs from the ACOE report. Additional discussion of the hydrology of Morro Creek can be found in the *Morro Bay Power Plant Flood Hazard Analysis (2001)* described later in this report. The authors of that report used the higher flow values in their analysis.

**FEMA:** The current FEMA Flood Insurance Study (FIS) for San Luis Obispo County (August 2008) states that peak flows for Morro Creek, as well as several other creeks in the area, were calculated with use of regional regression equations developed by USGS in 1977 for the Central Coast. The published peak discharges for Morro Creek at two locations are shown in a table from the FIS shown below:

<table>
<thead>
<tr>
<th>Flooding Source and Location</th>
<th>Drainage Area (sq miles)</th>
<th>10-Percent Annual Chance (cfs)</th>
<th>2-Percent Annual Chance (cfs)</th>
<th>1-Percent Annual Chance (cfs)</th>
<th>0.2-Percent Annual Chance (cfs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Morro Creek</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>At mouth</td>
<td>24.0</td>
<td>2,200</td>
<td>9,200</td>
<td>14,900</td>
<td>38,000</td>
</tr>
<tr>
<td>At State Highway 1</td>
<td>24.0</td>
<td>2,400</td>
<td>7,800</td>
<td>11,200</td>
<td>24,300</td>
</tr>
</tbody>
</table>

It should be noted that this table reveals three inconsistencies.

- The first is that the drainage areas given at the mouth and at State Hwy 1 are identical (24 square miles), when in fact they are not. Willow Camp Creek joins Morro Creek just west of the highway and adds 0.5 square miles to the total drainage area at the mouth.
- The second is that the large difference between the 1% chance flows in Morro Creek at the highway and at the mouth (11,200 and 14,900 cfs) cannot be accounted for by Willow Camp Creek. Because of Willow Camp Creek’s small drainage area and its proximity to the mouth, its contribution to the peak flow of Morro Creek is likely only a few hundred cfs.
- The third inconsistency is that the table shows a higher 10% chance flow at the highway than at the mouth.

We have contacted the FEMA contractor responsible for reviewing map change requests in regards to the anomalies in the FIS. At this writing, we are still awaiting a reply.

**ACOE:** The ACOE study was published in 1999, benefiting from over 20 years of additional streamflow records beyond what was available for the USGS study. They compared three different
methods for determining peak flows and concluded that their “regression analysis method is recommended for use in determining discharge frequency values for San Luis Obispo County streams.”\(^1\) According to the ACOE study, use of this method results in a 100-year peak flow for Morro Creek at Morro Bay of 11,668 cfs.

**On-site hydrology:** Runoff produced from on-site rainfall is small in comparison to flows delivered by flooding in the Morro Creek watershed, but are nevertheless a nuisance if not effectively managed. Estimated peak flows generated from onsite rainfall are shown in the table below:

<table>
<thead>
<tr>
<th>Frequency</th>
<th>2-yr</th>
<th>5-yr</th>
<th>10-yr</th>
<th>25-yr</th>
<th>50-yr</th>
<th>100-yr</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>0.95</td>
<td>0.95</td>
<td>0.95</td>
<td>0.95</td>
<td>0.95</td>
<td>0.95</td>
</tr>
<tr>
<td>I (in/hr)</td>
<td>1.3</td>
<td>1.9</td>
<td>2.3</td>
<td>2.6</td>
<td>3.0</td>
<td>3.2</td>
</tr>
<tr>
<td>A (acres)</td>
<td>6.0</td>
<td>6.0</td>
<td>6.0</td>
<td>6.0</td>
<td>6.0</td>
<td>6.0</td>
</tr>
<tr>
<td>Q (cfs)</td>
<td>7.4</td>
<td>10.8</td>
<td>13.1</td>
<td>14.8</td>
<td>17.1</td>
<td>18.2</td>
</tr>
</tbody>
</table>

**PAST FLOOD STUDIES**

**FEMA Flood Insurance Rate Map (FIRM)**

The Federal Emergency Management Agency (FEMA) issued revised flood maps on August 28, 2008 for all of San Luis Obispo County. The new maps display flood information somewhat differently than in the past, but do not, in general, reflect new analysis. The flood boundaries and depths at the WWTP site remain unchanged, though the flood zone names have changed. More than half of the 6-acre site is classified as Zone AE, signifying that 100-year flood elevations have been determined and are shown on the map. Approximately 2.5 acres of the west portion of the site is classified as Zone X, signifying land that is subject to flooding during the 500-year (0.2% chance) flood. Zone X boundaries are provided for informational purposes only and are not used for regulatory or design purposes. The portion of the map (06079C0813F) that covers the WWTP site is included as Exhibit 3.

The FIRM indicates that the 100-year flood elevation at the plant is just over 20 feet based on the NVGD 1929 datum. In our initial review, we recommended that available topographic information for the WWTP site be tied to this datum in order to determine the depths of flooding at the site. We also recommended that the FEMA hydraulic data be checked against available topography and/or field measurements to determine if the FEMA flood levels are reasonable.

