

SR 710 North Study

Engineering Document

Location Hydraulic Study

Prepared for



Metro

Los Angeles County
Metropolitan Transportation Authority

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Signature Page

This Location Hydraulic Study has been prepared by CH2M HILL Engineers under the direction of the following Registered Civil Engineer. The undersigned attests to the technical information contained herein and the qualifications of any technical specialist providing engineering data upon which recommendations, conclusions, and decisions are based:



A handwritten signature in blue ink, appearing to read "Robert M. Henderson", written over a horizontal line.

Robert M. Henderson, P.E., QSD/QSP
Registered Civil Engineer

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Acronyms and Abbreviations

ADT	Average Daily Traffic
BRT	Bus Rapid Transit
FEMA	Federal Emergency Management Agency
FIRM	Federal Insurance Rate Maps
FIS	Flood Insurance Study
HGL	Hydraulic Grade Line
I	Interstate
LACDPW	Los Angeles County Department of Public Works
LACFCD	Los Angeles County Flood Control District
LAR	Los Angeles River
LRT	Light Rail Transit
Metro	Los Angeles County Metropolitan Transportation Authority
MVP	Maintenance Vehicle Pull-Out
NAVD88	North American Vertical Datum 1988
NGVD29	National Geodetic Vertical Datum 1929
Project	Freeway Tunnel Alternative
RCB	Reinforced Concrete Box
RCC	Reinforced Concrete Channel
RCPA	Reinforced Concrete Pipe Arch
Specific Plan	City of Los Angeles Specific Plan for the Management of Flood Hazards
SR	State Route
TDM	Traffic Demand Management
TSM	Transportation System Management
UPRR	Union Pacific Rail Road
WSE	Water Surface Elevation

Location Hydraulic Study for SR 710 North Study

1. Introduction

Los Angeles County Metropolitan Transportation Authority (Metro), in cooperation with California Department of Transportation (Caltrans), proposes to improve mobility and relieve congestion in the area between SR 2 and Interstates (I) 5, 10, 210, and 605 in east/northeast Los Angeles and the San Gabriel Valley. As part of the environmental document phase of the project, several alternatives are being considered, including No Build, Transportation System Management/Traffic Demand Management (TSM/TDM), Bus Rapid Transit (BRT), Light Rail Transit (LRT), and Freeway Tunnel alternatives.

Of the proposed alternatives, only the Freeway Tunnel Alternative would incur floodplain impacts. The BRT, LRT, and TSM/TDM alternatives would not affect any floodplain within the project areas.

The Freeway Tunnel alternative would start at the existing SR 710 in Monterey Park, south of I-10, and connect to the existing northern stub of SR 710, south of the I-210/SR 134 interchange in Pasadena (see Figure 1). One of the variations to the Freeway Tunnel alternative (the Project) comprises two-level, dual-bore tunnels with four lanes in each direction. Short segments of cut-and-cover tunnels would be located at the south and north termini to provide access via portals to the bored tunnels. The access to the south portal will require widening of the freeway approaches. The widening of the freeway will encroach into the Dorchester Avenue Storm Drain (Dorchester Channel) on the west side and the Laguna Regulating Basin (Basin) on the east side of the new freeway (see Figure 2). Whereas the dual-bore tunnel alternative would incur floodplain impacts to the Dorchester Channel, the single-bore tunnel design variation would not. Therefore, this study addresses the floodplain impacts of the dual-bore alternative only.

This report assesses the existing and project conditions of the Basin and Dorchester Channel between the I-10 Freeway and Valley Boulevard with respect to hydrology, floodplain impacts, hydraulic impacts of the encroachment, property at risk, and environment impacts. Both facilities are owned and maintained by the Los Angeles County Department of Public Works (LACDPW) and Los Angeles County Flood Control District (LACFCD).

2. Project Description

2.1 Laguna Regulating Basin

The proposed I-710 alternative would encroach horizontally into the west side of the Basin if it were to be built on a widened embankment. The extent of the encroachment would be up to 20 ft wide and would be approximately 700 ft long along the western boundary of the Basin (see Figure 3). The freeway widening would also affect the existing maintenance access road along the west side of the Basin.

To reduce the impacts on the Basin, instead of constructing a widened embankment, the freeway will be built on elevated structure (see Figure 3). Most of elevated structure will be above the Basin operation level of 381.00 feet (ft) North American Vertical Datum, 1988 [NAVD88]. Construction and maintenance of the bridge will reduce the final grade below the structure to approximately Elevations 375.8 to 380.7 ft NAVD88. The excavation for the bridge structure would actually increase some basin storage volume. To minimize the impact to the Basin maintenance road, the maintenance road will be replaced by a new entrance and maintenance vehicle pull-out (MVP) area from the I-10/I-710 Connector.

2.2 Dorchester Channel

Under the dual-bore Tunnel option, the proposed I-710 on-ramp would encroach into the Dorchester Channel. The grading will encroach into the existing reinforced concrete channel (RCC) for approximately 728 ft just north of Hellman Avenue, and again further north for approximately 267 ft further north (see Figure 4). Where the embankment encroaches into the channel, the existing 20 ft x 14 ft RCC would be replaced with a double 9.67 ft x 14 ft reinforced concrete box (RCB) along the original channel alignment. The embankment would be constructed atop the new RCB. This proposed channel layout is intended to minimize the hydraulic impact to the existing condition (see Figure 4).

3. Setting

The Dorchester Channel and the Basin receive runoff from the watersheds north of I-10. The watershed has a gentle southerly slope from north up to near I-110, including the communities of Alhambra, Monterey Hills, and South Pasadena. After the runoff discharges from the Basin, it drains through several channel systems, mostly located within Caltrans right-of-way and, eventually, discharges into the Los Angeles River in the City of Vernon.

The existing regional drainage systems information is based on As-Built plans and design reports gathered from LACDPW and Caltrans. There are two drainage facilities located near the south portal of the tunnel: the Laguna Regulating Basin located at northeast corner of the I-10 and I-710 intersection and the Dorchester Channel, which carries water into the Basin from north of Hellman Avenue.

3.1 Laguna Regulating Basin

Available engineering documents for this basin include a design report prepared in 1955 (LACDPW, 1955) and As-Built information for the construction of the basin and spillway (LACDPW, 1967, 1970, and 1991). There was no basin stage-storage or stage-flow information available. The design documents indicate the top of the basin wall at elevation 375.00 ft (National Geodetic Vertical Datum 1929 [NGVD29]) and the spillway crest at 374.00 ft NGVD29; however, current topographic data show the spillway crest at elevation 378.58 ft NGVD29 (or 381.00 ft NAVD88)¹. No background documents (as-built plans or design reports) are available that describe the improvements which raised the basin crest (CH2M HILL, 2013b). Using the basin contours, the basin volume is estimated to be 290.6 acre-feet (ac-ft) at the spillway crest.

The outlet structure for this basin is a 12-foot (ft) reinforced concrete pipe arch (RCPA) culvert located just north of the I-10 freeway that discharges basin flows to the south. The basin outlet has an invert elevation of 340.87 ft NGVD29 (or 343.29 ft NAVD88).

The dominant inflow for this basin comes from the Dorchester Channel, with several other minor inflows from culverts draining the existing SR 710 and the surrounding neighborhoods.

3.2 Dorchester Channel

Available engineering documents for this storm drain channel include the 1956 (LACDPW, 1956) and 1960 (LACDPW, 1960) as-built information. The Dorchester Channel connection at the Laguna Regulating Basin is a 9.67- by 12.75-ft double RCB culvert (see Figure 2). Immediately upstream from the basin, it crosses SR 710 and runs generally north-south and approximately parallel to the new SR 710 alignment. It crosses Hellman Avenue and Valley Boulevard, and then approaches the Union Pacific Rail Road (UPRR) tracks before splitting into dual culverts.

¹ An adjustment of 2.42 ft is required to convert As-Built elevations from NGVD29 to NAVD88.

North of Hellman Avenue, the double RCB becomes a 20- by 14-ft reinforced concrete channel (RCC). The RCC runs between the west side of the freeway and the east side of a residential neighborhood. The RCC continues for about 1,875 ft upstream. The channel slope in the RCC is about 0.82 percent.

About 400 ft south of Valley Boulevard, the RCC then becomes a double 10- by 12-ft RCB. To the north of Valley Boulevard, the RCB continues for another 1,550 ft. The RCB then transitions to a double 12- by 12-ft RCPA at about 200 ft south of the UPRR.

The RCPA continues for about 185 ft further upstream; then the storm drain splits into two parallel RCBs: Line “A” West and Line “A” East. Line “A” West is an 11- by 12.5-ft RCB. Line “A” East is a 10.25- by 13.25-ft RCB. Line “A” West crosses the UPRR tracks, turns westerly along Alhambra Avenue, and then northerly toward Dorchester Avenue. Line “A” East crosses the UPRR tracks, continues northerly toward Lowell Avenue, and turns northeasterly along Concord Avenue.

4. Traffic

SR 710 is a north-south freeway currently connecting the cities of Long Beach and Alhambra. It passes through urbanized areas of Los Angeles County. There are between two and four lanes in each direction. Existing traffic volumes at the terminus of the freeway near Valley Boulevard are 43,000 vehicles/day (<http://traffic-counts.dot.ca.gov/2011all/Route505-980.html>). Traffic volumes to the south are much higher – up to 225,000 vehicles/day near SR 91. From the Alternative Analysis Report (Metro, 2012), future traffic volumes for the year 2035 in an eight-lane (untolled) SR 710 tunnel are expected to be approximately 180,000 vehicles/day.

According to the SR 710 Alternatives Analysis Report (Metro, 2012) and I-710 Major Corridor Study (Metro, 2005), “the I-710 freeway currently experiences high levels of congestion and emissions during the peak hours, a condition that is exacerbated by heavy truck volumes, design problems, and operational choke points along this 20-mile segment (Port of Los Angeles and Long Beach to SR 60) of the freeway. In addition, trucks and passenger vehicles that use surface streets and arterials as a means to avoid freeway congestion on I-710 contribute to existing traffic and quality of life concerns for the communities that line the I-710 Corridor.”

No traffic interruption is expected to occur from the base flood. The base flood does not inundate beyond the southbound edge of the shoulder.

5. Hydrologic Analysis

5.1 Hydrologic Characteristics

The Project is located within the Los Angeles River (LAR) Watershed, which covers over 830 square miles. Within the LAR watershed most tributaries have been engineered to reduce stream instability and the impact of flood events. The watershed includes a portion of the San Gabriel Mountains, Santa Susana Mountains, Verdugo Hills, and Santa Monica Mountains. Watershed terrain consists of foothills, valleys, and coastal plain. Mountain areas generally have chaparral cover that becomes flammable and burns in the dry, windy weather. Most hills and valley areas have been developed and have grassy or little vegetal cover (LACDPW, 2006). The watershed is 37 percent residential with a population of 9 million. The remaining land use is 8 percent commercial, 11 percent industrial, and 44 percent open space (LACDPW, 2013b).

The annual average precipitation can range from 15.5 inches in the coastal plain to 32.9 inches near the San Gabriel Mountains. Winter storms comprise most of the rainfall within the area and most precipitation occurs between December and March. January and July are the coldest and warmest months, respectively (LACDPW, 2006).

5.2 Flood of Record and Base Flood

Available information to establish the flood of record for the combined system is limited. LACDPW indicated there has never been an overtopping flood in the basin since it was constructed, even in very wet years (CH2M HILL, 2013b). No new watershed drainage study or detention modeling has been performed to analyze the existing facilities under the 100-year flood conditions. Therefore, the highest possible inundated area prior to spillway activity is assumed to be the flood of record and the basis for analyzing impacts to the existing floodplain.

For Dorchester Channel, no historic stream gage data or FEMA FIRM maps are available. Available hydraulic design data indicate that the design flows for this system were based on 50-year frequency, also known as the Capital Flood. The Capital Flood is based on the design storm falling on a saturated watershed, and is the basis for most Federal Insurance Rate Maps (FIRMs) in Los Angeles County (LACHM, 2006).

LACDPW provided design flows of the Dorchester channel main line (Line "A") and Line "A" West at various locations (LACDPW, 1955). These design flows are summarized in the Table 5-1. The system splits into Line "A" West and Line "A" East at the junction. Based on available hydrologic data, at the junction of Line "A" West and Line "A" East, a design flow of 2,813 (= 5,148-2,335) cubic feet per second (cfs) was derived for Line "A" East. These data were used for the hydraulic and floodplain analysis of the channel.

TABLE 5-1
Dorchester Channel Design Flows (Capital Flood)

Channel Reach	Design Flow [cfs]
Main Line/Line "A" West	
@ Gravios (Hellman) Avenue	5,481
@ Bohlig Road	5,392
@ Valley Boulevard	5,339
@ Junction with Line "A" East (Upstream becomes Line "A" West)	5,148
@ Alhambra Avenue	2,335
Line "A" East	
Alhambra Avenue	2,813
Note: Data extracted from microfilm design reports (LACDPW, 1955). cfs = cubic feet per second	

6. Hydraulic Analysis

Available hydrologic data were used to evaluate the performance of the physical structures in the storm drain system. No new hydrologic analysis was performed to evaluate the change in dynamics of the storm drainage system since the time of construction.

6.1 Laguna Regulating Basin

Outlet Analysis. No stage-discharge curves were available from existing LACDPW data (CH2M HILL, 2013a and 2013b). The existing Basin outflow discharge was estimated based on As-Built information and topographic elevation data. The maximum water surface elevation (WSE) was assumed to be the spillway crest at Elevation

381 ft (NAVD88). The Basin outlet is at Elevation 343.29 ft (NAVD88). Using the Basin contours, the Basin volume was estimated to be 290.6 ac-ft. At this WSE, the basin outlet would function under inlet-controlled conditions, with a peak flow capacity of about 3,500 cfs.

In the LACDPW design report (1955), the spillway crest was used to set the tail-water at the Laguna Regulating Basin for the hydraulic modeling of Dorchester Channel. However, it did not explain why the hydraulic jumps would occur in the Basin without sealing the Dorchester Channel RCB.

Drawdown Time. There are no published hydraulic data in the LACDPW records for the Dorchester Channel or Laguna Regulating Basin of flooding in the past. In the unlikely event that the Basin is full, it would take approximately 1.88 hours to drain the Basin empty or 0.66 hour to drain down to WSE 364.50 ft NAVD29 (or 366.92 ft NAVD88) when there is no major incoming flow to the Basin. This WSE was determined to be the maximum tail-water elevation that would not cause hydraulic jump in Dorchester Channel or affect the flow capacity of the channel. The drawdown analysis is presented in Attachment A.

Flood Routing. Because drawdown occurs rapidly, the likelihood of the peak inflow to the basin occurring at the same time as the peak WSE in the basin is extremely rare, i.e. the recurrence interval for this “peak-to-peak” event is likely to be much greater than 100 years. This may explain why the Basin has no history of overflowing its spillway and has not caused an overflow in Dorchester Channel. During a normal flood event, the peak inflow is therefore much more likely to occur at a time when the WSE in the basin is low. This study therefore takes a decoupled approach, assuming the Basin has enough storage to attenuate the peak flood such that peak flow in Dorchester Channel will not arrive at the peak elevation at the Basin.

In the Project condition, the basin floodplain elevation will not change, although the floodplain limits may be modified slightly due to additional excavation under the bridge structure. The floodplain impacts to the basin are presented in Figures 5 and 6.

6.2 Dorchester Channel

Storm drain systems are analyzed using the LACDPW software package, Water Surface and Pressure Gradient Hydraulic Analysis System (WSPG, originally the F0515P program from LACDPW). The program used for this project is the Windows version, modified by CivilDesign, Inc (CivilDesign, 2000).

For hydraulic modeling purposes, the mainline was established as (from downstream up) Line “A,” Line “A” East, and ends at Line “B,” (Note that the flow rates for Line “B” were used to address the mitigation measures and not related to the project reaches.) Copies of related pages of the original report are presented in the Attachment A.

Existing Conditions. The hydraulic models for the channel were created using As-Built drawings (see Attachment A) and the older NGVD29 datum. The models cover at least 2,700 ft upstream of the open channel and ended downstream at the Basin.

As discussed above, it is reasonable to assume a tail water elevation within the Basin to be lower than Elevation 364.50 ft NGVD29 (or 366.92 ft NAVD88). A lower tail-water is also technically necessary for the channel modeling because a higher WSE assumption would result in a hydraulic jump in the Dorchester Channel, causing the model to fail. For the reach between the Hellman Avenue and Valley Boulevard crossings (Station [Sta.] 12+50 to Sta. 26+75), the water depths range from 9.95 to 10.92 ft, velocities from 24.63 to 27.12 ft per section (ft/s), and Froude Numbers from 1.51 to 1.30. Therefore, the existing channel maintains a supercritical flow to drain into the Basin when the WSE in the Basin WSE is not higher than Elevation 364.50 ft NGVD29 (or 366.92 ft NAVD88).

Project Conditions. Under the project conditions, the widening of SR 710 would raise the roadway profile and fill in to the sunken channel, which would slightly affect the floodplain boundary. Where the channel will be impacted, it will be reconstructed as an RCB; fill will be placed above the RCB.

The proposed alternative was developed by updating the existing conditions model to reflect the design improvements. The design calls for a smaller RCB section (double 9.67-ft by 14-ft) with three openings in the channel. The maximum hydraulic grade line (HGL) impact of 2.11 ft would occur at Sta. 14+85.00, approximately 235 ft upstream of the Hellman Avenue crossing. Flow velocities decrease slightly due to extra energy loss within

the RCB; however, the HGL would be contained with the channel. There would be no change in WSE in the upstream channel that is not altered, starting at Sta. 25+50, approximately 1,275 ft downstream of Valley Avenue crossing. Therefore, there would be no increase to flood risk to the upstream community.

Summaries of the existing and proposed channel layouts and hydraulic results are presented in Appendix B. The hydraulic results were adjusted to the NAVD88 datum by adding 2.42 ft to the WSPG outputs and are summarized in Table 6-1.

The floodplain analysis for the Dorchester Channel could be complicated because of the direct connection to the basin. FEMA guidelines require that a floodplain of a supercritical-flow channel be mapped by its critical flow depths (FEMA, 2006). The hydraulic analysis indicated the Dorchester channel can hold the critical depth within the channel under project conditions whenever the basin WSE is below 364.50 (NGVD29) or 366.92 NAVD88).

Backwater Effects in Channel. In an extreme flood the Basin may fill completely to the elevation of the spillway crest, 381.00 ft (NAVD88). For this assessment an assumption is made that for the portion of the channel affected by this backwater effect the floodplain elevation is 381.00 (see Figure 6). This elevation would completely submerge approximately 800 ft of RCC north of Hellman Avenue. Because the RCC is within a sunken area between the SR 710 and local developments, the flood would be completely contained.

In the Project Condition, this backwater effect would remain because a portion of the submerged length of RCC (just north of Hellman Avenue) will remain uncovered. The Project Condition would modify the floodplain boundary for approximately 650 ft, shifting it west (see Figure 6).

6.3 Overtopping Condition

The LACDPW has indicated that the Laguna Regulating Basin has never overtopped in its history, even during wet years. Therefore, the overtopping condition is an extreme event with a return frequency likely to be much greater than 100 years. In such an event, spillway activity may be anticipated, with a peak water surface in excess of 381.00 ft.

In the worst-case scenario, i.e. a full Basin downstream, the high water surface would cause a backwater condition upstream of the basin. The RCB near Hellman Avenue would become completely sealed. Southern portions of the new RCB section also will become sealed. In these areas, the floodplain extents will rise above the Dorchester Channel walls and inundate areas beyond the channel, as shown in Figure 5. The floodplain would be contained by the surrounding slopes. However, no addition flooding risk is expected in both areas.

TABLE 6-1
Summary of Hydraulics of the Dorchester Channel

Cross Section	Project Condition		Existing Condition		WSE Difference (ft)
	WSE (ft)	Channel Velocity (ft/s)	WSE (ft)	Channel Velocity (ft/s)	
At Laguna Regulating Basin					
491.00	366.27	23.57	366.18	23.75	0.09
517.00	366.48	23.57	366.37	23.79	0.11
544.03	366.71	23.57	366.59	23.80	0.12
916.00	369.94	23.22	369.35	24.34	0.56
1078.00	371.53	22.75	370.50	24.79	1.03
1088.00	371.08	23.61	370.25	25.38	0.83
1153.80	371.64	23.60	370.67	25.68	0.97
1173.80	371.80	23.59	370.79	25.78	1.01
1250.00	372.44	23.57	371.25	26.19	1.19
End Hellman Avenue RCB Crossing					
1250.00	371.34	25.09	370.52	27.14	0.82
1279.74	371.67	24.91	370.78	27.11	0.89
1309.00	371.99	24.78	371.03	27.07	0.96
1309.00	373.07	23.29	371.03	27.07	2.04
1398.74	373.88	23.15	371.82	26.94	2.06
1485.00	374.69	22.95	372.58	26.80	2.12
1505.00	374.44	23.63	372.57	27.12	1.87
1754.09	376.42	23.74	374.75	26.75	1.68
2013.40	378.41	24.03	377.12	26.11	1.29
2037.00	378.58	24.06	377.35	25.52	1.24
2037.00	377.59	25.42	377.35	25.52	0.25
2190.00	379.25	24.49	378.84	25.43	0.41
2220.00	379.25	24.90	378.86	25.85	0.40
2264.53	379.75	24.61	379.29	25.68	0.46
2283.00	379.96	24.47	379.50	24.78	0.46
2283.00	381.10	22.95	379.50	24.78	1.60
2333.00	381.59	22.79	380.01	25.05	1.58
2450.00	382.98	22.02	381.24	24.68	1.75
2482.31	382.29	23.59	381.09	25.39	1.20
2550.00	382.83	23.61	381.79	25.05	1.04
2550.00	381.79	25.05	381.79	25.05	0.00
2625.00	382.61	24.58	382.61	24.58	0.00
2675.00	382.88	24.63	382.88	24.63	0.00
Begin Valley Boulevard RCB Crossing					
2675.00	383.77	23.45	383.77	23.45	0.00
2780.00	384.15	24.12	384.15	24.12	0.00
2790.00	383.75	24.95	383.75	24.95	0.00

Elevations are based on NAVD 1988. An adjustment of 2.42 ft is required to convert As-Built elevations from NGVD29 to NAVD88.

7. Property at Risk

The inundation area at Dorchester Channel is bordered by Hellman Avenue to the south, SR 710 to the east, and residences to the west. The inundation area along Dorchester Channel does not pose any additional risk to surrounding properties. Ponding does not encroach into adjacent properties or travel ways.

8. Risk Assessment

8.1 Risk Associated with Implementation

The minor change in water surface elevation in Dorchester Channel would not result in any significant change in flood risks or damage, and does not have the potential for interruption or termination of emergency service or emergency routes. While there is a negligible increased risk to flooding and floodplains, the Project requires new slopes to be constructed on top of the RCB. There is a 2:1 (horizontal to vertical) slope located west of the channel, between the channel and residential properties. Project impacts to slope stability present a risk during flooded conditions. These impacts will be addressed by geotechnical engineering during the design.

At the Laguna Regulating Basin, proper design of the structures will consider geotechnical considerations potential for submerged slopes. There will be no impact to the Laguna Regulating Basin's flood detention storage or function.

