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TECHNICAL MEMORANDUM

TO: Rachel Fatoohi, Santa Cruz County DATE: June 19, 2012

FROM: Dan Schaaf, P.E. JOB #: CRUZ.04.09

SUBJECT: Rio Del Mar Flats Surface Flooding Analysis

Introduction

Schaaf & Wheeler was contracted by the County of Santa Cruz to study the potential for interior drainage flooding in the Rio Del Mar Flats neighborhood. This area, adjacent to Aptos Creek and the Pacific Ocean, is flat and low-lying (Figure 1). Because of its scenic surroundings it is highly developed with residential and commercial buildings. The drainage basin is roughly 150 acres in size with a significant amount of impervious surface. This area is served by a 12-inch storm drain system with a gravity outfall to Aptos Creek. There is one additional single pipe system on Moosehead Drive. It appears the current system is undersized to provide this area the County standard 10-year level of service. The flooding in this region is also exacerbated by high water levels in Aptos Creek and sediment buildup in the pipes. Our study is intended to quantify the degree this region floods during various more frequent storm events.

Figure 1. Rio Del Mar Flats

Hydrology

The Rio Del Mar Flats neighborhood is low lying and surrounding by hills, a floodwall and beach turning it into a "reservoir" during storms. This topography causes the volume of rainfall runoff from storms to become more critical than the peak runoff rate. A short duration high intensity storm may surcharge the existing storm drain system, yet it would likely produce very little standing water. Our analysis included both 24-hour and 72-hour runoff events.

The effective County drainage standards include rainfall Intensity-Duration-Frequency (IDF) curves for events up to 24-hours. The standards provide no method for estimating rainfall volumes for longer events. The current County Storm Drain Master Plan (SDMP) models use a synthetic 24-hour rainfall pattern that is balanced to the County's IDF curves. To create IDF curves that extend our to 72-hours, a significant amount of statistical analysis and data collection would need to be performed. To avoid this lengthy, complex and somewhat unnecessary task, Schaaf & Wheeler used regression equations to estimate runoff volumes. These equations, developed by the Santa Clara Valley Water District (SCVWD), are used to determine the average flow for 1-, 2- and 3-day runoff in urban areas. They provide a mechanism to relate the 24-hour runoff volume to the 72-hour event. This ratio was applied to the 24-hour output hydrographs from the SDMP hydraulic models (using the IDF balanced storm). The volume regression equations are a relationship between Mean Annual Precipitation (MAP), basin area, length of flow, slope and storm frequency. Schaaf & Wheeler applied the characteristics from the Rio Del Mar basin and determined the following 1-day to 3-day ratios:

2-year, 173%
5-year, 178%
10-year, 180%

Because the peak runoff is not a major factor in long term events, runoff hydrographs were developed by adding 48-hours of constant runoff to the 24-hour event. Figure 2 shows the 72-hour hydrograph. Schaaf & Wheeler ran various sensitivity analyses to assure this is true. The models produced similar maximum ponding levels with the runoff peak occurring at different times.

