F I N A L   R E P O R T

J STREET DRAIN CHANNEL IMPROVEMENT STUDY AND PRELIMINARY DESIGN

Prepared for

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November 17, 2005

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1.0 INTRODUCTION

This report summarizes a proposed plan to improve the existing flood conveyance capacity of the J Street Drain Channel located in the City of Oxnard, California. Figure 1-1 depicts the location of the project vicinity. Technical procedures, assumptions, and analysis results of the design process are provided in the following sections. The study involved the development of a preliminary design plan for the 2.2-mile long J Street Drain Channel to improve its current capacity to the 100-year flood level.

1.1 PROJECT SITE DESCRIPTION

The J Street Drain Channel is a fully-lined concrete channel located within an urbanized area of Oxnard. The channel is located along the centerline of J Street and begins upstream at the Redwood Street crossing and ends downstream at the west boundary of the Ormond Beach Lagoon. Figure 1-2 shows the extent of the J Street Drain Channel and the surrounding area. The J Street Drain Channel is a fully-lined trapezoidal concrete channel built in the 1960s to discharge runoff into the ocean at Ormond Beach. The facility has a bottom width of 20 to 30 feet with 1:1 side slopes. The depth of the channel is about 4 feet.

According to Ventura County Watershed Protection District (VCWPD), the channel's limited capacity and backwater effects at the street crossings have resulted in flooding in the adjacent neighborhood. The channel's capacity was estimated at 500 to 600 cubic feet per second (cfs), which is equivalent to the peak of a 5-year event.

The outlet of the channel is constrained by a sand berm surrounding the Ormond Beach lagoon. This sand berm was established by the action of tidal waves and caused the formation of the lagoon. The sand berm blocks the direct flow path of the J Street Drain channel and the lagoon acts as a reservoir to the channel's flow. Prior to 1992, VCWPD regularly breached the sand berm to maintain a discharge path and prevent water and silt buildup in the channel. Since 1992, due to environmental concerns and restrictions, routine breaching of the sand berm has stopped. In September 1994, a storm caused water level in the lagoon to reach 7.5 feet above mean sea level, resulting in a breach of the sand berm into the ocean, which allowed discharge of the lagoon water and runoff of the upstream channel. To minimize the lagoon backwater effect, it is necessary to maintain an ocean passage for the J Street Drain Channel flood runoff.

Information presented in this report provides the basis of design for improving the existing flood carrying capacity of the J Street Drain Channel. The feasibility of creating channel's outlet with engineered solutions at the Ormond Beach lagoon was also evaluated.

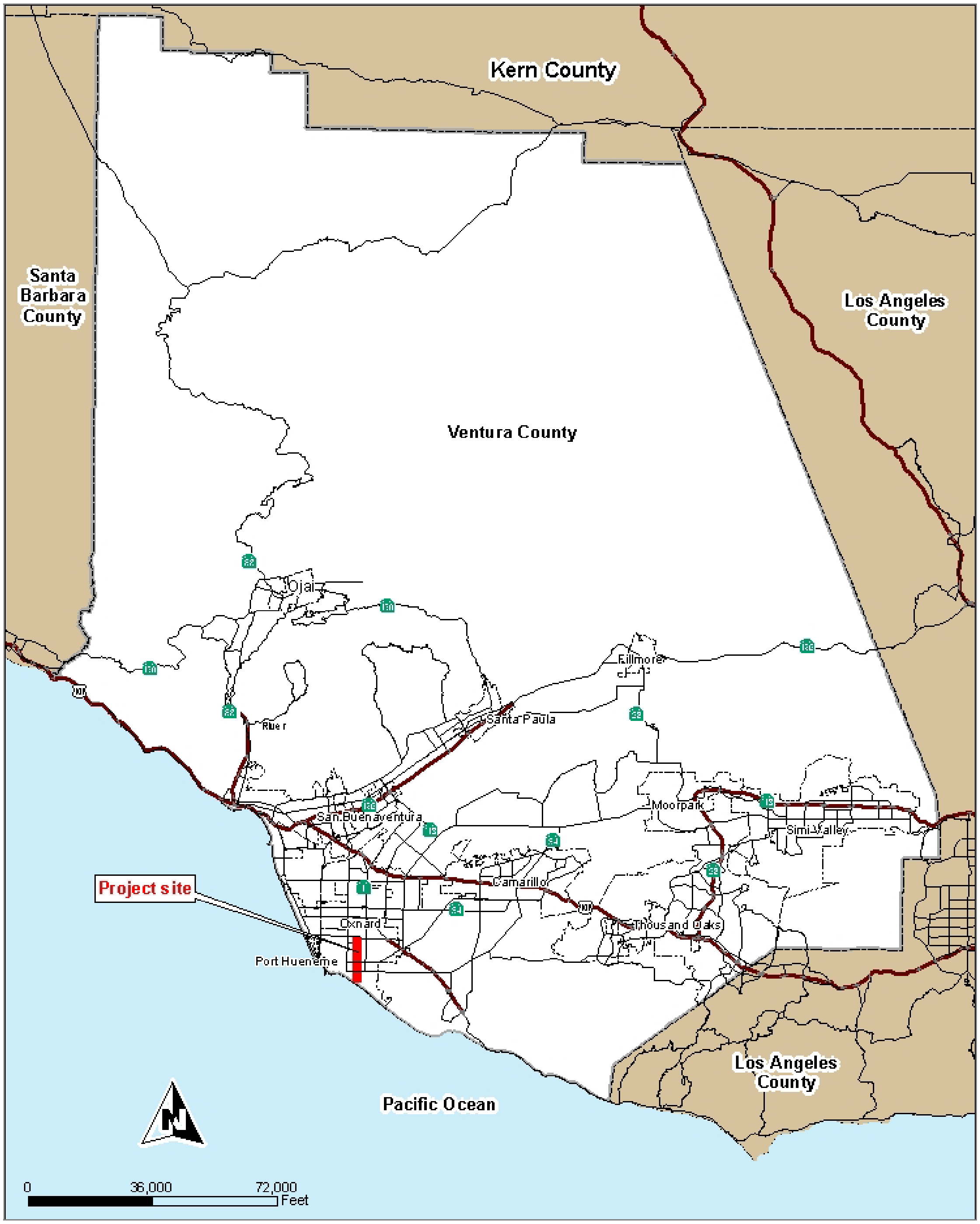


Figure 1-1. Project Location Map

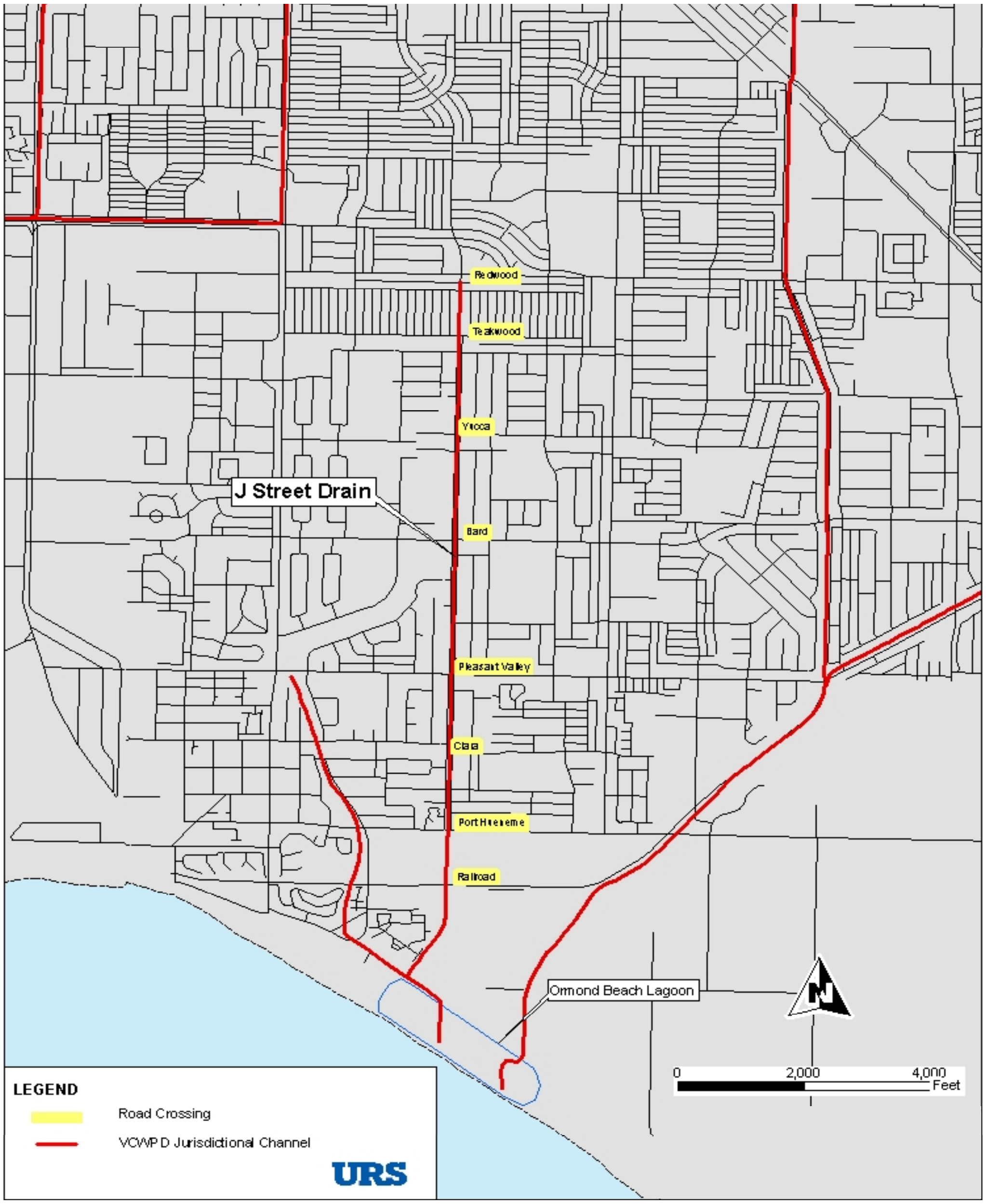


Figure 1-2. Extent of J Street Channel and Surrounding Area

1.2 PROJECT SCOPE OF WORK

The Proposed J Street Drain Channel improvement design involved the following scope of work elements:

- **Hydraulic Analysis of Existing Channel –** Performed an existing condition channel hydraulic analysis using the Corps of Engineers' HEC-RAS backwater model to determine the flood characteristics associated with the 100-year storm event and estimate the existing flood carrying capacity of the channel.
- **Development of Channel Improvement Alternatives** – Identified options for improving the existing channel and selected a feasible alternative that will meet the flood control objective and right-of-way constraint.
- **Proposed Condition Hydraulic Analysis** – Conducted a hydraulic analysis of the J Street Drain Channel under the proposed dimension to ensure that the facility will achieve the desired performance during a 100-year event.
- **Preliminary Construction Cost Estimates** – Prepared a preliminary construction cost estimate for the channel improvement project.
- **Flood Damage Estimate and Benefit Cost Analysis –** Estimated the value of flood damage for the properties affected by the J Street Drain Channel 100-year flood and identified a preliminary benefit/cost ratio for the channel improvement.
- **Ormond Beach Channel Outlet Alternatives Evaluation** – Developed and evaluated alternatives to establish or restore the outlet at Ormond Beach for the channel to ensure unconstrained discharge connection to the ocean.
- **Preliminary Channel Design (30% level)** – Prepared design drawings with 30% completion for the J Street Drain Channel improvement with plan, profile, and cross-sectional geometries.

2.0 EXISTING CONDITION HYDRAULIC ANALYSIS

2.1 HYDROLOGY

The hydrology for the project area was provided by VCWPD and was prepared based upon the VCRAT models of the J Street Drain Channel watershed area under a range of storm events. Table 2.1 provides a summary of the peak flow values at various locations along the channel.

Table 2-1. J Street Drain Channel Hydrology Summary

Location Description	100-Year Peak (cfs)	50-Year Peak (cfs)	10-Year Peak (cfs)	2-Year Peak (cfs)
Redwood St	880	723	555	239
Teawood Street	958	796	611	263
Yucca St	1,036	869	667	287
Bard St	1,605	1,337	1026	442
Pleasant Valley Rd	1,775	1,485	1150	487
Hueneme Rd	1,775	1,479	1145	485
Hueneme Drains	2,059	1,649	1277	541

2.2 HYDRAULIC ANALYSIS

To estimate the existing capacity of the J Street Drain Channel, a HEC-RAS model was prepared using the available as-built drawings. Three sets of drawing were received as follows:

(1) Oxnard Drainage South, from D/S of Teawood St Alley (As-built drawing Sta –0+00.62) to Hueneme Drain (As-built drawing Sta 111+75), by County of Ventura Department of Public Works, Flood Control District, in September 1956;

(2) Oxnard Drainage South Channel Lining, from Teawood Street (As-built drawing Sta 0+00) to Pleasant Valley Road (As-built drawing Sta 55+88.90), by County of Ventura Department of Public Works, Flood Control District, in April 1959; and

(3) Oxnard Drainage South Channel Lining, from Yucca Street (As-built drawing Sta. 16+55.09) to Hueneme Drain (As-built drawing Sta 108+25) by County of Ventura Department of Public Works, Flood Control District, in March 1961.

The existing condition hydraulic analysis considered the flood discharges listed in Table 2-1.The following subsections describe the model setup and results of the hydraulic calculations.

2.2.1 Existing Channel Geometry

Using the channel configuration from the as-built drawings, the existing condition HEC-RAS model for the J Street Drain was developed as described in the following paragraphs:

Cross-section Stationing - The HEC-RAS Model was constructed to analyze the J Street Drain from the beach sand berm (HEC-RAS station 2+25) to a location just downstream of Redwood Street (HEC-RAS station 128+55). The as-built drawing stationing is in the opposite direction to that of the HEC-RAS. The HEC-RAS stationing was started from the beach sand berm, using HEC-RAS Station 9+00 as a reference point to match the as-built drawing Station 108+25. To facilitate discussions, a channel alignment map was developed with the HEC-RAS stations as shown on Figures 2-1a and 2-1b.

Channel Reaches - The existing condition of the hydraulic model was constructed with the slope and cross-sections as shown in the as-built drawings. Because the as-built drawings were revised from 1956 to 1961, the latest drawing revision was used. For the channel reach between Stations 0+00 to 16+55.09, the 1959 drawings were used. For the reach from Stations 16+55.09 to 108+25, the 1961 drawings were used.

Elevation Datum - The vertical datum used in the hydraulic model was NGVD29 to be consistent with that in the as-built drawings.

Cross-Sections - The model cross-sections were spaced to represent changes in slope and cross-section geometry, including the road crossing culverts and their 25-foot long transition structures. Additional cross-sections were added in long reach lengths with the maximum cross-section spacing not to exceed 500 feet.

Manning's n - Per the VCWPD Hydraulic Design Manual (1968), lined channels and culverts were modeled with a Manning's n value of 0.015 and maintained earth channels were given an n value of 0.030. Existing road culverts were given entrance and exit loss coefficients of 0.5 and 1.0, respectively. Proposed road crossing culverts were assumed to have well-rounded entrances with entrance and exit loss coefficients of 0.2 and 1.0, respectively.

Boundary Conditions - At the most downstream area, where the beach sand berm exists, the J Street Drain Channel turns east. The beach sand berm height varies from 7 to 9 feet, at an average elevation of 8 feet. The following downstream boundary conditions were assumed for the flood events analyzed:

- For the 2-year and 10-year flood events, the downstream boundary water surface elevation was assumed as the height of the sand berm, which is at elevation 8 feet. Floodwater associated with these two events would likely accumulate behind the berm before the berm breaches.
- For the 50-year and 100-year floods, the sand berm was assumed as being already washed out and an outlet to the ocean established by the breaching. Under this scenario, the downstream boundary condition in the HEC-RAS was set at normal depth following the channel's lower reach slope of 0.000308.

Figure 2-1a. J Street Drain Channel Alignment Map with HEC-RAS Stations

Figure 2-1b. J Street Drain Channel Alignment Map with HEC-RAS Stations (continued)

2.2.2 Existing Channel Capacity

Using the established channel geometry as described above, the hydraulic capacity of the J Street Drain Channel under existing conditions was estimated. Table 2-2 summarizes the flow capacity, which varies along the channel, based upon the normal depth calculations.

Table 2-2. Existing Flow Capacity of J Street Drain

Reach	Channel Alignment Station	Channel Capacity (cfs)
Redwood Street to Teakwood Street	128+55	460
Teawood Street to Yucca Street	119+00	440
Yucca Street to Bard Street	101+62	400
Bard Street to Pleasant Valley Road	83+50	500
Pleasant Valley Road to Hueneme Road	61+36	600
Hueneme Road to Hueneme Drain Confluence	35+24	500
Downstream of Hueneme Drain Confluence	9+00	900

The existing hydraulic capacity of the J Street Drain Channel was also demonstrated through a HEC-RAS model. Figure 2-2 shows the water surface profile when the channel is at a full capacity.

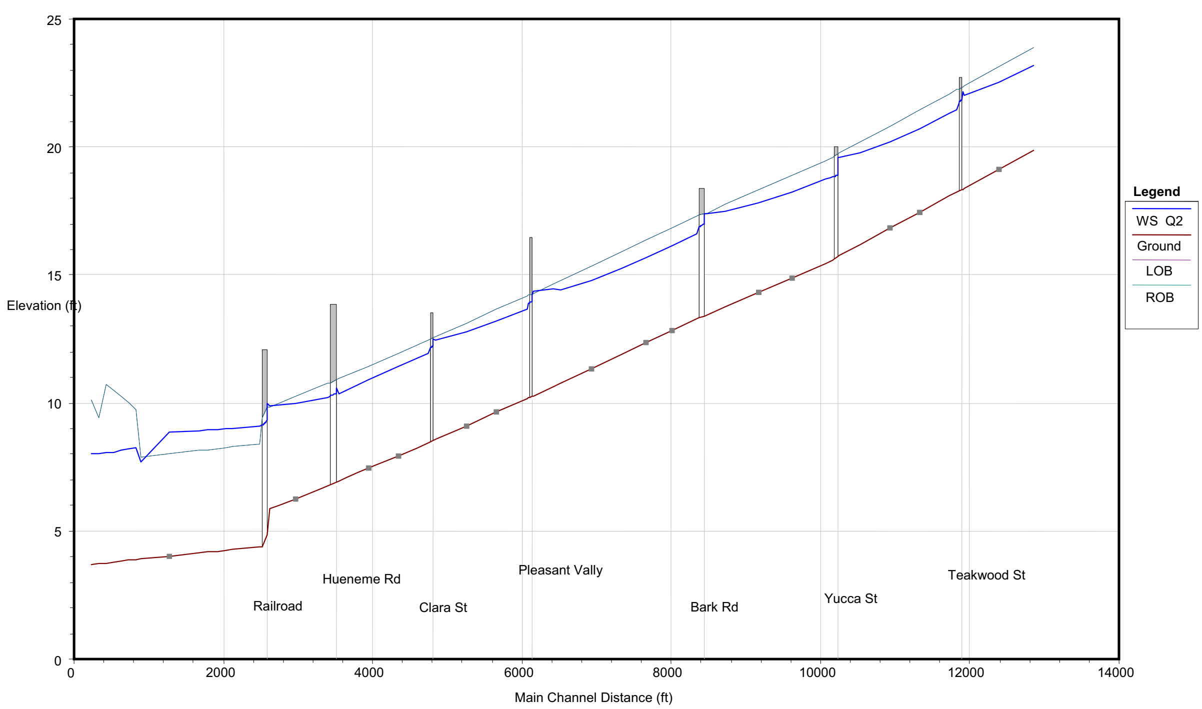


Figure 2-2. J Street Drain Channel Water Surface Profile at Full Capacity

2.2.3 Design Flood Hydraulics and Water Surface Profile

Hydraulic characteristics of the existing J Street Drain Channel under the 100-year flood peak were analyzed with the HEC-RAS procedure. The analysis results are summarized in the Table 2-3.