- **FEMA Flood Depths:** We were able to procure relatively recent topography (Fall 2000) from the Morro Bay Power Plant that includes topography at the WWTP site. This topography is on the NAVD 88 datum whereas the FEMA map is based on NGVD 29, but it includes a conversion factor to correlate the two surveys. Based on this topography, the typical FEMA flood depth on the WWTP site is approximately 6 feet but ranges between 5.5 to 7 feet. The deepest flooding would occur near the Primary Sedimentation Tank 2, as shown in Figure 1 on the next page. Note that the west part of the plant is shown as outside of the 100-year flood limit on the FIRM. The reason for this anomaly is that the FEMA flood limit is based on outdated topography of the site prior to the 1982 expansion. The area shown outside of the floodplain was part of the dune system prior to 1982.

- **Relation of FEMA flood levels to 1982 WWTP plans:** The procurement of new topographic maps has also allowed a determination to be made regarding the datum used in the Brown

---

\(^1\) U.S. Army Corps of Engineers. (June 1999). *Regional Discharge-Frequency Analysis – San Luis Obispo County*, p. 5.
and Caldwell drawings of 1982. Based on a comparison of the two, it appears that the Brown and Caldwell drawings have used a datum of NGVD29 plus 100 feet.

- **FEMA Hydraulic Data:** We made a request to FEMA for the hydraulic and topographic data used to determine the base flood elevations (100-year flood level) in the vicinity of the WWTP site. FEMA notified us that they do not have any records of the requested data.

![Figure 1: Portion of the FIRM showing the limits of the 100-year flood (shaded in pink)"

- **Regulatory Requirements:** The flood depths depicted on FEMA maps are important from a regulatory perspective. Floodplain ordinances are tied to the floodplain limits and other data shown on these maps. New development must abide by the floodplain ordinances and floodplain data depicted on these maps, even if maps are outdated, unless an official map has been revised through a Letter of Map Revision (LOMR). Morro Bay’s floodplain ordinance specifies floodproofing requirements for new non-residential buildings such as those proposed for the plant expansion. The ordinance requires elevation of structures or floodproofing to one foot above the base flood (100-year) elevation.

*2001 Morro Bay Power Plant (MBPP) Flood Hazard Analysis*

The Morro Bay Power Plant commissioned a flood hazard study as part of their plant renovation plans. The study, performed by West Consultants in Bellevue, Washington, was submitted to the California Energy Commission (CEC) in June 2001 and is now part of the public record. We were able to obtain a copy of this report from West with assistance from the Morro Bay Power Plant Manager. Though the study area is focused on the Power Plant site, it also extends north beyond the WWTP site. According to this study, flood depths at the WWTP site are approximately 2 to 3 feet less than indicated on the FEMA map, however, the floodplain covers 100% of the site.
It also shows the source of flood flows, with some flow coming from Morro Creek and other flooding from Atascadero Road (see Exhibit 2.2). The Atascadero Road flow results from the severe restriction of Morro Creek as it passes under several bridges in the vicinity of Hwy 1 (Main Street, Hwy 1 and ramps, and a pedestrian bridge). This causes floodwaters on the east side of Hwy 1 to back up and flow to the south and north. To the south, they flow over Highway 1 and through portions of the Power Plant and on to the ocean. To the north, floodwaters find their way through a mobile home park and Main Street where they would cross under Highway 1 at the Atascadero Road underpass. From there, flows follow Atascadero Road to the dunes with the some flow spreading out and heading towards the high school.

The Morro Creek overflow occurs at Keiser Park, where floodwaters pass through the park and Hansen Aggregates before reaching the WWTP site.

The MBPP study indicates two flood paths through the coastal dunes in addition to the primary route in the Morro Creek channel. As the coastal dunes are in an almost constant state of movement, the current analysis incorporates current dune topography into the hydraulic model.

**CURRENT (2009) FLOOD ANALYSIS**

The past flood studies discussed above served as a basis for the flood analysis in this report. The current flood study is based on the FLO-2D model originally prepared by West Consultants. The model was run with modified hydrology as discussed below and updated by field investigations and a topographic survey of the dunes in the vicinity of the WWTP. This section begins with a summary of field investigations and concludes with the results of the analysis.

**Field Investigations**

The following issues were noted during field investigations in 2007 and 2009:

- The existing headworks structure is below grade and is particularly at risk from flooding. Staff has constructed a low wall and installed facilities for placing flood gates. A stockpile of sand is also used for additional protection.
- The storm drain system is dependent on an open beach outfall. Due to shifting sand dunes, the outfall periodically becomes covered with sand. City maintenance crews are tasked with uncovering the outfall when needed. If this is not done, the plant storm drain system backs up. According to the WWTP Improvement Plans, the existing storm drain is a dedicated drain for the WWTP site.
- Some electrical control rooms are at grade and do not have flood protection other than operators placing berms and sand bags when needed.
- High ground water is present. Existing subsurface structures are filled with groundwater to within a few feet of the surface year-round.
- Staff coordinates with the neighboring Hanson Aggregate owners regarding the orientation of their yard and supplies. Flood waters from the southeast first cross the Hanson property. When Hanson has stock on hand of large concrete block, they store the blocks on-site in a manner that directs flood waters to Atascadero Road rather than through the WWTP.
- Recent flooding includes events in 1995 and 2004. In 1995, general flooding occurred from the Atascadero Road and from Morro Creek. In 2004, the flood source was limited to the overflows from the creek at Keiser Park. These flow paths are illustrated in Exhibit 2.2.
- The topography map reveals that sump conditions exist on the site in the vicinity of Primary Sedimentation Tank 2 with a low elevation of 15.7 feet. The lowest overland escape route for this sump is through the front entrance with an elevation of 16.3. Though this sump has an underground drain, high groundwater water table or blockage of this underground drain can cause over 6 inches of flooding of the sump area even during small storm events.
The elevation of the primary surface outlet through the dunes has risen approximately two feet, but the secondary outlet through the dunes to the north has remained roughly the same.

