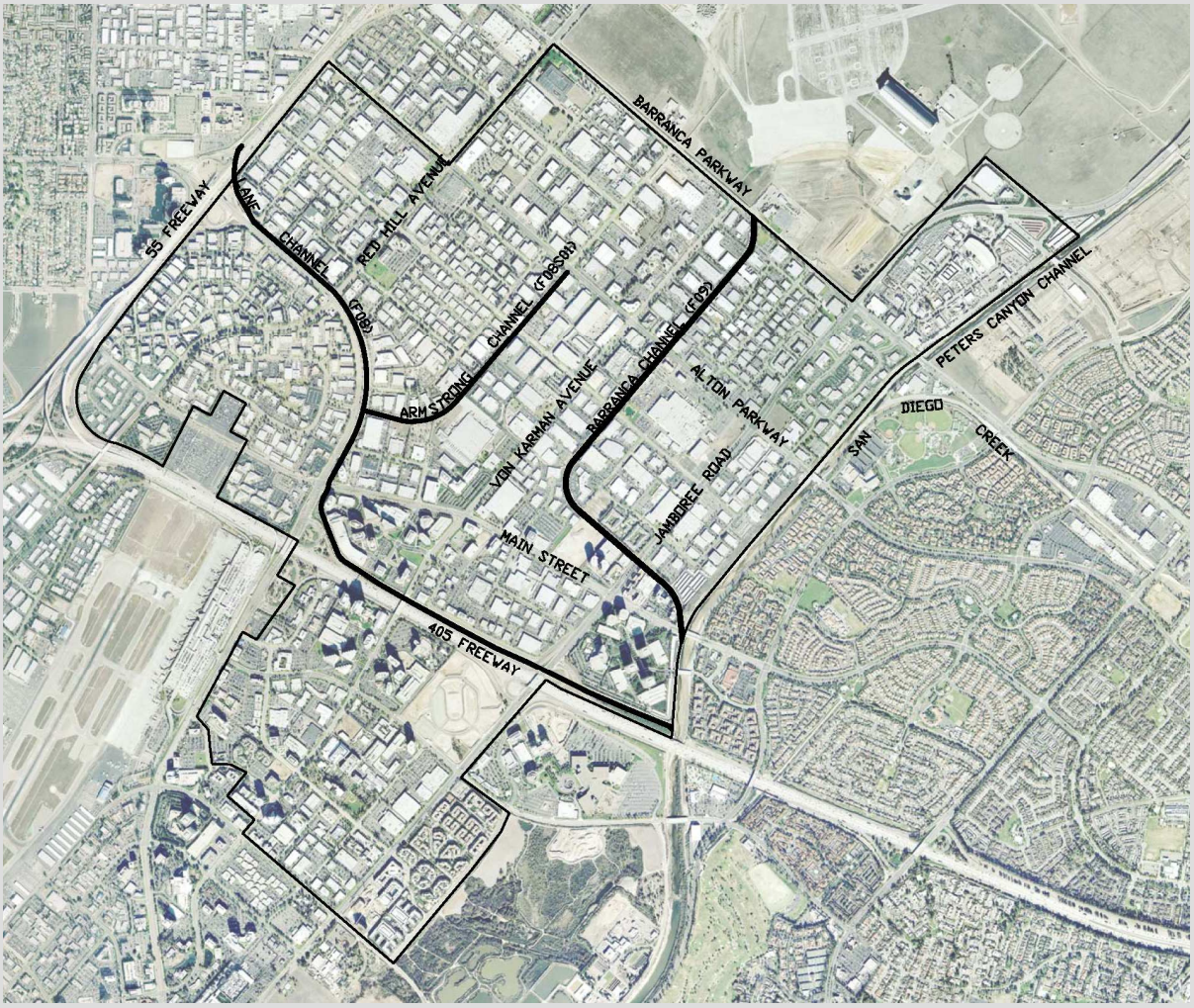
CITY OF IRVINE

PUBLIC WORKS DEPARTMENT

IRVINE BUSINESS COMPLEX (IBC)
MASTER DRAINAGE STUDY UPDATE



VA CONSULTING, INC.
Orange County Division / Corporate Office
6400 Oak Canyon, Suite 150
Irvine, CA 92618
949.474.1400
www.vaconsultinginc.com

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CITY OF IRVINE

IRVINE BUSINESS COMPLEX
MASTER DRAINAGE STUDY UPDATE

April 2009

Prepared for:

City of Irvine
1 Civic Center Plaza
Irvine, California 92623

Prepared by:

VA Consulting, Inc.
6400 Oak Canyon, Suite 150
Irvine, CA. 92618

CONSULTING

Table of Contents

1. INTRODUCTION

1.1 Background

Irvine Business Complex (IBC) is a business-concentrated area located in the City of Irvine (City), Orange County, California. IBC is bounded on the north by Alton Parkway, Barranca Parkway, and Warner Ave, which follow the City of Irvine/Tustin boundaries. It is bounded on the west by the Costa Mesa Freeway (SR-55 Freeway), on the east by San Diego Creek (F05), on the south by the San Diego Freeway (I-405 Freeway). A portion of the area south of the I-405 Freeway (bounded by Campus Drive to the south, Jamboree Road on the east and MacArthur Blvd on the west) is also included as part of this study. See Figure 1 Vicinity Map.

Since the early development of the IBC and the corresponding construction of the existing flood control facilities within this area, the methodology for analyzing storm water runoff in the County of Orange, has changed. In addition, the City has implemented a new general plan amendment, changing the characteristic development traits of the IBC area. Current zoning allows some properties to be redeveloped as residential developments. With several residential projects under construction, there is some concern as to the amount of flood protection provided to local property owners adjacent to the regional flood control facilities within the IBC.