8.2 Impacts to Floodplain Values

Natural and beneficial floodplain values are listed in the Caltrans Highway Manual. These values include, but are not limited to, fish, wildlife, plants, open space, natural beauty, scientific study, outdoor recreation, agriculture, forestry, natural moderation of floods, water quality maintenance, and groundwater recharge (Caltrans, 2012). The Laguna Regulating Basin and Dorchester Channel are constructed storm drain facilities in a developed urban area; changes to the floodplain are not expected to impact floodplain values. Because it is an engineered water way with restricted public access, the channel does not provide open space, natural beauty, or outdoor recreation value. It also has limited value to support fish, wildlife, and plant habitat. The Laguna Regulating Basin and Dorchester Channel are also not listed in the Los Angeles Region Basin Plan as having any beneficial uses (California Regional Water Quality Control Board [CRWQCB], 1994). These values are not anticipated to be adversely affected by the Project.

8.3 Support of Incompatible Development

The area surrounding the floodplain is already developed and there will be no changes to floodplain values. As such, the proposed Project will not support incompatible development.

8.4 Minimization of Floodplain Impact

Impacts to the Laguna Regulating Basin floodplain have been minimized by constructing the widened SR 710 on elevated bridge structures near the basin, allowing the freeway to be widened without grading into the basin. Fill within the Dorchester Channel reduces the overall floodplain area by 5 percent.

8.5 Restoration and Preservation of Floodplain Values

Since there will be no significant impacts to the floodplain and floodplain values, no restoration or preservation of floodplain values is required.

9. Alternatives to Longitudinal Encroachment

The dual-bore Freeway Tunnel Alternative design variation meets the design objectives, e.g. traffic capacity, while minimizing the longitudinal encroachment within the floodplain of the Dorchester Channel and Laguna Regulating Basin. Design variations that achieve the same design objectives would require geometric modifications to the horizontal or vertical alignment, or realignment of the freeway main line. Those design variations would induce more severe impacts to existing ROW, land use, and hydrology east of the Freeway. Alternatives to the longitudinal encroachment resulting from the dual-bore design variation may include the single-bore design variation. While this design variation will avoid the encroachment to the Dorchester Channel, it will not meet the same design objectives for traffic capacity. Therefore alternatives to the longitudinal encroachment are not feasible.

The longitudinal encroachment along the western boundary of the Laguna Regulating Basin is necessary to reduce impacts to existing ROW, slope easements, channel structures, land uses, hydrology, and potential geotechnical and seismic issues. As noted above, the longitudinal encroachment involves the construction of an elevated bridge structure to accommodate the widening of SR 710. The bridge structure would be supported by piers that would be placed in the floodplain. The area under the bridge would be excavated. By using a bridge structure to widen SR 710 at this location, the floodplain encroachment would not reduce the storage volume of the Laguna Regulating Basin; therefore, in the project condition, the base floodplain elevation would not change.

Alternatives to the longitudinal encroachment resulting from the dual-bore design variation may include the single-bore design variation. While this design variation may reduce the level of encroachment, it will not meet the same design objectives for traffic capacity.

10. Alternatives to Significant Encroachment

There is no significant encroachment to the Laguna Regulating Basin or the Dorchester Channel. As discussed above, the proposed flood improvements for the dual-bore design variation is designed to minimize physical impacts to these flood control facilities. Therefore there are no significant encroachments. No alternatives to significant encroachment are required.

11. Existing Watershed and Floodplain Management Programs

The Project is in compliance with the City of Los Angeles Specific Plan for the Management of Flood Hazards (Specific Plan), developed in 1980 and amended in 1988, 1998, and 2008. Per Section 4.C of the Specific Plan, the extent of flooding shall be considered in the planning, design, and construction of public and private development (City of Los Angeles, 1998). The impact to the floodplain has been minimized for this project.

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Figures

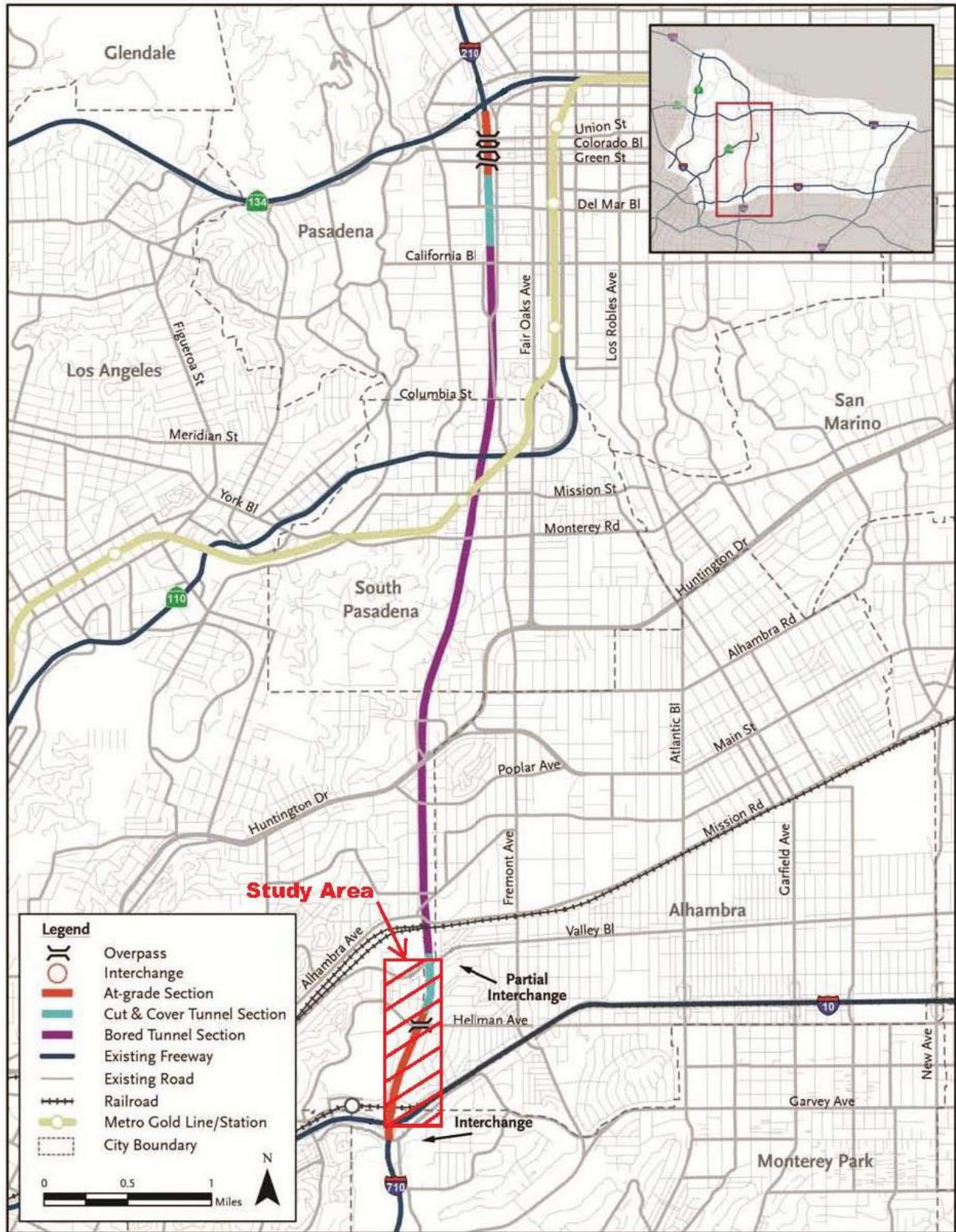
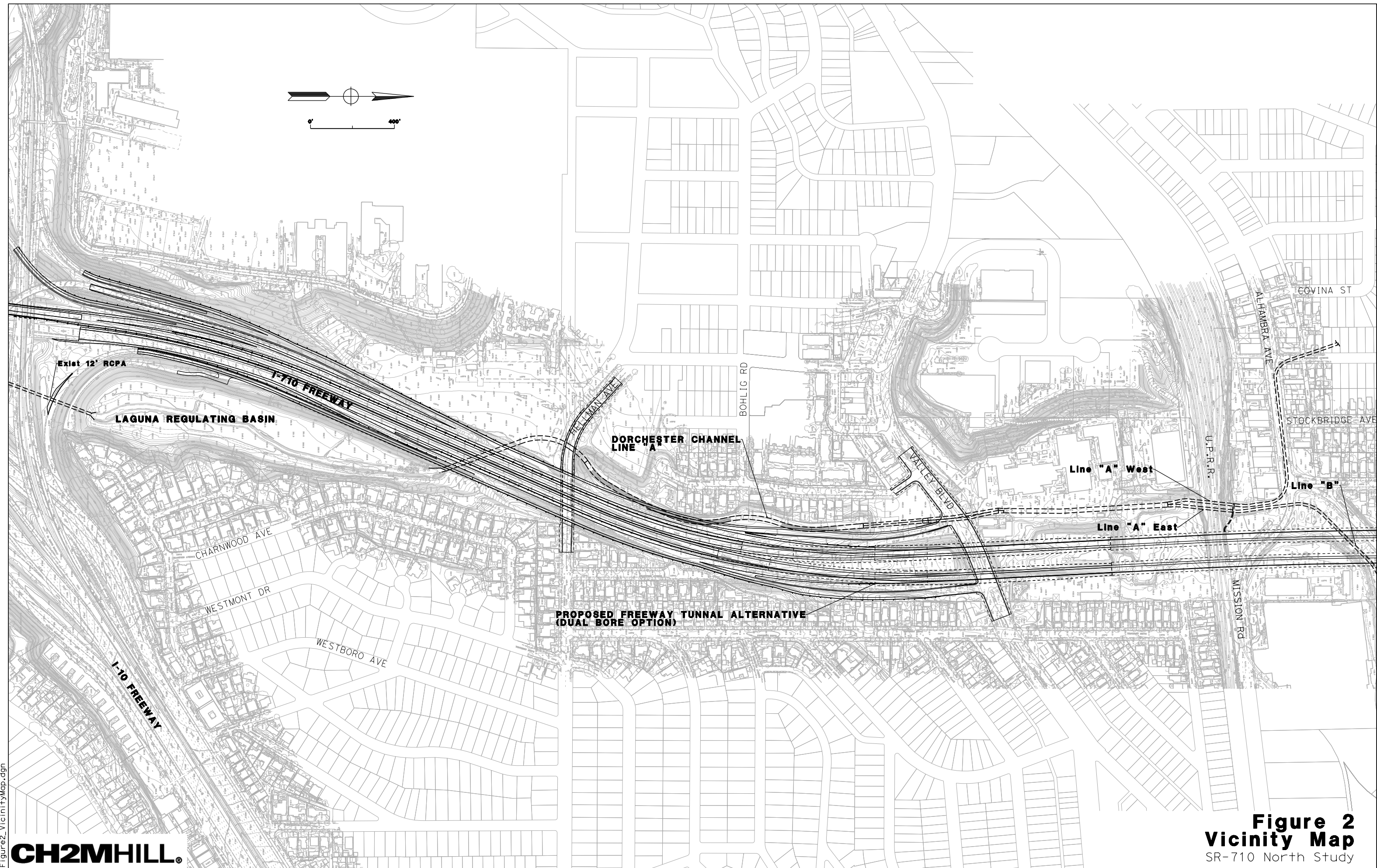
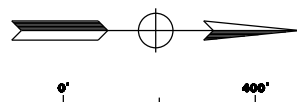


Figure 1
Location Map
 SR-710 North Study



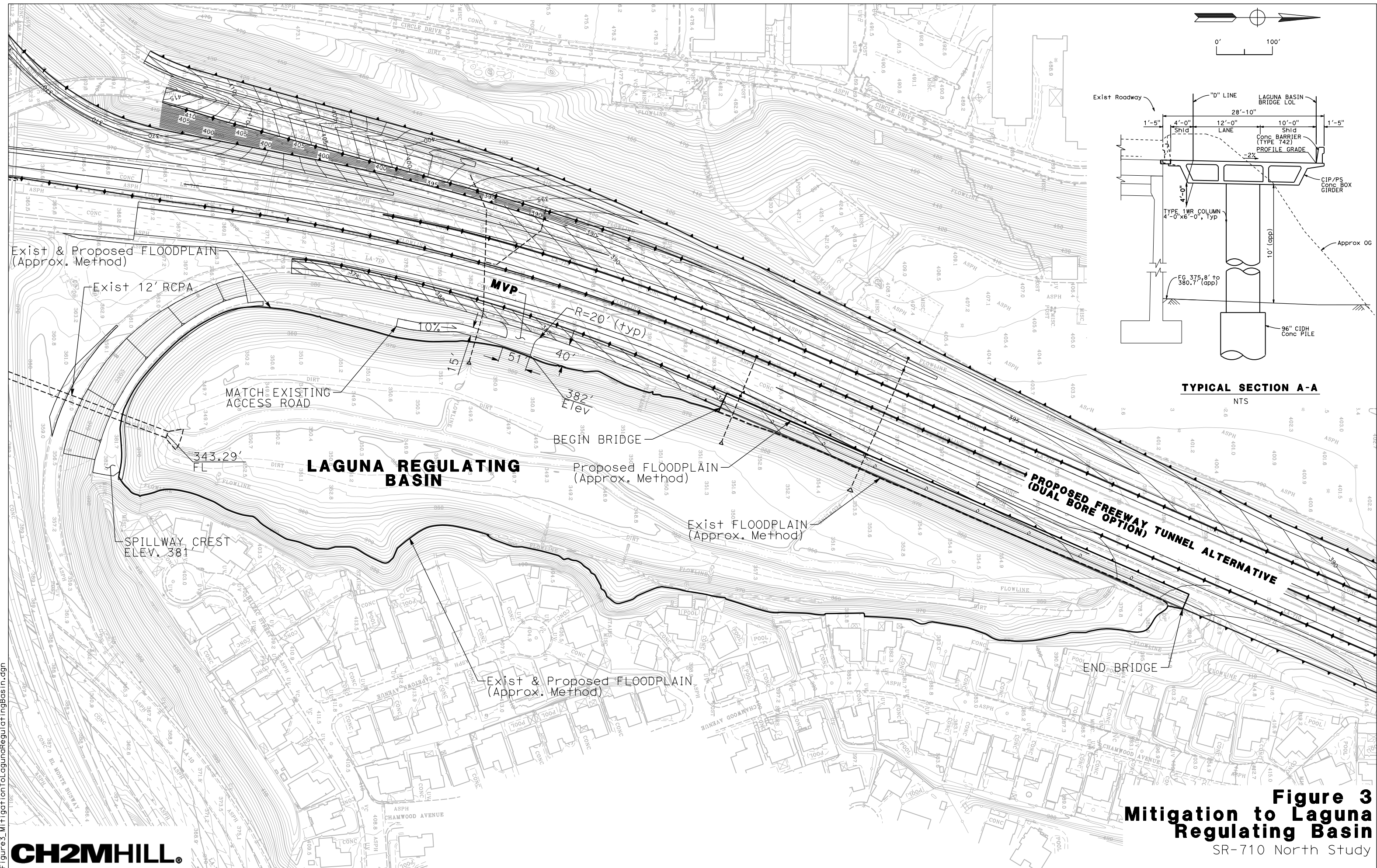


Figure 3_MitigationToLagunaRegulatingBas.in.dgn

Figure 3
Mitigation to Laguna
Regulating Basin
SR-710 North Study

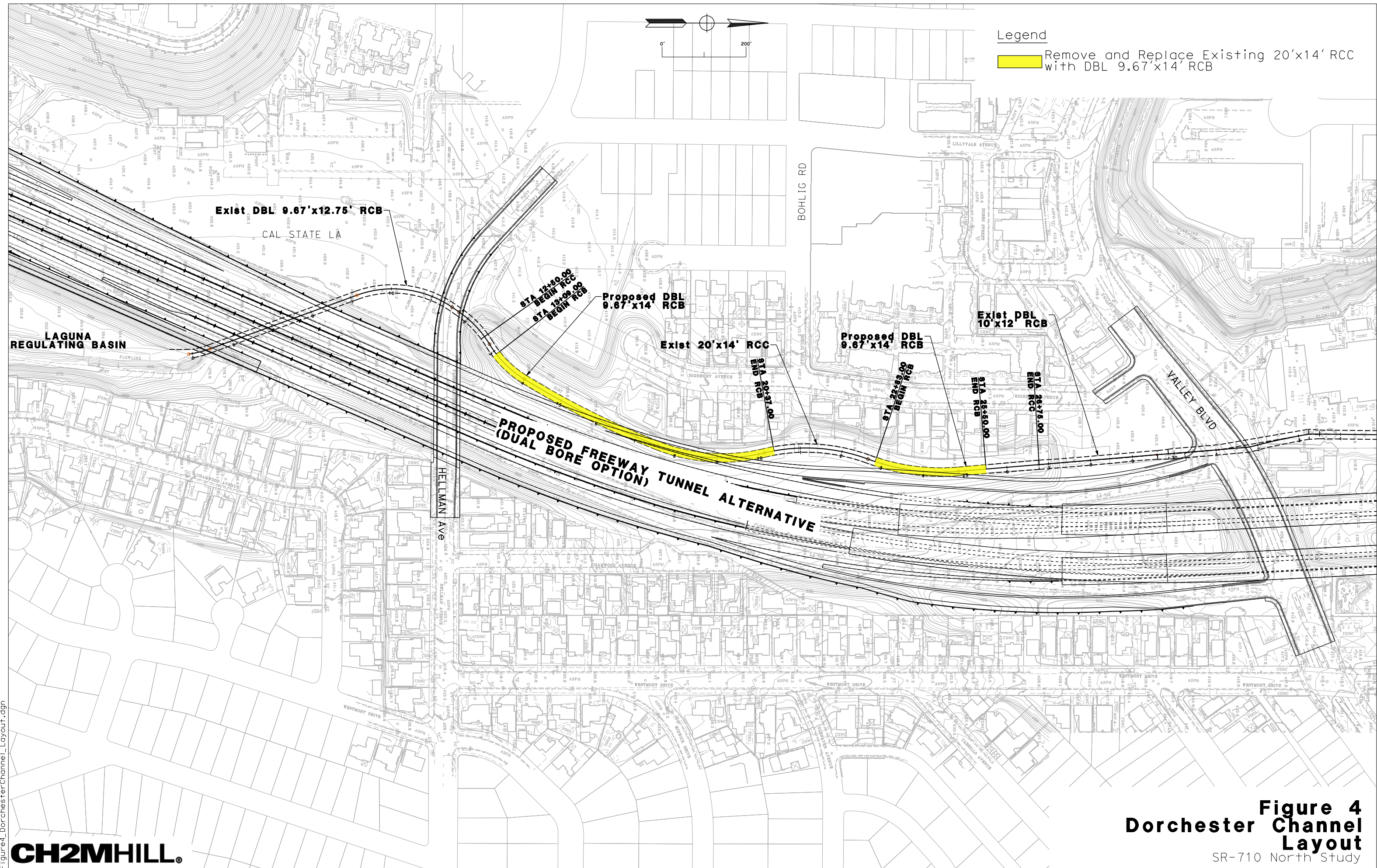
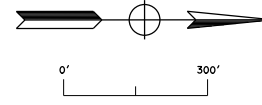





Figure4_DorchesterChannel_Layout.dgn

Figure 4
Dorchester Channel
Layout
 SR-710 North Study



Legend

-  Remove and Replace Existing 20'x14' RCC with DBL 9.67'x14' RCB
-  Existing Floodplain
-  Proposed Floodplain