Table 2-3. 100-year Flood Existing Condition Hydraulic Summary

Reach	Average 100-year Flood Peak (cfs)	Average Flow Depth (feet)	Average Flow Velocity (ft/sec)
Redwood Street to Teakwood Street	900	5.08	6.64
Teawood Street to Yucca Street	958	5.06	7.08
Yucca Street to Bard Street	1027	5.71	6.01
Bard Street to Pleasant Valley Road	1565	6.77	5.95
Pleasant Valley Road to Clara Street	1775	6.91	6.91
Clara Street to Hueneme Road	1775	8.24	4.45
Hueneme Road to Railroad Crossing	1775	8.61	5.15
Railroad Crossing to Downstream End	1917	7.05	5.29

The existing channel has an average depth of 4 to 5 feet, which would be overtopped should a 100-year flood take place. Figure 2-3 shows the 100-year flood peak water surface profile along the channel. In addition to the insufficient cross-sectional size, the flow is severely constricted at the street crossings.

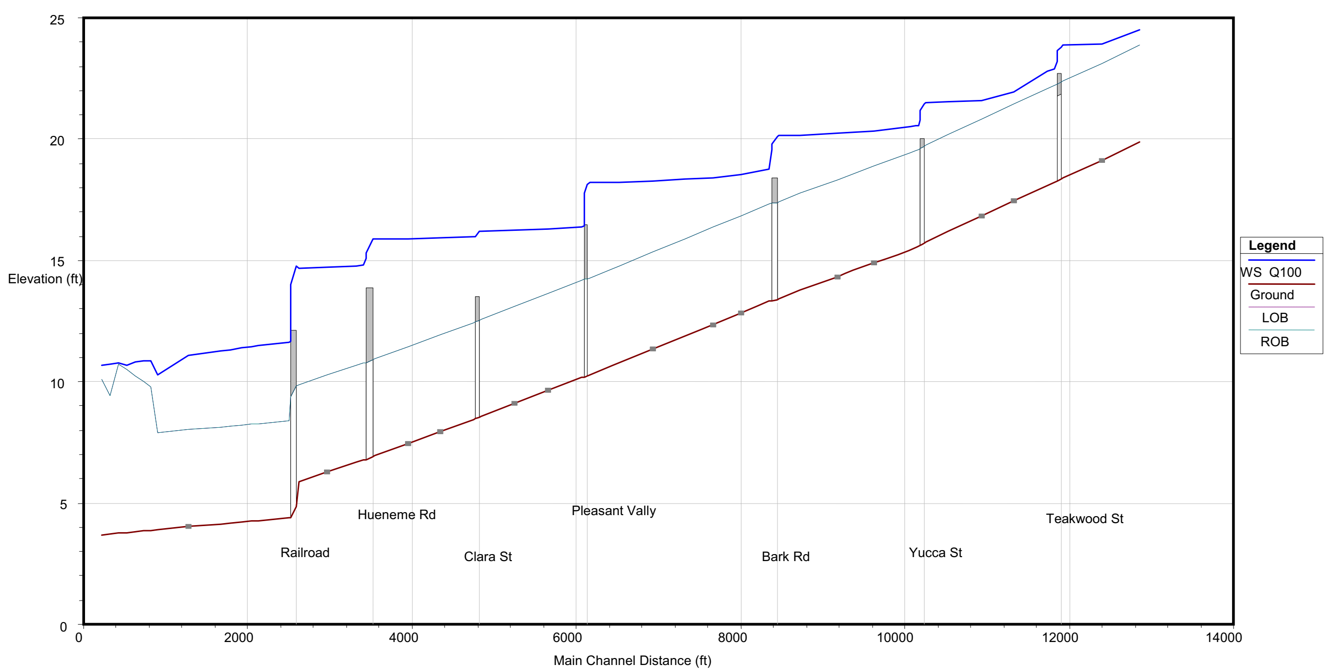


Figure 2-3. J Street Drain Channel 100-year Flood Water Surface Profile under Existing Conditions

3.0 PROPOSED CHANNEL IMPROVEMENT

To improve the flood carrying capacity of the J Street Drain Channel, several improvement alternatives were investigated. The alternatives included deepening the existing channel invert and constructing a bypass channel or storm drains parallel to the existing channel. Construction of bypass facilities may require additional right-of-way acquisition and significantly interferes with the massive existing utilities located close to or within the existing flood control right-of-way along the J Street Drain. Furthermore, additional discharge outlets at the Ormond Beach may be required and would face physical as well as environmental constraints.

Deepening the existing channel invert was selected as the preferred improvement alternative for the J Street Drain Channel because it would be less environmentally sensitive and costly than building a new parallel facility. Improvement of the Ormond Beach outlet was also considered in this design study. Its feasibility, however, would be very low due to its impact on the existing lagoon habitat, expected difficult regulatory permitting process, and high cost. The beach outlet evaluation is provided in Appendix A.

3.1 PROPOSED IMPROVEMENT DESCRIPTION

The following paragraphs describe the proposed improvement alternative for the J Street Drain Channel:

Cross-sectional Geometry - The existing trapezoidal concrete channel would be converted to a rectangular concrete channel with an invert about 4 feet below the existing channel bottom. The top of the proposed channel lining would follow that of the existing channel. A typical cross-section is illustrated on Figure 3-1.

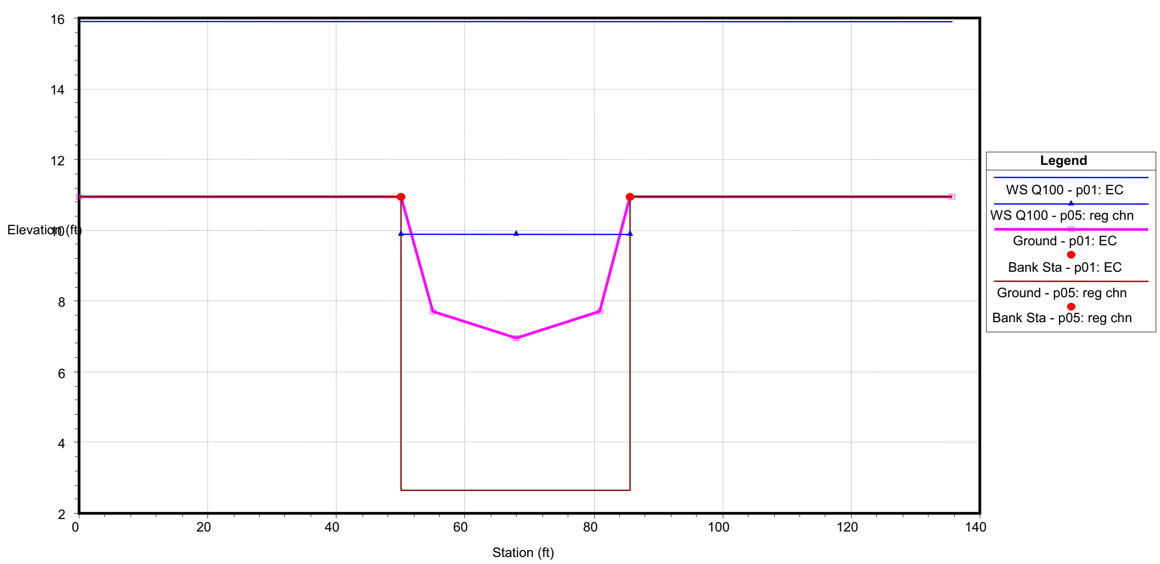


Figure 3-1. Proposed Channel Cross-section (retrieved from the HEC-RAS model)

Invert Slope – The proposed slope for the channel invert varies as follows:

Downstream End to Railroad Crossing	0.000308
Railroad Crossing to Bard Road	0.0015
Bard Road to Redwood Street	0.0018

Culvert Crossings – The existing culverts under the street crossings would also be replaced by larger structures to improve flow conveyance. Table 3-1 summarizes the proposed dimensions.

Table 3-1. Existing and Improved Street Crossing Culverts

Crossing	Existing Culverts	Proposed Culverts
Teakwood Street	Three 8 x 4 RCB	Two 14 x 6 RCB
Yucca Street	Two 10 x 4 RCB	Two 14.5 x 7 RCB
Bard Road	Two 10 x 4 RCB	Two 16 x 7 RCB
Pleasant Valley Road	Three 10 x 4 RCB	Two 17 x 8 RCB
Clara Street	Three 10 x 4 RCB	Two 18 x 8 RCB
Hueneme Road	Three 10 x 4 RCB	Two 19 x 8 RCB
Railroad Crossing	Five 60" CMP	Two 19 x 8 RCB

Downstream End – The existing J Street Drain Channel concrete lining terminates near the Hueneme Drain confluence. The earthen portion of the channel continues downstream before turning east at the sand berm (see Figure 2.1). Since the lined portion of the channel invert would be lowered about 4 feet to create the required capacity, the excavation is proposed to continue along the downstream earthen invert towards the sand berm. The finished invert would be daylighted to the sand berm at a 5:1 slope. The sand berm is expected to breach when the water surface reaches its height with an elevation of 7.5 to 8 feet. According to an estimate by the VCWPD, a 2-year event would produce enough runoff volume to fill the Ormond Beach Lagoon, which can cause the berm to breach. Since breaching would likely occur during smaller storms, an ocean outlet would have already been created to allow the 100-year event to pass through.

A set of 30% complete design drawings was prepared for the proposed J Street Drain Channel improvement, which included plan, profile, and typical cross-sections of the rectangular concrete channel and enlarged crossing culverts. These drawings are provided in Appendix B of this report.

3.2 OTHER IMPROVEMENT OPTIONS

Several other improvement options were considered for the J Street Drain Channel and have been discarded because of the perceived physical and environmental constraints. These options are briefly described in the following paragraphs:

Bypass Culverts – Two 8 foot diameter circular pipes or two 8 feet by 8 feet box culverts would be required for a bypass facility. Due to the shallow slope of the existing channel, a new pump station would need to be provided at the downstream end (near the Hueneme Drain confluence) to allow discharge from the bypass structure. While this option avoids the modification of the existing channel, it would require excavation along J Street and relocation of a vast number of existing utilities including sanitary sewer, water, gas and storm drain lines on both sides of the J Street Drain.

Earthen Channel – To increase capacity and also provide environmental values, the existing J Street Drain Channel may be replaced with a widened earthen trapezoidal channel with vegetated banks. Due to the increased roughness values and 2:1 side-slopes for this design, a channel bottom width of approximately 80 feet would be required from Bard Road to the Hueneme Drain confluence. This would significantly exceed the VCWPD right-of-way of 70.5 feet in this reach and require encroaching into J Street.

Floodwalls - Another considered improvement option was to enclose the channel with floodwalls to increase the flow head to drive it through the undersized road crossing culverts. Floodwalls 15 feet in height were added to the channel and road crossings in the existing channel HEC-RAS model. The model results showed that flows continued to overtop the floodwalls in the vicinity of the road crossings due to the undersized existing culverts. This measure was also rejected as infeasible.

4.0 PROPOSED CONDITION HYDRAULIC ANALYSIS

4.1 DESIGN FLOOD WATER SURFACE PROFILE

The hydraulic performance of the proposed J Street Drain Channel improvement was evaluated under the 100-year flood peak using the HEC-RAS. The geometry modeled in the analysis included the proposed rectangular cross-section and the improved street crossings. The results indicated that the 100-year flood would be contained in the channel and the 100-year floodwater surface profile is depicted on Figure 4-1.

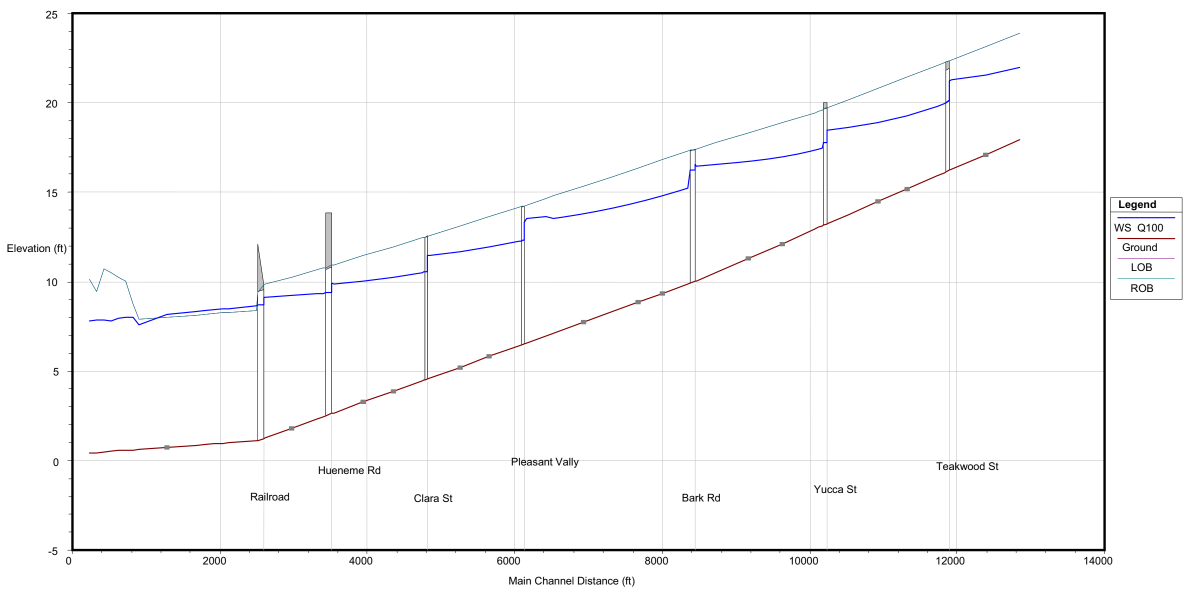


Figure 4-1. J Street Drain Channel 100-year Flood Water Surface Profile Under Proposed Condition

It should be noted that the starting water surface at the downstream end of the channel was set at normal depth based upon the expectation that the sand berm would have already breached prior to the 100-year event and an ocean outlet created to allow discharge of the channel flow.

4.2 CHANNEL FREEBOARD REQUIREMENT

The VCWPD design criteria stipulate that channel design be based on providing capacity for the 100-year flow in the channel-full condition or for the 50-year storm plus freeboard, whichever is greater. Therefore, the depth of the improved J Street Drain Channel was designed to meet both of these requirements. Section 324.20 of the Design Manual provides a description of four freeboard factors, including factors for air entrainment, unstable zone flow, superelevation, and residual freeboard.

Air entrainment – Air entrainment is required for flow with Froude Numbers (F) greater than 2. This was not considered in the J Street Drain design since the flow does not have Froude Numbers in that range.

Unstable Zone Flow - For flow in the unstable zone, the maximum required freeboard for unstable flow ($0.7<F^2<1.3$) is 25% of the critical depth. The maximum F^2 for J Street Drain 50-year flood flow is 0.59, which is less than 0.7. No unstable zone was present.

Superelevation - Superelevation provides sufficient flood protection height for the water surface transverse slope due to centrifugal force based on the radius of curvature and the flow velocity. This freeboard component was calculated for the curved section of the channel between the downstream end and Railroad crossing.

Residual Freeboard – Residual freeboard is a minimum freeboard above the calculate water surface. The allowance in reinforce concrete lined channels is 0.5 feet plus 10 %of the flow depth.

The depth of the improved channel was designed to contain the 50-year flood flow depth plus the freeboard allowances. The design has also met the 100-year flood peak condition.

4.3 EVALUATION OF SMALLER FLOOD EVENTS

The proposed J Street Drain improvement was also evaluated with the 2- and 10-year floods to ensure that they would be contained in the channel even with an unbreached sand berm downstream. The initial downstream water surface elevations for these two events were assumed at the height of the sand berm in the HEC-RAS model. The computed water surface profiles are plotted on Figure 4-2and are below the top of the channel.