The capacity of Morro Creek in the vicinity of Main Street/Hwy 1 is limited due to channel geometry, restrictions at bridge openings and a build-up of sediment in the main channel. A depth gage at the Hwy 1 bridge indicates that sediment depth is 6 feet at that location.

**Flood Model Updates**

The FLO-2D files used to analyze flood hazards in 2001 for the Morro Bay Power Plant were obtained and reformatted to run on the latest version of FLO-2D. The files were then reviewed and modified to reflect current conditions as follows:

- The main modification to the base model was to incorporate current dune topography based on survey information gathered in February, 2009. As suspected, the dunes have changed since 2001, gaining an additional 2 feet in height at a critical outlet location at the end of Atascadero Road. The dune outlet near the north side of the high school, however, was virtually unchanged.

- Per the suggestion of the FLO-2D program developers, the storm hydrograph was revised to better represent the design flood, keeping the same flood peak, but modifying the shape and volume of the hydrograph to conform to hydrographs commonly used on the Central Coast. The revised hydrograph has a smaller total storm volume. A second flood hydrograph was developed representing the smaller peak flows from the ACOE study.

- In addition, the model was reviewed to determine if the current WWTP building layout and areal coverage were correctly accounted for in the model. Some minor adjustments were made accordingly.

- The model was also modified to relocate the junction of Willow Camp Creek to its true location as shown on the topographic map.

The updated existing conditions model was then developed with ten different alternative scenarios, based on flood protection/reduction strategies described in earlier reports and as discussed with City and CSD staff. These flood protection and reduction strategies are further elaborated in the next section of this report.

**100-year Flood Event Scenarios**

Our research discovered a range of values for the 100-year peak flow of Morro Creek. We modeled the upper and lower range of these values for most of the scenarios.

**High Flow (14,900 cfs):** Including the original and existing conditions models, a total of twelve scenarios were modeled at this flow rate. They are described as follows:

1. **MB1: Original 2001 model with the revised hydrograph.** The flood hydrograph for Morro Creek upstream of the Hwy 1 bridge was modified as described above. The junction of Willow Camp Creek and Morro Creek was corrected. No other changes to the original model were made.

2. **MB2: Existing Conditions Model.** The current dune topography was incorporated into the model as well as changes in the model representation of WWTP facilities to account for blockage of flow by existing structures. This served as the base model for all other scenarios.

3. **MB3: Entire site protected.** A floodwall protecting or fill elevating the entire site including the area around the new oxidation ponds was incorporated into this model. A 6.4 acre area is protected in this scenario.

4. **MB4: Entire site protected with improved dune outlet.** Similar to MB3, but with the
addition of an improved outlet through the dunes at the end of Atascadero Road.

5. **MB5: Flood protection of individual buildings and sludge beds.** Individual buildings are floodproofed in this model, allowing floodwaters to pass through the site, except for the sludge beds, which are surrounded by a perimeter wall covering 1.8 acres.

6. **MB6: Flood barrier along north bank of Morro Creek at Keiser Park.** This scenario is based on MB5, but includes a full height floodwall or levee along the north bank of Morro Creek in Keiser Park.

7. **MB7: Entire site protected and flood barrier on north side of Keiser Park.** Similar to MB3, but with the addition a full height floodwall or levee on the north side of Keiser Park (allowing the park to flood).

8. **MB8: Reduced site footprint protected and flood barrier on north side of Keiser Park.** This scenario features a perimeter wall or fill that protects a smaller, 4.6 acre, area and includes a floodwall or levee on the north side of Keiser Park (allowing the park to flood).

9. **MB9: Reduced site footprint protected.** This scenario features a perimeter wall or fill that protects a smaller, 4.6 acre, area. The new oxidation pond area is included, but most of the structures within 200 feet of Atascadero Road would not be included inside this smaller plant footprint.

10. **MB10: 5.5-acre site footprint protected.** This scenario features a perimeter wall and/or fill that protects a 5.5 acre area including the existing sludge ponds and approximately 4 acres of land to the south that is currently used for RV storage. All existing WWTP structures are demolished in this scenario.

11. **MB11: 7.3-acre site footprint protected.** This scenario features a perimeter wall and/or fill that protects a 7.3 acre area including the existing sludge ponds, approximately 4 acres of land to the south that is currently used for RV storage, and 2 acres of land currently used by Hansen Aggregates (in the vicinity of the proposed oxidation ditches). All existing WWTP structures are demolished in this scenario.

12. **MB12: 9.1-acre site footprint protected.** This scenario features a perimeter wall and/or fill that protects a 9.1 acre area including the existing sludge beds and much of the south half of the plant, approximately 4 acres of land to the south of the plant that is currently used for RV storage, and 2 acres of land currently used by Hansen Aggregates (in the vicinity of the proposed oxidation ditches). All existing WWTP structures within 200 feet of Atascadero Road are demolished in this scenario.

**Low Flow (11,600 cfs):** Including the existing conditions models, a total of eight scenarios were modeled at this flow rate. They are described as follows:

1. **MB2b: Existing Conditions:** The current dune topography was incorporated into the model as well as changes in the model representation of WWTP facilities to account for blockage of flow by existing structures. This served as the base model for all other scenarios.