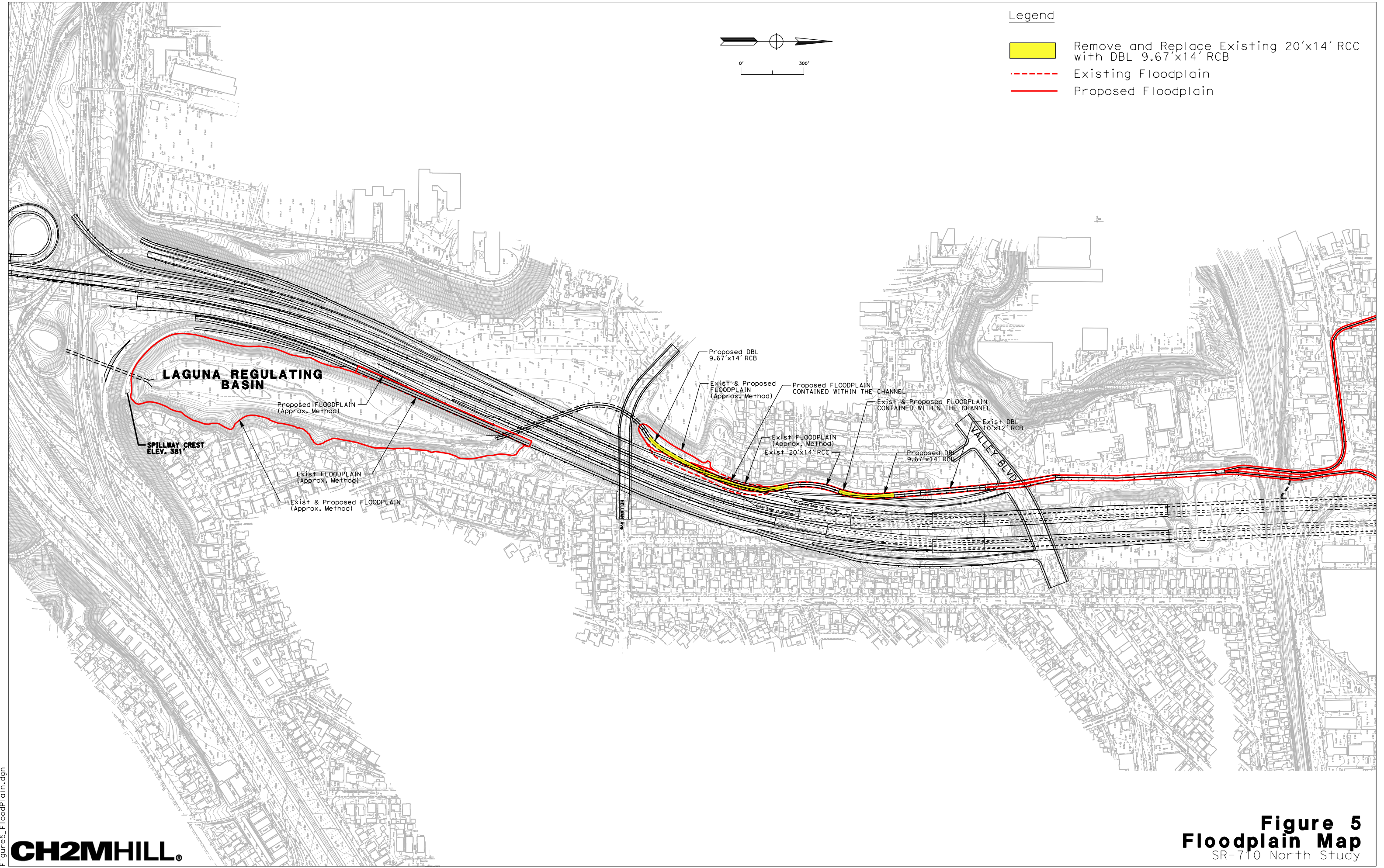


Figure5_FloodPlain.dgn

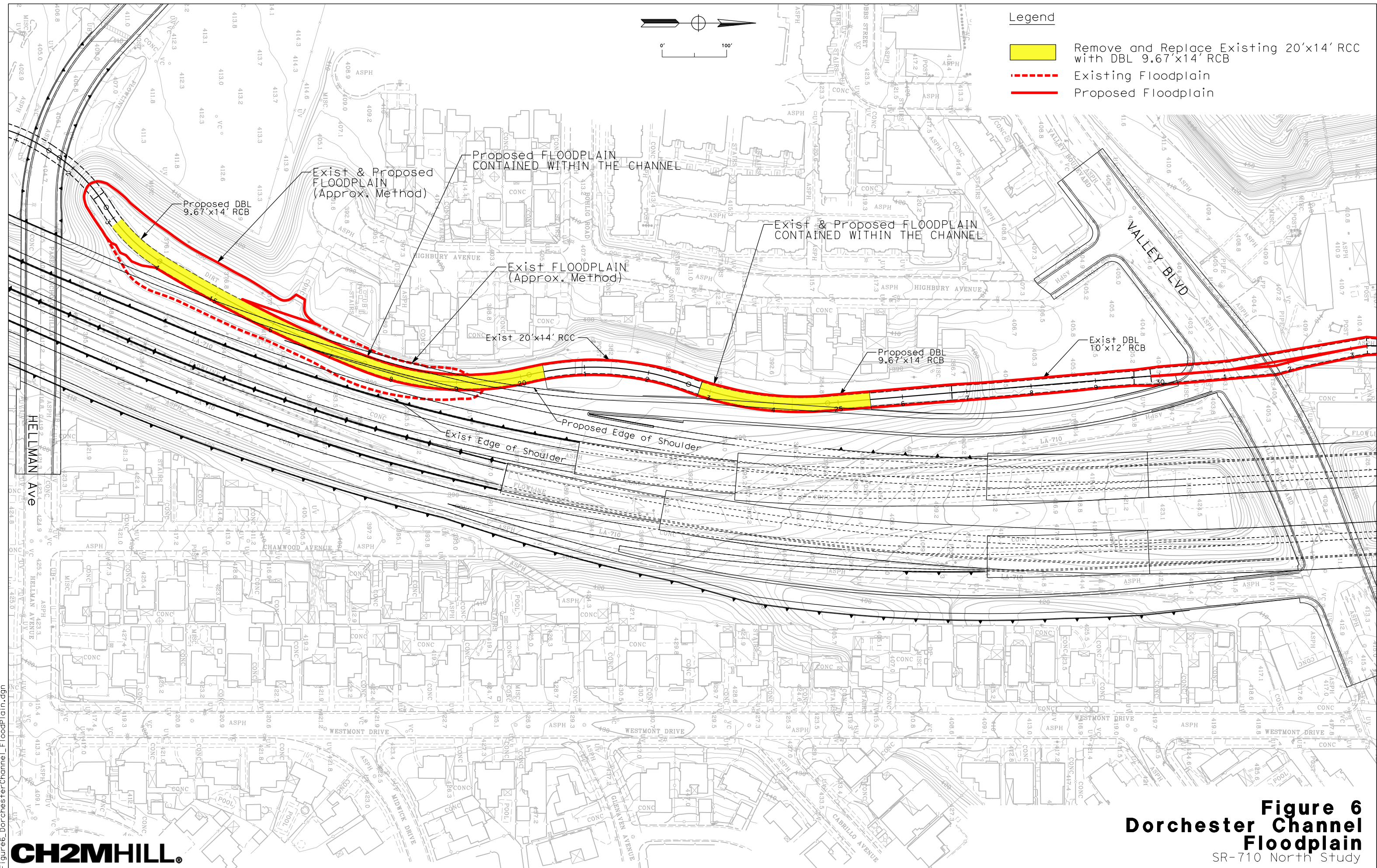


Figure6_DorchesterChannel_Floodplain.dgn

Figure 6
Dorchester Channel
Floodplain
 SR-710 North Study

Appendix A

Relevant Design Data

LOCATION HYDRAULIC STUDY FORM

Dist. 7 Co. LA Rte. 710 K.P. N/A
EA TBD Bridge No. N/A

Floodplain Description:

Floodplain is based on high water surface elevation in the Laguna Regulating Basin (downstream), and Capital Flood WSE in Dorchester Channel (upstream). Both are engineered LACDPW flood-control facilities.

1. Description of Proposal (include any physical barriers i.e. concrete barriers, soundwalls, etc. and design elements to minimize floodplain impacts)

Widening of Route 710 to provide proper transition to the proposed tunnel freeway, including southbound on-ramps. New bridge is proposed in the Laguna Regulating Basin to avoid storage impacts. Encroachment over Dorchester Channel will result in replacing two portions of rectangular channel with RC Box culvert on the existing alignment. See attached report for details.

2. ADT: Current 43,000 vpd Projected 180,000 vpd (in 2035)

3. Hydraulic Data: Base Flood Q₁₀₀= 5,481 cfs
WSE₁₀₀= Varies (see Report) The flood of record, if greater than Q₁₀₀:
Q= N/A m³ / s WSE= N/A
Overtopping flood Q= N/A cfs WSE= N/A
Are NFIP maps and studies available? YES _____ NO X

4. Is the highway location alternative within a regulatory floodway ?
YES _____ NO X

5. Attach map with flood limits outlined showing all buildings or other improvements within the base floodplain. **See Attached Report.**

Potential Q₁₀₀ backwater damages:

- A. Residences? NO X YES _____
- B. Other Bldgs? NO X YES _____
- C. Crops? NO X YES _____
- D. Natural and beneficial

FLOODPLAIN VALUES? NO _____ YES X

6. Type of Traffic:

- A. Emergency supply or evacuation route? NO _____ YES X
- B. Emergency vehicle access? NO _____ YES X
- C. Practicable detour available? NO _____ YES X
- D. School bus or mail route? NO _____ YES X

7. Estimated duration of traffic interruption for 100-year event hours: 0

8. Estimated value of Q₁₀₀ flood damages (if any) – moderate risk level.

A.	Roadway	\$	<u>0</u>
B	Property	\$	<u>0</u>
	Total	\$	<u>0</u>

9. Assessment of Level of Risk Low X
Moderate
High

For High Risk projects, during design phase, additional Design Study Risk Analysis May be necessary to determine design alternative.

Signature – Dist. Hydraulic Engineer _____ Date _____
(Item numbers 3,4,5,7,9)

Is there any longitudinal encroachment, significant encroachment, or any support of incompatible floodplain development? NO YES X

If yes, provide evaluation and discussion of practicability of alternatives in accordance with 23 CFR 650.113

See Report attached.

Information developed to comply with the Federal requirement for the Location Hydraulic Study shall be retained in the project files.

Signature – Dist. Project Engineer _____ Date _____
(Item numbers 1,2,6,8)

SR-710 NORTH STUDY -- REGIONAL CHANNEL SUMMARY, EXISTING CONDITION
(Project 65 Line A and Line B)

8/23/2013

System No	Station		Channel Type	Elevation (NGVD29) (ft)	Length (LF)	Slope (%)	Q50 (City) cfs	Q (Study) cfs	Note
	Model	Design plan							
Main Lines									
Dorchester Drain Line "A"	4+91.00	4+13.00	SYSTEM OUTLET	351.820			5481	5481	
	5+17.00	4+39.00	TRAN. STRUCTURE	352.033	26.00	0.821%	5481	5481	Δ=-5.959°, R=250'
	5+44.03	4+66.03	DBL 9.67'x12.75' RCB	352.255	27.03	0.821%	5481	5481	Δ=-6.195°, R=250'
	9+16.00	8+38.00	DBL 9.67'x12.75' RCB	355.310	371.97	0.821%	5481	5481	
	10+78.00	10+00.00	DBL 9.67'x12.75' RCB	356.640	162.00	0.821%	5481	5481	Δ=37.127°, R=250'
	10+88.00	+88.00	JUNCTION STRUCTURE	356.723	10.00	0.826%	5481	5481	10+00.00=0+78.00 JOIN 72" RCP (Q=30cfs) Δ=2.291°, R=250'
	11+53.80	1+53.80	DBL 9.67'x12.75' RCB	357.266	65.80	0.826%	N/A	5451	Δ=15.080°, R=250'
	11+73.80	1+73.80	DBL 9.67'x12.75' RCB	357.431	20.00	0.826%	N/A	5451	
	12+50.00	2+50.00	DBL 9.67'x12.75' RCB	358.060	76.20	0.826%	N/A	5451	Δ=17.464°, R=250'
	12+79.74	2+79.74	20.00'X14.00' RCC	358.304	29.74	0.819%	N/A	5451	Δ=6.816°, R=250'
	13+98.80	3+98.80	20.00'X14.00' RCC	359.279	119.06	0.819%	N/A	5451	Δ=-27.286°, R=250'
	14+85.00	4+85.00	20.00'X14.00' RCC	359.985	86.20	0.819%	N/A	5451	Δ=-2.469°, R=2000'
	15+05.00	5+05.00	JUNCTION STRUCTURE	360.149	20.00	0.819%	N/A	5451	Δ=-0.573°, R=2000' Lateral 30" RCP (Q=29 cfs)
	17+54.09	7+54.09	20.00'X14.00' RCC	362.189	249.09	0.819%	N/A	5422	Δ=-7.136°, R=2000'
	20+13.40	10+13.40	20.00'X14.00' RCC	364.313	259.31	0.819%	N/A	5422	Δ=-34.960°, R=425'
	21+90.00	11+90.00	20.00'X14.00' RCC	365.760	176.60	0.819%	N/A	5422	Δ=23.808°, R=425'
	22+20.00	12+20.00	JUNCTION STRUCTURE	366.005	30.00	0.819%	N/A	5422	Δ=4.044°, R=425' Lateral 30" RCP (Q=30cfs)
	22+64.53	12+64.53	20.00'X14.00' RCC	366.370	44.53	0.819%	5392	5392	Δ=6.003°, R=425'
	24+50.00	14+50.00	20.00'X14.00' RCC	367.893	185.47	0.821%	5392	5392	Δ=-21.253°, R=500'
	24+82.31	14+82.31	JUNCTION STRUCTURE	368.158	32.31	0.821%	5392	5392	Δ=-3.702°, R=500' Lateral 45" RCP (Q=53cfs)
	26+25.00	16+25.00	20.00'X14.00' RCC	369.330	142.69	0.821%	5339	5339	
	26+75.00	16+75.00	TRAN. STRUCTURE	369.970	50.00	1.280%	5339	5339	
	27+80.00	17+80.00	DBL 10.00'x12.00' RCB	370.661	105.00	0.658%	5339	5339	
	27+90.00	17+90.00	JUNCTION STRUCTURE	370.727	10.00	0.658%	5339	5339	Lateral 30" RCP (Q=50cfs)
	29+57.51	19+57.51	DBL 10.00'x12.00' RCB	371.830	167.51	0.658%	N/A	5289	
	29+82.51	+25.21	TRAN. STRUCTURE	372.380	25.00	2.200%	N/A	5289	19+57.51=0+00.21
	31+89.30	2+32.00	DBL 10.00'x12.00' RCB	374.520	206.79	1.035%	N/A	5289	Δ=5.027° MH 1
	31+99.30	2+42.00	JUNCTION STRUCTURE	374.623	10.00	1.035%	N/A	5289	Lateral 36" RCP(Q=45cfs)
	32+23.12	2+65.82	DBL 10.00'x12.00' RCB	374.870	23.82	1.035%	N/A	5244	MH 1
	33+03.90	3+46.60	DBL 10.00'x12.00' RCB	375.980	80.78	1.374%	N/A	5244	
	33+08.90	3+51.60	TRAN. STRUCTURE	376.015	5.00	0.703%	N/A	5244	
	33+29.44	3+72.14	TRAN. STRUCTURE	376.159	20.54	0.703%	N/A	5244	Δ=11.770°, R=100'
	33+45.18	3+87.88	TRAN. STRUCTURE	376.270	15.74	0.703%	N/A	5244	
	33+55.18	3+97.88	JUNCTION STRUCTURE	376.384	10.00	1.144%	N/A	5244	Lateral 24" RCP(Q=48cfs)
	35+99.63	6+42.33	DBL 10.00'x12.00' RCB	379.180	244.45	1.144%	N/A	5196	MH
	36+25.79	6+68.49	DBL 10.00'x12.00' RCB	379.479	26.16	1.144%	N/A	5196	Δ=-4.282°, R=350'
	38+87.30	9+30.00	TRAN. STRUCTURE	382.470	261.51	1.144%	N/A	5196	
	38+97.30	9+40.00	JUNCTION STRUCTURE	382.584	10.00	1.144%	N/A	5196	JOIN Line "A" West Lateral 24" RCP(Q=48cfs)
	40+89.30	11+32.00	DBL 10.00'x12.00' RCB	384.780	192.00	1.144%	5148	5148	
	Line "A" East	41+35.72	11+78.42	JUNCTION STRUCTURE	385.310	46.42	1.142%	5148	5148
41+41.60		11+84.30	DBL 10.00'x12.00' RCB	385.389	5.88	1.336%	5148	2813	
42+11.51		12+54.21	DBL 10.00'x12.00' RCB	386.322	69.91	1.336%	5148	2813	Δ=10.54°, R=380' MH
42+23.54		12+66.24	DBL 10.00'x12.00' RCB	386.483	12.03	1.336%	5148	2813	
42+43.54		12+86.24	TRAN. STRUCTURE	386.750	20.00	1.336%	5148	2813	
44+20.54		14+63.24	12.00'x12.00' Horseshoe Arch*	389.120	177.00	1.339%	5148	2813	
44+40.54		14+83.24	TRAN. STRUCTURE	390.218	20.00	5.488%	5148	2813	
44+53.21		14+95.91	TRAN. STRUCTURE	390.913	12.67	5.488%	N/A	2813	Δ=-3.156°, R=230'
44+63.54		15+06.24	TRAN. STRUCTURE	391.480	10.33	5.488%	N/A	2813	Δ=-2.573°, R=230'
44+97.74		15+40.44	10.25'x13.25' RCB	391.638	34.20	0.462%	N/A	2813	Δ=-8.520°, R=230'
45+79.22		16+21.92	10.25'x13.25' RCB	392.015	81.48	0.462%	N/A	2813	
45+95.38		16+38.08	TRAN. STRUCTURE	392.089	16.16	0.462%	N/A	2813	
46+23.64		16+66.34	10.25'x13.25' RCB	392.220	28.26	0.462%	N/A	2813	
Line "B"	47+03.02	7+03.62	10.25'x13.25' RCB	393.220	79.38	1.260%	N/A	2813	16+66.34=7+83.00 MH
	47+13.02	6+93.62	TRAN. STRUCTURE	393.340	10.00	1.200%	N/A	2813	
	47+39.96	6+66.68	10.00'x13.25' RCB	393.663	26.94	1.198%	N/A	2813	
	48+80.82	5+25.82	10.00'x13.25' RCB	395.350	140.86	1.198%	N/A	2813	Δ=51.785°, R=155.85'
	51+91.14	2+15.50	10.00'x13.25' RCB	397.650	310.32	0.741%	N/A	2813	
	53+83.64	+23.00	10.00'x13.25' RCB	399.749	192.50	1.090%	N/A	2813	Δ=46.177°, R=238.85' MH
	53+92.38	+14.26	TRAN. STRUCTURE	399.844	8.74	1.090%	N/A	2813	Δ=2.096°, R=238.85'
	54+06.64	+0.00	TRAN. STRUCTURE	400.000	14.26	1.090%	N/A	2813	Q=5148-2335 cfs

**SR-710 NORTH STUDY -- REGIONAL CHANNEL SUMMARY, EXISTING CONDITION
(Project 65 Line A and Line B)**

8/23/2013

System No	Station		Channel Type	Elevation (NGVD29) (ft)	Length (LF)	Slope	Q50 (City) cfs	Q (Study) cfs	Note
	Model	Design plan							
Laterals									
Line "A" West	+35.72	11+78.04	JUNCTION STRUCTURE	385.310			2335	2335	Join Line "A" West
	1+18.58	12+60.90	10.00'x12.00' RCB	386.389	82.86	1.303%	2335	2335	
	1+38.58	12+80.90	TRAN. STRUCTURE	386.650	20.00	1.303%	2335	2335	
	3+23.58	14+65.90	12.00'x12.00' Horseshoe Arch*	389.650	185.00	1.622%	2335	2335	
	3+33.58	14+75.90	TRAN. STRUCTURE	390.180	10.00	5.299%	2335	2335	
	3+45.83	14+88.15	11.00'x12.50' RCB	390.829	12.25	5.299%	2335	2335	
	3+58.50	15+00.82	TRAN. STRUCTURE	391.501	12.67	5.299%	2335	2335	
	3+72.83	15+15.15	11.00'x12.50' RCB	392.260	14.33	5.299%	2335	2335	
	3+74.58	15+16.90	11.00'x12.50' RCB	392.274	1.75	0.805%	2335	2335	
	4+31.78	15+74.10	11.00'x12.50' RCB	392.735	57.20	0.805%	2335	2335	$\Delta = -14.250^\circ$, R = 230'
	5+15.61	16+57.93	11.00'x12.50' RCB	393.410	83.83	0.805%	2335	2335	
	6+35.25	17+78.04	11.00'x12.50' RCB	394.374	119.64	0.805%	2335	2335	1657.93=1658.40 $\Delta = -68.547^\circ$, R = 100'
	7+05.01	18+47.80	11.00'x12.50' RCB	394.935	69.76	0.805%	2335	2335	$\Delta = -21.037^\circ$, R = 190' MH
	11+42.21	22+85.00	11.00'x12.50' RCB	398.460	437.20	0.805%	2335	2335	MH
	11+58.13	23+00.92	11.00'x12.50' RCB	398.612	15.92	0.955%	2335	2335	
	11+96.76	23+39.55	11.00'x12.50' RCB	398.981	38.63	0.955%	2335	2335	$\Delta = 34.05^\circ$, R = 65'
	12+75.03	24+17.82	11.00'x12.50' RCB	399.729	78.27	0.955%	2335	2335	$\Delta = 44.848^\circ$, R = 100'
15+22.21	26+65.00	11.00'x12.50' RCB	402.090	247.18	0.955%	2335	2335		

*For practical purpose, the Horse Shoe Arch was modeled as 9.73'x12.00' RCB.

SR-710 NORTH STUDY -- REGIONAL CHANNEL SUMMARY, PROPOSED CONDITION
(Project 65 Line A and Line B)

8/23/2013

System No	Station		Channel Type	Elevation (NGVD29) (ft)	Length (LF)	Slope (%)	Q50 (City) cfs	Q (Study) cfs	Note	
	Model	Design plan								
Main Lines										
Dorchester Drain Line "A"	4+91.00	4+13.00	SYSTEM OUTLET	351.820			5481	5481		
	5+17.00	4+39.00	TRAN. STRUCTURE	352.033	26.00	0.821%	5481	5481	Δ = -5.959°, R = 250'	
	5+44.03	4+66.03	DBL 9.67'x12.75' RCB	352.255	27.03	0.821%	5481	5481	Δ = -6.195°, R = 250'	
	9+16.00	8+38.00	DBL 9.67'x12.75' RCB	355.310	371.97	0.821%	5481	5481		
	10+78.00	10+00.00	DBL 9.67'x12.75' RCB	356.640	162.00	0.821%	5481	5481	Δ = 37.127°, R = 250'	
	10+88.00	+88.00	JUNCTION STRUCTURE	356.723	10.00	0.826%	5481	5481	10+00.00=0+78.00 JOIN 72" RCP (Q=30cfs) Δ = 2.291°, R = 250'	
	11+53.80	1+53.80	DBL 9.67'x12.75' RCB	357.266	65.80	0.826%	N/A	5451	Δ = 15.080°, R = 250'	
	11+73.80	1+73.80	DBL 9.67'x12.75' RCB	357.431	20.00	0.826%	N/A	5451		
	12+50.00	2+50.00	DBL 9.67'x12.75' RCB	358.060	76.20	0.826%	N/A	5451	Δ = 17.464°, R = 250'	
	12+50.00	2+50.00	Bridge Entrance	358.060	0.00	0.826%	N/A	5451		
	12+79.74	2+79.74	20.00'X14.00' RCC	358.304	29.74	0.819%	N/A	5451	Δ = 6.816°, R = 250'	
	13+09.00	3+09.00	20.00'X14.00' RCC	358.543	29.26	0.819%	N/A	5451	Δ = -6.706°, R = 250'	
	13+09.00	3+09.00	Bridge Exit	358.543	0.00	0.819%	N/A	5451		
	13+98.80	3+98.80	DBL 9.67'x14.00' RCB	359.279	89.80	0.819%	N/A	5451	Δ = -20.581°, R = 250'	
	14+85.00	4+85.00	DBL 9.67'x14.00' RCB	359.985	86.20	0.819%	N/A	5451	Δ = -2.469°, R = 2000'	
	15+05.00	5+05.00	JUNCTION STRUCTURE	360.149	20.00	0.819%	N/A	5451	Δ = -0.573°, R = 2000' Lateral 30" RCP (Q=29 cfs)	
	17+54.09	7+54.09	DBL 9.67'x14.00' RCB	362.189	249.09	0.819%	N/A	5422	Δ = -7.136°, R = 2000'	
	20+13.40	10+13.40	DBL 9.67'x14.00' RCB	364.313	259.31	0.819%	N/A	5422	Δ = -14.960°, R = 425'	
	20+37.00	10+37.00	DBL 9.67'x14.00' RCB	364.506	23.60	0.819%	N/A	5422	Δ = 3.182°, R = 425'	
	20+37.00	10+37.00	Bridge Entrance	364.506	0.00	0.819%	N/A	5392		
	21+90.00	11+90.00	20.00'X14.00' RCC	365.760	153.00	0.819%	N/A	5422	Δ = 20.626°, R = 425'	
	22+20.00	12+20.00	JUNCTION STRUCTURE	366.005	30.00	0.819%	N/A	5422	Δ = 4.044°, R = 425' Lateral 30" RCP (Q=30cfs)	
	22+64.53	12+64.53	20.00'X14.00' RCC	366.370	44.53	0.819%	5392	5392	Δ = 6.003°, R = 425'	
	22+83.00	12+83.00	Bridge Exit	366.521	18.47	0.819%	5392	5392		
	22+83.00	12+83.00	DBL 9.67'x14.00' RCB	366.521	0.00	0.819%	5392	5392	Δ = -2.117°, R = 500'	
	24+50.00	14+50.00	DBL 9.67'x14.00' RCB	367.893	167.00	0.819%	5392	5392	Δ = -19.137°, R = 500'	
	24+82.31	14+82.31	JUNCTION STRUCTURE	368.158	32.31	0.821%	5392	5392	Δ = -3.702°, R = 500' Lateral 45" RCP (Q=53cfs)	
	25+50.00	15+50.00	DBL 9.67'x14.00' RCB	368.714	67.69	0.821%	5392	5392		
	25+50.00	15+50.00	Bridge Entrance	368.714	0.00	0.821%	5392	5392		
	26+25.00	16+25.00	20.00'X14.00' RCC	369.330	75.00	0.821%	5339	5339		
	26+75.00	16+75.00	TRAN. STRUCTURE	369.970	50.00	1.280%	5339	5339		
	27+80.00	17+80.00	DBL 10.00'x12.00' RCB	370.661	105.00	0.658%	5339	5339		
	27+90.00	17+90.00	JUNCTION STRUCTURE	370.743	10.00	0.819%	5339	5339	Lateral 30" RCP (Q=50cfs)	
	29+57.51	19+57.51	DBL 10.00'x12.00' RCB	371.830	167.51	0.819%	N/A	5289		
	29+82.51	+25.21	TRAN. STRUCTURE	372.380	25.00	2.200%	N/A	5289	19+57.51=0+00.21	
	31+89.30	2+32.00	DBL 10.00'x12.00' RCB	374.078	206.79	0.821%	N/A	5289	∠ -5.027° MH 1	
	31+99.30	2+42.00	JUNCTION STRUCTURE	374.160	10.00	0.821%	N/A	5289	Lateral 36" RCP(Q=45cfs)	
	32+23.12	2+65.82	DBL 10.00'x12.00' RCB	374.870	23.82	0.821%	N/A	5244	MH 1	
	33+03.90	3+46.60	DBL 10.00'x12.00' RCB	375.980	80.78	1.374%	N/A	5244		
	33+08.90	3+51.60	TRAN. STRUCTURE	376.023	5.00	0.856%	N/A	5244		
	33+29.44	3+72.14	TRAN. STRUCTURE	376.199	20.54	0.856%	N/A	5244	Δ = 11.770°, R = 100'	
	33+45.18	3+87.88	TRAN. STRUCTURE	376.270	15.74	0.856%	N/A	5244		
	33+55.18	3+97.88	JUNCTION STRUCTURE	376.234	10.00	-0.363%	N/A	5244	Lateral 24" RCP(Q=48cfs)	
	35+99.63	6+42.33	DBL 10.00'x12.00' RCB	375.347	244.45	-0.363%	N/A	5196	MH	
	36+25.79	6+68.49	DBL 10.00'x12.00' RCB	375.252	26.16	-0.363%	N/A	5196	Δ = -4.282°, R = 350'	
	38+87.30	9+30.00	TRAN. STRUCTURE	374.303	261.51	-0.363%	N/A	5196		
	38+97.30	9+40.00	JUNCTION STRUCTURE	374.267	10.00	-0.363%	N/A	5196	JOIN Line "A" West	
	40+89.30	11+32.00	DBL 10.00'x12.00' RCB	384.780	192.00	-0.363%	5148	5148		
	Line "A" East	41+35.72	11+78.42	JUNCTION STRUCTURE	385.310	46.42	1.142%	5148	5148	Lateral 10.00'x12.00' RCB
		41+41.60	11+84.30	DBL 10.00'x12.00' RCB	385.296	5.88	-0.233%	5148	2813	
		42+11.51	12+54.21	DBL 10.00'x12.00' RCB	385.134	69.91	-0.233%	5148	2813	Δ = 10.54°, R = 380' MH
		42+23.54	12+66.24	DBL 10.00'x12.00' RCB	385.106	12.03	-0.233%	5148	2813	
		42+43.54	12+86.24	TRAN. STRUCTURE	386.750	20.00	-0.233%	5148	2813	
		44+20.54	14+63.24	12.00'x12.00' Horseshoe Arch*	389.120	177.00	1.339%	5148	2813	
		44+40.54	14+83.24	TRAN. STRUCTURE	389.531	20.00	2.056%	5148	2813	
44+53.21		14+95.91	TRAN. STRUCTURE	389.792	12.67	2.056%	N/A	2813	Δ = -3.156°, R = 230'	
44+63.54		15+06.24	TRAN. STRUCTURE	391.480	10.33	2.056%	N/A	2813	Δ = -2.573°, R = 230'	
44+97.74		15+40.44	10.25'x13.25' RCB	391.563	34.20	0.243%	N/A	2813	Δ = -8.520°, R = 230'	
45+79.22		16+21.92	10.25'x13.25' RCB	391.761	81.48	0.243%	N/A	2813		
45+95.38		16+38.08	TRAN. STRUCTURE	391.800	16.16	0.243%	N/A	2813		
46+23.64		16+66.34	10.25'x13.25' RCB	392.220	28.26	0.243%	N/A	2813		
Line "B"		47+03.02	7+03.82	10.25'x13.25' RCB	393.220	79.38	1.260%	N/A	2813	16+66.34=7+83.00 MH
		47+13.02	6+93.82	TRAN. STRUCTURE	393.340	10.00	1.200%	N/A	2813	
	47+39.96	6+66.68	10.00'x13.25' RCB	393.894	26.94	2.056%	N/A	2813		
	48+80.82	5+25.82	10.00'x13.25' RCB	395.350	140.86	2.056%	N/A	2813	Δ = 51.785°, R = 155.85'	
	51+91.14	2+15.50	10.00'x13.25' RCB	397.650	310.32	0.741%	N/A	2813		
	53+83.64	+23.00	10.00'x13.25' RCB	398.117	192.50	0.243%	N/A	2813	Δ = 46.177°, R = 238.85' MH	
	53+92.38	+14.26	TRAN. STRUCTURE	398.138	8.74	0.243%	N/A	2813	Δ = 7.096°, R = 238.85'	
	54+06.64	+0.00	TRAN. STRUCTURE	400.000	14.26	0.243%	N/A	2813	Q = 5148-2335 cfs	