The existing condition of the IBC consists of mostly commercial buildings, office buildings and warehouses with a few residential high rise condominiums. There are three regional flood control drainage channels located within the IBC – Lane Channel (F08), Armstrong Channel (F08S01) and Barranca Channel (F09). The majority of the IBC local drainage systems discharge to one of these three regional facilities and eventually confluence with San Diego Creek (F05).

1.2 Purpose of Report

The purpose of this report is to review available drainage information and evaluate the current level of flood protection provided by the three regional flood control facilities, Lane Channel (F08), Armstrong Channel (F08S01) and Barranca Channel (F09). The evaluation will be based upon the latest Orange County Hydrology Manual methodology and the updated land use plan within the tributary watersheds. This report will also categorize and list problem areas associated with deficiencies in the existing regional drainage infrastructure and recommend possible solutions to improve the level of protection where deficiencies exist. Lastly, this report will prioritize projects based on the highest degree of need and prepare project cost estimates for the projects identified and develop a priority rating system with three categories: short term (5 years), medium term (10 years), and long term (20 years).

1.3 Assumptions

The hydraulic analyses contain in this report assume that the 100-year high confidence flow rate in San Diego Creek (F05) results in a maximum water surface

elevation at 1.5 feet below the top of the banks. This assumption was used to determine the downstream tie-in water surface elevations for Lane Channel (F08) and Barranca Channel (F09). The top of the east bank elevation is 35.8 feet at station 159+30 (San Diego Creek and Lane Channel confluence point, reference OCFCD DWG No. F05-701-10 sheet 7 and OC Engineering's survey data). The top of the west bank elevation is 37.9 feet at station 172+59 (San Diego Creek and Barranca Channel confluence point, reference OCFCD DWG No. F05-701-11 and OC Engineering's survey data). It is also assumes that a 100-year expected value flow rate is the design flow rate for Armstrong Channel (F08S01) given that the downstream facility, Lane Channel, was designed to convey the 100-year expected value design flow rate for this facility. See Section 3.1.2 for further information.

2. REGIONAL FLOOD CONTROL FACILITIES DESCRIPTIONS

2.1 Lane Channel (F08)

Lane Channel is an earthen trapezoidal channel from its confluence with San Diego Creek immediately upstream of the I-405 Freeway and continues upstream and parallel to the I-405 freeway until it reaches the MacArthur Blvd off-ramp. At MacArthur Blvd, the channel transitions into a triple Reinforced Concrete Box (RCB) and turns northerly to run along MacArthur Boulevard until it crosses Main Street. After crossing Main Street, it transitions back from triple RCB to a concrete lined rectangular channel and continues along MacArthur Boulevard. The rectangular channel continues north until it reaches SR-55 Freeway, and crosses underneath the freeway as double RCB. This facility then transitions to an earthen trapezoidal channel that runs parallel to the westerly side of the freeway. See Figure 2, Regional Flood Control Facilities Location Map.

A portion of the Lane Channel from approximately 1,000 feet south of Red Hill Avenue to approximately 1,200 feet north of Red Hill Avenue has recently been improved as part of the MacArthur Boulevard and Red Hill Avenue intersection widening project. The proposed improvements include constructing an earthen bottom rectangular channel with concrete retaining walls to replace an earthen trapezoidal section and the extension of the existing triple RCB culvert for the widening of the intersection.

2.2 Armstrong Channel (F08S01)

Armstrong Channel is a riprap lined trapezoidal channel that discharges into Lane Channel approximately 360 feet downstream of Armstrong Avenue. In general, Armstrong Channel extends upstream from Lane Channel and parallel to Armstrong Avenue, crosses McGaw Avenue and continues upstream to Alton Parkway. See Figure 2, Regional Flood Control Facilities Location Map.

2.3 Barranca Channel (F09)

Barranca Channel confluences with San Diego Creek Channel at Main Street, approximately 1,800 feet upstream of the Lane Channel confluence. From there it continues upstream and to the northwest in a riprap lined trapezoidal soft bottom section, crosses Jamboree Road in a double RCB, then transitions into an earthen trapezoidal channel that parallels to Kelvin Avenue. This facility continues parallel to Kelvin Avenue for approximately 1,350 feet before curving northeasterly at the AT&SF railroad crossing. It then continues north, parallel to Von Karman Avenue until it reaches Barranca Parkway. The channel then continues upstream along northerly side of Barranca Parkway, south of the new Tustin Legacy development, as a riprap lined channel until it reaches Red Hill Avenue. The riprap lined trapezoidal section then transitions into RCB and turns northeasterly to continue upstream along Red Hill Avenue. See Figure 2, Regional Flood Control Facilities Location Map.

3. PREVIOUS STUDIES AND REPORTS

3.1 Lane Channel (F08) and Armstrong Channel (F08S01)

3.1.1 San Diego Creek Through Newport Highway (July 1974) by OCFCD

This report was prepared to examine the diversion of drainage areas from the Santa Ana-Delhi Channel watershed to the Lane Channel facility. The report recommended the diversion of 310 acres of area located to the north of MacArthur Boulevard and to the east of Main Street to the Lane Channel system. This report also recommended design water surfaces and the channel sections needed to establish a water surface profile for the facility. The report contains flow rates and drainage areas for Lane Channel Michelson Storm Drain (F08P07) to San Diego Creek (F05).