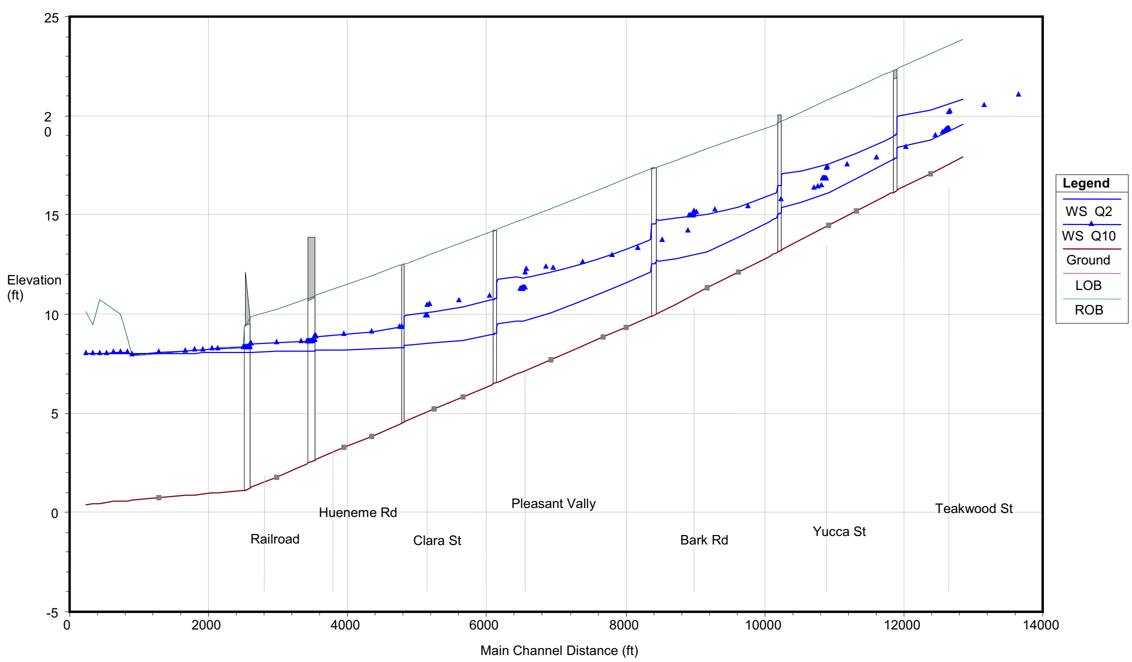


Figure 4-2. J Street Drain Channel 2- and 10-year Water Surface Profiles Under Improved Condition

5.0 Preliminary Construction Cost Estimates

Preliminary cost estimates were prepared for the proposed J Street Drain channel improvement and are summarized in Table 5-1. The unit cost information was based on cost data used to develop project costs for VCWPD's capital facilities planning studies and other cost information provided by VCWPD.

Table 5-1. Preliminary Construction Cost Estimates for J Street Drain Improvement

Activity	Quantity	Unit Cost	Unit	Item Cost
Demolition of Existing Culverts	2,721	$15	SY	$40,815
Demolition of Existing Channel Lining	56,000	$15	SY	$840,000
Excavation to Deepen Channel	72,000	$12	CY	$864,000
Crossing Reconstruction				
Railroad	314	$700	CY	$219,800
Hueneme Road	357	$700	CY	$249,900
Clara St	163	$700	CY	$114,100
Pleasant Valley Road	283	$700	CY	$198,100
Bard Road	250	$700	CY	$175,000
Yucca St	198	$700	CY	$138,600
Teakwood St	148	$700	CY	$103,600
Channel Construction				
Total RC Lining	21,024	$700	CY	$14,716,800
Surveying	1	$30,000	LS	$30,000
Project Design	1	$1,766,072	LS	$1,766,072
Utility Relocation	1	$300,000	LS	$300,000
Construction Mitigation	1	$2,199,286	LS	$2,119286
Permitting and Regulatory	1	$883,036	LS	$883,036
			TOTAL	**$22,759,108**

6.0 BENEFIT/COST ANALYSIS

The benefit for the J Street Drain Channel improvement project was evaluated based on the elimination or reduction of future flood damages or losses. Flood damages were estimated using the depth of flooding in the residential and commercial areas along J Street, the structural value data obtained from VCWPD, and the 1975 revised depth-damage curves for residential and small business structures calculated by the Federal Insurance Administration (FIA). These depth damage curves, which were provided by VCWPD, are also called the "HUD Curves" and are used by the United States Department of Housing and Urban Development. The benefit cost analysis (BCA) was conducted using estimated pre-project flood damages and losses to calculate benefits. The calculated project benefits were divided by the project cost to ultimately determine a benefit coat ratio (BCR). In general, a BCR equal to or greater than 1 indicates a cost effective mitigation project.

The following sections describe how the flood damage was estimated for each of the property types affected (single-family residential, multi-family residential, and commercial properties) and how the BCR was calculated.

6.1 FLOOD DAMAGE ESTIMATE

The 100-yr flood-damaged area, which was the computed result from the Flo-2D model, was provided by the County. The result presented the flooded depth along J-Street, illustrated on Figure 6-1. As described in Section 2.2.3, hydraulic characteristics of the existing J Street Drain Channel under the 100-year flood peak were analyzed and the existing channel would be overtopped should a 100-year flood take place.

6.1.1 Calculation Methodology

To determine potential structural damages and damages to contents, the value of the single-family, multi-family, and commercial structures had to be determined.

Single-Family Homes

To estimate the current value of a typical single-family residence, the published 2004 sale prices for the homes in the city of Oxnard were used as a reference. As shown in Table 6-1, an average value of $426,563 and an average price per square foot value of $348 were derived. The FIA assumes that the content value for single-family homes is equal to 35% of the structure value. The 1975 revised depth-damage curves from the FIA were used for calculating potential damages to building contents.

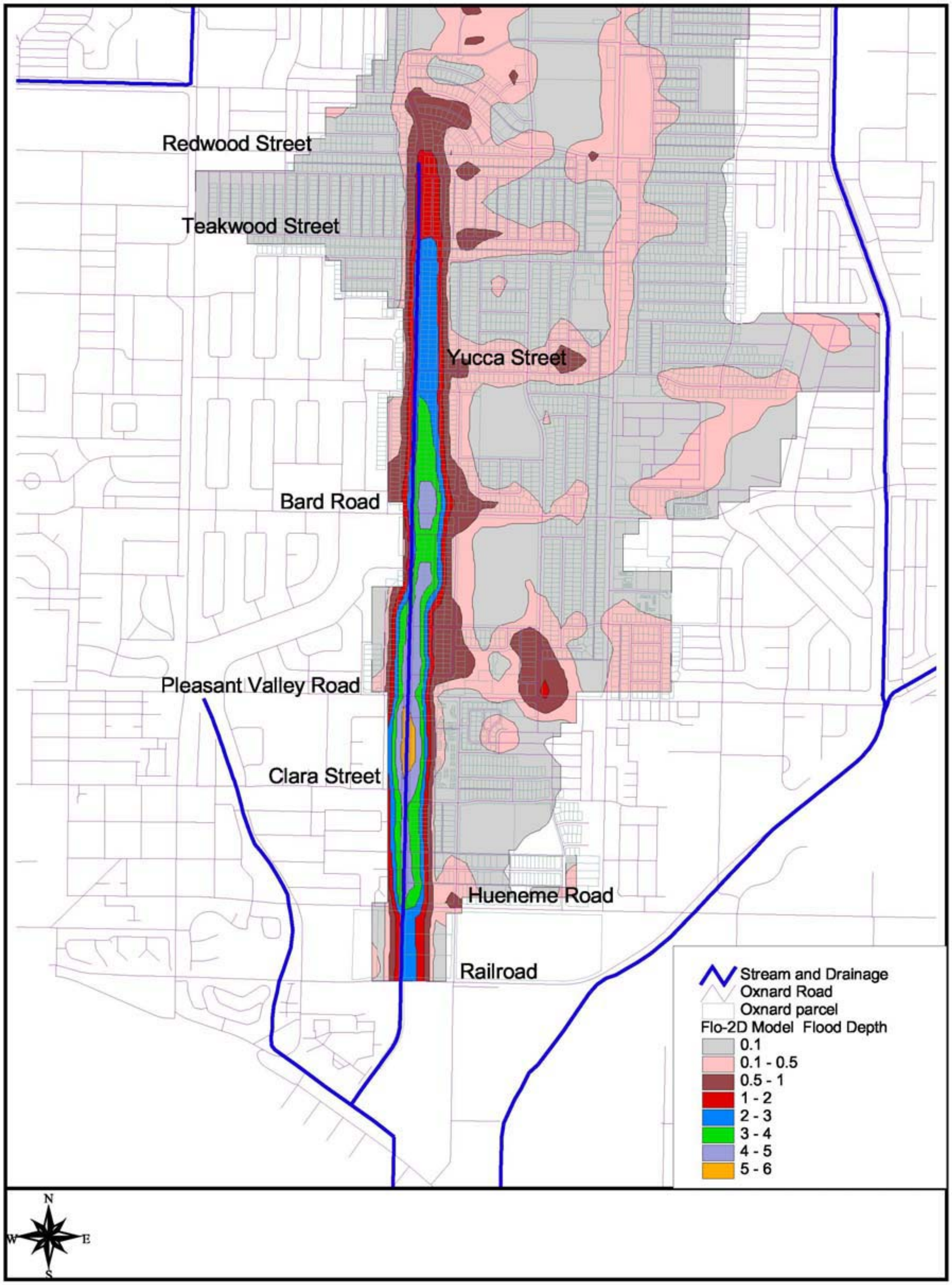


Figure 6-1. Flood Damage Estimate Map

Table 6-1. Typical Oxnard Home Sale Prices

Property Address	Proximity (miles)	Sales Price ($)	Sales Date	Bedrooms	Square Feet	Year Built
4801 S G	0.05	293,000	12/31/2002	3	1000	1960
4820 S G	0.07	325,000	6/4/2003	3	1000	1960
4601 S J	0.13	350,000	10/6/2003	3	1250	1955
4715 S J	0.08	360,000	11/25/2003	3	1250	1955
4914 S F	0.15	355,000	2/12/2004	3	1000	1960
4930 S J	0.06	442,000	5/28/2004	3	1000	1960
4920 S J	0.05	420,000	7/15/2004	3	1000	1960
710 SONOMA	0.12	450,000	8/4/2004	3	1250	1960
4830 S J	0.01	465,000	9/24/2004	4	1250	1960
320 CUESTA DEL MAR	1.46	565,000	3/5/2004	N/A	N/A	1960
401 CUESTA DEL MAR	1.45	575,000	3/18/2004	N/A	N/A	N/A
410 CUESTA DEL MAR	1.47	550,000	3/18/2004	N/A	N/A	N/A
231 CUESTA DEL MAR	1.44	550,000	3/19/2004	N/A	N/A	N/A
301 CUESTA DEL MAR	1.44	550,000	3/19/2004	N/A	N/A	N/A
331 CUESTA DEL MAR	1.44	575,000	3/23/2004	N/A	N/A	N/A
Average 2004 sales price		**426,563**	**Average price per square foot**		**348**	

Multi-Family Units

Multi-family units, including apartments, convalescent-care homes, and town homes, are located on both sides of the J-Street drain between Pleasant Valley Road and Hueneme Road. Recent sales information for multi-family homes was unavailable, but assessed values were available from the parcel data. A conservative, representative value of $100 per square foot was used to determine the structure replacement value for multi-family homes. Similar to the single-family units, the content value in a multi-family unit was assumed to equal 35% of the structure value.

Commercial Units

The commercial units in the flooded area include convenience stores, storage buildings, and warehouses. Current commercial unit values were estimated from recent sales and a representative value of $60 per square foot was used to determine the structure replacement value. The contents value was calculated to be 35% of the structure replacement value.

Depth Damage Calculations

Assuming each structure pad is at 1.0 feet above the surface of J Street, the depth of water calculated by the Flo-2D model was decreased by 1.0. The flood damage was estimated using depth-damage curves developed by the FIA. A depth-damage curve indicates a building's vulnerability to flood damage by showing the expected levels of damage as a percentage of the building value for each flood depth.

The structure depth-damage curve estimates the potential damage to occur to a building at each flood depth. The contents depth-damage curve indicates the vulnerability of the building's contents to flood damage by showing the expected levels of damage, as a percentage. Table 6-2 identifies the depth-damage curves developed by FIA and used for this project analysis.

Table 6-2. FIA Depth Damage Curves for a One Story Building Without a Basement and Two Story Building Without a Basement

Flood Depth (feet)	One Story Building		Two Story Building	
	Building Depth-Damage Curve (%)	Contents Depth-Damage Curve (%)	Building Depth-Damage Curve (%)	Contents Depth-Damage Curve (%)
	0	0	0	0
-2	0	0	0	0
-1	0	0	0	0
0	7	10	5	7
1	10	17	9	9
2	14	23	13	17
3	26	29	18	22
4	28	35	20	28
5	29	40	22	33
6	41	45	24	39

The same method was applied to single-family, multi-family, and commercial structures to estimate the flood damage.

The depth of flooding for each structure was recorded using the Flo-2D data. The following table identifies the total number of structures at each flood depth.

Table 6-3. Flood Depths and Structure Types

Flood Depth	Single-Family	Multi-Family	Commercial
<0.5	Not Counted	Not Counted	Not Counted
1	121	1	1
2	136	1	3
3	98	8	1
4	47	3	1
5	0	1	0
Totals			

The totals for potential damage to structure and contents were then added for 405 single-family units, 13 multi-family units, and 6 commercial structures. A total of $55.7 million was estimated as shown in Table 6-4.

Table 6-4. J Street Drain Channel Flood Damage Estimates

Categories	Units Flooded	Total Building Replacement Value ($)	Building Damages ($)	Content Damages ($)	Total Damages ($)
Single-Family Unit	405	187,181,892	32,040,910	15,628,549	47,669,459
Multi-Family Unit	13	22,037,500	5,130,078	2,369,059	7,499,137
Commercial Unit	6	8,328,000	383,668	195,915	579,583
Total	**424**	**217,554,656**	**37,673,048**	**18,193,523**	**55,748,179**

6.1.2 Total Estimated Flood Damage

In summary, a total of $55.7 million was estimated as the damage that would result from a 100-year flood in the J Street Drain Channel.

6.2 BENEFIT/COST RATIO

The benefit cost ratio for the proposed J Street Drain Channel improvement is 2.45, based on the estimated project cost of $22.8 million and the 100-year flood damage (benefit) of $55.7 million.

7.0 CONCLUSIONS

The proposed J Street Drain Channel improvement would involve replacing the existing facility with a deepened rectangular concrete-lined channel. The proposed channel would maintain the existing top width, but have an additional 4-foot depth below the existing channel invert to provide sufficient flood conveyance during a 100-year storm event. The proposed project would require replacing the existing culverts under the street crossings with larger structures to minimize the backwater effect caused by the undersized openings.

The channel's beach outlet is currently blocked by the buildup of a sand berm, which has resulted in the formation of the Ormond Beach Lagoon. A number of alternatives were identified and evaluated during this design study to create a permanent channel outlet with structural measures. A permanent ocean outlet, however, will significantly impact the lagoon habitat and require expensive construction and maintenance. Permitting would also be a difficult process. On the other hand, a man-made channel outlet may not be necessary because past storm events have caused the sand berm to breach, resulting in a hydraulic connection to the ocean when water in the lagoon reached top of the berm. It is likely that the breaching will take place during future storm events as long as there is enough water built up behind the berm. According to an estimate provided by VCWPD, a 2-year storm runoff from the J Street Drain Channel will produce enough volume of water to fill up the lagoon. Therefore, it is anticipated that the sand berm breaching would occur long before the 100-year event and a nature established ocean outlet created for the J Street Drain Channel.

To determine the financial viability of the J Street Drain channel improvement project, a benefit/cost ratio of 2.45 was estimated by comparing the cost for the improvement and the 100-year flood property damage. The flood property damage was computed based on a two-dimensional floodplain analysis (FLO-2D) result provide by VCWPD.

A set of 30% complete design drawings for the proposed J Street Drain Channel improvement showing plan, profile, and cross-sections is included in Appendix B. Estimated locations of utilities that may be affected by the project have been delineated on the drawings. Many of these utilities would require temporary relocation and the cost has been identified in the total project cost. Their exact locations may need to be verified during the final design phase.

Appendix A

Beach Outlet Evaluation

Ormond Beach Outlet Alternatives

A total of six alternatives for improving the J Street outlet near the lagoon were considered in the study, including the No Project alternative. The alternatives were designed to satisfy the following design criteria:

1. Improve the conveyance capacity of the J Street Drain outlet.
2. Minimize the disturbance to tidewater goby habitat downstream of the J Street lined channel or develop additional habitat within the lagoon to mitigate any habitat loss.
3. Maintain dry weather recharge to the Ormond Beach Lagoon from J Street and Hueneme Drains.
4. Minimize operation and maintenance requirements, especially during storms.
5. Minimize effects on water quality of the lagoon.
6. Minimize backwater effects from Oxnard Industrial Drain (OID) from affecting proposed solution.

The alternatives vary in the degree of hydraulic connection between the J St Drain and the Ormond Beach Lagoon. A backwater condition up to elevation 7.5 NGVD develops during dry weather periods due to the buildup of the sand berm between the lagoon and the ocean. Over the last year, significant runoff events (April, 2004, and October, 2004) have led to the formation of a breach in the berm at the Oxnard Industrial Drain end of the lagoon, leading to lagoon dewatering and a hydraulic connection with the ocean.

Previous analyses by the VCWPD have estimated that Hueneme Drain and Oxnard Industrial Drain (OID) are the primary sources of dry-weather recharge to the lagoon (2.02 and 2.82 cfs, respectively), with only trace amounts of dry weather recharge occurring from the J St Drain. Based on 100-year peak flows for Hueneme Drain, J St Drain, and Oxnard Industrial Drain (440, 1,775, and 4,759 cfs respectively) the wet weather recharge to the lagoon is approximately 6 percent from Hueneme Drain, 25 percent from J St Drain, and the remainder from OID. Any alternative to improve the J St Drain capacity that provides a significant connection between the J St Drain and the lagoon during storm events may be impacted by flow from the OID.

Based on limited sampling in the lagoon and its tributaries, the water quality is concluded to be better in the Hueneme and J St Drains than in OID. Water quality in OID is affected by historic industrial and agricultural activities along the drain. Fish surveys found populations of Tidewater Gobies in the unlined portion of the J St Drain, in the lagoon, and in the Hueneme Drain. No juveniles were found in the Hueneme Drain, possibly due to the silty conditions found in that channel. The gobies are reported to prefer a sandy substrate for reproduction. Shorebirds were reported to use the lagoon to obtain fish for their food.

The outlet improvement alternatives are described in the following sections.

Alternative 1: Two Rubber Dams

- Berm downstream of J St Channel excavated down to MHHW line
- Rubber dam installed in existing opening between J St Drain and lagoon to prevent flow from OID from causing a backwater condition in the J St Drain during stormflow before berm is breached. Dam would be inflated prior to storm to disconnect the two systems.
- Rubber dam installed in sand berm at channel outlet to maintain water levels in J St Drain and lagoon. O&M staff would deflate dam after channel/lagoon dam is inflated at beginning of storm to release backwater.

- Sand berm dam would be reflated at end of storm to restore backwater in lagoon and channel to desired depth. Channel/lagoon dam would be deflated to restore channel/lagoon connection.

Advantages:

- Lagoon and channel generally remain connected, minimal loss of habitat downstream of lined channel.
- Lagoon depth can be maintained as desired
- No changes to lagoon dry weather recharge
- J St storm flow can be diverted through lagoon when berm is breached to provide flushing.

Disadvantages:

- Requires active management of dams and maintenance to prevent seepage under corrosive beach conditions.
- Fish downstream of lined channel may be discharged to ocean during storm.
- May lead to fewer breaches and decreased breach periods due to decreased inflow from J St Drain to lagoon.

