APPENDIX J

SOUTHEAST VANDEN AREA MAJOR DRAINAGE FACILITIES MASTER PLAN AND ADDENDUM

WEST YOST ASSOCIATES

REGISTERED PROFESSIONAL ENGINEER
JEFFREY WANLASS
No. 60930
Exp. 12/31/2012
CIVIL
STATE OF CALIFORNIA

TECHNICAL MEMORANDUM

DATE: August 5, 2011 Project No.: 001-00-10-26.003

TO: Tim Burke, City of Vacaville
Christina Corsello, City of Vacaville

CC: Trenton Wilson, Analytical Environmental Services
Allan Haddox, Phillippi Engineering, Inc.
Vince Bossi, Phillippi Engineering, Inc.

FROM: Jeffrey Wanlass, R.C.E. #60930

REVIEWED BY: Jehan Fugitt, R.C.E. #77945

SUBJECT: Southeast Vanden Area Major Drainage Facilities Master Plan Addendum

BACKGROUND

The Southeast Vanden Area Major Drainage Facilities Master Plan (Master Plan) was completed on July 22, 2005. The Master Plan evaluated proposed regional storm drain facilities for both the Southtown and Vanden Meadows Developments (refer to Figure 1 in the Master Plan). Since completion of the Master Plan several changes have occurred to the proposed drainage facilities identified in the Master Plan. Consequently, some of the analysis results provided in the Master Plan are no longer valid. The changes that have occurred since completion of the Master Plan include the following:

- Reconfiguring of the regional detention basin
- Realignment of the 60 and 72-inch storm drain truck line along Vanden Road
- Revision of the watershed boundaries within the proposed Vanden Meadows Development

With the exception of the watershed boundaries revision, the hydrologic and hydraulic models were updated as the changes were made and a summary of the results were provided to the City of Vacaville (City) and Phillippi Engineering, Inc. (PEI) via email. Nevertheless, some confusion has arisen regarding which of the result summaries listed in the Master Plan are still valid. Therefore, the purpose of this addendum is to document the changes since the Master Plan and provide updated summary results and recommendations. More detailed descriptions of the changes listed above are provided in the following sections:

- Regional Detention Basin
- Storm Drain Trunkline
- Recommendations

REGIONAL DETENTION BASIN

PEI revised the regional detention basin configuration, which increased the storage volume over the recommended configuration presented in the Master Plan. The final detention basin configuration is based on improvement plans prepared by PEI, dated September 30, 2005 and approved by the City on October 3, 2005. A copy of the improvement plans is provided as Attachment A. Additional survey data downstream of the railroad along the Noonan Drain allowed for a more detailed evaluation of the flow overtopping the Noonan Drain. This evaluation resulted in a more accurate discharge rating curve for the pre-development culverts along the Noonan Drain and the discharge rating for the regional detention basin for the post-development condition.

Analysis Approach

The hydraulics of this system is complicated because of the severely under capacity culverts along the Noonan Drain and the resulting flow attenuation through existing overbank storage and the overbank losses. In lieu of an unsteady hydraulic analysis an iterative process was required to model the various components as a combined hydraulic system. The iterative process accounts for both the hydraulics and the routing of flow through detention storage. The following is a summary of the modeling approach used for the Master Plan and the subsequent analyses to develop the rating curves and to determine the water surface elevations in the detention basin and along the Noonan Drain:

1. Initial Culvert Rating: Culvert calculations were run for each set of culverts (the railroad culverts and the SID culverts) independently by varying the headwater and tailwater, then calculating the flow rate. From this information a rating curve was developed.
2. Elevation-storage relationships were developed for both the pre- and post-development conditions based on natural detention storage upstream of the railroad and Leisure Town Road and of the Regional Detention Basin. These relationships along with the initial culvert rating curves were input into the hydrologic (HEC-1) model to evaluate how the design flow is routed through the system.
3. The resulting flow rates from the hydrologic models were then input into the hydraulic (HEC-RAS) models to refine the culvert rating. HEC-RAS models were used to develop the refined rating curves for both the pre- and post-development conditions.
    - Since the culvert capacities are severely limited and the culverts along the creek are in close proximity to each other the decreased flows from the storage routing in hydrologic models were input into the hydraulic model downstream of the culverts and corresponding higher flows were input upstream.

4. The results from the hydraulic model rating curves were compared to the initial culvert rating curves that were input into the hydrologic models and adjustments were made to the initial rating curves to match the hydraulic rating curves. The adjusted rating curves were then input into the hydrologic models to determine the final detention basin water surface elevations and flow rates along the creek. Overflows were calculated manually using the standard weir equation (which is the same equation HEC-RAS uses to model lateral structures). The calculated overflows were added to the rating curves input into the hydrologic models.
5. The water surface profiles for pre- and post-development conditions were then determined for the entire creek system (refer to Figures 8 and 9, Master Plan). The following steps were used to develop the water surface profiles:
    a. The resulting flow rates from the hydrologic models were input into the hydraulic model for the channel reach between the detention basin and just downstream of the SID culverts.
    b. Downstream of the SID culverts, the channel is bermed on both sides along most of its length and discharge enters the channel via small lateral drains. Figure 7 in the Master Plan shows the location of the lateral drains. These drains were surveyed and their capacities determined (refer to Table 5, Master Plan). The estimated design flow in the channel downstream of the Railroad is assumed to be the combined capacity of the lateral drains and the discharge from the area upstream of the Railroad (refer to Table 6, Master Plan).

Results

The regional detention basin storage volume increased at lower stage elevations based on the final grading plan compared to the detention storage volume used in the Master Plan. The resulting 10-year water surface elevation (WSEL) in the detention basin is about 0.5 feet lower than the 10-year WSEL reported in the Master Plan. The resulting detention basin stage-storage-discharge relationship is provided in Figure 1.

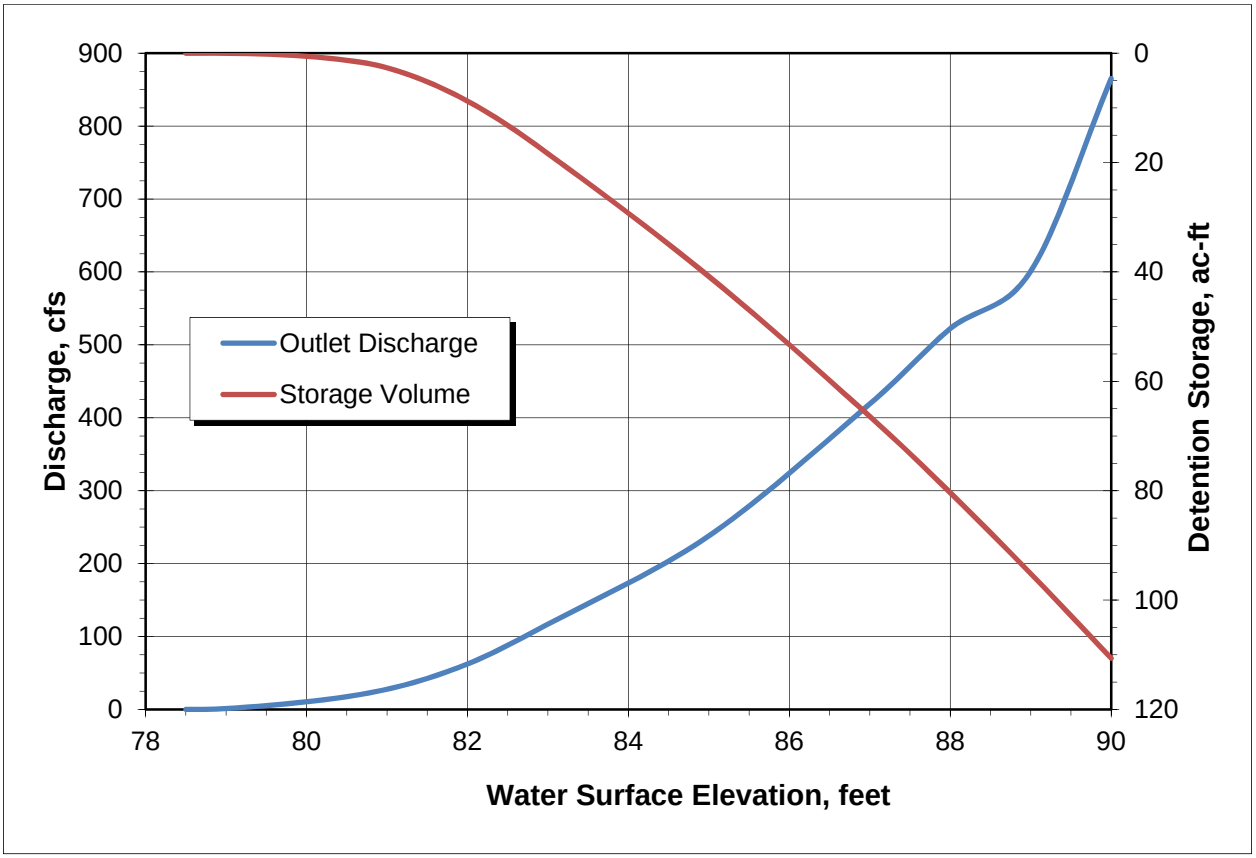


Figure 1. Regional Detention Basin Stage-Storage-Discharge Relationships

The pre-development existing natural detention storage stage-storage-discharge relationships were updated with the detailed surveying downstream of the railroad. Consequently, the flow summaries presented the Master Plan for both pre- and post-development conditions are no longer valid (refer to Table 3, Master Plan). Table 1 summarizes the changes between the Master Plan and subsequent analyses.

Table 1. Comparison of Model Results

Description	10-Year				100-Year			
	Pre-Development		Post-Development		Pre-Development		Post-Development	
	Master Plan[a]	Updated Analysis[b]	Master Plan	Updated Analysis	Master Plan	Updated Analysis	Master Plan	Updated Analysis
Basin Discharge, cfs	321[c]	330[c]	334	385	602[c]	599[c]	577	578
Basin WSEL, ft	n/a	n/a	87.1	86.6	n/a	n/a	89.3	88.7
Overflow to Alamo Creek[d], cfs	176	129	0	0	456	389	101	30
Remaining Flow in Noonan Drain, cfs	144[e]	145[e]	334	385	146[e]	145[e]	456	548

(a) Southeast Vanden Area Major Drainage Facilities Master Plan (July 22, 2005).
(b) Updated Analysis (May 2007), based on detention basin grading plans by PEI (September 30, 2005) – Attachment A; and additional survey data downstream of the railroad.
(c) Flow after natural detention storage upstream of Railroad and Leisure Town Road, but prior to overflow to Alamo Creek.
(d) Overflow to Alamo Creek begins to occur at elevation 87.5 feet under pre-development conditions and at elevation 88.5 feet, the detention basin spillway crest elevation, post-development conditions.
(e) The Master Plan assumed that flow that exceeds the capacity of the SID twin 36-inch culverts was diverted to Alamo Creek, while the Updated Analysis assumed that a portion of the overflow would be diverted to Alamo Creek and the remainder of the overflow would leave the channel between the Railroad culverts and the SID culverts.

STORM DRAIN TRUNKLINE

The storm drain trunkline was realigned along Vanden Road to the regional detention basin. The final alignment was based on a figure prepared by PEI, dated July 18, 2005. A copy is provided as Attachment B. An email dated July 29, 2008, sent to PEI, summarized the updated trunkline analysis based on the trunkline realignment and changes to the regional detention basin. A copy of the email and associated attachments are included as Attachment C. The watershed boundaries were recently revised by PEI, based on a letter dated December 7, 2009, and is included as Attachment D.

Analysis Approach

The storm drain trunkline was analyzed using a Rational Method analysis based on rainfall data contained in the Solano County Water Agency *Hydrology Manual* (June 1999) and the Pipeline Design criteria outlined in City's *Standard Specifications and Standard Drawings* (updated through April 2011). The analysis included calculation of the normal friction losses through the pipes and headlosses through manhole/inlet structures.

The design flow rate and time of concentration at the beginning of the trunkline (intersection of the Nut Tree Road and Opal Way) were based on the analysis for the existing Foxboro Development west of the Nut Tree Road. Refer to the Master Plan – Drainage Analysis, Existing Foxboro Storm Drain.

Results

The revised watershed map (see Attachment D) shifted the tributary storm drains connected to the trunkline further downstream, which resulted in minor increases in the hydraulic grade line (HGL) at the last three manhole/inlet structures. In general, however, the HGL decreased slightly compared to previous analyses (refer to Attachment C). Table 2 provides a summary of the hydraulic analysis for the trunkline and Figure 2 shows the trunkline alignment and node locations. Detailed hydraulic calculations are provided in Attachment E. Note that some of the node locations and identifiers have changed from the table presented in Attachment C.

The average HGL decrease is about 0.2 feet, with the greatest decrease by about 0.7 feet (Nodes I-34, J-11, & J-12) and the greatest increase by about 0.6 feet (Node I-36).

The HGL at the existing manhole at the intersection of Nut Tree Road and Opal Way decreased by about 0.4 feet and the HGL within the Southtown Development either remained unchanged or decreased; therefore, the proposed changes to the trunkline realignment and watershed boundaries within the proposed Vanden Meadows Development will not have an adverse impact to the existing Southtown or Foxboro Developments.

RECOMMENDATIONS

The mitigation measures recommended in the Master Plan were re-evaluated with the changes discussed in this Addendum and it was determined that those recommendation are still valid. The following improvements recommended in the Master Plan have been implemented:

- Regional detention basin with a capacity of about 110 acre-feet, including a spillway with a crest elevation of 88.5 feet.
- Storm drain trunkline, including about 2,660 feet of twin 60-inch drain and about 1,880 feet of twin 72-inch.
- 36-inch culvert under the Railroad with upstream invert elevation of 78.67 feet.

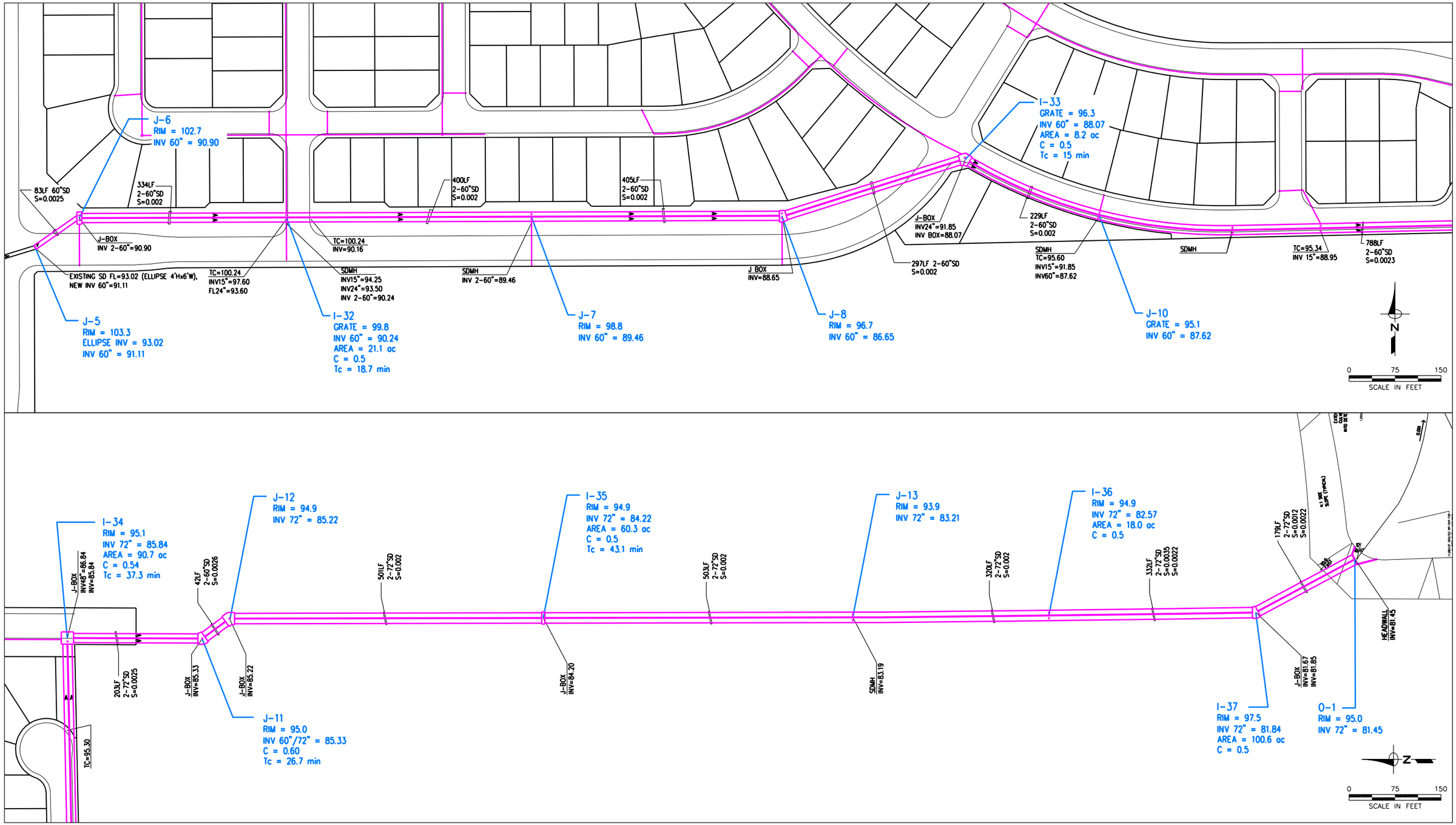
Since the 10- and 100-year post-development flows downstream of the regional detention increase over pre-development levels (see Table 1) the following drainage improvements, recommended in the Master Plan, are still necessary to mitigate for development of the Southtown and Vanden Meadows projects:

1. Remove or replace the existing SID twin 36-inch CMP culverts located just east of the Railroad. If the culverts are replaced, the capacity shall match or exceed the combined capacity of the culverts under the Railroad.

Table 2. Storm Drain Trunkline Hydraulic Analysis Summary

U/S Node	D/S Node	Time of Concentration, min	10-year Design Flow, cfs	Length, ft	Pipe Slope, ft/ft	Pipe Diameter, in	Full Capacity, cfs	U/S Invert Elevation, ft	D/S Invert Elevation, ft	U/S Ground Elevation, ft	D/S Ground Elevation, ft	U/S HGL, ft	D/S HGL, ft
J-5	J-6	38.8	197	83	0.0025	60	131	91.11	90.90	103.3	102.7	96.6	96.1
J-6	I-32	39.0	190	334	0.0020	Twin 60	231	90.90	90.25	102.7	99.8	96.2	95.7
I-32	J-7	40.0	203	400	0.0019	Twin 60	230	90.25	89.47	99.8	98.8	95.4	94.8
J-7	J-8	41.1	200	405	0.0020	Twin 60	234	89.47	88.66	98.8	96.7	94.6	94.0
J-8	I-33	42.2	198	297	0.0020	Twin 60	232	88.66	88.07	96.7	96.3	93.8	93.4
I-33	J-10	43.1	201	229	0.0020	Twin 60	232	88.07	87.62	96.3	95.1	93.2	92.8
J-10	I-34	43.7	201	788	0.0023	Twin 60	248	87.62	85.84	95.1	95.1	92.5	91.4
I-34	J-11	45.8	254	203	0.0025	Twin 60	261	85.84	85.33	95.1	95.0	90.8	90.3
J-11	J-12	46.3	253	42	0.0026	Twin 72	433	85.33	85.22	95.0	94.9	90.4	90.3
J-12	I-35	46.4	253	501	0.0020	Twin 72	380	85.22	84.22	94.9	94.1	90.2	89.7
I-35	J-13	47.7	289	503	0.0020	Twin 72	380	84.22	83.21	94.1	93.9	89.4	88.8
J-13	I-36	48.9	289	320	0.0020	Twin 72	380	83.21	82.57	93.9	94.9	88.6	88.2
I-36	I-37	49.7	292	332	0.0022	Twin 72	398	82.57	81.84	94.9	97.5	87.9	87.5
I-37	O-1	50.5	355	179	0.0022	Twin 72	398	81.84	81.45	97.5	95.0	86.9	86.6

Notes:
1. U/S = Upstream; D/S = Downstream
2. Elevations based on the NAVD 88 Datum.
3. Starting water surface elevation or HGL is based on the 10-year water surface elevation in the proposed detention basin of 86.6 ft.
4. Proposed storm drain based on alignment from PEI dated 9/19/2005. Sub-watershed boundaries based on delineation from PEI dated 12/7/2009.
5. 10-year design flows based on land use data received from PEI dated 12/7/2009.



NOTES:

1. RIM/GRATE ELEVATIONS ALONG VANDEN ROAD ARE BASED ON EXISTING SURFACE ELEVATIONS ALONG VANDEN ROAD.

LEGEND:

I-37 MODEL NODE & MODELING DATA (ELEVATIONS BASED ON NAVD 88 DATUM)

Figure 2

Southeast Vanden SD Master Plan Addendum
STORM DRAIN TRUNKLINE ANALYSIS
December 7, 2009 Alignment

WEST YOST ASSOCIATES
Consulting Engineers

N:\Clients\001 Vacaville\00-04-50 Southtown Analysis\CAD\Figures\Southtown SD-FIGURE 2.dwg 8-05-11 12:33:27 PM jwonlass

2. Replace the existing culverts at Meridian Road, Hay Road, and the private farm road with one of the following alternatives:
    - Twin 96-inch RCP culverts with concrete headwalls.
    - 16-foot by 8-foot ConSpan culverts at Meridian Road and Hay Road, and 16-foot by 10-foot ConSpan culvert at the private farm road.
3. Raise the top-of-bank elevations along the following reaches (see Table 7 and Figures 7 and 9 in Master Plan for more details):

    A – River Station 250+55 to 233+09 along the left bank.

    B – River Station 209+07 to 192+55 along the right bank.

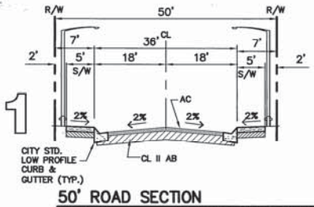
    C – River Station 137+52 to 122+52 along the right bank; and from Station 122+52 to 107+70 along both banks.

    D – River Station 90+53 to 85+53 along the right bank.

    E – River Station 65+67 to 54+60 along the both banks; and Station 54+60 to 42+46 along the left bank.

ATTACHMENTS

SOUTHTOWN
GRADING PLANS - PHASE 1
VACAVILLE, CA



50' ROAD SECTION

NOT TO SCALE 3.5" AC 7.5" AB TI=6 R=

A–CIRCLE, YOUNGSDALE DRIVE, A–COURT, B–CIRCLE, B–COURT, C–COURT, D–STREET, D–COURT, E–CIRCLE, E–COURT, F–STREET, F–COURT, G–STREET, H–COURT, OPAL WAY, J–STREET, K–STREET, AND K–COURT

PHASING NOTES

THE APPROVAL OF THESE "GRADING PLANS" ARE FOR THE FOLLOWING ITEMS OF WORK:

1. GRADING OF THE SITE WITHIN THE LIMITS SHOWN ON THE PLANS.

TEMPORARY GRADING LIMITS HAVE BEEN DENOTED ON THE GRADING PLANS AND SPECIFIED BELOW:

A) NO GRADING IS TO BE DONE IN THE WETLAND AREA UNTIL WETLAND PERMITTING IS COMPLETE AND AUTHORIZATION FROM THE CITY ENGINEER IS PROVIDED IN WRITING. THIS TEMPORARY GRADING LIMIT HAS BEEN DENOTED GRADING LIMIT A.

B) NO GRADING IS TO BE DONE IN THE SID AREA UNTIL SEPARATE WRITTEN PERMISSION FROM SID IS GRANTED AFTER THE IRRIGATION SEASON IS OVER, AND THE CANAL HAS BEEN REMOVED. THIS TEMPORARY GRADING LIMIT HAS BEEN DENOTED GRADING LIMIT B.

C) NO GRADING IS TO BE DONE ON PARCEL 136–110–130 UNTIL SEPARATE WRITTEN PERMISSION IS GRANTED FROM THE CITY. THIS TEMPORARY GRADING LIMIT HAS BEEN DENOTED GRADING LIMIT C.

2. OFF–SITE DETENTION BASIN.

3. ALL OTHER IMPROVEMENTS SHOWN ON THESE PLANS ARE SHOWN FOR CLARIFICATION PURPOSES ONLY, AND ARE NOT APPROVED FOR CONSTRUCTION, UNLESS OTHERWISE NOTED.

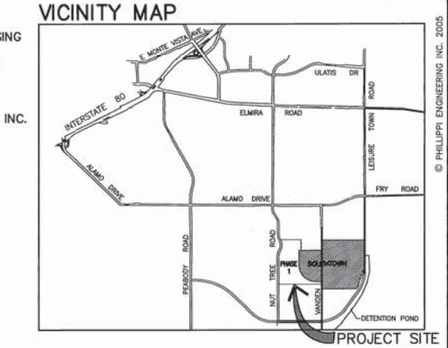
DEVELOPER:
WESTERN PACIFIC HOUSING
1210 CENTRAL BLVD.
BRENTWOOD, CA 94513
(925) 634–6023

ENGINEER:
PHILLIPPI ENGINEERING, INC.
425 MERCHANT ST
P.O. BOX 6556
VACAVILLE, CA 95688
(707)451–6556

SOILS ENGINEER:
KLEINFELDER INC.
780 CHADBOURNE RD.
SUITE D
FAIRFIELD, CA 94585
(707) 429–4070

A.P.N.:
136–11–080

VICINITY MAP



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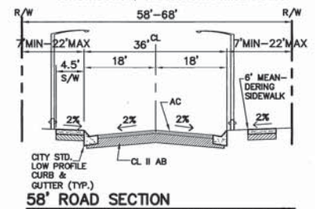
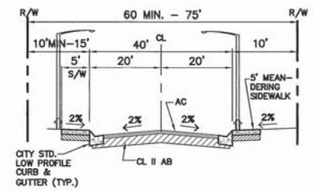


58' ROAD SECTION

NOT TO SCALE 3.5" AC 7.5" AB TI=6 R=
B–STREET STA 1+50 TO 10+00



60' ROAD SECTION

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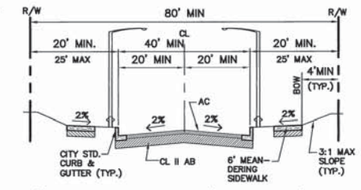
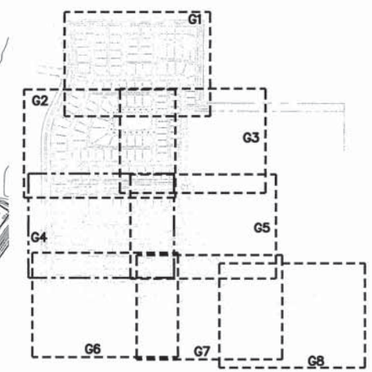
B–STREET STA 11+00 TO 30+00

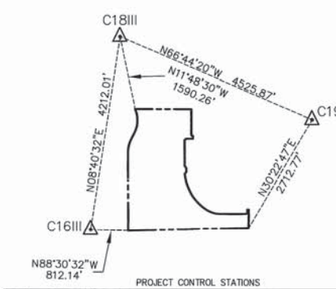


80' MIN ROAD SECTION (MAIN DRIVE)

NOT TO SCALE 4.5" AC 11.5" AB TI=8 R=
I–STREET STA 9+00 TO 12+00



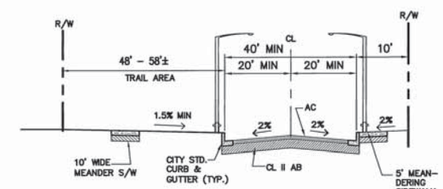
DRAWING INDEX



PROJECT CONTROL STATIONS

STA.	NORTHING	EASTING	ELEV.	DESCRIPTION
C16III	1879221.84'	6574575.82'	104.71'	CITY G.P.S. CONTROL MONUMENT "C16III"
C18III	1883385.66'	6575211.16'	106.63'	CITY G.P.S. CONTROL MONUMENT "C18III"
C19III	1881598.30'	6579369.14'	96.61'	CITY G.P.S. CONTROL MONUMENT "C19III"

NOTE: ALL COORDINATES ARE BASED UPON THE CITY OF VACAVILLE GPS CONTROL NETWORK
ALL MEASREMENTS ARE GRID AND IN U.S. SURVEY FEET



105' ROAD SECTION

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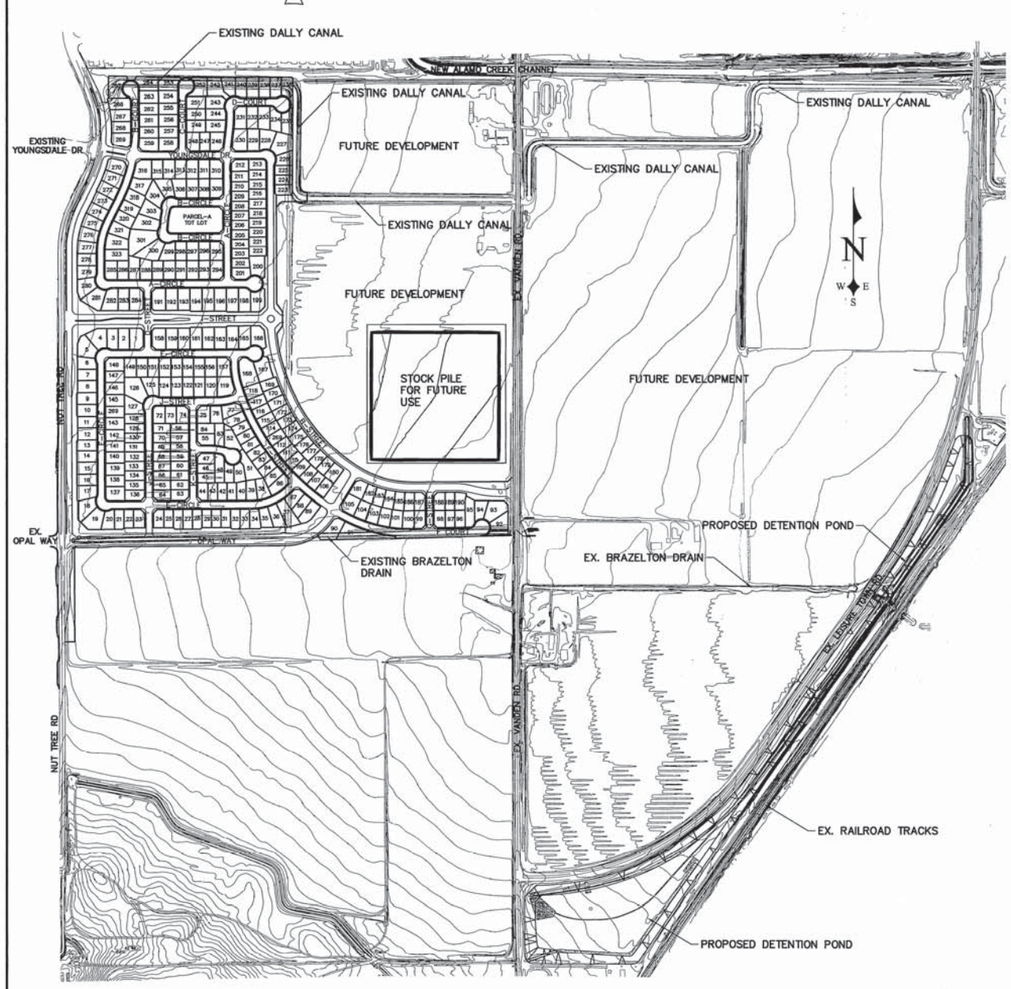
OPAL WAY STA 11+00 TO 26+50



SOUTHTOWN PHASE 1 MASTER GRADING PLAN

SCALE: 1"=400'

LEGEND

PROPOSED	EXISTING	
		CITY STANDARD MONUMENT
		CLEANOUT (C.O.)
		CURB GUTTER AND SIDEWALK
		DRAINAGE INLET (D.I.)
		ELECTROLIER/ STREET LIGHT
FG	EX. FG	FINISHED GRADE
		FIRE HYD. AND VALVE ASSEM.
12" SS	12"øSS	SANITARY SEWER, MANHOLE, SIZE AND SLOPE DIRECTION
18" SD	18"øSD	STORM DRAIN, MANHOLE, SIZE AND SLOPE DIRECTION
		TRAFFIC SIGN AS NOTED
8" W	8"øWM	WATER MAIN, SIZE AND VALVE
		INDICATES DIRECTION OF OVERLAND RELEASE

ABBREVIATIONS

AB – AGGREGATE BASE
AP – ANGLE POINT
AC – ASPHALT CONCRETE
ARV – AIR RELEASE VALVE
BFC– BACK FACE OF CURB
BOC –BACK OF CURB
BOW – BACK OF WALK
BOV – BLOW OFF VALVE
BV – BUTERFLY VALVE
BVCE – BEGIN VERTICAL CURVE ELEVATION
BVCS – BEGIN VERTICAL CURVE STATION
CL – CENTER LINE, CLASS
CMP – CORRUGATED METAL PIPE
CO – CLEANOUT
CONC. – CONCRETE
CR – CURVE RETURN
DI – DRAIN INLET
DIP – DUCTILE IRON PIPE
D/W – DRIVEWAY
DWG – DRAWING
E – EAST
ELEV – ELEVATION
EP – EDGE OF PAVEMENT
ESMT – EASEMENT
EVCE – END VERTICAL CURVE ELEVATION
EVCS – END VERTICAL CURVE STATION
EXIST/EX – EXISTING
F – FIRE
FDC – FIRE DEPARTMENT CONNECTION
FES – FLARED END SECTION
FF – FINISH FLOOR
FFC– FRONT FACE OF CURB
FL – FLOWLINE
FG – FINISH GRADE
FH – FIRE HYDRANT
FOC – FACE OF CURB
GB – GRADE BREAK
GL – GARAGE LIP
HCR– HANDICAP RAMP
HORIZ – HORIZONTAL
HP – HIGH POINT
I.E. INVERT ELEVATION
INV – INVERT
IRR – IRRIGATION
JB – JUNCTION BOX
JP – JOINT POLE
JT – JOINT TRENCH
LF – LINEAR FEET
LT – LEFT
MAX – MAXIMUM
MH – MANHOLE
MIN – MINIMUM
MISC – MISCELLANEOUS
PVMT – PAVEMENT
RCP – REINFORCED CONCRETE PIPE
RT – RIGHT
R/W – RIGHT OF WAY
S – SLOPE, SOUTH
SD – STORM DRAIN
MON – MONUMENT
N – NORTH
NPW – NON POTABLE WATER
NTS – NOT TO SCALE
OC – ON CENTER
PB – PULL BOX
PCC – POINT OF CONCENTRIC CURVATURE
PIV – POST INDICATOR VALVE
PL – PROPERTY LINE
PRC – POINT OF REVERSE CURVE
PRF– PAVEMENT REINFORCEMENT FABRIC
PUE – PUBLIC UTILITY EASEMENT
PVC– POLYVINYL CHLORIDE
SDJB – STORM DRAIN JUNCTION BOX
SS – SANITARY SEWER, SEWER SERVICE
SF – SQUARE FEET
SID – SOLANO IRRIGATION DISTRICT
SL–STREET LIGHT
STA – STATION
STD – STANDARD
S/W – SIDEWALK
SWTS – STORM WATER TREATMENT STRUCTURE
TB – TOP OF BANK
TC – TOP OF CURB
TEL – TELEPHONE
TW – TOP OF WALL
TYP – TYPICAL
VERT – VERTICAL
VCP – VITRIFIED CLAY PIPE
W – WEST
WM – WATER MAIN
WS – WATER SERVICE

DIRECTOR OF PUBLIC WORKS
DALE PFEIFFER, R.C.E. 24924
10-3-05
DATE

SOILS ENGINEER REVIEW

I HAVE REVIEWED THIS PLAN AND FIND IT IN GENERAL CONFORMANCE WITH THE SOILS REPORT PREPARED BY KLEINFELDER DATED SEPTEMBER 8, 2005 (JOB NO. 37979–2). WE ASSUME NO RESPONSIBILITY FOR THE NON–GEOTECHNICAL ASPECTS OF THIS GRADING PLAN.

THOMAS C. RIES, C.E. NO. 30809
EXP 03/31/06
10-3-05
DATE

SCALE:
HORIZ.:
VERT.:

CITY UTILITIES BEFORE YOU DIG CALL 800-642-2444 U.S.A.

PROFESSIONAL ENGINEER THOMAS C. RIES No. 30809 CIVIL STATE OF CALIFORNIA 10-3-05

APPROVED BY: CITY ENGINEER OCT - 3 2005 DATE OF APPROVAL
RCE NO. 43105

APPROVED

PHILLIPPI ENGINEERING
425 MERCHANT STREET
P.O. BOX 6556
VACAVILLE, CA 95688
OFFICE (707) 451-6556
FAX (707) 451-6555

DESIGNED BY:	VAB
DRAFTED BY:	VAB
CHECKED BY:	APH, II

PROJECT NAME/LOCATION: SOUTHTOWN PHASE 1 VACAVILLE CALIFORNIA

DRAWING TITLE: TITLE SHEET

REVISIONS: NO.	DESCRIPTION	DATE
1	SHEETS 31-35 ADDED (Chadbourne Rd.)	8/31/06

DRAWING FILE: 210860C1
XR: 210860M, T

ISSUE DATE: 09/30/05
PROJECT NO.: 210860
SHEET NO.: C1 OF 21

SEE SHEET G8

VANDEN ROAD

SEE REVISED RAMP DETAIL ON SHEET G-12

136-110-140
FUTURE ZOCCHI DEVELOPMENT

ULTIMATE LEISURE TOWN ROAD R/W

LEISURE TOWN ROAD R/W

136-140-100
CITY OF VACAVILLE

136-140-110
CITY OF VACAVILLE

167-230-070
ARDAVE ROBERT & CYNTHIA S

LEISURE TOWN ROAD

UNION PACIFIC RAILROAD TRACK

14" GAS

APPROX. LOCATION OF EX. 14" GAS LINE

SEE SHEET G10

CAUTION:
FIBER OPTIC AND 20" GAS MAIN IN RAILROAD RIGHT OF WAY

NOTE:
STORM DRAIN EXTENTIONS SHOWN IN SECTIONS SD 1-6 INTO DETENTION POND TO BE CONSTRUCTED WITH THIS GRADING PLAN

SECTION SD-1

SECTION SD-2

SECTION SD-3

SECTION SD-4
SEE SHEETS S1-S5 FOR HEADWALL DETAILS
SECTION SD-4 MOVED TO SHEET G-11

SECTION SD-5

SECTION SD-6

© PHILLIPPI ENGINEERING INC. 2005

SCALE:
HORIZ.: 1"=60'
VERT.:

APPROVED BY:
CITY ENGINEER
DATE OF APPROVAL: OCT - 3 2006

RCE NO. 43105

PHILLIPPI ENGINEERING
CIVIL ENGINEERING - LAND SURVEYING
1091 B GALE WYNNE PARKWAY
VACAVILLE, CA 95688
P.O.BOX 6556
OFFICE (707) 451-8858
FAX (707) 451-8858

DESIGNED BY: VAB
DRAFTED BY: VAB
CHECKED BY: AFH, II

APPROVED

PROJECT NAME/LOCATION:
SOUTHTOWN PHASE 1
VACAVILLE CALIFORNIA

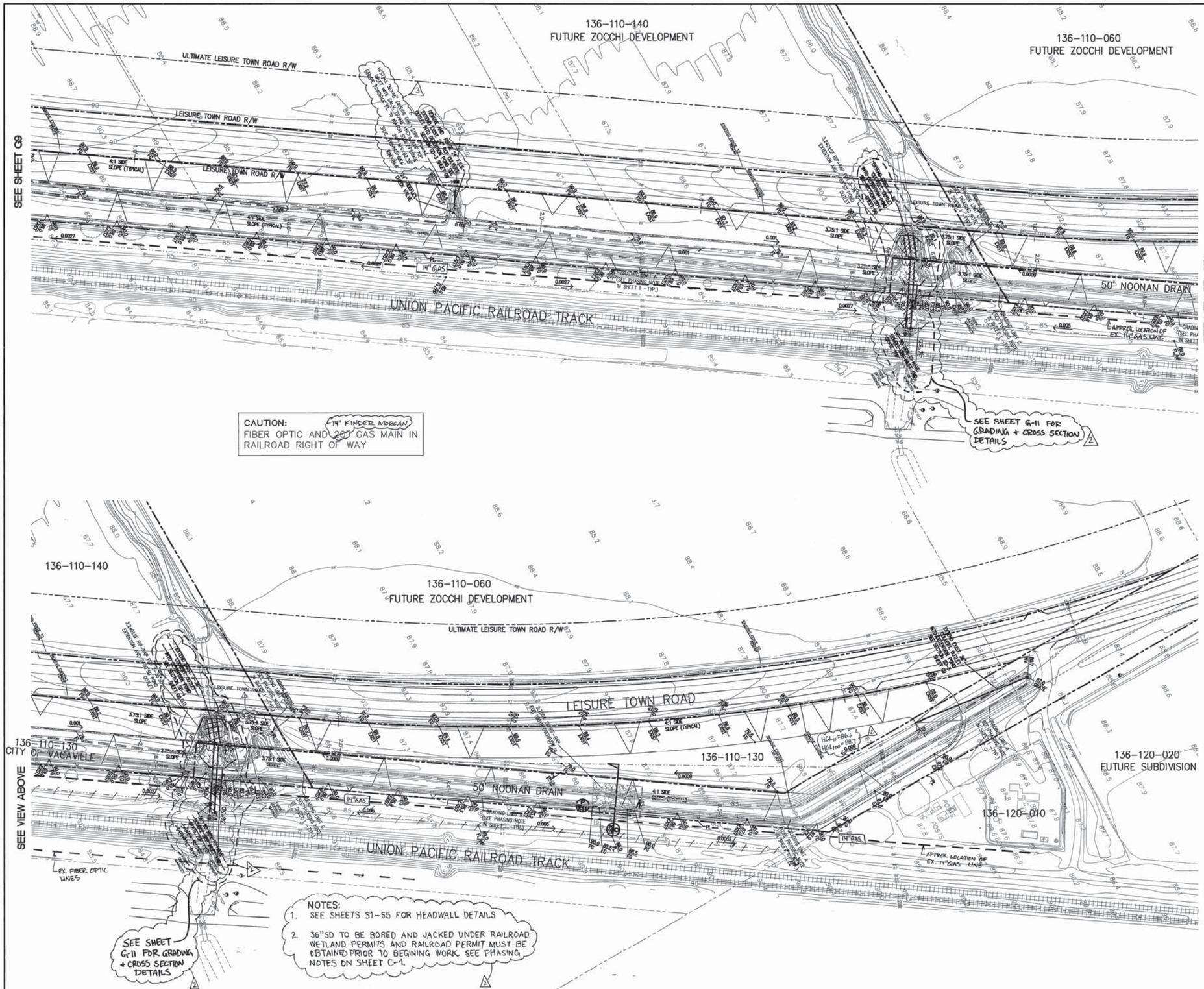
DRAWING TITLE:
GRADING PLAN

REVISIONS:

NO.	DESCRIPTION	DATE
1	SECTION SD-4 MOVED TO SHEET G-11	8/23/05
2	SECTION SD-6 REMOVED 18" SDP	8/13/05
3	REVISE ACCESS RAMP TO DET. POND AND SIDE OPEN. INLET TO SD-5	9/16/02

DRAWING FILE:
21086G9
XR: 210860M, T

ISSUE DATE: 09/30/05
PROJECT NO.: 210860
SHEET NO.: G9 OF 21



© PHILLIPPI ENGINEERING INC. 2005

SCALE:
HORIZ.: 1" = 60'
VERT.:

APPROVED BY:
CITY ENGINEER RCE NO. 43105
DATE OF APPROVAL OCT - 3 2005

PHILLIPPI ENGINEERING
CIVIL ENGINEERING - LAND SURVEYING
1091 HORNBLEND STREET - VACAVILLE, CA 95688
P.O.BOX 6558 VACAVILLE, CA 95696
OFFICE (707) 451-8558 FAX (707) 451-8558

APPROVED

DESIGNED BY: VAB
DRAFTED BY: VAB
CHECKED BY: AFH, II

PROJECT NAME/LOCATION:
SOUTHTOWN PHASE 1
VACAVILLE CALIFORNIA

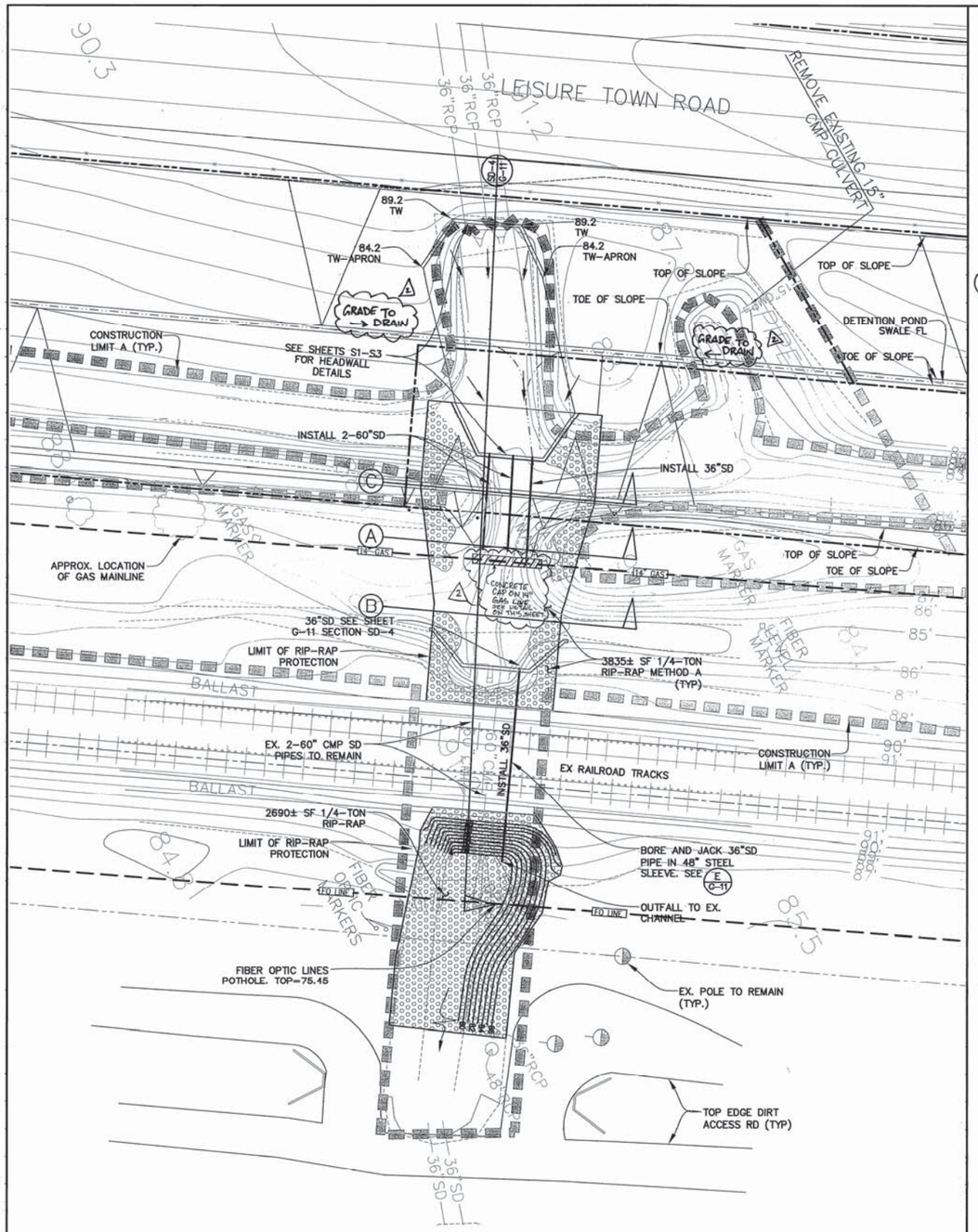
DRAWING TITLE:
GRADING PLAN

REVISIONS:

NO.	DESCRIPTION	DATE
1	DET. ROAD SIDE SLOPE	8/13/07
2	HEADWALLS AND 24"SD B.A.J.	8/13/07
3	ADD SIDE DRAIN INLET TO EX. 24"SD	10/29/07

DRAWING FILE:
210860G10
XR: 210860M, T

ISSUE DATE: 09/30/05
PROJECT NO.: 210860
SHEET NO.: G10 OF 21



DETENTION POND OUTFALL DETAIL

SCALE: 1"=20'

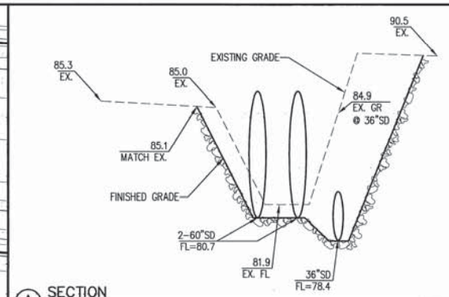
GENERAL NOTES:

1. SEE SHEETS S1-S5 FOR HEADWALL DETAILS
2. 36"SD TO BE BORED AND JACKED UNDER RAILROAD. WETLAND PERMITS AND RAILROAD PERMIT MUST BE OBTAIND PRIOR TO BEGINING WORK. SEE PHASING NOTES ON SHEET C-1.
3. CONTRACTOR SHALL BORE AND JACK 36" ~~RCP~~ D.I.P. SD PIPE PRIOR TO CONSTRUCTION OF HEADWALLS AND ANY OTHER STORM DRAIN PIPES SHOW ON THIS PLAN SHEET.