**SR-710 NORTH STUDY -- REGIONAL CHANNEL SUMMARY, PROPOSED CONDITION
(Project 65 Line A and Line B)**

8/23/2013

System No	Station		Channel Type	Elevation (NGVD29) (ft)	Length (LF)	Slope	Q50 (City) cfs	Q (Study) cfs	Note
	Model	Design plan							
Laterals									
Line "A" West	+35.72	11+78.04	JUNCTION STRUCTURE	385.310			2335	2335	Join Line "A" West
	1+18.58	12+60.90	10.00'x12.00' RCB	386.389	82.86	1.303%	2335	2335	
	1+38.58	12+80.90	TRAN. STRUCTURE	386.650	20.00	1.303%	2335	2335	
	3+23.58	14+65.90	12.00'x12.00' Horseshoe Arch*	389.650	185.00	1.622%	2335	2335	
	3+33.58	14+75.90	TRAN. STRUCTURE	390.180	10.00	5.299%	2335	2335	
	3+45.83	14+88.15	11.00'x12.50' RCB	390.829	12.25	5.299%	2335	2335	
	3+58.50	15+00.82	TRAN. STRUCTURE	391.501	12.67	5.299%	2335	2335	
	3+72.83	15+15.15	11.00'x12.50' RCB	392.260	14.33	5.299%	2335	2335	
	3+74.58	15+16.90	11.00'x12.50' RCB	392.274	1.75	0.805%	2335	2335	
	4+31.78	15+74.10	11.00'x12.50' RCB	392.735	57.20	0.805%	2335	2335	Δ = -14.250 ° , R = 230'
	5+15.61	16+57.93	11.00'x12.50' RCB	393.410	83.83	0.805%	2335	2335	
	6+35.25	17+78.04	11.00'x12.50' RCB	394.374	119.64	0.805%	2335	2335	1657.93=1658.40 Δ = -68.547 ° , R = 100'
	7+05.01	18+47.80	11.00'x12.50' RCB	394.935	69.76	0.805%	2335	2335	Δ = -21.037 ° , R = 190' MH
	11+42.21	22+85.00	11.00'x12.50' RCB	398.460	437.20	0.805%	2335	2335	MH
	11+58.13	23+00.92	11.00'x12.50' RCB	398.612	15.92	0.955%	2335	2335	
	11+96.76	23+39.55	11.00'x12.50' RCB	398.981	38.63	0.955%	2335	2335	
	12+75.03	24+17.82	11.00'x12.50' RCB	399.729	78.27	0.955%	2335	2335	Δ = 34.05 ° , R = 65'
15+22.21	26+65.00	11.00'x12.50' RCB	402.090	247.18	0.955%	2335	2335	Δ = 44.848 ° , R = 100'	

*For practical purpose, the Horse Shoe Arch was modeled as 9.73'x12.00' RCB.

gmk
7-11-JJ

PROJECT No. 65
HYDROLOGY REPORT

Intersection	City Q	L.A.C.F.C. Q	Adjusted Q	Orb. Diff.
Stockbridge + Poplar "A"	1027	981	1125	9
Lathrop "C"	857	802	919	7
Vincent "A" "C"	2072	1645	1887	9
Allan St.	2155	1755	2013	6 1/2
Alhambra Junction "A" & "B"	2335	1878	2153	8
	5148	4460	5114	0.7
Valley Blvd	5339	4638	5316	0.4
Bohling Rd	5392	4712	5402	0.1
Gravels Dr	5481	4781	5481	0

Ratio of intensity to 50 y. Q. (City Freq.)

$$\frac{5481}{4781} \times 1.00 = 1.14$$

District frequency is 100 yrs. based on Alhambra Wash Course.

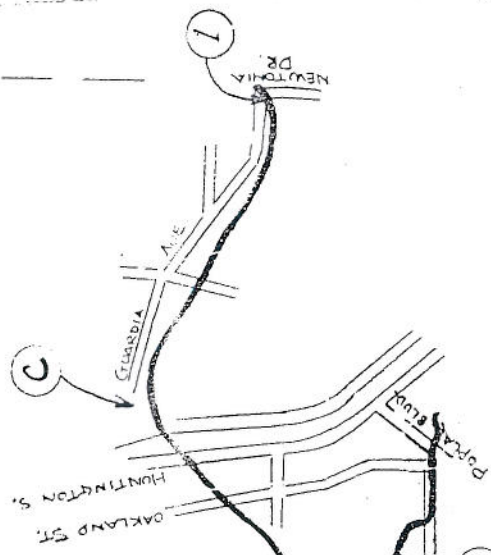
Submitted T_c, Line A = 10.5 min.
Line C = 12.5 min.
County T_c, Line A = 10.0 min.
Line C = 12.1 min.

Note that B. is originality called up a large portion of the project to the Open Channel. By city request, in which the City proposed to Design with Box or pipe, and approved by Mr. Hedger, the City to pay the difference in cost between the Open Channel and Box. See G. W. O. method, no date.

PROJECT



Unit 2



Faberwood

2

Dorchester Ave

3

Alhambra Ave

4

Coloso Ave

5

Spry Pl

6

Valley Blvd

Charwood Ave

7

CITY OF L.A.
CITY OF ALHAMBRA

SUBMITTED Q'S
Based on 50 yr. curve.

- ① Q = 357 c.f.s.
- ② Q = 1049 c.f.s.
- ③ Q = 1076 c.f.s.
- ④ Q = 5131 c.f.s.
- ⑤ Q = 2270 c.f.s.
- ⑥ Q = 5148 c.f.s.
- ⑦ Q = 5481 c.f.s.

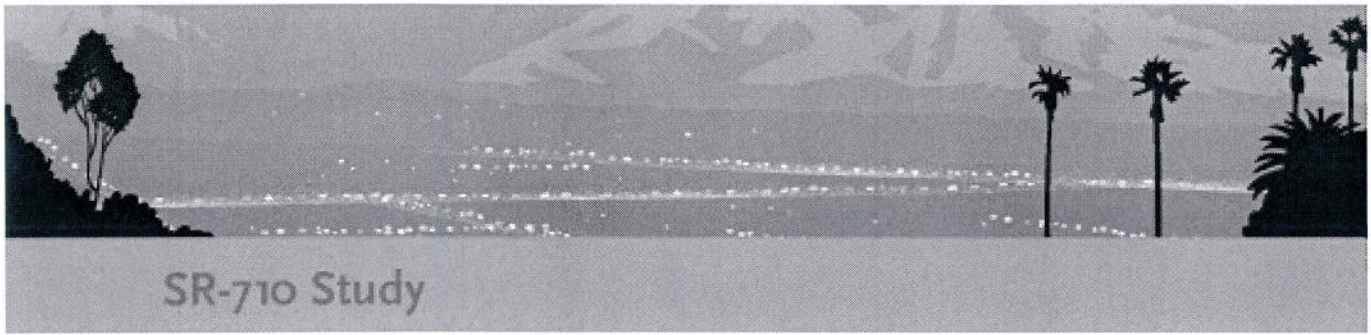
JMK
6-7-55

PROJECT 65

Elevation	Outlet Elevatin	HW	HW/D	Area	Volume (ft ³)	Q (ft ³ /s)	Average Q (ft ³ /s)	Time(s)	Time(hr)
381	343.29	37.71	3.1	539,305		3500			
380	343.29	36.71	3.1	529,757	534,531	3500	3500	152.72	0.04
378	343.29	34.71	2.9	513,118	1,042,875	3300	3400	306.73	0.09
376	343.29	32.71	2.7	496,686	1,009,804	3200	3250	310.71	0.09
374	343.29	30.71	2.6	480,527	977,213	3100	3150	310.23	0.09
372	343.29	28.71	2.4	465,357	945,884	3000	3050	310.13	0.09
370	343.29	26.71	2.2	450,046	915,404	2700	2850	321.19	0.09
368	343.29	24.71	2.1	435,194	885,240	2600	2650	334.05	0.09
366	343.29	22.71	1.9	420,228	855,422	2400	2500	342.17	0.10
364	343.29	20.71	1.7	405,492	825,720	2200	2300	359.01	0.10
362	343.29	18.71	1.6	390,334	795,826	2100	2150	370.15	0.10
360	343.29	16.71	1.4	374,141	764,475	1850	1975	387.08	0.11
358	343.29	14.71	1.2	355,641	729,781	1600	1725	423.06	0.12
356	343.29	12.71	1.1	330,590	686,231	1400	1500	457.49	0.13
354	343.29	10.71	0.9	295,074	625,664	1000	1200	521.39	0.14
352	343.29	8.71	0.7	241,980	537,054	690	845	635.57	0.18
350	343.29	6.71	0.6	97,974	339,953	500	595	571.35	0.16
348	343.29	4.71	0.4	34,334	132,307	260	380	348.18	0.10
346	343.29	2.71	0.2	18,822	53,156	80	170	312.68	0.09
Total Volume					12,656,542				
								Total Time	1.88

Time Needed
0.66

≈ 290.6 Ac-ft



SR 710 Study
Draft - Meeting Summary Notes
Los Angeles County Department of Public Works Coordination Meeting

PREPARED FOR: Michelle Smith/Metro

PREPARED BY: CH2M HILL

DATE: January 22, 2013

TIME: 3:00 p.m.

LOCATION: LACDPW Office, Alhambra, CA

ATTENDEES: See attached sign-in sheet.

OVERVIEW: The purpose of the meeting was to discuss the SR 710 Study alternatives and solicit feedback from LACFCD.

1. Yoga gave an introduction of the project, including the alternatives that are being considered and where we are currently in the schedule for the SR 710 Study.
2. Tom Ionta gave an overview of the Freeway tunnel alternative.
3. Ryan Mityr located the LACDPW facilities that would be impacted by the freeway tunnel alternative. The first impact is to the detention basin east of the SR 710 and north of the I-10, as the freeway is proposed to be widened in this area in order to accommodate the new improvements.
 - a. The connector ramp from westbound I-10 to northbound SR 710 will need to be realigned to accommodate the widened freeway.
 - b. The connector ramp and a portion of the SR 710 will encroach into the detention basin area.

CH2M HILL provided LACDPW maps and cross sections showing the impacts to the detention basin area. Ryan informed LACDPW that the access road located on the west edge of the basin would be impacted and will need to be relocated or removed.



4. Amir Zandieh said CH2M HILL will need to evaluate the storage impacts to the detention basin and propose mitigating measures to ensure there is minimal impact to the capacity and the hydraulic grade line.
 - a. LACDPW will provide CH2M HILL with the design storage volume and the design HGL of the basin.
 - b. Amir also stated that the County maintenance staff will need to review the plans and they will inform CH2M HILL of the access requirements needed.
5. George Hsu noted that the houses on the east side of the basin appear to be lower in elevation than that of the access road on the west. With the design HGL lower than the houses the proposed impacts might not affect the design capacity of the basin. CH2M HILL will confirm once information is received from County.
6. The second impact is on Dorchester Storm Drain Channel south of Valley Blvd., along the southbound on ramp from Valley Blvd. CH2M HILL provided LACDPW with maps and cross sections showing the impacts to the channel and proposed converting the encroached open channel segment into a reinforced concrete box (RCB).
 - a. Amir said LACDPW will provide CH2M HILL with the design flow rate and the design HGL of the channel. CH2M HILL will need to evaluate the hydraulic impacts to the channel and ensure the minimal HGL impact to the upstream reaches.
 - b. LACDPW will review the analysis and provide comments.
 - c. Amir noted that maintenance access to the RCB could be an issue with the channel.
7. Jamal Al-Mashat from AECOM described the light rail transit alternative and potential impacts on the basin, located on the east side of the I-710 south of I-10. The elevated LRT alignment passes near this basin.
 - a. Jamal noted that there will not be any construction proposed in the basin but there are proposed bridge piers just north of this area.
 - b. Amir said to evaluate the piers and see if they will have any effect on the basin.

Action Items:

1. Erik Bautista to send Tom Ionta design criteria for the Dorchester channel and the 2 basins.
2. CH2M HILL to determine impacts to the hydraulics of the facilities and propose mitigation solutions for LACDPW to review.
3. AECOM will evaluate the piers along the southerly basin to confirm there is no impact to the LACDPW basin.

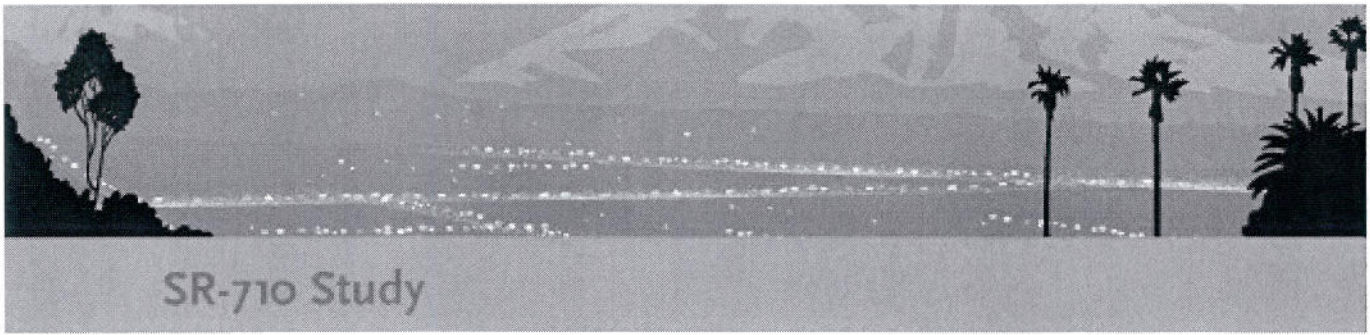




**SR 710 Study
LACDPW Coordination Meeting**

Date: January 22, 2013
Location: LACDPW

Name	Role	Agency	Phone	E-mail	Initial
Smith, Michelle	Project Manager	Metro	213-922-3057	smithmi@metro.net	MS
Govan, Cleavon	Environmental Lead	Metro	213-922-3034	govanc@metro.net	
Higa, Derek	Design Manager	Caltrans	213-897-0394	derek.higa@dot.ca.gov	DH
Saghafi, Abdi	Corridor Manager	Caltrans	213-897-9810	abdi.saghafi@dot.ca.gov	
Gaur, Jatinder		Caltrans		jatinder.gaur@dot.ca.gov	
Kung, Ainsley		Caltrans		ainsley.kung@dot.ca.gov	AK
Thurrow, Jim		LACDPW	626 458-7844	jthurrow@dpw.lacounty.cog	JT
Lasao, Manolito		LACDPW		mlasao@dpw.lacounty.gov	
Zandieh, Amir		LACDPW		azandieh@dpw.lacounty.gov	AZ
Chandran, Yoga	Project Manager	CH2M HILL	714-435-6111	Cyoga.Chandran@ch2m.com	YC
Ionta, Tom	Engineering	CH2M HILL	714-435-6238	tionta@ch2m.com	
Mitry, Ryan	Engineering	CH2M HILL	714-435-6337	rmitry@ch2m.com	Rm
Hsu, George	Drainage	CH2M HILL	714-435-6205	melissa.delapena@ch2m.com	GH
Greene, Steve	AA/Transit	AECOM	213-330-7182	steve.greene@aecom.com	
Acuna, Lilly	Project Assisatant	CH2M HILL	213-228-8250	lacuna@ch2m.com	
JAMES AL. HASNAFI	PROJECT ENGINEER MANAGER	AECOM	213-330-7235	JAMES.AL.HASNAFI@AECOM.COM	J.A.
ERIK BAUTISTA		LADPW	626 458 7164	ebautista@dpw.lacounty.gov	
				See record	



SR 710 North Study
Draft - Meeting Summary Notes
LACDPW Hydraulic Discussion Meeting

PREPARED FOR: Michelle Smith/Metro

PREPARED BY: CH2M HILL

DATE: April 03, 2013

TIME: 10:00 a.m.

LOCATION: LACDPW Office, Alhambra, CA

ATTENDEES: See attached sign-in sheet.

OVERVIEW: The purpose of the meeting was to discuss the alternatives for Dorchester Channel and Laguna Regulating Basin and solicit feedback from LACFCD.

1. George H. started with a summary of the data provided by LACDPW since the last meeting on 1/22/2013. CH2M HILL obtained the Dorchester channel design flows on 3/11/2013 from the original design report. The report was in microfilm format and the calculations were prepared by hand in 1995. George A. also provided some as-builts of the basin. The basin storage curve and FEMA floodplain map are still pending.
2. George H. gave an introduction of the channel layout, developed from the channel as-builts, and the two rectangular concrete channel (RCC) segments, impacted by the proposed roadway. The impacted segments of 20 ft channel width will be converted to double-barrel reinforced concrete boxes (RCBs). From upstream to downstream, there will be 3 openings – approximately 150 ft, 250 ft, and 50 ft long, respectively. The curvilinear channel alignment will remain unchanged because of housing on the west side of the channel. The channel design flows were based on the design report.
3. Amir said the LACDPW has switched from rainfall zoning to isohyets method a few years ago. CH2M HILL has the choice of re-investigating the whole watershed hydrology based on the new method, which could produce 30 to 40% less in the peak flows.
4. George H. presented the channel hydraulics of the existing and 4 proposed alternatives, assuming low tailwater condition. The analyses were mainly to address the mitigation



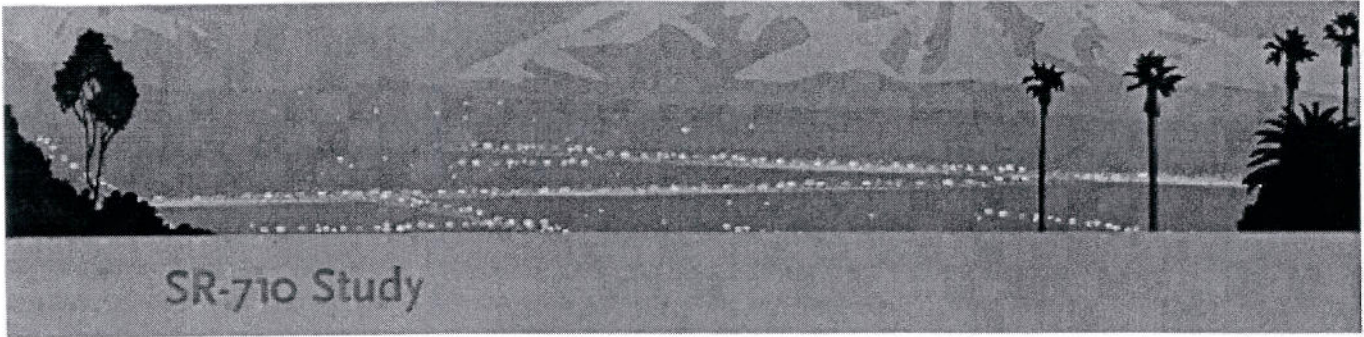
issues and would apply to most of flow conditions. With the channel slope steeper than 0.82%, the flow will be supercritical and the hydraulic grade line (HGL) is sensitive to channel size. The results showed that a smaller RCB width (9.67 ft each barrel) as that of under Hellman Avenue would provide the best results. The HGL in the proposed RCB will be unavoidably higher due to additional friction caused by the partition wall in the box. A wider RCB actually would cause a higher HGL and potential for a hydraulic jump. Under the best alternative, the maximum HGL impact is about 2.13 ft within the new RCB segment. The RCB will not be “sealed” or under pressure. There will be no hydraulic jump within the project reach and no impact to existing RCB upstream of the existing RCC.