Alternative 2: Rubber Dam and Permanent Weir

- Berm downstream of J St Channel excavated out to MHHW line and permanent concrete weir approximately 100' wide installed downstream of lagoon/ J St Drain channel confluence at elevation 4.5 NGVD.
- Rubber dam installed between J St channel and lagoon to be inflated during storms, preventing OID flow from causing a backwater in J St Drain if berm is not breached.

Advantages:

- Lagoon and channel generally remain connected, minimal loss of habitat downstream of lined channel.
- Less active management of channel/lagoon system than Alternative 1.
- Lagoon depth can be maintained as desired
- Backwater in J St Channel maintained at minimum 4.5 ft elevation and subjecting fish downstream of lined channel to lower flow velocities during storms.
- J St storm flow can be diverted through lagoon when breach is present to provide flushing.

Disadvantages:

- Requires active management of dam and maintenance to prevent seepage under corrosive beach conditions.
- May lead to fewer breaches and decreased breach periods due to decreased inflow from J St Drain to lagoon.

Alternative 3: Ocean Outfall

- Install pump station and sump at downstream end of J St Channel with capacity to discharge 100-yr storm peak flow (1,775 cfs) into ocean outfall.

- Install rubber dam across channel/lagoon opening to prevent OID flow from causing backwater condition during storm in J St Drain if berm is not breached. Inflate at beginning of storm and deflate at end of storm.

Advantages:

- No loss of habitat at end of lined channel.
- Water level in lagoon and J St will fluctuate naturally depending on recharge and breach conditions
- No changes to dry weather lagoon recharge sources if J St flow if pumps are shut off during dry weather periods.
- Water quality impacts in near-shore zone minimized.
- Pump station can be turned of so that J St storm flow can be diverted through lagoon when breach is present to provide flushing action.

Disadvantages:

- Expensive ocean outfall and pump station, including energy costs.
- Requires pump station maintenance and trash removal.
- Requires rubber dam installation and active management during storms.
- Fish downstream of lined channel may be sucked into pumps while operating.
- More permitting issues

The existing wastewater treatment plant outfall extends approximately 5,000 feet into the ocean, and ranges in size from a 30-in CIP to a 48-in RCP at the ocean end. Its capacity is 50 mgd, or about 77 cfs. City of Oxnard officials report that there is no additional capacity for storm flow and the flow capacity is too small to be used as an alternative for J Street Drain flow. An 11-ft diameter ocean outfall extending 3.5 miles out to sea in San Diego had a capacity of 333 mgd, or about 515 cfs, at a cost of $200 million in 1998. The flow velocity of this outfall during full flow conditions is about 5.4 fps. Based on these data, it was concluded that this alternative was very expensive, would not provide sufficient capacity, and required no further study.

Alternative 4: Extend Eastern Levee Across Lagoon Opening (Preferred)

- Levee between J St Channel and lagoon extended across existing lagoon opening,
- Sand berm downstream of J St Channel excavated out to MHHW line by O&M staff prior to winter storms
- Perkins Drain berm removed in lagoon and excavation done to provide additional tidewater goby habitat.
- Hueneme Drain discharge pipes rerouted to discharge dry weather flow into newly excavated portion of the lagoon and create low-salinity environment for tidewater gobies
- Hueneme Drain storm flow can be diverted to lagoon to encourage breaching or outletted into J St Drain for discharge to ocean
- Option: Install catch basin in J St Drain next to pump station to divert low flow into sump for pumping into lagoon with Hueneme flow.

Advantages:

- Lagoon depth will fluctuate naturally depending on sand berm height and OID and Hueneme Drain inflow.

- Does not require active management of lagoon levels by O&M staff.
- No changes to dry weather lagoon recharge sources if J St flow is routed through Hueneme pump station and into lagoon.
- Most efficient hydraulic design for J St and Hueneme Drain discharge- no backwater condition in J St Drain.

Disadvantages:

- Loss of habitat in unlined portion of J St Drain.
- May lead to fewer breaches and decreased breach periods due to decreased storm flow from J St Drain to lagoon.
- Flushing action provided by J St and possibly Hueneme Drain wet weather flows when breach occurs would be eliminated.
- Requires O&M staff to excavate accumulated sand prior to winter storms to provide adequate outlet conveyance.

Alternative 5: High Flow Bypass in J St Drain, Levee between Lagoon and Channel

- Weir added downstream of pump station to divert low flow into lagoon, prevent backwater from forming in J St Channel.
- Earth berm extended to block connection between J St and lagoon.
- Low flows diverted into lagoon through low flow inlet with flap gate from J St Drain when lagoon elevations are low. Flap gate prevents backflow into J St channel when lagoon elevations are high from OID flow.

Advantages:

- Lagoon depths will fluctuate naturally according to OID and Hueneme Drain inflow.

Disadvantages:

- Loss of habitat downstream of lined channel
- May lead to fewer breaches and decreased breach periods due to decreased storm flow from J St Drain and Hueneme Drain to lagoon.
- Flushing action provided by J St and possibly Hueneme Drain wet weather flows when breach occurs would be eliminated.
- Backwater condition caused by the in-channel weir to the J St Drain channel.

Alternative 6: Side Weir and Bypass Channel

- Side weir with top elevation of 5.5 ft NGVD and bypass channel constructed adjacent to existing J St channel downstream of pump station to discharge storm flows to ocean. Hydraulic analysis indicates that a side weir with length of 270 ft would be required to divert 1,775 cfs into bypass channel. The analysis assumes that the Hueneme Drain storm flow would be discharged directly into bypass channel.

Advantages:

- Existing lagoon and channel connection would not be affected
- Lagoon depth up to side weir elevation of 5.5 ft NGVD will fluctuate naturally depending on sand berm height, breach presence, and inflow from drains.

- Existing habitat downstream of unlined channel not affected
- Portion of new channel constructed through disturbed habitat adjacent to pump station

Disadvantages:

- Requires construction of side weir- some impacts to dune habitat at outlet downstream end of bypass channel
- OID inflow to lagoon prior to berm breaching could cause backwater condition in J St channel and affect performance of side weir during storm flow.

No Action Alternative:

The No Project condition would keep the existing channel configuration and lagoon operation. Existing flooding problems would not be solved with this alternative.

Preliminary Cost Estimates

Cost estimates were prepared for the various outlet alternatives as shown in the following tables. The cost information was based on cost data used to develop project costs for VCWPD's capital facilities planning studies and other cost information provided by VCWPD.

Ormond Beach Outlet Alternatives:

Alternative 1- 2 Rubber Dams

Activity	Quantity	Unit Cost	Unit	Item Cost
Rubber dam between channel and lagoon, 100' long, 8' high with control systems and piping	1	$480,000	LS	$480,000
2 feet thick concrete foundation for channel/lagoon rubber dam, 5' deep cutoff wall	111	$ 700	CY	$77,778
Control House	1	$25,000	LS	$25,000
Rubber dam at channel outlet, 100' long, 8' high with control systems and piping	1	$480,000	LS	$480,000
2 feet thick concrete foundation for channel outlet dam, 5' deep cutoff wall	111	$ 700	CY	$77,778
Diversion, Control and Removal of Water	1	$50,000	LS	$50,000
Water Pollution Control	1	$5,000	LS	$5,000
Excavation through sand berm	2,570	$15	CY	$38,548
Geotextile Soil Protection Fabric	222	$20	SY	$4,444
Filter Fabric Material B	37.0	$100	CY	$3,704
1/4 Ton Rip-Rap Protection at Outlet	740.7	$70	CY	$51,852
Total				**$1,242,251**

Alternative 2 - Rubber Dam and Permanent Outlet Weir

Activity	Quantity	Unit Cost	Unit	Item Cost
Rubber dam between channel and lagoon, 100' long, 8' high with control systems and piping	1	$480,000	LS	$480,000
2 feet thick concrete foundation for channel/lagoon rubber dam, 5' deep cutoff wall	111	$ 700	CY	$77,778
Control House	1	$25,000	LS	$25,000

Concrete weir at channel outlet 100 ft long, 10 ft wide, 0.67 ft thick concrete, 5' deep cutoff walls	50	$ 700	CY	$34,741
Structural Backfill	500	$ 20	CY	$10,000
Diversion, Control and Removal of Water	1	$50,000	LS	$50,000
Water Pollution Control	1	$5,000	LS	$5,000
Excavation through sand berm	2,570	$15	CY	$38,548
Geotextile Soil Protection Fabric	444	$20	SY	$8,889
Filter Fabric Material B	74.1	$100	CY	$7,407
1/4 Ton Rip-Rap Protection at Outlet	740.7	$70	CY	$51,852
Total				**$789,214**

Alternative 4 Extend Levee

Activity	Quantity	Unit Cost	Unit	Item Cost
Structural Backfill for Levee	1,111	$ 20	CY	$22,222
Concrete weir at channel outlet 100 ft long, 10 ft wide, 0.67 ft thick concrete, 5' deep cutoff walls	50	$ 700	CY	$34,741
Diversion, Control and Removal of Water	1	$50,000	LS	$50,000
Water Pollution Control	1	$5,000	LS	$5,000
Excavation through sand berm	2,570	$15	CY	$38,548
Geotextile Soil Protection Fabric	667	$20	SY	$13,333
Filter Fabric Material B	111.1	$100	CY	$11,111
1/4 Ton Rip-Rap Protection at Outlet	740.7	$70	CY	$51,852
Total				**$226,807**

Alternative 5. Low Flow Diversion Weir Downstream of Pump Station

Activity	Quantity	Unit Cost	Unit	Item Cost
Structural Backfill for Earth Berm between Lagoon and Channel	1,111	$ 20	CY	$22,222
Concrete weir downstream of pump station 48 ft long, 10 ft wide, 1.5 feet high	27	$ 700	CY	$18,667
Low flow diversion and culvert inlet to lagoon with flap gate	1	$ 10,000	LS	$10,000
Diversion, Control and Removal of Water	1	$50,000	LS	$50,000
Water Pollution Control	1	$5,000	LS	$5,000
Excavation through sand berm	2,570	$15	CY	$38,548
Geotextile Soil Protection Fabric	667	$20	SY	$13,333
Filter Fabric Material B	111.1	$100	CY	$11,111
1/4 Ton Rip-Rap Protection at Outlet	740.7	$70	CY	$51,852
Total				**$220,733**

Alternative 6. Side Channel Weir, Unlined Bypass Channel

Activity	Quantity	Unit Cost	Unit	Item Cost

Side Weir 270 ft long, 0.67 ft thick concrete, 5.5 ft high, 10 ft thick	74	$ 700	CY	$51,852
Concrete channel stabilizer at outlet 50' wide, 6' deep, 0.67' thick, 5 ' cutoff walls	25	$ 700	CY	$17,370
Diversion, Control and Removal of Water	1	$50,000	LS	$50,000
Water Pollution Control	1	$5,000	LS	$5,000
Excavation	7,014	$15	CY	$105,214
Geotextile Soil Protection Fabric	596	$20	SY	$11,911
Filter Fabric Material B	99.3	$100	CY	$9,926
Total				**$251,274**

PRELIMINARY ENVIRONMENTAL ASSESSMENT

J STREET OUTLET ALTERNATIVES

The environmental and permitting issues associated with the J Street Outlet Alternatives are addressed in this section. The analysis is focused on the primary issues that could affect the cost and feasibility of the alternatives – biological resources such as wetlands and endangered species, water quality, and public access and recreation. The alternatives considered in this analysis are described in detail in previous sections of the Pre-Design Report, and are listed below:

1. Two Inflatable Dams
2. Inflatable Dam and Permanent Weir
3. Ocean Outfall
4. Earthen Levee Across Lagoon Connection (Preferred Alternative)
5. High Flow Bypass in the J Street Drain Channel with Levee Across Lagoon Connection
6. Side Weir and Bypass Channel for High Flows
7. No Action Alternative

The primary objective of the improvement alternatives is to improve the conveyance capacity of the J Street Drain outlet at the ocean in order to reduce upstream flooding during the winter, particularly during the initial storm events. The outlet is blocked by the sand berms on the beach, creating backwater in the J Street Drain that extends into the City of Oxnard. The project would be designed to convey winter flows from J Street Drain to the ocean in a reliable and controlled manner.

1. LAND USE AND ENVIRONMENTAL SETTING

The project site consists of the following elements:

- The terminus of the Hueneme Drain and the Hueneme Drain Pump Station which pumps water from the drain (summer baseflows from springs) and winter runoff into the J Street Drain Lower Channel
- The J Street Drain Lower Channel, which is defined as the terminus of the concrete-lined J Street Drain. The lower channel extends about 250 feet from the end of the concrete lining at the pump station towards the beach, where it is connected to the main channel or water body in the Ormond Beach Lagoon.
- The Ormond Beach Lagoon, which is a large complex of wetlands, dune, and open water habitats that has formed in the backdunes of Ormond Beach between J Street Drain and the Oxnard Industrial Drain. The J Street Drain Lower Channel is included in the boundaries of the lagoon because it is hydrologically connected to the main lagoon channel, and discharges water to the lagoon. Although the project is located on the eastern edge of the lagoon, the project could affect the entire lagoon by altering water levels in the lagoon.
- The East Hueneme Drain is a remnant of the drainage system developed prior to 1960 in which discharge from the Oxnard Industrial Drain was directed upcoast to the pump station, where it was siphoned under the J Street Drain, and then pumped back to the J Street Drain at the Hueneme Pump Station. It appears that the East Hueneme Drain is no longer discharging to the Hueneme Drain. It now is a non-functioning ditch without circulation that contains water-year round. It is directly connected to the rest of the Ormond Beach Lagoon.
- Ormond Beach consists of the broad sandy beach that is located seaward of the J Street Lower Channel and Ormond Beach Lagoon.

Hueneme Drain and the Hueneme Drain Pump Station are located in the City of Port Hueneme. The J Street Drain, Ormond Beach Lagoon, East Hueneme Drain, and Ormond Beach are located in the City of Oxnard. These features are all located in the Coastal Zone.

The Watershed Protection District (District) owns the right-of-way for the Hueneme Drain and the Hueneme Drain Pump and a maintenance easement for the J Street Drain Lower Channel. Ormond Beach Lagoon, to the high tide limit, is located on City of Oxnard property. The District does not have a maintenance easement on any other part of the Ormond Beach Lagoon. *<<WPD needs to confirm this information>>*

The Hueneme Drain and Pump Station are located directly south of, and adjacent to, the Surfside Condominiums. The pump station is also located at the eastern end of the 50-acre Hueneme Beach Park, which includes a pier, picnic areas, swimming beaches, and parking lots. The only park improvements near the pump station and J Street Drain Lower Channel are trails to the beach. Hueneme Drain is also part of the Bubbling Springs Recreational Corridor that extends from the project site into town and the Bubbling Springs Park. The corridor provides open space and pathways.

The north side of Ormond Beach Lagoon consists of industrial uses – the Oxnard Wastewater Treatment Plant and the Halaco Metal Recycling Facility. Public access is provided to the north edge of the lagoon at the terminus of Perkins Road, where a City of Oxnard public parking lot is located. Formal access to the lagoon is not provided from the parking lot because the parking lot is separated from the lagoon by the East Hueneme Drain. However, informal crossings of the ditch (i.e., drift wood bridge) are often erected by the public, allowing pedestrians to enter the lagoon. Beach access is not possible from this location unless the lagoon has been fully drained to the ocean. An isolated non-tidal wetland is located between East Hueneme Drain and the Oxnard Wastewater Treatment Plant on City of Oxnard Property.

The remaining north side of the Ormond Beach Lagoon abuts directly with the Halaco Metal Recycling Facility. No public access is present.

2. ENVIRONMENTAL SETTING

2.1 Hueneme Drain

Hueneme Drain is a man-made earthen channel with a trapezoidal shape. The channel is about 75 feet from tope of bank to top of bank near the pump station. The banks of the channel are dominated by annual weeds and perennial introduced grasses. The banks and tops of the banks are landscaped and maintained as part of the Bubbling Springs Recreation Corridor. Water levels in the drain are regulated by the pump station. In the summer, the water is maintained at 1-2 foot depths. Emergent wetlands and riparian plants (e.g., willows and mulefat) are not present in the channel. There are anecdotal observations of the endangered tidewater goby in the drain. As described below, this species is a resident of the Ormond Beach Lagoon. It could migrate into the Hueneme Drain under very limited conditions. Fish in the East Hueneme Drain (which is part of the lagoon) could move through the culvert under the J Street Drain into Hueneme Drain, upstream of the pump station. However, it appears that this culvert has been blocked for many years. As such, tidewater gobies are not expected to occur in the Hueneme Drain.

2.2 J Street Drain Lower Channel

The J Street Drain is a fully lined concrete channel that ends at the pump station. The channel downstream of the pump station is earthen, except for a concrete bottom that extends 100 feet downstream of the pump station. The lower channel extends about 325 feet from this concrete bottom to a bend in the channel that connects it to the lagoon. The channel width at top of bank is about 100 feet. The banks are uneven and exhibit erosion and sloughing. A 10-foot wide compacted sand and gravel path is located on the top of the western bank; the area east of the channel consists of stabilized sand dunes. The eastern bank is located in the lagoon area, and is dominated by a mixture of upland weeds and native wetland plants. The elevations of the banks are about 12 feet NGVD. The elevation of the concrete bottom is about 3 feet NGVD. The elevation of the sand dunes at the seaward end of the lower channel, where it bends to the east, varies based on the extent of sand dune development, but appears to be about 7 or 8 feet NGVD at present time.

The banks of the lower channel contain a mixture of barren eroding areas, introduced weeds, and iceplant. No emergent wetlands or riparian vegetation is present along the banks or margins of the open water in the channel. The depth of the water in the lower channel matches that in the larger lagoon, and as such, is typically very high in the summer (3 to 4 feet) and less than 2 feet in the winters when the lagoon is open to the ocean.

The federally endangered tidewater goby (*Eucylogobius newberri*) resides in the Ormond Beach Lagoon (see below), including the J Street Drain Lower Channel. The distribution and abundance of the species in the lagoon water bodies are unknown. The occurrence of this species in the lagoon was first detected in 1996. Tidewater gobies exhibit a wide range of tolerance for water temperature, depth, and salinities. They breed in the areas with sandy substrates. They are typically found in the upper ends of lagoons in brackish water, usually in salinities of less than 10 parts per thousand (ppt), but have been found in water to range from 0 to 40 ppt. Tidewater gobies are bottom dwellers and are typically found at depths of less than three feet. In streams, they inhabit low-velocity areas. Tidewater gobies spawn throughout the year but spawning typically peaks in late April through early May. Spawning takes place in burrows dug 4 to 8 inches deep in coarse sand. Spawning is reported to take place at fairly low to moderate salinities (5 to 10 ppt). After hatching, the larval tidewater goby are planktonic (suspended in the water column) and are associated with aquatic plants in nearshore habitat. Juvenile tidewater goby are benthic dwellers similar to adults.