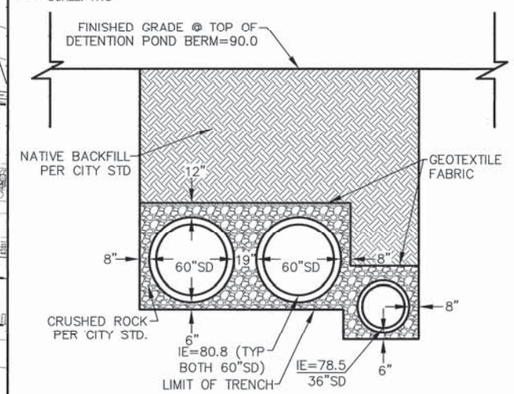
KINDER MORGAN 14" GAS LINE NOTES:

1. CONTRACTOR SHALL NOTIFY KINDER MORGAN AREA MANAGER PETE MURPHY (925) 682-0764 AT LEAST TWO WEEKS PRIOR TO COMMENCEMENT OF WORK.
2. THE 14" GAS PIPELINE MUST BE EXPOSED AND OBSERVABLE WHEN CROSSING THIS FACILITY.
3. BACKFILL AROUND THE PIPELINE MUST BE SAND (OR ROCK FREE DIRT) AND MUST BE HAND COMPACTED.

CAUTION:
FIBER OPTIC AND 14" KINDER MORGAN GAS MAIN IN RAILROAD RIGHT OF WAY



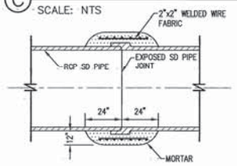
Ⓐ SECTION
SCALE: NTS



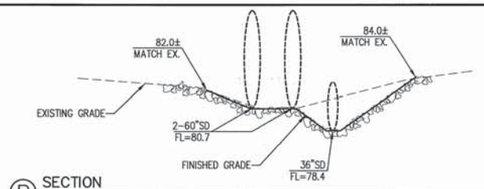
TRENCH BACKFILL DETAIL

SEE CITY STD. DETAIL 3-20B

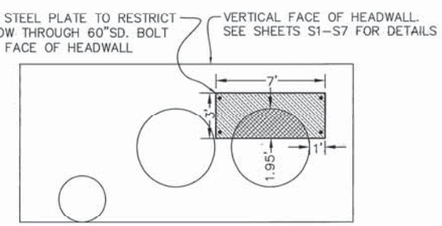
Ⓒ SECTION
SCALE: NTS



Ⓓ PIPE JOINT CONNECTION DETAIL
SCALE: NTS



Ⓑ SECTION
SCALE: NTS

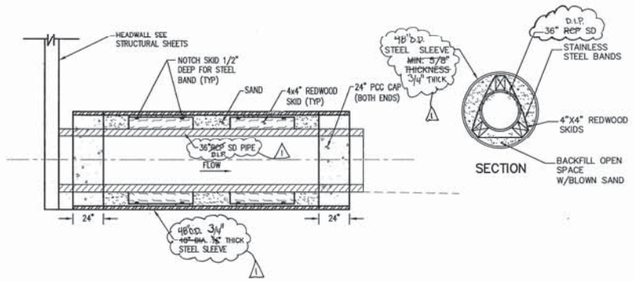


HEADWALL PIPE RESTRICTION DETAIL

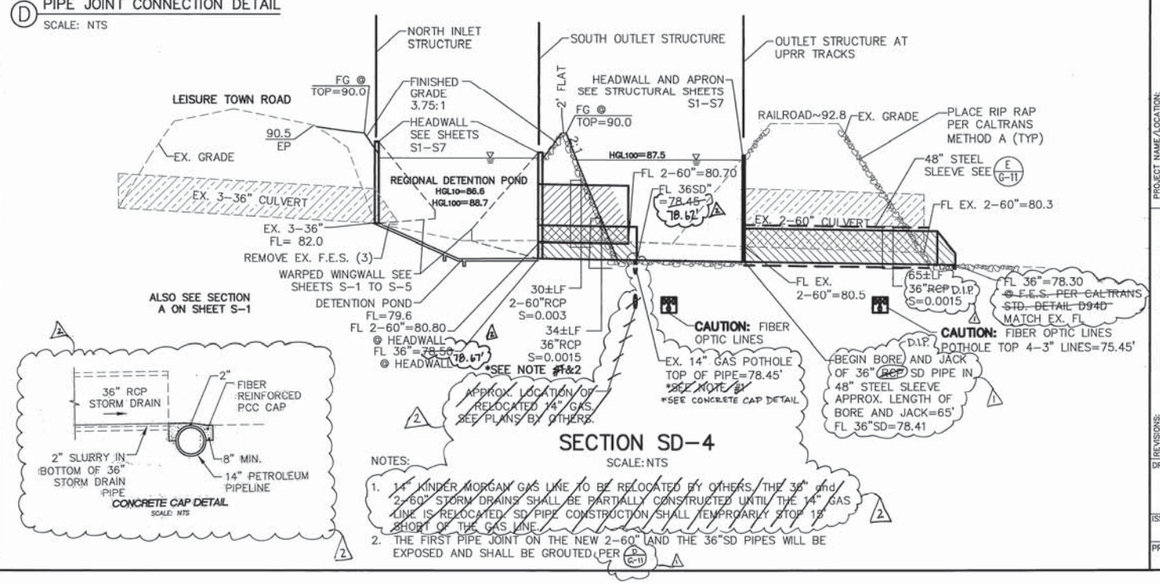
SCALE: NTS

NOTES:

1. THE RESTRICTION PLATE SHOWN ON THIS DETAIL IS NOT A PERMANENT IMPROVEMENT TO THE REGIONAL DETENTION POND. THE STEEL RESTRICTION PLATE SHALL REMAIN IN PLACE UNTIL WRITTEN AUTHORIZATION IS GRANTED BY THE CITY ENGINEER.



Ⓔ BORE AND JACK SLEEVE DETAIL
SCALE: NTS



SECTION SD-4

SCALE: NTS

NOTES:

1. 14" KINDER MORGAN GAS LINE TO BE RELOCATED BY OTHERS. THE 36" and 2-60" STORM DRAINS SHALL BE PARTIALLY CONSTRUCTED UNTIL THE 14" GAS LINE IS RELOCATED. SD PIPE CONSTRUCTION SHALL TEMPORARILY STOP 15' SHORT OF THE GAS LINE.
2. THE FIRST PIPE JOINT ON THE NEW 2-60" AND THE 36"SD PIPES WILL BE EXPOSED AND SHALL BE GROUTED PER D G-11

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SCALE:
HORIZ.:
VERT.:

CALL 811 TWO WORKING DAYS BEFORE YOU DIG 800.642.2444 USA

REGISTERED PROFESSIONAL ENGINEER — STATE OF CALIFORNIA

APPROVED BY: CITY ENGINEER — DATE OF APPROVAL: 8/13/07 — RCE NO.: 38251

PHILLIPPI ENGINEERING
CIVIL ENGINEERING - LAND SURVEYING
2780 SPAFFORD STREET, VACAVILLE, CA 95688
P.O. BOX 6556, VACAVILLE, CA 95696
OFFICE (707) 451-6556 FAX (707) 451-6555

DESIGNED BY: VAB
DRAFTED BY: VAB
CHECKED BY: AFH, II

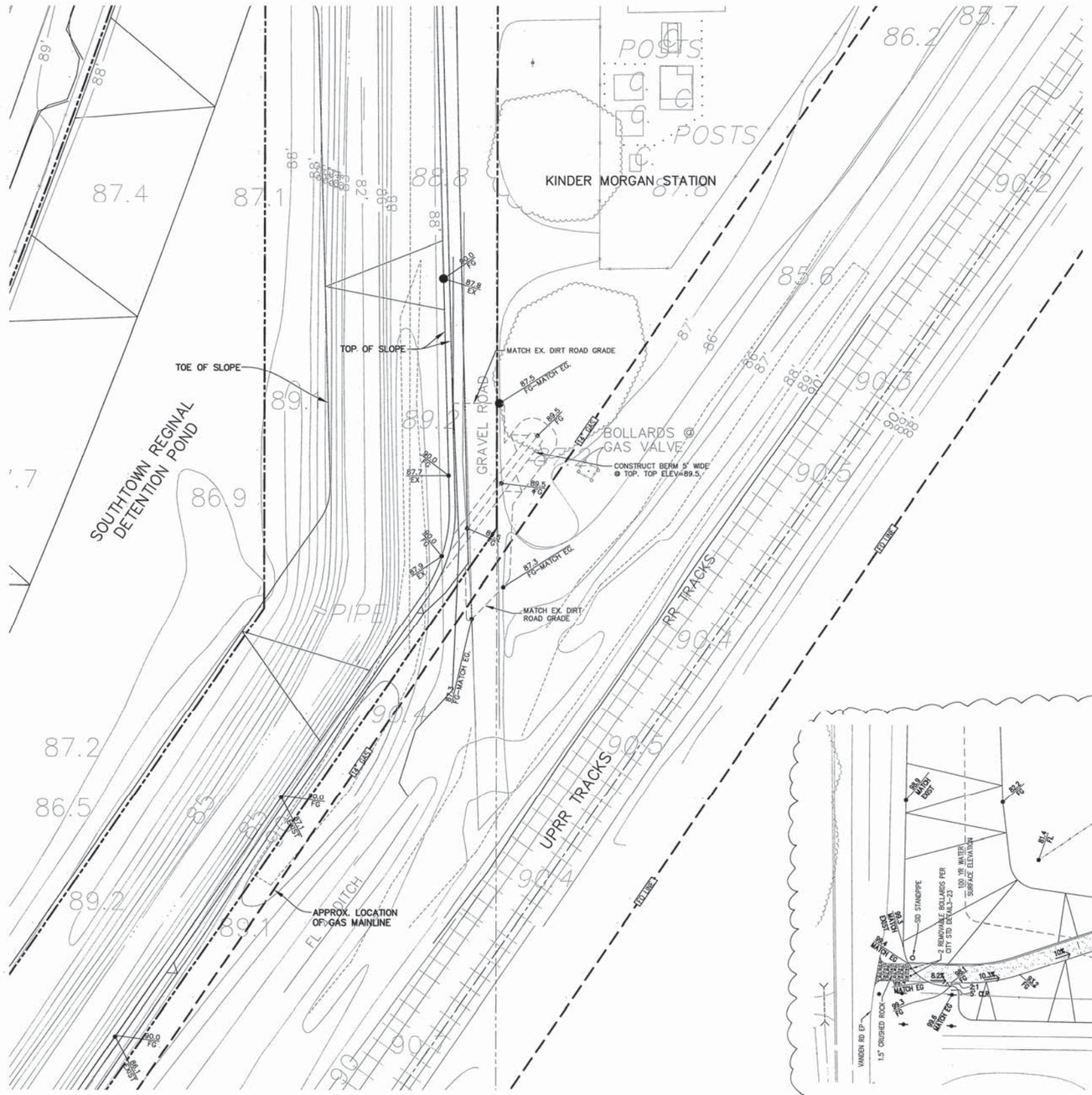
PROJECT NAME/LOCATION: SOUTHTOWN PHASE 1 — VACAVILLE — CALIFORNIA

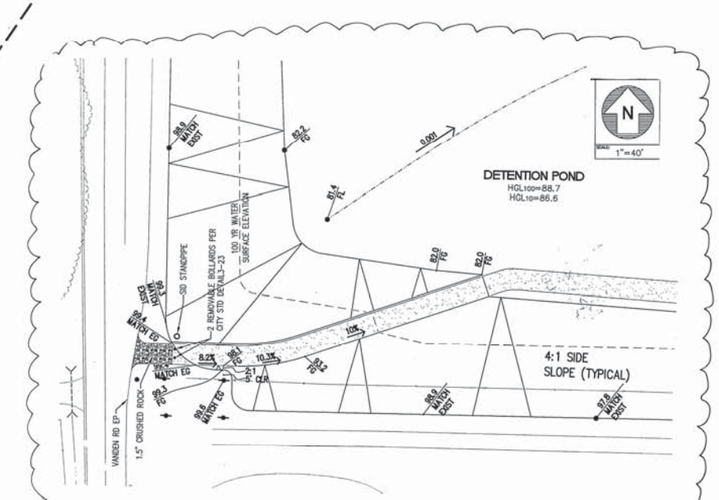
DRAWING TITLE: DETENTION POND OUTFALL DETAILS

REVISIONS: NO.	DESCRIPTION	DATE
1	BORE AND JACK 36"SD PER CALTRANS STD.	9/12/07
2	MOD TO CAP ON 14" GAS LINE	10/6/07

DRAWING FILE: 210860G10
XR: 210860M, T

ISSUE DATE: 08/08/07
PROJECT NO.: 210860
SHEET NO.: G11 OF 21





DETENTION POND F.C.C. ACCESS RAMP DETAIL

1

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SCALE:
HORIZ.:
VERT.:

CALL 1 BEFORE YOU DIG
CITY: 707-642-7488
PG&E: 800-642-7234

REGISTERED PROFESSIONAL ENGINEER
JEFFREY A. HUDSON
No. 37206
Exp. 12-31-07
CIVIL
STATE OF CALIFORNIA

APPROVED BY:
CITY ENGINEER
DATE OF APPROVAL
38521
RCE NO.

PHILLIPPI ENGINEERING
CIVIL ENGINEERING - LAND SURVEYING
4540 MEADOW WOOD STREET VACAVILLE, CA 95688
P.O.BOX 6556 VACAVILLE, CA 95696
OFFICE (707) 451-6556 FAX (707) 451-6555

DESIGNED BY:	VAB
DRAFTED BY:	VAB
CHECKED BY:	AFH, II

PROJECT NAME/LOCATION:
SOUTHTOWN PHASE 1
VACAVILLE CALIFORNIA

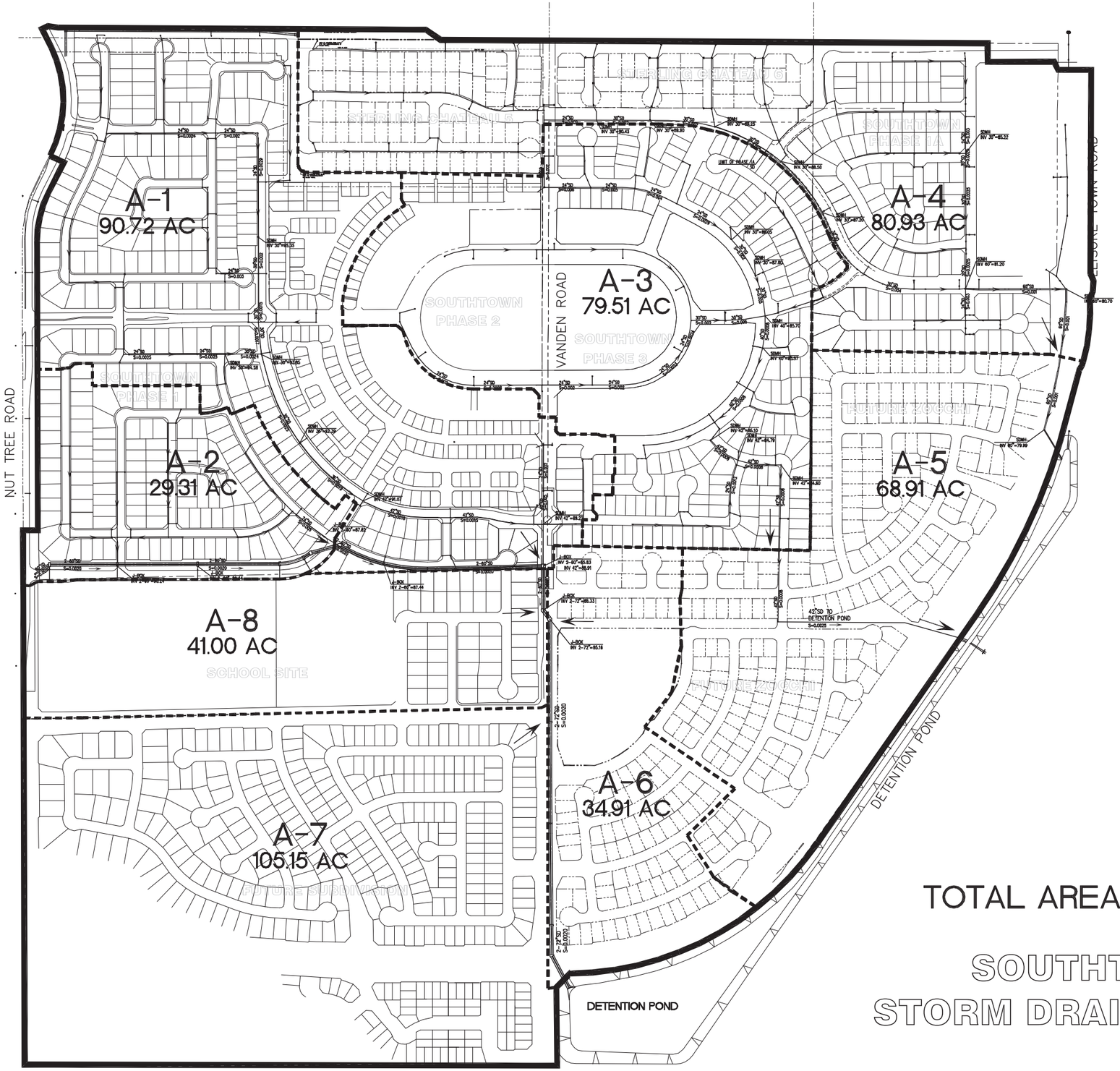
DRAWING TITLE:
DETENTION POND OUTFALL DETAILS

REVISIONS:

NO.	DESCRIPTION	DATE
1	ADD DET. Pond ACCESS RAMP DETAIL	7-8-08

DRAWING FILE:
210860G10
XR: 210860M, T

ISSUE DATE: 08/08/07
PROJECT NO.: 210860
SHEET NO.: G12 OF 21



TOTAL AREA=530.44 AC

SOUTHTOWN STORM DRAIN LAYOUT

© PHILLIPPI ENGINEERING INC. 2003

N

SCALE: 1"=200'

REGISTERED PROFESSIONAL ENGINEER — CIVIL — No. 32067 — STATE OF CALIFORNIA

PHILLIPPI ENGINEERING
CIVIL ENGINEERING • LAND PLANNING
P.O. BOX 1004 — 1091 DUNSMUIR STREET — VACAVILLE, CA 95688
OFFICE (707) 451-4594 FAX (707) 451-4595

PRELIMINARY

DESIGNED BY: E.T.V.
DRAFTED BY: E.T.V.
CHECKED BY: T.A.P.

PROJECT NAME/LOCATION: SOUTHTOWN AREA — CITY — STATE

DRAWING TITLE: STORM DRAIN LAYOUT

REVISIONS: NO. | DESCRIPTION | DATE

DRAWING FILE: MASTER UTIL/ 210860-S4-STORM

ISSUE DATE: 07/18/05

PROJECT NO.: 210860

SHEET NO.: 4 OF 5

Jeff Wanlass

From: Jeff Wanlass
Sent: Tuesday, July 29, 2008 2:09 PM
To: Vince Bossi
Subject: RE: Southtown Phase 1 Detention pond grading
Attachments: Trunkline Hydraulic Summary 7-29-08.pdf; Southtown SD 9-22-05.pdf

Vince,

Attached is the revised calculations for the Southtown Trunk Storm Drain. Please review the table to insure the data is still correct. Also attached is a figure showing the node location.

Jeffrey Wanlass, P.E.
West Yost Associates
P 530.792.3245
jwanlass@westyost.com

From: Vince Bossi [mailto:vbossi@phillippieng.com]
Sent: Wednesday, July 16, 2008 3:59 PM
To: Jeff Wanlass
Subject: FW: Southtown Phase 1 Detention pond grading

Forward of old email below.

Vincent A. Bossi

Staff Engineer
Phillippi Engineering, Inc.
(707) 451-6556

From: Jeff Wanlass [mailto:JWanlass@westyost.com]
Sent: Friday, July 27, 2007 9:30 AM
To: Vince Bossi
Cc: Allan Haddox; Tim Burke
Subject: RE: Southtown Phase 1 Detention pond grading

Vince,

1. The berm is intended to protect Leisure Town Road and the ultimately the Southtown Commons project. The green line shown on 210860P1M.pdf is the correct location. Overflows from the detention basin should be directed to Alamo Creek, not blocked. The berm height should be about 89.5 ft.
2. The revised water surface elevations in the detention basin under ultimate buildout are 86.6 feet during a 10-yr storm and 88.7 feet under a 100-yr storm. Between the railroad and the detention basin the water surface is about 87.5 feet.

Jeffrey Wanlass, P.E.
West Yost Associates

From: Vince Bossi [mailto:vbossi@phillippieng.com]
Sent: Wednesday, July 25, 2007 9:56 AM
To: Jeff Wanlass
Cc: 'Allan Haddox'; Tim Burke
Subject: Southtown Phase 1 Detention pond grading

Jeff,

We have received comment from the city on our plan revision at the railroad and there are two items that I need clarified.

1. The first is to include grading of a berm. Tim Burke and Allan had in mind two different places for this berm to be located. See attached pdf file (Green and orange lines). I will need to know where the berm needs to be located, the berm top elevation (88.0?), and the intended area we are trying to protect.

2. Tim has made note in his comments that the HGL in the pond is changing and that you can provide new elevations. Is this true? I currently have HGL_{10}=87.1 and HGL_{100}=89.3 (Ultimate build out). Tim is also asking what the HGL is between the pond and railroad tracks. Can you provide this.

Feel free to call if you have any questions. Thank you for your help.

Vincent A. Bossi, E.I.T.
Staff Engineer
Phillippi Engineering, Inc.
425 Merchant St
Vacaville, Ca. 95688
office (707) 451-6556
fax (707) 451-6555
<<...>> <<...>> <<...>>

Southtown Storm Drain Trunkline Hydraulic Analysis Summary Report

Detention Basin Starting Water Surface Elevation of 86.6 ft (10-year storm)

Upstream Node	Downstream Node	Time of Concentration (min)	10-year Design Flow (cfs)	Length (ft)	Pipe Slope (ft/ft)	Pipe Diameter (in)	Full Capacity (cfs)	Upstream Invert Elevation (ft)	Downstream Invert Elevation (ft)	Upstream Ground Elevation (ft)	Downstream Ground Elevation (ft)	Upstream HGL (ft)	Downstream HGL (ft)
J-5	J-6	38.9	196	83	0.0271	72 inch	697	93.19	90.94	103.3	102.7	97.0	96.5
J-6	I-32	39.0	196	334	0.0020	60 inch	232	90.90	90.24	102.7	99.8	96.2	95.7
I-32	J-7	40.1	210	400	0.0020	60 inch	230	90.24	89.46	99.8	98.8	95.6	95.0
J-7	J-8	41.3	206	405	0.0020	60 inch	233	89.46	88.65	98.8	96.7	95.0	94.3
J-8	I-33	42.6	203	297	0.0020	60 inch	230	88.65	88.07	96.7	96.3	94.1	93.7
I-33	J-10	43.6	206	229	0.0020	60 inch	231	88.07	87.62	96.3	95.1	93.4	93.1
J-10	I-34	44.3	205	788	0.0023	60 inch	248	87.62	85.84	95.1	95.1	93.1	91.8
I-34	I-35	46.8	266	203	0.0025	72 inch	425	85.84	85.33	95.1	95.0	91.6	91.4
I-35	I-36	47.3	298	42	0.0026	72 inch	433	85.33	85.22	95.0	94.9	91.1	91.0
I-36	I-37	47.3	322	501	0.0020	72 inch	382	85.22	84.20	94.9	94.1	90.6	90.1
I-37	J-11	48.4	388	503	0.0020	72 inch	380	84.20	83.19	94.1	93.9	89.5	88.5
J-11	J-12	49.5	382	505	0.0020	72 inch	379	83.19	82.18	93.9	94.9	88.5	87.7
J-12	J-13	50.6	376	147	0.0022	72 inch	401	82.18	81.85	94.9	97.5	87.7	87.4
J-13	O-1	50.9	375	179	0.0022	72 inch	400	81.85	81.45	97.5	95.0	86.9	86.6

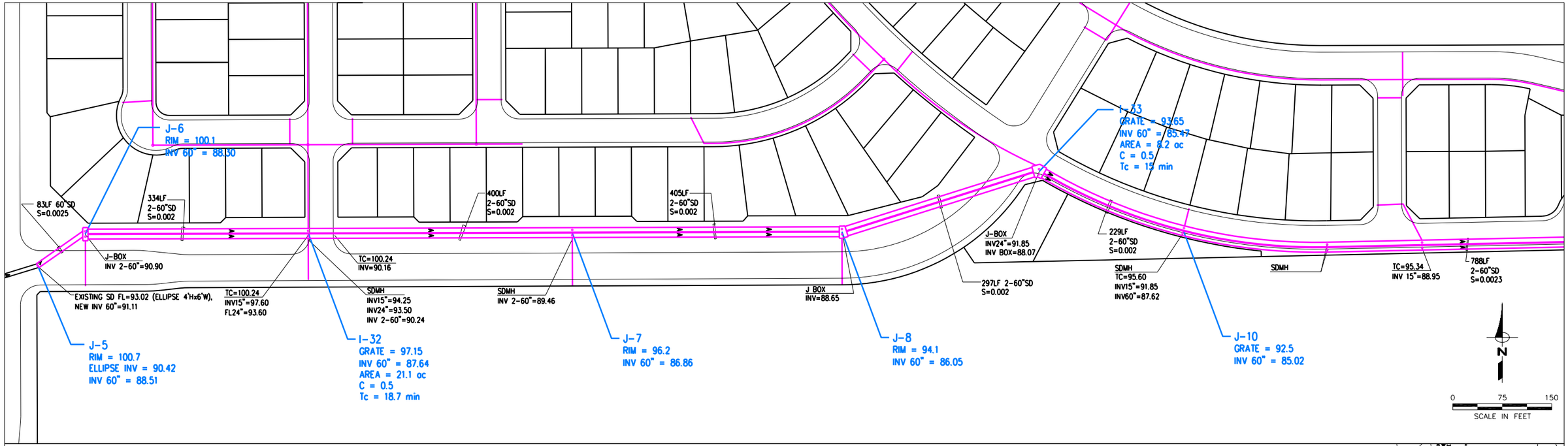
Notes:

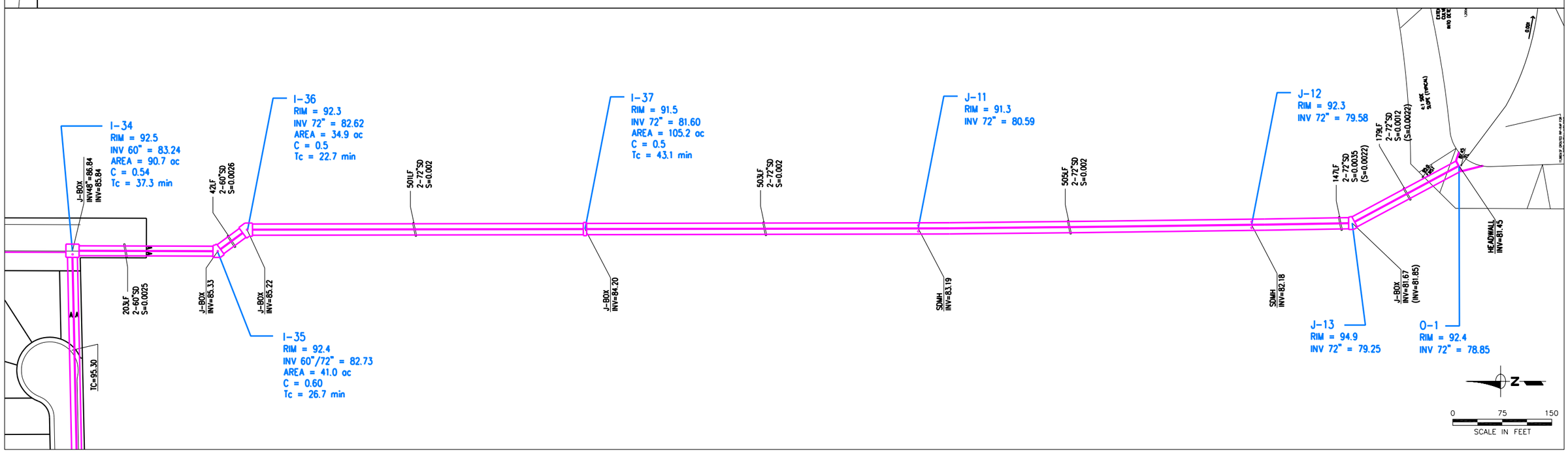
1- Elevations based on the NAVD 88 Datum.

2 - Starting water surface elevation or HGL is based on the 10-year water surface elevation in the proposed detention basin of 86.6 ft.

3 - Proposed storm drain based on alignment from PEI dated 9/19/2005. Sub-watershed boundaries based on delineation from PEI dated 7/18/05.

4 - 10-year design flows based on land use data received from PEI dated 2/11/2205.





NOTES:

1. ELEVATION DATA FOR THE EXISTING FOXBORO STORM DRAIN SYSTEM IS BASED ON THE NVGD 29 DATUM. THEREFORE, FOR MODELING PURPOSES ELEVATIONS SHOWN IN BLUE ARE ASLO BASED ON THE NVGD 29 DATUM. ELEVATIONS WERE CONVERTED TO THE NVGD 29 DATUM BY SUBTRACTING 2.6 FEET FROM THE ELEVATION BASED ON THE NAVD 88 DATUM.

2. RIM/GRATE ELEVATIONS ALONG VANDEN ROAD ARE BASED ON EXISTING SURFACE ELEVATIONS ALONG VANDEN ROAD.

LEGEND:

I-37	MODEL NODE & MODELING DATA (ELEVATIONS BASED ON NVGD 29 DATUM)
(S=0.0025)	REVISED DATA PER THIS ANALYSIS

Exhibit A

Southeast Vanden Area SD Master Plan
STORM DRAIN TRUNKLINE ANALYSIS
September 19, 2005 Alignment

WEST YOST & ASSOCIATES

I:\001\04-50\working files\Southtown SD 9-22-05.dwg 9-23-05 02:15:56 PM JWanlass

Attachment D

RECEIVED
DEC 08 2009
City of Vacaville
Planning Division

PHILLIPPI ENGINEERING, INC.
CIVIL ENGINEERING - LAND SURVEYING

December 7, 2009
Job No. 280280

Tim Burke
City of Vacaville
Department of Public Works
425 Merchant Street
Vacaville, Ca 95687

SUBJECT: Vanden Meadows Tentative Map and Storm Drain Master Plan addendum

Dear Tim,

Please find enclosed an addendum to the "Souteast Vanden Area Major Drainage Facilities Master Plan" prepared by West Yost and Associates dated July 22, 2005. This addendum has been prepared to reflect changes in the proposed development tributary to the twin 72" Storm Drain pipes constructed by the Southtown Phase 1 developer within Vanden Road as well as revised shed areas along Leisure Town Road.

The sub-shed areas tributary to the 2-72" pipes outlined in West Yost's storm drain master plan were in preliminary design stages at the time that the report was completed. The storm drainage shed areas were based upon preliminary site plans provided by Phillippi Engineering in July 2005. Since West Yost's storm drainage master plan was approved several revisions to the site plans, drainage shed areas, and connection locations have been made. The changes made over the past four years have made the attached addendum necessary to ensure that the current Vanden Meadows Storm Drain Master Plan significantly conforms to the "Souteast Vanden Area Major Drainage Facilities Master Plan" at project build out.

Please feel free to contact me if you have any questions or comments.

Thank you,

PHILLIPPI ENGINEERING, INC.

Allan Haddox, II PE, PLS
Engineering Manager

Vincent A. Bossi
Staff Engineer

THOMAS A. PHILLIPPI, R.C.E. #32067
P.O. BOX 6556 • 425 MERCHANT STREET, SUITE 200 • VACAVILLE, CA 95696-6556
OFFICE (707) 451-6556 • FAX (707) 451-6555 • EMAIL: pei@phillippieng.com

The Vanden Meadows Tentative Maps and Storm Drainage Master Plan submitted by Phillippi Engineering, Inc on September 9, 2009 substantially conforms to the previously approved West Yost and Associates report titled, "Souteast Vanden Area Major Drainage Facilities Master Plan" dated July 22, 2005. Below is a summary of the changes made since the original West Yost drainage master plan report was issued in 2005.

1. **Shed A-6** has been broken into two shed areas, A-6A and A-6B. At the time of the West Yost report shed A-6 was 34.91 acres with a discharge point into the twin 72"SD conservatively located at the Northwest corner of the watershed area. With the current Vanden Meadows tentative maps sheds A-6A and A-6B are 15.03 acres and 18.05 acres respectively. Some of the Leisure Town Road frontage was previously included in shed A-6. The Leisure Town Road frontage area has been removed from shed A-6 because it will drain to the existing 24" storm drain pipes which are directly tributary to the detention pond and will not contribute to the storm water flow within the twin 72" pipes. The collective areas of sheds A-6A and A-6B total 33.08 acres resulting in a reduction of shed A-6 by 1.83 acres since issuance of the West Yost 2005 report.
2. **Shed A-7** changed in area to now include a portion a of the future school site while a portion of the residential subdivision previously within shed A-7 is now included in shed A-8. At the time of the West Yost report shed A-7 was105.15 acres. With the current Vanden Meadows tentative maps shed A-7 has been determined to be 100.60 acres. Shed A-7 has therefore been reduced by 4.55 acres since issuance of the West Yost 2005 report.
3. **Shed A-8** changed in area to now include a portion of the residential subdivision originally in shed A-7 while a portion of the school site is now included in shed A-7 which was originally denoted within shed A-8. At the time of the West Yost report shed A-8 was 41.00 acres. With the current Vanden Meadows tentative maps shed A-8 has been determined to be 45.33 acres. Shed A-8 has therefore been increased by 4.33 acres since issuance of the West Yost 2005 report.
4. **Shed A-5** is not tributary to the twin 72" storm drain system in Vanden Road. This shed has reduced in size even though it has now included the additional area removed from the adjacent A-6 shed primarily as a result of more accurately modeling the Leisure Town Road frontage. In the West Yost study shed A-5 was 68.91 Acres that were directly tributary to the detention pond via a proposed 42" storm drain pipe. The entire limits of Leisure Town Road were originally included in shed A-5. With the current Vanden Meadows Tentative Map the eastern half of Leisure Town Road will drain to storm drain pipes directly tributary to the detention pond and therefore have been eliminated from shed A-5 and the 42" storm drain system. The western half of Leisure Town Road tributary to the 24" crossing storm drain pipes that are directly tributary to the detention pond has also been eliminated from shed area A-5. These changes have reduced shed A-5 to 60.50 acres resulting in a net reduction of 8.41 acres from the original value.

Conclusions

Although there have been changes to the common boundary line between sheds 7 and 8 there has been no change to the collective total area of both basins together. The total area tributary to the twin 72" pipes in Vanden Road from the Vanden Meadows project (sheds A-6A, A-6B, A-7, and A-8) was determined to be 179.01 acres resulting in a net reduction in contributing area by 2.05 acres. The reduction of area tributary to the twin 72" pipes is a result of additional area in tract being re-routed to shed A-5 and several areas in along Leisure Town Road being directly routed to the detention pond.

The total area draining into the regional detention pond has remained unchanged with a similar proposed land use as originally analyzed in the 2005 West Yost and Associates report, and the reduction in area tributary to the twin 72" storm drain system, the net result will be a minor reduction in the flow rate within the Vanden Road twin 72" storm drain. Since the reduction in peak flow rate within the twin 72" storm drain will be insignificant with respect to the total storm water flow conveyed the hydraulics for this pipe network will not be analyzed. The increase in the area directly tributary to the detention basin will not have an affect on the operation of the basin due to the fact that the total contributing area by Vanden Meadows to the detention basin is the same 208.19 acres analyzed by West Yost and Associates in 2005. The watershed areas within the Southtown development remain consistent with the original West Yost and Associates 2005 analysis and therefore have not been discussed within this addendum. The Vanden Meadows tentative map and storm drain master plan submitted September 9, 2009 substantially comply with the previously approved 2005 West Yost and Associates storm drain master plan report. The watershed tributary areas and determinations within this addendum shall amend the values and determinations contained within the original 2005 West Yost and Associates report.

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SCALE: HORIZ: 1"=200' VERT: N/A

APPROVED BY: DIV ENGINEER 43105 DATE OF APPROVAL

PHILLIPPI ENGINEERING

EXHIBIT

DESIGNED BY: VAB DRAFTED BY: VAB CHECKED BY: APPL. II

PROJECT NAME/LOCATION: VANDEN MEADOWS Vacaville California

DRAWING TITLE: MASTER DRAINAGE SHED PLAN

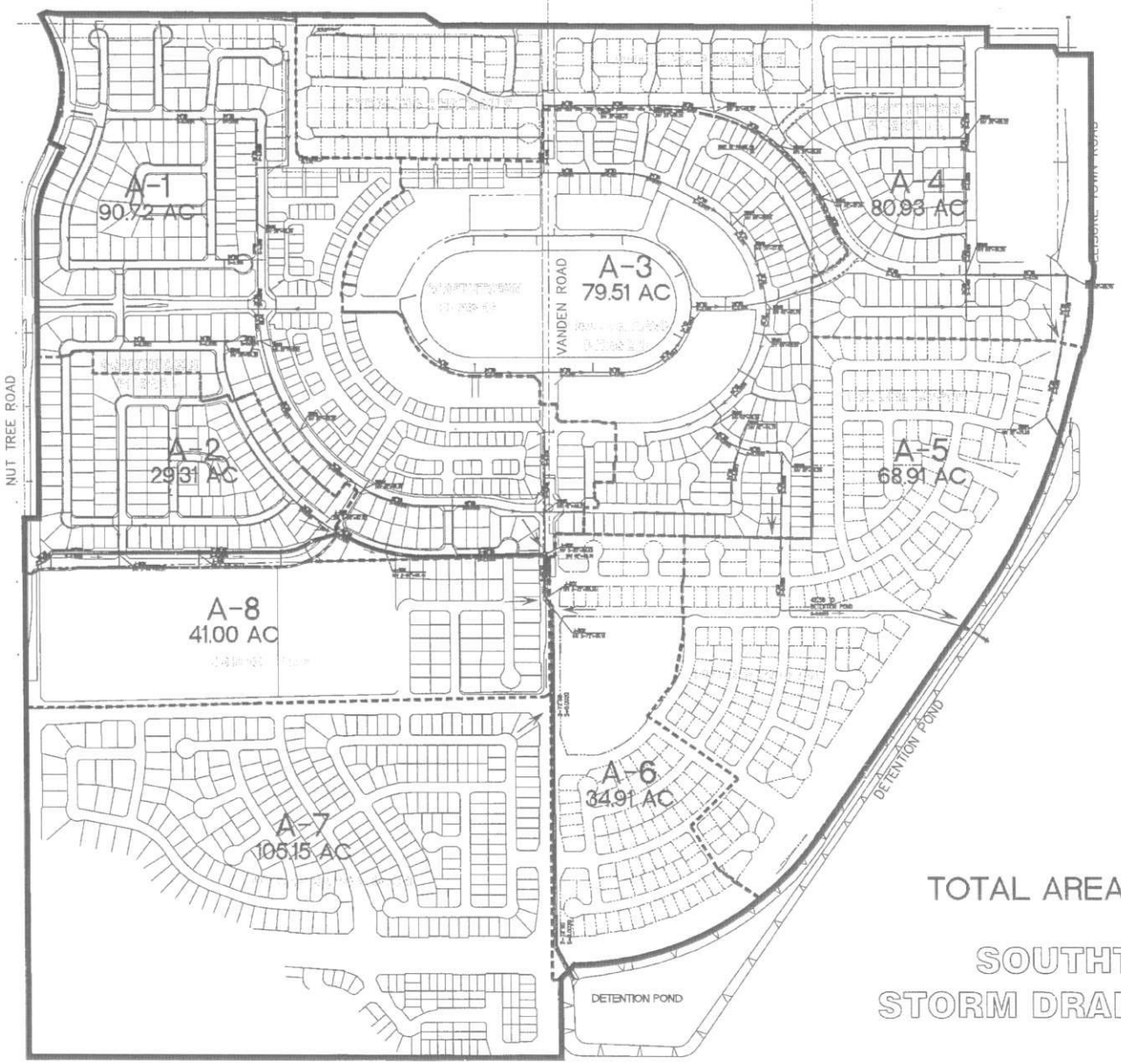
REVISIONS	NO.	DESCRIPTION	DATE

DRAWING FILE: 280280/MASTER UTIL PLANS/ 280280 Master Storm Drain Plan

ISSUE DATE: 09/08/09

SHEET NO.: SD-2 OF 2

PROJECT NO.: 280280



TOTAL AREA=530.44 AC

SOUTHTOWN
STORM DRAIN LAYOUT

N

SCALE: 1"=300'

PHILLIPS ENGINEERING
CIVIL ENGINEERING · LAND PLANNING
LAND SURVEYING · PROJECT MANAGEMENT
1234 PEARL STREET · SUITE 100
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DESIGNED BY: E.T.V.
DRAFTED BY: E.T.V.
CHECKED BY: T.A.P.

PRELIMINARY

PROJECT NAME/LOCATION: SOUTH-TOWN AREA
CITY: STATE:
DRAWING TITLE: STORM DRAIN LAYOUT

NO	DESCRIPTION	DATE

DRAWING FILE: MASTER UTIL/ 210860-34-STORM

DATE: 07/18/05
PROJECT NO.: 210860
SHEET NO.: 4 OF 5

7/18/05 SHED MAP

STORM DRAIN MASTER PLAN

FIGURE 7.3 VANDEN MEADOWS

Southeast Vanden Storm Drain Trunkline Hydraulic Calculations

Attachment E

WEST YOST & ASSOCIATES Consulting Engineers

Project No. : 001-00-10-26.003
Date : 01-Aug-11
Calc. By : J. Wanlass
Checked By :

Runoff Computations for : Southeast Vanden Area Master Plan Addendum
Notes : Elevations based on NAVD 88 datum. Starting WSEL based on 10-year water level in the regional detention basin from the hydrologic (HEC-1) modeling.