3.1.2 Hydrology Report for Lane Channel Entire Drainage System –Facility No. F08 (July 2002) by OCPFRD

This report was prepared to study the 100-year design discharges for Lane Channel (F08) and to update those discharges based on Addendum No.1 to the 1986 Orange County Hydrology Manual. This report also incorporated recent improvements that have been constructed within portions of Lane Channel. This report calculated 100-year expected value peak discharges and included a memo dated June 14, 2002 from H.I. Nakasone to Kenneth R. Smith that recommended the usage of 100-year expected value (50% confidence interval) design discharges for reasons listed below:

- Lane Channel was constructed in 1966 to convey 65% of the 25-year discharge per previous hydrologic criteria. This has been superseded by the County's Hydrology Manual and Addendum No. 1.
- Widening of the channel to accommodate 100-year high confidence discharge would be difficult, expensive and disruptive to neighboring communities. 100-year expected value capacity facilities are capable of being constructed within the existing right-of-way for Lane Channel.
- A 100-year expected value for Lane Channel hydrology study was generated in 1991 for planning purposes in response to a request from Caltrans to design improvements along MacArthur Boulevard, the San Diego Freeway (SH-73) and the Newport/Costa Mesa Freeway (I-55).
- Approximately 2,100 linear feet of improvements were designed and constructed by developers between 1986 and 2000 based on the 100-year expected value discharges.
- The 1991 Hydrology Study has now been updated.
- The proposed project by the City of Irvine to widen MacArthur Boulevard would require a portion of the flood control right-of-way to be used for the road widening and would not leave enough room to

convey high confidence discharges and provide the maintenance access roads on both sides of the channel.

- The majority of the channel was constructed in 1966 and no single reach is currently capable of conveying the 100-year expected value discharge. The Lane Channel watershed is highly urbanized, resulting in limited right-of-way being available for channel widening.

Kenneth R. Smith, Director Public Works/Chief Engineer concurred with contexts of this memorandum.

3.1.3 Drainage Report for Lane Channel (Facility No. F08) Improvements at MacArthur Boulevard/Red Hill Avenue Intersection in the City of Irvine, California (May 2004) by The Keith Companies

This report was prepared to present hydraulic information for the design of the proposed soft bottom Lane Channel in support of the MacArthur Boulevard and Red Hill Avenue Intersection and roadway widening improvement project. The channel modifications include the replacement of the earthen, trapezoidal channel with a soft bottom, rectangular channel, the addition of two access ramps for maintenance purposes, and the extension of the existing triple box culvert crossing at Red Hill Avenue. This report includes interim condition flow rates for the design of the channel modification that are approximately 90% of the ultimate condition 100-year expected value flow rates.

3.2 Barranca Channel (F09)

3.2.1 Hydrology Report Barranca Channel Facility No. F09 Entire Drainage System (June 1987) by EMA Flood Program Division

This report provides 100-year discharges in accordance with the 1986 Orange County Hydrology Manual for Barranca Channel (F09) between its outlet at San Diego Creek Channel and its crossing of Red Hill Avenue.

3.2.2 Final Runoff Management Plan for Tustin Legacy (December 2004) by RBF Consulting

This report documents existing watershed conditions and outlines a mitigation plan for developed condition runoff from the Tustin Legacy Development site. It includes overall planning of the drainage features of the development site as well as impacts of development to existing channels. The Tustin Legacy project site is tributary to two sub-watersheds: the Barranca Channel watershed and the Peters Canyon Channel watershed. The Barranca Channel watershed was shown to drain a tributary area of 2.2 square miles.

3.2.3 San Diego Creek Flood Control Master Plan Barranca Channel Update (September 2007) by RBF Consulting

This report provides the updated 100-year design discharges along the Barranca Channel (F09) from its confluence with San Diego Creek to its

upstream terminus at Red Hill Avenue. As a part of the cooperative agreement between the City of Tustin and Legacy Park Partners, the Barranca Channel Master Plan was to be revised to include proposed improvements to the Legacy Park Development and the improvements to Barranca Channel. Changes to Barranca Channel include the construction of a fully enclosed box culvert between Red Hill Avenue and the Barranca Parkway crossing. This box culvert will replace the existing trapezoidal riprap lined section. An in-line detention basin is proposed on the Legacy Park Development site that would intercept flows from Barranca Channel. This basin is designed to mitigate for the potential redevelopment impacts. This report also stated that as part of the Cooperative agreement, the 100-year peak discharges within Barranca Channel must not be increased beyond existing levels due to the Legacy Park Development or worsen the existing condition of any storm drains, culverts, district facilities, and street crossings.

4. HYDROLOGIC STUDIES

The methods and analysis used in the hydrology calculations for each of the regional flood control facilities tributary watershed are in conformance with the procedures outlined in the latest edition of the Orange County Hydrology Manual (Hydrology Manual) and the Addendum No.1 to the Hydrology Manual. A summary of these procedures is provided below.

- Times of Concentration
  The Rational Method was used to compute Times of Concentration (Tc) for each of the subareas in accordance with the Hydrology Manual. The Advance Engineering Software (AES) computer program RATSCx was used for the rational method calculations. Subarea boundaries and flow paths are illustrated on the Hydrology Maps, Figures 2 to 4.

- Loss Rates
  The maximum loss rate (Fm) and the low loss rate fraction (Y-Bar) were computed for each subarea using watershed data and the formulas from the Hydrology Manual. The watershed data consists of the hydrologic soil types as defined in the Hydrology Manual along with the latest land use plans within the subareas.

- S-Graph
  The Orange County Valley-Developed S-graph was used in computing hydrographs for the subareas.

- Hydrograph Generation
  A hydrograph was generated for each of the subareas using the AES computer program FLOODSCx. FLOODSCx generates hydrographs in accordance with the defined procedures stated in the Hydrology Manual. The hydrographs were generated using the unit hydrograph method.