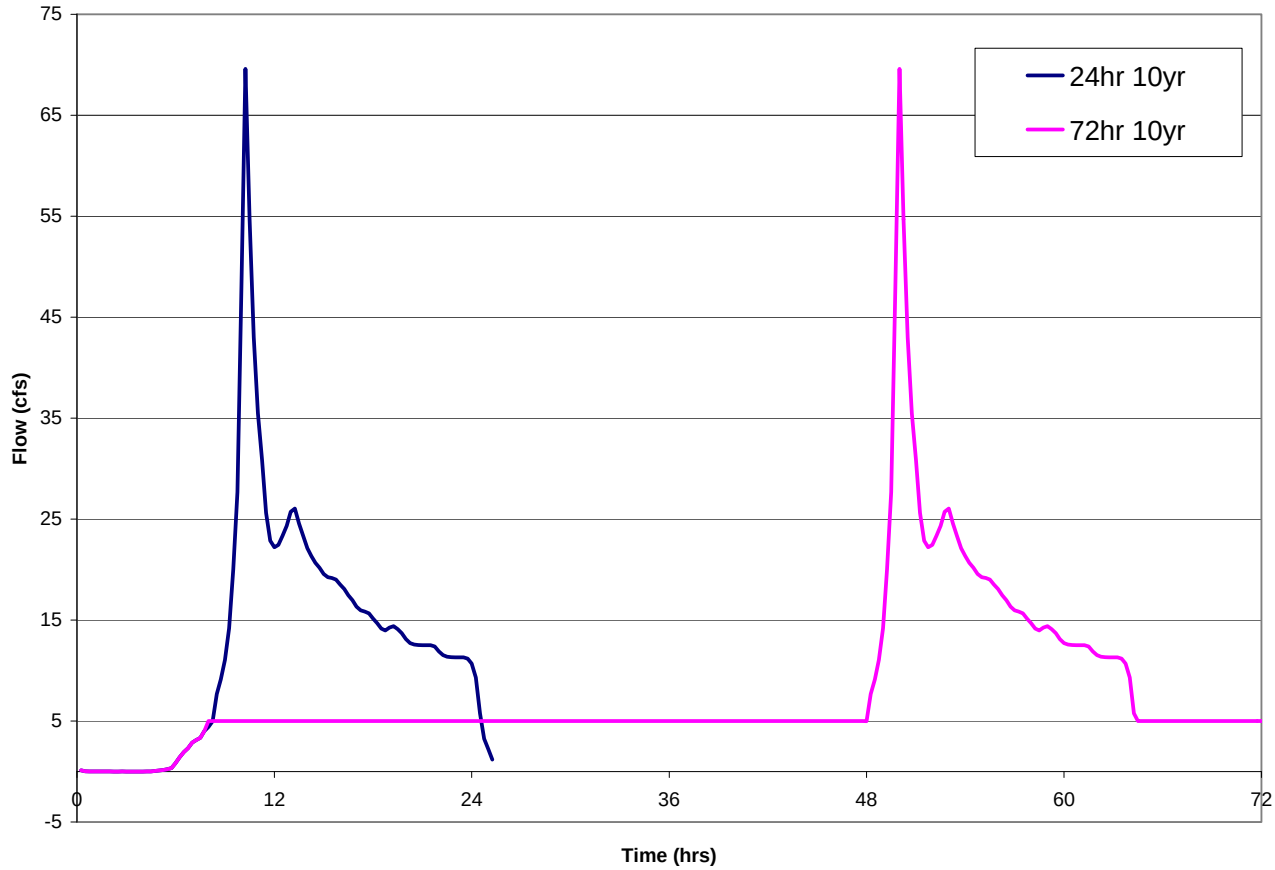

Figure 2. Runoff Hydrographs

Hydraulics

Schaaf & Wheeler has developed storm drain system models for Santa Cruz County Zones 5 and 6. These models include the existing storm drain pipe network 12-inch in diameter and larger. This effort includes the system for the Rio Del Mar neighborhood for the 24-hour 10-year event. This model provides an effective tool for determining the potential for surface flooding in this neighborhood during an array of storm events.

The County has topography for the Rio Del Mar area in 2-foot contour intervals. This data is roughly accurate to ± 1-foot. This accuracy limits the degree to which we can predict surface ponding during storm events. Fortunately, the County has acquired additional ground surveys for the study area. Schaaf & Wheeler supplemented the County topography with this data to create a more detailed surface model. The model provides a relationship of elevation to surface storage area and volume. Because the neighborhood is densely developed a 20% storage area reduction factor was added above elevation 14-feet (NAVD) to account for buildings. Figure 3 shows the elevation vs. volume curves.