Location : Vacaville
Design Frequency : 10 yr
n = 0.013
MAP = 24

Structure		Area	C	CA	ΣCA	Time (min)				I	CiA	Q_{design}	Conduit								Normal Depth	Friction Slope	Friction Head-Loss (ft)	Head-loss Coeff.	Node Head-loss (ft)	HGL (ft)		Invert (ft)		Surface Elev. (ft)	
From	To	(ac)				t_g	t_O	t_{cond}	t_C	in/hr		(cfs)	S_{pipe}	# Pipes	Dia (in)	Length (lf)	Q_{CAP}	V_{full} (1)	V_{dsgn} (2)	t_{cond}	ft.	full				up	down	up	down	up	down
J-5	J-6	251.5	0.5	125.8	125.8				38.8	1.52	191.1	196.7	0.0025	1	60	83	130.6	6.6	10.0	0.2	5.0	0.00567	0.47	0.5	0.8	96.6	96.1	91.11	90.90	103.3	102.7
J-6	I-32	0	0	0.0	125.8			0.2	39.0	1.51	189.9	189.9	0.002	2	60	334	231.2	5.9	4.8	0.9	3.4	0.00132	0.44	0.25	0.0	96.2	95.7	90.90	90.25	102.7	99.8
I-32	J-7	21.1	0.5	10.6	136.3		18.7	0.9	40.0	1.49	203.1	203.1	0.0019	2	60	400	230.0	5.8	5.2	1.1	3.6	0.00151	0.60	0.25	0.3	95.4	94.8	90.25	89.47	99.8	98.8
J-7	J-8	0	0	0.0	136.3			1.1	41.1	1.47	200.4	200.4	0.002	2	60	405	233.6	5.9	5.1	1.1	3.5	0.00147	0.60	0.5	0.2	94.6	94.0	89.47	88.66	98.8	96.7
J-8	I-33	0	0	0.0	136.3			1.1	42.2	1.45	197.6	197.6	0.002	2	60	297	232.4	5.9	5.0	0.8	3.5	0.00143	0.43	0.5	0.2	93.8	93.4	88.66	88.07	96.7	96.3
I-33	J-10	8.2	0.5	4.1	140.4		37.3	0.8	43.1	1.43	200.8	200.8	0.002	2	60	229	232.4	5.9	5.1	0.6	3.6	0.00148	0.34	0.5	0.2	93.2	92.8	88.07	87.62	96.3	95.1
J-10	I-34	0	0	0.0	140.4			0.6	43.7	1.42	199.4	200.8	0.0023	2	60	788	248.3	6.3	5.1	2.1	3.4	0.00148	1.16	0.25	0.3	92.5	91.4	87.62	85.84	95.1	95.1
I-34	J-11	90.7	0.5	45.4	185.8		26.7	2.1	45.8	1.37	254.5	254.5	0.0025	2	60	203	261.1	6.6	6.5	0.5	4.0	0.00237	0.48	0.25	0.6	90.8	90.3	85.84	85.33	95.1	95.0
J-11	J-12	0	0.5	0.0	185.8		22.7	0.5	46.3	1.36	252.6	252.6	0.0026	2	72	42	433.1	7.6	4.5	0.1	3.3	0.00088	0.04	0.5	0.0	90.4	90.3	85.33	85.22	95.0	94.9
J-12	I-35	0	0.5	0.0	185.8		43.1	0.1	46.4	1.36	252.6	252.6	0.002	2	72	501	379.8	6.7	4.5	1.2	3.6	0.00088	0.44	0.5	0.2	90.2	89.7	85.22	84.22	94.9	94.1
I-35	J-13	60.3	0.5	30.2	215.9			1.2	47.7	1.34	289.3	289.3	0.002	2	72	503	379.8	6.7	5.1	1.3	3.9	0.00116	0.58	0.25	0.3	89.4	88.8	84.22	83.21	94.1	93.9
J-13	I-36	0	0	0.0	215.9			1.3	48.9	1.32	285.0	289.3	0.002	2	72	320	379.8	6.7	5.1	0.8	3.9	0.00116	0.37	0.5	0.2	88.6	88.2	83.21	82.57	93.9	94.9
I-36	I-37	18.0	0.5	9.0	224.9			0.8	49.7	1.30	292.4	292.4	0.0022	2	72	332	398.4	7.0	5.2	0.8	3.8	0.00119	0.39	0.25	0.3	87.9	87.5	82.57	81.84	94.9	97.5
I-37	O-1	100.6	0.5	50.3	275.2			0.8	50.5	1.29	355.0	355.0	0.0022	2	72	179	398.4	7.0	6.3	0.4	4.4	0.00175	0.31	1.0	0.6	86.9	86.6	81.84	81.45	97.5	95.0

Notes:
1. Velocity based on full pipe & pipe capacity
2. Velocity based on full pipe & design flow

84.37 Does not meet the proposed HGL criteria - 1.0 feet below the top-of-curb
88.24 Does not meet the City current HGL design criteria - 1.5 feet below the top-of-curb

W E S T
Y O S T
& ASSOCIATES

Consulting Engineers

July 22, 2005

Mr. Kevin VanKatwyk
City of Vacaville
650 Merchant Street
Vacaville CA 95688

Project No.: 001-00-04-50.001

SUBJECT: Southeast Vanden Area Major Drainage Facilities Master Plan

Dear Kevin:

Please find enclosed the subject report for your use. The master plan includes an evaluation of the existing drainage facilities within the project area and the facilities downstream of the project area that will receive drainage from the proposed development. The existing drainage facilities do not have adequate capacity to convey existing design flows, which results in significant flooding between the Union Pacific Railroad and Vanden Road.

The master plan recommends the construction of adequate detention storage to eliminate the existing flooding within the project area. The detention basin facilities coupled with downstream improvements will mitigate impacts of increased runoff resulting from development of the proposed project.

Thank you for your input during the development of this document. We enjoy working with you and other City staff in planning the City's storm drainage needs.

Sincerely,

WEST YOST & ASSOCIATES

Steven R. Dalrymple
Principal

Jeffrey Wanlass
Associate Engineer

REGISTERED PROFESSIONAL ENGINEER
S. R. DALRYMPLE
NO. 21188
Exp. 9/30/05
CIVIL
STATE OF CALIFORNIA

REGISTERED PROFESSIONAL ENGINEER
JEFFREY WANLASS
No. 60930
Exp. 12/2006
CIVIL
STATE OF CALIFORNIA

SRD:JW:mta

cc: Tom Basye w/encl.
Rod Moresco w/encl.
Tom Phillippi (PEI) w/encl.
Emi Totschinger (Solano Irrigation District) w/encl.

1260 Lake Boulevard, Suite 240 Davis, California 95616 Phone 530 756-5905 Fax 530 756-5991 www.westyost.com

Southeast Vanden Area
Major Drainage Facilities Master Plan

Prepared for

City of Vacaville

July 22, 2005

WEST YOST & ASSOCIATES

Consulting Engineers

001-00-04-50

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INTRODUCTION

This study was initiated to evaluate existing and proposed drainage facilities related to development of the proposed Southtown project. However, it was found that many of the major drainage facilities required for development of the Southtown project will also be utilized by future development within the watershed. Accordingly, this study was expanded to include both development of the Southtown project and future development within the watershed.

The proposed Southtown Development is located in the southeast section of the City of Vacaville (City), situated between Nut Tree Road and Leisure Town Road. The proposed development includes about 261 acres of mostly residential with some commercial land use.

The Southtown area drains to an open channel commonly referred to as the Brazelton Drain, which conveys runoff from Nut Tree Road to Leisure Town Road. The Brazelton Drain conveys runoff from the existing 255-acre Foxboro (Westgate) development located west of Nut Tree Road. The total tributary area of the Brazelton Drain between Nut Tree Road and Leisure Town Road is about 589 acres of undeveloped agricultural land (commonly referred to as the Southeast Vanden Area). The total tributary area upstream of Leisure Town Road is about 844 acres. The Southtown project proposed to replace the Brazelton Drain with an underground pipeline that would discharge into the regional detention basin located east of Leisure Town Road.

The *Southtown Project Environmental Impact Report* (EIR) identified the following required mitigation measures for the proposed project:

- Demonstrate that the proposed drainage facilities adequately convey the design runoff and that the increased runoff will be mitigated through implementation of the proposed drainage facilities.
- The proposed project shall include drainage improvements and detention basins designed to accommodate the 10- and 100-year flows. Detention facilities shall be adequate to limit discharges from the proposed project such that peak flows do not exceed flows experienced under existing conditions.
- Alternatives for mitigating the increased runoff from the project area shall be evaluated to ensure their feasibility.

The City contracted with West Yost & Associates (WYA) to determine the detention storage volume and location required to eliminate the existing flooding within the proposed development site, evaluate detention storage alternatives, determine the capacity of the existing drainage facilities downstream of the proposed project, evaluate potential impacts to downstream facilities, and conduct a hydraulic analysis of the proposed Brazelton Drain pipeline. Finally, this study will identify the required drainage improvements necessary to provide adequate drainage facilities for development of the Southeast Vanden Area and to mitigate potential impacts to drainage facilities downstream of the proposed project.

WATERSHED DESCRIPTION

As discussed previously, the proposed Southtown Development discharges to the Brazelton Drain, which runs along the southern boundary of the Southtown project from Nut Tree Road to Leisure Town Road. The tributary watershed for the Brazelton Drain upstream of Leisure Town Road consists of about 255 acres of existing single-family residential development west of Nut Tree Road (Foxboro), and 261 acres of existing agricultural land between Nut Tree Road and Leisure Town Road. Figure 1 shows the existing drainage facilities within the Brazelton Drain Watershed and the location of the proposed development projects. This study assumes ultimate development of the entire Southeast Vanden Area (531 acres), per the *Southtown Area Site Layout* prepared by Phillippi Engineering Inc. (PEI), dated February 14, 2005. Appendix A provides a copy of the *Southtown Area Site Layout*.

Existing Drainage Facilities

The existing Foxboro Development discharges into the Brazelton Drain via a 68-inch by 42-inch oval concrete pipe at the intersection of Nut Tree Road and Opal Way. The existing Foxboro drainage system will be discussed in greater detail below.

The Brazelton Drain is an earthen trapezoidal channel. From Nut Tree Road to Vanden Road the channel has a bottom width of about 12 feet, with a depth of about six feet, and side slopes of 2:1 (H:V). This reach of the channel was constructed with the development of the Foxboro subdivision. At Vanden Road the channel crosses under Vanden Road through a 7.5-foot by 4.0-foot concrete box culvert. The channel is less defined between Vanden Road and Leisure Town Road, with a meandering flowline and areas of pooling. The channel through this reach has a bottom width between 10 and 15 feet, with a depth of about four to five feet, and side slopes of 5:1. The channel crosses under Leisure Town Road through triple 36-inch RCP culverts and then crosses under the Union Pacific Railroad (Railroad) through twin 60-inch CMP culverts.

Downstream of the Railroad the channel is referred to as the Noonan Drain and functions both to convey runoff during the winter and as a drain for irrigation water during the summer. The Solano Irrigation District (SID) operates and maintains the Noonan Drain. Just east of the Railroad the channel passes through twin 36-inch CMP culverts and then turns south and continues south for about 2,000 feet and then turns east again and continues east for about 7,800 feet. At Meridian Road the channel passes through twin 48-inch and a 24-inch CMP culverts, then about 2,500 feet downstream of Meridian Road the channel turns to the southeast and crosses under Hay Road via twin 54-inch CMP culverts. The channel dimensions vary through this reach.

Downstream of Hay Road the channel is referred to as the D-1-C Spill, which is also operated and maintained by SID and operates both in the winter and summer. The D-1-C Spill continues in a southeast direction for about 6,100 feet, and then turns to the east and continues east for about 7,900 feet, then turns south. The channel ultimately discharges into the Barker Slough. The channel dimensions also vary through this reach. Downstream of Box R Ranch Road the channel is not very defined and is not regular maintained.

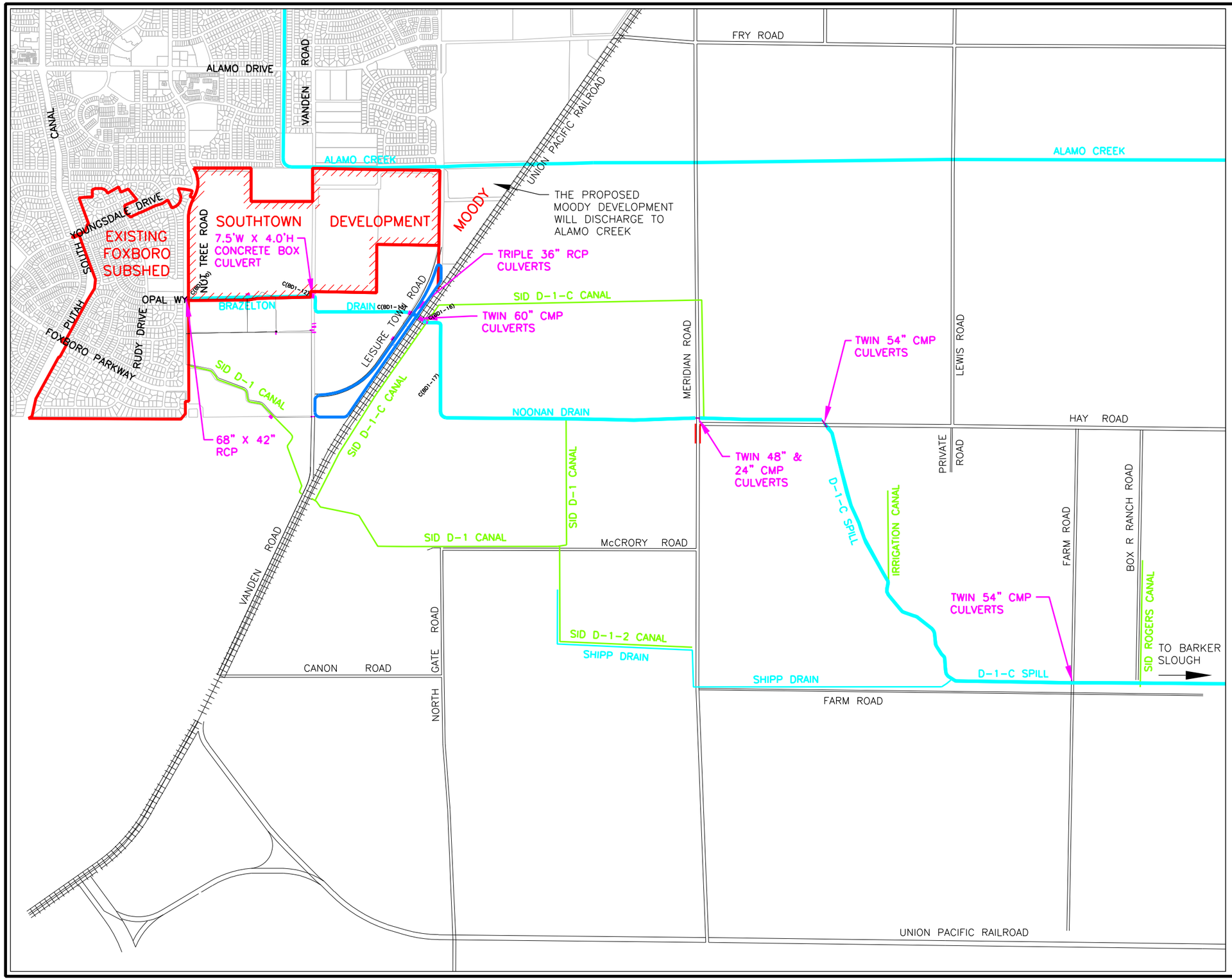

Figure 1

Southeast Vanden Area Major Drainage Facilities Master Plan

LOCATION MAP

N

0 1000 2000
SCALE IN FEET

LEGEND:

- DEVELOPMENT BOUNDARY
- SOUTHEAST VANDEN AREA BOUNDARY
- EXISTING CHANNEL FLOWLINE
- IRRIGATION CANAL
- CULVERT

VACAVILLE
ESTABLISHED 1850

WEST YOST & ASSOCIATES

N:\Clients\001 Vacaville\00-04-50 Southtown Analysis\CAD\Figures\001-04-50Figs.dwg 7-01-11 08:16:26 AM anichols

Topography, Soil Type and Land Use

The existing Foxboro Subdivision consists of single-family low density to medium density residential (4-10 units/acre). The Foxboro subshed generally slopes toward Opal Way at a slope of about 0.5 percent. The area north of Opal Way slopes to the southeast; while the area south of Opal Way slopes to the northeast.

The subshed between Nut Tree Road and Leisure Town Road and north of the Brazelton Drain slopes to the southeast at a slope of about 0.33 percent. This area has three rural residential properties with the remainder of the area used mainly for grazing cattle. Under the proposed developed conditions land use for this area would include single-family residential, park sites, some commercial development, and a multi-family site. Refer to Appendix A for a map of the proposed land uses.

The subshed between Nut Tree Road and Vanden Road and south of the Brazelton Drain generally slopes to the north east with slopes that vary from 0.38 to 2.5 percent. This area is also currently used for grazing cattle. Under the proposed developed conditions, land use for this area would include mostly single-family residential development with a middle and elementary school site.

The subshed between Vanden Road and Leisure Town Road and south of the Brazelton Drain generally slopes to the east to Leisure Town Road with a slope of about 0.3 percent. This area is also currently used for grazing cattle. Under the proposed developed conditions, land use for this area would include single-family residential development.

The soils within the Brazelton Drain Watershed generally consist of silty clay loam, sandy loam, or clay loam. A majority of the study area consists of Hydrologic Soil Group D, which has very low permeability and very high runoff rates. The northern portion of the Southtown site consists of Group C with a small area of Group B. The southwest portion of the Foxboro area also contains Group C and B soils. These soil groups have moderate to low permeability with moderate runoff rates. Appendix B provides a map showing the different soil types and Table B-1 provides a summary the soil characteristics for soil types with the study area.

METHODOLOGY

The analysis was divided into two components that include the following:

- The hydrologic modeling that determined the pre- and post-development 10- and 100-year peak flows and evaluated the detention storage alternatives.
- The hydraulic modeling that determined the capacity of the existing drainage facilities to convey the estimated peak flows, the extent of the existing floodplain along the Brazelton Drain upstream of the Railroad, and the hydraulic analysis of the proposed Brazelton Drain pipeline.

Hydrologic Modeling

The HEC-1 computer program was used to estimate the peak flows to be input into the HEC-RAS model, to determine the extent of the existing floodplain within the study area, and to

evaluate the detention storage basin alternatives. Models of the Brazelton Drain watershed were developed based on the following methods:

- Initial and Constant Loss Rate method to compute rainfall losses due to infiltration and interception
- Kinematic Overland Flow method to transform the rainfall excess into a runoff hydrograph
- Muskingum-Cunge Hydrograph Routing method to route overland flow to the subshed outlet

The rainfall distribution and depth is based on the rainfall data presented in the Solano County Water Agency's (SCWA) *Hydrology Manual* (June 1999) and the Army Corps of Engineers' temporal distribution. The existing subshed boundaries are based on the contour data obtained from PEI, as-built plans obtained from the City, and USGS Quad maps.

Hydrologic models were developed for the 10- and 100-year storm events for both pre- and post-development conditions. Figure 2 shows the Brazelton Drain watershed boundary, the existing conditions sub-shed boundaries, and the locations of the resulting HEC-1 hydrographs along the Brazelton Drain. The pre-development models were based on current land use. Table C-1 in Appendix C provides a summary of the existing conditions subshed parameters. The post-development conditions models were based on the *Southtown Area Site Layout* (refer to Appendix A). Figure 3 shows the developed conditions sub-shed boundaries and proposed drainage facilities. Table C-2 in Appendix C provides a summary of the buildout conditions subshed parameters. Tables C-3 and C-4 in Appendix C provide a summary of the Initial and Constant rainfall losses used for this study. The HEC-1 input files for both the existing conditions and developed conditions are provided in Appendix D. The summary output files for the HEC-1 models are provided in Appendix E.

Hydraulic Modeling

The HEC-RAS computer model was used to determine the conveyance capacity of the existing open-channel drainage facilities. The HEC-RAS model for this study was developed based on cross-section data from surveying conducted by WYA as part of this study. The HEC-RAS model includes the reach of the Brazelton Drain from Nut Tree Road to the Union Pacific Railroad, the Noonan Drain from the Railroad to the Hay Road crossing, and the D-1-C Spill from Hay Road to about one mile downstream of Box R Ranch Road.

The HEC-RAS model was also used to develop rating curves for the existing culverts at Leisure Town Road, the Railroad, and the SID twin 36-inch culverts. The rating curves, along with the stage-storage relationships, were used in the HEC-1 modeling to estimate the existing detention storage that occurs upstream of the Railroad.

The starting water surface elevation used for the HEC-RAS model was based on the normal depth routine available in the HEC-RAS computer program.

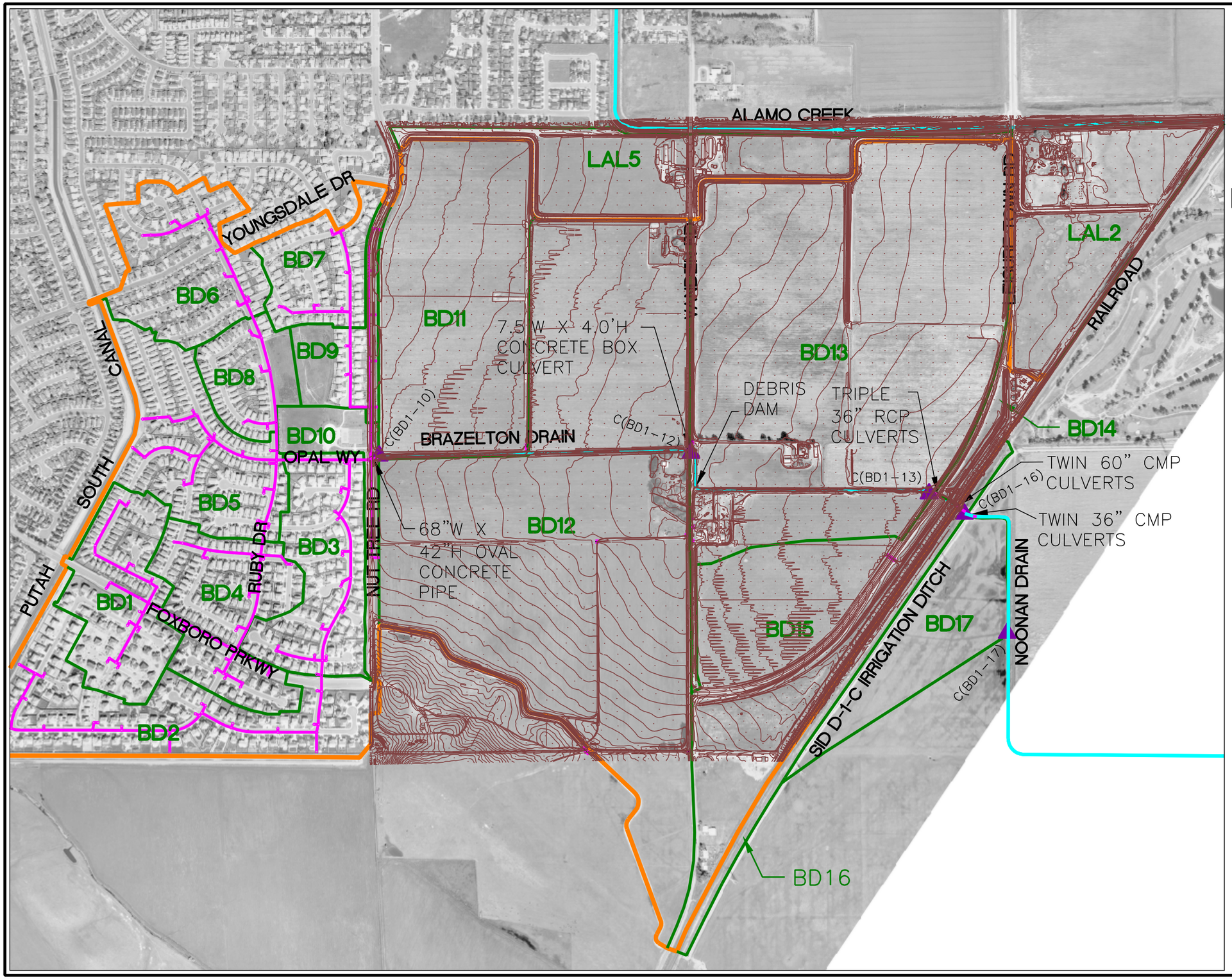

Figure 2

Southeast Vanden Area Major Drainage Facilities Master Plan

EXISTING BRAZELTON DRAIN WATERSHED

NOTES:

1. SUBSHEDS LAL5 & LAL2 DRAIN TO ALAMO CREEK UNDER EXISTING CONDITIONS.

LEGEND:

- BRAZELTON DRAIN WATERSHED BOUNDARY
- SUBSHED BOUNDARY
- BD11 SUBSHED AREA LABEL BOUNDARY
- C(BD1-10) LOCATION OF HYDROGRAPH W/ LABEL
- EXISTING STORM DRAIN/CULVERT
- OPEN CHANNEL

VACAVILLE
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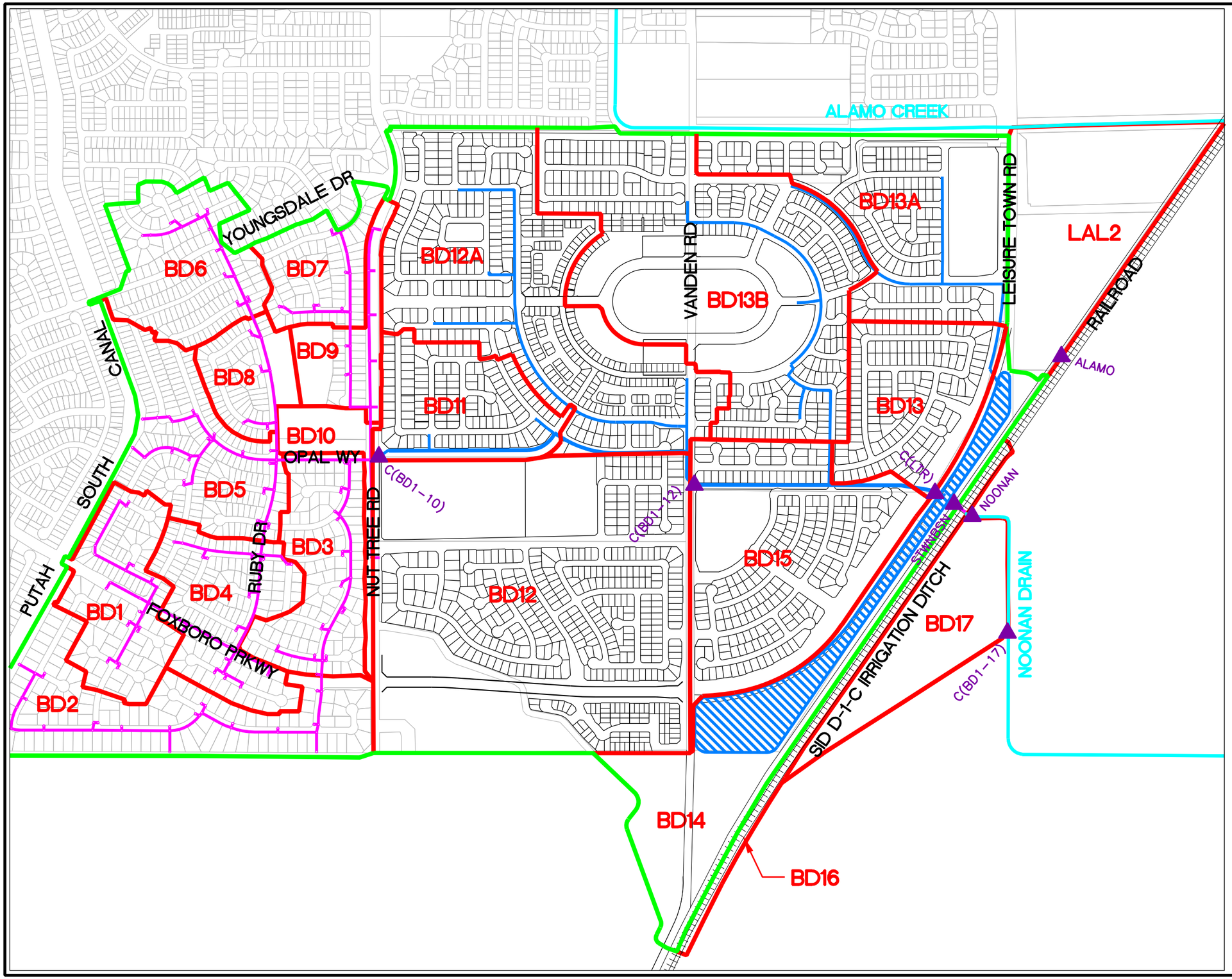

Figure 3

Southeast Vanden Area
Major Drainage Facilities
Master Plan

DEVELOPED CONDITIONS BRAZELTON DRAIN WATERSHED

N

0 400 800
SCALE IN FEET

NOTES:

1. SUBSHED LAL2 DRAINS TO ALAMO CREEK UNDER DEVELOPED CONDITIONS.

LEGEND:

- BRAZELTON DRAIN WATERSHED BOUNDARY
- SUBSHED BOUNDARY
- BD13A — SUBSHED AREA LABEL BOUNDARY
- PROPOSED DETENTION BASIN BOUNDARY
- PROPOSED STORM DRAINS (24" & LARGER)
- EXISTING STORM DRAIN/CULVERT
- OPEN CHANNEL
- C(BD1-10) — HYDROGRAPH W/ LABEL

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The StormCAD software package was used to evaluate the existing Foxboro storm drains and to analyze the proposed Brazelton Drain drainage pipeline. StormCAD is a steady-state computer program that utilizes the Rational Method to convert rainfall into flow. StormCAD utilizes both the direct step and standard step gradually varied flow methods. The storm drain data for the Foxboro subshed was based on as-built plans obtained from the City. The storm drain data for the proposed Brazelton Drain pipeline was based on AutoCAD file received from PEI on May 2, 2005.

DRAINAGE ANALYSIS

Existing Foxboro Storm Drain

The existing Foxboro storm drains were designed based on the City's current rainfall data (Standard Drawing No. 4-01); however, the proposed Southtown storm drain system will be designed based on the rainfall data contained in the SCWA *Hydrology Manual* (June 1999). The objective of this analysis is to determine the appropriate design flow rate that discharges from the existing Foxboro storm drain system into the proposed Brazelton Drain pipeline. This flow rate will be determined by evaluating the ability of the existing Foxboro storm drain system to convey the 10-year design flow based on the SCWA rainfall. The information resulting from this analysis will be used to set the design criteria for the proposed Brazelton Drain pipeline.

Models were developed based on both the City's current standard rainfall data and SCWA rainfall data. Figure 4 shows the existing Foxboro storm drains that were modeled. Table 1 provides a summary of the results of the hydraulic analysis and provides a comparison of the resulting flow and hydraulic grade line (HGL) between the two sets of rainfall data. As shown in Table 1, the existing storm drains provide adequate drain during the 10-year design storm based on the current City Design Standards. However, the drainage system does not have adequate capacity to convey the 10-year design flows based on the SCWA rainfall data. As a result, flooding will occur along most the existing system. However, once the water reaches the street surface it will spread out into the street section thereby reducing the HGLs shown in Table 1. Consequently, the flooding will most likely be confined within the street section.

The results from this analysis were used to ensure the proposed Brazelton Drain pipeline did not increase the HGLs in the existing Foxboro storm drain system. The proposed Brazelton Drain pipeline design flow from the Foxboro subshed is the peak flow using the SCWA rainfall of 196 cfs.

Existing Drainage Facilities

As discussed previously, the existing Brazelton Drain conveys runoff from the existing Foxboro subdivision via a 68-inch by 42-inch oval concrete pipe at the end of the Opal Way (see Figure 4). The Foxboro development discharges about 196 cfs to the Brazelton Drain during a 10-year design storm. The reach of the Brazelton Drain from Nut Tree Road to Vanden Road has sufficient capacity to convey the 10-year peak flow. However, the 7.5-foot by 4.0-foot box culvert under Vanden Road has a capacity of about 175 cfs, while the 10-year peak flow is about 330 cfs. In addition, there is a manmade debris dam just downstream of the Vanden Road that backs water up several hundred feet upstream even during the summer months. The hydraulic modeling results indicate that a 10-year storm flow will overtop Vanden Road. City staff confirmed this indicating that Vanden Road must be closed down during heavy rainfall due to floodwaters overtopping the road.

Table 1. Summary of the Existing Foxboro Storm Drain Hydraulic Analysis

Upstream Node	Down-stream Node	Upstream Inlet Area (ac)	Runoff Coefficient	Total Area (ac)	Upstream Calculated System CA (ac)	Time of Concentration (min)	Pipe Length (ft)	Pipe Slope (ft/ft)	Pipe Diameter (in)	Full Capacity (cfs)	Upstream Invert Elevation (ft)	Down-stream Invert Elevation (ft)	Upstream Ground Elevation (ft)	Down-stream Ground Elevation (ft)	City's Current Rainfall Data [a]				SCWA Rainfall Data [b]			
															System Intensity (in/hr)	10-year Design Flow (cfs)	Upstream HGL (ft)	Down-stream HGL (ft)	System Intensity (in/hr)	10-year Design Flow (cfs)	Upstream HGL (ft)	Down-stream HGL (ft)
I-1	J-1	13.75	0.5	13.8	6.9	20.4	115	0.0236	21	24.3	104.95	102.24	109.4	108.6	1.5	10.4	106.8	106.3	2.19	15.2	109.6	108.6
J-1	I-2	N/A	N/A	13.8	6.9	20.7	208	0.0055	21	11.7	102.24	101.10	108.6	108.9	1.49	10.3	106.2	105.3	2.18	15.1	109.2	107.3
I-2	I-3	3.54	0.5	17.3	8.7	22.4	476	0.0037	30	25.0	100.35	98.58	108.9	106.3	1.43	12.5	105.2	104.8	2.09	18.2	107.2	106.3
I-3	I-4	12.82	0.5	30.1	15.1	24.5	591	0.0008	36	19.0	98.58	98.10	106.3	105.3	1.31	19.9	104.7	104.2	1.97	29.9	106.5	105.3
I-4	I-5	8.25	0.5	38.4	19.2	26.9	427	0.0018	36	28.5	97.08	96.30	105.3	104.6	1.18	22.8	104.1	103.6	1.85	35.7	105.8	104.6
I-5	I-6	6.08	0.5	44.4	22.2	28.3	313	0.0022	36	31.5	96.30	95.60	104.6	104.7	1.12	25.2	103.5	103.1	1.77	39.7	105.8	104.7
I-7	I-6	22.4	0.5	22.4	11.2	24.8	566	0.0030	30	22.5	98.19	96.49	106.1	104.7	1.34	15.1	103.8	103.1	1.96	22.1	106.3	104.7
I-8	J-2	9.31	0.5	9.3	4.7	20.1	296	0.0020	24	10.1	103.36	102.77	110.3	110.2	1.52	7.1	108.6	108.3	2.21	10.4	110.8	110.2
J-2	I-9	N/A	N/A	9.3	4.7	21.6	132	0.0035	24	13.4	102.77	102.31	110.2	110.8	1.43	6.7	108.2	108.1	2.13	10.0	111.1	110.8
I-10	I-11	6.71	0.5	6.7	3.4	15.0	344	0.0012	24	7.8	103.31	102.90	110.0	110.5	1.71	5.8	109.1	108.8	2.48	8.4	111.0	110.5
I-11	I-9	7.6	0.5	14.3	7.2	17.2	209	0.0028	24	12.0	102.90	102.31	110.5	110.8	1.59	11.5	108.7	108.1	2.37	17.1	112.0	110.8
I-9	I-12	0	0	23.6	11.8	22.3	822	0.0020	30	18.5	102.31	100.63	110.8	109.1	1.39	16.6	108.0	106.6	2.09	24.9	112.1	109.1
I-12	J-3	10.31	0.5	33.9	17.0	25.0	168	0.0033	30	23.7	100.63	100.07	109.1	107.9	1.24	21.2	106.4	105.9	1.95	33.3	109.0	107.9
J-3	I-13	N/A	N/A	33.9	17.0	25.4	609	0.0029	36	35.9	99.57	97.81	107.9	106.4	1.22	20.8	105.8	105.3	1.93	32.9	107.9	106.4
I-13	I-14	19.18	0.5	53.1	26.6	27.6	533	0.0029	36	36.0	97.81	96.26	106.4	105.5	1.12	30.0	105.0	103.9	1.81	48.4	108.3	105.5
I-14	I-6	8.26	0.5	61.4	30.7	28.9	247	0.0027	36	34.5	96.26	95.60	105.5	104.7	1.1	33.9	103.7	103.1	1.74	53.8	106.3	104.7
I-6	I-15	4.24	0.5	132.5	66.2	29.4	602	0.0027	48	75.0	95.60	93.96	104.7	103.2	1.08	72.4	102.7	101.1	1.71	114.2	107.0	103.2
I-16	I-17	14.29	0.5	14.3	7.1	21.6	673	0.0018	24	9.5	103.65	102.46	111.3	109.9	1.46	10.5	108.2	106.8	2.13	15.3	113.0	109.9
I-17	I-18	6.26	0.5	20.6	10.3	23.9	948	0.0011	30	13.7	102.46	101.40	109.9	108.9	1.33	13.8	106.7	105.6	2.01	20.8	111.3	108.9
I-18	I-19	10.58	0.5	31.1	15.6	27.6	982	0.0009	36	19.6	101.40	100.55	108.9	108.3	1.13	17.8	105.6	104.9	1.81	28.3	110.1	108.3
I-19	I-20	12.82	0.5	44.0	22.0	31.7	479	0.0013	36	23.6	100.55	99.95	108.3	108.1	1.05	23.3	104.7	104.2	1.65	36.5	109.5	108.1
I-20	I-21	3.52	0.7	47.5	24.4	33.3	376	0.0019	36	29.4	99.95	99.22	108.1	107.0	1.02	25.1	104.1	103.5	1.62	39.9	108.3	107.0
I-21	J-4	9.57	0.5	57.0	29.2	34.4	216	0.0019	36	29.4	99.22	98.80	107.0	106.7	1	29.4	103.4	103.0	1.6	47.1	107.3	106.2
J-4	I-22	N/A	N/A	57.0	29.2	34.9	243	0.0011	36	21.8	98.80	98.54	106.7	104.7	0.99	29.1	102.8	102.4	1.59	46.8	105.9	104.7
I-22	I-23	4.88	0.5	61.9	31.7	35.5	534	0.0019	42	43.8	96.04	95.03	104.7	103.7	0.97	31.1	102.3	101.8	1.58	50.4	105.0	103.7
I-23	I-15	7.95	0.5	69.9	35.6	37.2	447	0.0024	42	49.2	95.03	93.96	103.7	103.2	0.94	33.7	101.6	101.1	1.55	55.6	104.6	103.2
I-15	I-24	6.59	0.5	208.9	105.2	38.5	173	0.0020	54	87.2	93.96	93.62	103.2	103.4	0.91	96.7	100.6	100.2	1.52	161.5	103.1	101.9
I-25	I-26	6.76	0.5	6.8	3.4	19.7	686	0.0027	18	5.4	100.05	98.21	106.1	105.3	1.53	5.2	102.7	101.0	2.23	7.6	107.6	104.1
I-26	I-27	10.71	0.5	17.5	8.7	22.4	772	0.0028	36	35.2	97.51	95.36	105.3	106.1	1.38	12.2	101.0	100.8	2.09	18.4	104.0	103.4
I-27	I-28	8.9	0.5	26.4	13.2	27.3	165	0.0008	36	19.4	95.36	95.22	106.1	103.7	1.13	15.0	100.7	100.6	1.82	24.2	103.2	103.0
I-28	I-24	1.8	0.9	30.6	17.0	28.9	437	0.0037	36	40.4	95.22	93.62	103.7	103.4	1.06	18.2	100.5	100.2	1.74	29.8	102.8	101.9
I-29	I-30	0.75	0.9	0.8	0.7	15.0	736	0.0021	15	2.9	97.72	96.21	105.1	104.4	1.71	1.2	101.4	101.1	2.48	1.7	104.9	104.4
I-30	I-28	1.72	0.9	2.5	2.2	23.9	760	0.0013	18	3.8	96.21	95.22	104.4	103.7	1.22	2.7	101.1	100.6	2	4.5	104.4	103.0
I-24	O-1	11.9	0.3	251.5	128.5	38.8	82	0.0020	42x68	95.4	93.62	93.46	103.4	103.1	0.91	117.3	99.5	99.3	1.52	196.7	99.9	99.3

(a) Based on the City of Vacaville's current design standards (Standard Drawing No. 4-01)

(b) Based on the SCWA *Hydrology Manaul* (June 1999)

(c) Elevations are based on the NAVD 88 Datum. Elevations on the as-built plans were based on the NGVD 29 Datum; therefore, 2.6 feet was added to the elevations on the as-built plans to convert to the NAVD 88 Datum

(d) Starting water surface elevation or HGL is based on the 10-year water surface elevation in the Brazelton Drain as determined by HEC-RAS analysis of the Brazelton Drain as part of this study

Figure 4

Southeast Vanden Area
Major Drainage Facilities
Master Plan

EXISTING FOXBORO STORM DRAINS MODELED

N

0 250 500
SCALE IN FEET

LEGEND:

- MODELED STORM DRAINS
- I-30 MODELED STORM DRAIN NODE W/ IDENTIFICATION
- EXISTING STORM DRAIN/CULVERT
- CREEK FLOWLINE

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The reach of the Brazelton Drain between Vanden Road and Leisure Town Road does not have capacity to convey the 10-year design flows. As a result, the channel banks will be over topped at many locations along this reach. Most of the over topping occurs along the southern bank of the channel. Figure 5 shows the estimated 10-year floodplain.

Downstream of the Southtown project there is a series of culverts along the Brazelton Drain that do not have sufficient capacity to convey the 10-year design flows. These culverts include the following:

- Triple 36-inch RCP culverts under Leisure Town Road with a capacity of about 150 cfs
- Twin 60-inch CMP culverts under the Railroad with a capacity of about 300 cfs
- Twin 36-inch CMP culverts under the SID D-1-C irrigation ditch with a capacity of about 125 cfs

The 10-year design flow at the Railroad is about 385 cfs. As a result of the limited capacity of the SID culverts, a backwater is created that results in significant flooding upstream of the Railroad, as shown in Figure 5. The flooding extends through the Moody property and will spill into Alamo Creek, during a 10-year storm. The estimated water level, during a 10-year storm, upstream of the Railroad is about 88.5 feet. Leisure Town Road has a low area about 300 feet south of the Brazelton Drain that extends for about 600 feet. The low spot is at an elevation of about 87.5 feet. Consequently, floodwaters will inundate Leisure Town Road during a 10-year storm. Figure 6 shows the 10-year water surface profile along the Brazelton Drain under existing conditions. Table F-1 in Appendix F provides a summary of the HEC-RAS output for the existing conditions. The HEC-RAS cross-sections for the Brazelton Drain between Nut Tree Road and the Railroad are provided in Appendix G. The cross-section in Appendix G also shows the 10-year pre-development conditions water surface elevations. Figure 5 shows the location of the HEC-RAS cross-sections.

The existing conditions 10- and 100-year HEC-1 design flows along the Brazelton Drain are provided in Table 2.

Table 2. Summary of the Existing Conditions 10- and 100-Year Peak Flows

Location	HEC-1 Node	10-year Peak Flow, cfs	100-year Peak Flow, cfs
Nut Tree Road	C(BD1-10)	216 [(a)]	337
Vanden Road	C(BD1-12)	333	537
Leisure Town Road	C(BD1-13)	357	587
Downstream Railroad [(b)]	C(BD1-16)	150	158
Overflow to Alamo Creek	Alamo	176	456

(a) Flows based on HEC-1 modeling, which are slightly different the Rational Method results
(b) Decrease in peak flow results from the limited capacity of the SID twin 36-inch CMP culverts and overflows to Alamo Creek

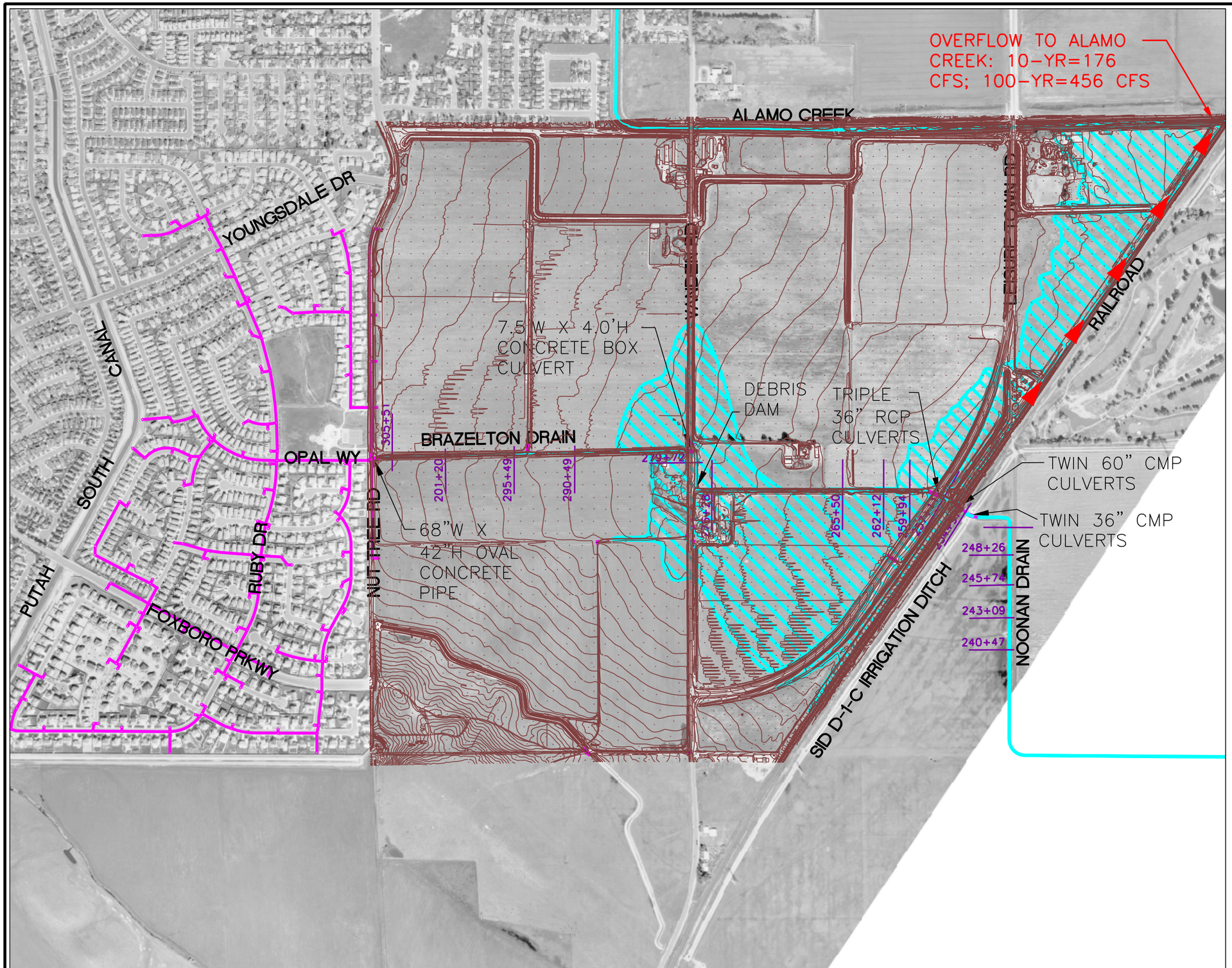

Figure 5

Southeast Vanden Area Major Drainage Facilities Master Plan

EXISTING 10- + 100-YEAR FLOODPLAIN

NOTES:

1. A PRELIMINARY ANALYSIS WAS CONDUCTED TO DETERMINE THE EXTENTS OF THE 10- & 100-YEAR FLOODPLAINS. THE FLOODPLAIN IS SHOWN HERE ONLY TO ILLUSTRATE THE EXISTING FLOODING PROBLEM. A DETAILED ANALYSIS HAS NOT BEEN CONDUCTED.
2. AS A RESULT OF THE RELEASE TO ALAMO CREEK DURING BOTH THE 10- & 100-YEAR STORM THE FLOODPLAINS FOR THE TWO STORMS ARE NEARLY IDENTICAL (THE 10-YEAR WSEL = 87.9 FT & THE 100-YR WSEL = 88.1 FT).