- FLOODSCx Models
  The Barranca Channel hydrologic model begins downstream of the proposed Legacy Park Development detention basin, the single area model analyses were used from downstream of the basin to San Diego Creek confluence to calculate the 100-year high confidence flow rate. Since there are no detention basins within Lane Channel and Armstrong Channel tributary areas, the single area model was used to obtain the 100-year expected values flow rates for these facilities.

- Depth-Area Factors
  Average storm rainfall intensity tends to decrease as the size of the tributary watershed increases. Depth-area factors were used to reduce rainfall depths and account for the increase in watershed size that occurs as one progresses further downstream along any given facility. Since the tributary area is different at each of the concentration points, the AES models were processed multiple

times and the depth-area factors were adjusted for each particular concentration point. Therefore, the resulting hydrograph and peak discharge are accurate for only the particular concentration point for which the model was processed.

4.1 Lane Channel (F08)

Tributary area for Lane Channel includes areas south of the I-405 Freeway, which lies within the City of Irvine boundary, north of Campus Drive. Also included are areas north of the I-405 Freeway, which are bounded on the north by Main Street, areas west of the channel bounded by Red Hill Avenue, and areas north of SR-55 Freeway, including portions of the City of Tustin and the City of Santa Ana. The total drainage area is approximately 3,143 acres. The primary land use for the watershed is zoned commercial and industrial with some high rise condominium residential. Soils within the watershed are primarily types C and D. Table 4.1.1 below summarizes the 100-year peak flow rates computed for Lane Channel.

Table 4.1.1
Lane Channel (F08)
100-Year Expected Value Peak Flow Rates Summary

Concentration Point No.	Location	Station	100-Year EV Flow Rate (cfs)	Description	Tributary Area (ac)
1.17	San Diego Creek	1+46.90	3,126	Earthen Trap. Channel	3,143
1.16	700' u/s of Jamboree Road	31+50	3,126	Earthen Trap. Channel	3,032
1.15	600' u/s of Von Karman Ave	57+00	2,807	Earthen Trap. Channel	2,532
1.14	Sky Park East	89+50	2,777	RC Rect. Channel soft bottom	2,310
1.13	Red Hill Ave	110+00	2,454	11'x6.5' Trip. RCB	1,896
1.12	Fitch	123+00	1,837	RC Rect. Channel soft bottom	1,474
1.11	Costa Mesa Freeway	140+00	1,414	Earthen Trap. Channel	1,063

4.2 Armstrong Channel (F08S01)

Armstrong Channel lies within the Lane Channel watershed. Therefore, Armstrong Channel shares the same hydrologic characteristics as Lane Channel as described above. Armstrong Channel comprises 356 acres of tributary area all within the City limits and the Irvine Business Complex (IBC). Table 4.2.1 on the next page summarizes the 100-year peak flow rates computed for Armstrong Channel.

Table 4.2.1
Armstrong Channel (F08S01)
100-Year Expected Value Peak Flow Rates Summary

Concentration Point No.	Location	Station	100-Year EV Flow Rate (cfs)	Description	Tributary Area (ac)
110	Lane Channel	1+38.56	519	10'x9' DBL RCB	356
109	McGaw Ave	33+50	419	12'x9' DBL RCB	235
108	Alton Parkway	46+00	338	Riprap Lined Trap. Channel	177

4.3 Barranca Channel (F09)

Barranca Channel is located within the Cities of Tustin and Irvine with a tributary area that expands into the City of Santa Ana for a total of 1,337 acres. The land use for the watershed is zoned commercial with portions of watershed located within Legacy Park Development zoned for residential used at a density of 3-4 dwelling units per acre. Soils within the watershed are primarily type C with some type D near the channel confluence with San Diego Creek. The detention basin routing for the proposed detention basin within the Legacy Park Development was duplicated from the approved RBF report (see section 3.2.3). The remaining models that were created as a part of this study extend downstream from the basin outlet to obtain the 100-year high confidence peak flow rates for Barranca Channel. Table 4.3.1 on the next page summarizes the 100-year peak flow rates.

Table 4.3.1
Barranca Channel
100-Year High Confidence Peak Flow Rates Summary

Concentration Point No.	Location	Station	100-Year HC Flow Rate (cfs)	Description	Tributary Area (ac)
102.2	San Diego Creek	2+84.89	1,470	12'x12' DBL RCB	1,337
102.1	Jamboree Road	19+00	1,470	Riprap Lined Trap. Channel	1,320
102.0	650' u/s of Jamboree Road	25+50	1,430	Earthen Trap. Channel	1,254
101.9	AT&SF Railroad	40+00	1,337	12'x9.5x DBL RCB	1,172
101.8	550' d/s of McGaw Ave	46+00	1,333	Earthen Trap. Channel	1,137
101.7	Alton Parkway	65+00	1,246	Riprap Line Trap. Channel	1,044
101.6	900' u/s of Alton Parkway	74+00	1,156	Earthen Trap. Channel	968
101.5	1600' u/s of Alton Parkway	81+00	1,013	Earthen Trap. Channel	883
101.4	Barranca Parkway	90+00	997	Earthen Trap. Channel	836

5. HYDRAULIC STUDIES

The hydraulic analysis of the channels was performed using the Water Surface Pressure Gradient (WSPG) computer software originally developed by the Los Angeles County Flood Control District. WSPG calculates frictional and transitional losses and corresponding velocities and depths in prismatic conveyances. The input parameters consist of station and invert elevation as well as conveyance geometry and horizontal alignment changes.