5. Amir said higher HGLs occurring in the proposed RCB could be acceptable, as long as it does not cause flooding in the upstream reaches. He was concerned about the high tailwater condition in the basin to which the channel discharges. George H. said the 1955 design report started the calculations at Valley Blvd. assuming a HGL at the RCB soffit. The calculations did not include the downstream reaches or the basin. If a high tailwater was used in the model, the whole channel will be flooded, even under the existing condition. But the flooding will not reach the surrounding houses, at approximately Elev. 390 ft. The high tailwater condition will be assessed to conduct the floodplain mapping.
6. The discussion then moved to the basin. George A. said Water Resource Department (WRD) did not study the whole system north of the I-10 Freeway. It was unclear what the design basin elevation was or the chance of overflow from the crest onto the I-10 Freeway. There was no record of basin overflow in the past, even in the very wet years. George A. cannot find any hydrologic analysis to support why the spillway crest was raised in 1992 from Elev. 374.0 to 380.3 ft or would it adversely impact the upstream channel.
7. George H. stated that no record of flooding in this area seems to support the fact that the channel and basin were over-designed. George H. questioned where the water would go if it overflowed onto the I-10 and I-710 interchange, as the storage in the interchange area is very limited without flooding the I-10 Freeway. George H. then explained the potential impact to the basin from the roadway widening. There will be about 900 ft longitudinal encroachment into the basin storage volume with widths varying from zero to 20 ft. It will be difficult to restore the access road on the top of the basin, along the northbound side of the SR-710 freeway. Instead, CH2M HILL proposes to provide a pull-out and driveway from the I-10 connector to connect to the existing access road. To address the encroachment to the storage, CH2M HILL is proposing to calculate and compare the storage volumes between the existing and proposed conditions based on the 2012 project topo contours. Instead of a retaining wall, a bridge overhanging structure could be proposed for the roadway widening, which will minimize the volume reduction. If feasible, additional basin grading will be proposed to compensate any volume loss. Every effort will be taken to restore the original storage volume.

8. Amir asked George A. to contact WRD again about the hydrologic modeling of the basin. If such analysis was not conducted, the LACDPW will not impose extra requirements to ask CH2M HILL to conduct a further study. In this case, he would agree that the approaches proposed by CH2M HILL seem reasonable. He said the LACDPW could accept the mitigation for the basin access road.
9. George A. asked if CH2M HILL should study an alternative to divert some flow from the channel before entering the basin, as the downstream RCC may have extra capacity. The new storm drain could run along the west side of I-710 to connect the open channel south of I-10 Freeway. George H. said the idea seems to defeat the purpose of using the basin for the peak flow attenuation. He pointed out some hydraulic problems of this idea, such as adding more flow to the downstream RCC and potential hydraulic instability at the diverting junction structure. George H. said such idea could be explored by the LACDPW as part of the master drainage plan, and not for this roadway project. In addition, this alternative may extend the environmental footprint beyond the current project limit. The new storm drain will be about 5,500 ft long and very costly to go under I-10 Freeway and connectors.
10. George H. said that CH2M HILL will prepare a preliminary drainage report to document the hydraulic analyses on the channel and basin mitigations. The report will be ready for LACDPW's review in a few weeks. In the meantime, CH2M HILL provided a set of as-builts, WSPG runs, and summary of results to George A. and asked for feedback on the hydraulic analyses from LACDPW.

Action Items:

1. George A. to check WRD about the basin routing and storage curve.
2. CH2M HILL to prepare a preliminary drainage report to document the hydraulic analyses on the channel and basin mitigations for LACDPW to review.
3. George A. to provide FEMA floodplain map of the channel and basin, if available.



SR-710 Study

SR-710 North Study
 LACDPW Hydraulic Discussion Meeting
 4/03/13 @ 10:00 am

ATTENDANCE FORM

Name	Role	Agency	Phone	E-mail
Wai Chen	Drainage	CH2M HILL	714-435-6156	wai.chen@ch2m.com
George Hsu	"	"	714-435-6205	ghsu2@ch2m.com
George Antakli	Design Division	LACDPW	626-458-7959	gambdd
Amir Zandh	"	"	" - " 7894	azandh@ladpw



Appendix B

Hydraulic Analysis

CARD	SECT	CHN	NO OF	AVE	PIER	HEIGHT	1	BASE	ZL	ZR	INV	Y(1)	Y(2)	Y(3)	Y(4)	Y(5)	Y(6)	Y(7)	Y(8)	Y(9)	Y(10)	
CODE	NO	TYPE	PIER/PIP	WIDTH	DIAMETER	WIDTH		DROP														
CD	1	3		.670	12.750	20.000	.000	.000	.00													
CD	2	2	0	.000	14.000	20.000	.000	.00														
CD	3	4	1		6.000																	
CD	4	3	1	.670	12.000	20.670	.000	.000	.00													
CD	5	3	1	.670	12.000	20.670	.000	.000	.00													
CD	6	3	0	.000	12.000	9.730	.000	.000	.00													
CD	7	3	0	.000	13.250	10.250	.000	.000	.00													
CD	8	3	0	.000	12.500	11.000	.000	.000	.00													
CD	9	4	1		3.750																	
CD	10	4	1		3.000																	
CD	11	4	1		2.000																	
CD	12	4	1		2.500																	
CD	13	2	0	.000	14.000	20.670	.000	.000	.00													
CD	14	3	0	.000	12.000	10.000	.000	.000	.00													

HEADING LINE NO 1 IS - WATER SURFACE PROFILE - TITLE CARD LISTING

HEADING LINE NO 2 IS - SR-710 NORTH STUDY

HEADING LINE NO 3 IS - DORCHESTER DRAIN LINE-A EAST & LINE-B (Existing) (NGVD 29)

MODEL: W.CHEN REVIEW: G.HSU

WATER SURFACE PROFILE - ELEMENT CARD LISTING

ELEMENT NO	IS A	SYSTEM	OUTLET	STATION	INVERT	SECT	W S P G W	W S ELEV	RADIUS	ANGLE	ANG PT	MAN H
1	IS A	SYSTEM	OUTLET	491.000	351.820	1		364.500	249.990	-5.959		0
2	IS A	TRANSITION							249.993	-6.195		0
3	IS A	REACH										0
4	IS A	REACH										0
5	IS A	REACH										0
6	IS A	JUNCTION										0
7	IS A	REACH										0

Existing

ELEMENT NO	8 IS A REACH	STATION	INVERT	SECT	N	RADIUS	ANGLE	ANG PT	MAN H
	U/S DATA	1173.800	357.431	1	.013	.000	.000	.000	0
ELEMENT NO	9 IS A REACH	STATION	INVERT	SECT	N	RADIUS	ANGLE	ANG PT	MAN H
	U/S DATA	1250.000	358.060	1	.013	249.996	17.464	.000	0
ELEMENT NO	10 IS A BRIDGE ENTRANCE	STATION	INVERT	SECT	FP				
	U/S DATA	1250.000	358.060	2	.100				
ELEMENT NO	11 IS A REACH	STATION	INVERT	SECT	N	RADIUS	ANGLE	ANG PT	MAN H
	U/S DATA	1279.740	358.304	2	.014	249.996	6.816	.000	0
ELEMENT NO	12 IS A REACH	STATION	INVERT	SECT	N	RADIUS	ANGLE	ANG PT	MAN H
	U/S DATA	1309.000	358.543	2	.014	249.996	-6.706	.000	0
W S P G W									
WATER SURFACE PROFILE - ELEMENT CARD LISTING									
ELEMENT NO	13 IS A REACH	STATION	INVERT	SECT	N	RADIUS	ANGLE	ANG PT	MAN H
	U/S DATA	1398.800	359.279	2	.014	250.008	-20.580	.000	0
ELEMENT NO	14 IS A REACH	STATION	INVERT	SECT	N	RADIUS	ANGLE	ANG PT	MAN H
	U/S DATA	1485.000	359.985	2	.014	2000.362	-2.469	.000	0
ELEMENT NO	15 IS A JUNCTION	STATION	INVERT	SECT	Q3	INVERT-3	INVERT-4	PHI 3	PHI 4
	U/S DATA	1505.000	360.149	2	.014	361.500	.000	60.000	.000
						RADIUS	ANGLE		
						1999.853	-5.73		
ELEMENT NO	16 IS A REACH	STATION	INVERT	SECT	N	RADIUS	ANGLE	ANG PT	MAN H
	U/S DATA	1754.090	362.189	2	.014	1999.972	-7.136	.000	0
ELEMENT NO	17 IS A REACH	STATION	INVERT	SECT	N	RADIUS	ANGLE	ANG PT	MAN H
	U/S DATA	2013.400	364.313	2	.014	424.982	-34.960	.000	0
ELEMENT NO	18 IS A REACH	STATION	INVERT	SECT	N	RADIUS	ANGLE	ANG PT	MAN H
	U/S DATA	2190.000	365.760	2	.014	425.001	23.808	.000	0
ELEMENT NO	19 IS A JUNCTION	STATION	INVERT	SECT	Q3	INVERT-3	INVERT-4	PHI 3	PHI 4
	U/S DATA	2220.000	366.005	2	.014	367.000	.000	60.000	.000
						RADIUS	ANGLE		
						425.043	4.044		
ELEMENT NO	20 IS A REACH	STATION	INVERT	SECT	N	RADIUS	ANGLE	ANG PT	MAN H
	U/S DATA	2264.530	366.370	2	.014	425.018	6.003	.000	0
ELEMENT NO	21 IS A REACH	STATION	INVERT	SECT	N	RADIUS	ANGLE	ANG PT	MAN H
	U/S DATA	2450.000	367.893	2	.014	500.007	-21.253	.000	0
ELEMENT NO	22 IS A JUNCTION	STATION	INVERT	SECT	Q3	INVERT-3	INVERT-4	PHI 3	PHI 4
	U/S DATA	2482.310	368.158	2	.014	370.000	.000	45.000	.000
						RADIUS	ANGLE		

W S P G W

WATER SURFACE PROFILE - ELEMENT CARD LISTING

ELEMENT NO	23 IS A REACH	U/S DATA	STATION	INVERT	SECT	N	RADIUS	ANGLE	ANG PT	MAN H
			2550.000	368.714	2	.014	.000	.000	.000	0
ELEMENT NO	24 IS A REACH	U/S DATA	STATION	INVERT	SECT	N	RADIUS	ANGLE	ANG PT	MAN H
			2625.000	369.330	2	.014	.000	.000	.000	0
ELEMENT NO	25 IS A TRANSITION	U/S DATA	STATION	INVERT	SECT	N	RADIUS	ANGLE		
			2675.000	369.970	13	.014	.000	.000		

ELEMENT NO	26 IS A BRIDGE EXIT	U/S DATA	STATION	INVERT	SECT					
			2675.000	369.970	4					
ELEMENT NO	27 IS A REACH	U/S DATA	STATION	INVERT	SECT	N	RADIUS	ANGLE	ANG PT	MAN H
			2780.000	370.661	4	.013	.000	.000	.000	0
ELEMENT NO	28 IS A JUNCTION	U/S DATA	STATION	INVERT	SECT	Q3	INVERT-3	INVERT-4	PHI 3	PHI 4
			2790.000	370.727	4	50.000	371.500	.000	60.000	.000

ELEMENT NO	29 IS A REACH	U/S DATA	STATION	INVERT	SECT	N	RADIUS	ANGLE	ANG PT	MAN H
			2957.510	371.830	4	.013	.000	.000	.000	0
ELEMENT NO	30 IS A TRANSITION	U/S DATA	STATION	INVERT	SECT	N	RADIUS	ANGLE		
			2982.510	372.380	5	.013	.000	.000		
ELEMENT NO	31 IS A REACH	U/S DATA	STATION	INVERT	SECT	N	RADIUS	ANGLE	ANG PT	MAN H
			3189.300	374.520	5	.013	.000	.000	-5.027	1

ELEMENT NO	32 IS A JUNCTION	U/S DATA	STATION	INVERT	SECT	Q3	INVERT-3	INVERT-4	PHI 3	PHI 4
			3199.300	374.623	5	45.000	374.623	.000	-90.000	.000

W S P G W

WATER SURFACE PROFILE - ELEMENT CARD LISTING

ELEMENT NO	33 IS A REACH	U/S DATA	STATION	INVERT	SECT	N	RADIUS	ANGLE	ANG PT	MAN H
			3223.120	374.870	5	.013	.000	.000	.000	1
ELEMENT NO	34 IS A REACH	U/S DATA	STATION	INVERT	SECT	N	RADIUS	ANGLE	ANG PT	MAN H
			3303.900	375.980	5	.013	.000	.000	.000	0
ELEMENT NO	35 IS A TRANSITION	U/S DATA	STATION	INVERT	SECT	N	RADIUS	ANGLE		
			3308.900	376.015	4	.013	.000	.000		

ELEMENT NO	36 IS A TRANSITION	U/S DATA	STATION	INVERT	SECT	N	RADIUS	ANGLE		
			3329.440	376.159	4	.013	.000	.000		

ELEMENT NO	IS A	REACH	U/S DATA	STATION	INVERT	SECT	LAT-1	LAT-2	Q3	Q4	INVERT-3	INVERT-4	PHI 3	PHI 4	RADIUS	ANGLE	MAN H
38	IS A	JUNCTION	U/S DATA	3345.180	376.270	4	*	*							.000	.000	
				3355.180	376.384	4	11	0	48.000		376.384	.000	-90.000	.000			
39	IS A	REACH	U/S DATA	3599.630	379.180	4	*	*							.000	.000	1
40	IS A	REACH	U/S DATA	3625.790	379.479	4	*	*							350.039	-4.282	0
41	IS A	REACH	U/S DATA	3887.300	382.470	4	*	*							.000	.000	0
42	IS A	JUNCTION	U/S DATA	3897.300	382.584	4	11	0	48.000		382.584	.000	-90.000	.000			

W S P G W
WATER SURFACE PROFILE - ELEMENT CARD LISTING

ELEMENT NO	IS A	REACH	U/S DATA	STATION	INVERT	SECT	LAT-1	LAT-2	Q3	Q4	INVERT-3	INVERT-4	PHI 3	PHI 4	RADIUS	ANGLE	MAN H
43	IS A	REACH	U/S DATA	4089.300	384.780	4	*	*							.000	.000	0
44	IS A	JUNCTION	U/S DATA	4135.720	385.310	14	14	0	2335.000		385.310	.000	-90.000	.000			
45	IS A	REACH	U/S DATA	4141.600	385.389	14	*	*							.000	.000	0
46	IS A	REACH	U/S DATA	4211.510	386.322	14	*	*							380.031	10.540	1
47	IS A	REACH	U/S DATA	4223.540	386.483	14	*	*							.000	.000	0
48	IS A	TRANSITION	U/S DATA	4243.540	386.750	6	*	*							.000	.000	
49	IS A	REACH	U/S DATA	4420.540	389.120	6	*	*							.000	.000	0
50	IS A	TRANSITION	U/S DATA	4440.540	390.218	7	*	*							.000	.000	
51	IS A	TRANSITION	U/S DATA	4453.210	390.913	7	*	*							230.017	-3.156	

ELEMENT NO	52	IS	A	TRANSITION	*	STATION	4463.540	INVERT	391.480	SECT	7	N	.013	RADIUS	230.031	ANGLE	-2.573	ANG PT	MAN	H	
				U/S DATA	*																
ELEMENT NO	53	IS	A	REACH	*	STATION	4497.740	INVERT	391.638	SECT	7	N	.013	RADIUS	229.991	ANGLE	-8.520	ANG PT	MAN	H	
				U/S DATA	*																
ELEMENT NO	54	IS	A	REACH	*	STATION	4579.220	INVERT	392.015	SECT	7	N	.013	RADIUS	.000	ANGLE	.000	ANG PT	MAN	H	
				U/S DATA	*																

W S P G W

WATER SURFACE PROFILE - ELEMENT CARD LISTING

ELEMENT NO	55	IS	A	TRANSITION	*	STATION	4595.380	INVERT	392.089	SECT	7	N	.013	RADIUS	.000	ANGLE	.000	ANG PT	MAN	H	
				U/S DATA	*																
ELEMENT NO	56	IS	A	REACH	*	STATION	4623.640	INVERT	392.220	SECT	7	N	.013	RADIUS	.000	ANGLE	.000	ANG PT	MAN	H	
				U/S DATA	*																
ELEMENT NO	57	IS	A	REACH	*	STATION	4703.020	INVERT	393.220	SECT	7	N	.013	RADIUS	.000	ANGLE	.000	ANG PT	MAN	H	
				U/S DATA	*																
ELEMENT NO	58	IS	A	TRANSITION	*	STATION	4713.020	INVERT	393.340	SECT	7	N	.013	RADIUS	.000	ANGLE	.000	ANG PT	MAN	H	
				U/S DATA	*																
ELEMENT NO	59	IS	A	REACH	*	STATION	4739.960	INVERT	393.663	SECT	7	N	.013	RADIUS	.000	ANGLE	.000	ANG PT	MAN	H	
				U/S DATA	*																
ELEMENT NO	60	IS	A	REACH	*	STATION	4880.820	INVERT	395.350	SECT	7	N	.013	RADIUS	155.850	ANGLE	51.785	ANG PT	MAN	H	
				U/S DATA	*																
ELEMENT NO	61	IS	A	REACH	*	STATION	5191.140	INVERT	397.650	SECT	7	N	.013	RADIUS	.000	ANGLE	.000	ANG PT	MAN	H	
				U/S DATA	*																
ELEMENT NO	62	IS	A	REACH	*	STATION	5383.640	INVERT	399.749	SECT	7	N	.013	RADIUS	238.851	ANGLE	46.177	ANG PT	MAN	H	
				U/S DATA	*																
ELEMENT NO	63	IS	A	TRANSITION	*	STATION	5392.380	INVERT	399.844	SECT	7	N	.013	RADIUS	238.908	ANGLE	2.096	ANG PT	MAN	H	
				U/S DATA	*																
ELEMENT NO	64	IS	A	TRANSITION	*	STATION	5406.640	INVERT	400.000	SECT	7	N	.013	RADIUS	.000	ANGLE	.000	ANG PT	MAN	H	
				U/S DATA	*																
ELEMENT NO	65	IS	A	SYSTEM HEADWORKS	*	STATION	5406.640	INVERT	400.000	SECT	7	N	.013	RADIUS	.000	ANGLE	.000	ANG PT	MAN	H	
				U/S DATA	*																

W S ELEV
400.000

SR-710 NORTH STUDY
 DORCHESTER DRAIN LINE-A EAST & LINE-B (Existing) (NGVD 29)
 MODEL: W.CHEN REVIEW: G.HSU

Station	Invert Elev	Depth (FT)	Water Elev	Q (CFS)	Vel (FPS)	Vel Head	Energy Grd.El.	Super Elev	Critical Depth	Flow Top Width	Height/Dia.-FT	Base Wt or I.D.	ZL	No Wth Prs/Pip	
491.000	351.820	11.941	363.761	5481.00	23.75	8.76	372.52	12.75	12.75	20.00	12.750	20.000	.00	1 .7	
TRANS STR	.0082				.0083		.22	12.75	1.23		.013	.00	.00	BOX	
----- WARNING - Flow depth near top of box conduit -----															
517.000	352.033	11.920	363.953	5481.00	23.79	8.79	372.74	12.75	12.75	20.00	12.750	20.000	.00	1 .7	
27.030	.0082				.0084		.23	12.75	1.24	12.00	.013	.00	.00	BOX	
----- WARNING - Flow depth near top of box conduit -----															
544.030	352.255	11.912	364.167	5481.00	23.80	8.80	372.97	.00	12.75	20.00	12.750	20.000	.00	1 .7	
371.970	.0082				.0086		3.19	11.91	1.24	12.00	.013	.00	.00	BOX	
----- WARNING - Flow depth near top of box conduit -----															
916.000	355.310	11.648	366.958	5481.00	24.34	9.20	376.16	12.75	12.75	20.00	12.750	20.000	.00	1 .7	
162.000	.0082				.0090		1.46	12.75	1.28	12.00	.013	.00	.00	BOX	
----- WARNING - Flow depth near top of box conduit -----															
1078.000	356.640	11.440	368.080	5481.00	24.79	9.54	377.62	12.75	12.75	20.00	12.750	20.000	.00	1 .7	
JUNCT STR	.0083				.0095		.09	12.75	1.31		.013	.00	.00	BOX	

SR-710 NORTH STUDY
 DORCHESTER DRAIN LINE-A EAST & LINE-B (Existing) (NGVD 29)
 MODEL: W.CHEN REVIEW: G.HSU

Station	Invert Elev	Depth (FT)	Water Elev	Q (CFS)	Vel (FPS)	Vel Head	Energy Grd.El.	Super Elev	Critical Depth	Flow Top Width	Height/Dia.-FT	Base Wt or I.D.	ZL	No Wth Prs/Pip
1088.000	356.723	11.111	367.834	5451.00	25.38	10.00	377.84	1.55	12.75	20.00	12.750	20.000	.00	1 .7
65.800	.0083				.0099		.65	12.66	1.36	11.92	.013	.00	.00	BOX
1153.800	357.266	10.980	368.246	5451.00	25.68	10.24	378.49	.00	12.75	20.00	12.750	20.000	.00	1 .7
20.000	.0083				.0101		.20	10.98	1.39	11.92	.013	.00	.00	BOX
1173.800	357.431	10.937	368.368	5451.00	25.78	10.32	378.69	1.60	12.75	20.00	12.750	20.000	.00	1 .7
76.200	.0083				.0103		.79	12.53	1.40	11.92	.013	.00	.00	BOX
1250.000	358.060	10.767	368.827	5451.00	26.19	10.65	379.48	1.65	12.75	20.00	12.750	20.000	.00	1 .7
BRIDGE ENTRANCE														
1250.000	358.060	10.041	368.101	5451.00	27.14	11.44	379.54	1.83	13.21	20.00	14.000	20.000	.00	0 .0
29.740	.0082				.0076		.23	11.87	1.51	9.77	.014	.00	.00	RECTANG
1279.740	358.304	10.055	368.359	5451.00	27.11	11.41	379.77	1.83	13.21	20.00	14.000	20.000	.00	0 .0
29.260	.0082				.0076		.22	11.88	1.51	9.79	.014	.00	.00	RECTANG
1309.000	358.543	10.068	368.611	5451.00	27.07	11.38	379.99	1.82	13.21	20.00	14.000	20.000	.00	0 .0
89.800	.0082				.0075		.68	11.89	1.50	9.77	.014	.00	.00	RECTANG
1398.800	359.279	10.116	369.395	5451.00	26.94	11.27	380.67	.23	13.21	20.00	14.000	20.000	.00	0 .0
86.200	.0082				.0074		.64	10.34	1.49	9.78	.014	.00	.00	RECTANG
1485.000	359.985	10.171	370.156	5451.00	26.80	11.15	381.31	.22	13.21	20.00	14.000	20.000	.00	0 .0
JUNCT STR	.0082				.0075		.15	10.39	1.48		.014	.00	.00	RECTANG