LEGEND:

254+97 — BRAZELTON DRAIN HEC-RAS RIVER STATION

10- & 100-YEAR FLOODPLAIN

CULVERT

OVERFLOW PATH

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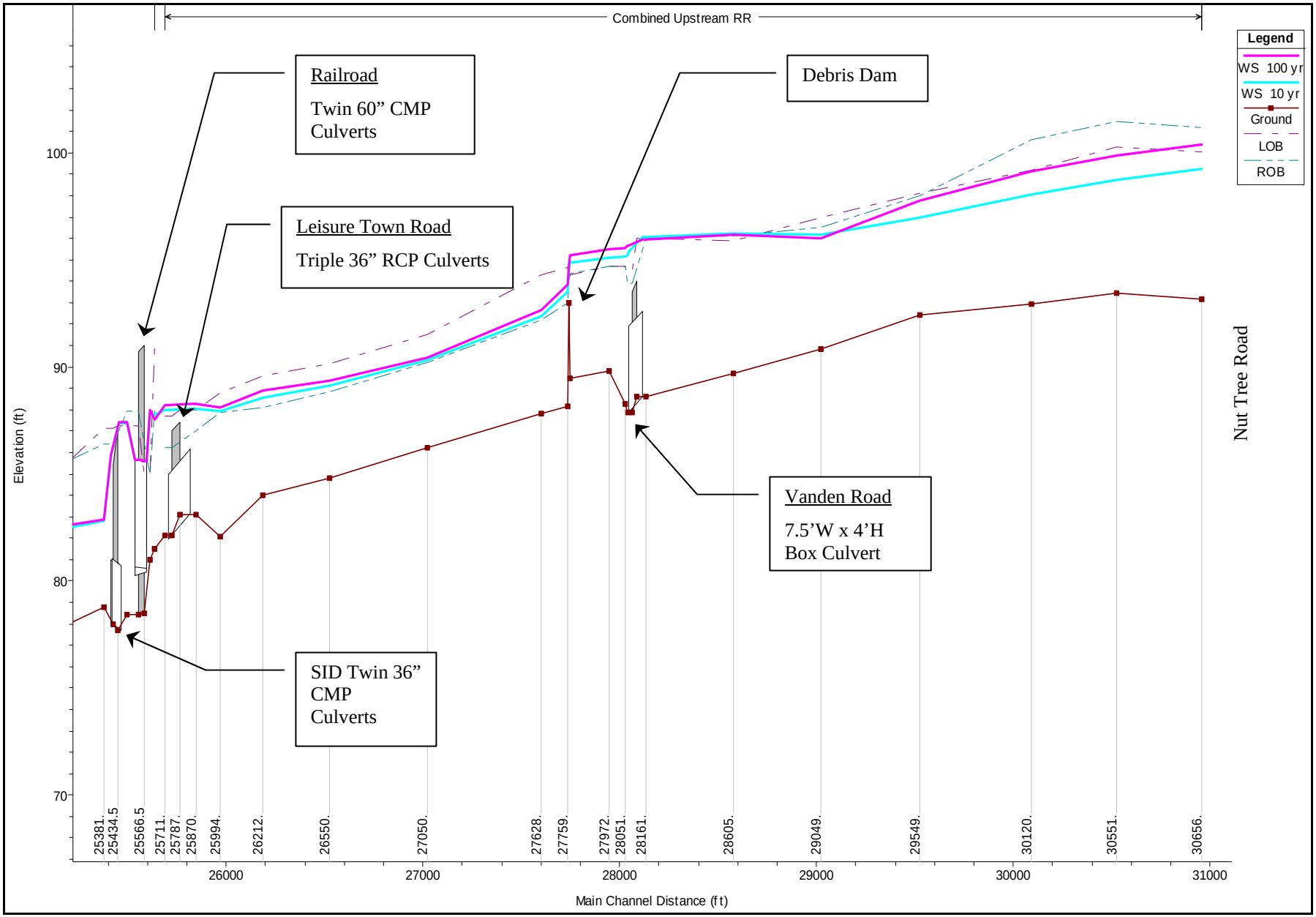

Figure 6. Brazelton Drain 10- and 100-Year Water Surface Profiles Under Existing Conditions

Proposed Detention Basin

An analysis was conducted to determine the required detention storage volume that would be necessary to achieve the following objectives:

- Eliminate the existing floodplain shown in Figure 5
- Provide a 10-year HGL within the detention basin that allows for a cost effective design of the proposed drainage facilities within the Southeast Vanden Area and that would not impact the existing Foxboro drainage facilities
- Mitigate impacts to drainage facilities downstream of the proposed development projects
- Provide detention for the 10-year storm event, and provide for release of the 100-year storm event to Alamo Creek

To achieve the above objectives several alternatives were evaluated and include the following:

- Alternative 1 – This alternative includes development of the area north of the Brazelton Drain (Southtown Development only) with a proposed detention basin located on the west side of Leisure Town Road. The proposed detention basin will provide about 32 ac-ft of detention storage with a bottom elevation of 78 feet and a top elevation of 88 feet. This alternative includes a 215 cfs pump station. The existing detention area between Leisure Town Road and the Railroad is also utilized under this alternative.
- Alternative 2 – This alternative is similar to Alternative 1, except the detention storage volume is increased to 68 ac-ft and the pump station capacity is reduced to 70 cfs.
- Alternative 3 – This alternative includes ultimate development of the entire Southeast Vanden Area with the proposed detention basin located on the west side of Leisure Town Road. The proposed detention basin will provide about 32 ac-ft of detention storage with a bottom elevation of 78 feet and a top elevation of 88 feet. This alternative includes a pump station with a capacity of 450 cfs to match the approximate capacity of the downstream channel.
- Alternative 4 – This alternative is similar to Alternative 3 except the capacity of the pump station is decreased to 100 cfs to match the capacity of the existing SID twin 36-inch CMP culverts located downstream of the Railroad.
- Alternative 5 – This alternative includes ultimate development of the entire Southeast Vanden Area with the proposed detention basin located between Leisure Town Road and the Railroad. The proposed detention basin would include about 70 ac-ft of detention storage with a bottom elevation of 80 feet and a top elevation of 88.5 feet. This alternative does not include a pump station; therefore, the proposed detention basin would have a gravity outlet. The outlet is assumed to function under free outfall conditions with no downstream restrictions.
- Alternative 6 – This alternative is similar to Alternative 5 except this alternative includes a 300 cfs pump station.
- Alternative 7 – This alternative is also similar to Alternative 5 except the bottom of the detention basin is decreased by 1.5 feet to elevation 78.5 feet and the top elevation is

increase by 1.5 feet to elevation 90 feet. This increases the detention storage volume to 112 ac-ft. Also under this alternative a 36-inch RCP culvert is added under the Railroad and the existing SID twin 36-inch CMP culverts downstream of the Railroad are replaced with twin 60-inch and 36-inch culverts.

Table 3 provides a summary of the results from the evaluation of the detention storage alternatives. For comparison purposes the table also includes the pre-development conditions.

As noted above, Alternatives 1 and 2 included only development of the area north the Brazelton Drain. These alternatives focused on individual detention storage basins for each development in the Southeast Vanden area. Alternatives 3 and 4 included development of the entire Southeast Vanden Area, but the detention basin was located just north of Brazelton Drain and west of Leisure Town Road and configured to fit within the constraints for the proposed surrounding developments. Alternatives 1-4 also did not provide sufficient detention storage to mitigate for the loss of the existing floodplain that would result from development of the Southeast Vanden Area. Consequently, these alternatives were not considered further.

Alternatives 5-7 considered ultimate buildout of the Southeast Vanden Area but moved the detention basin to the east side of Leisure Town Road. These alternatives were developed to account for the detention storage that occurs within the floodplain under existing conditions; accordingly, these alternatives mitigate for the loss of floodplain storage resulting from development of the Southeast Vanden Area. Under Alternative 5 the resulting water surface elevation in the detention basin was too high for the proposed Southtown storm drain system to meet the City's HGL criteria. Therefore, Alternative 6 was developed that included a pump station that better utilized the available detention storage; however, construction of a large pump station would be expensive. Consequently, Alternative 7 was developed which lowered the bottom of the detention basin by 1.5 feet and increased the top elevation by 1.5 feet; thus increasing the detention storage by 40 acre-feet. Alternative 7 eliminates the need for a pump station and meets above detention storage objectives. Therefore, Alternative 7 is recommended.

Alternative 7 would increase the discharge to the Noonan Drain from about 145 cfs under existing conditions during both the 10- and 100-year storms due to the undersized SID culverts to 334 cfs and 456 cfs under developed conditions during the 10- and 100-year storm, respectively. This increase in flows necessitated an evaluation of the downstream drainage facilities.

Evaluation of the Downstream Drainage Facilities (Noonan Drain & D-1-C Spill)

As discussed previously, the proposed detention basin will discharge into the Noonan Drain which drains to the D-1-C Spill. These channels function to both convey runoff during the winter and drain irrigation water during the summer, and are maintained and operated by SID. Since the proposed detention basin will increase the discharge to these channels by about 190 cfs during the 10-year storm and about 310 cfs during the 100-year storm, a hydraulic analysis was conducted to determine the conveyance capacity of these channels. A HEC-RAS computer model was developed based on cross-sections surveyed by WYA. Figure 7 shows the location of the cross-sections included in the HEC-RAS model and Appendix H provides the HEC-RAS cross-sections for the Noonan Drain and the D-1-C Spill from the Railroad to downstream of Box R Ranch Road. The cross-section in Appendix H also shows the 10- and 100-year pre-development conditions water surface elevations.

Table 3. Summary the Southeast Vanden Area Detention Storage Alternatives Evaluation

Alternative	Description	Storm Event	Peak Flow at Leisure Town Road, cfs	Proposed Detention Basin			Existing Floodplain Storage		Discharge to Noonan Drain, cfs	Overflow to Alamo Creek, cfs
				Storge, ac-ft	Stage, ft	Discharge from Detention Basin, cfs	Storge, ac-ft	Stage, ft		
Pre-Development Conditions										
	Existing Brazelton Drain Watershed upstream of the Southern Pacific Railroad. Includes floodplain storage upstream of the Railroad.	10-year	357	N/A	N/A	N/A	19	87.9	144	176
		100-year	587	N/A	N/A	N/A	24	88.1	146	456
Post-Development Conditions										
1	Includes development of the area north of the Brazelton Drain. 32 ac-ft detention basin with 215 cfs pump station. Detention basin located west of Leisure Town Road.	10-year	321	39	89.8	215	12 [(a)]	87.3	291	34
		100-year	N/A [b]							
2	Includes development of the area north of the Brazelton Drain. 68 ac-ft detention basin with 70 cfs pump station. Detention basin located west of Leisure Town Road.	10-year	176	97	93.3	70	12 [(a)]	87.3	126	33
		100-year	N/A [b]							
3 [(c)]	Includes buildout of the Southeast Vanden Area. Detention basin located west of Leisure Town Road with 450 cfs pump station.	10-year	622	28	87.0	450	Existing detention storage within the floodplain not included in the analyses of these alternatives		468	0
		100-year	978	61	N/A	450			482	0
4 [(c)]	Includes buildout of the Southeast Vanden Area. Detention basin located west of Leisure Town Road with 100 cfs pump station.	10-year	622	110	N/A	100			117	0
		100-year	978	175	N/A	100			131	0
5 [(c)]	Includes buildout of the Southeast Vanden Area. Detention basin located between Leisure Town Road and Railroad. Proposed basin includes 70 ac-ft, with unrestricted discharge to Noonan Drain.	10-year	622	57	87.6	302			302	0
		100-year	978	92	90.0	421			421	0
6 [(c)]	Includes buildout of the Southeast Vanden Area. Detention basin located between Leisure Town Road and Railroad. Proposed basin includes 70 ac-ft, with 300 cfs pump station.	10-year	622	58	86.6	300			300	0
		100-year	978	100	89.3	300			300	90
7	Includes ultimate buildout of the Southeast Vanden Area. Detention basin located between Leisure Town Road and Railroad. Proposed basin includes 110 ac-ft, with 36-inch culvert added under Railroad & SID twin 36-inch culverts removed.	10-year	650	69	87.1	334			334	0
		100-year	1020	101	89.3	577			456	101

(a) Discharge from proposed detention basin routed to existing detention basin between Leisure Town Road and the Railroad

(b) 100-year model was not developed because the 10-year storm exceeded the design constraints

(c) Analysis did not include entire Southeast Vanden Area. The area indicated a "Area T" shown on the *Southtown Area Site Layout* figure in Appendix A is not part of the existing Brazelton Drain Watershed; therefore, was not included in the initial evaluation of the detention basin alternatives.

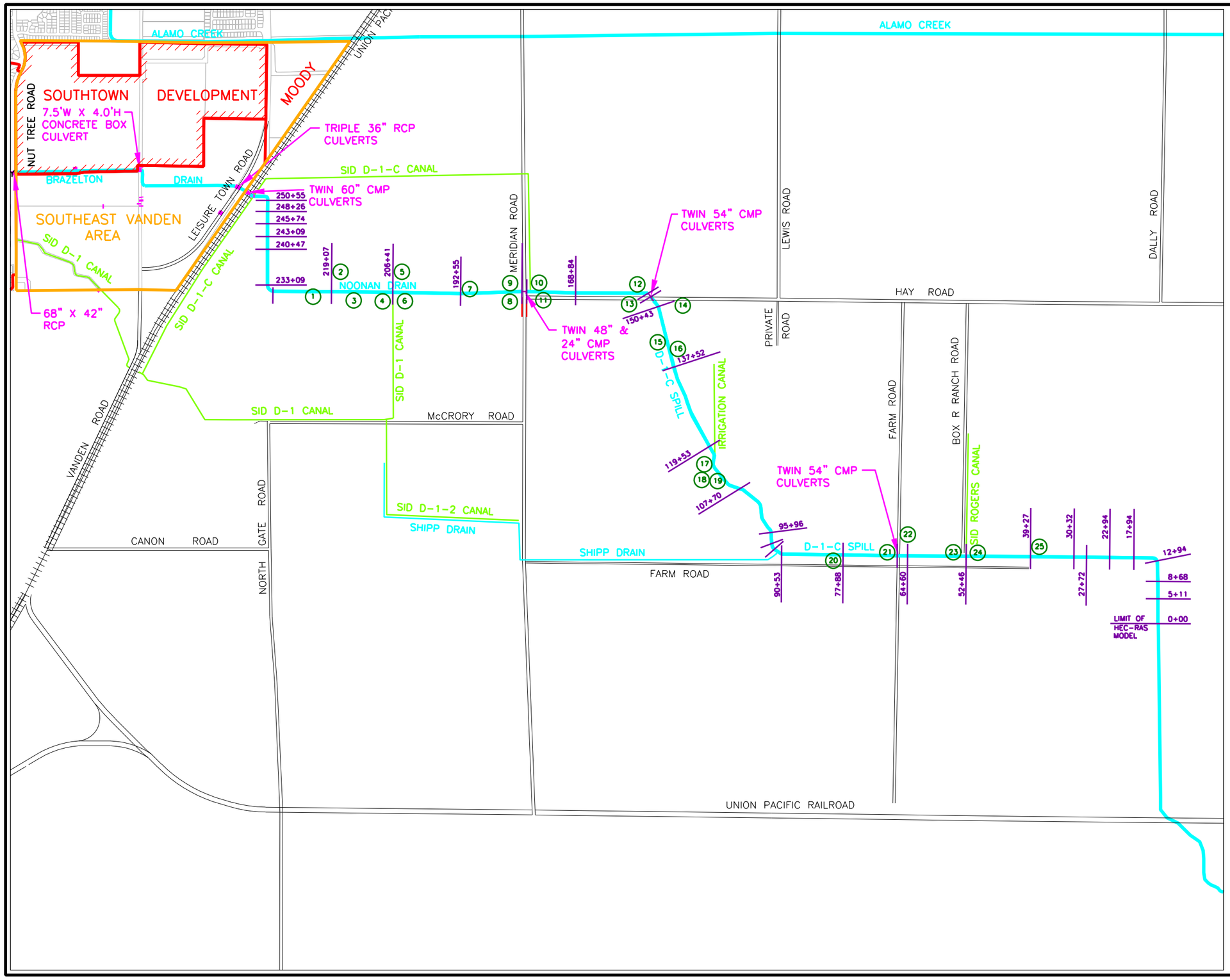

Figure 7

Southeast Vanden Area
Major Drainage Facilities
Master Plan

EXISTING NOONAN DRAIN / D-1-C SPILL DRAINAGE FACILITIES

N

0 1000 2000
SCALE IN FEET

LEGEND:

- DEVELOPMENT BOUNDARY
- SOUTHEAST VANDEN AREA BOUNDARY
- EXISTING OPEN CHANNEL
- IRRIGATION CANAL
- EXISTING CULVERT
- 206+41 HEC-RAS RIVER STATION
- (25) INFLOW CULVERT LOCATION & NO.

VACAVILLE
ESTABLISHED 1850

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The Noonan Drain/D-1-C Spill (D/S Channel) channel size and capacity varies along the study reach, with a maximum capacity of about 1,330 cfs and a minimum capacity less than 200 cfs. Table 4 provides a summary of the channel dimensions and estimated capacity. Downstream of river station 42+46 the channel is unmaintained, and as shown in Table 4, the size and capacity is significantly less compared to the upstream reaches. As the channel turns south at about river station 12+94, the channel drains through marsh lands and beyond the limits of the study (river station 0+00) the channel is not well defined.

Table 4. Summary of Noonan Drain/D-1-C Spill Channel Dimensions and Capacity

Reach [(a)]	Type	Bottom Width, feet	Depth, feet	Side Slopes, H:V	Capacity [(b)], cfs
0+00 to 39+27	Triangular	N/A	4.0	4:1	< 200
39+27 to 64+60	Trapezoidal	11.0	7.8	1.5:1	800
64+60 to 77+88	Trapezoidal	8.0	9.2	1.6:1	1,300
77+88 to 92+36	Trapezoidal	3.0	9.0	1.4:1	400
92+36 to 107+70	Trapezoidal	9.0	9.4	2:1	1,060
107+70 to 119+53	Trapezoidal	5.0	7.3	2:1	430
119+53 to 137+52	Trapezoidal	8.0	8.3	2:1	670
137+52 to 152+95	Trapezoidal	5.0	11.9	1.1:1	1,300
152+95 to 178+91	Trapezoidal	6.0	9.2	1.4:1	750
178+91 to 192+55	Trapezoidal	4.0	8.5	1.3:1	620
192+55 to 219+07	Trapezoidal	5.5	7.7	1.2:1	530
219+07 to 252+01	Trapezoidal	8.0	9.5	1.5:1	1,330

(a) For reach location refer to Figure 7.
(b) Channel capacity based on Manning's Equation with a Manning's roughness coefficient of 0.035.

There are three culvert road crossings along the D/S Channel, which include the following and are also shown in Figure 7:

- Twin 48-inch CMP and 24-inch CMP culverts under Meridian Road. These culverts have a capacity of about 235 cfs.
- Twin 54-inch CMP culverts under Hay Road with a capacity of about 303 cfs.
- Twin 54-inch CMP culverts under a private farm road about 1,200 feet west of Box R Ranch Road. These culverts have a capacity of about 380 cfs.

Downstream of the Railroad the channel is bermed on both sides along most of its length to Box R Ranch Road. As a result, discharge into the channel occurs only via inlet culverts along the channel. Along the study reach of the channel there are 25 inlet culverts and one channel (Shipp Drain) discharging into the D/S Channel. Figure 7 shows the location of each of these culverts and the channel. Table 5 provides a summary of each culvert and the Shipp Drain,

including size, material, and estimated capacity. The estimated capacity of the inlet culverts were determined by surveying the upstream and downstream invert elevations, and the top of the berm over the culverts. Then, assuming the culverts were under a submerged condition, the head on the culvert used to calculate the flow capacity was equal to the difference between the elevation of the top of the berm and the crown elevation of the downstream end of the culvert.

Table 5. Summary of the Noonan Drain/D-1-C Spill Inflow Culverts

Culvert No.	Culvert Size, inches	Culvert Material	Capacity, cfs
1	16	CMP	8.2
2	18	CMP	13.7
3	16	CMP	7.0
4	24	CMP	20.0
5	24	HDPE	30.2
6	21	CMP	20.4
7	24	CMP	22.7
8	18	CMP	10.8
9	24	CMP	15.9
10	24	CMP	24.5
11	Twin 24	CMP	40.1
12	24	HDPE	31.7
13	24	CMP	19.9
14	36	CMP	61.1
15	15	CMP	9.8
16	24	CMP	26.4
17	15	HDPE	10.1
18	12	CMP	5.6
19	36	CMP	56.3
Shipp Drain			41 [(a)]
20	30	CMP	42.6
21	Did not find upstream end of culvert		
22	27	Steel	5.4
23	17	Steel	3.3
24	18	CMP	13.0
25	24	CMP	25.2

(a) Discharge from the Shipp Drain limited by upstream culvert capacity

The tributary watershed of the D/S Channel includes a large area that drains to the D/S Channel via field drains and roadside ditches, most of which are not included on available mapping. Therefore, the estimated design flows in the D/S Channel are assumed to be the combined capacity of the inlet culverts (indicated in Table 5) along the D/S Channel and the discharge from area upstream of the Railroad. For the area upstream of the Railroad the results from the HEC-1 analysis were used. Table 6 provides a summary of the 10- and 100-year design flows for the D/S Channel under both existing conditions and with development of the Southeast Vanden Area.

Table 6. Summary of the 10- and 100-Year Design Flows for the Noonan Drain/D-1-C Spill

HEC-RAS River Station	Existing Conditions		Developed Conditions [(a)]	
	10-Year Flow	100-Year Flow	10-Year Flow	100-Year Flow
256+11	144	146	334	456
243+09	157	171	345	478
221+20	165	179	353	480
219+07	179	193	367	500
214+07	186	200	374	507
205+91	236	250	424	557
205+41	256	270	444	577
192+55	279	293	467	600
179+90	290	304	478	611
178+81	370	384	558	691
153+89	402	416	590	723
152+85	483	497	671	804
137+52	519	533	707	840
107+70	592	606	780	913
92+36	633	647	821	954
77+87	675	689	863	996
64+60	681	695	869	1,002
52+46	684	698	872	1,005
51+96	697	711	885	1,018
39+27	722	736	910	1,043

(a) Includes ultimate development of the Southeast Vanden Area

Figure 8 shows the existing 10- and 100-year water surface profiles along the D/S Channel from downstream of the Railroad to east of Box R Ranch Road. As shown in Figure 8 and discussed previously, the existing channel and culverts do not have sufficient capacity to convey existing design flows. This results in several reaches of the channel overflowing and flooding across all three road crossings during both the 10- and 100-year storms. Consequently, any increase in the flow rate to the D/S Channel will require mitigation to ensure the proposed development of the Southeast Vanden Area does not increase the potential for downstream flooding over existing conditions.

As shown in Figure 8, the existing culvert crossings have significant headloss resulting in a backwater that increases the water surface upstream of the culverts. Therefore, one of the recommended mitigation to eliminate impacts to the downstream drainage facilities is to replace the culvert crossings. After evaluation of several different configurations the following two alternatives are recommended:

- Replace the existing culverts at Meridian Road, Hay Road, and the private farm road with twin 96-inch RCP culverts and concrete headwalls.
- Replace the existing culverts at Meridian Road, and Hay Road with 16-foot by 8-foot ConSpan culverts, and at the private farm road with 16-foot by 10-foot ConSpan culverts.

Figure 9 shows the 10- and 100-year water surface profile under ultimate development of the Southeast Vanden Area and Table F-2 in Appendix F provides a summary of the HEC-RAS output for the post-development conditions. Both of the above alternatives eliminate overtopping of the roads during the 10- and 100-year storm. The water surface profiles upstream of the road crossings are significantly lower than the profiles under existing conditions. There are a few reaches where the water surface profiles are higher than the profiles under existing conditions. The increase is most significant upstream of Meridian Road were the backwater from the existing Meridian Road culverts have a smaller effect upstream. Therefore, in addition to replacing the existing culvert crossings, channel improvements are recommended to mitigate for the increased flow in the D/S Channel. The channel improvements consist of raising the top of bank to contain the estimated 10- and 100-year water surface profile within the channel. Table 7 provides a summary of the required improvements along various reaches of the channel and Figure 9 shows the location of these reaches. Channel improvements are not recommended downstream of river station 42+46 because this area is marsh land that experiences widespread flooding under existing conditions. Detailed surveying and mapping of the Noonan Drain and D-1-C Spill is needed to better define the needed channel and bank construction.

Table 7. Summary of Required Channel Improvements along the Noonan Drain/D-1-C Spill

Reach [a]	River Station [b]	Bank to be Raised [c]	Approximate Height to be Raised, feet	Recommended Top of Bank Elevation, feet
A	250+55	Left	0.7	85.6
	248+26		1.6	85.4
	245+74		1.6	84.7
	243+09		1.6	84.6
	240+47		1.0	84.6
	233+09	End		
B	209+07	Begin		
	206+41	Right	1.4	75.0
	205+91		1.4	75.0
	205+41		0.8	74.5
	201+41		1.3	73.5
	196+41		1.5	72.9
	192+55	End		
C	137+52	Right	0.9	62.0
	132+52		1.0	61.7
	127+52		1.0	61.2
	122+52		1.0	60.6
	119+53	Right & Left	1.2 (L), 2.3 (R)	60.0
	114+53		1.2 (L), 2.2 (R)	59.5
	109+53		1.1 (L), 2.2 (R)	59.0
	107+70	End		
D	90+53	Right	1.4	57.0
	85+53		0.9	56.4
E	65+67	Right & Left	0.8	52.0
	64+60		1.0	52.0
	59+60		1.0	51.0
	54+60		1.0	50.0
	52+46	Left	1.9	49.0
	51+46		1.9	49.0
	47+46		1.6	48.5
	42+46	End		

(a) Refer Figure 9 for reach location
(b) Refer to Figures 7 and 9 for location of river stations
(c) Right and left bank designation based on looking downstream

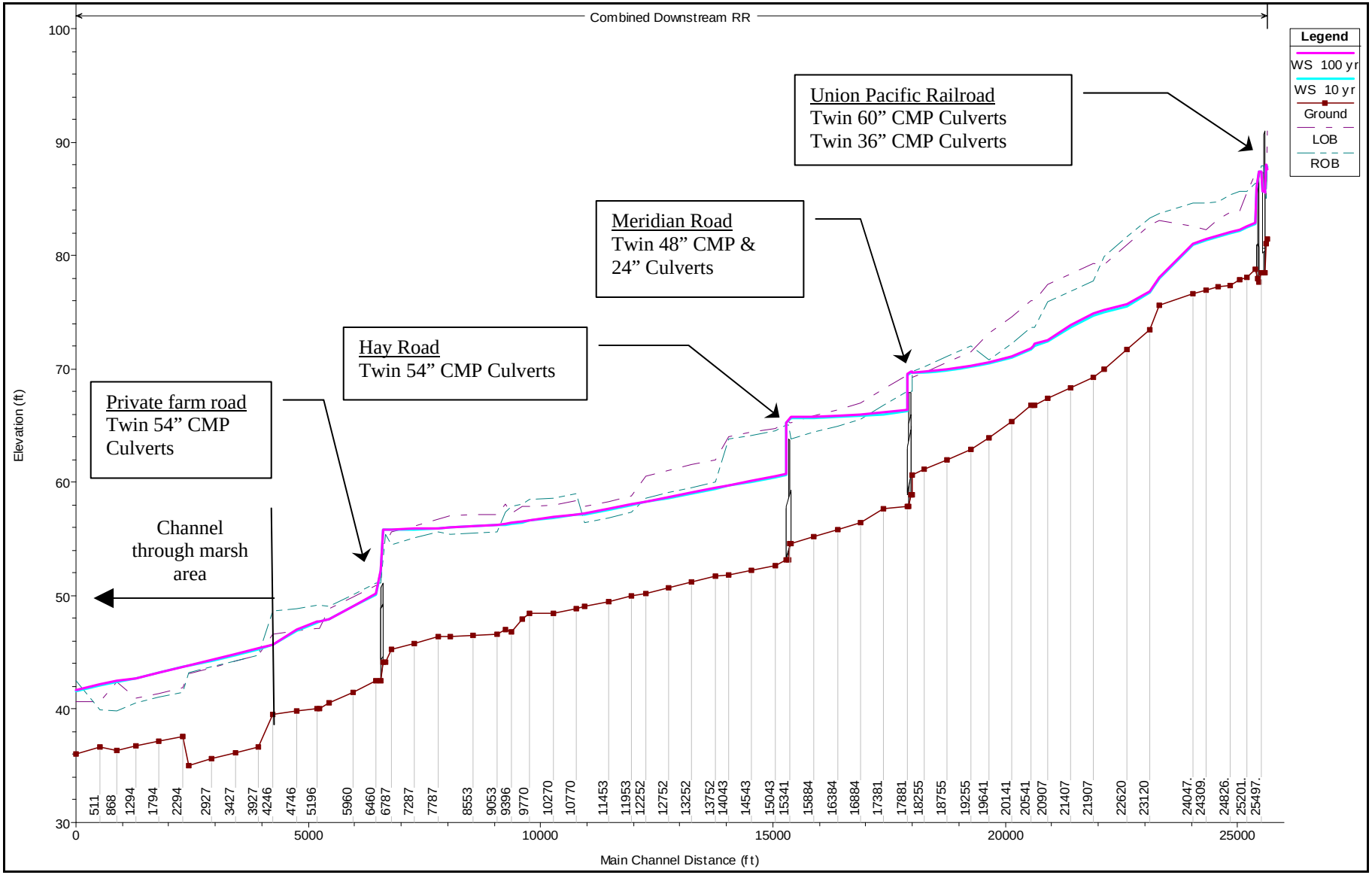

Figure 8. Noonan Drain/D-1-C Spill 10- and 100-Year Water Surface Profiles Under Existing Conditions

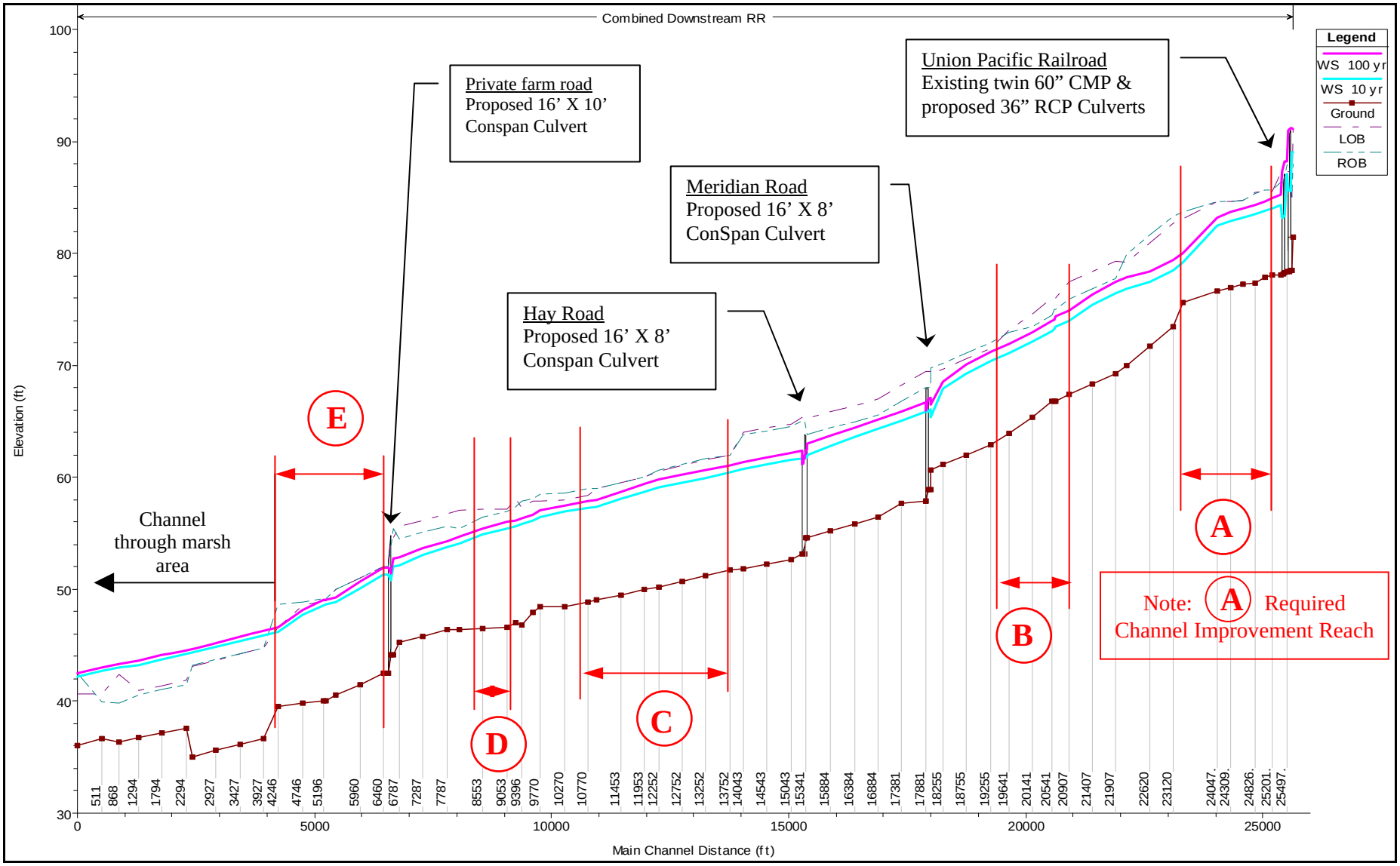

Figure 9. Noonan Drain/D-1-C Spill 10- and 100-Year Water Surface Profiles Under Developed Conditions

Overland Release to Alamo Creek

Under existing conditions overflows from the Brazelton Drain during both the 10- and 100-year storms flow overland along the Railroad and discharge into Alamo Creek near the Railroad Bridge. Under developed conditions the proposed detention will detain the 10-year, but the proposed detention basin is limited in size and will not have sufficient volume to completely detain the 100-year storm event without still having overland release to Alamo Creek. Consequently, an overland release path will be necessary to route overflows from the detention basin to Alamo Creek. Under existing conditions during the 100-year storm about 460 cfs discharge to Alamo Creek; however, under developed conditions only 101 cfs will discharge to Alamo Creek. To ensure the overflows released from the proposed detention basin do not adversely impact adjacent properties the following mitigation measures are required.

1. The proposed detention basin shall have a spillway located at the north end with a crest elevation of 88.5 feet and a crest length of 40 feet.
2. The existing drainage swale along the Railroad shall be maintained with a minimum width of 40 feet.
3. A berm or floodwall shall be constructed from the proposed detention basin to Alamo Creek to contain the overflows to Alamo Creek. The proposed masonry wall along the proposed Moody Development could function as a floodwall. However, this wall does not form a continuous barrier from the proposed detention basin to Alamo Creek. Therefore, additional barriers will be necessary to form a continuous barrier from the detention basin to Alamo Creek. The estimated water level along the overflow path is about 1.5 feet; therefore, the minimum barrier height to provide 3 feet of freeboard is 4.5 feet.

Figure 10 shows the approximate location of the proposed berm or floodwall.

Brazelton Drain Drainage Pipeline

The proposed Brazelton Drain pipeline was designed based on the following criteria:

- Rainfall based on the SCWA *Hydrology Manual* (June 1999)
- The proposed pipeline shall be designed to convey the 10-year peak discharge from the Foxboro subshed of 196 cfs
- Starting water surface elevation is 87.1 feet (NAVD 88), which is the estimated 10-year water level in the proposed regional detention basin between Leisure Town Road and the Railroad
- The 10-year HGLs within the Foxboro subshed, with the proposed pipeline in place and under ultimate development of the Southeast Vanden Area, shall not be higher the 10-year HGLs presented in Table 1 using the SCWA rainfall data.

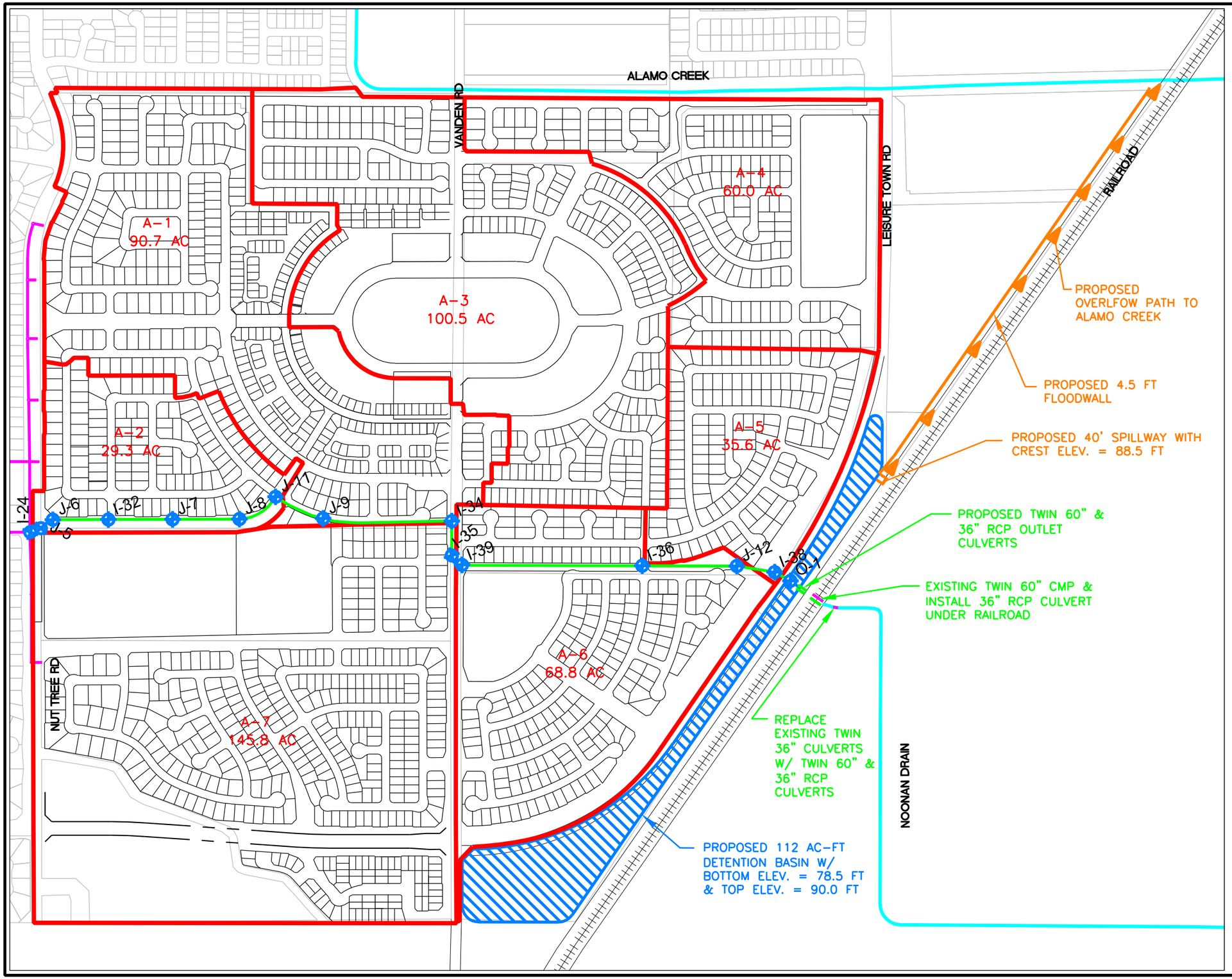

Figure 10

Southeast Vanden Area Major Drainage Facilities Master Plan

RECOMMENDED MAJOR DRAINAGE IMPROVEMENTS

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The alignment and elevations of the pipeline and the subshed boundaries were set by PEI. Accordingly, the objective of this analysis was to determine the appropriate pipe size necessary to convey the 10-year design flows based on the above criteria; and to determine the 10-year HGLs along the Brazelton Drain pipeline that will be used as the starting HGL for design of the storm drains within the Southtown Development and future developments within the Southeast Vanden Area. Figure 10 shows the proposed alignment, subshed boundaries, and modeling nodes (Figure 10 shows the final alignment and shed boundaries; therefore, Figure 10 is not consistent with the preliminary analysis).

A preliminary analysis was conducted where several alternatives were evaluated that included: a 60-inch pipeline from Nut Tree Road to Leisure Town Road; twin 60-inch pipes from Nut Tree Road to Leisure Town Road; multiple combinations of 6-foot by 5-foot, 8-foot by 5-foot, 9-foot by 5-foot, and 10-foot 5-foot box culverts. The only two alternatives that met the above criteria include the following:

- Alternative 1 – Twin 60-inch storm drains from Nut Tree Road to Vanden Road, and down Vanden Road. Then twin 72-inch storms drain across Vanden Road to the proposed detention basin.
- Alternative 2 – A 7-foot by 5-foot box culvert from Nut Tree Road for about 1,530 feet, then a 9-foot by 5-foot box culvert to Vanden Road and down Vanden Road, and then a 10-foot by 5-foot box culvert across Vanden Road to the proposed detention basin.

Table 8 provides a comparison of the HLG under existing conditions and the HGL under Alternatives 1 and 2. As shown in Table 8, the HGL under both alternatives is less than or equal to the HGL under existing conditions. The advantage of Alternative 1 over Alternative 2 is the HGL is lower along the proposed storm drain alignment; therefore, Alternative 1 is recommended.

Upon completion of the preliminary analysis and acceptance of the recommended alternative the alignment was finalized and a final analysis of tha proposed pipeline was conducted to determine the HGL to be used for design of the connecting storm drains. The alignment for the final analysis was based on an AutoCAD file (Phase 1 SD.dwg) received from PEI on May 2, 2005. The following two scenarios were analyzed:

- Construction of Southtown Phase 1 and 1A only (see Figure 10), which includes construction of the proposed Brazelton Drain pipeline from Nut Tree Road to the proposed detention basin, construction of the proposed detention basin east of Leisure Town Road. Under this scenario the 36-inch RCP culvert under the Railroad and the recommended improvements east of the Railroad would not be constructed.
- Ultimate buildout of the Southeast Vanden Area and construction of all the required drainage improvements (refer to Required Drainage Improvements below).

Under the first scenario, Phase 1 and 1A only, the water surface elevation in the proposed detention basin will increase from 87.1 to 87.6, which results in an increase in the HGL in the Brazelton Drain pipeline through the first 350 feet upstream of the proposed detention basin. Along the remainder of the Brazelton Drain pipeline, the resulting HGL is lower by about 1.2 feet compared to ultimate buildout. As a result, the Phase 1 and 1A scenario meets the above design criteria; therefore, the recommended improvements east of the Railroad are not necessary for construction of Southtown Phase 1 and 1A.