The following Manning's n values were used to perform the hydraulic analyses of the three channels:

- Earthen : 0.025
- Concrete lined slopes, earthen bottom : 0.020
- Riprap lined : 0.035
- Riprap lined slopes, earthen bottom : 0.030
- Concrete lined, or RCBs : 0.014

All of the hydraulic analyses and calculations performed for Lane Channel, Armstrong Channel, and Barranca Channel are included in the Technical Appendices of this report.

5.1 Lane Channel (F08)

The initial water surface elevation (WSEL) at the downstream end of Lane Channel was obtained from the assumed San Diego Creek water surface elevation at the point of confluence. The water surface elevation in San Diego Creek at the Lane Channel confluence was assumed at 34.3 feet, or 1.5 feet below the top of the channel, which is at 35.8 feet.

Lane Channel discharges a peak 100-year expected value flow rate of 3,126 cubic-feet-per-second (cfs) into San Diego Creek at station 159+30.00. The depth of flow at the discharge point is 18.6 feet, with velocity of 3.24 feet-per-second (fps). The flow depth varies from 17-18 feet in the trapezoidal channel section with velocities generally less than 4 fps. Flow depth reduces to between 16-17 feet when going through the Jamboree Road box culvert, and the velocity is approximately 7 fps. From Jamboree Road to the I-405 Freeway Jamboree Road Off-Ramp, the channel's depth of flow ranges from 17-18 feet with an average velocity of approximately 3 fps. The height of channel varies from 19 feet to 17 feet as it continues upstream to Von Karman Avenue. Upstream of Von Karman Avenue the height of the channel gradually drops to 15 feet with the depth of flow nearing the top of channel. As channel transitions into a triple box culvert under the I-405 Freeway MacArthur Boulevard Off-Ramp, the average flow depth is about 17 feet and the velocity increases to 6.5 fps.

Upon exiting the triple box culvert, the channel transitions to a 13-foot high, 37.5-foot wide rectangular channel that extends about 530 feet upstream, then transitions to 12-foot wide, 13-foot deep earthen trapezoidal channel. The flow depth stays above 17 feet, which overtops the channel by an average of 4 feet. After the earthen

trapezoidal channel ends at about station 100+00, it transitions to a concrete walled, earthen bottom rectangular channel. The rectangular channel has base widths ranging from 15 feet to 23 feet, with a 12-foot wide access road located within the channel section. Its height varies from 14.7 to 14.8 feet. When crossing Red Hill Ave, the rectangular channel transitions into an 11'x6.5' triple RCB, and then back to the aforementioned rectangular channel section. The depth of flow downstream of Red Hill Avenue is at 17.5 feet, which is higher than the depth of the rectangular channel. The velocity remains less than 4 fps. Inside the RCB, velocity increases to 8.6 fps, then to 4-5 fps upstream of Red Hill Avenue. The depth of flow reduces down to 16 feet, with 14.8 feet of channel depth.

The earthen trapezoidal channel section resumes after rectangular channel section ends at station 122+60, and flow depths within the trapezoidal section range from 13-14 feet, with channel depth at 13 feet. The velocity is an average of 3 fps. Passing through the RCB culvert at the SR-55 Freeway, velocity increases to 15.7 fps.

5.2 Armstrong Channel (F08S01)

The initial water surface elevation for Armstrong Channel was set equal to the Lane Channel water surface elevation at its point of confluence with Lane Channel. Armstrong Channel joins Lane Channel at Lane Channel station 89+00, and the water surface elevation at the confluence is 38.45 feet. The Expected Value 100-year flow rate conveyed by Armstrong Channel is 519 cfs at this location.

At the downstream end of Armstrong Channel, where the RCB ties in with Lane Channel, the depth of flow is at 18.0 feet, with 2.9 fps of velocity. Upstream of the RCB, the channel transitions to a riprap lined 12-foot wide by 11.5-foot high trapezoidal channel, with 1.5H to 1V side slopes. Along the trapezoidal section of the channel, flow depths range from 13 feet to 15 feet, with velocities of 0.9-1.0 fps. This results in an overflow of the channel by 1.5 to 3.5 feet. When crossing McGaw Ave, the trapezoidal channel transitions into a 12'x8' RCB, and then to 8-foot wide by 11.5-foot high riprap lined trapezoidal channel, with 1.5H to 1V side slopes. At McGaw Ave, the channel conveys 419 cfs. Inside the 12'x8' RCB, the depth of flow is generally less than 14 feet with velocity of approximately 4 fps. Upon exiting the box, the velocity reduces to less than 1 fps, with flow depths remaining higher than 13 feet. At the upstream end of the channel, at Alton Parkway, it transitions to a 72-inch RCP, which carries 338 cfs of flow at 11.99 fps.

5.3 Barranca Channel (F09)

The initial water surface elevation for Barranca Channel was assumed to be 36.4, which is 1.5 feet below the San Diego Creek top of channel elevation of 37.9, at Station 172+59.48. Barranca Channel carries 1,470 cfs (100-year high confidence) of flow at its point of confluence with San Diego Creek.

Barranca Channel confluences with San Diego Creek as a 12'x12' double RCB. Depth of flow ranges from 16 feet to 18 feet and flow velocities are approximately 5.1 fps. The double RCB then transitions into a 26.5-foot wide, 14-foot high riprap lined

trapezoidal channel. Within the riprap lined trapezoidal channel, water depths is about 13 feet, with an average velocity is less than 4 fps. At the Jamboree Road culvert, the channel transitions to a double 12'x9.5' RCB, where flow velocity increases to 6.0 fps the channel transitions back into an earthen trapezoidal channel at the upstream end of the box culvert, and flow depth remains at about 13 feet with a corresponding flow velocity of about 2.7 fps. The channel continues through three more crossings at the AT&SF rail road, McGaw Avenue, and Alton Parkway. At each crossing the channel section transitions to a double 12'x9.25' RCB culvert and then transitions back to an earthen trapezoidal channel. Inside the RCB sections, the average velocity increases to 6.4 fps, and then reduces to 3-4 fps within the connecting upstream trapezoidal channel section.