2. **MB3b: Entire site protected:** A floodwall protecting or fill elevating the entire site including the area around the new oxidation ponds was incorporated into this model. A 6.4 acre area is protected in this scenario.

3. **MB5b: Flood protection of individual buildings and sludge beds.** Individual buildings are floodproofed in this model, allowing floodwaters to pass through the site, except for the sludge beds, which are surrounded by a perimeter wall covering 1.8 acres.

4. **MB7b: Entire site protected and flood barrier on north side of Keiser Park.** Similar to MB3, but with the addition a full height floodwall or levee on the north side of Keiser Park (allowing the park to flood).
5. **MB9b: Reduced site footprint protected.** This scenario features a perimeter wall or fill that protects a smaller, 4.6 acre, area. The new oxidation pond area is included, but most of the structures within 200 feet of Atascadero Road would not be included inside this area.

6. **MB10b: 5.5-acre site footprint protected.** This scenario features a perimeter wall and/or fill that protects a 5.5 acre area including the existing sludge ponds and approximately 4 acres of land to the south that is currently used for RV storage. All existing WWTP structures are demolished in this scenario.

7. **MB11b: 7.3-acre site footprint protected.** This scenario features a perimeter wall and/or fill that protects a 7.3 acre area including the existing sludge ponds, approximately 4 acres of land to the south that is currently used for RV storage, and 2 acres of land currently used by Hansen Aggregates (in the vicinity of the proposed oxidation ditches). All existing WWTP structures are demolished in this scenario.

8. **MB12b: 9.1-acre site footprint protected.** This scenario features a perimeter wall and/or fill that protects a 9.1 acre area including the existing sludge beds and much of the south half of the plant, approximately 4 acres of land to the south of the plant that is currently used for RV storage, and 2 acres of land currently used by Hansen Aggregates (in the vicinity of the proposed oxidation ditches). All existing WWTP structures within 200 feet of Atascadero Road are demolished in this scenario.

These scenarios are discussed in greater detail in the section on Flood Protection and Flood Reduction Methods.

**Results of the Flood Event Scenarios**

Results of the above described scenarios are shown in maps form in Exhibit 4. The tables on the following pages summarize the results at select locations. All elevations are given in feet based on the NAVD datum of 1988. Rows titled “FF elev.” are finish floor elevations of the indicated building according to survey information obtained on July 1, 2009. Rows titled “Ground El.” are average ground elevations in the vicinity of the location indicated based on topographic mapping performed in 2001. The row marked “Difference” shows the impact in depth of flooding, measured in feet relative to existing conditions, due to the modeled improvements. These values are color coded as follows to facilitate comparison:

- **Light red** indicates impact greater than 1.5 inches.
- **Yellow** indicates impact between 0 and 1.5 inches.
- **Light green** indicates a reduction in the depth of flooding.
### MBCSD WWTP Flood Hazard Analysis

**Q100 = 14,900 cfs**

<table>
<thead>
<tr>
<th>Location</th>
<th>Grid#</th>
<th>MB1</th>
<th>MB2</th>
<th>MB3</th>
<th>MB4</th>
<th>MB5</th>
<th>MB6</th>
<th>MB7</th>
<th>MB8</th>
<th>MB9</th>
<th>MB10</th>
<th>MB11</th>
<th>MB12</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>WSEL 20.55</strong></td>
<td>2001 topo</td>
<td>Existing Conditions</td>
<td>Protect Entire Site</td>
<td>Protect Entire Site + Dune Breach</td>
<td>Protect Bldgs &amp; Beds</td>
<td>Protect Bldgs &amp; Beds + Creek Fwall</td>
<td>Entire Site Protected + KPark Fwall</td>
<td>Reduced Size + KPark Fwall</td>
<td>Reduced Size Protected</td>
<td>5.5-acre Protected</td>
<td>7.3-acre Protected</td>
<td>9.1-acre Protected</td>
<td></td>
</tr>
<tr>
<td>Maint Bldg 161</td>
<td>0.87</td>
<td>0.82</td>
<td>0.15</td>
<td>0.29</td>
<td>0.38</td>
<td>-0.34</td>
<td>0.24</td>
<td>0.09</td>
<td>0.04</td>
<td>0.2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Desal Bldg 182</td>
<td>0.9</td>
<td>0.88</td>
<td>0.15</td>
<td>-0.28</td>
<td>0.37</td>
<td>-0.29</td>
<td>0.26</td>
<td>-0.01</td>
<td>-0.04</td>
<td>0.23</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Admin Bldg 179</td>
<td>0.48</td>
<td>0.47</td>
<td>0.05</td>
<td>-0.16</td>
<td>0.16</td>
<td>-0.35</td>
<td>0.17</td>
<td>0.26</td>
<td>0.2</td>
<td>0.14</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chlor Bldg 180</td>
<td>0.02</td>
<td>0.03</td>
<td>0.06</td>
<td>-0.43</td>
<td>0.11</td>
<td>0.02</td>
<td>0.01</td>
<td>0.01</td>
<td>0.01</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MBHS 123</td>
<td>0.02</td>
<td>0.03</td>
<td>0.03</td>
<td>-0.35</td>
<td>0.03</td>
<td>0.03</td>
<td>0.03</td>
<td>0.03</td>
<td>0.03</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Motel 6 186</td>
<td>0.38</td>
<td>0.37</td>
<td>0.04</td>
<td>-0.23</td>
<td>-0.09</td>
<td>-0.31</td>
<td>0.11</td>
<td>0.07</td>
<td>0.13</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Morro Strand RV 184</td>
<td>0.08</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Morro Shores Inn 187</td>
<td>0.8</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>So. Dune Outlet 178</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Power Plant 353</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

**Morro Bay Cayucos Sanitary District (MBCSD) Wastewater Treatment Plant**

Flood Hazard Analysis

August 7, 2009

Page 12
The results shown in the tables above reveal several significant findings related to flood hazards in the vicinity of the WWTP. The following set of comments applies to scenarios with the high flow (14,900 cfs) assumption.