Table 8. Comparison of the Existing Conditions with the Brazelton Drain Pipeline Alternatives

Upstream Node	Down-stream Node	Upstream Inlet Area (ac)	Total Area (ac)	Time of Concentration (min)	System Intensity (in/hr)	Total System Flow [a] (cfs)	Pipe Length (ft)	Pipe Slope (ft/ft)	Pipe Size (in)	Full Capacity (cfs)	Upstream Invert Elevation (ft)	Down-stream Invert Elevation (ft)	Upstream Ground Elevation (ft)	Down-stream Ground Elevation (ft)	Existing Conditions		Alternative 1 - Concrete Pipeline				Alternative 2 - Concrete Box Pipeline			
															Upstream HGL (ft)	Down-stream HGL (ft)	Pipe Size (in)	Full Capacity (cfs)	Upstream HGL (ft)	Down-stream HGL (ft)	Pipe Size (in)	Full Capacity (cfs)	Upstream HGL (ft)	Down-stream HGL (ft)
I-1	J-1	13.8	13.8	20.4	2.19	15.2	115	0.0236	21	24.3	104.95	102.24	109.4	108.6	109.6	108.6			109.6	108.6			109.6	108.6
J-1	I-2	N/A	13.8	20.7	2.18	15.1	208	0.0055	21	11.7	102.24	101.10	108.6	108.9	109.2	107.3			109.2	107.3			109.2	107.3
I-2	I-3	3.5	17.3	22.4	2.09	18.2	476	0.0037	30	25.0	100.35	98.58	108.9	106.3	107.2	106.3			107.2	106.3			107.2	106.3
I-3	I-4	12.8	30.1	24.5	1.97	29.9	591	0.0008	36	19.0	98.58	98.10	106.3	105.3	106.5	105.3			106.5	105.3			106.5	105.3
I-4	I-5	8.3	38.4	26.9	1.85	35.7	427	0.0018	36	28.5	97.08	96.30	105.3	104.6	105.8	104.6			105.8	104.6			105.8	104.6
I-5	I-6	6.1	44.4	28.3	1.77	39.7	313	0.0022	36	31.5	96.30	95.60	104.6	104.7	105.8	104.7			105.8	104.7			105.8	104.7
I-7	I-6	22.4	22.4	24.8	1.96	22.1	566	0.0030	30	22.5	98.19	96.49	106.1	104.7	106.3	104.7			106.3	104.7			106.3	104.7
I-8	J-2	9.3	9.3	20.1	2.21	10.4	296	0.0020	24	10.1	103.36	102.77	110.3	110.2	110.8	110.2			110.8	110.2			110.8	110.2
J-2	I-9	N/A	9.3	21.6	2.13	10.0	132	0.0035	24	13.4	102.77	102.31	110.2	110.8	111.1	110.8			111.1	110.8			111.1	110.8
I-10	I-11	6.7	6.7	15.0	2.48	8.4	344	0.0012	24	7.8	103.31	102.90	110.0	110.5	111.0	110.5			111.0	110.5			111.0	110.5
I-11	I-9	7.6	14.3	17.2	2.37	17.1	209	0.0028	24	12.0	102.90	102.31	110.5	110.8	112.0	110.8			112.0	110.8			112.0	110.8
I-9	I-12	0.0	23.6	22.3	2.09	24.9	822	0.0020	30	18.5	102.31	100.63	110.8	109.1	112.1	109.1			112.1	109.1			112.1	109.1
I-12	J-3	10.3	33.9	25.0	1.95	33.3	168	0.0033	30	23.7	100.63	100.07	109.1	107.9	109.0	107.9			109.0	107.9			109.0	107.9
J-3	I-13	N/A	33.9	25.4	1.93	32.9	609	0.0029	36	35.9	99.57	97.81	107.9	106.4	107.9	106.4			107.9	106.4			107.9	106.4
I-13	I-14	19.2	53.1	27.6	1.81	48.4	533	0.0029	36	36.0	97.81	96.26	106.4	105.5	108.3	105.5			108.3	105.5			108.3	105.5
I-14	I-6	8.3	61.4	28.9	1.74	53.8	247	0.0027	36	34.5	96.26	95.60	105.5	104.7	106.3	104.7			106.3	104.7			106.3	104.7
I-6	I-15	4.2	132.5	29.4	1.71	114.2	602	0.0027	48	75.0	95.60	93.96	104.7	103.2	107.0	103.2	No change, same as existing conditions		107.0	103.2	No change, same as existing conditions		107.0	103.2
I-16	I-17	14.3	14.3	21.6	2.13	15.3	673	0.0018	24	9.5	103.65	102.46	111.3	109.9	113.0	109.9			113.0	109.9			113.0	109.9
I-17	I-18	6.3	20.6	23.9	2.01	20.8	948	0.0011	30	13.7	102.46	101.40	109.9	108.9	111.3	108.9			111.3	108.9			111.3	108.9
I-18	I-19	10.6	31.1	27.6	1.81	28.3	982	0.0009	36	19.6	101.40	100.55	108.9	108.3	110.1	108.3			110.1	108.3			110.1	108.3
I-19	I-20	12.8	44.0	31.7	1.65	36.5	479	0.0013	36	23.6	100.55	99.95	108.3	108.1	109.5	108.1			109.5	108.1			109.5	108.1
I-20	I-21	3.5	47.5	33.3	1.62	39.9	376	0.0019	36	29.4	99.95	99.22	108.1	107.0	108.3	107.0			108.3	107.0			108.3	107.0
I-21	J-4	9.6	57.0	34.4	1.6	47.1	216	0.0019	36	29.4	99.22	98.80	107.0	106.7	107.3	106.2			107.3	106.2			107.3	106.2
J-4	I-22	N/A	57.0	34.9	1.59	46.8	243	0.0011	36	21.8	98.80	98.54	106.7	104.7	105.9	104.7			105.9	104.7			105.9	104.7
I-22	I-23	4.9	61.9	35.5	1.58	50.4	534	0.0019	42	43.8	96.04	95.03	104.7	103.7	105.0	103.7			105.0	103.7			105.0	103.7
I-23	I-15	8.0	69.9	37.2	1.55	55.6	447	0.0024	42	49.2	95.03	93.96	103.7	103.2	104.6	103.2			104.6	103.2			104.6	103.2
I-15	I-24	6.6	208.9	38.5	1.52	161.5	173	0.0020	54	87.2	93.96	93.62	103.2	103.4	103.1	101.9			102.8	101.6			102.9	101.7
I-25	I-26	6.8	6.8	19.7	2.23	7.6	686	0.0027	18	5.4	100.05	98.21	106.1	105.3	107.6	104.1			107.3	103.8			107.5	103.9
I-26	I-27	10.7	17.5	22.4	2.09	18.4	772	0.0028	36	35.2	97.51	95.36	105.3	106.1	104.0	103.4			103.7	103.1			103.8	103.2
I-27	I-28	8.9	26.4	27.3	1.82	24.2	165	0.0008	36	19.4	95.36	95.22	106.1	103.7	103.2	103.0			102.9	102.7			103.1	102.8
I-28	I-24	1.8	30.6	28.9	1.74	29.8	437	0.0037	36	40.4	95.22	93.62	103.7	103.4	102.8	101.9			102.5	101.6			102.6	101.7
I-29	I-30	0.8	0.8	15.0	2.48	1.7	736	0.0021	15	2.9	97.72	96.21	105.1	104.4	104.9	104.4			104.7	104.2			104.8	104.3
I-30	I-28	1.7	2.5	23.9	2.00	4.5	760	0.0013	18	3.8	96.21	95.22	104.4	103.7	104.4	103.0			104.1	102.7			104.2	102.8
I-24	J-5	11.9	251.5	38.8	1.52	196.7	79	0.0076	42x68	188.3	93.62	93.02	103.4	103.1	99.9	99.3			99.6	99.0			99.8	99.1
J-5	J-6	N/A	251.5	38.9	1.52	196.4	31	0.0026			91.11	91.03	103.1	102.7			Twin 60	264.6	98.7	98.7	7 x 5 ft	261.4	98.8	98.8
J-6	I-37	N/A	251.5	39.0	1.52	196.2	391	0.0020			91.03	90.24	102.7	100.6			Twin 60	266.0	98.4	97.8	7 x 5 ft	231.3	98.4	97.8
I-37	J-8	29.3	280.8	40.2	1.49	215.5	666	0.0020			90.24	88.91	100.6	97.0			Twin 60	211.7	97.6	96.5	7 x 5 ft	229.9	97.5	96.3
J-8	J-9	N/A	280.8	42.0	1.46	210.7	444	0.0020			88.91	88.01	97.0	96.5			Twin 60	234.5	96.2	95.5	7 x 5 ft	231.6	96.1	95.3
J-9	J-10	N/A	280.8	43.2	1.44	207.5	661	0.0020			88.01	86.68	96.5	94.8			Twin 60	233.6	95.2	94.2	9 x 5 ft	316.6	95.1	94.5
J-10	I-32	N/A	280.8	45.6	1.39	201.2	440	0.0020	N/A	N/A	86.68	85.79	94.8	94.8	Existing Brazelton Drain Open Channel		Twin 60	234.3	94.0	93.3	9 x 5 ft	317.4	94.4	94.0
I-32	I-33	90.7	371.5	47.2	1.36	264.2	225	0.0020			85.79	85.33	94.8	95.0			Twin 60	235.5	92.8	92.3	9 x 5 ft	319.1	93.6	93.3
I-33	J-11	145.8	517.3	60.0	1.13	308.5	82	0.0021			85.33	85.16	95.0	93.2			Twin 72	385.6	91.9	91.8	10 x 5 ft	365.8	92.8	92.7
J-11	I-34	N/A	517.3	60.2	1.13	307.4	1,100	0.0025			85.16	82.39	93.2	92.2			Twin 72	425.0	91.5	90.1	10 x 5 ft	403.2	92.4	90.8
I-34	I-35	110.5	627.8	63.2	1.07	351.1	591	0.0040			82.39	80.03	92.2	91.5			Twin 72	535.2	89.6	88.6	10 x 5 ft	507.7	90.2	89.1
I-35	I-36	68.8	696.6	64.6	1.05	378.9	244	0.0040			80.03	79.05	91.5	91.2			Twin 72	581.5	88.2	87.7	10 x 5 ft	509.1	88.5	87.9
I-36	O-1	95.6	792.2	65.1	1.04	430.2	109	0.0041			79.05	78.60	91.2	90.0			Twin 72	429.3	87.1	86.8	10 x 5 ft	516.2	87.1	86.8

(a) Based on the SCWA *Hydrology Manaul* (June 1999)

(b) Elevations are based on the NAVD 88 Datum. Elevations for the existing Foxboro storm drains were based on the NGVD 29 Datum; therefore, 2.6 feet was added to the elevations on the as-built plans to convert to the NAVD 88 Datum

(c) Starting water surface elevation or HGL is based on the 10-year water surface elevation in the proposed regional detention basin

Table 9 provides a comparison of the HGL under existing conditions and under ultimate buildout of the Southeast Vanden Area.

REQUIRED DRAINAGE IMPROVEMENTS

This section provides a summary of the required drainage improvements that are necessary for development of the Southeast Vanden Area and to mitigate potential impacts to drainage facilities downstream of the proposed project.

Southtown Phase 1 and Phase 1A Requirements

The following improvements are required with construction of Phase 1 and 1A of the proposed Southtown Development:

1. Provide detention storage to mitigate for increased runoff resulting from development of the Southeast Vanden Area and to mitigate for loss of existing floodplain storage within the project area. The following are required to provide adequate detention storage for the proposed development of the Southeast Vanden Area:
    - The proposed detention basin shall be located between Leisure Town Road and the Railroad and have a volume of approximately 112 acre-feet at elevation 90 feet. The basin shall have a top elevation of 90 feet and a bottom elevation of 78.5 feet.
    - The proposed detention basin is limited in size and will not have sufficient volume to completely detain the 100-year storm event; consequently, an overland release path shall be provided that will route excess flows to Alamo Creek (which is the current overland release during the 10- and 100-year storm event). The proposed detention basin shall include a spillway located at the north end with a crest elevation of 88.5 feet and a crest length of 40 feet. A berm or floodwall will be required from the proposed basin to the proposed masonry wall along the proposed Moody Development to prevent flooding and provide an overflow path from the proposed detention basin to Alamo Creek.
2. The following storm drain pipeline will be required to route flows from the existing Foxboro Subdivision through the proposed Southtown Development to the proposed detention basin located between Leisure Town Road and the Railroad.
    - About 84 feet of 60-inch storm drain pipe from the existing 42-inch by 68-inch concrete pipe at the end of Opal Way, then about 2,730 feet of twin 60-inch storm drain pipes to Vanden Road, and down Vanden Road. Then about 1,775 feet of twin 72-inch storm drain pipes across Vanden Road to Leisure Town Road, and finally 353 feet of twin 84-inch storm drain pipes across Leisure Town Road to the proposed detention basin.

Table 10 provides a summary of the HGL along the proposed Brazelton Drain pipeline, which shall be used as the starting HGL for design of storm drain facilities within the Southeast Vanden Area.

Table 9. Comparison of the Existing Conditions with the Brazelton Drain Pipeline Under Ultimate Buildout Conditions

Upstream Node	Down-stream Node	Upstream Inlet Area (ac)	Total Area (ac)	Time of Concentration (min)	System Intensity (in/hr)	10-year Design Flow (cfs)	Pipe Length (ft)	Pipe Slope (ft/ft)	Pipe Size (in)	Full Capacity (cfs)	Average Velocity (ft/s)	Upstream Invert Elevation (ft)	Down-stream Invert Elevation (ft)	Upstream Ground Elevation (ft)	Down-stream Ground Elevation (ft)	Existing Conditions		Ultimate Buildout	
																Upstream HGL (ft)	Down-stream HGL (ft)	Upstream HGL (ft)	Down-stream HGL (ft)
I-1	J-1	13.8	13.8	20.4	2.19	15.2	115	0.0236	21	24.3	6.3	104.95	102.24	109.4	108.6	109.6	108.6	109.6	108.6
J-1	I-2	N/A	13.8	20.7	2.18	15.1	208	0.0055	21	11.7	6.3	102.24	101.10	108.6	108.9	109.2	107.3	109.2	107.3
I-2	I-3	3.5	17.3	22.4	2.09	18.2	476	0.0037	30	25.0	3.7	100.35	98.58	108.9	106.3	107.2	106.3	107.2	106.3
I-3	I-4	12.8	30.1	24.5	1.97	29.9	591	0.0008	36	19.0	4.2	98.58	98.10	106.3	105.3	106.5	105.3	106.5	105.3
I-4	I-5	8.3	38.4	26.9	1.85	35.7	427	0.0018	36	28.5	5.1	97.08	96.30	105.3	104.6	105.8	104.6	105.8	104.6
I-5	I-6	6.1	44.4	28.3	1.77	39.7	313	0.0022	36	31.5	5.6	96.30	95.60	104.6	104.7	105.8	104.7	105.8	104.7
I-7	I-6	22.4	22.4	24.8	1.96	22.1	566	0.0030	30	22.5	4.5	98.19	96.49	106.1	104.7	106.3	104.7	106.3	104.7
I-8	J-2	9.3	9.3	20.1	2.21	10.4	296	0.0020	24	10.1	3.3	103.36	102.77	110.3	110.2	110.8	110.2	110.8	110.2
J-2	I-9	N/A	9.3	21.6	2.13	10.0	132	0.0035	24	13.4	3.2	102.77	102.31	110.2	110.8	111.1	110.8	111.1	110.8
I-10	I-11	6.7	6.7	15.0	2.48	8.4	344	0.0012	24	7.8	2.7	103.31	102.90	110.0	110.5	111.0	110.5	111.0	110.5
I-11	I-9	7.6	14.3	17.2	2.37	17.1	209	0.0028	24	12.0	5.4	102.90	102.31	110.5	110.8	112.0	110.8	112.0	110.8
I-9	I-12	0.0	23.6	22.3	2.09	24.9	822	0.0020	30	18.5	5.1	102.31	100.63	110.8	109.1	112.1	109.1	112.1	109.1
I-12	J-3	10.3	33.9	25.0	1.95	33.3	168	0.0033	30	23.7	6.8	100.63	100.07	109.1	107.9	109.0	107.9	109.0	107.9
J-3	I-13	N/A	33.9	25.4	1.93	32.9	609	0.0029	36	35.9	4.7	99.57	97.81	107.9	106.4	107.9	106.4	107.9	106.4
I-13	I-14	19.2	53.1	27.6	1.81	48.4	533	0.0029	36	36.0	6.9	97.81	96.26	106.4	105.5	108.3	105.5	108.3	105.5
I-14	I-6	8.3	61.4	28.9	1.74	53.8	247	0.0027	36	34.5	7.6	96.26	95.60	105.5	104.7	106.3	104.7	106.3	104.7
I-6	I-15	4.2	132.5	29.4	1.71	114.2	602	0.0027	48	75.0	9.1	95.60	93.96	104.7	103.2	107.0	103.2	107.0	103.2
I-16	I-17	14.3	14.3	21.6	2.13	15.3	673	0.0018	24	9.5	4.9	103.65	102.46	111.3	109.9	113.0	109.9	113.0	109.9
I-17	I-18	6.3	20.6	23.9	2.01	20.8	948	0.0011	30	13.7	4.2	102.46	101.40	109.9	108.9	111.3	108.9	111.3	108.9
I-18	I-19	10.6	31.1	27.6	1.81	28.3	982	0.0009	36	19.6	4.0	101.40	100.55	108.9	108.3	110.1	108.3	110.1	108.3
I-19	I-20	12.8	44.0	31.7	1.65	36.5	479	0.0013	36	23.6	5.2	100.55	99.95	108.3	108.1	109.5	108.1	109.5	108.1
I-20	I-21	3.5	47.5	33.3	1.62	39.9	376	0.0019	36	29.4	5.7	99.95	99.22	108.1	107.0	108.3	107.0	108.3	107.0
I-21	J-4	9.6	57.0	34.4	1.6	47.1	216	0.0019	36	29.4	6.7	99.22	98.80	107.0	106.7	107.3	106.2	107.3	106.2
J-4	I-22	N/A	57.0	34.9	1.59	46.8	243	0.0011	36	21.8	6.6	98.80	98.54	106.7	104.7	105.9	104.7	105.9	104.7
I-22	I-23	4.9	61.9	35.5	1.58	50.4	534	0.0019	42	43.8	5.2	96.04	95.03	104.7	103.7	105.0	103.7	105.0	103.7
I-23	I-15	8.0	69.9	37.2	1.55	55.6	447	0.0024	42	49.2	5.8	95.03	93.96	103.7	103.2	104.6	103.2	104.6	103.2
I-15	I-24	6.6	208.9	38.5	1.52	161.5	173	0.0020	54	87.2	10.2	93.96	93.62	103.2	103.4	103.1	101.9	102.9	101.7
I-25	I-26	6.8	6.8	19.7	2.23	7.6	686	0.0027	18	5.4	4.3	100.05	98.21	106.1	105.3	107.6	104.1	107.5	103.9
I-26	I-27	10.7	17.5	22.4	2.09	18.4	772	0.0028	36	35.2	2.6	97.51	95.36	105.3	106.1	104.0	103.4	103.8	103.2
I-27	I-28	8.9	26.4	27.3	1.82	24.2	165	0.0008	36	19.4	3.4	95.36	95.22	106.1	103.7	103.2	103.0	103.1	102.9
I-28	I-24	1.8	30.6	28.9	1.74	29.8	437	0.0037	36	40.4	4.2	95.22	93.62	103.7	103.4	102.8	101.9	102.6	101.7
I-29	I-30	0.8	0.8	15.0	2.48	1.7	736	0.0021	15	2.9	1.4	97.72	96.21	105.1	104.4	104.9	104.4	104.8	104.3
I-30	I-28	1.7	2.5	23.9	2	4.5	760	0.0013	18	3.8	2.5	96.21	95.22	104.4	103.7	104.4	103.0	104.2	102.9
I-24	J-5	11.9	251.5	38.8	1.52	196.7	82	0.0073	42x68	184.8	11.9	93.62	93.02	103.4	103.3	99.9	99.3	99.8	99.1
J-5	J-6	N/A	251.5	38.9	1.52	196.4	84	0.0020	60	117.2	10.0	91.11	90.94	103.3	102.7	Existing Brazelton Drain Open Channel		99.1	98.6
J-6	I-32	N/A	251.5	39.1	1.51	196.1	330	0.0021	Twin 60	239.9	5.0	90.94	90.24	102.7	99.7			98.4	97.9
I-32	J-7	29.3	280.8	40.2	1.49	215.5	392	0.0020	Twin 60	235.3	5.5	90.24	89.44	99.7	98.8			97.6	97.0
J-7	J-8	N/A	280.8	41.3	1.47	212.4	400	0.0021	Twin 60	235.8	5.4	89.44	88.62	98.8	96.7			96.8	96.2
J-8	J-11	N/A	280.8	42.6	1.45	209.1	273	0.0020	Twin 60	233.8	5.3	88.62	88.07	96.7	96.1			96.0	95.6
J-11	J-9	N/A	280.8	43.4	1.43	206.9	314	0.0020	Twin 60	233.3	5.3	88.07	87.44	96.1	95.1			95.2	94.7
J-9	I-34	N/A	280.8	44.4	1.42	204.2	798	0.0020	Twin 60	233.2	5.2	87.44	85.84	95.1	95.1			94.6	93.4
I-34	I-35	90.7	371.5	47.0	1.37	265.0	222	0.0023	Twin 60	249.7	6.8	85.84	85.33	95.1	95.0			92.8	92.2
I-35	I-39	145.8	517.3	60.0	1.13	308.5	82	0.0021	Twin 72	385.6	5.5	85.33	85.16	95.0	93.3			91.9	91.8
I-39	I-36	68.8	586.1	60.3	1.13	346.3	1,103	0.0025	Twin 72	424.4	6.1	85.16	82.39	93.3	92.2			91.5	89.6
I-36	J-12	100.5	686.6	63.3	1.07	387.9	589	0.0025	Twin 72	423.1	7.0	82.39	80.92	92.2	91.5			89.1	87.9
J-12	I-38	N/A	686.6	64.7	1.04	378.5	243	0.0025	Twin 84	634.8	8.6	80.92	80.32	91.5	91.2			87.6	87.4
I-38	O-1	35.6	722.2	65.1	1.04	394.0	110	0.0025	Twin 84	644.6	8.8	80.32	80.04	91.2	90.0			87.2	87.1

(a) Based on the SCWA *Hydrology Manaul* (June 1999)

(b) Elevations are based on the NAVD 88 Datum. Elevations for the existing Foxboro storm drains were based on the NGVD 29 Datum; therefore, 2.6 feet was added to the elevations on the as-built plans to convert to the NAVD 88 Datum

(c) Starting water surface elevation or HGL is based on the 10-year water surface elevation in the proposed regional detention basin

(d) Proposed storm drain (from Node J-5 to O-1) based on alignment developed by Phillippi Engineering, Inc., received May 2, 2005

(e) 10-year design flows based on Land Use data received from Phillippi Engineering, Inc., dated Feb. 14, 2005 (see Appendix A)

Table 10. Summary of the Brazelton Drain Pipeline Hydraulic Grade Line

Upstream Node	Downstream Node	Total Area (ac)	10-year Design Flow (cfs)	Length (ft)	Pipe Slope (ft/ft)	Pipe Diameter (in)	Full Capacity (cfs)	Upstream Invert Elevation (ft)	Downstream Invert Elevation (ft)	Upstream Ground Elevation (ft)	Downstream Ground Elevation (ft)	Upstream HGL (ft)	Downstream HGL (ft)
J-5	J-6	251.5	196	84	0.0020	60	117.2	91.11	90.94	103.3	102.7	99.1	98.6
J-6	I-32	251.5	196	330	0.0021	Twin 60	239.9	90.94	90.24	102.7	99.7	98.4	97.9
I-32	J-7	280.8	216	392	0.0020	Twin 60	235.3	90.24	89.44	99.7	98.8	97.6	97.0
J-7	J-8	280.8	212	400	0.0021	Twin 60	235.8	89.44	88.62	98.8	96.7	96.8	96.2
J-8	J-11	280.8	209	273	0.0020	Twin 60	233.8	88.62	88.07	96.7	96.1	96.0	95.6
J-11	J-9	280.8	207	314	0.0020	Twin 60	233.3	88.07	87.44	96.1	95.1	95.2	94.7
J-9	I-34	280.8	204	798	0.0020	Twin 60	233.2	87.44	85.84	95.1	95.1	94.6	93.4
I-34	I-35	371.5	265	222	0.0023	Twin 60	249.7	85.84	85.33	95.1	95.0	92.8	92.2
I-35	I-39	517.3	308	82	0.0021	Twin 72	385.6	85.33	85.16	95.0	93.3	91.9	91.8
I-39	I-36	586.1	346	1,103	0.0025	Twin 72	424.4	85.16	82.39	93.3	92.2	91.5	89.6
I-36	J-12	686.6	388	589	0.0025	Twin 72	423.1	82.39	80.92	92.2	91.5	89.1	87.9
J-12	I-38	686.6	378	243	0.0025	Twin 84	634.8	80.92	80.32	91.5	91.2	87.6	87.4
I-38	O-1	722.2	394	110	0.0025	Twin 84	644.6	80.32	80.04	91.2	90.0	87.2	87.1

(a) Elevations based on the NAVD 88 Datum

(b) Starting water surface elevation or HGL is based on the 10-year water surface elevation in the proposed detention basin

(c) Proposed storm drain based on alignment from PEI dated 7/7/2005. Assumes the Phase 1A area drains directly to the detention basin and all other areas are assumed to drain to the proposed Brazelton Drain pipeline.

(d) 10-year design flows based on land use data received from PEI dated 2/11/2205

Requirements for Subsequent Phases

1. A 36-inch RCP culvert shall be installed under the Railroad with upstream invert elevation of 78.5 feet.
2. The exiting SID twin 36-inch CMP culverts located just east of the Railroad shall be replaced with twin 60-inch culverts and a 36-inch culvert; or the culverts under the Railroad could be extended.
3. Under ultimate development of the Southeast Vanden Area an additional 190 cfs during the 10-year storm and about 310 cfs during the 100-year storm will be discharged to the existing open channel east of the Railroad (Noonan Drain and the D-1-C Spill); therefore, the following improvements are required:

    - The existing culverts at Meridian Road, Hay Road, and the private farm road shall be replaced with one of the following alternatives:
        - Twin 96-inch RCP culverts. The new culverts shall include concrete headwalls.
        - 16-foot by 8-foot ConSpan culverts shall be installed at Meridian Road and Hay Road, and 16-foot by 10-foot ConSpan culvert at the private farm road.
    - The top-of-bank shall be raised along the following reaches (see Table 7 for more detail)

      A – River Station 250+55 to 233+09 along the left bank

      B – River Station 209+07 to 192+55 along the right bank

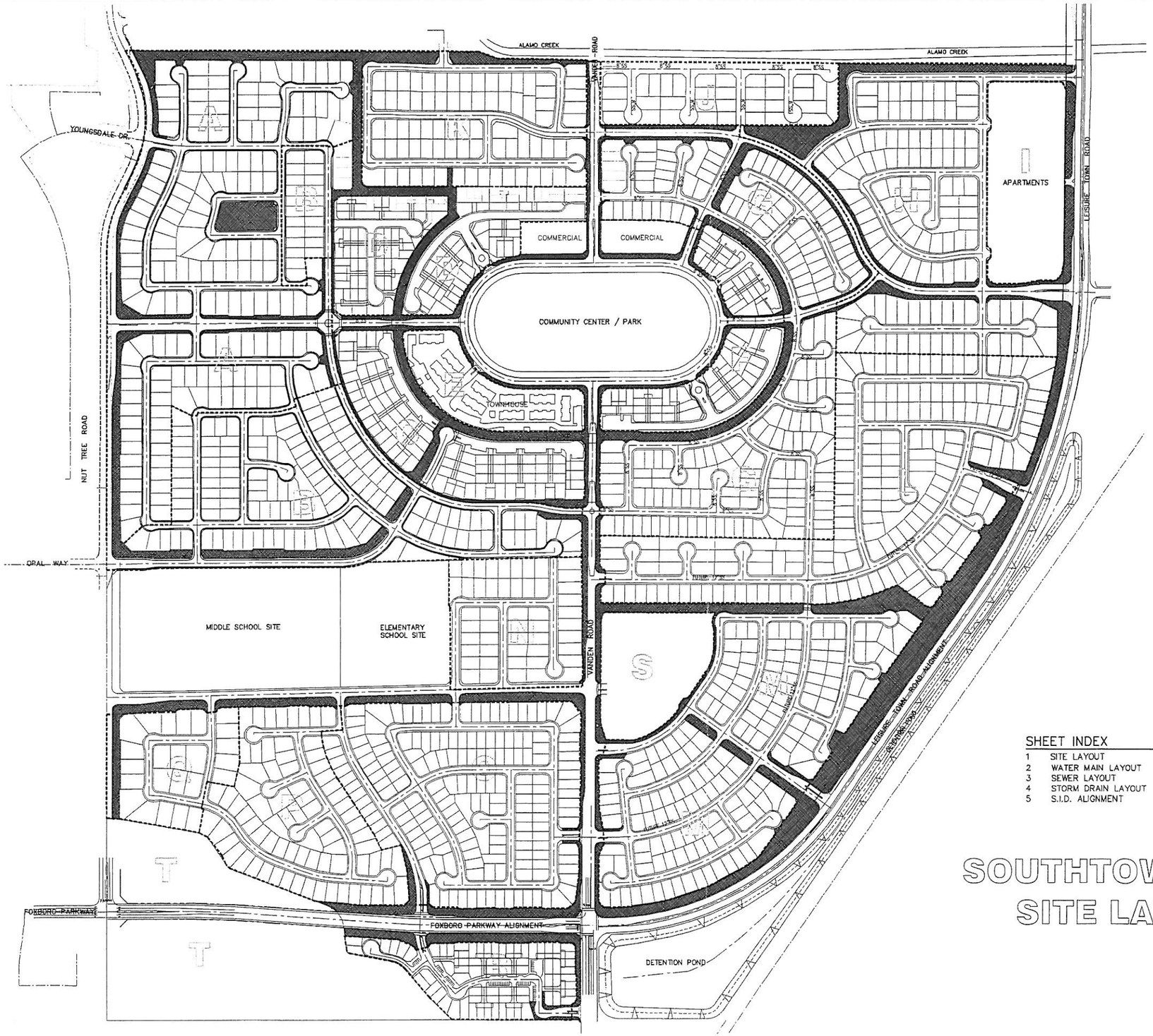
      C - River Station 137+52 to 122+52 along the right bank; and from Station 122+52 to 107+70 along both banks

      D - River Station 90+53 to 85+53 along the right bank

      E - River Station 65+67 to 54+60 along the both banks; and Station 54+60 to 42+46 along the left bank

APPENDIX A

Southtown Area Site Layout (PEI)



AREA	MIN. LOT SIZE	NUMBER OF UNITS
A	85' x 110'	165 UNITS
B	55' x 100'	158 UNITS
C	50' x 80' (CLUSTER)	78 UNITS
D	40' x 80' (CLUSTER)	114 UNITS
E	TOWNHOUSE	60 UNITS
F	40' x 80' (CLUSTER)	61 UNITS
G	50' x 100'	178 UNITS
H	60' x 100'	117 UNITS
I	APARTMENTS	240 UNITS
J	65' x 100'	34 UNITS
K	85' x 100'	77 UNITS
L	60' x 100'	174 UNITS
M	55' x 90'	161 UNITS
N	65' x 100'	48 UNITS
O	50' x 90'	175 UNITS
P	50' x 100'	76 UNITS
Q	60' x 125'	24 UNITS
R	40' x 80' CLUSTER	72 UNITS
S	8.0± AC 10 UNITS/AC	80 UNITS
T	28.3± AC 4 UNITS/AC	113 UNITS

TOTAL NUMBER OF UNITS	2,205

SHEET INDEX

1 SITE LAYOUT
2 WATER MAIN LAYOUT
3 SEWER LAYOUT
4 STORM DRAIN LAYOUT
5 S.I.D. ALIGNMENT

SOUTHTOWN AREA SITE LAYOUT

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N

SCALE: 1"=200'

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DESIGNED BY: E.T.V.
DRAWN BY: E.T.V.
CHECKED BY: T.A.P.

PRELIMINARY

BID SET
APPROVED

PROJECT NAME/LOCATION: SOUTHTOWN AREA
CITY
STATE

DRAWING TITLE: SITE LAYOUT

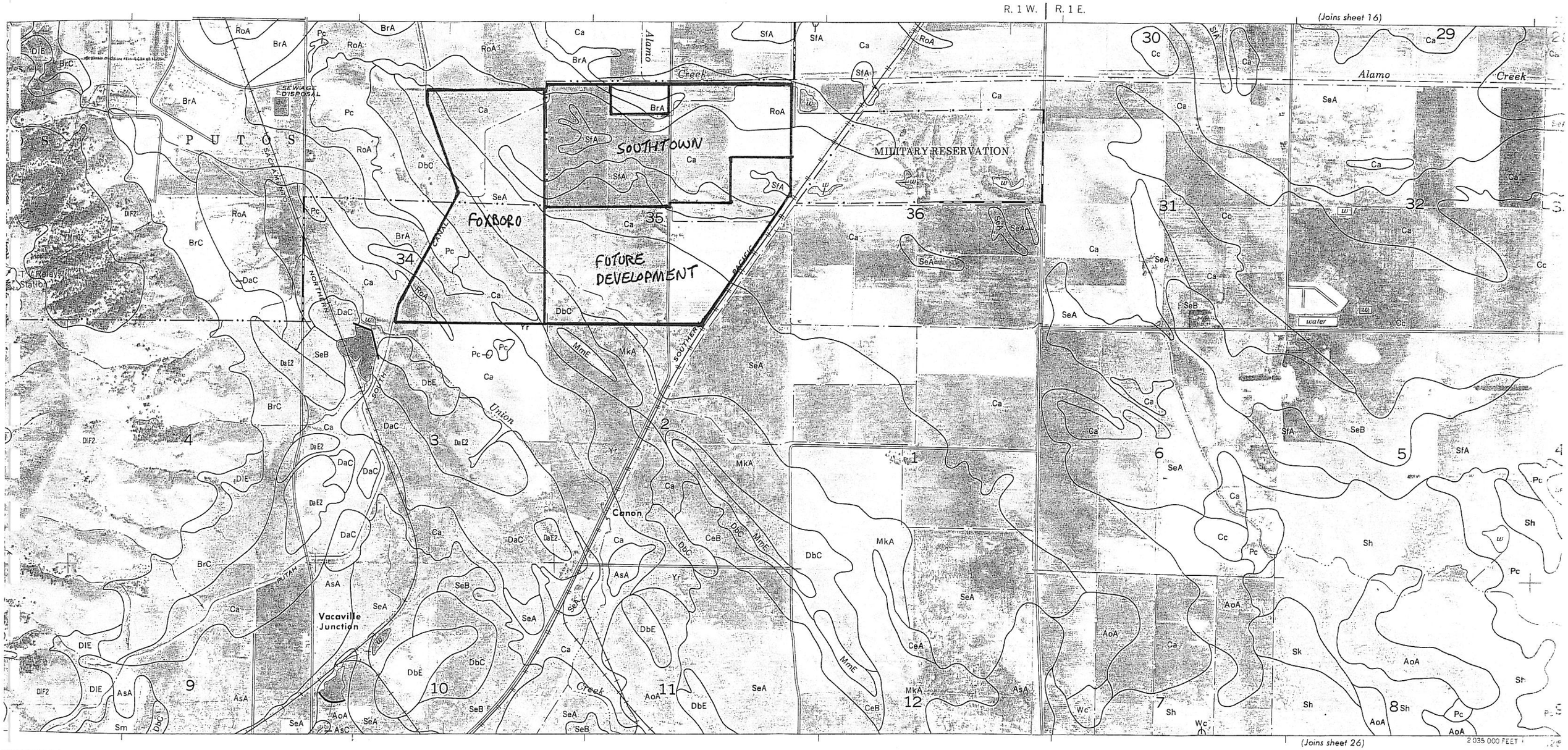
REVISIONS NO.	DESCRIPTION	DATE

DRAWING FILE: MASTER UTIL/ 210860-S1-SITE

ISSUE DATE: 02/01/05
PROJECT NO.: 210860
SHEET NO.: 1 OF 5

APPENDIX B

Soil Types and Soil Characteristics



rth American datum
nia coordinate system
photographs

Table B-1. Summary of Soil Type Characteristics

Map Symbol	Soil Series	Hydrologic Soil Group	Description of Soil Features Affecting Drainage
BrA	Brentwood Clay Loam	B	Moderately slow permeability
Ca	Capay Silty Clay Loam	D	Slow permeability
DbC	Dibble-Los Osos Loams	C	Slow permeability; sandstone at depths of 1.5 to 3.5 feet
MkA	Millsap Sandy Loam	D	Very slow permeability; sandstone at depths of 1.5 to 2.5 feet
Pc	Pescadero Clay Loam	C	Slow permeability
RoA	Rincon Clay Loam	C	Slow permeability
SeA	San Ysidro Sandy Loam, 0-2 % slopes	D	Very slow permeability
SfA	San Ysidro Sandy Loam, thick surface, 0-2 % percent slopes	D	Very slow permeability

APPENDIX C

HEC-1 Rainfall Transformation and Routing Parameters

Table C-1. Pre-Development Conditions Subshed HEC-1 Rainfall Transformation and Routing Parameters

					Rainfall Losses						Rainfall Transformation Data				Routing Data					
								Area-Weighted Average												
Shed	Land Use	Hydrologic Soil Group	Total Area (mi^2)	Area (ac)	Initial Loss	Constant Loss	% Impervious	Initial Loss	Constant Loss	% Impervious	Overland Flow Length (ft)	Slope (ft/ft)	Roughness Coefficient	% of Subbasin	Channel Length (ft)	Channel Slope (ft/ft)	Manning's n	Type (shape)	Bottom width or diameter (ft)	Side Slopes
BD 1	RL-10	C	0.043	15.5	0.2	0.10	40	0.200	0.100	48.6	385	0.0030	0.20	100	660	0.0012	0.015	CIRC	2.0	
	RM-5	C		11.7	0.2	0.10	60								820	0.002	0.015	CIRC	2.5	
BD 2	RL-10	D	0.074	47.3	0.2	0.05	40	0.200	0.050	40.0	1050	0.0050	0.20	100	1600	0.0014	0.015	CIRC	2.25	
															1460	0.001	0.015	CIRC	3.0	
BD 3	RL-8	D	0.046	29.1	0.2	0.05	40	0.200	0.050	40.0	545	0.0050	0.20	100	500	0.001	0.015	CIRC	1.5	
															1570	*0.001*	*0.015*	*CIRC*	*3.5*	
BD 4	RL-10	D	0.046	9.1	0.2	0.05	40	0.200	0.050	51.21	500	0.0050	0.20	100	700	0.003	0.015	CIRC	1.0	
	RL-8	D		3.9	0.2	0.05	40								*780*	*0.0025*	*0.015*	*CIRC*	*3.0*	
	RM-5	D		16.5	0.2	0.05	60													
BD 5	RM-5	C	0.055	35.0	0.2	0.10	60	0.200	0.100	60.0	910	0.0050	0.20	100	460	0.014	0.015	CIRC	1.25	
															570	0.003	0.015	CIRC	2.25	
BD 6	RL-6	D	0.047	16.7	0.2	0.05	50	0.200	0.050	54.46	460	0.0050	0.20	100	525	0.0045	0.015	CIRC	1.25	
	RM-5	D		13.4	0.2	0.05	60								800	0.0037	0.015	CIRC	2.25	
															1020	*0.0022*	*0.015*	*CIRC*	*3.0*	
BD 7	RL-7	D	0.027	17.5	0.2	0.05	50	0.200	0.050	50.0	665	0.0050	0.20	100	690	0.0027	0.015	CIRC	1.5	
BD 8	RM-5	D	0.022	10.7	0.2	0.05	60	0.200	0.050	57.49	700	0.0050	0.20	100	245	0.0025	0.015	CIRC	1.5	
	RL-7	D		3.6	0.2	0.05	50								*315*	*0.0022*	*0.015*	*CIRC*	*3.0*	
BD 9	RL-7	D	0.021	10.7	0.2	0.05	50	0.181	0.044	58.54	200	0.0050	0.50	100	500	0.001	0.015	CIRC	1.5	
	Paved	D		2.5	0.1	0.02	95								*910*	*0.0025*	*0.015*	*CIRC*	*3.0*	
BD 10	Park	D	0.019	9.1	0.3	0.06	5	0.253	0.051	26.11	800	0.0400	0.04	70	1000	0.002	0.015	CIRC	1.5	
	Paved	D		2.8	0.1	0.02	95				1000	0.0060	0.02	30	*1100*	*0.002*	*0.06*	*TRAP*	*10*	*1*
BD 11	OS	D	0.113	72.2	0.4	0.07	2	0.400	0.070	2.0	1300	0.0036	0.20	100	1200	0.002	0.07	TRAP	2	1
															1400	*0.002*	*0.06*	*TRAP*	*10*	*1*
BD 12	OS	D	0.301	190.7	0.4	0.07	2	0.397	0.069	2.97	1440	0.0035	0.20	30	960	0.005	0.07	TRAP	2	1
	Paved	D		2.0	0.1	0.02	95				1250	0.0096	0.20	70	1430	0.005	0.07	TRAP	2	1
															1900	*0.002*	*0.06*	*TRAP*	*15*	*1*
BD 13	OS	D	0.275	172.4	0.4	0.07	2	0.394	0.069	3.95	2870	0.0038	0.20	100	930	0.003	0.07	TRAP	2	1
	Paved	D		3.7	0.1	0.02	95													
BD 14	OS	D	0.013	6.2	0.4	0.07	2	0.327	0.058	24.71	300	0.0030	0.20	100	1210	0.003	0.05	TRAP	5	2
	Paved	D		2.0	0.1	0.02	95													
BD 15	OS	D	0.106	65.2	0.4	0.07	2	0.389	0.068	5.44	1350	0.0037	0.20	100	450	0.003	0.06	TRAP	2	1
	Paved	D		2.5	0.1	0.02	95													
BD 16	OS	D	0.017	10.8	0.4	0.07	2	0.400	0.070	2.0	350	0.0030	0.20	100	2000	0.003	0.05	TRAP	10	5
															1100	*0.002*	*0.06*	*TRAP*	*15*	*1.5*
BD 17	OS	D	0.046	29.5	0.4	0.07	2	0.400	0.070	2.0	1800	0.0030	0.20	100	500	0.003	0.05	TRAP	2	1

Italics indicate routing of combine flows from multiple subbasins

Table C-2. Post-Development Conditions Subshed HEC-1 Rainfall Transformation and Routing Parameters

					Rainfall Losses						Rainfall Transformation Data				Routing Data					
								Area-Weighted Average												
Shed	Land Use		Total Area (mi^2)	Area (ac)	Initial Loss	Constant Loss	% Impervious	Initial Loss	Constant Loss	% Impervious	Overland Flow Length (ft)	Slope (ft/ft)	Roughness Coefficient	% of Subbasin	Channel Length (ft)	Channel Slope (ft/ft)	Manning's n	Type (shape)	Bottom width or diameter (ft)	Side Slopes
BD 1	RL-10	C	0.043	15.5	0.2	0.10	40	0.200	0.100	48.6	385	0.0030	0.20	100	660	0.0012	0.015	CIRC	2.0	
	RM-5	C		11.7	0.2	0.10	60								820	0.002	0.015	CIRC	2.5	
BD 2	RL-10	D	0.074	47.3	0.2	0.05	40	0.200	0.050	40.0	1050	0.0050	0.20	100	1600	0.0014	0.015	CIRC	2.25	
															1460	0.001	0.015	CIRC	3.0	
BD 3	RL-8	D	0.046	29.1	0.2	0.05	40	0.200	0.050	40.0	545	0.0050	0.20	100	500	0.001	0.015	CIRC	1.5	
															1570	*0.001*	*0.015*	*CIRC*	*3.5*	
BD 4	RL-10	D	0.046	9.1	0.2	0.05	40	0.200	0.050	51.2	500	0.0050	0.20	100	700	0.003	0.015	CIRC	1.0	
	RL-8	D		3.9	0.2	0.05	40								*780*	*0.0025*	*0.015*	*CIRC*	*3.0*	
	RM-5	D		16.5	0.2	0.05	60													
BD 5	RM-5	C	0.055	35.0	0.2	0.10	60	0.200	0.100	60.0	910	0.0050	0.20	100	460	0.014	0.015	CIRC	1.25	
															570	0.003	0.015	CIRC	2.25	
BD 6	RL-6	D	0.047	16.7	0.2	0.05	50	0.200	0.050	54.5	460	0.0050	0.20	100	525	0.0045	0.015	CIRC	1.25	
	RM-5	D		13.4	0.2	0.05	60								800	0.0037	0.015	CIRC	2.25	
															1020	*0.0022*	*0.015*	*CIRC*	*3.0*	
BD 7	RL-7	D	0.027	17.5	0.2	0.05	50	0.200	0.050	50.0	665	0.0050	0.20	100	690	0.0027	0.015	CIRC	1.5	
BD 8	RM-5	D	0.022	10.7	0.2	0.05	60	0.200	0.050	57.5	700	0.0050	0.20	100	245	0.0025	0.015	CIRC	1.5	
	RL-7	D		3.6	0.2	0.05	50								*315*	*0.0022*	*0.015*	*CIRC*	*3.0*	
BD 9	RL-7	D	0.021	10.7	0.2	0.05	50	0.181	0.044	58.5	200	0.0050	0.50	100	500	0.001	0.015	CIRC	1.5	
	Paved	D		2.5	0.1	0.02	95								*910*	*0.0025*	*0.015*	*CIRC*	*3.0*	
BD 10	Park	D	0.019	9.1	0.3	0.06	5	0.253	0.051	26.1	800	0.0400	0.04	70	1000	0.002	0.015	CIRC	1.5	
	Paved	D		2.8	0.1	0.02	95				1000	0.0060	0.02	30	*410*	*0.002*	*0.015*	*CIRC*	*8*	
BD 11	RLM(6-8)	D	0.046	29.3	0.2	0.05	50	0.200	0.050	50.0	470	0.0015	0.20	100	790	0.0025	0.015	CIRC	1.5	
															1820	*0.002*	*0.015*	*CIRC*	*8*	
BD 12A	RLM(6-8)	D	0.142	61.2	0.2	0.05	50	0.224	0.052	40.6	470	0.0015	0.20	100	2575	0.002	0.015	CIRC	2.5	
	Park	D		1.1	0.3	0.06	5								1100	0.002	0.015	CIRC	3.5	
	RM(5)	D		22.0	0.2	0.05	60													
	RM(4)	D		6.4	0.2	0.05	70													
BD 12	RL(8-10)	D	0.228	37.4	0.2	0.05	40	0.200	0.047	51.1	470	0.0015	0.20	100	2000	0.002	0.015	CIRC	2.5	
	RLM(6-8)	D		30.0	0.2	0.05	50								2000	0.002	0.015	CIRC	4	
	RM(5)	D		34.5	0.2	0.05	60													
	RM(4)	D		11.9	0.2	0.05	70													
	School	D		32.0	0.2	0.035	50													
BD 13A	RLM(6-8)	D	0.094	42.4	0.2	0.05	50	0.202	0.047	57.4	400	0.0015	0.20	100	1600	0.004	0.015	CIRC	2.5	
	Apartments	D		16.5	0.2	0.037	80								1400	0.001	0.015	CIRC	4.5	
	Park	D		1.1	0.3	0.06	5													
BD 13B	RLM(6-8)	D	0.157	53.9	0.2	0.05	50	0.216	0.047	50.3	470	0.0015	0.20	100	1800	0.002	0.015	CIRC	2.5	
	RM(4)	D		25.3	0.2	0.05	70								1100	0.002	0.015	CIRC	3.5	
	Commercial	D		5.7	0.2	0.05	90								*830*	*0.0025*	*0.015*	*CIRC*	*9*	
	Park	D		15.6	0.3	0.03	5													
BD 13	RLM(6-8)	D	0.056	35.6	0.2	0.05	50	0.200	0.050	50.0	470	0.0015	0.20	100	790	0.0025	0.015	CIRC	1.5	
															110	*0.0025*	*0.015*	*CIRC*	*9*	
BD 14	OS	D	0.091	38.8	0.4	0.07	2	0.390	0.047	33.2	300	0.0015	0.20	100	1210	0.003	0.05	TRAP	5	2
	Basin	D		17.6	0.4	0	95													
	Paved	D		2.0	0.1	0.02	95													
BD 15	RM(5)	D	0.108	68.8	0.2	0.05	60	0.200	0.050	60.0	470	0.0015	0.20	100	1500	0.0025	0.015	CIRC	2	
															1400	*0.0025*	*0.015*	*CIRC*	*9*	
BD 16	OS	D	0.017	10.8	0.4	0.07	2	0.400	0.070	2.0	350	0.0030	0.40	100	2000	0.003	0.05	TRAP	10	5
															1100	*0.002*	*0.06*	*TRAP*	*15*	*1.5*
BD 17	OS	D	0.046	29.5	0.4	0.07	2	0.400	0.070	2.0	1800	0.0030	0.40	100	500	0.003	0.05	TRAP	2	1