At about station 65+00, the channel width decreases to 10 feet, with an 11.5-foot depth. The depth of flow varies from 10-12 feet within this trapezoidal channel section, which is partially contained by the channel, and partially overtops the channel bank by 0.5-1.5 feet.

6. SUMMARY OF RESULTS

Hydrology studies were performed for the Lane Channel (F08), Armstrong Channel (F08S01) and Barranca Channel (F09) watershed, which included the latest land use plans obtained from the Cities of Santa Ana, Tustin and Irvine. The 100-year high confidence flow rates for each regional flood control facility were computed in accordance with the latest edition of the Orange County Hydrology Manual and Addendum No.1. Based on the previous policies established by the OCRDMD (see section 3.1.2), it was concluded that the analysis criteria for Lane Channel and Armstrong Channel would be 100-year Expected Value (50% confidence) flow rates.

Using the flow rates obtained from the hydrology studies, the hydraulic modeling for each channel was performed to evaluate its performance under specified 100-year design flow rates. The hydraulic analyses assume that the 100-year water surface elevation in San Diego Creek (F05) is at a maximum of 1.5 feet below the top of the existing banks. This assumption affects the results of the hydraulic analyses of all three regional systems. It is also assumed that 100-year Expected Value flow rates are acceptable for Armstrong Channel (F08S01) due to the similar policy established for the downstream tie-in facility, Lane Channel.

Lane Channel and Armstrong Channel were shown to not have enough capacity to convey the 100-year expected value flow rates and provide at least 1.5 feet of freeboard. An inundation area from the overflow of these two regional flood control facilities is shown on Figure 13. The inundation area shown on Figure 13 was derived through an examination of city street elevations in the vicinity of the aforementioned channels. Channel flow depths were projected outward from the channels along city streets until the channel flow elevation was reached. Secondary inundation effects may be present outside of the depicted inundation area due to flow leaving the inundation area by means of secondary flow escape routes.

The on-site detention basin as proposed by the Legacy Park Development will maintain the water surface elevation at 40.5 at Barranca Channel station 88+14.33. Barranca Channel is not capable of conveying the design flow and providing at least 1.5 feet of freeboard from the basin to its point of confluence with San Diego Creek due to the high tail water condition from San Diego Creek Channel. The inundation area is shown on Figure 13.

7. RECOMMENDED PROJECT PRIORITIES AND COST ESTIMATE

Based on the analytical results included in this report, Barranca Channel, Lane Channel and Armstrong Channel are shown to be deficient and will require improvements to prevent overflow into existing City areas.

The high tail water condition in San Diego Creek impaired Lane Channel to function and operate properly. The 100-year expected value flow overtops the channel in most of the reaches. In order to provide sufficient capacity to convey the expected value 100-year flow, San Diego Creek will require significant improvements to lower the tie-in water surface elevation. The recently constructed replacement of the existing earthen trapezoidal sections with a concrete walled, soft bottom rectangular section from station 100+06.61 to station 122+49 will only function as designed if the water surface elevation immediately upstream of the Main Street box culvert is approximately 1.5 feet below the top of channel (reference to Drainage Report for Lane Channel by TKC). However, this assumption cannot be achieved. Therefore, the 100-year expected value flow will still overtop the newly improved reach. Within the scope of this study, there is no recommended project that can be done to Lane Channel to prevent overflow into the IBC area. Furthermore, to add height to the existing channel banks to contain the flow will create a levee condition that will need to be reviewed by FEMA and this approach will not prevent flooding in IBC area. The higher water surface elevation in the channel will back up the flow in the local drainage systems in IBC and cause flooding.

Armstrong Channel discharges into Lane Channel, and with a tie-in flow depth in Lane Channel of 18 feet, Armstrong Channel does not have the capacity to convey the expected value 100-year design flow rate. In order for Armstrong Channel to contain the 100-year expected value design flow, Lane Channel would need to lower the tie-in water surface elevation and the water surface elevation in Lane Channel is depended upon the water surface elevation in San Diego Creek. Therefore, there is no recommended project to Armstrong Channel to increase the capacity to convey 100-year expected value flow.

The deficiency of Barranca Channel is also caused by a high tail water condition in San Diego Creek. In order to improve the Barranca Channel deficiency, significant improvement to San Diego Creek will need to take place to lower the tie-in water surface elevation. Therefore, there is no recommended project for Barranca Channel.

In conclusion, the IBC flooding issue is greatly hinge on the improvement to San Diego Creek. To relieve the IBC from potential flooding during a 100-year storm, significant improvements to San Diego Creek will need to be undertaken.

8. FIGURES

9. REFERENCES

EMA Flood Program Division. *Hydrology Report for Barranca Channel Facility No. F09 Entire Drainage System.* June 1987.

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RBF Consulting. Final *Runoff Management Plan for Tustin Legacy.* December 2004.

RBF Consulting. *San Diego Creek Flood Control Master Plan Barranca Channel Update.* September 2007.

The Keith Companies. *Drainage Report for Lane Channel (Facility No. F08) Improvements at MacArthur Boulevard/Red Hill Avenue Intersection in the City of Irvine, California.* May 2004.