- The increase in dune height at the end of Atascadero Road since 2001 has closed one of the surface outlets through the dunes. The outlet through the dunes to the north remains open and is an important outlet for floodwaters. The restriction to one dune outlet has raised the flood elevation at the WWTP Administration Building and somewhat less at other locations.
- The perimeter floodwall or full site fill (modeled as MB3) has a significant impact on
surrounding properties, raising flood elevations as much as 0.5 foot at the High School. This impact is due to the plant’s low elevation on the floodplain, directly in the path of floodwaters as they make their way to the dunes. Blocking that path with fill or an impermeable floodwall will raise floodwater elevations elsewhere.

- Restoring the outlet in the dune at the end of Atascadero Street (modeled as MB4) will decrease flood levels at the plant site, but will do little to mitigate the impact of the full perimeter floodwall on other properties.
- Flood protection of individual buildings and facilities (modeled as MB5) shows a minimal impact on surrounding properties (i.e. only 0.05 foot rise at MBHS). This scenario is based on the proposed site plan which includes construction of new facilities and demolition of retired structures.
- The construction of a full height flood barrier along the north bank of Morro Creek in Keiser Park (modeled as MB6) will provide some flood protection for all properties on the north bank, but will not eliminate flooding. Floodwaters from the Atascadero Road underpass will continue to cause flooding at the WWTP site, though flood elevations will be lessened by approximately 0.3 foot at the WWTP. Though this scenario was modeled and initially considered as a viable option, its cost and difficulty of construction has removed it from consideration.
- The placement of the full height flood barrier on the north side of the park (MB7&8), allowing the park to flood, reduces impact to the Power Plant, but raises flood levels at the two motels on Atascadero Road. Based on this impact, this wall is also not recommended.
- Protection of a reduced plant footprint (MB9) significantly reduces but does not eliminate the impact on surrounding properties. Impact at the high school is reduced from 6 inches to less than 1.5 inches relative to full site protection.
- Moving portions of the plant to existing high ground to the south of the WWTP is modeled in MB10-12, showing that the least flood impact occurs with a total plant footprint of 5.5 acres, 2/3 of which is located on existing high ground. The 7.3-acre scenario (MB11) also shows a very low level of flood impact on neighboring properties.
- Though not shown on the above table, it was discovered that overtopping of the banks of Morro Creek at Keiser Park occur when the flow in the creek exceeds 3,500 cfs. This is somewhat greater than the 10% chance flood (10-year flood) and would explain why flooding from this direction has been experienced at the WWTP site in recent memory.
- Floodwall height for all perimeter walls will be approximately 5.5 feet tall. Height of fill would be similar. This includes 1 foot of freeboard as required by ordinance for both walls and fill.

The analyses based on a smaller peak flow (11,600 cfs) lead to these findings:

- The overall flood depth in the vicinity of the plant is reduced 6 inches on average.
- Flood impacts for the various scenarios are reduced, but not eliminated. Protection of the entire site, for example, still raises flood levels at the school by 0.4 foot. The smaller footprint site with flood protection reduces impact at the school to less than an inch.
- The three models that use existing high ground (MB10b-12b), show that flood impacts at this flow rate are virtually insignificant.
- When combined with the recommended mitigation of reconstruction of Atascadero Road with an inverted crown, the overall project impact will be favorable, reducing or nearly eliminating flooding at select locations (MB13b)
- Protective floodwall and fill height requirements would be reduced by 6 inches from 5.5 to 5 feet.

Our analysis shows that flooding during the 100-year flood is likely to occur over the entire site with floodwaters originating from both Morro Creek to the south and from the Atascadero Road underpass to the east. Because of the limited capacity of Morro Creek, storms of lesser magnitude
will also cause flooding from these same sources. The limited capacity of the underground drainage system does little to reduce flood risk from large storm events. Various methods of flood protection and flood reduction will have different levels of impact on the site itself and on nearby properties. These methods are discussed in the following section.

FLOOD PROTECTION AND FLOOD REDUCTION METHODS

There are essentially two approaches that may be applicable for addressing drainage and flooding when designing the WWTP expansion. One approach is flood protection or floodproofing and the second approach is through flood reduction. These two approaches can be used together for the greatest reduction in flood risk. A description of how these methods would be specifically implemented in and around the WWTP are described below.