Italics indicate routing of combine flows from multiple subbasins

Table C-3. Initial Rainfall Losses

Land Use	Initial Loss, inches
Agricultural/Open Space	0.4
Wooded Areas	0.5
Rural Areas	0.3
Urban Areas	0.2
Parks/Lawns	0.3
Industrial/Commercial	0.1

Table C-4. Constant Rainfall Losses and Percent Impervious

Land Use	Density Range, units/acre	Percent Impervious	Soil Group Constant Loss Rate, inches/hour		
			B	C	D
Highway/Parking	—	95	0.14	0.07	0.02
Commercial/Office	—	90	0.16	0.08	0.03
Industrial	—	85	0.162	0.082	0.032
School/Hospital/Place of Worship	—	50	0.165	0.085	0.035
Residential Urban High Density/ Multi-Family	20-36	80	0.167	0.087	0.037
Residential High Density/Mobil Home	14-20	75	0.17	0.09	0.04
Residential Medium Density	10-14	70	0.18	0.10	0.05
	8-10	60			
Residential Low/Med. Density	6-8	50			
	4-6	40			
Residential Low Density	3-4	30			
Residential Estate	2-3	25			
	1-2	20			
	0.5-1	15			
Residential Rural	0.1-0.5	10			
Park/Recreation	—	5	0.19	0.11	0.06
Open Space/Grassland/Agricultural	—	2	0.20	0.12	0.07
Open Space/Woodland/Natural	—	1	0.22	0.14	0.08
Dense Oak/Shrubs/Vines	—	1	0.25	0.16	0.09

Adopted from the Sacramento City/County Drainage Manual, Volume 2 – Hydrology Standards (Dec. 1996)

APPENDIX D

HEC-1 Input Files

D-1

Existing Conditions 10-Year HEC-1 Model

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ID      VACAVILLE BRAZELTON DRAIN WATERSHED
*       EXISTING CONDITIONS SUBAREA HYDROLOGY
*       INCLUDES NATURAL DETENTION AREA AT LEISURE TOWN RD AND RAILROAD AS SINGLE BASIN
*       10-YEAR 24-HOUR PRECIPITATION
*       INITIAL UNIFORM LOSS RATE METHOD
*       MUSKINGUM-CUNGE
*       WEST YOST AND ASSOCIATES
*       SEPT 2004
*       FN = BD-10X.DAT
*
*       PRECIPITATION DATA BASED ON GOODRIDGE DATA FOR SOLANO COUNTY (SCWA HYDROLOGY MANUAL 1999)
*
*DIAGRAM
*FREE
IT 5,16DEC99,0,,17DEC99
IO 3
*FIX
*
KK  BD1
KM  RUNOFF FROM SOUTH OF FOXBORO PRKWY AND EAST OF PUTAH CANAL
BA 0.043
BF  -2.5       0       1
IN    30
PB  4.08
PI  0.01    0.01    0.01    0.01    0.01    0.01    0.01    0.01    0.01    0.01
PI  0.01   0.016   0.016   0.016   0.016   0.016   0.023   0.023   0.023   0.023
PI 0.033   0.045   0.065   0.190   0.045   0.033   0.023   0.023   0.023   0.016
PI 0.016   0.016   0.016   0.016   0.016    0.01    0.01    0.01    0.01    0.01
PI  0.01    0.01    0.01    0.01    0.01    0.01    0.01    0.01
LU  0.20    0.10    48.6
UK   385   0.002    0.20     100
RD   660  0.0012   0.015            CIRC       2       0
RD   820   0.002   0.015            CIRC     2.5       0      NO
*
*FREE
*
KK  BD4
KM  RUNOFF FROM NORTH OF FOXBORO PRKWY AND WEST OF RUBY DR
PB  4.08
BA  0.046
LU  0.20,0.05,51.2
UK  500,0.003,0.20,100
RD  700,0.003,0.015,,CIRC,1,0,NO
*
KK  C(BD1+4)
KM  COMBINED FLOW FOR SUBSHED BD 1 AND 4
HC  2
*
KK  R(BD1+4)
KM  ROUTE FLOWS DOWN RUBY DR TO OPAL WY
RD  1450,0.0025,0.015,,CIRC,3,0
*
KK  BD5
KM  RUNOFF FROM BWTN PUTAH CANAL AND RUBY DR SOUTH OF CELESTINE
PB  4.08
BA  0.055
LU  0.20,0.10,60.0
UK  910,0.005,0.20,100
RD  460,0.014,0.015,,CIRC,1.25,0
RD  570,0.003,0.015,,CIRC,2.25,0,NO
*
KK  BD6
KM  RUNOFF FROM ALONG YOUNGSDALE BTWN PUTAH CANAL AND RUBY DR
PB  4.08
BA  0.047
LU  0.20,0.05,54.5
UK  460,0.004,0.20,100
RD  525,0.0045,0.015,,CIRC,1.25,0
RD  800,0.0037,0.015,,CIRC,2.25,0,NO
*
KK  R(BD6)
KM  ROUTE RUNOFF FROM BD6 DOWN RUDY DR
RD  1020,0.0022,0.015,,CIRC,3.0,0
*
KK  BD8
KM  RUNOFF FROM SAPPHIRE CR AREA
PB  4.08
BA  0.022
LU  0.20,0.05,57.5
UK  700,0.0035,0.20,100
RD  245,0.0025,0.015,,CIRC,1.5,0,NO
*
KK  C(BD6+8)
KM  COMBINED FLOW FOR SUBSHED BD 6 AND 8
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```
HC  2
*
KK  R(BD6+8)
KM  ROUTE FLOWS RUBY DR
RD  315,0.0022,0.015,,CIRC,3,0
*
KK  C(RUBY)
KM  COMBINED RUNOFF AT RUDY DR AND OPAL WY
KM  AREA BTWN PUTAH CANAL AND RUBY DR
HC  3
*
KK  R(OPAL)
KM  ROUTE FLOWS DOWN OPAL WY TO NUT TREE RD
RD  800,0.0027,0.015,,CIRC,4,0
*
KK  BD2
KM  RUNOFF FROM EAST OF BD1 AND WEST OF NUT TREE RD
PB  4.08
BA  0.074
LU  0.20,0.05,40.0
UK  1050,0.005,0.20,100
RD  1600,0.0014,0.015,,CIRC,2.25,0
RD  1460,0.001,0.015,,CIRC,3,0,NO
*
KK  BD3
KM  RUNOFF NORTH OF FOXBORO PRKWY, BTWN RUDY DR AND NUT TREE RD
PB  4.08
BA  0.046
LU  0.20,0.05,40.0
UK  545,0.005,0.20,100
RD  500,0.001,0.015,,CIRC,1.5,0,NO
*
KK  C(BD2+3)
KM  COMBINED FLOW FOR SUBSHED BD 2 AND 3
HC  2
*
KK  R(BD2+3)
KM  ROUTE FLOWS DOWN MIRNOSA DR
RD  1570,0.001,0.015,,CIRC,3.5,0
*
KK  BD7
KM  RUNOFF SOUTH OF YOUNGSDALE - TOPAZ CR AND COPPER WY AREA
PB  4.08
BA  0.027
LU  0.20,0.05,50.0
UK  665,0.005,0.20,100
RD  690,0.0027,0.015,,CIRC,1.5,0,NO
*
KK  BD9
KM  RUNOFF FROM COPPER WY AND FUTURE SCHOOL SITE
PB  4.08
BA  0.021
LU  0.181,0.044,58.5
UK  200,0.005,0.50,100
RD  500,0.001,0.015,,CIRC,1.5,0,NO
*
KK  C(BD7+9)
KM  COMBINED FLOW FOR SUBSHED BD 7 AND 9
HC  2
*
KK  R(BD7+9)
KM  ROUTE FLOWS DOWN COPPER DR
RD  910,0.0025,0.015,,CIRC,3,0
*
KK  BD10
KM  RUNOFF FROM PARK AND NUT TREE ROAD
PB  4.08
BA  0.019
LU  0.253,0.051,26.1
UK  800,0.04,0.40,70
UK  1000,0.006,0.02,30
RD  1000,0.002,0.015,,CIRC,1.5,0,NO
*
KK  C(BD1-10)
KM  COMBINED FLOWS FROM THE FOXBORO MEADOWS WATERSHED
HC  4
*
KK  R(BD1-10)
KM  ROUTE DOWN BRAZELTON DRAIN
RD  1100,0.002,0.06,,TRAP,10,1
*
KK  BD11
KM  AREA EAST OF NUT TREE RD AND NORTH OF BRAZELTON DRAIN
PB  4.08
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```
BA  0.113
LU  0.40,0.07,2.0
UK  1300,0.0036,0.40,100
RD  1200,0.002,0.07,,TRAP,10,1,NO
*
KK  C(BD1-11)
KM  COMBINED FLOW AT VANDEN ROAD
HC  2
*
KK  R(BD1-11)
KM  ROUTE DOWN BRAZELTON DRAIN TO VANDEN ROAD
RD  1400,0.002,0.06,,TRAP,15,1
*
KK  BD12
KM  AREA BETWEEN NUT TREE RD AND VANDEN RD EXCLUDING BD11
PB  4.08
BA  0.301
LU  0.397,0.069,3.0
UK  1400,0.0035,0.40,30
UK  1250,0.0096,0.40,70
RD  1430,0.005,0.07,,TRAP,20,1,NO
*
KK  C(BD1-12)
KM  COMBINED FLOW AT VANDEN ROAD
KO  2
HC  2
*
KK  R(BD1-12)
KM  ROUTE DOWN BRAZELTON DRAIN TO LEISURE TOWN ROAD
RD  1900,0.002,0.06,,TRAP,20,1
*
KK  BD13
KM  AREA BTWN VANDEN AND LEISURE TOWN, NORTH OF BRAZELTON DRAIN
PB  4.08
BA  0.275
LU  0.394,0.069,3.9
UK  2870,0.0038,0.40,100
RD  930,0.003,0.07,,TRAP,20,1,NO
*
KK  C(BD1-13)
KM  COMBINED FLOW AT LEISURE TOWN ROAD
KO  2
HC  2
*
KK  BD14
KM  AREA NORTH OF BRAZELTON DRAIN AND EAST OF LTR
PB  4.08
BA  0.013
LU  0.327,0.058,24.7
UK  300,0.003,0.40,100
RD  1210,0.003,0.05,,TRAP,5,1,NO
*
KK  BD15
KM  AREA SOUTH OF BRAZELTON DRAIN AND WEST OF LTR
PB  4.08
BA  0.106
LU  0.389,0.068,5.4
UK  1350,0.0037,0.40,100
RD  450,0.003,0.06,,TRAP,10,5,NO
*
KK  C(BD1-15)
KM  COMBINE FLOW AT RAILROAD
HC  3
*
*   Includes diversion to Alamo Creek
*
KK  RRBSN
KM  NATURAL DETENTION STORAGE UPSTREAM OF RAILROAD
KM  FLOW CROSSES LEISURE TOWN RD AT ELEV. 87.4 FT
KO  1,2
RS  1,STOR,0,0
SV  0,0.09,0.33,1.15,2.64,5.41,9.98,12.89,19.76,65.00
SE  82,82.5,83,84,85,86,87,87.4,88,89
SQ  38.6,50.5,61.9,83.1,102.0,118.6,133.1,174.0,343,2930
*
KK  D(BD)
KM  DIVERSION OF FLOW TO ALAMO CREEK
DT  ALAMO
DI  0,174.0,343,2930
DQ  0,35.8,198,2775
*
KK  BD16
KM  AREA BTWN RAILROAD AND SID IRRIGATION CANAL
PB  4.08
```

```
BA  0.017
LU  0.40,0.070,2.0
UK  350,0.003,0.40,100
RD  2000,0.003,0.05,,TRAP,5,3,NO
*
KK  C(BD1-16)
KM  COMBINED FLOW AT SID IRRIGATION CANAL
HC  2
*
KK  R(BD1-16)
KM  ROUTE FLOWS DOWN NOONAN DRAIN
RD  1100,0.002,0.06,,TRAP,20,1.5
*
KK  BD17
KM  AREA BTWN NOONAN DRAIN AND SID CANAL
PB  4.08
BA  0.046
LU  0.40,0.070,2.0
UK  1800,0.003,0.40,100
RD  500,0.003,0.05,,TRAP,20,1,NO
*
KK  C(BD1-17)
KM  COMBINED FLOW AT STUDY LIMITS
HC  2
*
ZZ
```

D-2

Existing Conditions 100-Year HEC-1 Model

```
ID      VACAVILLE BRAZELTON DRAIN WATERSHED
*       EXISTING CONDITIONS SUBAREA HYDROLOGY
*       INCLUDES NATURAL DETENTION AREA AT LEISURE TOWN RD AND RAILROAD AS SINGLE BASIN
*       100-YEAR 24-HOUR PRECIPITATION
*       INITIAL UNIFORM LOSS RATE METHOD
*       MUSKINGUM-CUNGE
*       WEST YOST AND ASSOCIATES
*       SEPT 2004
*       FN = BD-100X.DAT
*
*       PRECIPITATION DATA BASED ON GOODRIDGE DATA FOR SOLANO COUNTY (SCWA HYDROLOGY MANUAL 1999)
*
*DIAGRAM
*FREE
IT 5,16DEC99,0,,17DEC99
IO 3
*FIX
*
KK  BD1
KM  RUNOFF FROM SOUTH OF FOXBORO PRKWY AND EAST OF PUTAH CANAL
BA 0.043
BF  -2.5       0       1
IN    30
PB  5.78
PI  0.01    0.01    0.01    0.01    0.01    0.01    0.01    0.01    0.01    0.01
PI  0.01    0.016   0.016   0.016   0.016   0.016   0.016   0.023   0.023   0.023
PI 0.033    0.045   0.065   0.190   0.045   0.033   0.023   0.023   0.023   0.016
PI 0.016    0.016   0.016   0.016   0.016   0.01    0.01    0.01    0.01    0.01
PI  0.01    0.01    0.01    0.01    0.01    0.01    0.01    0.01
LU  0.20    0.10    48.6
UK   385    0.002   0.20     100
RD   660   0.0012   0.015            CIRC       2       0
RD   820   0.002    0.015            CIRC     2.5       0      NO
*
*FREE
*
KK  BD4
KM  RUNOFF FROM NORTH OF FOXBORO PRKWY AND WEST OF RUBY DR
PB  5.78
BA  0.046
LU  0.20,0.05,51.2
UK  500,0.003,0.20,100
RD  700,0.003,0.015,,CIRC,1,0,NO
*
KK  C(BD1+4)
KM  COMBINED FLOW FOR SUBSHED BD 1 AND 4
HC  2
*
KK  R(BD1+4)
KM  ROUTE FLOWS DOWN RUBY DR TO OPAL WY
RD  1450,0.0025,0.015,,CIRC,3,0
*
KK  BD5
KM  RUNOFF FROM BWTN PUTAH CANAL AND RUBY DR SOUTH OF CELESTINE
PB  5.78
BA  0.055
LU  0.20,0.10,60.0
UK  910,0.005,0.20,100
RD  460,0.014,0.015,,CIRC,1.25,0
RD  570,0.003,0.015,,CIRC,2.25,0,NO
*
KK  BD6
KM  RUNOFF FROM ALONG YOUNGSDALE BTWN PUTAH CANAL AND RUBY DR
PB  5.78
BA  0.047
LU  0.20,0.05,54.5
UK  460,0.004,0.20,100
RD  525,0.0045,0.015,,CIRC,1.25,0
RD  800,0.0037,0.015,,CIRC,2.25,0,NO
*
KK  R(BD6)
KM  ROUTE RUNOFF FROM BD6 DOWN RUDY DR
RD  1020,0.0022,0.015,,CIRC,3.0,0
*
KK  BD8
KM  RUNOFF FROM SAPPHIRE CR AREA
PB  5.78
BA  0.022
LU  0.20,0.05,57.5
UK  700,0.0035,0.20,100
RD  245,0.0025,0.015,,CIRC,1.5,0,NO
*
KK  C(BD6+8)
KM  COMBINED FLOW FOR SUBSHED BD 6 AND 8
```

```
HC  2
*
KK  R(BD6+8)
KM  ROUTE FLOWS RUBY DR
RD  315,0.0022,0.015,,CIRC,3,0
*
KK  C(RUBY)
KM  COMBINED RUNOFF AT RUDY DR AND OPAL WY
KM  AREA BTWN PUTAH CANAL AND RUBY DR
HC  3
*
KK  R(OPAL)
KM  ROUTE FLOWS DOWN OPAL WY TO NUT TREE RD
RD  800,0.0027,0.015,,CIRC,4,0
*
KK  BD2
KM  RUNOFF FROM EAST OF BD1 AND WEST OF NUT TREE RD
PB  5.78
BA  0.074
LU  0.20,0.05,40.0
UK  1050,0.005,0.20,100
RD  1600,0.0014,0.015,,CIRC,2.25,0
RD  1460,0.001,0.015,,CIRC,3,0,NO
*
KK  BD3
KM  RUNOFF NORTH OF FOXBORO PRKWY, BTWN RUDY DR AND NUT TREE RD
PB  5.78
BA  0.046
LU  0.20,0.05,40.0
UK  545,0.005,0.20,100
RD  500,0.001,0.015,,CIRC,1.5,0,NO
*
KK  C(BD2+3)
KM  COMBINED FLOW FOR SUBSHED BD 2 AND 3
HC  2
*
KK  R(BD2+3)
KM  ROUTE FLOWS DOWN MIRNOSA DR
RD  1570,0.001,0.015,,CIRC,3.5,0
*
KK  BD7
KM  RUNOFF SOUTH OF YOUNGSDALE - TOPAZ CR AND COPPER WY AREA
PB  5.78
BA  0.027
LU  0.20,0.05,50.0
UK  665,0.005,0.20,100
RD  690,0.0027,0.015,,CIRC,1.5,0,NO
*
KK  BD9
KM  RUNOFF FROM COPPER WY AND FUTURE SCHOOL SITE
PB  5.78
BA  0.021
LU  0.181,0.044,58.5
UK  200,0.005,0.50,100
RD  500,0.001,0.015,,CIRC,1.5,0,NO
*
KK  C(BD7+9)
KM  COMBINED FLOW FOR SUBSHED BD 7 AND 9
HC  2
*
KK  R(BD7+9)
KM  ROUTE FLOWS DOWN COPPER DR
RD  910,0.0025,0.015,,CIRC,3,0
*
KK  BD10
KM  RUNOFF FROM PARK AND NUT TREE ROAD
PB  5.78
BA  0.019
LU  0.253,0.051,26.1
UK  800,0.04,0.40,70
UK  1000,0.006,0.02,30
RD  1000,0.002,0.015,,CIRC,1.5,0,NO
*
KK  C(BD1-10)
KM  COMBINED FLOWS FROM THE FOXBORO MEADOWS WATERSHED
HC  4
*
KK  R(BD1-10)
KM  ROUTE DOWN BRAZELTON DRAIN
RD  1100,0.002,0.06,,TRAP,10,1
*
KK  BD11
KM  AREA EAST OF NUT TREE RD AND NORTH OF BRAZELTON DRAIN
PB  5.78
```

```
BA  0.113
LU  0.40,0.07,2.0
UK  1300,0.0036,0.40,100
RD  1200,0.002,0.07,,TRAP,10,1,NO
*
KK  C(BD1-11)
KM  COMBINED FLOW AT VANDEN ROAD
HC  2
*
KK  R(BD1-11)
KM  ROUTE DOWN BRAZELTON DRAIN TO VANDEN ROAD
RD  1400,0.002,0.06,,TRAP,15,1
*
KK  BD12
KM  AREA BETWEEN NUT TREE RD AND VANDEN RD EXCLUDING BD11
PB  5.78
BA  0.301
LU  0.397,0.069,3.0
UK  1400,0.0035,0.40,30
UK  1250,0.0096,0.40,70
RD  1430,0.005,0.07,,TRAP,20,1,NO
*
KK  C(BD1-12)
KM  COMBINED FLOW AT VANDEN ROAD
KO  2
HC  2
*
KK  R(BD1-12)
KM  ROUTE DOWN BRAZELTON DRAIN TO LEISURE TOWN ROAD
RD  1900,0.002,0.06,,TRAP,20,1
*
KK  BD13
KM  AREA BTWN VANDEN AND LEISURE TOWN, NORTH OF BRAZELTON DRAIN
PB  5.78
BA  0.275
LU  0.394,0.069,3.9
UK  2870,0.0038,0.40,100
RD  930,0.003,0.07,,TRAP,20,1,NO
*
KK  C(BD1-13)
KM  COMBINED FLOW AT LEISURE TOWN ROAD
KO  2
HC  2
*
KK  BD14
KM  AREA NORTH OF BRAZELTON DRAIN AND EAST OF LTR
PB  5.78
BA  0.013
LU  0.327,0.058,24.7
UK  300,0.003,0.40,100
RD  1210,0.003,0.05,,TRAP,5,1,NO
*
KK  BD15
KM  AREA SOUTH OF BRAZELTON DRAIN AND WEST OF LTR
PB  5.78
BA  0.106
LU  0.389,0.068,5.4
UK  1350,0.0037,0.40,100
RD  450,0.003,0.06,,TRAP,10,5,NO
*
KK  C(BD1-15)
KM  COMBINE FLOW AT RAILROAD
HC  3
*
KK  RRBSN
KM  NATURAL DETENTION STORAGE UPSTREAM OF RAILROAD
KM  FLOW CROSSES LEISURE TOWN RD AT ELEV. 87.4 FT
KM  OVERFLOW CROSSES DIVERTS TO ALAMO CRK AT ELEV. 87.5 FT
KO  1,2
RS  1,STOR,0,0
SV  0,0.09,0.33,1.15,2.64,5.41,9.98,12.89,13.83,19.76,65.00,162.20
SE  82,82.5,83,84,85,86,87,87.4,87.5,88,89,90
SQ  38.6,50.5,61.9,83.1,102.0,118.6,133.1,173.5,174,343,2930,17387
*
KK  D(BD)
KM  DIVERSION OF FLOW TO ALAMO CREEK
DT  ALAMO
DI  0,174.0,343,2930,17387
DQ  0,35.8,198,2775,17224
*
KK  BD16
KM  AREA BTWN RAILROAD AND SID IRRIGATION CANAL
PB  5.78
BA  0.017
```

```
LU  0.40,0.070,2.0
UK  350,0.003,0.40,100
RD  2000,0.003,0.05,,TRAP,5,3,NO
*
KK  C(BD1-16)
KM  COMBINED FLOW AT SID IRRIGATION CANAL
HC  2
*
KK  R(BD1-16)
KM  ROUTE FLOWS DOWN NOONAN DRAIN
RD  1100,0.002,0.06,,TRAP,20,1.5
*
KK  BD17
KM  AREA BTWN NOONAN DRAIN AND SID CANAL
PB  5.78
BA  0.046
LU  0.40,0.070,2.0
UK  1800,0.003,0.40,100
RD  500,0.003,0.05,,TRAP,20,1,NO
*
KK  C(BD1-17)
KM  COMBINED FLOW AT STUDY LIMITS
HC  2
*
ZZ
```

D-3

Post-Development Conditions
10-Year HEC-1 Model

```
ID      VACAVILLE BRAZELTON DRAIN WATERSHED
*       PROPOSED CONDITIONS SUBAREA HYDROLOGY
*       DEVELOPMENT OF THE ENTIRE SOUTHEAST VANDEN AREA
*       INCLUDES PROPOSED DETENTION BTWN RR & LTR, WITH NO PUMPING
*       10-YEAR 24-HOUR PRECIPITATION
*       INITIAL UNIFORM LOSS RATE METHOD
*       MUSKINGUM-CUNGE
*       WEST YOST AND ASSOCIATES
*       JULY 2005
*       FN = BD-10F9.DAT
*
*       PRECIPITATION DATA BASED ON GOODRIDGE DATA FOR SOLANO COUNTY (SCWA HYDROLOGY MANUAL 1999)
*
*DIAGRAM
*FREE
IT 5,16DEC99,0,,17DEC99
IO 3
*FIX
*
KK  BD1
KM  RUNOFF FROM SOUTH OF FOXBORO PRKWY AND EAST OF PUTAH CANAL
BA 0.043
BF  -2.5       0       1
IN    30
PB  4.08
PI  0.01    0.01    0.01    0.01    0.01    0.01    0.01    0.01    0.01    0.01
PI  0.01   0.016   0.016   0.016   0.016   0.016   0.016   0.023   0.023   0.023
PI 0.033   0.045   0.065   0.190   0.045   0.033   0.023   0.023   0.023   0.016
PI 0.016   0.016   0.016   0.016   0.016    0.01    0.01    0.01    0.01    0.01
PI  0.01    0.01    0.01    0.01    0.01    0.01    0.01    0.01
LU  0.20    0.10    48.6
UK   385   0.002    0.20     100
RD   660  0.0012   0.015            CIRC       2       0
RD   820   0.002   0.015            CIRC     2.5       0      NO
*
*FREE
*
KK  BD4
KM  RUNOFF FROM NORTH OF FOXBORO PRKWY AND WEST OF RUBY DR
PB  4.08
BA  0.046
LU  0.20,0.05,51.2
UK  500,0.003,0.20,100
RD  700,0.003,0.015,,CIRC,1,0,NO
*
KK  C(BD1+4)
KM  COMBINED FLOW FOR SUBSHED BD 1 AND 4
HC  2
*
KK  R(BD1+4)
KM  ROUTE FLOWS DOWN RUBY DR TO OPAL WY
RD  1450,0.0025,0.015,,CIRC,3,0
*
KK  BD5
KM  RUNOFF FROM BWTN PUTAH CANAL AND RUBY DR SOUTH OF CELESTINE
PB  4.08
BA  0.055
LU  0.20,0.10,60.0
UK  910,0.005,0.20,100
RD  460,0.014,0.015,,CIRC,1.25,0
RD  570,0.003,0.015,,CIRC,2.25,0,NO
*
KK  BD6
KM  RUNOFF FROM ALONG YOUNGSDALE BTWN PUTAH CANAL AND RUBY DR
PB  4.08
BA  0.047
LU  0.20,0.05,54.5
UK  460,0.004,0.20,100
RD  525,0.0045,0.015,,CIRC,1.25,0
RD  800,0.0037,0.015,,CIRC,2.25,0,NO
*
KK  R(BD6)
KM  ROUTE RUNOFF FROM BD6 DOWN RUDY DR
RD  1020,0.0022,0.015,,CIRC,3.0,0
*
KK  BD8
KM  RUNOFF FROM SAPPHIRE CR AREA
PB  4.08
BA  0.022
LU  0.20,0.05,57.5
UK  700,0.0035,0.20,100
RD  245,0.0025,0.015,,CIRC,1.5,0,NO
*
KK  C(BD6+8)
```

```
KM  COMBINED FLOW FOR SUBSHED BD 6 AND 8
HC  2
*
KK  R(BD6+8)
KM  ROUTE FLOWS RUBY DR
RD  315,0.0022,0.015,,CIRC,3,0
*
KK  C(RUBY)
KM  COMBINED RUNOFF AT RUDY DR AND OPAL WY
KM  AREA BTWN PUTAH CANAL AND RUBY DR
HC  3
*
KK  R(OPAL)
KM  ROUTE FLOWS DOWN OPAL WY TO NUT TREE RD
RD  800,0.0027,0.015,,CIRC,4,0
*
KK  BD2
KM  RUNOFF FROM EAST OF BD1 AND WEST OF NUT TREE RD
PB  4.08
BA  0.074
LU  0.20,0.05,40.0
UK  1050,0.005,0.20,100
RD  1600,0.0014,0.015,,CIRC,2.25,0
RD  1460,0.001,0.015,,CIRC,3,0,NO
*
KK  BD3
KM  RUNOFF NORTH OF FOXBORO PRKWY, BTWN RUDY DR AND NUT TREE RD
PB  4.08
BA  0.046
LU  0.20,0.05,40.0
UK  545,0.005,0.20,100
RD  500,0.001,0.015,,CIRC,1.5,0,NO
*
KK  C(BD2+3)
KM  COMBINED FLOW FOR SUBSHED BD 2 AND 3
HC  2
*
KK  R(BD2+3)
KM  ROUTE FLOWS DOWN MIRNOSA DR
RD  1570,0.001,0.015,,CIRC,3.5,0
*
KK  BD7
KM  RUNOFF SOUTH OF YOUNGSDALE - TOPAZ CR AND COPPER WY AREA
PB  4.08
BA  0.027
LU  0.20,0.05,50.0
UK  665,0.005,0.20,100
RD  690,0.0027,0.015,,CIRC,1.5,0,NO
*
KK  BD9
KM  RUNOFF FROM COPPER WY AND FUTURE SCHOOL SITE
PB  4.08
BA  0.021
LU  0.181,0.044,58.5
UK  200,0.005,0.50,100
RD  500,0.001,0.015,,CIRC,1.5,0,NO
*
KK  C(BD7+9)
KM  COMBINED FLOW FOR SUBSHED BD 7 AND 9
HC  2
*
KK  R(BD7+9)
KM  ROUTE FLOWS DOWN COPPER DR
RD  910,0.0025,0.015,,CIRC,3,0
*
KK  BD10
KM  RUNOFF FROM PARK AND NUT TREE ROAD
PB  4.08
BA  0.019
LU  0.253,0.051,26.1
UK  800,0.04,0.40,70
UK  1000,0.006,0.02,30
RD  1000,0.002,0.015,,CIRC,1.5,0,NO
*
KK  C(BD1-10)
KM  COMBINED FLOWS FROM THE FOXBORO MEADOWS WATERSHED
HC  4
*
KK  R(BD1-10)
KM  ROUTE DOWN BRAZELTON DRAIN PIPELINE
RD  410,0.0020,0.015,,CIRC,8
*
KK  BD11
KM  SOUTHTOWN DEVELOPMENT AREA - PORTION OF PHASE 1
```

```
KM  EAST OF NUT TREE RD AND NORTH OF BRAZELTON DRAIN
PB  4.08
BA  0.046
LU  0.20,0.05,50.0
UK  470,0.0035,0.20,100
RD  790,0.0025,0.015,,CIRC,1.5,,NO
*
KK  C(BD1-11)
KM  COMBINED FLOWS IN BRAZELTON DRAIN PIPELINE
HC  2
*
KK  R(BD1-11)
KM  ROUTE DOWN BRAZELTON DRAIN PIPELINE
RD  1820,0.002,0.015,,CIRC,8
*
KK  BD12A
KM  SOUTHTOWN DEVELOPMENT AREA - PHASE 1
KM  AREA WEST OF VANDEN RD AND NORTH OF BRAZELTON DRAIN
PB  4.08
BA  0.142
LU  0.224,0.052,40.6
UK  470,0.0015,0.20,100
RD  2575,0.002,0.015,,CIRC,3.5
RD  1100,0.002,0.015,,CIRC,3.5,,NO
*
KK  BD12
KM  DEVELOPED AREA SOUTH OF BRAZELTON DRAIN BTWN NUT TREE & VANDEN RD
PB  4.08
BA  0.228
LU  0.200,0.047,51.1
UK  470,0.0015,0.20,100
RD  2000,0.002,0.015,,CIRC,2.5
RD  2000,0.002,0.015,,CIRC,4.0,,NO
*
KK  BD15
KM  AREA SOUTH OF BRAZELTON DRAIN AND BWTN VANDEN RD & LTR
PB  4.08
BA  0.108
LU  0.200,0.050,60.0
UK  470,0.0015,0.20,100
RD  1500,0.0025,0.015,,CRIC,2.0,,NO
*
KK  C(BD1-12)
KM  COMBINED FLOW AT VANDEN ROAD
HC  4
*
KK  R(BD1-12)
KM  ROUTE DOWN BRAZELTON DRAIN PIPELINE
RD  1400,0.0025,0.015,,CIRC,9.0
*
KK  BD13B
KM  SOUTHTOWN DEVELOPMENT AREA
KM  AREA ADJACENT TO VANDEN BTWN ALAMO CREEK AND BRAZELTON DRAIN
PB  4.08
BA  0.157
LU  0.216,0.047,50.3
UK  470,0.0015,0.20,100
RD  1800,0.002,0.015,,CIRC,2.5
RD  1100,0.002,0.015,,CIRC,3.5,,NO
*
KK  C(BD1-13B)
KM  COMBINED FLOW
HC  2
*
KK  R(BD1-13B)
KM  ROUTE FLOWS DOWN BRAZELTON DRAIN PIPELINE
RD  830,0.0025,0.015,,CIRC,9.0
*
KK  BD13
KM  DEVELOPED AREA BTWN VANDEN AND LEISURE TOWN, NORTH OF BRAZELTON DRAIN
PB  4.08
BA  0.056
LU  0.200,0.050,50.0
UK  470,0.0015,0.20,100
RD  790,0.0025,0.015,,CIRC,1.5,,NO
*
KK  C(BD1-13)
KM  COMBINED FLOW IN THE BRAZELTON DRAIN PIPELINE
HC  2
*
KK  R(BD1-13)
KM  ROUTE FLOWS FROM BRAZELTON DRAIN PIPELINE TO BASIN
RD  110,0.0025,0.015,,CIRC,9
*
```

```
KK  BD13A
KM  SOUTHTOWN DEVELOPMENT AREA - PHASE 1A
KM  AREA EAST OF BD13B, WEST LEISURE TOWN ROAD
PB  4.08
BA  0.094
LU  0.202,0.047,57.4
UK  400,0.0015,0.20,100
RD  1600,0.004,0.015,,CIRC,2.5
RD  1400,0.001,0.015,,CIRC,4.5,,NO
*
KK  C(LTR)
KM  COMBINED FLOW AT LEISURE TOWN ROAD
HC  2
*
KK  BD14
KM  AREA BTWN LTR AND RAIL, INLCUDING THE DETENTION BASIN
PB  4.08
BA  0.091
LU  0.390,0.047,33.2
UK  300,0.0015,0.40,100
RD  1210,0.003,0.05,,TRAP,5,1,NO
*
KK  C(BD1-15)
KM  COMBINED FLOWS FROM SOUTHEAST VANDEN AREA INTO DETENTION BASIN
HC  2
*
KK  STWNBSN
KM  PROPOSED SOUTHEAST VANDEN DETENTION BASIN
KM  BASIN LOCATION BWTN LTR & RAILROAD
KO  1,2
RS  1,STOR,0,0
SV  0,0.12,1.2,4.0,9.5,18.6,41.3,67.1,88.6
SE  78,79,80,81,82,83,85,87,88.5
SQ  0,11.3,22.7,34.0,45.4,101.4,213.5,325.6,409.6
*
KK  BD16
KM  AREA BTWN RAILROAD AND SID IRRIGATION CANAL
PB  4.08
BA  0.017
LU  0.40,0.070,2.0
UK  350,0.003,0.40,100
RD  2000,0.003,0.05,,TRAP,5,3,NO
*
KK  C(BD1-16)
KM  COMBINED FLOW AT SID IRRIGATION CANAL
HC  2
*
KK  R(BD1-16)
KM  ROUTE FLOWS DOWN NOONAN DRAIN
RD  1100,0.002,0.06,,TRAP,15,1.5
*
KK  BD17
KM  AREA BTWN NOONAN DRAIN AND SID CANAL
PB  4.08
BA  0.046
LU  0.40,0.070,2.0
UK  1800,0.003,0.40,100
RD  500,0.003,0.05,,TRAP,20,1,NO
*
KK  C(BD1-17)
KM  COMBINED FLOW AT STUDY LIMITS
HC  2
*
ZZ
```

D-4

Post-Development Conditions
100-Year HEC-1 Model

```
ID      VACAVILLE BRAZELTON DRAIN WATERSHED
*       PROPOSED CONDITIONS SUBAREA HYDROLOGY
*       DEVELOPMENT OF THE ENTIRE SOUTHEAST VANDEN AREA
*       INCLUDES PROPOSED DETENTION BTWN RR & LTR, WITH NO PUMPING
*       100-YEAR 24-HOUR PRECIPITATION
*       INITIAL UNIFORM LOSS RATE METHOD
*       MUSKINGUM-CUNGE
*       WEST YOST AND ASSOCIATES
*       JULY 2005
*       FN = BD-100F9.DAT
*
*       PRECIPITATION DATA BASED ON GOODRIDGE DATA FOR SOLANO COUNTY (SCWA HYDROLOGY MANUAL 1999)
*
*DIAGRAM
*FREE
IT 5,16DEC99,0,,17DEC99
IO 3
*FIX
*
KK  BD1
KM  RUNOFF FROM SOUTH OF FOXBORO PRKWY AND EAST OF PUTAH CANAL
BA 0.043
BF  -2.5       0       1
IN    30
PB  5.78
PI  0.01    0.01    0.01    0.01    0.01    0.01    0.01    0.01    0.01    0.01
PI  0.01   0.016   0.016   0.016   0.016   0.016   0.016   0.023   0.023   0.023
PI 0.033   0.045   0.065   0.190   0.045   0.033   0.023   0.023   0.023   0.016
PI 0.016   0.016   0.016   0.016   0.016    0.01    0.01    0.01    0.01    0.01
PI  0.01    0.01    0.01    0.01    0.01    0.01    0.01    0.01
LU  0.20    0.10    48.6
UK   385   0.002    0.20     100
RD   660  0.0012   0.015            CIRC       2       0
RD   820   0.002   0.015            CIRC     2.5       0      NO
*
*FREE
*
KK  BD4
KM  RUNOFF FROM NORTH OF FOXBORO PRKWY AND WEST OF RUBY DR
PB  5.78
BA  0.046
LU  0.20,0.05,51.2
UK  500,0.003,0.20,100
RD  700,0.003,0.015,,CIRC,1,0,NO
*
KK  C(BD1+4)
KM  COMBINED FLOW FOR SUBSHED BD 1 AND 4
HC  2
*
KK  R(BD1+4)
KM  ROUTE FLOWS DOWN RUBY DR TO OPAL WY
RD  1450,0.0025,0.015,,CIRC,3,0
*
KK  BD5
KM  RUNOFF FROM BWTN PUTAH CANAL AND RUBY DR SOUTH OF CELESTINE
PB  5.78
BA  0.055
LU  0.20,0.10,60.0
UK  910,0.005,0.20,100
RD  460,0.014,0.015,,CIRC,1.25,0
RD  570,0.003,0.015,,CIRC,2.25,0,NO
*
KK  BD6
KM  RUNOFF FROM ALONG YOUNGSDALE BTWN PUTAH CANAL AND RUBY DR
PB  5.78
BA  0.047
LU  0.20,0.05,54.5
UK  460,0.004,0.20,100
RD  525,0.0045,0.015,,CIRC,1.25,0
RD  800,0.0037,0.015,,CIRC,2.25,0,NO
*
KK  R(BD6)
KM  ROUTE RUNOFF FROM BD6 DOWN RUDY DR
RD  1020,0.0022,0.015,,CIRC,3.0,0
*
KK  BD8
KM  RUNOFF FROM SAPPHIRE CR AREA
PB  5.78
BA  0.022
LU  0.20,0.05,57.5
UK  700,0.0035,0.20,100
RD  245,0.0025,0.015,,CIRC,1.5,0,NO
*
KK  C(BD6+8)
```

```
KM  COMBINED FLOW FOR SUBSHED BD 6 AND 8
HC  2
*
KK  R(BD6+8)
KM  ROUTE FLOWS RUBY DR
RD  315,0.0022,0.015,,CIRC,3,0
*
KK  C(RUBY)
KM  COMBINED RUNOFF AT RUDY DR AND OPAL WY
KM  AREA BTWN PUTAH CANAL AND RUBY DR
HC  3
*
KK  R(OPAL)
KM  ROUTE FLOWS DOWN OPAL WY TO NUT TREE RD
RD  800,0.0027,0.015,,CIRC,4,0
*
KK  BD2
KM  RUNOFF FROM EAST OF BD1 AND WEST OF NUT TREE RD
PB  5.78
BA  0.074
LU  0.20,0.05,40.0
UK  1050,0.005,0.20,100
RD  1600,0.0014,0.015,,CIRC,2.25,0
RD  1460,0.001,0.015,,CIRC,3,0,NO
*
KK  BD3
KM  RUNOFF NORTH OF FOXBORO PRKWY, BTWN RUDY DR AND NUT TREE RD
PB  5.78
BA  0.046
LU  0.20,0.05,40.0
UK  545,0.005,0.20,100
RD  500,0.001,0.015,,CIRC,1.5,0,NO
*
KK  C(BD2+3)
KM  COMBINED FLOW FOR SUBSHED BD 2 AND 3
HC  2
*
KK  R(BD2+3)
KM  ROUTE FLOWS DOWN MIRNOSA DR
RD  1570,0.001,0.015,,CIRC,3.5,0
*
KK  BD7
KM  RUNOFF SOUTH OF YOUNGSDALE - TOPAZ CR AND COPPER WY AREA
PB  5.78
BA  0.027
LU  0.20,0.05,50.0
UK  665,0.005,0.20,100
RD  690,0.0027,0.015,,CIRC,1.5,0,NO
*
KK  BD9
KM  RUNOFF FROM COPPER WY AND FUTURE SCHOOL SITE
PB  5.78
BA  0.021
LU  0.181,0.044,58.5
UK  200,0.005,0.50,100
RD  500,0.001,0.015,,CIRC,1.5,0,NO
*
KK  C(BD7+9)
KM  COMBINED FLOW FOR SUBSHED BD 7 AND 9
HC  2
*
KK  R(BD7+9)
KM  ROUTE FLOWS DOWN COPPER DR
RD  910,0.0025,0.015,,CIRC,3,0
*
KK  BD10
KM  RUNOFF FROM PARK AND NUT TREE ROAD
PB  5.78
BA  0.019
LU  0.253,0.051,26.1
UK  800,0.04,0.40,70
UK  1000,0.006,0.02,30
RD  1000,0.002,0.015,,CIRC,1.5,0,NO
*
KK  C(BD1-10)
KM  COMBINED FLOWS FROM THE FOXBORO MEADOWS WATERSHED
HC  4
*
KK  R(BD1-10)
KM  ROUTE DOWN BRAZELTON DRAIN PIPELINE
RD  410,0.0020,0.015,,CIRC,8
*
KK  BD11
KM  SOUTHTOWN DEVELOPMENT AREA - PORTION OF PHASE 1
```

```
KM  EAST OF NUT TREE RD AND NORTH OF BRAZELTON DRAIN
PB  5.78
BA  0.046
LU  0.20,0.05,50.0
UK  470,0.0035,0.20,100
RD  790,0.0025,0.015,,CIRC,1.5,,NO
*
KK  C(BD1-11)
KM  COMBINED FLOWS IN BRAZELTON DRAIN PIPELINE
HC  2
*
KK  R(BD1-11)
KM  ROUTE DOWN BRAZELTON DRAIN PIPELINE
RD  1820,0.002,0.015,,CIRC,8
*
KK  BD12A
KM  SOUTHTOWN DEVELOPMENT AREA - PHASE 1
KM  AREA WEST OF VANDEN RD AND NORTH OF BRAZELTON DRAIN
PB  5.78
BA  0.142
LU  0.224,0.052,40.6
UK  470,0.0015,0.20,100
RD  2575,0.002,0.015,,CIRC,3.5
RD  1100,0.002,0.015,,CIRC,3.5,,NO
*
KK  BD12
KM  DEVELOPED AREA SOUTH OF BRAZELTON DRAIN BTWN NUT TREE & VANDEN RD
PB  5.78
BA  0.228
LU  0.200,0.047,51.1
UK  470,0.0015,0.20,100
RD  2000,0.002,0.015,,CIRC,2.5
RD  2000,0.002,0.015,,CIRC,4.0,,NO
*
KK  BD15
KM  AREA SOUTH OF BRAZELTON DRAIN AND BWTN VANDEN RD & LTR
PB  5.78
BA  0.108
LU  0.200,0.050,60.0
UK  470,0.0015,0.20,100
RD  1500,0.0025,0.015,,CRIC,2.0,,NO
*
KK  C(BD1-12)
KM  COMBINED FLOW AT VANDEN ROAD
HC  4
*
KK  R(BD1-12)
KM  ROUTE DOWN BRAZELTON DRAIN PIPELINE
RD  1400,0.0025,0.015,,CIRC,9.0
*
KK  BD13B
KM  SOUTHTOWN DEVELOPMENT AREA
KM  AREA ADJACENT TO VANDEN BTWN ALAMO CREEK AND BRAZELTON DRAIN
PB  5.78
BA  0.157
LU  0.216,0.047,50.3
UK  470,0.0015,0.20,100
RD  1800,0.002,0.015,,CIRC,2.5
RD  1100,0.002,0.015,,CIRC,3.5,,NO
*
KK  C(BD1-13B)
KM  COMBINED FLOW
HC  2
*
KK  R(BD1-13B)
KM  ROUTE FLOWS DOWN BRAZELTON DRAIN PIPELINE
RD  830,0.0025,0.015,,CIRC,9.0
*
KK  BD13
KM  DEVELOPED AREA BTWN VANDEN AND LEISURE TOWN, NORTH OF BRAZELTON DRAIN
PB  5.78
BA  0.056
LU  0.200,0.050,50.0
UK  470,0.0015,0.20,100
RD  790,0.0025,0.015,,CIRC,1.5,,NO
*
KK  C(BD1-13)
KM  COMBINED FLOW IN THE BRAZELTON DRAIN PIPELINE
HC  2
*
KK  R(BD1-13)
KM  ROUTE FLOWS FROM BRAZELTON DRAIN PIPELINE TO BASIN
RD  110,0.0025,0.015,,CIRC,9
*
```