SR-710 NORTH STUDY
 DORCHESTER DRAIN LINE-A EAST & LINE-B (Existing) (NGVD 29)
 MODEL: W.CHEN REVIEW: G.HSU

Station	Invert Elev	Depth (FT)	Water Elev	Q (CFS)	Vel (FPS)	Vel Head	Energy Grd.El.	Super Elev	Critical Depth	Flow Top Width	Height/Dia. -FT	Base Wt or I.D.	ZL	No Wth Prs/Pip
L/Elem	Ch Slope				SF Ave		SE Dpth	Froude N	Norm Dp	"N"	X-Fall	ZR	Type Ch	
1505.000	360.149	9.997	370.146	5422.00	27.12	11.42	381.57	.23	13.17	20.00	14.000	20.000	.00	0 .0
249.090	.0082				.0075		1.87	10.23	1.51	9.74	.014	.00	.00	RECTANG
1754.090	362.189	10.136	372.325	5422.00	26.75	11.11	383.43	1.05	13.17	20.00	14.000	20.000	.00	0 .0
259.310	.0082				.0071		1.85	11.18	1.48	9.74	.014	.00	.00	RECTANG
2013.400	364.313	10.383	374.696	5422.00	26.11	10.59	385.28	1.00	13.17	20.00	14.000	20.000	.00	0 .0
176.600	.0082				.0067		1.18	11.38	1.43	9.74	.014	.00	.00	RECTANG
2190.000	365.760	10.662	376.422	5422.00	25.43	10.04	386.46	.94	13.17	20.00	14.000	20.000	.00	0 .0
JUNCT STR	.0082				.0066		.20	11.61	1.37		.014	.00	.00	RECTANG
2220.000	366.005	10.431	376.436	5392.00	25.85	10.37	386.81	.98	13.12	20.00	14.000	20.000	.00	0 .0
44.530	.0082				.0067		.30	11.41	1.41	9.70	.014	.00	.00	RECTANG
2264.530	366.370	10.500	376.870	5392.00	25.68	10.24	387.11	.82	13.12	20.00	14.000	20.000	.00	0 .0
185.470	.0082				.0063		1.17	11.32	1.40	9.69	.014	.00	.00	RECTANG
2450.000	367.893	10.923	378.816	5392.00	24.68	9.46	388.28	.76	13.12	20.00	14.000	20.000	.00	0 .0
JUNCT STR	.0082				.0062		.20	11.68	1.32		.014	.00	.00	RECTANG
2482.310	368.158	10.512	378.670	5339.00	25.39	10.01	388.68	.00	13.03	20.00	14.000	20.000	.00	0 .0
67.690	.0082				.0064		.43	10.51	1.38	9.62	.014	.00	.00	RECTANG
2550.000	368.714	10.657	379.371	5339.00	25.05	9.74	389.11	.00	13.03	20.00	14.000	20.000	.00	0 .0
75.000	.0082				.0061		.46	10.66	1.35	9.62	.014	.00	.00	RECTANG

Program Package Serial Number: 1806

Date: 8-23-2013 Time:10:47: 1

WATER SURFACE PROFILE LISTING

SR-710 NORTH STUDY

DORCHESTER DRAIN LINE-A EAST & LINE-B (Existing) (NGVD 29)

MODEL: W.CHEN REVIEW: G.HSU

Station	Invert Elev	Depth (FT)	Water Elev	Q (CFS)	Vel (FPS)	Vel Head	Energy Grd.El.	Super Elev	Critical Depth	Flow Top Width	Height/Dia.-FT	Base Wt or I.D.	ZL	No Wth Prs/Pip	
L/Elem	Ch Slope				SF Ave		HF	SE Dpth	Froude N	Norm Dp	"N"	X-Fall	ZR	Type Ch	
2625.000	369.330	10.861	380.191	5339.00	24.58	9.38	389.57	.00	13.03	20.00	14.000	20.000	.00	0 .0	
TRANS STR	.0128				.0060		.30	10.86	1.31		.014	.00	.00	RECTANG	
2675.000	369.970	10.485	380.455	5339.00	24.63	9.42	389.88	.00	12.75	20.67	14.000	20.670	.00	0 .0	
BRIDGE EXIT															
2675.000	369.970	11.384	381.354	5339.00	23.45	8.54	389.89	.00	12.00	20.67	12.000	20.670	.00	1 .7	
105.000	.0066				.0083		.87	11.38	1.25	12.00	.013	.00	.00	BOX	
----- WARNING - Flow depth near top of box conduit -----															
2780.000	370.661	11.068	381.729	5339.00	24.12	9.03	390.76	.00	12.00	20.67	12.000	20.670	.00	1 .7	
JUNCT STR	.0066				.0089		.09	11.07	1.30		.013	.00	.00	BOX	
----- WARNING - Flow depth near top of box conduit -----															
2790.000	370.727	10.601	381.328	5289.00	24.95	9.66	390.99	.00	12.00	20.67	12.000	20.670	.00	1 .7	
27.323	.0066				.0094		.26	10.60	1.37	12.00	.013	.00	.00	BOX	
2817.323	370.907	10.509	381.416	5289.00	25.16	9.83	391.25	.00	12.00	20.67	12.000	20.670	.00	1 .7	
140.187	.0066				.0101		1.42	10.51	1.39	12.00	.013	.00	.00	BOX	
2957.510	371.830	10.020	381.850	5289.00	26.39	10.82	392.67	.00	12.00	20.67	12.000	20.670	.00	1 .7	
TRANS STR	.0220				.0104		.26	10.02	1.49		.013	.00	.00	BOX	

SR-710 NORTH STUDY
 DORCHESTER DRAIN LINE-A EAST & LINE-B (Existing) (NGVD 29)
 MODEL: W.CHEN REVIEW: G.HSU

Station	Invert Elev	Depth (FT)	Water Elev	Q (CFS)	Vel (FPS)	Vel Head	Energy Grd.El.	Super Elev	Critical Depth	Flow Top Width	Flow Top Dia.	Height/FT or I.D.	Base Wt	ZL	No Wth Prs/Pip
2982.510	372.380	10.243	382.623	5289.00	25.82	10.35	392.97	.00	12.00	20.67	12.000	20.670	.00	.00	1 .7
206.790	.0103				.0101		2.08	10.24	1.45	10.16	.013	.00	.00	.00	BOX
3189.300	374.520	10.300	384.820	5289.00	25.68	10.24	395.06	.00	12.00	20.67	12.000	20.670	.00	.00	1 .7
JUNCT STR	.0103				.0103		.10	10.30	1.43		.013	.00	.00	.00	BOX
3199.300	374.623	9.965	384.588	5244.00	26.31	10.75	395.34	.00	12.00	20.67	12.000	20.670	.00	.00	1 .7
23.820	.0104				.0107		.25	9.96	1.49	10.08	.013	.00	.00	.00	BOX
3223.120	374.870	9.959	384.829	5244.00	26.33	10.76	395.59	.00	12.00	20.67	12.000	20.670	.00	.00	1 .7
80.780	.0137				.0104		.84	9.96	1.49	8.99	.013	.00	.00	.00	BOX
3303.900	375.980	10.211	386.191	5244.00	25.68	10.24	396.43	.00	12.00	20.67	12.000	20.670	.00	.00	1 .7
TRANS STR	.0070				.0101		.05	10.21	1.44		.013	.00	.00	.00	BOX
3308.900	376.015	10.185	386.200	5244.00	25.74	10.29	396.49	.00	12.00	20.67	12.000	20.670	.00	.00	1 .7
TRANS STR	.0070				.0102		.21	10.19	1.45		.013	.00	.00	.00	BOX
3329.440	376.159	10.081	386.240	5244.00	26.01	10.50	396.74	.00	12.00	20.67	12.000	20.670	.00	.00	1 .7
TRANS STR	.0071				.0105		.16	10.08	1.47		.013	.00	.00	.00	BOX
3345.180	376.270	10.002	386.272	5244.00	26.21	10.67	396.94	.00	12.00	20.67	12.000	20.670	.00	.00	1 .7
JUNCT STR	.0114				.0109		.11	10.00	1.48		.013	.00	.00	.00	BOX
3355.180	376.384	9.677	386.061	5196.00	26.85	11.19	397.25	.00	12.00	20.67	12.000	20.670	.00	.00	1 .7
244.450	.0114				.0112		2.73	9.68	1.55	9.61	.013	.00	.00	.00	BOX

SR-710 NORTH STUDY
 DORCHESTER DRAIN LINE-A EAST & LINE-B (Existing) (NGVD 29)
 MODEL: W.CHEN REVIEW: G.HSU

Station	Invert Elev	Depth (FT)	Water Elev	Q (CFS)	Vel (FPS)	Vel Head	Energy Grd.EI.	Super Elev	Critical Depth	Flow Top Width	Height/Dia.-FT	Base Wt or I.D.	ZL	No Wth Prs/Pip
I/Elem	Ch Slope				SF Ave	HF	SE Dpth	Proude N	Norm Dp	"N"	X-Fall	ZR	Type Ch	
3599.630	379.180	9.727	388.907	5196.00	26.71	11.08	399.98	1.27	12.00	20.67	12.000	20.670	.00	1 .7
26.160	.0114				.0111		.29	10.99	1.53	9.61	.013	.00	.00	BOX
3625.790	379.479	9.734	389.213	5196.00	26.69	11.06	400.27	.00	12.00	20.67	12.000	20.670	.00	1 .7
261.510	.0114				.0109		2.86	9.73	1.53	9.61	.013	.00	.00	BOX
3887.300	382.470	9.840	392.310	5196.00	26.40	10.82	403.13	.00	12.00	20.67	12.000	20.670	.00	1 .7
JUNCT STR	.0114				.0111		.11	9.84	1.51		.013	.00	.00	BOX
3897.300	382.584	9.523	392.107	5148.00	27.03	11.34	403.45	.00	12.00	20.67	12.000	20.670	.00	1 .7
192.000	.0114				.0115		2.21	9.52	1.57	9.54	.013	.00	.00	BOX
4089.300	384.780	9.515	394.295	5148.00	27.05	11.36	405.66	.00	12.00	20.67	12.000	20.670	.00	1 .7
JUNCT STR	.0114				.0120		.56	9.52	1.57		.013	.00	.00	BOX
4135.720	385.310	9.913	395.223	2813.00	28.38	12.50	407.73	.00	12.00	10.00	12.000	10.000	.00	0 .0
5.880	.0134				.0124		.07	9.91	1.59	9.60	.013	.00	.00	BOX
4141.600	385.389	9.917	395.306	2813.00	28.37	12.49	407.80	.66	12.00	10.00	12.000	10.000	.00	0 .0
69.910	.0133				.0123		.86	10.57	1.59	9.63	.013	.00	.00	BOX
4211.510	386.322	9.964	396.286	2813.00	28.23	12.38	408.66	.00	12.00	10.00	12.000	10.000	.00	0 .0
12.030	.0134				.0123		.15	9.96	1.58	9.62	.013	.00	.00	BOX
4223.540	386.483	9.973	396.456	2813.00	28.21	12.36	408.81	.00	12.00	10.00	12.000	10.000	.00	0 .0
TRANS STR	.0133				.0121		.24	9.97	1.57		.013	.00	.00	BOX

Program Package Serial Number: 1806 Date: 8-23-2013 Time:10:47: 1
 WATER SURFACE PROFILE LISTING

SR-710 NORTH STUDY
 DORCHESTER DRAIN LINE-A EAST & LINE-B (Existing) (NGVD 29)
 MODEL: W.CHEN REVIEW: G.HSU

Station	Invert Elev	Depth (FT)	Water Elev	Q (CFS)	Vel (FPS)	Vel Head	Energy Grd.El.	Super Elev	Critical Depth	Flow Top Width	Height/Dia.-FT or I.D.	Base Wt	ZL	No Wth Prs/Pip
L/Elem	Ch Slope				SF Ave	HF	SE Dpth	Proude N	Norm Dp	"N"	X-Fall	ZR	Type Ch	
4243.540	386.750	10.440	397.190	2813.00	27.69	11.91	409.10	.00	12.00	9.73	12.000	9.730	.00	0 .0
177.000	.0134				.0115		2.03	10.44	1.51	9.93	.013	.00	.00	BOX
4420.540	389.120	10.722	399.842	2813.00	26.96	11.29	411.13	.00	12.00	9.73	12.000	9.730	.00	0 .0
TRANS STR	.0549				.0107		.21	10.72	1.45		.013	.00	.00	BOX
4440.540	390.218	10.429	400.647	2813.00	26.31	10.75	411.40	.96	13.25	10.25	13.250	10.250	.00	0 .0
TRANS STR	.0549				.0097		.12	11.39	1.44		.013	.00	.00	BOX
4453.210	390.913	10.944	401.857	2813.00	25.08	9.76	411.62	.87	13.25	10.25	13.250	10.250	.00	0 .0
TRANS STR	.0549				.0085		.09	11.81	1.34		.013	.00	.00	BOX
4463.540	391.480	11.531	403.011	2813.00	23.80	8.80	411.81	.39	13.25	10.25	13.250	10.250	.00	0 .0
34.200	.0046				.0082		.28	11.92	1.24	13.25	.013	.00	.00	BOX
4497.740	391.638	11.316	402.954	2813.00	24.25	9.13	412.09	.00	13.25	10.25	13.250	10.250	.00	0 .0
81.480	.0046				.0088		.72	11.32	1.27	13.25	.013	.00	.00	BOX
4579.220	392.015	10.840	402.855	2813.00	25.32	9.95	412.81	.00	13.25	10.25	13.250	10.250	.00	0 .0
TRANS STR	.0046				.0095		.15	10.84	1.36		.013	.00	.00	BOX
4595.380	392.089	10.682	402.771	2813.00	25.69	10.25	413.02	.00	13.25	10.25	13.250	10.250	.00	0 .0
28.260	.0046				.0098		.28	10.68	1.39	13.25	.013	.00	.00	BOX
4623.640	392.220	10.530	402.750	2813.00	26.06	10.55	413.30	.00	13.25	10.25	13.250	10.250	.00	0 .0
79.380	.0126				.0097		.77	10.53	1.42	9.58	.013	.00	.00	BOX

Program Package Serial Number: 1806

Date: 8-23-2013 Time:10:47: 1

WATER SURFACE PROFILE LISTING

SR-710 NORTH STUDY

DORCHESTER DRAIN LINE-A EAST & LINE-B (Existing) (NGVD 29)

MODEL: W.CHEN REVIEW: G.HSU

Station	Invert Elev	Depth (FT)	Water Elev	Q (CFS)	Vel (FPS)	Vel Head	Energy Grd.El.	Super Elev	Critical Depth	Flow Top Width	Height/Dia.-FT	Base Wt or I.D.	ZL	No Wth Prs/Pip
L/Elem	Ch Slope					SF Ave	HF	SE Dpth	Froude N	Norm Dp	"N"	X-Fall	ZR	Type Ch
4703.020	393.220	10.774	403.994	2813.00	25.47	10.07	414.07	.00	13.25	10.25	13.250	10.250	.00	0 .0
TRANS STR	.0120					.0094	.09	10.77	1.37		.013	.00	.00	BOX
4713.020	393.340	10.798	404.138	2813.00	25.42	10.03	414.17	.00	13.25	10.25	13.250	10.250	.00	0 .0
26.940	.0120					.0093	.25	10.80	1.36	9.77	.013	.00	.00	BOX
4739.960	393.663	10.885	404.548	2813.00	25.21	9.87	414.42	1.30	13.25	10.25	13.250	10.250	.00	0 .0
52.066	.0120					.0090	.47	12.18	1.35	9.78	.013	.00	.00	BOX
4792.026	394.287	11.087	405.373	2813.00	24.75	9.51	414.89	1.25	13.25	10.25	13.250	10.250	.00	0 .0
88.794	.0120					.0083	.74	12.34	1.31	9.78	.013	.00	.00	BOX
4880.820	395.350	11.628	406.978	2813.00	23.60	8.65	415.63	.00	13.25	10.25	13.250	10.250	.00	0 .0
310.320	.0074					.0082	2.56	11.63	1.22	11.91	.013	.00	.00	BOX
5191.141	397.650	11.184	408.833	2813.00	24.54	9.35	418.18	.80	13.25	10.25	13.250	10.250	.00	0 .0
47.437	.0109					.0085	.40	11.99	1.29	10.16	.013	.00	.00	BOX
5238.577	398.167	11.367	409.534	2813.00	24.14	9.05	418.59	.78	13.25	10.25	13.250	10.250	.00	0 .0
87.583	.0109					.0078	.69	12.14	1.26	10.16	.013	.00	.00	BOX
5326.160	399.122	11.922	411.044	2813.00	23.02	8.23	419.27	.71	13.25	10.25	13.250	10.250	.00	0 .0
42.513	.0109					.0070	.30	12.63	1.17	10.16	.013	.00	.00	BOX
5368.673	399.586	12.504	412.089	2813.00	21.95	7.48	419.57	.64	13.25	10.25	13.250	10.250	.00	0 .0
14.967	.0109					.0062	.09	13.15	1.09	10.16	.013	.00	.00	BOX

----- WARNING - Flow depth near top of box conduit -----

Station	Invert Elev	Depth (FT)	Water Elev	Q (CFS)	Vel (FPS)	Vel Head	Energy Grd.El.	Super Elev	Critical Depth	Flow Top Width	Height/Dia. -FT or I.D.	Base Wt	ZL	No Wth Prs/Pip	
L/Elem	Ch Slope				SF Ave	HF	SE Dpth	Froude N	Norm Dp	"N"	X-Fall	ZR	Type Ch		
5383.640	399.749	13.114	412.863	2813.00	20.93	6.80	419.66	13.25	13.25	10.25	13.250	10.250	.00	0	.0
TRANS STR	.0109					.0061	.05	13.25	1.02		.013	.00	.00	BOX	
----- WARNING - Flow depth near top of box conduit -----															
5392.380	399.844	12.816	412.660	2813.00	21.41	7.12	419.78	.00	13.25	10.25	13.250	10.250	.00	0	.0
TRANS STR	.0109					.0060	.09	12.82	1.05		.013	.00	.00	BOX	
----- WARNING - Flow depth near top of box conduit -----															
5406.640	400.000	13.250	413.250	2813.00	20.71	6.66	419.91	.00	13.25	10.25	13.250	10.250	.00	0	.0
TRANS STR															