- **Flood Protection**: This approach acknowledges that flooding occurs and measures are taken to floodproof the improvements needing protection. Floodproofing can be done on individual buildings and critical components or the entire site could be floodproofed with a perimeter wall.
  - **Floodproofing of individual components** involves such measures as provision of watertight seals for doors and windows of buildings, elevation of electrical components above flood level, and/or constructing floodwalls around critical areas (such as the headworks and sludge beds). This allows floodwaters to move freely through the site, with little impact on the surrounding neighborhood. The major disadvantage of individual component floodproofing is that human movement between and entry to sealed buildings and walled areas is not possible during flood stage. Also, the cumulative wear-and-tear on a building’s external components as a result of recurring inundation may render a floodproofing strategy infeasible. The cost of repeated service interruption and of frequent cleanup activities, as well as the effects of having to repeatedly implement a flood emergency plan, must be assessed.
  - A **perimeter flood wall** around the entire plant would provide a higher level of protection. Such a wall would include a watertight gate for vehicular access and use existing drain pipes to drain the site from internal runoff. Once the gate is closed, internal movement between buildings is possible, though entrance and exit from the plant would have to be curtailed. The biggest drawback to this approach would be the impact on flood levels for adjacent properties, especially the high school, where flood levels would rise as much as 6 inches.
  - Building the plant on imported fill or existing high ground, elevated a foot above the calculated flood level, would provide the highest level of protection as it eliminates the need for closing gates in anticipation of a flood. Impact on surrounding properties depends on the location of the new plant. Importing fill to raise the existing site would have the greatest impact on surrounding properties, while moving all or part of the plant to the south on existing high ground would minimize impact. The hydraulic model shows the level of impact for several different plan footprint configurations.

- **Flood reduction**: This approach seeks to improve drainage in the vicinity of the WWPT site so that flooding is reduced or eliminated. Considering the mechanisms of flooding, the opportunities for reducing flooding are:
  - Atascadero Road Overflow: As this is one of the paths of major floods, the improvement of flow along Atascadero Road would benefit all properties on the north side of Morro Creek. The current road is constructed with 6 inch curb faces along much of its length, but the inconsistent road section leaves the road with very little flood carrying capacity. Converting this road to one that conveys flow in the center of the street in an inverted crown section would significantly increase flow capacity to approximately 150 cfs which
would reduce or eliminate flooding in smaller storms. For the greatest effectiveness, the reconstruction of the road with an inverted crown should be accompanied by an increase in the culvert size from the end of Atascadero Road through the dunes. This would improve the area drainage, but would still be dependent on city maintenance to keep the storm drain beach outfall uncovered from sand.

- **Dune Outlet Improvements:** Surface outlet improvements through the dunes could have a beneficial impact on the plant site, especially in smaller floods. An improved dune outlet would not have a significant beneficial effect during larger floods, especially on buildings further away from the dunes. One drawback to this alternative is the likely difficulty in obtaining authorization to construct improvements in this area, which is adjacent to Snowy Plover habitat. The land itself, however, is jointly owned by the City of Morro Bay and Cayucos Sanitary District and is covered with ice plant, a non-native species. There may be an opportunity for improvements in exchange for eradication of this exotic plant and revegetation of the dunes with native vegetation. Another issue is the danger of wave runup. Though FEMA has predicted a wave runup elevation of 11.4 feet (NAVD 88) in the 1% chance (100-year) event, anecdotal information indicates that waves reach the base of dunes (~ 10 feet NAVD) annually. There has been at least one observation of a wave overtopping the dunes at the former outlet where the elevation was approximately 17 feet at the time of the observation. Any improvement of a surface opening in the dunes must account for the risk of storm surge and wave runup.

- **On-site Drainage:** Improvements that would be of benefit in smaller storms would be to increase the size of the storm drain from the plant to the outfall. Another alternative to a gravity storm drain is the installation of a storm water pumping station, which would allow for a higher outlet. However, a pump station sized to handle plant drainage would be overwhelmed during periods of inundation from upstream overflow. Rebuilding the plant on raised fill will eliminate the need for any of these measures.

- **Creek Overflow (from Southeast):** This flooding comes from an 800-foot reach of Morro Creek, along the low banks upstream of the Morro Dunes RV Park and downstream of the highway. One flood reduction option is to construct a berm to reduce flows that overtop the bank at this location. A FEMA certified levee may not be feasible, but a smaller non-erodable berm designed to keep smaller flows from overtopping may be a reasonable alternative. Another option is to increase the capacity of the creek by cutting a bypass channel through the meander just downstream of Keiser Park. However, there are many concerns with this – environmental, property ownership, extensive excavation, and hydraulic feasibility. If pursued, the creek modifications could be combined with a creek habitat enhancement strategy to address environmental concerns. The flood barrier on the bank would likely be much easier to permit since it does not involve work directly in the creek. This section of the creek is a large source of flood risk, and addressing it could be very helpful for reducing flooding, not only on the WWTP, but also for all properties on that side of the creek.

**RECOMMENDATIONS**

Based on these findings, we recommend the following actions to address flooding issues at the WWTP site. The recommendations are grouped according to type of flooding.

**To address 100-year flooding issues:**
- Construct the new WWTP facilities on higher ground. Construction on elevated fill provides the highest level of protection and least amount of operational inconveniences.
- Construct all or part of the new facilities on City owned land to the south of the current site that is already elevated, modeled in the analysis as MB10 through 12. Construction at this location will have the least adverse flood impact on neighboring properties. An illustration of one of these scenarios (MB11) is shown in Exhibit 6.
• Reconstruct Atascadero Road with an inverted crown. This will reduce flooding for all properties along the road and nearly eliminate flooding at the high school for all but the most extreme storm events.