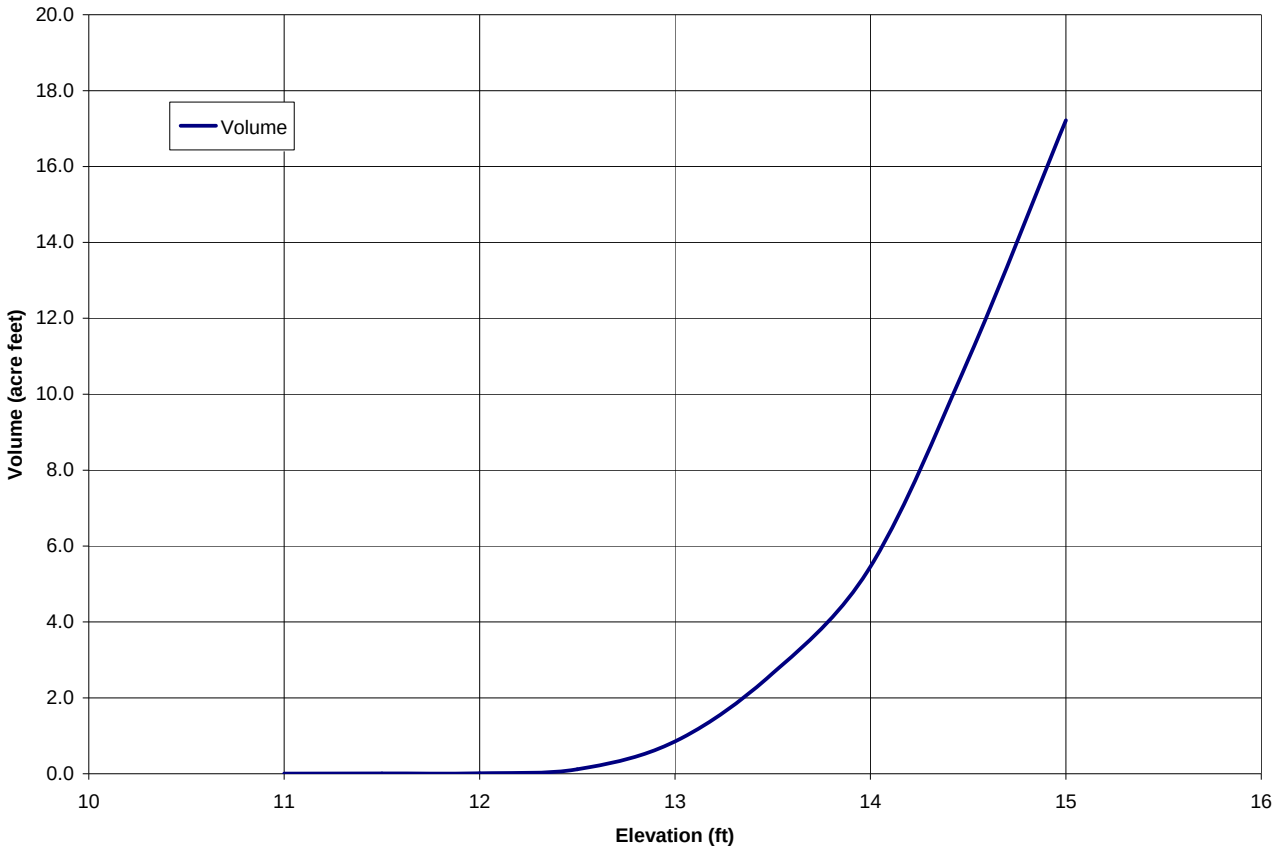

Figure 3. Surface Storage

The Rio Del Mar Flats neighborhood has 3 outfalls to Aptos Creek. This channel is subject to high backwater levels when the mouth is closed off from the ocean by sand. Traditionally California State Parks Department mechanically breaches the mouth when the water level gets too high or the water quality reaches certain levels. Our research indicates that the County only breached the mouth in 2009 in an emergency. Because of the uncertainty in Aptos Creek water level, Schaaf & Wheeler analyzed the system both with the mouth closed and breached. The breached condition would be subject to the ocean conditions; therefore the published FEMA water levels in Aptos Creek were applied. For the mouth closed conditions, Schaaf & Wheeler applied the boundary conditions used by the County in their HEC-RAS models of Aptos Creek. Table 1 show the range of water levels in Aptos Creek. There is a weir along the Aptos Creek floodwall estimated to be at elevation 14.1 feet (NAVD). The opening along the seawall, elevation 13.4 feet (NAVD), is assumed to be blocked by high sand during winter months.

Table 1. Aptos Creek Water Levels

Storm Event	Mouth Condition	Water Level (NAVD)
2-year	Open	9.2’
2-year	Closed	11.7’
5-year	Open	9.2’
5-year	Closed	12.2’
10-year	Open	9.2’
10-year	Closed	12.7’

The condition of the lower portion of the existing pipe network is poor. The outfall was damaged and repaired following the 1982 storms. This repair included a second outlet from the system at a higher elevation. The drainage pipes are often filled with sand, sediment and organic materials from wave runup and beach users. This reduces the hydraulic capacity of the pipe system. Schaaf & Wheeler applied a 50% reduction factor on the outfall to determine the potential increase in flooding due to sedimentation.

Results

The results of the hydraulic models provide a range of potential flooding in the Rio Del Mar Flat neighborhood. The surface ponding levels appear to be regulated by outfall conditions. Sedimentation in the pipe can increase flooding levels as much as a foot. Additionally, there is potential for street flows due the storm drain system surcharging during short duration events.