In April and September 2004, the District retained a fisheries expert to capture and temporarily relocated tidewater gobies from around the Hueneme Drain Pump Station during an upgrade project. Over 250 adult gobies were collected; the high number suggests that the lower channel provides favorable habitat conditions. The absence of aquatic and emergent vegetation in the channel would limit use by larvae.

Other native species that occur in the J Street Drain Lower Channel and the Ormond Beach Lagoon include Fish species captured and relocated out of the work area include topsmelt (*Atherinops affinis*), staghorn sculpin (*Leptocottus armatus*) and longjaw mudsucker (*Gillichthys mirabilis*). Exotic species include mosquitofish (*Gambusia* affinis) and crawfish.

Two federally listed bird species occur in and around Ormond Beach which could forage on occasion at the J Street Drain Lower Channel (and throughout the Ormond Beach Lagoon) for fish. The endangered California least tern (*Sterna antillarum browni*) and the California brown pelican (*Pelecanus occidentalis californicus*). The least tern nests on Ormond Beach south of the project site, but forages widely along the local beaches. The tern will forage for fish in the J Street Drain Lower Channel (and the Ormond Beach Lagoon) if there is sufficient water depth and fish density. The brown pelican forages widely along the coast and in the nearshore waters. It may occasionally forage for fish in the J Street Drain Lower Channel (and the Ormond Beach Lagoon), but it requires a greater water depth and surface area than terns, and is expected to be an infrequent forager at the project site.

2.3 Ormond Beach Lagoon

2.3.1 Origin and Current Hydrologic Conditions

The Ormond Beach Lagoon consist of a complex array of wetland, freshwater, estuarine, and marine habitats. It was formed through a complex interaction of natural hydraulic and tidal actions, and man-made drainage improvements involving the Oxnard Industrial Drain, Hueneme Drain, and J Street Drain. Prior to the 1960s, these drains discharged directly to the ocean. In the 1960s, the Oxnard Industrial Drain was directed upcoast to a pump station for discharge to the J Street Drain. Eventually, this system deteriorated, and a lagoon was formed on the beach from year-round flows from the Oxnard Industrial Drain. Prior to 1992, the District breached the sand berms on the beach that formed the lagoon to lower water levels in the lagoon that caused backwater flooding in the J Street Drain and Oxnard Industrial Drain. At this time, the water levels in the lagoon are not actively managed by any entity.

Under current conditions, the lagoon receives inflow throughout the year from the Hueneme Drain (pumped to the J Street Drain), J Street Drain, and Oxnard Industrial Drain. Water levels in the lagoon rise during the winter, and the lagoon may breach due to the combined hydraulic head from storm flows and the erosion of the upper beach sand dunes from winter wave action. The lagoon does not breach every year. Hence, water levels in the winter can vary greatly from 2 - 3 feet NGVD when the lagoon is fully open to the ocean, to 7 – 9 feet NGVD when the lagoon is impounded. Sand dune elevations along the upper beach can reach up to 9 feet NGVD.

The location of the outlet when the lagoon breaches has varied over the past 10 years. At one time, it was located at the center of the lagoon, but in recent years, it has been located downcoast from where the Oxnard Industrial Drain enters the lagoon. It does not appear that an outlet was ever formed in recent times at the J Street Drain Channel, indicating that the hydraulic forces from runoff that contribute to the natural breaching are stronger at the mouth of the Oxnard Industrial Drain which has a greater watershed than the J Street Drain.

During the summer, wave actions do not erode the sand dunes, and as such, the lagoon remains impounded. Water levels in the lagoon during the summer and fall are controlled by a combination of baseflows from Hueneme Drain and Oxnard Industrial Drain, evaporation, and seepage to and from the ocean through the beach sand. Typical summer water levels in the lagoon appear to be about 5 to 7 feet NGVD. Upstream flooding in the City of Oxnard occurs when water levels exceed 7 feet NGVD.

2.3.2 Wetland and Aquatic Habitats

The Ormond Beach Lagoon contains a mixture of fresh water and brackish water habitats, including vegetated marsh habitats with emergent and seasonally inundated plants, and open water aquatic habitats. The distribution and extent of these habitat types vary greatly on a seasonal and annual basis. The amount of open water habitat is controlled by the water elevation in the lagoon, described above. The occurrence of different habitat types also varies based on soil and water salinities. The lagoon receives ocean water through tidal influence during the winter months when the sand barrier is breached. Generally, low salinity and high water conditions occur during the summer when the lagoon is filled with fresh water inflows. Higher salinity and lower water levels occur in the winter if the sand dune berm has breached. At that time, extensive mudflats are present in the previously flooded areas.

The dominant species in the salt marsh areas are glasswort pickleweed *(Salicvrnia virginica), j*aumea *(Jaumea carnosa,)* and saltgrass *(Distichlis spicata)*. Other common species include alkali weed *(Cressa truxillensis),* alkali heath *(Frankenia grandifolia),* California sea blite *(Suaeda calif arnica),* brass buttons *(Cotula coronopifolia),* arrow-leaf saltbush *(Atriplex patula),* and sicklegrass *(Parapholis incurva).* The most common freshwater/brackish marsh species is bulrush *(Scirpus* sp.), which occurs in the lagoon area near the mouth of the Oxnard Industrial Drain, Rabbitsfoot grass *(Polypogon monspeliensis)* and white sweetclover *(Melilotus albus)* are also common along the water's edge south of Perkins Road. Aquatic ditch-grass *(Ruppia cirrhosa)* also occurs in the lagoon.

The sand dunes along the seaward edge of the lagoon are vegetated by silver beach bur *(Ambrosia chamissonis),* sea rocket *(Cakile maritima),* beach morning glory *(Calystegia soldanella),* red sand verbena *(Abronia maritima),* beach evening primrose *(Camissonia cheiranthifolia),* sea fig *(Carpobrotus chilensis),* and pink sand verbena *(Abronia umbellata* ssp. *umbellata).*

2.3.3 Special Interest Species

As described above in Section 2.2, the federally endangered tidewater goby (*Eucylogobius newberri*) resides in the Ormond Beach Lagoon. The distribution and abundance of the species in the lagoon water bodies are unknown. However, it is anticipated that the fish occur throughout the lagoon based on water temperature, depth, and salinity conditions that change seasonally and annual. The population is expected to exhibit a wide range from year to year based on the amount of open water in the lagoon.

As noted above, the endangered California least tern forages in the lagoon when there is sufficient water depth and fish density. The endangered brown pelican may also use the lagoon, but much on a more limited basis.

The threatened western snowy plover (*Charadrius alexandrinus nivosus*) nests at various locations along Ormond Beach, including in proximity to the lagoon. This species does not forage for fish, but instead forages for insects in the rack line of the upper beach and dune scrub area.

3. ENVIRONMENTAL IMPACTS AND ISSUES

3.1 Project Elements

The project alternatives involve a range of potential actions that could directly and indirectly affect the environmental resources at the project site. The key elements of the project alternatives that could result in environmental impacts are listed below and summarized in Table 1 for each alternative:

- Construction related disturbances (e.g., noise, traffic) associated with the construction of levees, channels, weirs, or rubber dams
- Temporary and permanent losses of habitat due to construction of levees, channels, weirs, or rubber dams
- Alteration of the hydrologic regime at the project site due to modified drainage patterns, which in turn could affect habitats, water quality, and endangered species
- Change in landforms and addition of new structures on or near a public beach

For all alternatives, the project would reduce upstream flooding in Oxnard, which would be a beneficial and desirable effect of the project. In addition, the project may provide opportunities to enhance habitat conditions at the project site through project design and mitigation.

A summary of the major project features of each alternative that could cause environmental impacts is provided in Table 1. The major physical features and structures associated with the alternatives include the following:

- Inflatable dams with associated concrete footings – Alternatives 1, 2, and 3
- Concrete weirs – Alternatives 2, 5, and 6
- Rip-rap – Alternatives 1 and 2
- Earthen dams – Alternatives 4 and 5
- Earthen channels – Alternatives 1, 2, 4, 5, and 6
- New pump station and buried ocean outfall – Alternative 3

The major hydrologic impacts of the alternatives are summarized in Table 2. The primary hydrologic effects are as follows:

- Possible reduction in the water depth and amount in the J Street Drain Lower Channel in the summer or winter
- Possible reduction in the amount of discharge to the Ormond Beach Lagoon due to diversion of J Street Drain winter storm flows to ocean, which could reduce the amount of water in the lagoon

All but two alternatives would maintain the current water levels in the J Street Drain Lower Channel in the summer. Alternatives 4 and 5 would result in lower water levels because the channel would be opened to the ocean in the summer.

In the winter, all of the alternatives would provide improved flows from the J Street Drain Lower Channel to the ocean. All but two alternatives could result in complete dewatering of the channel in between storm events. Alternatives 2 and 6 would involve a permanent weir in the channel that would retain water in the channel at acceptable depths in the winter, preventing the complete dewatering of the channel.

Only one alternative would affect the water level in the Ormond Beach lagoon as a whole. The permanent weir on the by-pass channel for Alternative 6 would control the elevations of the lagoon throughout the year. For all other alternatives, the summer elevations in the lagoon would remain similar to current conditions. All alternatives would reduce inflows from J Street Drain to the lagoon in the winter, and as such, could create lower water levels in the lagoon, which in turn, could affect the frequency of breaching the sand berm at the beach. This effect is expected to be very small, as the flows from J Street Drain are minor compared to the Oxnard Industrial Drain.

3.2 Construction Disturbance

Alternative 3 would involve the greatest construction disturbance area and duration, as this alternative would involve a new pump station and an ocean outfall to be installed under the beach and under the bed of the nearshore waters.

Alternative 6 would involve construction of a new channel with a concrete weir adjacent to the existing J Street Drain Lower Channel.

The other alternatives would have a similar level of construction disturbance and duration. Alternatives 1, 2, and 5 would require less disturbance for construction in comparison, but would still involve the installation of concrete dam footings and/or weirs at the project site. Alternative 4 would require installation of a short earthen levee and new drain outlets from the Hueneme Pump Station in the lagoon.

In summary, the alternatives are listed below in decreasing order of relative construction disturbance:

Alt. 3. - Ocean Outfall

Alt. 6. - Side Weir and Bypass Channel for High Flows

Alt. 1. - Two Inflatable Dams; Alt. 2. - Inflatable Dam and Permanent Weir; Alt. 5. - High Flow Bypass in the J Street Drain Channel with Levee Across Lagoon Connection

Alt. 4. - Earthen Levee Across Lagoon Connection (Preferred Alternative)

3.3 Operations and Maintenance Requirements

Each alternative would long-term operations and maintenance requirements. For example, the inflatable dams would require personnel to inflate and deflate them at the appropriate time. The channel to convey winter storm flows across the beach would require periodic excavation during the year to remove sand accumulating from wind.

The alternatives are listed below in decreasing order of relative operation and maintenance requirements:

Alt. 3. - Ocean Outfall

Alt. 1. - Two Inflatable Dams; Alt. 2. - Inflatable Dam and Permanent Weir

Alt. 6. - Side Weir and Bypass Channel for High Flows

Alt. 5. - High Flow Bypass in the J Street Drain Channel with Levee Across Lagoon Connection

Alt. 4. - Earthen Levee Across Lagoon Connection (Preferred Alternative)

3.4 Effect on Beach Access and Recreation

Public access to the project site occurs along the foot path on the top of the west bank of the J Street Drain Lower Channel, and across the beach seaward of the channel and the Ormond Beach Lagoon. Beach users at and east of the project site are typically hiking or strolling on the beach. Swimming and wading primarily occurs at the beaches to the west, in Hueneme Beach Park where there are lifeguards. Hence, the potential for the project to directly and adversely affect beach access and recreational activities is low. The primary impacts of each alternative is listed below in decreasing order of magnitude.

- Alternative 3. This alternative would involve a new pump station on the west side of J Street Drain Lower Channel, and as such, would require relocation of a popular path to the beach.
- Alternative 6. This alternative would involve a new channel on the west side of J Street Drain Lower Channel, and as such, would require relocation of a popular path to the beach, as above.
- Alternatives. 1, 2, 4, and 5. These alternatives would involve establishment and periodic maintenance of a channel across the upper dunes, which would affect travel patterns by beach users, but would not create a lateral beach barrier.

3.4 Habitat Impacts

The project alternatives would have varying effects on wetland, open water, and beach dune habitats. A summary of the habitat impacts from direct disturbance associated with project facilities is provided in Table 3. Installation of the inflatable dams and weirs would cause small and localized impacts to wetland and open water habitats at the project site. The establishment and maintenance of a channel across the beach dune area would affect a greater area of habitat. The construction of the pump station (Alternative 3) or the by-pass channel (Alternative 6) would affect beach dune scrub habitat. For several alternatives, the eroded and weedy banks of the J Street Drain Lower Channel would be stabilized and restored with native plants.

The alternatives are listed below in decreasing order of relative habitat impacts:

Alt. 3. - Ocean Outfall (due to impacts to nearshore marine habitats)

Alt. 1. - Two Inflatable Dams; Alt. 2. - Inflatable Dam and Permanent Weir

Alt. 5. - High Flow Bypass in the J Street Drain Channel with Levee Across Lagoon Connection

Alt. 4. - Earthen Levee Across Lagoon Connection (Preferred Alternative)

Alt. 6. - Side Weir and Bypass Channel for High Flows

3.5 Impacts to Endangered Species

The proposed project could affect two endangered species – the California least tern and tidewater goby. The former species would be affected if the water levels in the Ormond Beach Lagoon were significantly reduced in the summer when this species is foraging in the lagoon. As shown in Table 2, all project alternatives are designed to avoid a reduction in the amount of water discharged to the lagoon in the summer from J Street Drain and Hueneme Drain. Note that Alternative 4 would require the pumping of summer flows in the J Street Drain to the lagoon to maintain current levels of inflow to the lagoon, while other alternatives would provide these flows in a passive manner. Hence, no significant impact on foraging habitat for the least tern is anticipated from any of the project alternatives.

The endangered tidewater goby occurs in the Ormond Beach Lagoon and in the J Street Drain Lower Channel. As noted above, the proposed project would not affect water levels in the lagoon in the summer. The impact of reduced flows to the lagoon in the winter (for all alternatives, see Table 2) is expected to be negligible, and would not have a significant impact on gobies in the lagoon in the winter. In the winter, all alternatives would cause a reduction in the amount of water in the J Street Drain Lower Channel as storm flows are conveyed to the ocean. However, the amount of water that is retained in the channel between storms would vary from little to 4 or 5 feet. The project alternatives are listed below in decreasing order of impact on the tidewater gobies in the J Street Drain Lower Channel under winter conditions:

Alt. 6. - Side Weir and Bypass Channel for High Flows

Alt. 2. - Inflatable Dam and Permanent Weir

Alt. 1. - Two Inflatable Dams; Alt. 3. - Ocean Outfall (due to impacts to nearshore marine habitats); Alt. 4. - Earthen Levee Across Lagoon Connection (Preferred Alternative) and Alt. 5. - High Flow Bypass in the J Street Drain Channel with Levee Across Lagoon Connection

The alternatives would have varying levels of impacts on the tidewater gobies residing in the J Street Drain Lower Channel in the summer. For some alternatives, the channel would be mostly dewatered in the summer by conveying flows to the beach. Other alternatives would allow for impoundment of water in the channel, although the amount may be slightly less than under current conditions.

The project alternatives are listed below in decreasing order of impact on the tidewater gobies in the J Street Drain Lower Channel under summer conditions:

Alt. 4. - Earthen Levee Across Lagoon Connection (Preferred Alternative) and Alt. 5. - High Flow Bypass in the J Street Drain Channel with Levee Across Lagoon Connection

Alt. 3. - Ocean Outfall; Alt. 1. - Two Inflatable Dams; Alt. 2. - Inflatable Dam and Permanent Weir; Alt. 6. - Side Weir and Bypass Channel for High Flows

4. Mitigation Needs and Issues

Temporary and permanent impacts to wetland, open water, and dune habitats associated with each alternative would require offsetting mitigation in the form of habitat restoration at the project site. The amount of restoration would be based on the impact level. Hence, the relative habitat mitigation requirements for the alternatives would follow the order for habitat impact described in Section 3.4.

Impacts to the tidewater goby would also need to be mitigated, although mitigation would only be applied once it has been demonstrated that the District has avoided impacts to this endangered species to the extent practicable. Alternatives 4 and 5 would essentially remove the existing goby habitat in the J Street Drain Lower Channel. Mitigation for this impact would be to create new open water habitat in the lagoon and provide inflows of freshwater from the Hueneme Drain and J Street Drain, as under current conditions. This mitigation can be incorporated into Alternatives 4 and 5.

Similarly, Alternatives 1 – 3 would remove gobies and their habitat during the winters with high storm flows, essentially causing the annual loss of this population. This impact could also be mitigated by creating new open water habitat in the Ormond Beach Lagoon that is suitable for gobies.

Alternative 6 would retain summer and winter habitats for the gobies, and as such, would have a lesser requirement for mitigation for gobies.

5. ENVIRONMENTAL REVIEW REQUIREMENTS

The proposed project would represent a discretionary action to be funded, designed, and constructed by the District. The project must be approved by the District Board of Directors. The project is subject to the environmental review requirements of CEQA. The appropriate environmental document would be an Environmental Impact Report (EIR) because the project alternatives would have the potential to cause one or more significant impacts, such as impacts to wetlands, endangered species, and coastal resources.

The project is not expected to require a separate environmental document under the National Environmental Policy Act (NEPA) because the project is not being funded or proposed by a federal agency, nor occur on federal lands. The federal agencies involved in permitting (see below) would rely on the District's EIR to complete their requirements under NEPA without a separate document and public review process.