```
KK  BD13A
KM  SOUTHTOWN DEVELOPMENT AREA - PHASE 1A
KM  AREA EAST OF BD13B, WEST LEISURE TOWN ROAD
PB  5.78
BA  0.094
LU  0.202,0.047,57.4
UK  400,0.0015,0.20,100
RD  1600,0.004,0.015,,CIRC,2.5
RD  1400,0.001,0.015,,CIRC,4.5,,NO
*
KK  C(LTR)
KM  COMBINED FLOW AT LEISURE TOWN ROAD
HC  2
*
KK  BD14
KM  AREA BTWN LTR AND RAIL, INLCUDING THE DETENTION BASIN
PB  5.78
BA  0.091
LU  0.390,0.047,33.2
UK  300,0.0015,0.40,100
RD  1210,0.003,0.05,,TRAP,5,1,NO
*
KK  C(BD1-15)
KM  COMBINED FLOWS FROM SOUTHEAST VANDEN AREA INTO DETENTION BASIN
HC  2
*
KK  STWNBSN
KM  PROPOSED SOUTHEAST VANDEN DETENTION BASIN
KM  BASIN LOCATION BWTN LTR & RAILROAD
KO  1,2
RS  1,STOR,0,0
SV  0,0.12,1.2,4.0,9.5,18.6,41.3,67.1,88.6,96.1,112.0
SE  78,79,80,81,82,83,85,87,88.5,89,90
SQ  0,11.3,22.7,34.0,45.4,101.4,213.5,325.6,409.6,480.1,714.1
*
KK  NOONAN
KM  DIVERSION FOR OVERFLOW FROM DETENTION BASIN TO ALAMO CREEK
DT  ALAMO
DI  0,409.6,480.1,714.1
DQ  0,0,42.4,220.5
*
KK  BD16
KM  AREA BTWN RAILROAD AND SID IRRIGATION CANAL
PB  5.78
BA  0.017
LU  0.40,0.070,2.0
UK  350,0.003,0.40,100
RD  2000,0.003,0.05,,TRAP,5,3,NO
*
KK  C(BD1-16)
KM  COMBINED FLOW AT SID IRRIGATION CANAL
HC  2
*
KK  R(BD1-16)
KM  ROUTE FLOWS DOWN NOONAN DRAIN
RD  1100,0.002,0.06,,TRAP,15,1.5
*
KK  BD17
KM  AREA BTWN NOONAN DRAIN AND SID CANAL
PB  5.78
BA  0.046
LU  0.40,0.070,2.0
UK  1800,0.003,0.40,100
RD  500,0.003,0.05,,TRAP,20,1,NO
*
KK  C(BD1-17)
KM  COMBINED FLOW AT STUDY LIMITS
HC  2
*
ZZ
```

APPENDIX E

HEC-1 Summary Output Files

E-1

Existing Conditions 10-Year HEC-1 Summary Results

```
1****************************************                                    ******************
 *                                      *                                    *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1)  *                                    *   U.S. ARMY COR
 *              JUN   1998              *                                    *   HYDROLOGIC EN
 *           VERSION 4.1                *                                    *         609 SEC
 *                                      *                                    *      DAVIS, CAL
 *  RUN DATE   08JUL05  TIME  16:20:02  *                                    *          (916)
 *                                      *                                    *
 ****************************************                                    ******************


                                                X     X  XXXXXXX   XXXXX           X
                                                X     X  X        X     X         XX
                                                X     X  X        X                X
                                                XXXXXXX  XXXX     X        XXXXX   X
                                                X     X  X        X                X
                                                X     X  X        X     X          X
                                                X     X  XXXXXXX   XXXXX         XXX


          THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HE

          THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE I
          THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRA
          NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUE
          DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL   LOSS RATE:GREEN AND AMPT INFILTRATION
          KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM


              SCHEMATIC DIAGRAM OF STREAM NETWORK
INPUT
 LINE      (V) ROUTING          (--->) DIVERSION OR PUMP FLOW

  NO.      (.) CONNECTOR        (<---) RETURN OF DIVERTED OR PUMPED FLOW

    4        BD1
                .
                .
   19           .         BD4
                .           .
                .           .
   26    C(BD1+4)............
                V
                V
   29    R(BD1+4)
                .
                .
   32           .         BD5
                .           .
                .           .
   40           .           .         BD6
                .           .           V
                .           .           V
   48           .           .      R(BD6)
                .           .           .
                .           .           .
   51           .           .           .         BD8
                .           .           .           .
                .           .           .           .
   58           .           .    C(BD6+8)............
                .           .           V
                .           .           V
   61           .           .    R(BD6+8)
                .           .           .
                .           .           .
   64     C(RUBY)......................
                V
                V
   68     R(OPAL)
                .
                .
   71           .         BD2
                .           .
                .           .
   79           .           .         BD3
                .           .           .
```

```
                .          .          .
  86            .    C(BD2+3)............
                .          V
                .          V
  89            .    R(BD2+3)
                .          .
                .          .
  92            .          .        BD7
                .          .          .
                .          .          .
  99            .          .          .        BD9
                .          .          .          .
                .          .          .          .
 106            .          .    C(BD7+9)............
                .          .          V
                .          .          V
 109            .          .    R(BD7+9)
                .          .          .
                .          .          .
 112            .          .          .       BD10
                .          .          .          .
                .          .          .          .
 120    C(BD1-10.....................................
               V
               V
 123    R(BD1-10
               .
               .
 126           .        BD11
               .           .
               .           .
 133    C(BD1-11............
               V
               V
 136    R(BD1-11
               .
               .
 139           .        BD12
               .           .
               .           .
 147    C(BD1-12............
               V
               V
 151    R(BD1-12
               .
               .
 154           .        BD13
               .           .
               .           .
 161    C(BD1-13............
               .
               .
 165           .        BD14
               .           .
               .           .
 172           .           .        BD15
               .           .          .
               .           .          .
 179    C(BD1-15........................
               V
               V
 182       RRBSN
               .
               .
 192           .-------->   ALAMO
 190       D(BD)
               .
               .
 195           .        BD16
               .           .
               .           .
 202    C(BD1-16............
               V
               V
 205    R(BD1-16
               .
               .
 208           .        BD17
               .           .
               .           .
 215    C(BD1-17............
```

(***) RUNOFF ALSO COMPUTED AT THIS LOCATION

RUNOFF SUMMARY
FLOW IN CUBIC FEET PER SECOND
TIME IN HOURS, AREA IN SQUARE MILES

	OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD 6-HOUR	24-HOUR	72-HOUR	BASIN AREA	MAXIMU STAGE
+	HYDROGRAPH AT	BD1	25.	12.17	9.	3.	3.	.04	
+	HYDROGRAPH AT	BD4	27.	12.08	10.	4.	4.	.05	
+	2 COMBINED AT	C(BD1+4)	52.	12.17	19.	7.	7.	.09	
+	ROUTED TO	R(BD1+4)	51.	12.25	19.	7.	7.	.09	
+	HYDROGRAPH AT	BD5	27.	12.08	12.	4.	4.	.05	
+	HYDROGRAPH AT	BD6	31.	12.08	10.	4.	4.	.05	
+	ROUTED TO	R(BD6)	31.	12.08	10.	4.	4.	.05	
+	HYDROGRAPH AT	BD8	12.	12.08	5.	2.	2.	.02	
+	2 COMBINED AT	C(BD6+8)	42.	12.08	15.	6.	6.	.07	
+	ROUTED TO	R(BD6+8)	42.	12.17	15.	6.	6.	.07	
+	3 COMBINED AT	C(RUBY)	121.	12.17	47.	17.	17.	.21	
+	ROUTED TO	R(OPAL)	120.	12.17	47.	17.	17.	.21	
+	HYDROGRAPH AT	BD2	34.	12.42	16.	6.	6.	.07	
+	HYDROGRAPH AT	BD3	28.	12.17	10.	4.	4.	.05	
+	2 COMBINED AT	C(BD2+3)	62.	12.25	26.	10.	10.	.12	
+	ROUTED TO	R(BD2+3)	60.	12.33	26.	10.	10.	.12	
+	HYDROGRAPH AT	BD7	16.	12.08	6.	2.	2.	.03	
+	HYDROGRAPH AT	BD9	14.	12.08	5.	2.	2.	.02	
+	2 COMBINED AT	C(BD7+9)	30.	12.08	11.	4.	4.	.05	
+	ROUTED TO	R(BD7+9)	29.	12.17	11.	4.	4.	.05	
+	HYDROGRAPH AT	BD10	14.	12.00	4.	2.	2.	.02	
+	4 COMBINED AT	C(BD1-10	219.	12.25	88.	33.	33.	.40	
+	ROUTED TO	R(BD1-10	216.	12.33	88.	33.	33.	.40	
+	HYDROGRAPH AT	BD11	26.	13.58	20.	7.	7.	.11	

```
          2 COMBINED AT
+                     C(BD1-11      237.   12.33       106.       39.       39.       .51
          ROUTED TO
+                     R(BD1-11      234.   12.50       106.       39.       39.       .51
          HYDROGRAPH AT
+                         BD12       99.   12.58        65.       26.       26.       .30
          2 COMBINED AT
+                     C(BD1-12      333.   12.50       171.       66.       66.       .81
          ROUTED TO
+                     R(BD1-12      329.   12.67       171.       65.       65.       .81
          HYDROGRAPH AT
+                         BD13       39.   16.83        35.       15.       15.       .28
          2 COMBINED AT
+                     C(BD1-13      357.   12.67       202.       80.       80.      1.09
          HYDROGRAPH AT
+                         BD14        7.   12.25         3.        1.        1.       .01
          HYDROGRAPH AT
+                         BD15       25.   13.42        19.        7.        7.       .11
          3 COMBINED AT
+                     C(BD1-15      386.   12.67       223.       87.       87.      1.21
          ROUTED TO
+                        RRBSN      321.   13.42       209.       96.       96.      1.21
+                                                                                           87.9
          DIVERSION TO
+                        ALAMO      176.   13.42        78.       28.       28.      1.21
          HYDROGRAPH AT
+                         D(BD)     144.   13.42       131.       67.       67.      1.21
          HYDROGRAPH AT
+                         BD16        8.   12.42         3.        1.        1.       .02
          2 COMBINED AT
+                     C(BD1-16      150.   13.08       134.       68.       68.      1.22
          ROUTED TO
+                     R(BD1-16      150.   13.25       134.       68.       68.      1.22
          HYDROGRAPH AT
+                         BD17        8.   15.00         7.        3.        3.       .05
          2 COMBINED AT
+                     C(BD1-17      157.   13.25       141.       71.       71.      1.27
```

E-2

Existing Conditions 100-Year HEC-1 Summary Results

```
1*****************************************                                    ******************
 *                                       *                                    *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *                                    *    U.S. ARMY COR
 *              JUN   1998               *                                    *    HYDROLOGIC EN
 *            VERSION 4.1                *                                    *          609 SEC
 *                                       *                                    *       DAVIS, CAL
 *  RUN DATE   08JUL05  TIME  16:34:53   *                                    *           (916)
 *                                       *                                    *
 *****************************************                                    ******************


                                                X     X  XXXXXXX   XXXXX           X
                                                X     X  X        X     X         XX
                                                X     X  X        X                X
                                                XXXXXXX  XXXX     X        XXXXX   X
                                                X     X  X        X                X
                                                X     X  X        X     X          X
                                                X     X  XXXXXXX   XXXXX         XXX


          THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HE

          THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE I
          THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRA
          NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUE
          DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL   LOSS RATE:GREEN AND AMPT INFILTRATION
          KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM


                 SCHEMATIC DIAGRAM OF STREAM NETWORK
INPUT
 LINE      (V) ROUTING          (--->) DIVERSION OR PUMP FLOW

  NO.      (.) CONNECTOR        (<---) RETURN OF DIVERTED OR PUMPED FLOW

    4        BD1
                .
                .
   19           .         BD4
                .           .
                .           .
   26    C(BD1+4)............
                V
                V
   29    R(BD1+4)
                .
                .
   32           .         BD5
                .           .
                .           .
   40           .           .         BD6
                .           .           V
                .           .           V
   48           .           .      R(BD6)
                .           .           .
                .           .           .
   51           .           .           .         BD8
                .           .           .           .
                .           .           .           .
   58           .           .    C(BD6+8)............
                .           .           V
                .           .           V
   61           .           .    R(BD6+8)
                .           .           .
                .           .           .
   64     C(RUBY)......................
                V
                V
   68     R(OPAL)
                .
                .
   71           .         BD2
                .           .
                .           .
   79           .           .         BD3
                .           .           .
```

```
                .           .           .
  86            .   C(BD2+3)............
                .           V
                .           V
  89            .   R(BD2+3)
                .           .
                .           .
  92            .           .        BD7
                .           .          .
                .           .          .
  99            .           .          .        BD9
                .           .          .          .
                .           .          .          .
 106            .           .   C(BD7+9)............
                .           .          V
                .           .          V
 109            .           .   R(BD7+9)
                .           .          .
                .           .          .
 112            .           .          .       BD10
                .           .          .          .
                .           .          .          .
 120    C(BD1-10.................................
                V
                V
 123    R(BD1-10
                .
                .
 126            .        BD11
                .           .
                .           .
 133    C(BD1-11............
                V
                V
 136    R(BD1-11
                .
                .
 139            .        BD12
                .           .
                .           .
 147    C(BD1-12............
                V
                V
 151    R(BD1-12
                .
                .
 154            .        BD13
                .           .
                .           .
 161    C(BD1-13............
                .
                .
 165            .        BD14
                .           .
                .           .
 172            .           .        BD15
                .           .          .
                .           .          .
 179    C(BD1-15........................
                V
                V
 182       RRBSN
                .
                .
 196            .-------->   ALAMO
 194       D(BD)
                .
                .
 199            .        BD16
                .           .
                .           .
 206    C(BD1-16............
                V
                V
 209    R(BD1-16
                .
                .
 212            .        BD17
                .           .
                .           .
 219    C(BD1-17............
```

(***) RUNOFF ALSO COMPUTED AT THIS LOCATION

RUNOFF SUMMARY
FLOW IN CUBIC FEET PER SECOND
TIME IN HOURS, AREA IN SQUARE MILES

	OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD 6-HOUR	24-HOUR	72-HOUR	BASIN AREA	MAXIMU STAGE
+	HYDROGRAPH AT	BD1	39.	12.17	13.	5.	5.	.04	
+	HYDROGRAPH AT	BD4	43.	12.08	15.	6.	6.	.05	
+	2 COMBINED AT	C(BD1+4)	82.	12.08	28.	11.	11.	.09	
+	ROUTED TO	R(BD1+4)	81.	12.17	28.	11.	11.	.09	
+	HYDROGRAPH AT	BD5	44.	12.08	17.	7.	7.	.05	
+	HYDROGRAPH AT	BD6	48.	12.08	15.	6.	6.	.05	
+	ROUTED TO	R(BD6)	48.	12.08	15.	6.	6.	.05	
+	HYDROGRAPH AT	BD8	19.	12.08	7.	3.	3.	.02	
+	2 COMBINED AT	C(BD6+8)	66.	12.08	22.	9.	9.	.07	
+	ROUTED TO	R(BD6+8)	66.	12.08	22.	9.	9.	.07	
+	3 COMBINED AT	C(RUBY)	190.	12.17	68.	26.	26.	.21	
+	ROUTED TO	R(OPAL)	189.	12.17	68.	26.	26.	.21	
+	HYDROGRAPH AT	BD2	54.	12.33	24.	9.	9.	.07	
+	HYDROGRAPH AT	BD3	43.	12.17	15.	6.	6.	.05	
+	2 COMBINED AT	C(BD2+3)	97.	12.25	39.	15.	15.	.12	
+	ROUTED TO	R(BD2+3)	94.	12.33	39.	15.	15.	.12	
+	HYDROGRAPH AT	BD7	25.	12.08	9.	3.	3.	.03	
+	HYDROGRAPH AT	BD9	21.	12.08	7.	3.	3.	.02	
+	2 COMBINED AT	C(BD7+9)	46.	12.08	16.	6.	6.	.05	
+	ROUTED TO	R(BD7+9)	46.	12.17	16.	6.	6.	.05	
+	HYDROGRAPH AT	BD10	21.	12.00	6.	2.	2.	.02	
+	4 COMBINED AT	C(BD1-10	343.	12.17	129.	50.	50.	.40	
+	ROUTED TO	R(BD1-10	337.	12.25	129.	50.	50.	.40	
+	HYDROGRAPH AT	BD11	46.	13.00	31.	10.	10.	.11	

```
          2 COMBINED AT
+                     C(BD1-11      380.   12.25       159.       60.       60.       .51
          ROUTED TO
+                     R(BD1-11      374.   12.42       158.       60.       60.       .51
          HYDROGRAPH AT
+                         BD12      163.   12.50        96.       39.       39.       .30
          2 COMBINED AT
+                     C(BD1-12      537.   12.42       255.       99.       99.       .81
          ROUTED TO
+                     R(BD1-12      531.   12.50       255.       99.       99.       .81
          HYDROGRAPH AT
+                         BD13       74.   14.75        64.       25.       25.       .28
          2 COMBINED AT
+                     C(BD1-13      587.   12.50       313.      123.      123.      1.09
          HYDROGRAPH AT
+                         BD14       11.   12.17         4.        2.        2.       .01
          HYDROGRAPH AT
+                         BD15       44.   12.92        30.       10.       10.       .11
          3 COMBINED AT
+                     C(BD1-15      640.   12.50       347.      135.      135.      1.21
          ROUTED TO
+                        RRBSN      602.   12.83       334.      141.      141.      1.21
+                                                                                              88.1
          DIVERSION TO
+                        ALAMO      456.   12.83       191.       60.       60.      1.21
          HYDROGRAPH AT
+                         D(BD)     146.   12.83       143.       81.       81.      1.21
          HYDROGRAPH AT
+                         BD16       13.   12.33         5.        2.        2.       .02
          2 COMBINED AT
+                     C(BD1-16      158.   12.42       147.       83.       83.      1.22
          ROUTED TO
+                     R(BD1-16      158.   12.58       147.       83.       83.      1.22
          HYDROGRAPH AT
+                         BD17       15.   13.50        12.        4.        4.       .05
          2 COMBINED AT
+                     C(BD1-17      171.   12.67       159.       87.       87.      1.27
```

E-3

Post-Development Conditions 10-Year HEC-1 Summary Results

```
1****************************************
 *                                      *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1)  *
 *              JUN   1998              *
 *           VERSION 4.1                *
 *                                      *
 *  RUN DATE   18JUL05  TIME  15:01:20  *
 *                                      *
 ****************************************
```

```
******************
*
*    U.S. ARMY COR
*    HYDROLOGIC EN
*          609 SEC
*       DAVIS, CAL
*           (916)
*
******************
```

```
X     X  XXXXXXX   XXXXX           X
X     X  X        X     X         XX
X     X  X        X                X
XXXXXXX  XXXX     X        XXXXX   X
X     X  X        X                X
X     X  X        X     X          X
X     X  XXXXXXX   XXXXX          XXX
```

THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HE

THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE I
THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRA
NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUE
DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL LOSS RATE:GREEN AND AMPT INFILTRATION
KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM

```
                 SCHEMATIC DIAGRAM OF STREAM NETWORK
INPUT
 LINE       (V) ROUTING          (--->) DIVERSION OR PUMP FLOW

  NO.       (.) CONNECTOR        (<---) RETURN OF DIVERTED OR PUMPED FLOW

    4         BD1
                 .
                 .
   19            .         BD4
                 .           .
                 .           .
   26    C(BD1+4)............
                 V
                 V
   29    R(BD1+4)
                 .
                 .
   32            .         BD5
                 .           .
                 .           .
   40            .           .         BD6
                 .           .           V
                 .           .           V
   48            .           .      R(BD6)
                 .           .           .
                 .           .           .
   51            .           .           .         BD8
                 .           .           .           .
                 .           .           .           .
   58            .           .    C(BD6+8)............
                 .           .           V
                 .           .           V
   61            .           .    R(BD6+8)
                 .           .           .
                 .           .           .
   64     C(RUBY).......................
                 V
                 V
   68     R(OPAL)
                 .
                 .
   71            .         BD2
                 .           .
                 .           .
   79            .           .         BD3
                 .           .           .
```

```
                .          .          .
 86             .   C(BD2+3)............
                .          V
                .          V
 89             .   R(BD2+3)
                .          .
                .          .
 92             .          .        BD7
                .          .          .
                .          .          .
 99             .          .          .        BD9
                .          .          .          .
                .          .          .          .
106             .          .   C(BD7+9)............
                .          .          V
                .          .          V
109             .          .   R(BD7+9)
                .          .          .
                .          .          .
112             .          .          .       BD10
                .          .          .          .
                .          .          .          .
120     C(BD1-10.................................
                V
                V
123     R(BD1-10
                .
                .
126             .       BD11
                .          .
                .          .
134     C(BD1-11............
                V
                V
137     R(BD1-11
                .
                .
140             .      BD12A
                .          .
                .          .
149             .          .       BD12
                .          .          .
                .          .          .
157             .          .          .       BD15
                .          .          .          .
                .          .          .          .
164     C(BD1-12.................................
                V
                V
167     R(BD1-12
                .
                .
170             .      BD13B
                .          .
                .          .
179     C(BD1-13............
                V
                V
182     R(BD1-13
                .
                .
185             .       BD13
                .          .
                .          .
192     C(BD1-13............
                V
                V
195     R(BD1-13
                .
                .
198             .      BD13A
                .          .
                .          .
207       C(LTR)............
                .
                .
210             .       BD14
                .          .
                .          .
217     C(BD1-15............
                V
                V
220      STWNBSN
                .
```

```
                .
228             .        BD16
                .           .
                .           .
235     C(BD1-16............
                V
                V
238     R(BD1-16
                .
                .
241             .        BD17
                .           .
                .           .
248     C(BD1-17............
```

(***) RUNOFF ALSO COMPUTED AT THIS LOCATION

RUNOFF SUMMARY
FLOW IN CUBIC FEET PER SECOND
TIME IN HOURS, AREA IN SQUARE MILES

+	OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD 6-HOUR	24-HOUR	72-HOUR	BASIN AREA	MAXIMU STAGE
+	HYDROGRAPH AT	BD1	25.	12.17	9.	3.	3.	.04	
+	HYDROGRAPH AT	BD4	27.	12.08	10.	4.	4.	.05	
+	2 COMBINED AT	C(BD1+4)	52.	12.17	19.	7.	7.	.09	
+	ROUTED TO	R(BD1+4)	51.	12.25	19.	7.	7.	.09	
+	HYDROGRAPH AT	BD5	27.	12.08	12.	4.	4.	.05	
+	HYDROGRAPH AT	BD6	31.	12.08	10.	4.	4.	.05	
+	ROUTED TO	R(BD6)	31.	12.08	10.	4.	4.	.05	
+	HYDROGRAPH AT	BD8	12.	12.08	5.	2.	2.	.02	
+	2 COMBINED AT	C(BD6+8)	42.	12.08	15.	6.	6.	.07	
+	ROUTED TO	R(BD6+8)	42.	12.17	15.	6.	6.	.07	
+	3 COMBINED AT	C(RUBY)	121.	12.17	47.	17.	17.	.21	
+	ROUTED TO	R(OPAL)	120.	12.17	47.	17.	17.	.21	
+	HYDROGRAPH AT	BD2	34.	12.42	16.	6.	6.	.07	
+	HYDROGRAPH AT	BD3	28.	12.17	10.	4.	4.	.05	
+	2 COMBINED AT	C(BD2+3)	62.	12.25	26.	10.	10.	.12	
+	ROUTED TO	R(BD2+3)	60.	12.33	26.	10.	10.	.12	
+	HYDROGRAPH AT	BD7	16.	12.08	6.	2.	2.	.03	
+	HYDROGRAPH AT	BD9	14.	12.08	5.	2.	2.	.02	
+	2 COMBINED AT	C(BD7+9)	30.	12.08	11.	4.	4.	.05	

```
                ROUTED TO
+                          R(BD7+9)     29.   12.17      11.      4.      4.     .05
                HYDROGRAPH AT
+                             BD10      14.   12.00       4.      2.      2.     .02
                4 COMBINED AT
+                          C(BD1-10    219.   12.25      88.     33.     33.     .40
                ROUTED TO
+                          R(BD1-10    219.   12.25      88.     33.     33.     .40
                HYDROGRAPH AT
+                             BD11      29.   12.08      10.      4.      4.     .05
                2 COMBINED AT
+                          C(BD1-11    246.   12.25      99.     37.     37.     .45
                ROUTED TO
+                          R(BD1-11    245.   12.25      98.     37.     37.     .45
                HYDROGRAPH AT
+                            BD12A      73.   12.17      31.     12.     12.     .14
                HYDROGRAPH AT
+                             BD12     118.   12.25      51.     19.     19.     .23
                HYDROGRAPH AT
+                             BD15      57.   12.08      25.     10.     10.     .11
                4 COMBINED AT
+                          C(BD1-12    492.   12.25     206.     78.     78.     .92
                ROUTED TO
+                          R(BD1-12    490.   12.33     206.     78.     78.     .92
                HYDROGRAPH AT
+                            BD13B      81.   12.17      36.     13.     13.     .16
                2 COMBINED AT
+                          C(BD1-13    571.   12.25     242.     91.     91.    1.08
                ROUTED TO
+                          R(BD1-13    570.   12.33     242.     91.     91.    1.08
                HYDROGRAPH AT
+                             BD13      29.   12.17      13.      5.      5.     .06
                2 COMBINED AT
+                          C(BD1-13    598.   12.33     254.     96.     96.    1.14
                ROUTED TO
+                          R(BD1-13    598.   12.33     254.     96.     96.    1.14
                HYDROGRAPH AT
+                            BD13A      53.   12.17      22.      8.      8.     .09
                2 COMBINED AT
+                            C(LTR)    650.   12.33     276.    104.    104.    1.23
                HYDROGRAPH AT
+                             BD14      41.   12.25      20.      7.      7.     .09
                2 COMBINED AT
+                          C(BD1-15    691.   12.33     296.    111.    111.    1.32
                ROUTED TO
+                            STWNBSN   334.   13.58     258.    106.    106.    1.32
+                                                                                     87.1
                HYDROGRAPH AT
+                             BD16       8.   12.42       3.      1.      1.     .02
                2 COMBINED AT
+                          C(BD1-16    338.   13.50     262.    107.    107.    1.34
                ROUTED TO
+                          R(BD1-16    338.   13.58     261.    107.    107.    1.34
                HYDROGRAPH AT
+                             BD17       8.   15.00       7.      3.      3.     .05
                2 COMBINED AT
```

```
+                    C(BD1-17      345.   13.58       268.       109.       109.       1.38
```

E-4

Post-Development Conditions 100-Year HEC-1 Summary Results

```
1****************************************
 *                                      *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1)  *
 *              JUN   1998              *
 *           VERSION 4.1                *
 *                                      *
 *  RUN DATE   18JUL05  TIME  15:15:10  *
 *                                      *
 ****************************************
```

```
******************
*
*    U.S. ARMY COR
*    HYDROLOGIC EN
*          609 SEC
*       DAVIS, CAL
*           (916)
*
******************
```

```
X     X  XXXXXXX   XXXXX           X
X     X  X        X     X         XX
X     X  X        X                X
XXXXXXX  XXXX     X        XXXXX   X
X     X  X        X                X
X     X  X        X     X          X
X     X  XXXXXXX   XXXXX          XXX
```

THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HE

THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE I
THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRA
NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUE
DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL LOSS RATE:GREEN AND AMPT INFILTRATION
KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM

```
                SCHEMATIC DIAGRAM OF STREAM NETWORK
INPUT
 LINE       (V) ROUTING          (--->) DIVERSION OR PUMP FLOW

  NO.       (.) CONNECTOR        (<---) RETURN OF DIVERTED OR PUMPED FLOW

    4         BD1
                .
                .
   19           .         BD4
                .           .
                .           .
   26    C(BD1+4)............
                V
                V
   29    R(BD1+4)
                .
                .
   32           .         BD5
                .           .
                .           .
   40           .           .         BD6
                .           .           V
                .           .           V
   48           .           .      R(BD6)
                .           .           .
                .           .           .
   51           .           .           .         BD8
                .           .           .           .
                .           .           .           .
   58           .           .    C(BD6+8)............
                .           .           V
                .           .           V
   61           .           .    R(BD6+8)
                .           .           .
                .           .           .
   64     C(RUBY)......................
                V
                V
   68     R(OPAL)
                .
                .
   71           .         BD2
                .           .
                .           .
   79           .           .         BD3
                .           .           .
```

```
                .         .         .
 86             .    C(BD2+3)............
                .         V
                .         V
 89             .    R(BD2+3)
                .         .
                .         .
 92             .         .        BD7
                .         .         .
                .         .         .
 99             .         .         .          BD9
                .         .         .           .
                .         .         .           .
106             .         .   C(BD7+9)............
                .         .         V
                .         .         V
109             .         .   R(BD7+9)
                .         .         .
                .         .         .
112             .         .         .        BD10
                .         .         .           .
                .         .         .           .
120     C(BD1-10.....................................
                V
                V
123     R(BD1-10
                .
                .
126             .       BD11
                .         .
                .         .
134     C(BD1-11............
                V
                V
137     R(BD1-11
                .
                .
140             .      BD12A
                .         .
                .         .
149             .         .       BD12
                .         .         .
                .         .         .
157             .         .         .        BD15
                .         .         .           .
                .         .         .           .
164     C(BD1-12.....................................
                V
                V
167     R(BD1-12
                .
                .
170             .      BD13B
                .         .
                .         .
179     C(BD1-13............
                V
                V
182     R(BD1-13
                .
                .
185             .       BD13
                .         .
                .         .
192     C(BD1-13............
                V
                V
195     R(BD1-13
                .
                .
198             .      BD13A
                .         .
                .         .
207       C(LTR)............
                .
                .
210             .       BD14
                .         .
                .         .
217     C(BD1-15............
                V
                V
220      STWNBSN
                .
```

```
                .
 233            .-------->   ALAMO
 231      NOONAN
                .
                .
 236            .        BD16
                .           .
                .           .
 243    C(BD1-16............
                V
                V
 246    R(BD1-16
                .
                .
 249            .        BD17
                .           .
                .           .
 256    C(BD1-17............
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(***) RUNOFF ALSO COMPUTED AT THIS LOCATION

RUNOFF SUMMARY
FLOW IN CUBIC FEET PER SECOND
TIME IN HOURS, AREA IN SQUARE MILES

	OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD 6-HOUR	24-HOUR	72-HOUR	BASIN AREA	MAXIMU STAGE
+	HYDROGRAPH AT	BD1	39.	12.17	13.	5.	5.	.04	
+	HYDROGRAPH AT	BD4	43.	12.08	15.	6.	6.	.05	
+	2 COMBINED AT	C(BD1+4)	82.	12.08	28.	11.	11.	.09	
+	ROUTED TO	R(BD1+4)	81.	12.17	28.	11.	11.	.09	
+	HYDROGRAPH AT	BD5	44.	12.08	17.	7.	7.	.05	
+	HYDROGRAPH AT	BD6	48.	12.08	15.	6.	6.	.05	
+	ROUTED TO	R(BD6)	48.	12.08	15.	6.	6.	.05	
+	HYDROGRAPH AT	BD8	19.	12.08	7.	3.	3.	.02	
+	2 COMBINED AT	C(BD6+8)	66.	12.08	22.	9.	9.	.07	
+	ROUTED TO	R(BD6+8)	66.	12.08	22.	9.	9.	.07	
+	3 COMBINED AT	C(RUBY)	190.	12.17	68.	26.	26.	.21	
+	ROUTED TO	R(OPAL)	189.	12.17	68.	26.	26.	.21	
+	HYDROGRAPH AT	BD2	54.	12.33	24.	9.	9.	.07	
+	HYDROGRAPH AT	BD3	43.	12.17	15.	6.	6.	.05	
+	2 COMBINED AT	C(BD2+3)	97.	12.25	39.	15.	15.	.12	
+	ROUTED TO	R(BD2+3)	94.	12.33	39.	15.	15.	.12	
+	HYDROGRAPH AT	BD7	25.	12.08	9.	3.	3.	.03	
	HYDROGRAPH AT								

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+                                BD9        21.   12.08        7.        3.        3.      .02
          2 COMBINED AT
+                           C(BD7+9)        46.   12.08       16.        6.        6.      .05
          ROUTED TO
+                           R(BD7+9)        46.   12.17       16.        6.        6.      .05
          HYDROGRAPH AT
+                               BD10        21.   12.00        6.        2.        2.      .02
          4 COMBINED AT
+                           C(BD1-10       343.   12.17      129.       50.       50.      .40
          ROUTED TO
+                           R(BD1-10       341.   12.17      129.       50.       50.      .40
          HYDROGRAPH AT
+                               BD11        45.   12.08       15.        6.        6.      .05
          2 COMBINED AT
+                           C(BD1-11       385.   12.17      144.       56.       56.      .45
          ROUTED TO
+                           R(BD1-11       382.   12.25      144.       56.       56.      .45
          HYDROGRAPH AT
+                              BD12A       116.   12.17       46.       18.       18.      .14
          HYDROGRAPH AT
+                               BD12       186.   12.17       75.       29.       29.      .23
          HYDROGRAPH AT
+                               BD15        91.   12.08       34.       13.       13.      .11
          4 COMBINED AT
+                           C(BD1-12       770.   12.17      299.      115.      115.      .92
          ROUTED TO
+                           R(BD1-12       768.   12.25      298.      115.      115.      .92
          HYDROGRAPH AT
+                              BD13B       129.   12.17       52.       20.       20.      .16
          2 COMBINED AT
+                           C(BD1-13       896.   12.25      350.      135.      135.     1.08
          ROUTED TO
+                           R(BD1-13       894.   12.25      350.      135.      135.     1.08
          HYDROGRAPH AT
+                               BD13        46.   12.08       18.        7.        7.      .06
          2 COMBINED AT
+                           C(BD1-13       939.   12.25      368.      142.      142.     1.14
          ROUTED TO
+                           R(BD1-13       939.   12.25      368.      142.      142.     1.14
          HYDROGRAPH AT
+                              BD13A        82.   12.17       30.       12.       12.      .09
          2 COMBINED AT
+                             C(LTR)      1020.   12.25      399.      154.      154.     1.23
          HYDROGRAPH AT
+                               BD14        67.   12.17       29.       11.       11.      .09
          2 COMBINED AT
+                           C(BD1-15      1086.   12.25      428.      165.      165.     1.32
          ROUTED TO
+                             STWNBSN       557.   13.25      373.      157.      157.     1.32
+                                                                                                89.3
          DIVERSION TO
+                              ALAMO       101.   13.25       17.        4.        4.     1.32
          HYDROGRAPH AT
+                             NOONAN       456.   13.25      356.      153.      153.     1.32
          HYDROGRAPH AT
+                               BD16        13.   12.33        5.        2.        2.      .02
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          2 COMBINED AT
+                         C(BD1-16      464.   13.17        361.        154.        154.        1.34
          ROUTED TO
+                         R(BD1-16      463.   13.25        361.        154.        154.        1.34
          HYDROGRAPH AT
+                             BD17       15.   13.50         12.          4.          4.         .05
          2 COMBINED AT
+                         C(BD1-17      478.   13.25        373.        158.        158.        1.38
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APPENDIX F

HEC-RAS Summary Output Files

Table F-1. HEC-RAS Summary Output for Existing Channel Conditions

River Station	Profile	Channel Flow (cfs)	Minimum Channel Elevation (ft)	Manning's Channel Roughness Coefficient	Water Surface Elevation (ft)	Critical Water Surface Elevation (ft)	Energy Grade Elevation (ft)	Energy Grade Slope (ft/ft)	Channel Velocity (ft/s)	Flow Area (sq ft)	Channel Top Width (ft)	Channel Froude #
30656	10 yr	219	93.18	0.045	99.25	96.01	99.43	0.001145	3.39	64.62	30.28	0.26
30656	100 yr	343	93.18	0.045	100.38	96.78	100.46	0.00084	2.37	145.58	38.94	0.2
30551	10 yr	219	93.44	0.045	98.76		98.86	0.001404	2.53	86.6	27.37	0.25
30551	100 yr	343	93.44	0.045	99.86		99.99	0.001453	2.88	119.18	31.66	0.26
30120	10 yr	219	92.92	0.045	98.07		98.19	0.001691	2.78	78.72	24.19	0.27
30120	100 yr	343	92.92	0.045	99.12		99.28	0.001863	3.24	105.71	27.48	0.29
29549	10 yr	237	92.43	0.045	96.98	94.9	97.12	0.002074	2.96	79.95	26.92	0.3
29549	100 yr	380	92.43	0.045	97.79	95.58	98	0.002666	3.69	103	452.81	0.35
29049	10 yr	237	90.83	0.035	96.18	93.83	96.32	0.001274	2.96	79.99	652.64	0.3
29049	100 yr	380	90.83	0.035	96.02	94.63	96.41	0.003796	5.03	75.62	639.78	0.52
28605	10 yr	237	89.72	0.035	96.25	92.72	96.25	0.000021	0.45	1417.24	1535.55	0.04
28605	100 yr	380	89.72	0.035	96.2	93.53	96.21	0.000062	0.75	1351.11	1488.52	0.07
28161	10 yr	333	88.6	0.045	96.04	93	96.1	0.000475	1.91	174.69	2432.92	0.15
28161	100 yr	537	88.6	0.045	95.94	93	96.1	0.001316	3.15	170.37	2309.52	0.25
28106.5	Vanden Road - 7.5' X 4' Concrete Box Culvert											
28066	10 yr	333	87.9	0.045	95.23	90.33	95.25	0.000135	1.18	493.52	2368.43	0.08
28066	100 yr	537	87.9	0.045	95.66	91.22	95.68	0.000145	1.28	966.39	2822.32	0.08
28051	10 yr	333	88.28	0.045	95.16		95.24	0.000705	2.29	189.7	261.32	0.19
28051	100 yr	537	88.28	0.045	95.57		95.67	0.000931	2.78	299.97	272.9	0.22
27972	10 yr	333	89.8	0.045	95.11		95.16	0.00096	2.24	241.45	250.78	0.21
27972	100 yr	537	89.8	0.045	95.51		95.58	0.001059	2.53	346.05	270.04	0.23
27773	10 yr	333	89.44	0.07	94.85		94.9	0.002042	2.14	265.92	253.76	0.2
27773	100 yr	537	89.44	0.07	95.2		95.26	0.002626	2.59	358.68	274.07	0.23
27766	10 yr	333	93	0.06	94.5	94.5	94.83	0.032536	5.26	91.05	132.44	0.82
27766	100 yr	537	93	0.06	94.76	94.76	95.18	0.035665	6.22	125.58	138.95	0.88
27759	10 yr	333	88.17	0.07	93.52	91.89	93.7	0.007538	3.53	108.93	101.51	0.37
27759	100 yr	537	88.17	0.07	93.86	92.65	94.17	0.011782	4.68	152.07	148.31	0.47
27628	10 yr	333	87.81	0.05	92.37	91.51	92.65	0.008309	4.48	104.97	288.65	0.53
27628	100 yr	537	87.81	0.05	92.68	92.61	92.9	0.007423	4.54	219.05	419.38	0.51
27050	10 yr	333	86.21	0.05	90.31		90.36	0.002209	2.36	390.1	1429.43	0.27
27050	100 yr	537	86.21	0.05	90.42	90.3	90.46	0.002605	2.63	543.75	1438.2	0.3
26550	10 yr	333	84.83	0.045	89.12		89.2	0.002372	2.84	299.76	1065.66	0.32
26550	100 yr	537	84.83	0.045	89.33		89.38	0.001822	2.61	527.72	1069.19	0.28
26212	10 yr	333	84.03	0.045	88.55		88.6	0.001328	2.24	319.6	578.94	0.24
26212	100 yr	537	84.03	0.045	88.87		88.91	0.0011	2.16	505.81	582.94	0.22
25994	10 yr	333	82.08	0.045	87.94	86.59	88.12	0.003976	3.68	130.81	250.43	0.4
25994	100 yr	537	82.08	0.045	88.13	87.34	88.41	0.006172	4.78	182.16	283.63	0.5
25870	10 yr	357	83.1	0.07	88.02	85.7	88.02	0.000132	0.56	1059.29	1320	0.05
25870	100 yr	587	83.1	0.07	88.26	87.25	88.27	0.000168	0.66	1381.19	1320	0.06
25787	Leisure Town Road - Triple 36-inch RCP Culverts											
25711	10 yr	357	82.15	0.08	87.99	84.54	87.99	0.000127	0.55	1262.49	1147.76	0.05
25711	100 yr	587	82.15	0.08	88.23	85.39	88.23	0.000187	0.69	1586.12	1350	0.06
25639	10 yr	386	81.5	0.08	87.76		87.95	0.008591	3.46	112.16	44.04	0.35

River Station	Profile	Channel Flow (cfs)	Minimum Channel Elevation (ft)	Manning's Channel Roughness Coefficient	Water Surface Elevation (ft)	Critical Water Surface Elevation (ft)	Energy Grade Elevation (ft)	Energy Grade Slope (ft/ft)	Channel Velocity (ft/s)	Flow Area (sq ft)	Channel Top Width (ft)	Channel Froude #
25639	100 yr	640	81.5	0.08	87.55	86.31	88.14	0.027495	6.15	104.01	34.51	0.62
25611	10 yr	144	81	0.07	87.89	83.15	87.89	0.000003	0.1	1538.94	454.9	0.01
25611	100 yr	146	81	0.07	87.96	83.16	87.96	0.000003	0.1	1569.88	454.9	0.01
25566.5	Southern Pacific Railroad - Twin 60-inch CMP Culverts											
25497	10 yr	144	78.44	0.06	87.34	81.18	87.35	0.000142	0.8	182.83	55.65	0.06
25497	100 yr	146	78.44	0.06	87.4	81.2	87.41	0.000141	0.8	185.76	55.74	0.06
25434.5	SID D-1-C Irrigation Canal Crossing - Twin 36-inch CMP Culverts											
25381	10 yr	144	78.77	0.045	82.83	80.96	82.92	0.001731	2.43	59.28	23.58	0.27
25381	100 yr	146	78.77	0.045	82.89	80.97	82.98	0.001664	2.4	60.73	23.81	0.27
25201	10 yr	144	78.02	0.045	82.51		82.6	0.00184	2.39	60.2	25.37	0.27
25201	100 yr	146	78.02	0.045	82.58		82.67	0.001726	2.35	62.2	25.69	0.27
25055	10 yr	144	77.88	0.05	82.22		82.31	0.002086	2.43	59.21	22.88	0.27
25055	100 yr	146	77.88	0.05	82.32		82.4	0.001936	2.37	61.48	23.27	0.26
24826	10 yr	144	77.32	0.05	81.92		81.97	0.00103	1.87	77.17	26.27	0.19
24826	100 yr	146	77.32	0.05	82.04		82.09	0.000944	1.82	80.43	26.7	0.18
24574	10 yr	144	77.21	0.05	81.64		81.7	0.001167	1.95	73.72	25.6	0.2
24574	100 yr	146	77.21	0.05	81.79		81.84	0.001039	1.88	77.61	26.09	0.19
24309	10 yr	157	76.93	0.05	81.3		81.37	0.001318	2.11	74.5	25.2	0.22
24309	100 yr	171	76.93	0.05	81.45		81.52	0.001356	2.18	78.39	25.68	0.22
24047	10 yr	157	76.63	0.045	80.95		81.03	0.001282	2.24	69.95	24.79	0.24
24047	100 yr	171	76.63	0.045	81.09		81.17	0.001328	2.33	73.48	25.28	0.24
23309	10 yr	157	75.65	0.035	77.96	77.96	78.6	0.018294	6.43	24.41	19.65	1.02
23309	100 yr	171	75.65	0.035	78.05	78.05	78.71	0.01743	6.52	26.24	19.92	1
23120	10 yr	157	73.42	0.035	76.73	75.59	76.98	0.003423	4.04	38.84	16.74	0.47
23120	100 yr	171	73.42	0.035	76.89	75.7	77.15	0.003368	4.11	41.58	17.21	0.47
22620	10 yr	157	71.71	0.035	75.5	73.88	75.67	0.001994	3.32	47.31	18.16	0.36
22620	100 yr	171	71.71	0.035	75.68	73.99	75.86	0.00197	3.38	50.59	18.68	0.36
22120	10 yr	165	70	0.035	75.01	72.23	75.09	0.000713	2.3	71.64	21.72	0.22
22120	100 yr	179	70	0.035	75.19	72.34	75.27	0.00073	2.37	75.44	22.23	0.23
21907	10 yr	179	69.27	0.035	74.67	72.56	74.85	0.001805	3.38	53	17.31	0.34
21907	100 yr	193	69.27	0.035	74.84	72.69	75.03	0.001821	3.45	55.91	17.77	0.34
21407	10 yr	186	68.35	0.035	73.68	71.7	73.88	0.002084	3.6	51.69	17.1	0.36
21407	100 yr	200	68.35	0.035	73.83	71.81	74.04	0.002103	3.68	54.39	17.53	0.37
20907	10 yr	186	67.43	0.035	72.4	70.78	72.65	0.002894	4.07	45.69	16.11	0.43
20907	100 yr	200	67.43	0.035	72.54	70.89	72.81	0.002939	4.17	47.97	16.49	0.43
20641	10 yr	186	66.78	0.035	72.06	69.54	72.18	0.001056	2.77	67.27	26.52	0.27
20641	100 yr	200	66.78	0.035	72.19	69.64	72.31	0.001099	2.86	69.9	28.72	0.27
20591	10 yr	236	66.78	0.035	71.88	69.88	72.09	0.001968	3.7	63.74	23.52	0.36
20591	100 yr	250	66.78	0.035	72.01	69.97	72.23	0.001985	3.77	66.29	25.7	0.37
20541	10 yr	256	66.78	0.035	71.69	70	71.97	0.002735	4.27	59.97	20.24	0.43
20541	100 yr	270	66.78	0.035	71.82	70.09	72.11	0.002721	4.32	62.48	22.43	0.43
20141	10 yr	256	65.33	0.035	70.96	68.55	71.15	0.001508	3.43	74.62	32.56	0.32
20141	100 yr	270	65.33	0.035	71.09	68.64	71.28	0.001524	3.49	77.31	34.71	0.32
19641	10 yr	256	63.88	0.035	70.5	67.1	70.61	0.000747	2.65	96.72	49.34	0.23