Table 2. Model Results (feet NAVD)

Condition	2yr	5yr	10yr
24hr Breached Mouth	12.8	13.6	14.0
72hr Breached Mouth	12.8	13.5	13.9
24hr Closed Mouth	13.4	14.1	14.2
72hr Closed Mouth	13.5	14.1	14.2
24hr Breached Mouth Poor Pipe Condition	13.5	14.2	14.2
72hr Breached Mouth Poor Pipe Condition	13.5	14.1	14.2
24hr Closed Mouth Poor Pipe Condition	14.0	14.2	14.3
72hr Closed Mouth Poor Pipe Condition	13.8	14.2	14.4

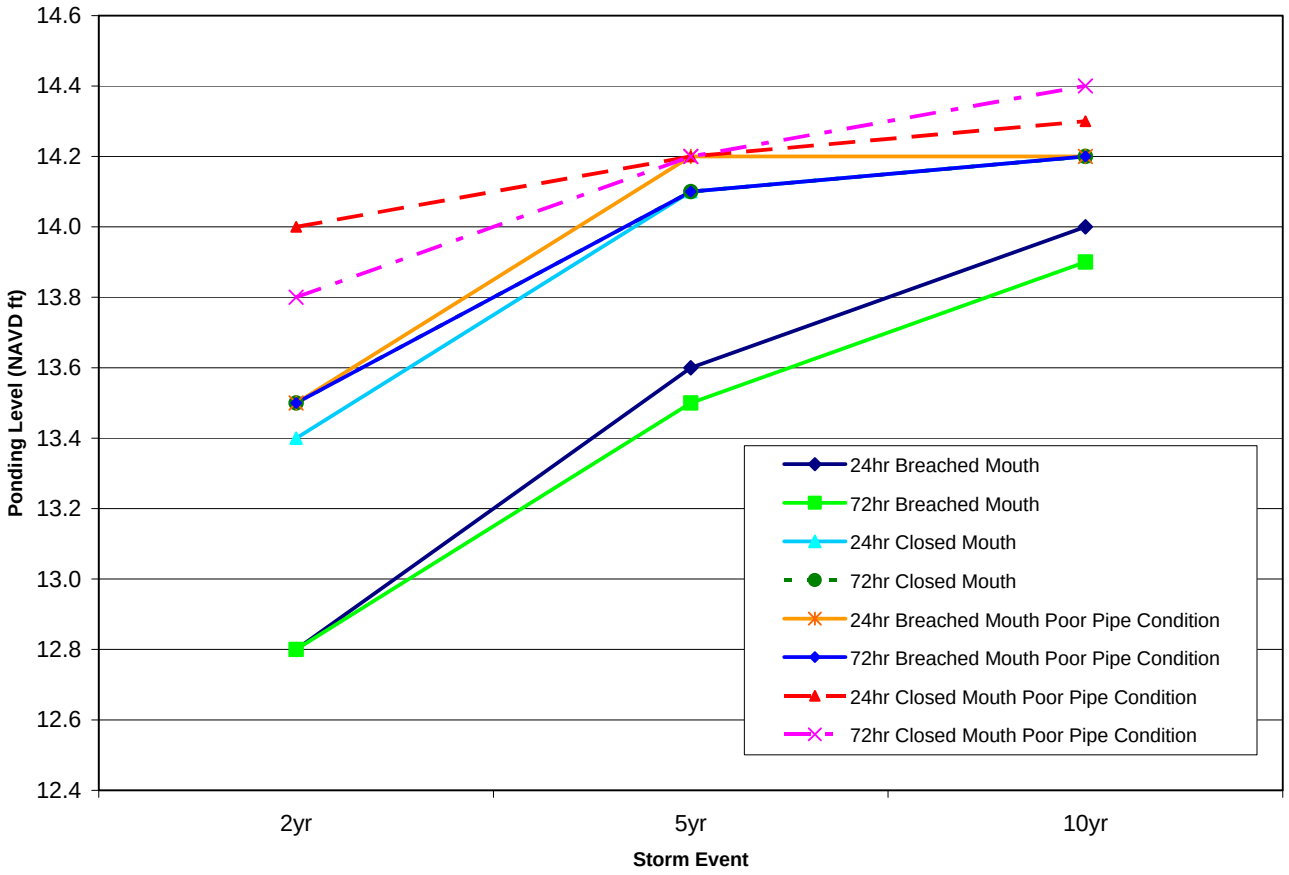

Figure 4. Pond Levels

Conclusion

The Rio Del Mar Flats neighborhood is subject to flooding due to its geographic location and its lack of an effective storm drain system. The current system limits the drainage to a 12-inch pipe network. This size is not adequate for such a large impervious watershed. The conditions in Aptos Creek further limit the systems ability to drain this area. Our models predict the potential flooding levels for the 2-, 5- and 10-year 24- and 72-hour storm events. The models were also adjusted to simulate loss of hydraulic capacity due to siltation.

This neighborhood clearly needs a more effective storm drain system. Possible improvements could include larger pipes, additional pipes and inlets, and a pump station. These systems could discharge directly to the ocean, but would require a significant degree of permitting. Long term planning should account for the likelihood of Sea Level Rise and uneven land subsidence, both of which will increase the flooding potential in this neighborhood.