SR-710 NORTH STUDY -- DORCHESTER CHANNEL MAJOR ALTERNATIVES SUMMARY

Preferred Alternative

Station	FL Elevation	Existing		P18		P19		All Covered		P20		P22		3 Opening		3 Opening HGL Above Ft.(ft)	Δ HGL (ft)
		Existing Channel Type	100% Q. (cfs)	HGL Above Ft.(ft)	Proposed Channel Type	HGL Above Ft.(ft)	Proposed Channel Type	HGL Above Ft.(ft)	Proposed Channel Type	HGL Above Ft.(ft)	Proposed Channel Type	HGL Above Ft.(ft)	Proposed Channel Type	HGL Above Ft.(ft)	Proposed Channel Type		
4+91.00	351.820	SYSTEM OUTLET	5481	11.941	SYSTEM OUTLET	0.091	12.032	SYSTEM OUTLET	0.091	12.032	SYSTEM OUTLET	0.091	12.032	SYSTEM OUTLET	12.029	0.088	
5+17.00	352.033	TRAN. STRUCTURE	5481	11.920	TRAN. STRUCTURE	0.112	12.036	TRAN. STRUCTURE	0.112	12.036	TRAN. STRUCTURE	0.109	12.029	TRAN. STRUCTURE	12.029	0.109	
5+44.00	352.255	DBL 9.67x12.75' RCB	5481	11.912	DBL 9.67x12.75' RCB	0.124	12.036	DBL 9.67x12.75' RCB	0.124	12.036	DBL 9.67x12.75' RCB	0.120	12.032	DBL 9.67x12.75' RCB	12.023	0.120	
9+16.00	355.310	DBL 9.67x12.75' RCB	5481	11.648	DBL 9.67x12.75' RCB	0.594	12.242	DBL 9.67x12.75' RCB	0.594	12.242	DBL 9.67x12.75' RCB	0.562	12.210	DBL 9.67x12.75' RCB	12.214	0.566	
10+78.00	356.640	DBL 9.67x12.75' RCB	5481	11.440	DBL 9.67x12.75' RCB	1.121	12.561	DBL 9.67x12.75' RCB	1.121	12.561	DBL 9.67x12.75' RCB	1.025	12.465	DBL 9.67x12.75' RCB	12.476	1.036	
10+88.00	356.723	JUNCTION STRUCTURE	5481	11.111	JUNCTION STRUCTURE	0.899	12.010	JUNCTION STRUCTURE	0.899	12.010	JUNCTION STRUCTURE	0.833	11.944	JUNCTION STRUCTURE	11.951	0.840	
11+53.80	357.266	DBL 9.67x12.75' RCB	5451	10.980	DBL 9.67x12.75' RCB	1.055	12.035	DBL 9.67x12.75' RCB	1.055	12.035	DBL 9.67x12.75' RCB	0.970	11.950	DBL 9.67x12.75' RCB	11.960	0.980	
11+73.00	357.431	DBL 9.67x12.75' RCB	5451	10.937	DBL 9.67x12.75' RCB	1.108	12.045	DBL 9.67x12.75' RCB	1.108	12.045	DBL 9.67x12.75' RCB	1.015	11.952	DBL 9.67x12.75' RCB	11.962	1.025	
12+50.00	358.060	DBL 9.67x12.75' RCB	5451	10.767	DBL 9.67x12.75' RCB	1.322	12.089	DBL 9.67x12.75' RCB	1.322	12.089	DBL 9.67x12.75' RCB	1.195	11.962	DBL 9.67x12.75' RCB	11.976	1.209	
12+50.00	358.060	Bridge Entrance	5451	10.041	DBL 9.67x12.75' RCB	2.048	12.089	DBL 9.67x12.75' RCB	2.048	12.089	Bridge Entrance	0.821	10.870	Bridge Entrance	10.870	0.829	
13+09.00	358.304	20.00x14.00' RCC	5451	10.055	DBL 9.67x12.75' RCB	2.052	12.107	DBL 9.67x12.75' RCB	2.052	12.107	20.00x14.00' RCC	0.886	10.941	20.00x14.00' RCC	10.950	0.895	
13+09.00	358.543	20.00x14.00' RCC	5451	10.068	DBL 9.67x12.75' RCB	2.064	12.132	DBL 9.67x12.75' RCB	2.064	12.132	20.00x14.00' RCC	0.958	11.026	20.00x14.00' RCC	11.036	0.958	
13+09.00	358.543	20.00x14.00' RCC	5451	10.068	DBL 9.67x12.75' RCB	2.064	12.132	DBL 9.67x12.75' RCB	2.064	12.132	Bridge Exit	2.041	12.126	20.00x14.00' RCC	12.126	2.068	
13+98.00	359.279	20.00x14.00' RCC	5451	10.116	DBL 9.67x12.75' RCB	2.091	12.207	DBL 9.67x12.75' RCB	2.091	12.207	DBL 9.67x14' RCB	2.064	12.180	DBL 9.67x14' RCB	12.207	2.091	
14+85.00	359.985	20.00x14.00' RCC	5451	10.171	DBL 9.67x12.75' RCB	1.959	12.330	DBL 9.67x12.75' RCB	1.959	12.330	JUNCTION STRUCTURE	2.115	12.296	DBL 9.67x14' RCB	12.330	2.159	
15+05.00	360.149	JUNCTION STRUCTURE	5451	9.997	JUNCTION STRUCTURE	1.907	11.904	JUNCTION STRUCTURE	1.907	11.904	JUNCTION STRUCTURE	1.872	11.869	JUNCTION STRUCTURE	11.904	1.907	
17+54.09	362.189	20.00x14.00' RCC	5422	10.136	DBL 9.67x12.75' RCB	1.766	11.902	DBL 9.67x12.75' RCB	1.766	11.902	DBL 9.67x14' RCB	1.677	11.813	DBL 9.67x14' RCB	11.902	1.766	
20+13.40	364.313	20.00x14.00' RCC	5422	10.383	DBL 9.67x12.75' RCB	1.514	11.897	DBL 9.67x12.75' RCB	1.514	11.897	DBL 9.67x14' RCB	1.291	11.674	DBL 9.67x14' RCB	11.897	1.514	
20+37.00	364.506	20.00x14.00' RCC	5422	10.420	DBL 9.67x12.75' RCB	1.476	11.896	DBL 9.67x12.75' RCB	1.476	11.896	DBL 9.67x14' RCB	1.236	11.656	DBL 9.67x14' RCB	11.896	1.476	
20+37.00	364.506	20.00x14.00' RCC	5422	10.420	Bridge Entrance	0.390	10.810	DBL 9.67x14' RCB	0.390	10.810	Bridge Entrance	0.245	10.655	Bridge Entrance	10.810	0.390	
21+90.00	365.760	20.00x14.00' RCC	5422	10.662	20.00x14.00' RCC	0.677	11.339	DBL 10.00x14.00' RCB	0.677	11.339	20.00x14.00' RCC	0.409	11.071	20.00x14.00' RCC	11.339	0.677	
22+20.00	366.005	JUNCTION STRUCTURE	5422	10.431	JUNCTION STRUCTURE	0.652	11.083	JUNCTION STRUCTURE	0.652	11.083	JUNCTION STRUCTURE	0.396	10.827	JUNCTION STRUCTURE	11.083	0.652	
22+33.00	366.112	20.00x14.00' RCC	5392	10.451	20.00x14.00' RCC	0.683	11.134	DBL 10.00x14.00' RCB	0.683	11.134	20.00x14.00' RCC	0.412	10.863	20.00x14.00' RCC	11.134	0.683	
22+64.53	366.370	20.00x14.00' RCC	5392	10.500	20.00x14.00' RCC	0.769	11.269	DBL 10.00x14.00' RCB	0.769	11.269	20.00x14.00' RCC	0.456	10.956	20.00x14.00' RCC	11.269	0.769	
22+83.00	366.522	20.00x14.00' RCC	5392	10.554	20.00x14.00' RCC	0.807	11.361	DBL 10.00x14.00' RCB	0.807	11.361	20.00x14.00' RCC	0.464	11.018	20.00x14.00' RCC	11.361	0.807	
22+83.00	366.522	20.00x14.00' RCC	5392	10.554	Bridge Exit	2.868	13.422	DBL 10.00x14.00' RCB	2.868	13.422	Bridge Exit	1.602	12.156	Bridge Exit	13.422	2.868	
23+33.00	366.932	20.00x14.00' RCC	5392	10.656	DBL 9.77x14.00' TS	1.571	12.227	DBL 10.00x14.00' RCB	1.571	12.227	DBL 9.67x14' RCB	1.583	12.239	DBL 9.67x14' TS	14.378	3.722	
24+90.00	367.893	20.00x14.00' RCC	5392	10.923	DBL 9.77x14.00' RCB	3.515	14.438	JUNCTION STRUCTURE	3.515	14.438	DBL 9.67x14' RCB	1.748	12.671	DBL 10'x14' RCB	14.658	3.735	
24+92.31	368.158	JUNCTION STRUCTURE	5392	10.512	JUNCTION STRUCTURE	4.109	14.621	DBL 10.00x14.00' RCB	4.109	14.621	DBL 9.67x14' RCB	1.197	11.709	JUNCTION STRUCTURE	14.817	4.305	
25+20.00	368.468	20.00x14.00' RCC	5392	10.593	DBL 9.77x14.00' RCB	3.680	14.273	JUNCTION STRUCTURE	3.680	14.273	JUNCTION STRUCTURE	1.043	11.700	DBL 10'x14' RCB	14.758	4.165	
25+50.00	368.714	20.00x14.00' RCC	5339	10.657	DBL 9.77x14.00' RCB	3.339	13.996	DBL 10.00x14.00' RCB	3.339	13.996	DBL 9.67x14' RCB	0.000	11.700	DBL 9.67x14' TS	14.404	3.747	
25+50.00	368.714	20.00x14.00' RCC	5339	10.657	DBL 9.77x14.00' RCB	3.339	13.996	DBL 10.00x14.00' RCB	3.339	13.996	DBL 9.67x14' RCB	0.000	11.700	DBL 9.67x14' TS	14.404	3.747	
26+25.00	369.330	20.00x14.00' RCC	5339	10.861	DBL 9.77x14.00' RCB	3.606	14.467	DBL 10.00x14.00' RCB	3.606	14.467	DBL 9.67x14' RCB	0.000	11.700	20.00x14.00' RCC	21.172	11.204	
26+75.00	369.970	TRAN. STRUCTURE	5339	10.485	DBL 9.77x14.00' RCB	2.358	12.843	DBL 10.00x14.00' RCB	2.358	12.843	20.00x14.00' RCC	0.000	10.861	20.00x14.00' RCC	20.622	10.137	
26+75.00	369.970	Bridge Exit	5339	11.384	DBL 10.00x12.00' TS	1.459	12.843	DBL 10.00x12.00' TS	1.459	12.843	Bridge Exit	0.000	11.384	20.00x14.00' RCC	20.622	10.137	
27+00.00	370.661	JUNCTION STRUCTURE	5339	11.068	DBL 10.00x12.00' RCB	2.128	13.196	DBL 10.00x12.00' RCB	2.128	13.196	DBL 10.00x12.00' RCB	0.000	10.861	20.00x14.00' RCC	21.172	11.204	
27+00.00	370.727	JUNCTION STRUCTURE	5339	10.601	JUNCTION STRUCTURE	2.881	13.482	JUNCTION STRUCTURE	2.881	13.482	Bridge Entrance	0.000	10.861	20.00x14.00' RCC	20.622	10.137	
28+57.51	371.830	DBL 10.00x12.00' RCB	5289	10.020	DBL 10.00x12.00' RCB	3.993	14.013	DBL 10.00x12.00' RCB	3.993	14.013	JUNCTION STRUCTURE	0.000	11.068	JUNCTION STRUCTURE	20.975	9.907	
29+82.51	372.380	TRAN. STRUCTURE	5289	10.243	TRAN. STRUCTURE	3.464	13.707	TRAN. STRUCTURE	3.464	13.707	DBL 10.00x12.00' RCB	0.000	10.601	JUNCTION STRUCTURE	21.261	10.660	
31+89.30	374.520	DBL 10.00x12.00' RCB	5289	10.300	DBL 10.00x12.00' RCB	3.786	14.086	DBL 10.00x12.00' RCB	3.786	14.086	TRAN. STRUCTURE	0.000	10.243	TRAN. STRUCTURE	21.486	11.772	
31+89.30	374.520	JUNCTION STRUCTURE	5289	9.965	JUNCTION STRUCTURE	4.370	14.335	JUNCTION STRUCTURE	4.370	14.335	DBL 10.00x12.00' RCB	0.000	10.300	DBL 10.00x12.00' RCB	21.865	11.565	
32+23.12	374.870	DBL 10.00x12.00' RCB	5244	9.959	DBL 10.00x12.00' RCB	4.728	14.687	DBL 10.00x12.00' RCB	4.728	14.687	JUNCTION STRUCTURE	0.000	9.965	JUNCTION STRUCTURE	22.114	12.149	
33+03.90	375.980	DBL 10.00x12.00' RCB	5244	10.211	DBL 10.00x12.00' RCB	4.141	14.352	DBL 10.00x12.00' RCB	4.141	14.352	DBL 10.00x12.00' RCB	0.000	10.211	DBL 10.00x12.00' RCB	22.466	12.507	
33+03.90	375.980	TRAN. STRUCTURE	5244	10.185	TRAN. STRUCTURE	4.180	14.365	TRAN. STRUCTURE	4.180	14.365	DBL 10.00x12.00' RCB	0.000	10.185	DBL 10.00x12.00' RCB	22.131	11.920	
33+08.90	376.015	TRAN. STRUCTURE	5244	10.185	TRAN. STRUCTURE	4.180	14.365	TRAN. STRUCTURE	4.180	14.365	TRAN. STRUCTURE	0.000	10.185	TRAN. STRUCTURE	22.144	11.959	
33+29.44	376.159	TRAN. STRUCTURE	5244	10.081	TRAN. STRUCTURE	4.337	14.418	TRAN. STRUCTURE	4.337	14.418	TRAN. STRUCTURE	0.000	10.081	TRAN. STRUCTURE	22.197	12.116	
33+45.18	376.270	TRAN. STRUCTURE	5244	10.002	TRAN. STRUCTURE	4.456	14.458	TRAN. STRUCTURE	4.456	14.458	TRAN. STRUCTURE	0.000	10.002	TRAN. STRUCTURE	22.237	12.135	
33+55.18	376.384	JUNCTION STRUCTURE	5244	9.677	JUNCTION STRUCTURE	5.032	14.709	JUNCTION STRUCTURE	5.032	14.709	JUNCTION STRUCTURE	0.000	9.677	JUNCTION STRUCTURE	22.488	12.811	
35+99.63	379.180	DBL 10.00x12.00' RCB	5196	9.727	DBL 10.00x12.00' RCB	4.851	14.578	DBL 10.00x12.00' RCB	4.851	14.578	DBL 10.00x12.00' RCB	0.000	9.727	DBL 10.00x12.00' RCB	22.357	12.630	
36+25.79	379.479	DBL 10.00x12.00' RCB	5196	9.734	DBL 10.00x12.00' RCB	5.109	14.843	DBL 10.00x12.00' RCB	5.109	14.843	DBL 10.00x12.00' RCB	0.000	9.734	DBL 10.00x12.00' RCB	22.622	12.858	
38+87.30	382.470	TRAN. STRUCTURE	5196	9.840	TRAN. STRUCTURE	4.474	14.314	TRAN. STRUCTURE	4.474	14.314	TRAN. STRUCTURE	4.127	9.917	TRAN. STRUCTURE	22.093	12.253	
38+97.30	382.584	JUNCTION STRUCTURE	5196	9.515	JUNCTION STRUCTURE	5.038	14.561	JUNCTION STRUCTURE	5.038	14.561	JUNCTION STRUCTURE	0.000	9.840	JUNCTION STRUCTURE	22.093	12.253	
40+89.30	384.780	DBL 10.00x12.00' RCB	5148	9.233	DBL 10.00x12.00' RCB	4.624	14.139	DBL 10.00x12.00' RCB	4.624	14.139	JUNCTION STRUCTURE	0.000	9.515	JUNCTION STRUCTURE	22.340	12.817	
41+35.72	385.310	JUNCTION STRUCTURE	5148	9.913	JUNCTION STRUCTURE	4.003	13.916	JUNCTION STRUCTURE	4.003	13.916	DBL 10.00x12.00' RCB	0.000	9.913	JUNCTION STRUCTURE	21.918	12.403	
41+41.60	385.389	10.00x12.00' RCB	2813	9.917	10.00x12.00' RCB	3.984	13.901	10.00x12.00' RCB	3.984	13.901	JUNCTION STRUCTURE	0.000	9.917	JUNCTION STRUCTURE	21.680	11.763	
42+11.51	386.322	10.00x12.00' RCB	2813	9.964	10.00x12.00' RCB	4.787	14.751	10.00x12.00' RCB	4.787	14.751	10.00x12.00' RCB	0.000	9.964	10.00x12.00' RCB	22.530	12.566	

CARD	SECT	CHN	NO OF	AVE	PIER	HEIGHT	1	BASE	ZL	ZR	INV	Y(1)	Y(2)	Y(3)	Y(4)	Y(5)	Y(6)	Y(7)	Y(8)	Y(9)	Y(10)	
CODE	NO	TYPE	PIER/PIP	WIDTH	DIAMETER	WIDTH	DROP															
CD	1	3		.670	12.750	20.000	.000	.000	.000	.000	.00											
CD	2	2	0	.000	14.000	20.000	.000	.000	.000	.000	.00											
CD	3	4	1		6.000																	
CD	4	3	1	.670	12.000	20.670	.000	.000	.000	.000	.00											
CD	5	3	1	.670	12.000	20.670	.000	.000	.000	.000	.00											
CD	6	3	0	.000	12.000	9.730	.000	.000	.000	.000	.00											
CD	7	3	0	.000	13.250	10.250	.000	.000	.000	.000	.00											
CD	8	3	0	.000	12.500	11.000	.000	.000	.000	.000	.00											
CD	9	4	1		3.750																	
CD	10	4	1		3.000																	
CD	11	4	1		2.000																	
CD	12	4	1		2.500																	
CD	13	2	0	.000	14.000	20.670	.000	.000	.000	.000	.00											
CD	14	3	1	.670	14.000	20.000	.000	.000	.000	.000	.00											
CD	15	3	1	.670	14.000	20.670	.000	.000	.000	.000	.00											
CD	25	3	0	.000	12.000	10.000	.000	.000	.000	.000	.00											

W S P G W
 WATER SURFACE PROFILE - TITLE CARD LISTING

HEADING LINE NO 1 IS - SR-710 NORTH STUDY
 HEADING LINE NO 2 IS - DORCHESTER DRAIN LINE-A EAST & LINE-B (P22)
 HEADING LINE NO 3 IS -

MODEL: W.CHEN REVIEW: G.HSU
 W S P G W

ELEMENT NO	IS A	SYSTEM	OUTLET	STATION	INVERT	SECT	W S ELEV	RADIUS	ANGLE	ANG PT	MAN H
1	IS A	SYSTEM	OUTLET	491.000	351.820	1	364.500	249.990	-5.959	.000	0
2	IS A	TRANSITION		517.000	352.033	1		249.993	-6.195	.000	0
3	IS A	REACH		544.030	352.255	1		.000	.000	.000	0
4	IS A	REACH		916.000	355.310	1		250.004	37.127	.000	0
5	IS A	REACH		1078.000	356.640	1		INVERT-3	INVERT-4	PHI 3	PHI 4
6	IS A	JUNCTION		1088.000	356.723	1	30.000	361.000	.000	-76.000	.000
7	IS A	REACH						250.091	2.291		

Proposed

ELEMENT NO	U/S DATA	STATION	INVERT	SECT	N	RADIUS	ANGLE	ANG PT	MAN H
8	IS A REACH	1153.800	357.266	1	.013	250.004	15.080	.000	0
9	IS A REACH	1173.800	357.431	1	.013				
10	IS A BRIDGE ENTRANCE	1250.000	358.060	1	.013	249.996	17.464	.000	0
11	IS A REACH	1279.740	358.304	2	.014				
12	IS A REACH	1309.000	358.543	2	.014				
W S P G W									
WATER SURFACE PROFILE - ELEMENT CARD LISTING									
13	IS A BRIDGE EXIT	1309.000	358.543	14	.013				
14	IS A REACH	1398.800	359.279	14	.013	250.008	-20.580	.000	0
15	IS A REACH	1485.000	359.985	14	.013	2000.362	-2.469	.000	0
16	IS A JUNCTION	1505.000	360.149	14	.013				
17	IS A REACH	1754.090	362.189	14	.013				
18	IS A REACH	2013.400	364.313	14	.013				
19	IS A REACH	2037.000	364.506	14	.013				
20	IS A BRIDGE ENTRANCE	2037.000	364.506	2	.100				
21	IS A REACH	2190.000	365.760	2	.014				
22	IS A JUNCTION	2220.000	366.005	2	.014				
Q3 30.000									
Q4 60.000									
1999.853 - .573									
361.500 .000 60.000 .000									
RADIUS ANGLE									
1999.972 -7.136									
RADIUS ANGLE									
424.982 -34.960									
RADIUS ANGLE									
424.946 3.182									
RADIUS ANGLE									
425.010 20.626									
RADIUS ANGLE									
INVERT-3 INVERT-4 PHI 3 PHI 4									
367.000 .000 60.000 .000									
RADIUS ANGLE									

PAGE NO 3

ELEMENT NO	IS A REACH	STATION	INVERT	SECT	N	Q3	Q4	RADIUS	ANGLE	MAN H
38	IS A REACH	2957.510	371.830	4	.013			.000	.000	0
39	IS A TRANSITION	2982.510	372.380	5	.013			.000	.000	
40	IS A REACH	3189.300	374.520	5	.013			.000	.000	-5.027
41	IS A JUNCTION	3199.300	374.623	5	.013	45.000		374.623	.000	PHI 3 PHI 4
42	IS A REACH	3223.120	374.870	5	.013			.000	.000	
43	IS A REACH	3303.900	375.980	5	.013			.000	.000	
44	IS A TRANSITION	3308.900	376.015	4	.013			.000	.000	
45	IS A TRANSITION	3329.440	376.159	4	.013			.000	.000	
46	IS A TRANSITION	3345.180	376.270	4	.013			.000	.000	
47	IS A JUNCTION	3355.180	376.384	4	.013	48.000		376.384	.000	PHI 3 PHI 4
48	IS A REACH	3599.630	379.180	4	.013			.000	.000	
49	IS A REACH	3625.790	379.479	4	.013			350.039	-4.282	
50	IS A REACH	3887.300	382.470	4	.013			.000	.000	
51	IS A JUNCTION	3897.300	382.584	4	.013	48.000		382.584	.000	PHI 3 PHI 4

W S P G W
WATER SURFACE PROFILE - ELEMENT CARD LISTING

ELEMENT NO	IS A REACH	STATION	INVERT	SECT	N	RADIUS	ANGLE	ANG PT	MAN H
52	IS A REACH	4089.300	384.780	4	.013	.000	.000	.000	0
53	IS A JUNCTION								
	U/S DATA	4135.720	385.310	25	.013	385.310	.000	.000	.000
	U/S DATA								
	U/S DATA								

W S P G W

WATER SURFACE PROFILE - ELEMENT CARD LISTING

ELEMENT NO	IS A REACH	STATION	INVERT	SECT	N	RADIUS	ANGLE	ANG PT	MAN H
54	IS A REACH	4141.600	385.389	25	.013	.000	.000	.000	0
55	IS A REACH	4211.510	386.322	25	.013	.000	.000	.000	0
56	IS A REACH	4223.540	386.483	25	.013	380.031	10.540	.000	1
57	IS A TRANSITION	4243.540	386.750	6	.013	.000	.000	.000	0
58	IS A REACH	4420.540	389.120	6	.013	.000	.000	.000	0
59	IS A TRANSITION	4440.540	390.218	7	.013	.000	.000	.000	0
60	IS A TRANSITION	4453.210	390.913	7	.013	.000	.000	.000	0
61	IS A TRANSITION	4463.540	391.480	7	.013	230.017	-3.156	.000	0
62	IS A REACH	4497.740	391.638	7	.013	.000	.000	.000	0
63	IS A REACH	4579.220	392.015	7	.013	.000	.000	.000	0
64	IS A TRANSITION	4595.380	392.089	7	.013	.000	.000	.000	0
65	IS A REACH	4623.640	392.220	7	.013	.000	.000	.000	0
66	IS A REACH	4703.020	393.220	7	.013	.000	.000	.000	1
67	IS A TRANSITION	4713.020	393.340	7	.013	.000	.000	.000	0

PAGE NO 7

W S P G W
WATER SURFACE PROFILE - ELEMENT CARD LISTING

ELEMENT NO	IS A REACH	U/S DATA	STATION	INVERT	SECT	N	RADIUS	ANGLE	ANG PT	MAN H
68	IS A REACH	U/S DATA	4739.960	393.663	7	.013	.000	.000	.000	0
69	IS A REACH	U/S DATA	4880.820	395.350	7	.013	155.850	51.785	.000	0
70	IS A REACH	U/S DATA	5191.140	397.650	7	.013	.000	.000	.000	0
71	IS A REACH	U/S DATA	5383.640	399.749	7	.013	238.851	46.177	.000	1
72	IS A TRANSITION	U/S DATA	5392.380	399.844	7	.013	238.908	2.096		
73	IS A TRANSITION	U/S DATA	5406.640	400.000	7	.013	.000	.000		
74	IS A SYSTEM HEADWORKS	U/S DATA	5406.640	400.000	7	.013				

*
W S ELEV
400.000

Program Package Serial Number: 1806
 WATER SURFACE PROFILE LISTING
 Date: 8-23-2013 Time: 10:45: 9

SR-710 NORTH STUDY
 DORCHESTER DRAIN LINE-A EAST & LINE-B (P20) (NGVD 29)
 MODEL: W.CHEN REVIEW: G.HSU

Station	Invert Elev	Depth (FT)	Water Elev	Q (CFS)	Vel (FPS)	Vel Head	Energy Grd.El.	Super Elev	Critical Depth	Flow Top Width	Height/ Dia.-Ft	Base Wt or I.D.	ZL	No Wth Prs/Pip
L/Elem	Ch Slope					SF Ave	HF	SE Dpth	Froude N	Norm Dp	"N"	X-Fall	ZR	Type Ch
491.000	351.820	12.029	363.849	5481.00	23.57	8.63	372.48	12.75	12.75	20.00	12.750	20.000	.00	1 .7
TRANS STR	.0082					.0082	.21	12.75	1.22		.013	.00	.00	BOX
----- WARNING - Flow depth near top of box conduit -----														
517.000	352.033	12.029	364.062	5481.00	23.57	8.63	372.69	12.75	12.75	20.00	12.750	20.000	.00	1 .7
27.030	.0082					.0082	.22	12.75	1.22	12.00	.013	.00	.00	BOX
----- WARNING - Flow depth near top of box conduit -----														
544.030	352.255	12.032	364.287	5481.00	23.57	8.62	372.91	.00	12.75	20.00	12.750	20.000	.00	1 .7
371.970	.0082					.0080	2.98	12.03	1.22	12.00	.013	.00	.00	BOX
----- WARNING - Flow depth near top of box conduit -----														
916.000	355.310	12.210	367.521	5481.00	23.22	8.37	375.89	12.75	12.75	20.00	12.750	20.000	.00	1 .7
162.000	.0082					.0077	1.25	12.75	1.19	12.00	.013	.00	.00	BOX
----- WARNING - Flow depth near top of box conduit -----														
1078.000	356.640	12.465	369.105	5481.00	22.75	8.04	377.14	12.75	12.75	20.00	12.750	20.000	.00	1 .7
JUNCT STR	.0083					.0079	.08	12.75	1.15		.013	.00	.00	BOX
----- WARNING - Flow depth near top of box conduit -----														

Program Package Serial Number: 1806
 WATER SURFACE PROFILE LISTING
 Date: 8-23-2013 Time: 10:45: 9