6. PERMITTING REQUIREMENTS AND ISSUES

All of the project alternatives would require the following permits:

1. Coastal Development Permit from the City of Oxnard, appealable to the California Coastal Commission
2. Coastal Development Permit from the City of Port Hueneme, appealable to the California Coastal Commission
3. Section 10 and 404 permits from the Corps of Engineers for the discharge of dredge or fill material into "waters of the United States" and wetlands
4. Section 1600 Streambed Alteration Agreement from the California Department of Fish and Game Section 401 water quality certification and possible NPDES discharge permit from the Los Angeles Regional Water Quality Control Board
5. Biological Opinion from the US Fish and Wildlife Service regarding protection of the goby, snowy plover, and least tern

The most challenging permit issues are listed below, which could affect the feasibility of acquiring permits:

- Use of beach outfall - inconsistency with Coastal Act policies which would precluded permitting for Alternative 3
- Use of hard structures on the beach – inconsistency with Coastal Act policies which may affect permitting for Alternatives 1 and 2
- Substantial impact to goby population in the J Street Drain Lower Channel – conflicts with federal endangered species act which requires avoidance to the extent possible. This impact may affect feasibility of all alternatives.

7. COMPARISON OF ALTERNATIVES

A comparison of the relative importance of the environmental and permitting issues for each alternative is provided in Table 5. Alternative 3, which involves the ocean outfall, has the highest ranking for environmental impacts and permitting issues. The project should be considered infeasible because it is highly unlikely that a coastal development permit would be issued for a structure under the beach and in the nearshore waters.

Alternative 4 has the lowest ranking compared to other alternatives because of the following main reasons: (1) it does not include concrete structures such as inflatable dam footings, weirs, or rip-rip; and (2) it does not include inflatable dams which require new operations and maintenance on the beach. Similar to other alternatives, it would have a significant impact on the endangered tidewater goby in the J Street Drain Lower Channel. This impact would be mitigated in a similar manner for this and other alternatives – creation of additional suitable open water habitat in the Ormond Beach Lagoon and the supply of suitable summer inflows from the Hueneme Drain and J Street Drain to maintain this habitat. This alternative can be constructed and operated without altering the overall hydrologic regime in the Ormond Beach Lagoon and Oxnard Industrial Drain. In addition, the cost of this alternative appears to lower than other alternatives, and it can be removed or readily modified at a later date if there are unintended impacts or other ways to improve its performance and reduce its environmental impacts.

TABLE 1
SUMMARY OF MAJOR PROJECT FEATURES FOR EACH ALTERNATIVE

Alternative	Proposed Modifications or Facilities			
	J Street Drain Lower Channel	Ormond Beach Lagoon	Beach	Other
1. Two Inflatable Dams	Inflatable dam at the terminus of lower channel to prevent outflow to beach in the summer (inflate in summer only). Stabilize banks with geotextiles.	Inflatable dam at the connection between the J Street Drain Lower Channel and the lagoon to prevent inflow to J Street Channel from lagoon in winter (inflate in winter only)	Channel excavated and maintained through the sand dunes at MHHW to convey winter flows (excavate in winter only)	Rip-rap would be placed on the downstream end of the inflatable dam at the beach outlet
2. Inflatable Dam and Permanent Weir	100-foot wide concrete weir at 4.5 foot elevation NGVD at the terminus of lower channel to regulate outflow to beach in the summer and winter. Stabilize banks with geotextiles.	Inflatable dam at the connection between the J Street Drain Lower Channel and the lagoon to prevent inflow to J Street Channel from lagoon in winter (inflate in winter only)	Channel excavated and maintained through the sand dunes at MHHW to convey winter flows (excavate in winter only)	Rip-rap would be placed on the downstream end of the weir at the beach outlet
3. Ocean Outfall	Install new pump station on the west bank of the channel and buried pipeline across the beach and nearshore waters to pump storm flows only (up to 1,775 cfs).	Inflatable dam at the connection between the J Street Drain Lower Channel and the lagoon to prevent inflow to J Street Channel from lagoon in winter (inflate in winter only)	Install pipeline under beach at a depth where it would not be exposed during winter storms	Install pipeline in nearshore waters at a depth where it would not be exposed during winter storms
4. Earthen Levee Across Lagoon Connection (Preferred Alternative)	Close Hueneme Drain Pump Station outlet pipes. Stabilize banks with geotextiles.	Construct earthen dam at the connection between the J Street Drain Lower Channel and the lagoon to prevent outflow to J Street Channel from lagoon in winter.	Channel excavated and maintained through the sand dunes at MHHW to convey winter flows (excavate in winter only)	Re-route Hueneme Drain pump discharge to lagoon.
5. High Flow Bypass in the J Street Drain Channel with Levee Across Lagoon Connection	100-foot wide concrete weir at 4.5 foot elevation NGVD immediately below pump station to divert summer low flows to lagoon and to regulate outflow to beach in the summer. Stabilize banks with geotextiles.	Construct earthen dam at the connection between the J Street Drain Lower Channel and the lagoon to prevent outflow from lagoon to the beach during the summer.	Channel excavated and maintained through the sand dunes at MHHW to convey winter flows (excavate in winter only).	
6. Side Weir and Bypass Channel for High Flows	Concrete weir on west bank at 5.5 feet NGVD to by-pass high	None	Channel excavated and maintained through the sand	

Alternative	Proposed Modifications or Facilities			
	J Street Drain Lower Channel	Ormond Beach Lagoon	Beach	Other
	winter flows. 300-foot long earthen channel west of J Street Lower Channel that discharges to the beach.		dunes at MHHW to convey winter flows (excavate in winter only)	

TABLE 2
SUMMARY OF MAJOR HYDROLOGIC ELEMENTS OF EACH ALTERNATIVE

Alternative	J Street Drain Lower Channel			Ormond Beach Lagoon		
	Change in Hydrologic Conditions	Summer Water Level Lower?	Winter Water Level Lower?	Change in Hydrologic Conditions	Summer Inflow to Lagoon?	Winter Inflow to Lagoon?
1. Two Inflatable Dams	No change in summer. Channel is opened to the ocean during the winter. Hence, water depth is low in winter.	No	Yes	No change in summer. No connection in winter, so J Street flows don't enter lagoon	No change	Slight reduction
2. Inflatable Dam and Permanent Weir	Channel is open to the ocean all year at 4.5 foot elevation. Water maintained at this depth all year.	No	Slightly	No change in summer. No connection in winter, so J Street flows don't enter lagoon	No change	Slight reduction
3. Ocean Outfall	No change in summer. Water level in channel in the winter is lowered by pumping.	No	Yes	No change in summer. No connection in winter, so J Street flows don't enter lagoon	No change	Slight reduction
4. Earthen Levee Across Lagoon Connection (Preferred Alternative)	Channel water level is low in the summer and fall; permanently separated from lagoon	Yes	Yes	Construct earthen dam at the connection between the J Street Drain Lower Channel and the lagoon to prevent outflow to J Street Channel from lagoon in winter.	Slight reduction; can be mitigated by pumping J Street summer flows to lagoon	Slight reduction
5. High Flow Bypass in the J Street Drain Channel with Levee Across Lagoon Connection	Channel is reduced in length/size and water level lowered in summer.	Yes	Yes	Construct earthen dam at the connection between the J Street Drain Lower Channel and the lagoon to prevent outflow from lagoon to the beach during the summer.	No change	Slight reduction
6. Side Weir and Bypass Channel for High Flows	Channel is open to the ocean all year at 5.5 foot elevation. Water maintained at this depth all year.	No	No	None	No change	Slight reduction

TABLE 3
SUMMARY OF MAJOR HABITAT IMPACTS FOR EACH ALTERNATIVE

Alternative	J Street Drain Lower Channel		Beach Impacts	Other Habitat Impacts?	Habitat Improvements?
	Wetland Impacts	Open Water Impacts			
1. Two Inflatable Dams	1,000 SF for four dam footings	1,400 SF for two dams	5,000 SF dune habitat 9,000 SF open beach		Restore 950 LF of banks with native vegetation and geotextiles
2. Inflatable Dam and Permanent Weir	500 SF for two dam footings; 1,000 SF for weir and rip-rap	700 SF for one dam	5,000 SF dune habitat 9,000 SF open beach		Restore 950 LF of banks with native vegetation and geotextiles
3. Ocean Outfall	None	None		2,000 SF dune scrub for pump station; 1,000s SF for pipeline under beach and nearshore waters	
4. Earthen Levee Across Lagoon Connection (Preferred Alternative)	None	700 SF for levee	5,000 SF dune habitat 9,000 SF open beach		Restore 950 LF of banks with native vegetation and geotextiles
5. High Flow Bypass in the J Street Drain Channel with Levee Across Lagoon Connection	1,000 SF for weir to lagoon and weir in J Street channel	700 SF for levee	5,000 SF dune habitat 9,000 SF open beach		Restore 950 LF of banks with native vegetation and geotextiles
6. Side Weir and Bypass Channel for High Flows	None	None	5,000 SF dune habitat 9,000 SF open beach	10,000 SF dune scrub habitat for new channel	

TABLE 4
COMPARISON OF RELATIVE BIOLOGICAL IMPACTS FOR THE ALTERNATIVES

7.1.1 Alternative	J Street Drain Lower Channel		Beach Impacts	Other Habitat Impacts?	J Street Drain Lower Channel		Total
	Wetland Impacts	Open Water Impacts			Impacts to Gobies in the Summer	Impacts to Gobies in the Winter	
1. Two Inflatable Dams	2	3	1	0	0	3	9
2. Inflatable Dam and Permanent Weir	3	2	1	0	0	3	9
3. Ocean Outfall	0	0	0	3*	0	3	6*
4. Earthen Levee Across Lagoon Connection (Preferred Alternative)	0	2	1	0	3	3	9
5. High Flow Bypass in the J Street Drain Channel with Levee Across Lagoon Connection	2	2	1	0	3	2	10
6. Side Weir and Bypass Channel for High Flows	0	0	1	3	0	2	6

* Impacts to nearshore marine habitats would be extensive and significantly beyond the scale of this ranking system.
Scores: High values = high impacts (unfavorable). Low values = low impact (favorable). Scores of 1 to 3 were assigned to alternative in each column.

TABLE 5
COMPARISON OF RELATIVE ENVIRONMENTAL IMPACTS AND ISSUES FOR THE ALTERNATIVES

Alternative	Construction Impacts	Operations and Maintenance Requirements	Public Access and Recreation	Habitat Impacts	Endangered Species Impacts	Permitting Issues	Total
1. Two Inflatable Dams	2	4	1	4	2	2	15
2. Inflatable Dam and Permanent Weir	2	4	1	4	2	2	15
3. Ocean Outfall	4	5	3	5	2	3	22
4. Earthen Levee Across Lagoon Connection (Preferred Alternative)	1	1	1	2	2	1	8
5. High Flow Bypass in the J Street Drain Channel with Levee Across Lagoon Connection	2	2	1	3	2	1	11
6. Side Weir and Bypass Channel for High Flows	3	3	2	1	1	1	11

Scores: High values = high impacts (unfavorable). Low values = low impact (favorable). The ranking scores were assigned based on the number of rankings for each category, as presented in the text.

Appendix B

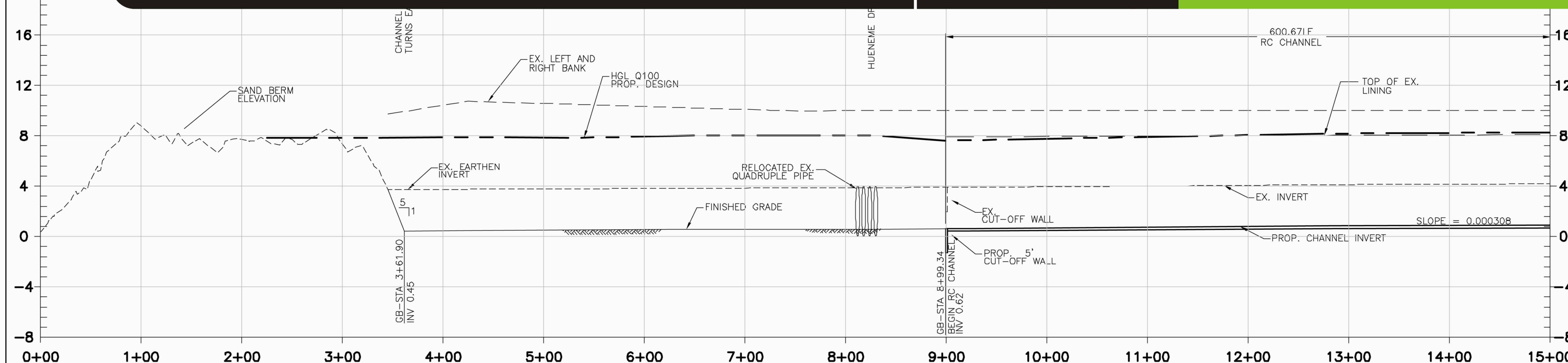
30% Complete Design Drawings

J Street Drain Project

Ventura County Watershed Protection District

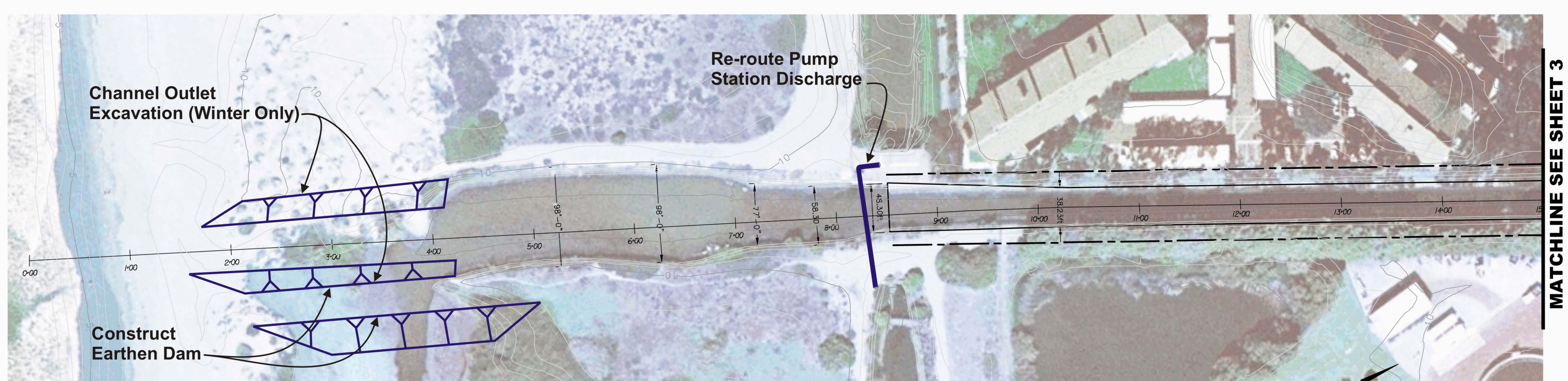
HDR — ONE COMPANY | *Many Solutions*

J Street Drain Outlet Alternative No. 4



PROFILE

SCALE: HORIZONTAL 1" = 50' VERTICAL 1" = 4'



PLAN

SCALE: 1" = 50'

SCALE: 1" = 50'

REVISION	DESCRIPTION	APP.	DATE
D			
C			
B			
A			

URS
2020 East First Street, Suite 400
Santa Ana, CA 92705
TEL: (714) 835-6886
FAX: (714) 973-4086

DESIGNED ____ DRAWN ____ CHECKED ____
PROJ. ENG. ____ RECOMMENDED ____
REG. NO. ____ DATE ____ APPROVED ____

COUNTY OF VENTURA - PUBLIC WORKS AGENCY
VENTURA COUNTY WATERSHED PROTECTION DISTRICT

SPEC. NO. SPEC
PROJ. NO. PROJ#

"J" STREET DRAIN CHANNEL IMPROVEMENT DESIGN
30% COMPLETION PRELIMINARY DESIGN
PLAN AND PROFILE STA. 0+00 TO STA. 15+00

SHEET 2 OF 12
DRAWING NO.

Appendix C

HEC-RAS Model Summary of Existing Channel

HEC-RAS Model Output for J-Street Drain

Existing Condition		(100-yr Flood)						
River Sta	Q	Min Ch	Water	Bank	Channel	As-built Chn	As-built Chn	Channel
	Total	Elevation	Surf. Elev.	Elevation	Velocity	Bottom Width	Top Width	Froude #
(ft)	(cfs)	(ft)	(ft)	(ft)	(ft/s)	(ft)	(ft)	
12855	880	19.88	24.49	23.88	7.95	19.5	27.75	0.73
12390	880	19.12	23.91	23.12	7.3	19.5	27.75	0.66
11925	880	18.4	23.86	22.4	5.49	19.5	27.75	0.46
11900	958	18.35	23.79	22.35	5.82	25	26	0.46
11899	Teakwood St							
11850	958	18.27	23.22	22.27	7.05	25	26	0.59
11825	958	18.23	22.89	22.23	8.19	25	26	0.76
11725	958	18.08	22.79	22.08	8.01	19.5	29.25	0.74
11325	958	17.45	21.94	21.45	8.89	19.5	29.25	0.84
10925	958	16.82	21.61	20.82	7.72	19.5	29.25	0.7
10525	958	16.19	21.54	20.19	6.05	19.5	29.25	0.51
10253	958	15.76	21.51	19.76	5.2	19.5	29.25	0.42
10228.5	958	15.72	21.47	19.72	5.49	22.5	22.5	0.41
10228	Yucca St							
10187	958	15.62	20.77	19.62	6.88	22.5	22.5	0.54
10162	1036	15.58	20.57	19.58	7.62	19.5	29.25	0.68
10125	1036	15.52	20.55	19.52	7.48	19.5	29.25	0.66
10070	1036	15.45	20.51	19.45	7.4	19.5	29.25	0.65
9621.7	1036	14.89	20.32	18.89	6.35	19.5	29.25	0.53
9173.4	1036	14.32	20.22	18.32	5.34	19.5	29.25	0.43
8725	1036	13.76	20.16	17.76	4.55	19.5	29.25	0.35
8469	1036	13.41	20.13	17.41	4.14	19.5	29.25	0.31
8444	1036	13.38	20.12	17.38	4.35	22.5	22.5	0.3
8443	Bard Rd							
8375	1036	13.35	19.56	17.35	5.1	22.5	22.5	0.36
8350	1605	13.31	18.77	17.31	8.8	23	32.75	0.73