• The City floodplain management ordinance and funding agencies require that WWTP improvements be protected from flooding to the level of one foot above the 100-year flood elevation. Because of the potential reduction of flood levels relative to the current FIRM, we recommend that a Letter of Map Revision (LOMR) be applied for, including new hydrology and new hydraulic analyses. The LOMR process typically takes 3 to 6 months for complex situations such as this.

To address smaller, more frequent flooding:

• Drainage along Atascadero Road should be improved. The options listed below could be implemented individually or in combination:
  o Increasing the size of the 24 inch culvert through the dunes at the end of the street
  o Reestablishment of a surface flow path to the ocean through the dunes at the end of the street.
  o Reconstruction of Atascadero Road with an inverted crown will increase street capacity from a few cfs to approximately 150 cfs, which is very significant for small storms.
  o Atascadero Road could be managed as a flood conveyance facility with appropriate warning signs for traffic and parking limitations.

• Raising the WWTP site with fill will alleviate most of the inconveniences of smaller floods on the operation of the plant, but will not improve the flooding situation for neighboring properties. We recommend that one or more of the measures to alleviate smaller flooding be implemented to mitigate the small impact that the new plant will have on the floodplain.
APPENDIX
MORRO BAY CAYUCOS SANITARY DISTRICT WASTEWATER TREATMENT PLANT
FLOOD HAZARD ANALYSIS
EXISTING DRAINAGE SYSTEM

24" STORM DRAIN @ 0.43 %
CAPACITY = 8 cfs

24" STORM DRAIN @ 0.23 %
CAPACITY = 11 cfs

HISTORIC SURFACE OUTLET THROUGH DUNES
EXISTING OUTLET THROUGH DUNES

INTERNAL RECAPTURE AREA
CAPTURE POINT

MORRO CREEK
EXHIBIT 2.1
The MBCWWTP is vulnerable to flooding from overflows of Morro Creek coming from two directions as shown. Hydraulic modeling predicts that these overflows occur when flows in Morro Creek exceed approximately 3,500 cfs, which is slightly larger than the FEMA 10% chance (10-year) flood. Flooding from these sources has been experienced in 1995 and 2004.
MORRO BAY CAYUCOS SANITARY DISTRICT WASTEWATER TREATMENT PLANT
FLOOD HAZARD ANALYSIS
100-YEAR FLOOD ELEVATIONS - EXISTING CONDITIONS

Q100 = 14,900 CFS

MB2
EXHIBIT 4.2
MORRO BAY CAYUCOS SANITARY DISTRICT WASTEWATER TREATMENT PLANT

FLOOD HAZARD ANALYSIS

100-YEAR FLOOD ELEVATIONS - WITH FULL PLANT PROTECTION

Q100 = 14,900 CFS

MB3

EXHIBIT 4.3
MORRO BAY CAYUCOS SANITARY DISTRICT WASTEWATER TREATMENT PLANT
FLOOD HAZARD ANALYSIS
100-YEAR FLOOD ELEVATIONS-WITH SLUDGE-BED WALL AND COMPONENT FLOODPROOFING

Q100 = 14,900 CFS

EXHIBIT 4.5

LEGEND
MAX WATER SURFACE ELEVATION
GRID ELEVATION
GRID NUMBER
MAX FLOOD DEPTH

ELEVATIONS ARE IN FEET NAVD88
100-YEAR FLOOD ELEVATIONS-WITH SLUDGE-BED WALL, COMPONENT FLOODPROOFING AND CREEK FLOOD BARRIER

Q100 = 14,900 CFS

EXHIBIT 4.6

MORRO BAY CAYUCOS SANITARY DISTRICT WASTEWATER TREATMENT PLANT
FLOOD HAZARD ANALYSIS

LEGEND

MAX WATER SURFACE ELEVATION
GRID ELEVATION
GRID NUMBER
MAX FLOOD DEPTH

ELEVATIONS ARE IN FEET NAVD88
MORRO BAY CAYUCOS SANITARY DISTRICT WASTEWATER TREATMENT PLANT
FLOOD HAZARD ANALYSIS
100-YEAR FLOOD ELEVATIONS WITH FULL PLANT PROTECTION AND FLOOD BARRIER

Q100 = 14,900 CFS

MB7
EXHIBIT 4.7

LEGEND
MAX WATER SURFACE ELEVATION
GRID ELEVATION
GRID NUMBER
MAX FLOOD DEPTH

ELEVATIONS ARE IN FEET NAVD88
MORRO BAY CAYUCOS SANITARY DISTRICT WASTEWATER TREATMENT PLANT
FLOOD HAZARD ANALYSIS
100-YEAR FLOOD ELEVATIONS—WITH REDUCED FOOTPRINT PROTECTION, AND PARK FLOOD BARRIER