10. LIST OF AS-BUILT DRAWINGS

Armstrong Storm Channel – Lane Channel to McGaw Avenue, September 1967. Plan No. F08S01-101-1A

Armstrong Storm Channel Facility No. F08-S01 – McGaw Avenue to Alton Avenue and Appurtenant Storm Drains, Williamson & Schmid Civil Eng's, June 1968. Plan No. F08S01-701-1A

Barranca Channel – From San Diego Creek Channel to Barranca Road, Facility No. F09, July 1970. Plan No. F09-101-1A

Barranca Channel – Along Barranca Road to Red Hill Avenue, Facility No. F09, July 1971. Plan No. F09-101-2A

Barranca Channel – Reinforced Concrete Box Culvert at Jamboree Blvd. Sta 17+89.17 to Sta 19+90.83, Williamson & Schmid Civil Eng's, June 1973. Plan No. F09-701-2

Barranca Channel – From Main Street to Jamboree Boulevard, Facility No. F09, February 1993. Plan No. F09-101-3A

Lane Channel – From MacArthur Blvd Off-Ramp to Dyer Road, August 1964. Plan No. F08-509-1A

Lane Channel – San Diego Creek Channel to Newport Freeway, May 1965. Plan No. F08-101-1A

Lane Channel – Plans for Construction of Extension of Triple 12'x12' Reinforced Concrete Box Culvert at Main Street and MacArthur Blvd. in the City of Irvine, O.C.F.C.D. Facility No. F08, Church Engineering, Inc., April 1987. Plan No. F08-701-2A

Lane Channel – Plans for Construction of that Portion of Facility No. F08 From Approximately 200 Ft. N/O Main Street to Approximately 770 Ft. N/O Main Street in the City of Irvine, ASL Consulting Engineers, December 1994. Plan No. F08-701-3

Lane Channel – Plans for Modification of that Portion of Facility No. F08 From Approximately 182 Ft. N/O Main Street to Approximately 634 Ft. N/O Main Street in the City of Irvine, The Keith Companies, March 2001. Plan No. F08-701-5

Lane Channel – Plans for Modification of that Portion of Facility No. F08 From Approximately 1,000 Ft S/O Red Hill Avenue to Approximately 1,200 Ft N/O Red Hill Avenue in the City of Irvine, Stantec Consulting, Inc, April 2006. Plan No. F08-701-6

Peters Canyon Channel – Lane Road to Navy Way, July 1963. Plan No. F06-101-2A

San Diego Creek Channel – Land Road to Culver Drive, August 1965, Plan No. F05-101-2A

Plans for Construction on Main Street, Red Hill Ave to Newport FRWY, Grand Avenue 1300' N/Talbert to Warner Ave, May 1965, Plan No. 1121

Improvement Plans – Tract No. 6190 in the County of Orange, California, Williamson & Schmid Civil Eng's, March 1966. Plan No. 6190

Improvement Plans – Tract No. 6411 in the County of Orange, California, Williamson & Schmid Civil Eng's, September 1967. Plan No. 6411

Improvement Plans – Tract No. 6410 in the County of Orange, California, Williamson & Schmid Civil Eng's, November 1967. Plan No. TR6410

Improvement Plans – Aston St (Barranca Rd – 660' Southerly), Red Hill Ave (Barranca Rd – 660' Southerly), Barranca Rd (Red Hill Ave – 1330' Easterly) in the County of Orange, California Williamson & Schmid Civil Eng's, January 1968. Plan No. 1005

Construction Plans for the Improvement of McGaw Avenue – South Side – Red Hill Avenue to 521 Feet Westerly, Austin-Frost Associates, Inc., January 1968. Plan No. 418

Improvement Plans – Tract No. 6456 in the County of Orange, California, Williamson & Schmid Civil Eng's, June 1968. Plan No. 6456

Improvement Plans – Aston St From Alton Ave to Deere Ave, Alton Ave From Red Hill Ave to Aston St, Sewer in Alton From Gillette Ave to Armstrong, Red Hill Ave From Deere Ave to Alton Ave in the County of Orange, California, Williamson & Schmid Civil Eng's, August 1968. Plan No. 1004

Improvement Plans – Sky Park Industrial Development in the County of Orange, California Williamson & Schmid Civil Eng's, October 1968. Plan No. 1093

Plans for Construction on Jamboree Boulevard Between MacArthur Blvd and Main Street, Voorheis-Trindle-Nelson Inc, November 1968. Plan No. 1049

Improvement Plans – Deere Avenue, Armstrong Ave, Barranca Road in the County of Orange, California Williamson & Schmid Civil Eng's, December 1968. Plan No. 1044

Improvement Plans – Tract No. 6636 in the County of Orange, California, Williamson & Schmid Civil Eng's, April 1969. Plan No. 6636

Improvement Plans – Tract No. 6902 in the County of Orange, California, Williamson & Schmid Civil Eng's, June 1969. Plan No. TR6902

Improvement Plans – Main Street From 140' E/O MacArthur to 623' E/O MacArthur, Gillette Avenue From F08 Channel to Main Street in the County of Orange, California Williamson & Schmid Civil Eng's, October 1969. Plan No. 1069

Improvement Plans – Barranca Road From 292 E/O Armstrong Ave. to 242' E/O Von Karman Ave, Von Karman Avenue From Barranca Rd to Alton Ave, Alton Avenue From 687' E/O Armstrong Ave to Von Karman Ave. Williamson & Schmid Civil Eng's, October 1969. Plan No. 1007

Plans for Construction on MacArthur Boulevard From Main Street to 733 Feet Easterly of Newport Freeway, May 1971, Plan No. 1067