Existing Condition		(100-yr Flood)						
River Sta	Q	Min Ch	Water	Bank	Channel	As-built Chn	As-built Chn	Channel
	Total	Elevation	Surf. Elev.	Elevation	Velocity	Bottom Width	Top Width	Froude #
(ft)	(cfs)	(ft)	(ft)	(ft)	(ft/s)	(ft)	(ft)	
8008.4	1605	12.84	18.55	16.84	8.04	23	32.75	0.65
7666.7	1605	12.36	18.42	16.36	7.16	23	32.75	0.56
7325	1605	11.89	18.34	15.89	6.39	23	32.75	0.48
6925	1605	11.34	18.26	15.34	5.61	23	32.75	0.4
6525	1605	10.78	18.22	14.78	4.95	23	32.75	0.34
6425	1605	10.64	18.23	14.64	4.51	23	32.75	0.31
6161	1605	10.27	18.21	14.27	4.19	23	32.75	0.28
6136	1775	10.24	18.15	14.24	4.72	31	31	0.3
6135	Pleasant Valley							
6094	1775	10.21	16.42	14.21	7.08	31	31	0.51
6069	1775	10.19	16.4	14.19	7.05	26	35.75	0.54
5659	1775	9.65	16.3	13.65	6.24	26	35.75	0.46
5249	1775	9.11	16.23	13.11	5.54	26	35.75	0.39
4839	1775	8.57	16.18	12.57	4.96	26	35.75	0.34
4814	1775	8.53	16.18	12.53	4.98	31	31	0.32
4813	Clara							
4772	1775	8.48	15.98	12.48	5.14	31	31	0.33
4747	1775	8.45	15.98	12.45	5.05	26	35.75	0.35
4347.7	1775	7.95	15.94	11.95	4.59	26	35.75	0.3
3948.4	1775	7.44	15.91	11.44	4.18	26	35.75	0.27
3549	1775	6.94	15.89	10.94	3.85	26	35.75	0.24
3524	1775	6.91	15.88	10.91	3.88	31	31	0.23
3523	Hueneme Rd							
3432	1775	6.79	15.09	10.79	4.37	31	31	0.27
3407	1775	6.76	14.79	10.76	5.78	28.5	38.25	0.38
3325	1775	6.67	14.78	10.67	5.71	28.5	38.25	0.37
2971.5	1775	6.27	14.73	10.26	5.42	28.5	38.25	0.35
2618	1775	5.86	14.69	9.86	5.14	28.5	38.25	0.32

Existing Condition		(100-yr Flood)						
River Sta	Q	Min Ch	Water	Bank	Channel	As-built Chn	As-built Chn	Channel
	Total	Elevation	Surf. Elev.	Elevation	Velocity	Bottom Width	Top Width	Froude #
(ft)	(cfs)	(ft)	(ft)	(ft)	(ft/s)	(ft)	(ft)	
2593	1775	4.83	14.75	9.83	4.45	36	36	0.25
2592	Railroad							
2521	1775	4.4	11.66	9.4	6.41	36	36	0.42
2496	1775	4.39	11.64	8.39	6.58	28.5	38.25	0.46
2125	1775	4.28	11.48	8.28	6.64	28.5	38.25	0.47
2045	1775	4.25	11.45	8.25	6.65	28.5	38.25	0.47
1920	1775	4.21	11.39	8.21	6.66	28.5	38.25	0.47
1795	1775	4.18	11.33	8.18	6.7	28.5	38.25	0.47
1670	1775	4.14	11.28	8.14	6.72	28.5	38.25	0.47
1285	1775	4.02	11.09	8.02	6.8	28.5	38.25	0.48
900	2059	3.9	10.26	7.9	9.06	28.5	38.25	0.68
825	2059	3.88	10.87	9.77	3.87	59	91	0.28
725	2059	3.85	10.86	10.01	3.35	77	97	0.24
625	2059	3.82	10.82	10.25	3.34	79	98	0.23
525	2059	3.78	10.7	10.49	3.9	59	98	0.3
425	2059	3.75	10.75	10.73	2.53	79	146.4	0.19
325	2059	3.72	10.72	9.43	2.66	79	146.4	0.19
225	2059	3.69	10.68	10.12	2.76	79	146.4	0.2
0	Beach edge							

Appendix D

HEC-RAS Model Summary of Improved Channel

HEC-RAS Model Output for J-Street Drain
Proposed Rectangular Channel Design
(100-yr flood)

River Sta	Q	Min Ch	Water	Bank	Channel	Wetted Chnl	Channel
	Total	Elevation	Surf. Elev.	Elevation	Velocity	Top Width	Froude #
(ft)	(cfs)	(ft)	(ft)	(ft)	(ft/s)	(ft)	
12855	880	17.94	21.99	23.88	7.83	27.75	0.69
12390	880	17.1	21.56	23.12	7.11	27.75	0.59
11925	880	16.27	21.28	22.4	6.32	27.75	0.5
11900	958	16.22	21.22	22.35	6.56	29.25	0.52
11899	Teakwood St						
11850	958	16.13	20	22.27	8.47	29.25	0.76
11825	958	16.09	19.96	22.23	8.46	29.25	0.76
11725	958	15.91	19.8	22.08	8.4	29.25	0.75
11325	958	15.19	19.28	21.45	8	29.25	0.7
10925	958	14.47	18.89	20.82	7.41	29.25	0.62
10525	958	13.75	18.61	20.19	6.73	29.25	0.54
10253	958	13.26	18.48	19.76	6.27	29.25	0.48
10228.5	958	13.21	18.47	19.72	6.23	29.25	0.48
10228	Yucca St						
10187	958	13.14	17.75	19.62	7.1	29.25	0.58
10162	1036	13.09	17.46	19.58	8.12	29.25	0.68
10125	1036	13.03	17.41	19.52	8.08	29.25	0.68
10070	1036	12.93	17.35	19.45	8.01	29.25	0.67
9621.7	1036	12.12	16.97	18.89	7.31	29.25	0.58
9173.4	1036	11.31	16.71	18.32	6.56	29.25	0.5
8725	1036	10.51	16.54	17.76	5.87	29.25	0.42
8469	1036	10.05	16.46	17.41	5.52	29.25	0.38
8444	1036	10	16.53	17.38	4.84	32.75	0.33
8443	Bard Rd						
8375	1036	9.9	16.24	17.35	4.99	32.75	0.35

River Sta	Q	Min Ch	Water	Bank	Channel	Wetted Chnl	Channel
	Total	Elevation	Surf. Elev.	Elevation	Velocity	Top Width	Froude #
(ft)	(cfs)	(ft)	(ft)	(ft)	(ft/s)	(ft)	
8350	1605	9.86	15.22	17.31	9.14	32.75	0.7
8008.4	1605	9.35	14.82	16.84	8.96	32.75	0.68
7666.7	1605	8.84	14.45	16.36	8.72	32.75	0.65
7325	1605	8.32	14.13	15.89	8.43	32.75	0.62
6925	1605	7.72	13.82	15.34	8.04	32.75	0.57
6525	1605	7.12	13.56	14.78	7.62	32.75	0.53
6425	1605	6.97	13.63	14.64	6.75	35.75	0.46
6161	1605	6.58	13.53	14.27	6.46	35.75	0.43
6136	1775	6.54	13.31	14.24	7.34	35.75	0.5
6135	Pleasant Valley						
6094	1775	6.48	12.27	14.21	8.56	35.75	0.63
6069	1775	6.44	12.25	14.19	8.54	35.75	0.62
5659	1775	5.82	11.93	13.65	8.13	35.75	0.58
5249	1775	5.21	11.67	13.11	7.68	35.75	0.53
4839	1775	4.59	11.46	12.57	7.23	35.75	0.49
4814	1775	4.56	11.45	12.53	7.2	35.75	0.48
4813	Clara						
4772	1775	4.49	10.54	12.48	8.21	35.75	0.59
4747	1775	4.46	10.52	12.45	8.19	35.75	0.59
4347.7	1775	3.86	10.26	11.95	7.76	35.75	0.54
3948.4	1775	3.26	10.04	11.44	7.32	35.75	0.5
3549	1775	2.66	9.87	10.94	6.88	35.75	0.45
3524	1775	2.62	9.94	10.91	6.34	38.25	0.41
3523	Hueneme Rd						
3432	1775	2.48	9.37	10.79	6.74	38.25	0.45
3407	1775	2.45	9.35	10.76	6.72	38.25	0.45
3325	1775	2.32	9.33	10.67	6.63	38.25	0.44
2971.5	1775	1.79	9.21	10.26	6.25	38.25	0.4
2618	1775	1.26	9.12	9.86	5.9	38.25	0.37

River Sta	Q	Min Ch	Water	Bank	Channel	Wetted Chnl	Channel
	Total	Elevation	Surf. Elev.	Elevation	Velocity	Top Width	Froude #
(ft)	(cfs)	(ft)	(ft)	(ft)	(ft/s)	(ft)	
2593	1775	1.22	9.12	9.83	5.88	38.25	0.37
2592	Railroad						
2521	1775	1.12	8.68	9.4	6.14	38.25	0.39
2496	1775	1.11	8.67	8.39	6.14	42	0.39
2125	1775	1	8.51	8.28	6.17	42	0.4
2045	1775	0.97	8.48	8.25	6.18	42	0.4
1920	1775	0.93	8.42	8.21	6.19	42	0.4
1795	1775	0.89	8.37	8.18	6.2	42	0.4
1670	1775	0.85	8.32	8.14	6.22	42	0.4
1285	1775	0.74	8.15	8.02	6.26	42	0.41
900	2059	0.62	7.59	7.9	7.72	38.25	0.52
825	2059	0.59	8	8.77	4.06	85.64	0.29
725	2059	0.59	8.01	10.01	3.4	88.99	0.23
625	2059	0.56	7.97	10.25	3.36	89.15	0.23
525	2059	0.5	7.79	10.49	4.28	78.09	0.3
425	2059	0.47	7.86	10.73	2.78	123.48	0.2
325	2059	0.44	7.83	9.43	2.85	117.59	0.2
225	2059	0.41	7.79	10.12	2.91	112.9	0.2
0	Beach edge						

HEC-RAS Model Output for J-Street Drain
Proposed Rectangular Channel Design
(50-yr flood)

River Sta	Q	Min Ch	Water	Bank	Channel	Wetted Chnl	Channel
	Total	Elevation	Surf. Elev.	Elevation	Velocity	Top Width	Froude #
(ft)	(cfs)	(ft)	(ft)	(ft)	(ft/s)	(ft)	
12855	723	17.94	21.44	23.88	7.44	27.75	0.7
12390	723	17.1	20.99	23.12	6.7	27.75	0.6
11925	723	16.27	20.71	22.4	5.86	27.75	0.49
11900	796	16.22	20.63	22.35	6.17	29.25	0.52
11899	Teakwood St						
11850	796	16.13	19.51	22.27	8.05	29.25	0.77
11825	796	16.09	19.47	22.23	8.04	29.25	0.77
11725	796	15.91	19.3	22.08	8.01	29.25	0.77
11325	796	15.19	18.72	21.45	7.7	29.25	0.72
10925	796	14.47	18.28	20.82	7.14	29.25	0.64
10525	796	13.75	17.98	20.19	6.43	29.25	0.55
10253	796	13.26	17.84	19.76	5.94	29.25	0.49
10228.5	796	13.21	17.83	19.72	5.9	29.25	0.48
10228	Yucca St						
10187	796	13.14	17.17	19.62	6.76	29.25	0.59
10162	869	13.09	16.84	19.58	7.94	29.25	0.72
10125	869	13.03	16.78	19.52	7.91	29.25	0.72
10070	869	12.93	16.71	19.45	7.86	29.25	0.71
9621.7	869	12.12	16.25	18.89	7.2	29.25	0.62
9173.4	869	11.31	15.95	18.32	6.41	29.25	0.52
8725	869	10.51	15.76	17.76	5.66	29.25	0.44
8469	869	10.05	15.68	17.41	5.27	29.25	0.39
8444	869	10	15.74	17.38	4.62	32.75	0.34
8443	Bard Rd						
8375	869	9.9	15.47	17.35	4.76	32.75	0.36
8350	1337	9.86	14.54	17.31	8.72	32.75	0.71

River Sta	Q	Min Ch	Water	Bank	Channel	Wetted Chnl	Channel
	Total	Elevation	Surf. Elev.	Elevation	Velocity	Top Width	Froude #
(ft)	(cfs)	(ft)	(ft)	(ft)	(ft/s)	(ft)	
8008.4	1337	9.35	14.11	16.84	8.58	32.75	0.69
7666.7	1337	8.84	13.71	16.36	8.37	32.75	0.67
7325	1337	8.32	13.36	15.89	8.1	32.75	0.64
6925	1337	7.72	13.02	15.34	7.71	32.75	0.59
6525	1337	7.12	12.74	14.78	7.26	32.75	0.54
6425	1337	6.97	12.8	14.64	6.42	35.75	0.47
6161	1337	6.58	12.7	14.27	6.11	35.75	0.43
6136	1485	6.54	12.49	14.24	6.98	35.75	0.5
6135	Pleasant Valley						
6094	1485	6.48	11.49	14.21	8.29	35.75	0.65
6069	1485	6.44	11.46	14.19	8.27	35.75	0.65
5659	1485	5.82	11.1	13.65	7.87	35.75	0.6
5249	1485	5.21	10.81	13.11	7.41	35.75	0.55
4839	1485	4.59	10.59	12.57	6.93	35.75	0.5
4814	1485	4.56	10.58	12.53	6.9	35.75	0.5
4813	Clara						
4772	1485	4.49	9.67	12.48	8.03	35.75	0.62
4747	1485	4.46	9.65	12.45	8	35.75	0.62
4347.7	1485	3.86	9.34	11.95	7.57	35.75	0.57
3948.4	1485	3.26	9.11	11.44	7.1	35.75	0.52
3549	1485	2.66	8.92	10.94	6.63	35.75	0.47
3524	1479	2.62	8.98	10.91	6.08	38.25	0.42
3523	Hueneme Rd						
3432	1479	2.48	8.44	10.79	6.5	38.25	0.47
3407	1479	2.45	8.42	10.76	6.47	38.25	0.47
3325	1479	2.32	8.39	10.67	6.37	38.25	0.46
2971.5	1479	1.79	8.27	10.26	5.96	38.25	0.41
2618	1479	1.26	8.18	9.86	5.59	38.25	0.37
2593	1479	1.22	8.17	9.83	5.56	38.25	0.37

River Sta	Q	Min Ch	Water	Bank	Channel	Wetted Chnl	Channel
	Total	Elevation	Surf. Elev.	Elevation	Velocity	Top Width	Froude #
(ft)	(cfs)	(ft)	(ft)	(ft)	(ft/s)	(ft)	
2592	Railroad						
2521	1479	1.12	7.78	9.4	5.8	38.25	0.4
2496	1479	1.11	7.77	8.39	5.81	38.25	0.4
2125	1479	1	7.61	8.28	5.85	38.25	0.4
2045	1479	0.97	7.57	8.25	5.86	38.25	0.4
1920	1479	0.93	7.52	8.21	5.87	38.25	0.4
1795	1479	0.89	7.46	8.18	5.89	38.25	0.4
1670	1479	0.85	7.4	8.14	5.9	38.25	0.41
1285	1479	0.74	7.22	8.02	5.96	38.25	0.41
900	1649	0.62	6.79	7.9	6.98	38.25	0.49
825	1649	0.59	7.12	8.77	3.8	79.44	0.29
725	1649	0.59	7.12	10.01	3.13	86.33	0.22
625	1649	0.56	7.08	10.25	3.09	86.5	0.22
525	1649	0.5	6.93	10.49	3.96	70.71	0.29
425	1649	0.47	6.98	10.73	2.6	116.4	0.2
325	1649	0.44	6.95	9.43	2.65	111.95	0.2
225	1649	0.41	6.91	10.12	2.7	108.85	0.2
0	Beach edge						

HEC-RAS Model Output for J-Street Drain
Proposed Rectangular Channel Design
(10-yr flood)

River Sta	Q	Min Ch	Water	Bank	Channel	Wetted Chnl	Channel
	Total	Elevation	Surf. Elev.	Elevation	Velocity	Top Width	Froude #
(ft)	(cfs)	(ft)	(ft)	(ft)	(ft/s)	(ft)	
12855	555	17.94	20.8	23.88	7	27.75	0.73
12390	555	17.1	20.28	23.12	6.3	27.75	0.62
11925	555	16.27	19.99	22.4	5.38	27.75	0.49
11900	611	16.22	19.92	22.35	5.65	29.25	0.52
11899	Teakwood St						
11850	611	16.13	18.95	22.27	7.41	29.25	0.78
11825	611	16.09	18.91	22.23	7.4	29.25	0.78
11725	611	15.91	18.73	22.08	7.39	29.25	0.78
11325	611	15.19	18.08	21.45	7.23	29.25	0.75
10925	611	14.47	17.55	20.82	6.77	29.25	0.68
10525	611	13.75	17.21	20.19	6.03	29.25	0.57
10253	611	13.26	17.06	19.76	5.5	29.25	0.5
10228.5	611	13.21	17.05	19.72	5.45	29.25	0.49
10228	Yucca St						
10187	611	13.14	16.45	19.62	6.31	29.25	0.61
10162	667	13.09	16.13	19.58	7.5	29.25	0.76
10125	667	13.03	16.07	19.52	7.49	29.25	0.76
10070	667	12.93	15.98	19.45	7.47	29.25	0.75
9621.7	667	12.12	15.4	18.89	6.96	29.25	0.68
9173.4	667	11.31	15.03	18.32	6.14	29.25	0.56
8725	667	10.51	14.81	17.76	5.3	29.25	0.45
8469	667	10.05	14.73	17.41	4.87	29.25	0.4
8444	667	10	14.78	17.38	4.26	32.75	0.34
8443	Bard Rd						
8375	667	9.9	14.55	17.35	4.38	32.75	0.36
8350	1026	9.86	13.75	17.31	8.06	32.75	0.72

8008.4	1026	9.35	13.28	16.84	7.96	32.75	0.71
7666.7	1026	8.84	12.85	16.36	7.8	32.75	0.69
7325	1026	8.32	12.47	15.89	7.55	32.75	0.65
6925	1026	7.72	12.1	15.34	7.15	32.75	0.6
6525	1026	7.12	11.81	14.78	6.68	32.75	0.54
6425	1026	6.97	11.86	14.64	5.88	35.75	0.47
6161	1026	6.58	11.76	14.27	5.54	35.75	0.43
6136	1150	6.54	11.57	14.24	6.4	35.75	0.5
6135	Pleasant Valley						
6094	1150	6.48	10.73	14.21	7.56	35.75	0.65
6069	1150	6.44	10.71	14.19	7.54	35.75	0.64
5659	1150	5.82	10.37	13.65	7.08	35.75	0.59
5249	1150	5.21	10.11	13.11	6.57	35.75	0.52
4839	1150	4.59	9.92	12.57	6.04	35.75	0.46
4814	1150	4.56	9.9	12.53	6.02	35.75	0.46
4813	Clara						
4772	1150	4.49	9.33	12.48	6.65	35.75	0.53
4747	1150	4.46	9.31	12.45	6.62	35.75	0.53
4347.7	1150	3.86	9.12	11.95	6.12	35.75	0.47
3948.4	1150	3.26	8.97	11.44	5.63	35.75	0.41
3549	1150	2.66	8.86	10.94	5.18	35.75	0.37
3524	1145	2.62	8.9	10.91	4.77	38.25	0.34
3523	Hueneme Rd						
3432	1145	2.48	8.62	10.79	4.88	38.25	0.35
3407	1145	2.45	8.62	10.76	4.85	38.25	0.34
3325	1145	2.32	8.6	10.67	4.77	38.25	0.34
2971.5	1145	1.79	8.54	10.26	4.44	38.25	0.3
2618	1145	1.26	8.49	9.86	4.14	38.25	0.27
2593	1145	1.22	8.49	9.83	4.12	38.25	0.27
2592	Railroad						
2521	1145	1.12	8.31	9.4	4.16	38.25	0.27
2496	1145	1.11	8.31	8.39	4.16	38.25	0.27