Q₁₀₀ = 14,900 CFS

EXHIBIT 4.8
Q100 = 14,900 CFS

MB9

EXHIBIT 4.9
MORRO BAY CAYUCOS SANITARY DISTRICT WASTEWATER TREATMENT PLANT

FLOOD HAZARD ANALYSIS

100-YEAR FLOOD ELEVATIONS - WITH 5.5-ACRE FOOTPRINT PROTECTION

Q100 = 14,900 CFS

MB10

EXHIBIT 4.10
### 100-Year Flood Elevations - With 7.3-Acre Footprint Protection

**Q100** = 14,900 CFS

**MB11**

**EXHIBIT 4.11**

**Legend**
- **Max Water Surface Elevation**
- **Grid Elevation**
- **Grid Number**
- **Max Flood Depth**

Elevations are in feet NAVD88.
MORRO BAY CAYUCOS SANITARY DISTRICT WASTEWATER TREATMENT PLANT
FLOOD HAZARD ANALYSIS

100-YEAR FLOOD ELEVATIONS - WITH 9.1-ACRE FOOTPRINT PROTECTION

Q100 = 14,900 CFS

EXHIBIT 4.12

LEGEND
MAX WATER SURFACE ELEVATION
GRID ELEVATION
GRID NUMBER
MAX FLOOD DEPTH
ELEVATIONS ARE IN FEET NAVD88

FLOOD DEPTH LEGEND

Flood Depth
0.0 ft
0.5 ft
1.0 ft
1.5 ft
2.0 ft
2.5 ft
3.0 ft
3.5 ft
4.0 ft
4.5 ft
>5.0 ft

Q100 = 14,900 CFS
MB12
EXHIBIT 4.12
MORRO BAY CAYUCOS SANITARY DISTRICT WASTEWATER TREATMENT PLANT
FLOOD HAZARD ANALYSIS
100-YEAR FLOOD ELEVATIONS-EXISTING CONDITIONS

EXHIBIT 4.2b

Q100 = 11,600 CFS

ELEVATIONS ARE IN FEET NAVD88
MORRO BAY CAYUCOS SANITARY DISTRICT WASTEWATER TREATMENT PLANT
FLOOD HAZARD ANALYSIS
100-YEAR FLOOD ELEVATIONS - WITH FULL PLANT PROTECTION

Q100 = 11,600 CFS

LEGEND

MAX WATER SURFACE ELEVATION
GRID ELEVATION
GRID NUMBER
MAX FLOOD DEPTH

ELEVATIONS ARE IN FEET NAVD88
100-YEAR FLOOD ELEVATIONS—WITH SLUDGE-BED WALL AND COMPONENT FLOODPROOFING

Q₁₀₀₀ = 11,600 CFS

LEGEND

- MAX WATER SURFACE ELEVATION
- GRID ELEVATION
- GRID NUMBER
- MAX FLOOD DEPTH

ELEVATIONS ARE IN FEET NAVD88
MORRO BAY CAYUCOS SANITARY DISTRICT WASTEWATER TREATMENT PLANT
FLOOD HAZARD ANALYSIS
100-YEAR FLOOD ELEVATIONS-WITH FULL PLANT PROTECTION
AND PARK FLOOD BARRIER

Q100 = 11,600 CFS

LEGEND
- MAX WATER SURFACE ELEVATION
- GRID ELEVATION
- GRID NUMBER
- MAX FLOOD DEPTH

ELEVATIONS ARE IN FEET NAVD88
MORRO BAY CAYUCOS SANITARY DISTRICT WASTEWATER TREATMENT PLANT
FLOOD HAZARD ANALYSIS
100-YEAR FLOOD ELEVATIONS WITH REDUCED FOOTPRINT PROTECTION

**LEGEND**
- MAX WATER SURFACE ELEVATION
- GRID ELEVATION
- GRID NUMBER
- MAX FLOOD DEPTH

**FLOOD DEPTH LEGEND**

**Q100 = 11,600 CFS**

**MB9b EXHIBIT 4.9b**
MORRO BAY CAYUCOS SANITARY DISTRICT WASTEWATER TREATMENT PLANT
FLOOD HAZARD ANALYSIS
100-YEAR FLOOD ELEVATIONS-WITH 5.5-ACRE FOOTPRINT PROTECTION

EXHIBIT 4.10b

Q100 = 11,600 CFS

LEGEND

26.95 MAX WATER SURFACE ELEVATION
19 GRID ELEVATION
13 GRID NUMBER
1.99 MAX FLOOD DEPTH

ELEVATIONS ARE IN FEET NAVD88
MORRO BAY CAYUCOS SANITARY DISTRICT WASTEWATER TREATMENT PLANT
FLOOD HAZARD ANALYSIS
100-YEAR FLOOD ELEVATIONS-WITH 9.1-ACRE FOOTPRINT PROTECTION

LEGEND
MAX WATER SURFACE ELEVATION
GRID ELEVATION
GRID NUMBER
MAX FLOOD DEPTH

ELEVATIONS ARE IN FEET NAVD88
This flap gate in Morro Creek is the outlet to the storm drain system serving the south side of the WWTP.

The storm drain outlet to the ocean is often blocked by sand, restricting the flow.
The surface outlet through the dunes at the end of Atascadero Street is now closed due to sand accumulation and encroachment by non-native vegetation (ice plant) from the south.

The surface path for flood flows is to the north and parallel to the dunes until it reaches a small creek to the north.
The surface outlet through the dunes at the end of Atascadero Street was much larger in the past, as shown in this photo from 1972.

The outlet through the dunes is beginning to narrow, as shown in this photo from 1979.
The area outlined above encompasses an area of approximately 7.3 acres. The southern portion is currently existing high ground used for RV storage, while the northern portion, currently occupied by sludge beds and aggregate operations, would require imported fill to raise the area above the 100-year flood level. This scenario is modeled as MB11 and MB11b in the accompanying analysis.