Improvement Plans – McGaw Avenue From Von Karman Avenue to Future Jamboree Boulevard and Alton Avenue From OCFCD F09 Channel to Future Jamboree Boulevard in the City of Irvine, California, Williamson & Schmid Civil Eng's, October 1971. Plan No. 24

Improvement Plans – Von Karman Ave (McGaw Ave to 1320' SW'ly of McGaw Ave), McGaw Ave (Von Karman Ave to 815' SE'ly of Von Karman Ave) in the City of Irvine, California, Williamson & Schmid Civil Eng's, December 1971. Plan No. 1114

Improvement Plans – Main Street, Von Karman in the City of Irvine, California Williamson & Schmid Civil Eng's, May 1972. Plan No. 23

Improvement Plans – Alton Avenue From Von Karman Ave to 680' E/O Von Karman Ave, Von Karman Avenue From Alton Ave to McGaw Ave, McGaw Avenue From Von Karman Ave to 1900' W/O Von Karman Ave, Williamson & Schmid Civil Eng's, July 1972. Plan No. 7

Improvement Plans – Tract No. 7840 in the County of Orange, California, Williamson & Schmid Civil Eng's, August 1972. Plan No. 7840

Improvement Plans – Tract No. 8018 in the City of Irvine, Orange County, California, Williamson & Schmid Civil Eng's, September 1972. Plan No. TR8018

Improvement Plans – Barranca Road From 262' East of Von Karman Ave 416' East of Von Karman Ave in the City of Irvine, California Williamson & Schmid Civil Eng's, December 1972. Plan No. 26

Improvement Plans – Tract No. 7905 in the City of Irvine, Orange County, California, Williamson & Schmid Civil Eng's, March 1973. Plan No. TR7905

Improvement Plans – Tract No. 7815 in the City of Irvine, Orange County, California, Williamson & Schmid Civil Eng's, April 1973. Plan No. TR7815

Improvement Plans – Main Street From 1984.72 L.F. West of Von Karman to Von Karman, Von Karman Avenue From Main St to 906.14 L.F. and Storm Drain Facility No. F08P01 in the City of Irvine, California, Williamson & Schmid Civil Eng's, May 1973. Plan No. 12

Improvement Plans – Jamboree Boulevard From Main St to 775' NE'ly Main St, Main Street From Jamboree Blvd to 1249 SE'ly Jamboree Blvd, Williamson & Schmid Civil Eng's, June 1973. Plan No. 36

Improvement Plans – Main Street (From MacArthur Blvd to Sky Park Boulevard South) and MacArthur Blvd (From Main St to Sky Park Boulevard), City of Irvine, California Williamson & Schmid Civil Eng's, May 1974. Plan No. 10

Improvement Plans – Main Street From Von Karman Ave to Jamboree Blvd, Jamboree Boulevard From Main St to 913.95 ft S'ly Along Jamboree and Storm Drain Facility No. F08P01 in the City of Irvine, California Williamson & Schmid Civil Eng's, August 1974. Plan No. 13

Plans for Construction of Main Street From 680 Feet to 1680 Feet Southeasterly of Red Hill Avenue, Williamson & Schmid Civil Eng's, August 1976. Plan No. 1133

Construction Plans for the Improvement of Park Red Hill Phase I, Williamson & Schmid, October 1977. Plan No. 64

Construction Plans for the Improvement of Park Red Hill Phase III, Genge Consultants, January 1978. Plan No. 71

Construction Plans for the Improvement of Park Red Hill Phase I, Williamson & Schmid, October 1977. Plan No. 71

Construction Plans for the Improvement of Street, Sewer, Water, Storm Drain For Main Street From Sta 87+84.50 to Red Hill Avenue From Sta 101+76.30 to Main Street McDurmott Drive (Private), Williamson & Schmid, September 1979. Plan No. 111

Construction Plans for the Improvement of Southeast Corner Main St & Von Karman Ave, Michelson Drive, Von Karman Ave, Jamboree Blvd, Williamson & Schmid, April 1982. Plan No. 210

Construction Plans for the Improvement of McGaw Avenue – S'ly Side From Red Hill Avenue to Gillette Avenue, Walden & Associates, Inc., December 1983. Plan No. 304

Construction Plans for the Improvement of Street, Sewer, Water, Storm Drain P.M. No.83-0609 Koll Center Irvine North, Phase 1, Church Engineering, February 1984. Plan No. 321

Construction Plans for the Improvement of Main Street West of Jamboree Blvd. Sta 80+54.86 to 86+41.86, Sta 88+28.85 to 92+81.48, Jamboree Blvd North of Main Street Sta 13+63.95 to 16+29.58, Williamson & Schmid, January 1986. Plan No. 386

Construction Plans for the Improvement of Alton Parkway From Murphy Avenue to Harvard Avenue and Alton Parkway/San Diego Creek Bridge, CDC Engineering, Inc, August 1987. Plan No. 456

Construction Plans for the Improvement of San Diego Creek Channel – Westpark, Boyle Engineering, September 1988. Plan No. F05-701-10

Street Widening Plans for Jamboree Road Main Street to Barranca Parkway and Alton Parkway 400' W/O Jamboree Rd to San Diego Creek Channel, Norris-Repke, Inc, October 1992. Plan No. 714

Improvement Plans For Barranca Parkway Widening From Red Hill Avenue to Peter's Canyon Wash, Nolte and Associates, June 1993. Plan No. 824

Construction Plans for the Improvement of MacArthur Boulevard (Reach III), ASL Consulting Engineers, January 1994. Plan No. 751

Construction Plans for the Improvement of Main Street S'ly Widening From Sta 66+91.60 to Sta 71+52.46, BV Engineering, March 2003. Plan No. 1218

11. TECHNICAL APPENDICES