2125	1145	1	8.24	8.28	4.13	38.25	0.27
2045	1145	0.97	8.22	8.25	4.13	38.25	0.27
1920	1145	0.93	8.2	8.21	4.12	38.25	0.27
1795	1145	0.89	8.17	8.18	4.11	38.25	0.27
1670	1145	0.85	8.15	8.14	4.1	42	0.27
1285	1145	0.74	8.08	8.02	4.07	42	0.26
900	1277	0.62	7.93	7.9	4.56	42	0.3
825	1277	0.59	8.07	8.77	2.49	86.12	0.18
725	1277	0.59	8.07	10.01	2.09	89.26	0.14
625	1277	0.56	8.06	10.25	2.06	89.43	0.14
525	1277	0.5	8	10.49	2.57	79.84	0.18
425	1277	0.47	8.03	10.73	1.68	124.76	0.12
325	1277	0.44	8.01	9.43	1.72	119.06	0.12
225	1277	0.41	8	10.12	1.74	113.85	0.12
0	Beach edge						

HEC-RAS Model Output for J-Street Drain
Proposed Rectangular Channel Design
(2-yr flood)

River Sta	Q	Minimum Ch	Water	Bank	Channel	Wetted Chnl	Channel
	Total	Elevation	Surf. Elev.	Elevation	Velocity	Top Width	Froude #
(ft)	(cfs)	(ft)	(ft)	(ft)	(ft/s)	(ft)	
12855	239	17.94	19.54	23.88	5.38	27.75	0.75
12390	239	17.1	18.76	23.12	5.19	27.75	0.71
11925	239	16.27	18.38	22.4	4.07	27.75	0.49
11900	263	16.22	18.34	22.35	4.25	29.25	0.52
11899	Teakwood St						
11850	263	16.13	17.78	22.27	5.46	29.25	0.75
11825	263	16.09	17.73	22.23	5.46	29.25	0.75
11725	263	15.91	17.55	22.08	5.46	29.25	0.75
11325	263	15.19	16.83	21.45	5.46	29.25	0.75
10925	263	14.47	16.12	20.82	5.43	29.25	0.74
10525	263	13.75	15.6	20.19	4.84	29.25	0.63
10253	263	13.26	15.41	19.76	4.18	29.25	0.5
10228.5	263	13.21	15.39	19.72	4.12	29.25	0.49
10228	Yucca St						
10187	263	13.14	15.03	19.62	4.75	29.25	0.61
10162	287	13.09	14.84	19.58	5.62	29.25	0.75
10125	287	13.03	14.77	19.52	5.62	29.25	0.75
10070	287	12.93	14.67	19.45	5.63	29.25	0.75
9621.7	287	12.12	13.86	18.89	5.66	29.25	0.76
9173.4	287	11.31	13.14	18.32	5.38	29.25	0.7
8725	287	10.51	12.77	17.76	4.34	29.25	0.51
8469	287	10.05	12.66	17.41	3.75	29.25	0.41
8444	287	10	12.69	17.38	3.26	32.75	0.35
8443	Bard Rd						
8375	287	9.9	12.55	17.35	3.3	32.75	0.36
8350	442	9.86	12.1	17.31	6.03	32.75	0.71

River Sta	Q	Minimum Ch	Water	Bank	Channel	Wetted Chnl	Channel
	Total	Elevation	Surf. Elev.	Elevation	Velocity	Top Width	Froude #
(ft)	(cfs)	(ft)	(ft)	(ft)	(ft/s)	(ft)	
8008.4	442	9.35	11.59	16.84	6.02	32.75	0.71
7666.7	442	8.84	11.08	16.36	6.01	32.75	0.71
7325	442	8.32	10.58	15.89	5.97	32.75	0.7
6925	442	7.72	10.05	15.34	5.79	32.75	0.67
6525	442	7.12	9.64	14.78	5.36	32.75	0.59
6425	442	6.97	9.63	14.64	4.65	35.75	0.5
6161	442	6.58	9.51	14.27	4.21	35.75	0.43
6136	487	6.54	9.42	14.24	4.73	35.75	0.49
6135	Pleasant Valley						
6094	487	6.48	8.98	14.21	5.44	35.75	0.6
6069	487	6.44	8.96	14.19	5.4	35.75	0.6
5659	487	5.82	8.69	13.65	4.76	35.75	0.5
5249	487	5.21	8.53	13.11	4.1	35.75	0.4
4839	487	4.59	8.43	12.57	3.55	35.75	0.32
4814	487	4.56	8.43	12.53	3.52	35.75	0.31
4813	Clara						
4772	487	4.49	8.29	12.48	3.59	35.75	0.32
4747	487	4.46	8.29	12.45	3.56	35.75	0.32
4347.7	487	3.86	8.23	11.95	3.12	35.75	0.26
3948.4	487	3.26	8.19	11.44	2.76	35.75	0.22
3549	487	2.66	8.16	10.94	2.47	35.75	0.19
3524	485	2.62	8.17	10.91	2.28	38.25	0.17
3523	Hueneme Rd						
3432	485	2.48	8.12	10.79	2.25	38.25	0.17
3407	485	2.45	8.12	10.76	2.24	38.25	0.17
3325	485	2.32	8.11	10.67	2.19	38.25	0.16
2971.5	485	1.79	8.1	10.26	2.01	38.25	0.14
2618	485	1.26	8.09	9.86	1.86	38.25	0.13
2593	485	1.22	8.09	9.83	1.85	38.25	0.12

River Sta	Q	Minimum Ch	Water	Bank	Channel	Wetted Chnl	Channel
	Total	Elevation	Surf. Elev.	Elevation	Velocity	Top Width	Froude #
(ft)	(cfs)	(ft)	(ft)	(ft)	(ft/s)	(ft)	
2592	Railroad						
2521	485	1.12	8.06	9.4	1.83	38.25	0.12
2496	485	1.11	8.05	8.39	1.83	38.25	0.12
2125	485	1	8.04	8.28	1.8	38.25	0.12
2045	485	0.97	8.04	8.25	1.79	38.25	0.12
1920	485	0.93	8.03	8.21	1.79	38.25	0.12
1795	485	0.89	8.03	8.18	1.78	38.25	0.12
1670	485	0.85	8.03	8.14	1.77	38.25	0.12
1285	485	0.74	8.01	8.02	1.74	38.25	0.11
900	541	0.62	7.99	7.9	1.92	42	0.12
825	541	0.59	8.01	8.77	1.06	85.7	0.08
725	541	0.59	8.01	10.01	0.89	89.01	0.06
625	541	0.56	8.01	10.25	0.88	89.28	0.06
525	541	0.5	8	10.49	1.09	79.84	0.08
425	541	0.47	8	10.73	0.71	124.6	0.05
325	541	0.44	8	9.43	0.73	118.98	0.05
225	541	0.41	8	10.12	0.74	113.85	0.05
0	Beach edge						

HEC-RAS Model Output for J-Street Drain
Freeboard Calculation
(50-yr flood)

River Sta	Q	Min Ch	Water	Bank	Channel	Wetted Chnl	Channel	Froude #	Flow	H3	H4	Total H	Depth+	50-yr WSE+	100-yr W.S.
	Total	Elevation	Surf. Elev.	Elevation	Velocity	Top Width	Froude #	Square	Depth	Super-Elev	Residual	FB	FB	FB	FB
(ft)	(cfs)	(ft)	(ft)	(ft)	(ft/s)	(ft)		F^2	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)
12855	723	17.94	21.44	23.88	7.44	27.75	0.7	0.49	3.5		0.85	0.85	4.35	22.29	21.99
12390	723	17.1	20.99	23.12	6.7	27.75	0.6	0.36	3.89		0.889	0.89	4.78	21.88	21.56
11925	723	16.27	20.71	22.4	5.86	27.75	0.49	0.24	4.44		0.944	0.94	5.38	21.65	21.28
11900	796	16.22	20.63	22.35	6.17	29.25	0.52	0.27	4.41		0.941	0.94	5.35	21.57	21.22
11899	Teakwood St														
11850	796	16.13	19.51	22.27	8.05	29.25	0.77	0.59	3.38		0.838	0.84	4.22	20.35	20
11825	796	16.09	19.47	22.23	8.04	29.25	0.77	0.59	3.38		0.838	0.84	4.22	20.31	19.96
11725	796	15.91	19.3	22.08	8.01	29.25	0.77	0.59	3.39		0.839	0.84	4.23	20.14	19.8
11325	796	15.19	18.72	21.45	7.7	29.25	0.72	0.52	3.53		0.853	0.85	4.38	19.57	19.28
10925	796	14.47	18.28	20.82	7.14	29.25	0.64	0.41	3.81		0.881	0.88	4.69	19.16	18.89
10525	796	13.75	17.98	20.19	6.43	29.25	0.55	0.30	4.23		0.923	0.92	5.15	18.90	18.61
10253	796	13.26	17.84	19.76	5.94	29.25	0.49	0.24	4.58		0.958	0.96	5.54	18.80	18.48
10228.5	796	13.21	17.83	19.72	5.9	29.25	0.48	0.23	4.62		0.962	0.96	5.58	18.79	18.47
10228	Yucca St														
10187	796	13.14	17.17	19.62	6.76	29.25	0.59	0.35	4.03		0.903	0.90	4.93	18.07	17.75
10162	869	13.09	16.84	19.58	7.94	29.25	0.72	0.52	3.75		0.875	0.88	4.63	17.72	17.46
10125	869	13.03	16.78	19.52	7.91	29.25	0.72	0.52	3.75		0.875	0.88	4.63	17.66	17.41
10070	869	12.93	16.71	19.45	7.86	29.25	0.71	0.50	3.78		0.878	0.88	4.66	17.59	17.35
9621.7	869	12.12	16.25	18.89	7.2	29.25	0.62	0.38	4.13		0.913	0.91	5.04	17.16	16.97
9173.4	869	11.31	15.95	18.32	6.41	29.25	0.52	0.27	4.64		0.964	0.96	5.60	16.91	16.71
8725	869	10.51	15.76	17.76	5.66	29.25	0.44	0.19	5.25		1.025	1.03	6.28	16.79	16.54
8469	869	10.05	15.68	17.41	5.27	29.25	0.39	0.15	5.63		1.063	1.06	6.69	16.74	16.46
8444	869	10	15.74	17.38	4.62	32.75	0.34	0.12	5.74		1.074	1.07	6.81	16.81	16.53
8443	Bard Rd														

River Sta	Q	Min Ch	Water	Bank	Channel	Wetted Chnl	Channel	Froude #	Flow	H3	H4	Total H	Depth+	50-yr WSE+	100-yr W.S.
	Total	Elevation	Surf. Elev.	Elevation	Velocity	Top Width	Froude #	Square	Depth	Super-Elev	Residual	FB	FB	FB	FB
(ft)	(cfs)	(ft)	(ft)	(ft)	(ft/s)	(ft)		F^2	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)
8375	869	9.9	15.47	17.35	4.76	32.75	0.36	0.13	5.57		1.057	1.06	6.63	16.53	16.24
8350	1337	9.86	14.54	17.31	8.72	32.75	0.71	0.50	4.68		0.968	0.97	5.65	15.51	15.22
8008.4	1337	9.35	14.11	16.84	8.58	32.75	0.69	0.48	4.76		0.976	0.98	5.74	15.09	14.82
7666.7	1337	8.84	13.71	16.36	8.37	32.75	0.67	0.45	4.87		0.987	0.99	5.86	14.70	14.45
7325	1337	8.32	13.36	15.89	8.1	32.75	0.64	0.41	5.04		1.004	1.00	6.04	14.36	14.13
6925	1337	7.72	13.02	15.34	7.71	32.75	0.59	0.35	5.3		1.03	1.03	6.33	14.05	13.82
6525	1337	7.12	12.74	14.78	7.26	32.75	0.54	0.29	5.62		1.062	1.06	6.68	13.80	13.56
6425	1337	6.97	12.8	14.64	6.42	35.75	0.47	0.22	5.83		1.083	1.08	6.91	13.88	13.63
6161	1337	6.58	12.7	14.27	6.11	35.75	0.43	0.18	6.12		1.112	1.11	7.23	13.81	13.53
6136	1485	6.54	12.49	14.24	6.98	35.75	0.5	0.25	5.95		1.095	1.10	7.05	13.59	13.31
6135	Pleasant Valley														
6094	1485	6.48	11.49	14.21	8.29	35.75	0.65	0.42	5.01		1.001	1.00	6.01	12.49	12.27
6069	1485	6.44	11.46	14.19	8.27	35.75	0.65	0.42	5.02		1.002	1.00	6.02	12.46	12.25
5659	1485	5.82	11.1	13.65	7.87	35.75	0.6	0.36	5.28		1.028	1.03	6.31	12.13	11.93
5249	1485	5.21	10.81	13.11	7.41	35.75	0.55	0.30	5.6		1.06	1.06	6.66	11.87	11.67
4839	1485	4.59	10.59	12.57	6.93	35.75	0.5	0.25	6		1.1	1.10	7.10	11.69	11.46
4814	1485	4.56	10.58	12.53	6.9	35.75	0.5	0.25	6.02		1.102	1.10	7.12	11.68	11.45
4813	Clara														
4772	1485	4.49	9.67	12.48	8.03	35.75	0.62	0.38	5.18		1.018	1.02	6.20	10.69	10.54
4747	1485	4.46	9.65	12.45	8	35.75	0.62	0.38	5.19		1.019	1.02	6.21	10.67	10.52
4347.7	1485	3.86	9.34	11.95	7.57	35.75	0.57	0.32	5.48		1.048	1.05	6.53	10.39	10.26
3948.4	1485	3.26	9.11	11.44	7.1	35.75	0.52	0.27	5.85		1.085	1.09	6.94	10.20	10.04
3549	1485	2.66	8.92	10.94	6.63	35.75	0.47	0.22	6.26		1.126	1.13	7.39	10.05	9.87
3524	1479	2.62	8.98	10.91	6.08	38.25	0.42	0.18	6.36		1.136	1.14	7.50	10.12	9.94
3523	Hueneme Rd														
3432	1479	2.48	8.44	10.79	6.5	38.25	0.47	0.22	5.96		1.096	1.10	7.06	9.54	9.37
3407	1479	2.45	8.42	10.76	6.47	38.25	0.47	0.22	5.97		1.097	1.10	7.07	9.52	9.35

River Sta	Q	Min Ch	Water	Bank	Channel	Wetted Chnl	Channel	Froude #	Flow	H3	H4	Total H	Depth+	50-yr WSE+	100-yr W.S.
	Total	Elevation	Surf. Elev.	Elevation	Velocity	Top Width	Froude #	Square	Depth	Super-Elev	Residual	FB	FB	FB	FB
(ft)	(cfs)	(ft)	(ft)	(ft)	(ft/s)	(ft)		F^2	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)
3325	1479	2.32	8.39	10.67	6.37	38.25	0.46	0.21	6.07		1.107	1.11	7.18	9.50	9.33
2971.5	1479	1.79	8.27	10.26	5.96	38.25	0.41	0.17	6.48		1.148	1.15	7.63	9.42	9.21
2618	1479	1.26	8.18	9.86	5.59	38.25	0.37	0.14	6.92		1.192	1.19	8.11	9.37	9.12
2593	1479	1.22	8.17	9.83	5.56	38.25	0.37	0.14	6.95		1.195	1.20	8.15	9.37	9.12
2592	Railroad														
2521	1479	1.12	7.78	10	5.8	38.25	0.4	0.16	6.66	0.0488	1.166	1.21	7.87	8.99	8.68
2496	1479	1.11	7.77	10	5.81	38.25	0.4	0.16	6.66	0.0490	1.166	1.21	7.87	8.98	8.67
2125	1479	1	7.61	10	5.85	38.25	0.4	0.16	6.61	0.0496	1.161	1.21	7.82	8.82	8.51
2045	1479	0.97	7.57	10	5.86	38.25	0.4	0.16	6.6	0.0498	1.16	1.21	7.81	8.78	8.48
1920	1479	0.93	7.52	10	5.87	38.25	0.4	0.16	6.59	0.0500	1.159	1.21	7.80	8.73	8.42
1795	1479	0.89	7.46	10	5.89	38.25	0.4	0.16	6.57	0.0503	1.157	1.21	7.78	8.67	8.37
1670	1479	0.85	7.4	10	5.9	38.25	0.41	0.17	6.55	0.0505	1.155	1.21	7.76	8.61	8.32
1285	1479	0.74	7.22	10	5.96	38.25	0.41	0.17	6.48	0.0515	1.148	1.20	7.68	8.42	8.15
900	1649	0.62	6.79	10	6.98	38.25	0.49	0.24	6.17	0.0707	1.117	1.19	7.36	7.98	7.59
825	1649	0.59	7.12	10	3.8	79.44	0.29	0.08	6.53		1.153	1.15	7.68	8.27	8
725	1649	0.59	7.12	10.01	3.13	86.33	0.22	0.05	6.53		1.153	1.15	7.68	8.27	8.01
625	1649	0.56	7.08	10.25	3.09	86.5	0.22	0.05	6.52		1.152	1.15	7.67	8.23	7.97
525	1649	0.5	6.93	10.49	3.96	70.71	0.29	0.08	6.43		1.143	1.14	7.57	8.07	7.79
425	1649	0.47	6.98	10.73	2.6	116.4	0.2	0.04	6.51		1.151	1.15	7.66	8.13	7.86
325	1649	0.44	6.95	9.43	2.65	111.95	0.2	0.04	6.51		1.151	1.15	7.66	8.10	7.83
225	1649	0.41	6.91	10.12	2.7	108.85	0.2	0.04	6.5		1.15	1.15	7.65	8.06	7.79
0	Beach edge														