SR-710 NORTH STUDY
 DORCHESTER DRAIN LINE-A EAST & LINE-B (P20) (NGVD 29)
 MODEL: W.CHEN REVIEW: G.HSU

Station	Invert Elev	Depth (FT)	Water Elev	Q (CFS)	Vel (FPS)	Vel Head	Energy Grd.El.	Super Elev	Critical Depth	Flow Top Width	Height/Dia.-FT	Base Wt or I.D.	ZL	No Wth Prs/Pip
1088.000	356.723	11.944	368.667	5451.00	23.61	8.66	377.32	12.75	12.75	20.00	12.750	20.000	.00	1 .7
65.800	.0083				.0082		.54	12.75	1.22	11.92	.013	.00	.00	BOX
1153.800	357.266	11.950	369.216	5451.00	23.60	8.65	377.86	.00	12.75	20.00	12.750	20.000	.00	1 .7
20.000	.0083				.0082		.16	11.95	1.22	11.92	.013	.00	.00	BOX
1173.800	357.431	11.952	369.383	5451.00	23.59	8.64	378.03	12.75	12.75	20.00	12.750	20.000	.00	1 .7
76.200	.0083				.0082		.62	12.75	1.22	11.92	.013	.00	.00	BOX
1250.000	358.060	11.962	370.022	5451.00	23.57	8.63	378.65	12.75	12.75	20.00	12.750	20.000	.00	1 .7

BRIDGE ENTRANCE
 ----- WARNING - Flow depth near top of box conduit -----

SR-710 NORTH STUDY
 DORCHESTER DRAIN LINE-A EAST & LINE-B (P20) (NGVD 29)
 MODEL: W.CHEN REVIEW: G.HSU

Station	Invert Elev	Depth (FT)	Water Elev	Q (CFS)	Vel (FPS)	Vel Head	Energy Grd.El.	Super Elev	Critical Depth	Flow Top Width	Height Dia.-FT	Base Wt or I.D.	ZL	No Wth Prs/Pip	
L/Elem	Ch Slope					SF Ave	HF	SE Dpth	Froude N	Norm Dp	"N"	X-Fall	ZR	Type Ch	
1250.000	358.060	10.862	368.922	5451.00	25.09	9.78	378.70	1.56	13.21	20.00	14.000	20.000	.00	0 .0	
29.740	.0082					.0061	.18	12.43	1.34	9.77	.014	.00	.00	RECTANG	
1279.740	358.304	10.941	369.245	5451.00	24.91	9.64	378.88	1.54	13.21	20.00	14.000	20.000	.00	0 .0	
29.260	.0082					.0060	.18	12.48	1.33	9.79	.014	.00	.00	RECTANG	
1309.000	358.543	11.026	369.569	5451.00	24.72	9.49	379.06	1.52	13.21	20.00	14.000	20.000	.00	0 .0	
BRIDGE EXIT															
1309.000	358.543	12.109	370.652	5451.00	23.29	8.42	379.07	1.30	13.52	20.00	14.000	20.000	.00	1 .7	
89.800	.0082					.0079	.71	13.41	1.20	11.95	.013	.00	.00	BOX	
1398.800	359.279	12.180	371.459	5451.00	23.15	8.32	379.78	.16	13.52	20.00	14.000	20.000	.00	1 .7	
86.200	.0082					.0078	.67	12.34	1.19	11.96	.013	.00	.00	BOX	
1485.000	359.985	12.286	372.271	5451.00	22.95	8.18	380.45	.16	13.52	20.00	14.000	20.000	.00	1 .7	
JUNCT STR	.0082					.0080	.16	12.44	1.17		.013	.00	.00	BOX	
1505.000	360.149	11.869	372.018	5422.00	23.63	8.67	380.69	.17	13.47	20.00	14.000	20.000	.00	1 .7	
249.090	.0082					.0083	2.07	12.04	1.23	11.91	.013	.00	.00	BOX	
1754.090	362.189	11.813	374.002	5422.00	23.74	8.75	382.76	.80	13.47	20.00	14.000	20.000	.00	1 .7	
259.310	.0082					.0085	2.19	12.61	1.24	11.90	.013	.00	.00	BOX	
2013.400	364.313	11.674	375.987	5422.00	24.03	8.96	384.95	.82	13.47	20.00	14.000	20.000	.00	1 .7	
23.600	.0082					.0086	.20	12.49	1.26	11.91	.013	.00	.00	BOX	

SR-710 NORTH STUDY
 DORCHESTER DRAIN LINE-A EAST & LINE-B (P20) (NGVD 29)
 MODEL: W.CHEN REVIEW: G.HSU

Station	Invert Elev	Depth (FT)	Water Elev	Q (CFS)	Vel (FPS)	Vel Head	Energy Grd.El.	Super Elev	Critical Depth	Flow Top Width	Height Dia.-FT	Base Wt or I.D.	ZL	No Wth Prs/Pip
2037.000	364.506	11.656	376.162	5422.00	24.06	8.99	385.15	.82	13.47	20.00	14.000	20.000	.00	1 .7
BRIDGE ENTRANCE														
2037.000	364.506	10.665	375.171	5422.00	25.42	10.03	385.20	.94	13.17	20.00	14.000	20.000	.00	0 .0
153.000	.0082					.0061	.94	11.61	1.37	9.74	.014	.00	.00	RECTANG
2190.000	365.760	11.071	376.831	5422.00	24.49	9.31	386.14	.88	13.17	20.00	14.000	20.000	.00	0 .0
JUNCT STR														
2220.000	366.005	10.827	376.832	5392.00	24.90	9.63	386.46	.91	13.12	20.00	14.000	20.000	.00	0 .0
13.000	.0082					.0061	.08	11.73	1.33	9.68	.014	.00	.00	RECTANG
2233.000	366.112	10.863	376.975	5392.00	24.82	9.56	386.54	.90	13.12	20.00	14.000	20.000	.00	0 .0
31.530	.0082					.0060	.19	11.76	1.33	9.70	.014	.00	.00	RECTANG
2264.530	366.370	10.956	377.326	5392.00	24.61	9.40	386.73	.75	13.12	20.00	14.000	20.000	.00	0 .0
18.470	.0082					.0059	.11	11.71	1.31	9.68	.014	.00	.00	RECTANG
2283.000	366.522	11.018	377.540	5392.00	24.47	9.30	386.84	.74	13.12	20.00	14.000	20.000	.00	0 .0
BRIDGE EXIT														
2283.000	366.522	12.156	378.678	5392.00	22.95	8.18	386.85	.63	13.42	20.00	14.000	20.000	.00	1 .7
50.000	.0082					.0076	.38	12.79	1.18	11.84	.013	.00	.00	BOX
2333.000	366.932	12.239	379.171	5392.00	22.79	8.07	387.24	.62	13.42	20.00	14.000	20.000	.00	1 .7
117.000	.0082					.0073	.85	12.86	1.17	11.84	.013	.00	.00	BOX

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 WATER SURFACE PROFILE LISTING

SR-710 NORTH STUDY
 DORCHESTER DRAIN LINE-A EAST & LINE-B (P20) (NGVD 29)
 MODEL: W.CHEN REVIEW: G.HSU

Station	Invert Elev	Depth (FT)	Water Elev	Q (CFS)	Vel (FPS)	Vel Head	Energy Grd.EI.	Super Elev	Critical Depth	Flow Top	Width	Height/Dia.-FT	Base Wt or I.D.	ZL	No Wth Prs/Pip	
I/Elem	Ch Slope				SF Ave	HF	SE Dpth	Froude N	Norm Dp	"N"	X-Fall	ZR	Type Ch			
2450.000	367.893	12.671	380.564	5392.00	22.02	7.53	388.09	.58	13.42	20.00	14.000	20.000	.00	1	.7	
JUNCT STR	.0082				.0076	.25	13.25	1.11	.013			.00	.00	BOX		
----- WARNING - Flow depth near top of box conduit -----																
2482.310	368.158	11.709	379.867	5339.00	23.59	8.64	388.51	.00	13.33	20.00	14.000	20.000	.00	1	.7	
67.690	.0082				.0083	.56	11.71	1.24	.013			.00	.00	BOX		
2550.000	368.714	11.700	380.414	5339.00	23.61	8.65	389.07	.00	13.33	20.00	14.000	20.000	.00	1	.7	
BRIDGE ENTRANCE																
2550.000	368.714	10.657	379.371	5339.00	25.05	9.74	389.11	.00	13.03	20.00	14.000	20.000	.00	0	.0	
75.000	.0082				.0061	.46	10.66	1.35	.014			.00	.00	RECTANG		
2625.000	369.330	10.861	380.191	5339.00	24.58	9.38	389.57	.00	13.03	20.00	14.000	20.000	.00	0	.0	
TRANS STR	.0128				.0060	.30	10.86	1.31	.014			.00	.00	RECTANG		
2675.000	369.970	10.485	380.455	5339.00	24.63	9.42	389.88	.00	12.75	20.67	14.000	20.670	.00	0	.0	
BRIDGE EXIT																
2675.000	369.970	11.384	381.354	5339.00	23.45	8.54	389.89	.00	12.00	20.67	12.000	20.670	.00	1	.7	
105.000	.0066				.0083	.87	11.38	1.25	.013			.00	.00	BOX		
----- WARNING - Flow depth near top of box conduit -----																

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 WATER SURFACE PROFILE LISTING

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SR-710 NORTH STUDY

DORCHESTER DRAIN LINE-A EAST & LINE-B (P20) (NGVD 29)

MODEL: W.CHEN REVIEW: G.HSU

Station	Invert Elev	Depth (FT)	Water Elev	Q (CFS)	Vel (FPS)	Vel Head	Energy Grd.El.	Super Elev	Critical Depth	Flow Width	Flow Top Dia.-FT	Base Wt or I.D.	ZL	No Wth Prs/Pip
L/Elem	Ch Slope					SF Ave	HF	SE Dpth	Froude N	Norm Dp	"N"	X-Fall	ZR	Type Ch
2780.000	370.661	11.068	381.729	5339.00	24.12	9.03	390.76	.00	12.00	20.67	12.000	20.670	.00	1 .7
JUNCT STR	.0066					.0089	.09	11.07	1.30		.013	.00	.00	BOX
----- WARNING - Flow depth near top of box conduit -----														
2790.000	370.727	10.601	381.328	5289.00	24.95	9.66	390.99	.00	12.00	20.67	12.000	20.670	.00	1 .7
27.323	.0066					.0094	.26	10.60	1.37	12.00	.013	.00	.00	BOX
2817.323	370.907	10.509	381.416	5289.00	25.16	9.83	391.25	.00	12.00	20.67	12.000	20.670	.00	1 .7
140.187	.0066					.0101	1.42	10.51	1.39	12.00	.013	.00	.00	BOX
2957.510	371.830	10.020	381.850	5289.00	26.39	10.82	392.67	.00	12.00	20.67	12.000	20.670	.00	1 .7
TRANS STR	.0220					.0104	.26	10.02	1.49		.013	.00	.00	BOX
2982.510	372.380	10.243	382.623	5289.00	25.82	10.35	392.97	.00	12.00	20.67	12.000	20.670	.00	1 .7
206.790	.0103					.0101	2.08	10.24	1.45	10.16	.013	.00	.00	BOX
3189.300	374.520	10.300	384.820	5289.00	25.68	10.24	395.06	.00	12.00	20.67	12.000	20.670	.00	1 .7
JUNCT STR	.0103					.0103	.10	10.30	1.43		.013	.00	.00	BOX
3199.300	374.623	9.965	384.588	5244.00	26.31	10.75	395.34	.00	12.00	20.67	12.000	20.670	.00	1 .7
23.820	.0104					.0107	.25	9.96	1.49	10.08	.013	.00	.00	BOX
3223.120	374.870	9.959	384.829	5244.00	26.33	10.76	395.59	.00	12.00	20.67	12.000	20.670	.00	1 .7
80.780	.0137					.0104	.84	9.96	1.49	8.99	.013	.00	.00	BOX

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 WATER SURFACE PROFILE LISTING

SR-710 NORTH STUDY
 DORCHESTER DRAIN LINE-A EAST & LINE-B (P20) (NGVD 29)
 MODEL: W.CHEN REVIEW: G.HSU

Station	Invert Elev	Depth (FT)	Water Elev	Q (CFS)	Vel (FPS)	Vel Head	Energy Grd.El.	Super Elev	Critical Depth	Flow Top Width	Height/Dia.-FT	Base Wt or I.D.	ZL	No Wth Prs/Pip
L/Elem	Ch Slope				SF Ave	SE Dpth	Froude N	Norm Dp	"N"	X-Fall	ZR	Type Ch		
3303.900	375.980	10.211	386.191	5244.00	25.68	10.24	396.43	.00	12.00	20.67	12.000	20.670	.00	1 .7
TRANS STR	.0070				.0101		.05	10.21	1.44		.013	.00	.00	BOX
3308.900	376.015	10.185	386.200	5244.00	25.74	10.29	396.49	.00	12.00	20.67	12.000	20.670	.00	1 .7
TRANS STR	.0070				.0102		.21	10.19	1.45		.013	.00	.00	BOX
3329.440	376.159	10.081	386.240	5244.00	26.01	10.50	396.74	.00	12.00	20.67	12.000	20.670	.00	1 .7
TRANS STR	.0071				.0105		.16	10.08	1.47		.013	.00	.00	BOX
3345.180	376.270	10.002	386.272	5244.00	26.21	10.67	396.94	.00	12.00	20.67	12.000	20.670	.00	1 .7
JUNCT STR	.0114				.0109		.11	10.00	1.48		.013	.00	.00	BOX
3355.180	376.384	9.677	386.061	5196.00	26.85	11.19	397.25	.00	12.00	20.67	12.000	20.670	.00	1 .7
244.450	.0114				.0112		2.73	9.68	1.55	9.61	.013	.00	.00	BOX
3599.630	379.180	9.727	388.907	5196.00	26.71	11.08	399.98	1.27	12.00	20.67	12.000	20.670	.00	1 .7
26.160	.0114				.0111		.29	10.99	1.53	9.61	.013	.00	.00	BOX
3625.790	379.479	9.734	389.213	5196.00	26.69	11.06	400.27	.00	12.00	20.67	12.000	20.670	.00	1 .7
261.510	.0114				.0109		2.86	9.73	1.53	9.61	.013	.00	.00	BOX
3887.300	382.470	9.840	392.310	5196.00	26.40	10.82	403.13	.00	12.00	20.67	12.000	20.670	.00	1 .7
JUNCT STR	.0114				.0111		.11	9.84	1.51		.013	.00	.00	BOX
3897.300	382.584	9.523	392.107	5148.00	27.03	11.34	403.45	.00	12.00	20.67	12.000	20.670	.00	1 .7
192.000	.0114				.0115		2.21	9.52	1.57	9.54	.013	.00	.00	BOX

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SR-710 NORTH STUDY
 DORCHESTER DRAIN LINE-A EAST & LINE-B (P20) (NGVD 29)
 MODEL: W.CHEN REVIEW: G.HSU

Station	Invert Elev	Depth (FT)	Water Elev	Q (CFS)	Vel (FPS)	Vel Head	Energy Grd.El.	Super Elev	Critical Depth	Flow Top Width	Height/Dia.-FT or I.D.	Base Wt	No Wth Prs/Pip	
I/Elem	Ch Slope					SF Ave	HF	SE Dpth	Froude N	Norm Dp	"N"	X-Fall	ZR	Type Ch
4089.300	384.780	9.515	394.295	5148.00	27.05	11.36	405.66	.00	12.00	20.67	12.000	20.670	.00	1 .7
JUNCT STR	.0114					.0120	.56	9.52	1.57		.013	.00	.00	BOX
4135.720	385.310	9.913	395.223	2813.00	28.38	12.50	407.73	.00	12.00	10.00	12.000	10.000	.00	0 .0
5.880	.0134					.0124	.07	9.91	1.59	9.60	.013	.00	.00	BOX
4141.600	385.389	9.917	395.306	2813.00	28.37	12.49	407.80	.66	12.00	10.00	12.000	10.000	.00	0 .0
69.910	.0133					.0123	.86	10.57	1.59	9.63	.013	.00	.00	BOX
4211.510	386.322	9.964	396.286	2813.00	28.23	12.38	408.66	.00	12.00	10.00	12.000	10.000	.00	0 .0
12.030	.0134					.0123	.15	9.96	1.58	9.62	.013	.00	.00	BOX
4223.540	386.483	9.973	396.456	2813.00	28.21	12.36	408.81	.00	12.00	10.00	12.000	10.000	.00	0 .0
TRANS STR	.0133					.0121	.24	9.97	1.57		.013	.00	.00	BOX
4243.540	386.750	10.440	397.190	2813.00	27.69	11.91	409.10	.00	12.00	9.73	12.000	9.730	.00	0 .0
177.000	.0134					.0115	2.03	10.44	1.51	9.93	.013	.00	.00	BOX
4420.540	389.120	10.722	399.842	2813.00	26.96	11.29	411.13	.00	12.00	9.73	12.000	9.730	.00	0 .0
TRANS STR	.0549					.0107	.21	10.72	1.45		.013	.00	.00	BOX
4440.540	390.218	10.429	400.647	2813.00	26.31	10.75	411.40	.96	13.25	10.25	13.250	10.250	.00	0 .0
TRANS STR	.0549					.0097	.12	11.39	1.44		.013	.00	.00	BOX
4453.210	390.913	10.944	401.857	2813.00	25.08	9.76	411.62	.87	13.25	10.25	13.250	10.250	.00	0 .0
TRANS STR	.0549					.0085	.09	11.81	1.34		.013	.00	.00	BOX

Program Package Serial Number: 1806 Date: 8-23-2013 Time: 10:45: 9
 WATER SURFACE PROFILE LISTING

SR-710 NORTH STUDY
 DORCHESTER DRAIN LINE-A EAST & LINE-B (P20) (NGVD 29)
 MODEL: W.CHEN REVIEW: G.HSU

Station	Invert Elev	Depth (FT)	Water Elev	Q (CFS)	Vel (FPS)	Vel Head	Energy Grd.El.	Super Elev	Critical Depth	Flow Top Width	Height Dia.-FT	Base Wt or I.D.	ZL	No Wth Prs/Pip
I/Elem	Ch Slope				SF Ave	HF	SE Dpth	Froude N	Norm Dp	"N"	X-Fall	ZR	Type Ch	
4463.540	391.480	11.531	403.011	2813.00	23.80	8.80	411.81	.39	13.25	10.25	13.250	10.250	.00	0 .0
34.200	.0046				.0082	.28	11.92		1.24	13.25	.013	.00	.00	BOX
4497.740	391.638	11.316	402.954	2813.00	24.25	9.13	412.09	.00	13.25	10.25	13.250	10.250	.00	0 .0
81.480	.0046				.0088	.72	11.32		1.27	13.25	.013	.00	.00	BOX
4579.220	392.015	10.840	402.855	2813.00	25.32	9.95	412.81	.00	13.25	10.25	13.250	10.250	.00	0 .0
TRANS STR	.0046				.0095	.15	10.84		1.36		.013	.00	.00	BOX
4595.380	392.089	10.682	402.771	2813.00	25.69	10.25	413.02	.00	13.25	10.25	13.250	10.250	.00	0 .0
28.260	.0046				.0098	.28	10.68		1.39	13.25	.013	.00	.00	BOX
4623.640	392.220	10.530	402.750	2813.00	26.06	10.55	413.30	.00	13.25	10.25	13.250	10.250	.00	0 .0
79.380	.0126				.0097	.77	10.53		1.42	9.58	.013	.00	.00	BOX
4703.020	393.220	10.774	403.994	2813.00	25.47	10.07	414.07	.00	13.25	10.25	13.250	10.250	.00	0 .0
TRANS STR	.0120				.0094	.09	10.77		1.37		.013	.00	.00	BOX
4713.020	393.340	10.798	404.138	2813.00	25.42	10.03	414.17	.00	13.25	10.25	13.250	10.250	.00	0 .0
26.940	.0120				.0093	.25	10.80		1.36	9.77	.013	.00	.00	BOX
4739.960	393.663	10.885	404.548	2813.00	25.21	9.87	414.42	1.30	13.25	10.25	13.250	10.250	.00	0 .0
52.066	.0120				.0090	.47	12.18		1.35	9.78	.013	.00	.00	BOX
4792.026	394.287	11.087	405.373	2813.00	24.75	9.51	414.89	1.25	13.25	10.25	13.250	10.250	.00	0 .0
88.794	.0120				.0083	.74	12.34		1.31	9.78	.013	.00	.00	BOX

SR-710 NORTH STUDY
 DORCHESTER DRAIN LINE-A EAST & LINE-B (P20) (NGVD 29)
 MODEL: W.CHEN REVIEW: G.HSU

Station	Invert Elev	Depth (FT)	Water Elev	Q (CFS)	Vel (FPS)	Vel Head	Energy Grd.El.	Super Elev	Critical Depth	Flow Top Width	Height/Dia. - FT	Base Wt or I.D.	ZL	No Wth Prs/Pip
L/Elem	Ch Slope				SF Ave	HF	SE Dpth	Froude N	Norm Dp	"N"	X-Fall	ZR	Type Ch	
4880.820	395.350	11.628	406.978	2813.00	23.60	8.65	415.63	.00	13.25	10.25	13.250	10.250	.00	0 .0
310.320	.0074				.0082		2.56	11.63	1.22	11.91	.013	.00	.00	BOX
5191.141	397.650	11.184	408.833	2813.00	24.54	9.35	418.18	.80	13.25	10.25	13.250	10.250	.00	0 .0
47.437	.0109				.0085		.40	11.99	1.29	10.16	.013	.00	.00	BOX
5238.577	398.167	11.367	409.534	2813.00	24.14	9.05	418.59	.78	13.25	10.25	13.250	10.250	.00	0 .0
87.583	.0109				.0078		.69	12.14	1.26	10.16	.013	.00	.00	BOX
5326.160	399.122	11.922	411.044	2813.00	23.02	8.23	419.27	.71	13.25	10.25	13.250	10.250	.00	0 .0
42.513	.0109				.0070		.30	12.63	1.17	10.16	.013	.00	.00	BOX
5368.673	399.586	12.504	412.089	2813.00	21.95	7.48	419.57	.64	13.25	10.25	13.250	10.250	.00	0 .0
14.967	.0109				.0062		.09	13.15	1.09	10.16	.013	.00	.00	BOX
----- WARNING - Flow depth near top of box conduit -----														
5383.640	399.749	13.114	412.863	2813.00	20.93	6.80	419.66	13.25	13.25	10.25	13.250	10.250	.00	0 .0
TRANS STR	.0109				.0061		.05	13.25	1.02		.013	.00	.00	BOX
----- WARNING - Flow depth near top of box conduit -----														
5392.380	399.844	12.816	412.660	2813.00	21.41	7.12	419.78	.00	13.25	10.25	13.250	10.250	.00	0 .0
TRANS STR	.0109				.0060		.09	12.82	1.05		.013	.00	.00	BOX
----- WARNING - Flow depth near top of box conduit -----														

SR-710 NORTH STUDY
 DORCHESTER DRAIN LINE-A EAST & LINE-B (P20) (NGVD 29)
 MODEL: W.CHEN REVIEW: G.HSU

Station	Invert Elev	Depth (FT)	Water Elev	Q (CFS)	Vel (FPS)	Vel Head	Energy Grd.El.	Super Elev	Critical Depth	Flow Top Width	Height/Dia. -FT	Base Wt or I.D.	ZL	No Wth Prs/Pip
L/Elem	Ch Slope													
5406.640	400.000	13.250	413.250	2813.00	20.71	6.66	419.91	.00	13.25	10.25	13.250	10.250	.00	0 .0