River Station	Profile	Channel Flow (cfs)	Minimum Channel Elevation (ft)	Manning's Channel Roughness Coefficient	Water Surface Elevation (ft)	Critical Water Surface Elevation (ft)	Energy Grade Elevation (ft)	Energy Grade Slope (ft/ft)	Channel Velocity (ft/s)	Flow Area (sq ft)	Channel Top Width (ft)	Channel Froude #
19641	100 yr	270	63.88	0.035	70.62	67.19	70.73	0.00077	2.71	99.47	51.3	0.23
19255	10 yr	279	62.91	0.035	70.2	66.59	70.31	0.000778	2.73	102.15	24.51	0.24
19255	100 yr	293	62.91	0.035	70.3	66.68	70.43	0.000802	2.8	104.78	24.82	0.24
18755	10 yr	279	62.01	0.035	69.9	65.69	69.98	0.000538	2.38	117.35	26.24	0.2
18755	100 yr	293	62.01	0.035	69.99	65.78	70.08	0.000561	2.44	119.85	26.51	0.2
18255	10 yr	279	61.11	0.035	69.7	64.79	69.76	0.000355	2.03	142.9	54.72	0.16
18255	100 yr	293	61.11	0.035	69.78	64.88	69.85	0.000369	2.09	147.33	56.92	0.17
18000	10 yr	279	60.65	0.035	69.63	64.33	69.68	0.000273	1.85	162.74	64.55	0.14
18000	100 yr	293	60.65	0.035	69.71	64.42	69.77	0.000285	1.91	167.08	66.68	0.15
17990	10 yr	290	58.9	0.035	69.65	62.42	69.67	0.000074	1.15	276.62	70.67	0.08
17990	100 yr	304	58.9	0.035	69.73	62.49	69.75	0.000077	1.19	282.67	70.67	0.08
17900	Meridian Road - Twin 48-inch CMP & 24-inch CMP Culverts											
17881	10 yr	370	57.9	0.035	66.25	61.82	66.34	0.000517	2.48	148.9	30.69	0.2
17881	100 yr	384	57.9	0.035	66.38	61.88	66.48	0.000518	2.51	152.96	31.09	0.2
17381	10 yr	370	57.67	0.035	66.01	61.62	66.1	0.000457	2.34	158.32	33.3	0.19
17381	100 yr	384	57.67	0.035	66.14	61.7	66.23	0.000457	2.36	162.73	33.72	0.19
16884	10 yr	370	56.44	0.035	65.87	60.39	65.92	0.000251	1.88	196.56	44.19	0.14
16884	100 yr	384	56.44	0.035	66	60.47	66.06	0.000251	1.91	201.67	47.53	0.14
16384	10 yr	370	55.84	0.035	65.76	59.79	65.81	0.000192	1.72	216.65	56.8	0.13
16384	100 yr	384	55.84	0.035	65.9	59.87	65.94	0.000193	1.75	222.32	60.13	0.13
15884	10 yr	370	55.24	0.035	65.69	59.19	65.73	0.000146	1.57	239.79	68.09	0.11
15884	100 yr	384	55.24	0.035	65.82	59.27	65.86	0.000148	1.6	245.71	70.45	0.11
15389	10 yr	402	54.6	0.035	65.63	58.09	65.66	0.000111	1.46	304.66	70.67	0.1
15389	100 yr	416	54.6	0.035	65.76	58.15	65.79	0.000111	1.48	313.92	70.67	0.1
15341	Hay Road - Twin 54-inch CMP Culverts											
15285	10 yr	483	53.18	0.035	60.65	56.97	60.79	0.000763	3	161.14	35.31	0.25
15285	100 yr	497	53.18	0.035	60.73	57.03	60.88	0.000767	3.03	164.23	35.61	0.25
15043	10 yr	483	52.6	0.035	60.46	57.09	60.6	0.000765	2.94	164.31	37.32	0.25
15043	100 yr	497	52.6	0.035	60.55	57.13	60.69	0.000767	2.97	167.56	37.61	0.25
14543	10 yr	483	52.24	0.035	60.08	56.72	60.21	0.000778	2.96	163.3	37.23	0.25
14543	100 yr	497	52.24	0.035	60.16	56.77	60.3	0.000781	2.99	166.5	37.51	0.25
14043	10 yr	483	51.88	0.035	59.68	56.37	59.82	0.000796	2.98	161.97	37.11	0.25
14043	100 yr	497	51.88	0.035	59.77	56.41	59.91	0.000799	3.01	165.1	37.39	0.25
13752	10 yr	519	51.68	0.035	59.42	55.73	59.58	0.000844	3.17	163.67	35.71	0.26
13752	100 yr	533	51.68	0.035	59.51	55.78	59.66	0.000849	3.2	166.64	36.03	0.26
13252	10 yr	519	51.2	0.035	59.01	55.25	59.16	0.000811	3.12	166.16	35.98	0.26
13252	100 yr	533	51.2	0.035	59.09	55.3	59.25	0.000816	3.15	169.06	36.28	0.26
12752	10 yr	519	50.72	0.035	58.62	54.77	58.77	0.00077	3.06	169.38	36.32	0.25
12752	100 yr	533	50.72	0.035	58.7	54.82	58.85	0.000778	3.1	172.18	36.61	0.25
12252	10 yr	519	50.24	0.035	58.25	54.29	58.39	0.000723	2.99	173.46	36.74	0.24
12252	100 yr	533	50.24	0.035	58.33	54.34	58.47	0.000732	3.03	176.14	37.02	0.24
11953	10 yr	519	49.96	0.035	58	54.2	58.16	0.000831	3.23	162.6	58.85	0.26
11953	100 yr	533	49.96	0.035	58.07	54.25	58.23	0.00084	3.27	165.3	59.2	0.26
11453	10 yr	519	49.51	0.035	57.59	53.75	57.75	0.00081	3.2	164.23	59.06	0.26

River Station	Profile	Channel Flow (cfs)	Minimum Channel Elevation (ft)	Manning's Channel Roughness Coefficient	Water Surface Elevation (ft)	Critical Water Surface Elevation (ft)	Energy Grade Elevation (ft)	Energy Grade Slope (ft/ft)	Channel Velocity (ft/s)	Flow Area (sq ft)	Channel Top Width (ft)	Channel Froude #
11453	100 yr	533	49.51	0.035	57.65	53.8	57.82	0.00082	3.24	166.78	59.39	0.26
10953	10 yr	519	49.06	0.035	57.19	53.3	57.35	0.000783	3.16	166.36	59.33	0.25
10953	100 yr	533	49.06	0.035	57.25	53.35	57.41	0.000796	3.21	168.68	59.63	0.25
10770	10 yr	592	48.89	0.035	57.12	52.98	57.22	0.000491	2.62	226.13	78.37	0.21
10770	100 yr	606	48.89	0.035	57.18	53.03	57.29	0.000498	2.65	228.77	78.91	0.21
10270	10 yr	592	48.48	0.035	56.89	52.57	56.99	0.000445	2.53	234.33	80.03	0.2
10270	100 yr	606	48.48	0.035	56.94	52.62	57.05	0.000453	2.56	236.83	80.54	0.2
9770	10 yr	592	48.44	0.035	56.64	52.53	56.75	0.000498	2.63	225.12	78.17	0.21
9770	100 yr	606	48.44	0.035	56.69	52.58	56.81	0.000507	2.67	227.37	78.63	0.21
9596	10 yr	592	47.92	0.035	56.48		56.64	0.000814	3.2	184.96	38.96	0.26
9596	100 yr	606	47.92	0.035	56.53		56.69	0.000831	3.24	186.78	39.14	0.26
9396	10 yr	592	46.83	0.035	56.36		56.48	0.000533	2.75	214.9	41.08	0.21
9396	100 yr	606	46.83	0.035	56.4		56.52	0.000546	2.8	216.7	41.25	0.22
9236	10 yr	633	46.99	0.035	56.26		56.4	0.000676	2.92	216.68	46.73	0.24
9236	100 yr	647	46.99	0.035	56.31		56.44	0.000689	2.96	218.65	46.94	0.24
9053	10 yr	633	46.64	0.035	56.24	51.22	56.3	0.000252	2.06	378.25	141.37	0.15
9053	100 yr	647	46.64	0.035	56.29	51.25	56.34	0.000256	2.08	382.28	141.51	0.15
8553	10 yr	633	46.54	0.035	56.12	51.12	56.17	0.000256	2.07	375.58	141.28	0.15
8553	100 yr	647	46.54	0.035	56.16	51.15	56.22	0.000261	2.1	379.39	141.41	0.15
8053	10 yr	633	46.44	0.035	55.98	51.02	56.04	0.000262	2.09	372.66	141.18	0.15
8053	100 yr	647	46.44	0.035	56.02	51.05	56.08	0.000267	2.11	376.23	141.3	0.15
7787	10 yr	675	46.39	0.035	55.93	50.27	55.98	0.000194	1.87	443.05	145.04	0.13
7787	100 yr	689	46.39	0.035	55.97	50.31	56.02	0.000197	1.9	446.82	145.16	0.13
7287	10 yr	675	45.82	0.035	55.86	49.7	55.9	0.000145	1.69	494.15	146.68	0.12
7287	100 yr	689	45.82	0.035	55.89	49.74	55.93	0.000148	1.71	497.78	146.8	0.12
6787	10 yr	675	45.25	0.035	55.83	49.13	55.84	0.000063	1.16	808.03	157.44	0.08
6787	100 yr	689	45.25	0.035	55.86	49.17	55.88	0.000064	1.18	813.44	157.44	0.08
6662	10 yr	675	44.11	0.035	55.79	48.25	55.83	0.000118	1.63	449.02	78.85	0.11
6662	100 yr	689	44.11	0.035	55.82	48.29	55.86	0.000121	1.65	451.64	78.85	0.11
6561	Private Farm Road - Twin 54-inch CMP Culverts											
6460	10 yr	681	42.51	0.035	50.11	46.92	50.51	0.002084	5.11	133.35	24.39	0.38
6460	100 yr	695	42.51	0.035	50.18	46.97	50.59	0.002091	5.14	135.2	24.52	0.39
5960	10 yr	681	41.51	0.035	49.03	45.92	49.45	0.00216	5.18	131.58	49.01	0.39
5960	100 yr	695	41.51	0.035	49.1	45.97	49.53	0.002174	5.22	133.27	49.73	0.39
5460	10 yr	681	40.51	0.035	47.89	44.92	48.33	0.002325	5.32	128.06	47.51	0.41
5460	100 yr	695	40.51	0.035	47.94	44.97	48.39	0.002352	5.37	129.44	48.1	0.41
5246	10 yr	684	40.07	0.035	47.7	44.25	47.93	0.001114	3.85	182.67	49.53	0.3
5246	100 yr	698	40.07	0.035	47.76	44.29	47.99	0.001117	3.88	185.58	49.63	0.31
5196	10 yr	697	40.07	0.035	47.63	44.29	47.87	0.001215	3.99	178.9	49.4	0.32
5196	100 yr	711	40.07	0.035	47.68	44.34	47.93	0.001218	4.02	181.79	49.5	0.32
4746	10 yr	697	39.81	0.035	46.94	44.03	47.24	0.001601	4.37	159.48	38.28	0.36
4746	100 yr	711	39.81	0.035	47	44.08	47.3	0.001606	4.41	161.67	40.83	0.36
4246	10 yr	697	39.55	0.035	45.66	43.77	46.14	0.003087	5.56	125.28	31.49	0.49
4246	100 yr	711	39.55	0.035	45.71	43.82	46.2	0.003115	5.61	126.71	31.65	0.49

River Station	Profile	Channel Flow (cfs)	Minimum Channel Elevation (ft)	Manning's Channel Roughness Coefficient	Water Surface Elevation (ft)	Critical Water Surface Elevation (ft)	Energy Grade Elevation (ft)	Energy Grade Slope (ft/ft)	Channel Velocity (ft/s)	Flow Area (sq ft)	Channel Top Width (ft)	Channel Froude #
3927	10 yr	722	36.69	0.035	45.32	42.12	45.53	0.001055	3.69	212.99	75.36	0.3
3927	100 yr	736	36.69	0.035	45.37	42.17	45.58	0.001057	3.72	216.55	75.36	0.3
3427	10 yr	722	36.15	0.035	44.8	41.58	45	0.00104	3.67	214.36	75.36	0.29
3427	100 yr	736	36.15	0.035	44.85	41.62	45.05	0.001042	3.7	217.84	75.36	0.3
2927	10 yr	722	35.61	0.035	44.29	41.04	44.49	0.001017	3.65	216.55	75.36	0.29
2927	100 yr	736	35.61	0.035	44.33	41.08	44.54	0.00102	3.68	219.9	75.36	0.29
2427	10 yr	722	35.07	0.035	43.79	40.5	43.99	0.000983	3.61	219.83	75.36	0.29
2427	100 yr	736	35.07	0.035	43.83	40.54	44.03	0.000988	3.64	222.99	75.36	0.29
2294	10 yr	722	37.63	0.035	43.7	41.47	43.85	0.000943	3.33	264.76	82.54	0.29
2294	100 yr	736	37.63	0.035	43.74	41.5	43.89	0.000943	3.35	268.26	82.54	0.29
1794	10 yr	722	37.18	0.035	43.22	41.02	43.37	0.000971	3.36	262.17	82.54	0.29
1794	100 yr	736	37.18	0.035	43.26	41.05	43.41	0.000971	3.39	265.68	82.54	0.29
1294	10 yr	722	36.73	0.035	42.72	40.57	42.87	0.001017	3.41	258	82.54	0.3
1294	100 yr	736	36.73	0.035	42.76	40.6	42.92	0.001016	3.44	261.55	82.54	0.3
868	10 yr	722	36.35	0.035	42.42	39.82	42.52	0.000634	2.69	323.76	118.49	0.24
868	100 yr	736	36.35	0.035	42.46	39.85	42.56	0.000632	2.71	329.03	118.49	0.24
511	10 yr	722	36.66	0.035	42.13	39.78	42.26	0.000802	3.07	275.54	86.78	0.27
511	100 yr	736	36.66	0.035	42.17	39.8	42.31	0.000801	3.09	279.39	86.78	0.27
0	10 yr	722	36.02	0.035	41.6	39.31	41.78	0.0011	3.39	225.86	77.18	0.3
0	100 yr	736	36.02	0.035	41.65	39.34	41.83	0.0011	3.41	229.16	77.34	0.3

Table F-2. HEC-RAS Summary Output for Post-Development Conditions

River Station	Profile	Channel Flow (cfs)	Minimum Channel Elevation (ft)	Manning's Channel Roughness Coefficient	Water Surface Elevation (ft)	Critical Water Surface Elevation (ft)	Energy Grade Elevation (ft)	Energy Grade Slope (ft/ft)	Channel Velocity (ft/s)	Flow Area (sq ft)	Channel Top Width (ft)	Channel Froude #
25639	10 yr	334	81.5	0.035	89.06		89.1	0.000293	1.73	302.29	177.42	0.15
25639	100 yr	456	81.5	0.035	91.13		91.14	0.000084	1.16	713.71	275	0.09
25611	10 yr	334	78.5	0.035	89.08	80.4	89.08	0.000002	0.21	2225.73	454.9	0.01
25611	100 yr	456	78.5	0.035	91.14	80.79	91.14	0.000001	0.2	3159.56	454.9	0.01
25566.5	Southern Pacific Railroad - Existing 60-inch CMP Culverts & Proposed 36-inch RCP Culvert											
25497	10 yr	338	78.4	0.035	87.11	80.1	87.13	0.000051	0.99	340.64	51.86	0.07
25497	100 yr	464	78.4	0.035	88.26	80.48	88.28	0.000056	1.14	423.36	78.92	0.07
25434.5	SID D-1-C Irrigation Canal Crossing - Proposed 60-inch RCP & 36-inch RCP Culverts											
25381	10 yr	338	78.02	0.04	84.34	81.9	84.51	0.001613	3.26	103.74	29.28	0.31
25381	100 yr	464	78.02	0.04	85.22	82.33	85.41	0.001624	3.55	130.83	32.58	0.31
25201	10 yr	338	78.02	0.04	84.04	81.79	84.2	0.001755	3.26	103.82	31.52	0.32
25201	100 yr	464	78.02	0.04	84.93	82.28	85.12	0.001661	3.48	133.38	37.9	0.31
25055	10 yr	338	77.88	0.04	83.76	81.36	83.94	0.001821	3.41	99.26	28.99	0.32
25055	100 yr	464	77.88	0.04	84.65	81.91	84.86	0.001794	3.66	126.8	32.81	0.33
24826	10 yr	338	77.32	0.04	83.48	80.44	83.61	0.001076	2.86	118.18	29.78	0.25
24826	100 yr	464	77.32	0.04	84.36	80.96	84.52	0.001146	3.19	145.6	34.43	0.27
24574	10 yr	338	77.21	0.04	83.19	80.28	83.33	0.00116	2.96	114.17	28.67	0.26
24574	100 yr	464	77.21	0.04	84.05	80.8	84.22	0.001251	3.32	139.67	30.94	0.28
24309	10 yr	345	76.93	0.04	82.87	79.91	83.01	0.001234	3.06	112.91	27.89	0.27
24309	100 yr	478	76.93	0.04	83.67	80.46	83.86	0.001411	3.51	136.33	34.9	0.29
24047	10 yr	345	76.63	0.045	82.46	79.73	82.62	0.001828	3.23	106.72	27.65	0.29
24047	100 yr	478	76.63	0.045	83.2	80.28	83.41	0.002135	3.74	127.94	33.06	0.32
23309	10 yr	345	75.65	0.035	79.17		79.9	0.010195	6.85	50.33	23.2	0.82
23309	100 yr	478	75.65	0.035	80.02		80.72	0.0072	6.72	71.12	25.69	0.71
23120	10 yr	345	73.42	0.035	78.49	76.78	78.84	0.002979	4.73	72.87	21.89	0.46
23120	100 yr	478	73.42	0.035	79.43	77.42	79.82	0.002818	5.05	94.74	24.63	0.45
22620	10 yr	345	71.71	0.035	77.41	75.07	77.66	0.001827	3.95	87.34	23.74	0.36
22620	100 yr	478	71.71	0.035	78.4	75.7	78.68	0.001788	4.26	112.2	26.62	0.37
22120	10 yr	353	70	0.035	76.88	73.4	77.02	0.000866	3.01	117.28	27.17	0.26
22120	100 yr	486	70	0.035	77.85	74.03	78.02	0.000929	3.35	145.02	30	0.27
21907	10 yr	367	69.27	0.035	76.47	73.86	76.74	0.001934	4.14	88.6	22.26	0.37
21907	100 yr	500	69.27	0.035	77.41	74.55	77.73	0.001985	4.52	110.7	38.72	0.38
21407	10 yr	374	68.35	0.035	75.4	72.97	75.7	0.002227	4.39	85.23	21.84	0.39
21407	100 yr	507	68.35	0.035	76.31	73.67	76.66	0.002281	4.78	106.17	35.28	0.4
20907	10 yr	374	67.43	0.035	73.99	72.05	74.38	0.003149	5	74.82	20.48	0.46
20907	100 yr	507	67.43	0.035	74.86	72.75	75.32	0.003178	5.41	93.73	25.45	0.47
20641	10 yr	374	66.78	0.035	73.5	70.73	73.74	0.001669	3.96	94.43	33.33	0.34
20641	100 yr	507	66.78	0.035	74.33	71.37	74.64	0.001839	4.44	114.17	43.45	0.36
20591	10 yr	424	66.78	0.035	73.28	70.98	73.63	0.002472	4.73	89.61	31.57	0.41
20591	100 yr	557	66.78	0.035	74.12	71.59	74.52	0.002523	5.12	108.87	38.83	0.42
20541	10 yr	444	66.78	0.035	73.08	71.05	73.48	0.003	5.13	86.5	31.79	0.46
20541	100 yr	577	66.78	0.035	73.92	71.65	74.38	0.002931	5.45	105.93	39.55	0.46
20141	10 yr	444	65.33	0.035	72.08	69.63	72.42	0.002288	4.65	95.43	33.84	0.4
20141	100 yr	577	65.33	0.035	72.94	70.23	73.32	0.002302	4.99	115.64	44.85	0.41

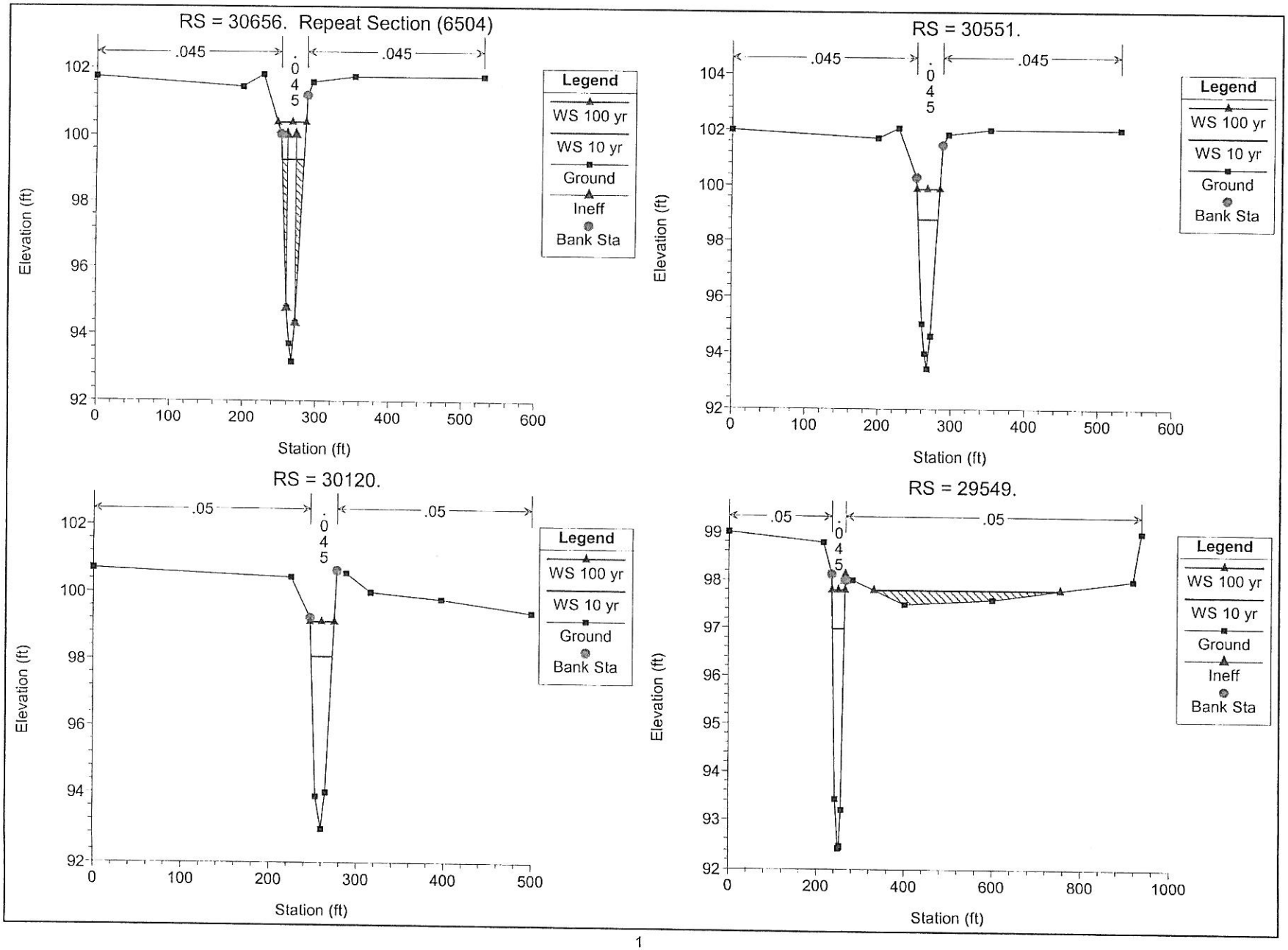
River Station	Profile	Channel Flow (cfs)	Minimum Channel Elevation (ft)	Manning's Channel Roughness Coefficient	Water Surface Elevation (ft)	Critical Water Surface Elevation (ft)	Energy Grade Elevation (ft)	Energy Grade Slope (ft/ft)	Channel Velocity (ft/s)	Flow Area (sq ft)	Channel Top Width (ft)	Channel Froude #
19641	10 yr	444	63.88	0.035	71.11	68.21	71.39	0.001807	4.28	103.86	34.18	0.36
19641	100 yr	577	63.88	0.035	71.92	68.82	72.26	0.001919	4.68	123.41	49.5	0.37
19255	10 yr	467	62.91	0.035	70.36	67.63	70.66	0.001969	4.4	106.14	24.98	0.38
19255	100 yr	600	62.91	0.035	71.15	68.23	71.5	0.002024	4.73	126.79	35.91	0.39
18755	10 yr	467	62.01	0.035	69.3	66.73	69.62	0.002182	4.57	102.13	24.51	0.39
18755	100 yr	600	62.01	0.035	70.04	67.33	70.42	0.002289	4.96	121.07	26.64	0.41
18255	10 yr	467	61.11	0.035	67.95	65.84	68.35	0.002928	5.11	91.46	23.22	0.45
18255	100 yr	600	61.11	0.035	68.56	66.43	69.05	0.003256	5.66	106.08	24.97	0.48
18000	10 yr	467	60.65	0.035	65.38	65.38	66.8	0.015655	9.57	48.8	17.13	1
18000	100 yr	600	60.65	0.035	66.49	65.97	67.64	0.010019	8.62	69.59	20.33	0.82
17990	10 yr	478	58.9	0.035	66.12	63.35	66.35	0.001518	3.89	122.89	29.7	0.34
17990	100 yr	611	58.9	0.035	67.09	63.86	67.34	0.001359	3.98	153.36	32.82	0.32
17900	Meridian Road - Proposed 16' X 8' ConSpan Culvert											
17881	10 yr	558	57.9	0.035	65.92	62.64	66.17	0.001413	4.01	139.04	29.7	0.33
17881	100 yr	691	57.9	0.035	66.67	63.14	66.95	0.001436	4.26	162.09	31.96	0.33
17381	10 yr	558	57.67	0.035	65.07	62.43	65.36	0.001834	4.34	128.43	30.29	0.37
17381	100 yr	691	57.67	0.035	65.83	62.9	66.15	0.001766	4.53	152.44	32.73	0.37
16884	10 yr	558	56.44	0.035	64.34	61.2	64.57	0.00135	3.88	143.78	31.87	0.32
16884	100 yr	691	56.44	0.035	65.12	61.67	65.38	0.001318	4.07	169.86	34.38	0.32
16384	10 yr	558	55.84	0.035	63.62	60.6	63.87	0.001443	3.98	140.28	31.52	0.33
16384	100 yr	691	55.84	0.035	64.44	61.07	64.71	0.001379	4.14	167.02	34.12	0.33
15884	10 yr	558	55.24	0.035	62.84	60	63.1	0.001621	4.15	134.42	30.92	0.35
15884	100 yr	691	55.24	0.035	63.71	60.47	63.99	0.001484	4.25	162.54	33.7	0.34
15389	10 yr	590	54.6	0.035	62.03	58.85	62.3	0.001613	4.22	139.77	30.18	0.35
15389	100 yr	723	54.6	0.035	62.99	59.36	63.27	0.001427	4.25	170.26	33.25	0.33
15341	Hay Road - Proposed 16' X 8' ConSpan Culvert											
15285	10 yr	671	53.18	0.035	61.71	57.62	61.88	0.000814	3.34	200.65	39.03	0.26
15285	100 yr	804	53.18	0.035	62.39	58.03	62.58	0.000828	3.53	227.97	41.4	0.26
15043	10 yr	671	52.6	0.035	61.52	57.68	61.69	0.000794	3.26	205.55	40.85	0.26
15043	100 yr	804	52.6	0.035	62.2	58.04	62.38	0.000798	3.44	234.03	43.11	0.26
14543	10 yr	671	52.24	0.035	61.11	57.32	61.28	0.000814	3.29	203.72	40.7	0.26
14543	100 yr	804	52.24	0.035	61.79	57.68	61.98	0.000817	3.47	232.01	42.96	0.26
14043	10 yr	671	51.88	0.035	60.7	56.96	60.87	0.000841	3.33	201.38	40.5	0.26
14043	100 yr	804	51.88	0.035	61.37	57.32	61.56	0.000843	3.5	229.46	42.76	0.27
13752	10 yr	707	51.68	0.035	60.42	56.39	60.61	0.000904	3.51	201.26	39.6	0.27
13752	100 yr	840	51.68	0.035	61.1	56.78	61.31	0.000908	3.67	228.89	42.31	0.28
13252	10 yr	707	51.2	0.035	59.98	55.9	60.17	0.000886	3.49	202.63	39.67	0.27
13252	100 yr	840	51.2	0.035	60.65	56.31	60.86	0.000891	3.65	230.17	42.26	0.28
12752	10 yr	707	50.72	0.035	59.54	55.42	59.73	0.000866	3.46	204.4	39.85	0.27
12752	100 yr	840	50.72	0.035	60.21	55.83	60.41	0.000873	3.62	231.92	42.44	0.27
12252	10 yr	707	50.24	0.035	59.12	54.95	59.3	0.000842	3.42	206.64	40.12	0.27
12252	100 yr	840	50.24	0.035	59.78	55.34	59.98	0.000854	3.59	234.17	42.76	0.27
11953	10 yr	707	49.96	0.035	58.74	54.88	59	0.001171	4.05	174.6	53.75	0.3
11953	100 yr	840	49.96	0.035	59.38	55.31	59.67	0.001219	4.3	195.41	57.03	0.31

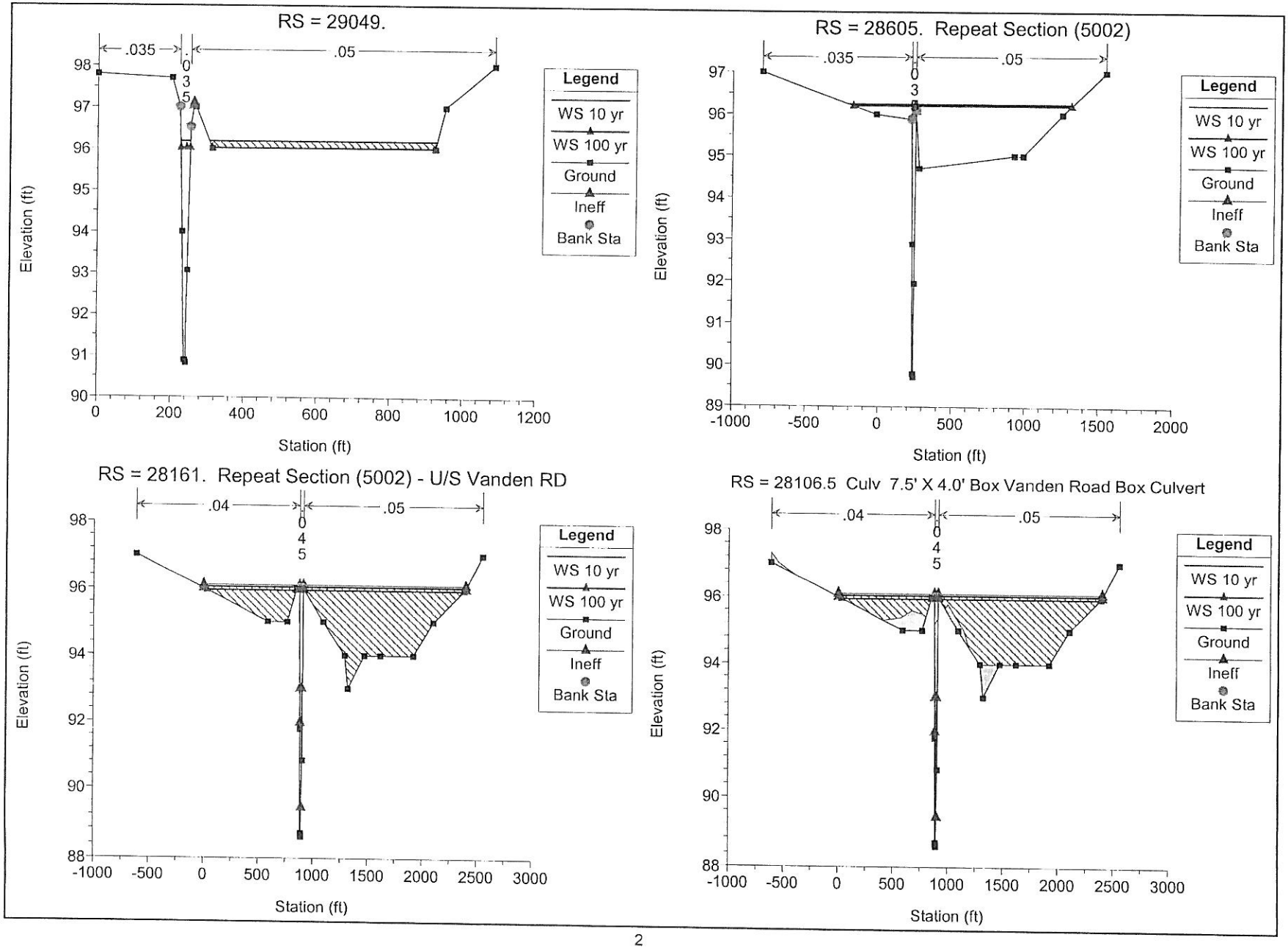
River Station	Profile	Channel Flow (cfs)	Minimum Channel Elevation (ft)	Manning's Channel Roughness Coefficient	Water Surface Elevation (ft)	Critical Water Surface Elevation (ft)	Energy Grade Elevation (ft)	Energy Grade Slope (ft/ft)	Channel Velocity (ft/s)	Flow Area (sq ft)	Channel Top Width (ft)	Channel Froude #
11453	10 yr	707	49.51	0.035	58.11	54.43	58.38	0.001277	4.18	169.21	52.93	0.32
11453	100 yr	840	49.51	0.035	58.72	54.86	59.03	0.001341	4.45	188.75	56.11	0.33
10953	10 yr	707	49.06	0.035	57.4	53.98	57.7	0.001456	4.38	161.37	51.6	0.34
10953	100 yr	840	49.06	0.035	57.96	54.4	58.31	0.001549	4.69	179.08	54.64	0.35
10770	10 yr	780	48.89	0.035	57.3	53.47	57.48	0.00077	3.32	234.59	80.09	0.26
10770	100 yr	913	48.89	0.035	57.88	53.79	58.07	0.000782	3.5	261.2	85.32	0.26
10270	10 yr	780	48.48	0.035	56.92	53.06	57.09	0.000758	3.31	235.93	80.35	0.26
10270	100 yr	913	48.48	0.035	57.49	53.38	57.68	0.000774	3.48	262.24	85.52	0.26
9770	10 yr	780	48.44	0.035	56.47	53.02	56.67	0.000955	3.59	217.19	76.54	0.29
9770	100 yr	913	48.44	0.035	57.02	53.34	57.24	0.000964	3.77	242.32	81.63	0.29
9596	10 yr	780	47.92	0.035	56.11		56.43	0.001749	4.56	170.9	37.55	0.38
9596	100 yr	913	47.92	0.035	56.66		57.01	0.00175	4.75	192.04	39.65	0.38
9396	10 yr	780	46.83	0.035	55.83		56.08	0.00122	4.03	193.68	39.03	0.32
9396	100 yr	913	46.83	0.035	56.37		56.65	0.001259	4.24	215.41	41.13	0.33
9236	10 yr	821	46.99	0.035	55.59		55.89	0.001703	4.41	186.17	43.32	0.37
9236	100 yr	954	46.99	0.035	56.14		56.46	0.001647	4.52	210.99	46.11	0.37
9053	10 yr	821	46.64	0.035	55.43	51.74	55.64	0.000891	3.63	226.27	117.88	0.28
9053	100 yr	954	46.64	0.035	55.99	52.04	56.21	0.000908	3.81	250.09	121.33	0.28
8553	10 yr	821	46.54	0.035	54.89	51.64	55.13	0.001133	3.94	208.49	116	0.31
8553	100 yr	954	46.54	0.035	55.44	51.95	55.7	0.001137	4.12	231.62	119.64	0.31
8053	10 yr	821	46.44	0.035	54.13	51.54	54.44	0.001688	4.5	182.37	113.23	0.37
8053	100 yr	954	46.44	0.035	54.69	51.85	55.02	0.001626	4.64	205.53	117.63	0.37
7787	10 yr	863	46.39	0.035	53.76	50.8	54.03	0.001361	4.2	205.37	114.47	0.34
7787	100 yr	996	46.39	0.035	54.33	51.13	54.62	0.001302	4.31	230.95	118.87	0.34
7287	10 yr	863	45.82	0.035	53.02	50.23	53.31	0.001505	4.36	198.14	113.2	0.36
7287	100 yr	996	45.82	0.035	53.65	50.56	53.95	0.00139	4.41	225.66	117.97	0.35
6787	10 yr	863	45.25	0.035	52.15	49.66	52.48	0.001818	4.66	185.36	110.9	0.39
6787	100 yr	996	45.25	0.035	52.89	49.99	53.21	0.001547	4.58	217.24	116.53	0.36
6662	10 yr	863	44.11	0.035	51.99	48.78	52.26	0.001424	4.19	205.99	48.22	0.35
6662	100 yr	996	44.11	0.035	52.76	49.12	53.02	0.001206	4.11	242.33	53.45	0.32
6561	Private Farm Road - Proposed 16' X 10' Conspan Culvert											
6460	10 yr	869	42.51	0.035	51.29	47.66	51.77	0.002185	5.56	156.16	24.82	0.39
6460	100 yr	1002	42.51	0.035	51.92	48.1	52.44	0.00224	5.82	172.05	25.81	0.4
5960	10 yr	869	41.51	0.035	50.13	46.66	50.64	0.002339	5.71	152.27	42.84	0.4
5960	100 yr	1002	41.51	0.035	50.71	47.1	51.27	0.002432	6.01	166.84	47.22	0.41
5460	10 yr	869	40.51	0.035	48.82	45.66	49.38	0.002682	6	144.73	40.51	0.43
5460	100 yr	1002	40.51	0.035	49.31	46.1	49.95	0.002879	6.39	156.69	44.19	0.45
5246	10 yr	872	40.07	0.035	48.61	44.93	48.91	0.001341	4.4	198.04	49.74	0.33
5246	100 yr	1005	40.07	0.035	49.11	45.31	49.44	0.001389	4.64	218.19	75.24	0.34
5196	10 yr	885	40.07	0.035	48.52	44.97	48.84	0.001445	4.54	194.74	47.58	0.35
5196	100 yr	1018	40.07	0.035	49.01	45.34	49.37	0.001499	4.78	213.33	73.14	0.36
4746	10 yr	885	39.81	0.035	47.7	44.7	48.09	0.001907	5.03	176	34.97	0.39
4746	100 yr	1018	39.81	0.035	48.15	45.07	48.59	0.001989	5.3	192.24	45.36	0.41
4246	10 yr	885	39.55	0.035	46.23	44.34	46.82	0.003433	6.16	143.7	33.48	0.52
4246	100 yr	1018	39.55	0.035	46.59	44.71	47.25	0.003641	6.53	155.95	34.75	0.54

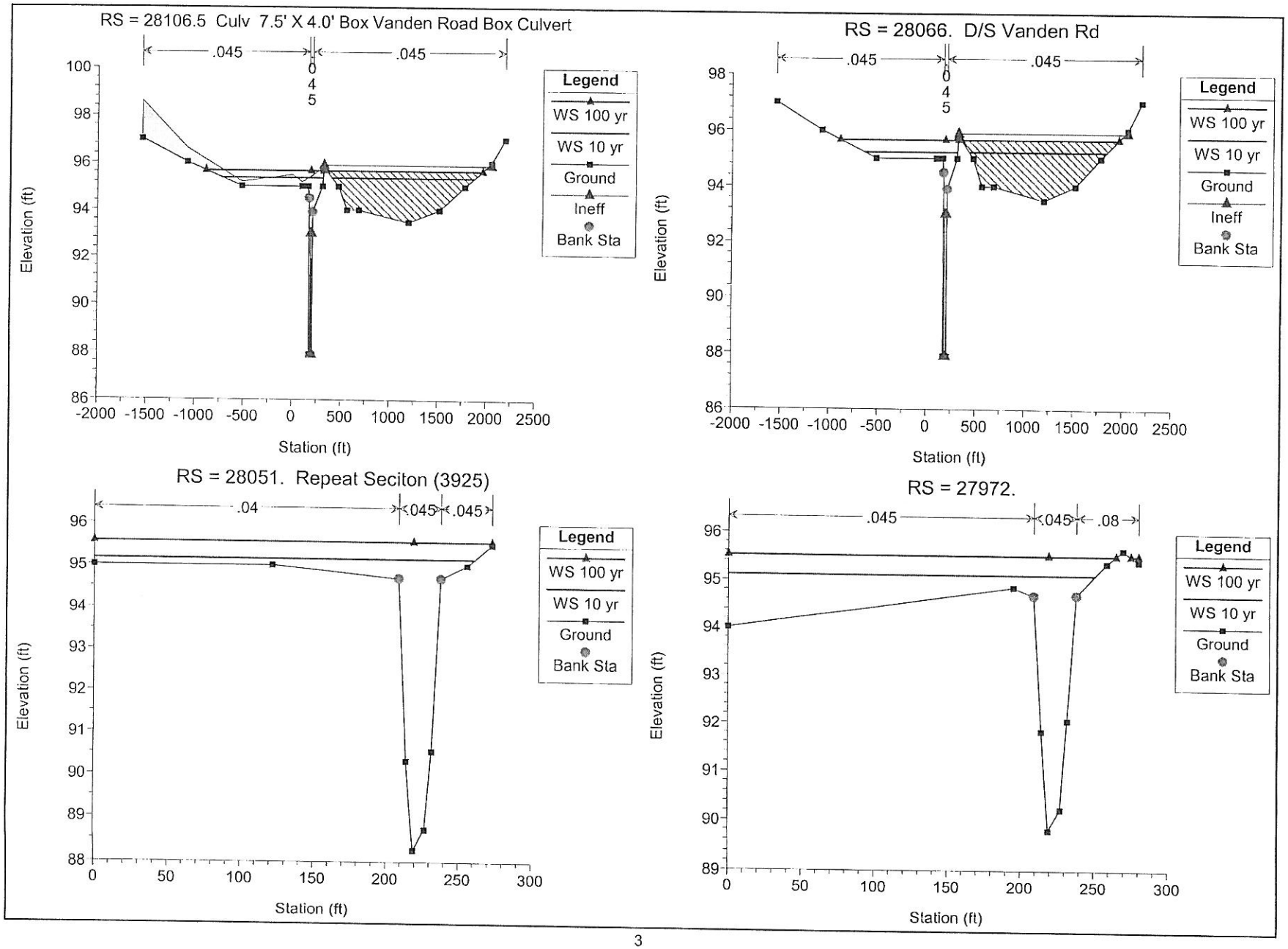
River Station	Profile	Channel Flow (cfs)	Minimum Channel Elevation (ft)	Manning's Channel Roughness Coefficient	Water Surface Elevation (ft)	Critical Water Surface Elevation (ft)	Energy Grade Elevation (ft)	Energy Grade Slope (ft/ft)	Channel Velocity (ft/s)	Flow Area (sq ft)	Channel Top Width (ft)	Channel Froude #
3927	10 yr	910	36.69	0.035	45.91	42.62	46.15	0.001071	4.02	257.73	75.36	0.3
3927	100 yr	1043	36.69	0.035	46.3	42.93	46.56	0.001079	4.22	286.42	75.36	0.31
3427	10 yr	910	36.15	0.035	45.38	42.08	45.62	0.001065	4.01	258.3	75.36	0.3
3427	100 yr	1043	36.15	0.035	45.76	42.39	46.02	0.001078	4.22	286.5	75.36	0.31
2927	10 yr	910	35.61	0.035	44.85	41.54	45.09	0.001057	4	259.12	75.36	0.3
2927	100 yr	1043	35.61	0.035	45.22	41.85	45.48	0.001076	4.22	286.64	75.36	0.31
2427	10 yr	910	35.07	0.035	44.33	41	44.56	0.001044	3.98	260.37	75.36	0.3
2427	100 yr	1043	35.07	0.035	44.68	41.31	44.94	0.001074	4.21	286.84	75.36	0.31
2294	10 yr	910	37.63	0.035	44.24	42.06	44.41	0.000945	3.62	309.65	82.54	0.29
2294	100 yr	1043	37.63	0.035	44.6	42.27	44.79	0.000948	3.8	338.92	82.54	0.3
1794	10 yr	910	37.18	0.035	43.76	41.61	43.94	0.000968	3.65	307.08	82.54	0.3
1794	100 yr	1043	37.18	0.035	44.11	41.82	44.31	0.000971	3.83	336.22	82.54	0.3
1294	10 yr	910	36.73	0.035	43.26	41.16	43.44	0.001005	3.69	303.28	82.54	0.3
1294	100 yr	1043	36.73	0.035	43.62	41.37	43.81	0.001004	3.87	332.42	82.54	0.3
868	10 yr	910	36.35	0.035	42.99	40.19	43.1	0.000606	2.87	391	118.49	0.23
868	100 yr	1043	36.35	0.035	43.35	40.37	43.47	0.000594	2.99	434.01	118.49	0.24
511	10 yr	910	36.66	0.035	42.69	40.19	42.85	0.000792	3.32	324.55	86.78	0.27
511	100 yr	1043	36.66	0.035	43.05	40.41	43.22	0.000794	3.49	355.6	86.78	0.27
0	10 yr	910	36.02	0.035	42.17	39.65	42.37	0.001101	3.66	268	79.24	0.31
0	100 yr	1043	36.02	0.035	42.52	39.88	42.74	0.0011	3.83	301.29	93.36	0.31

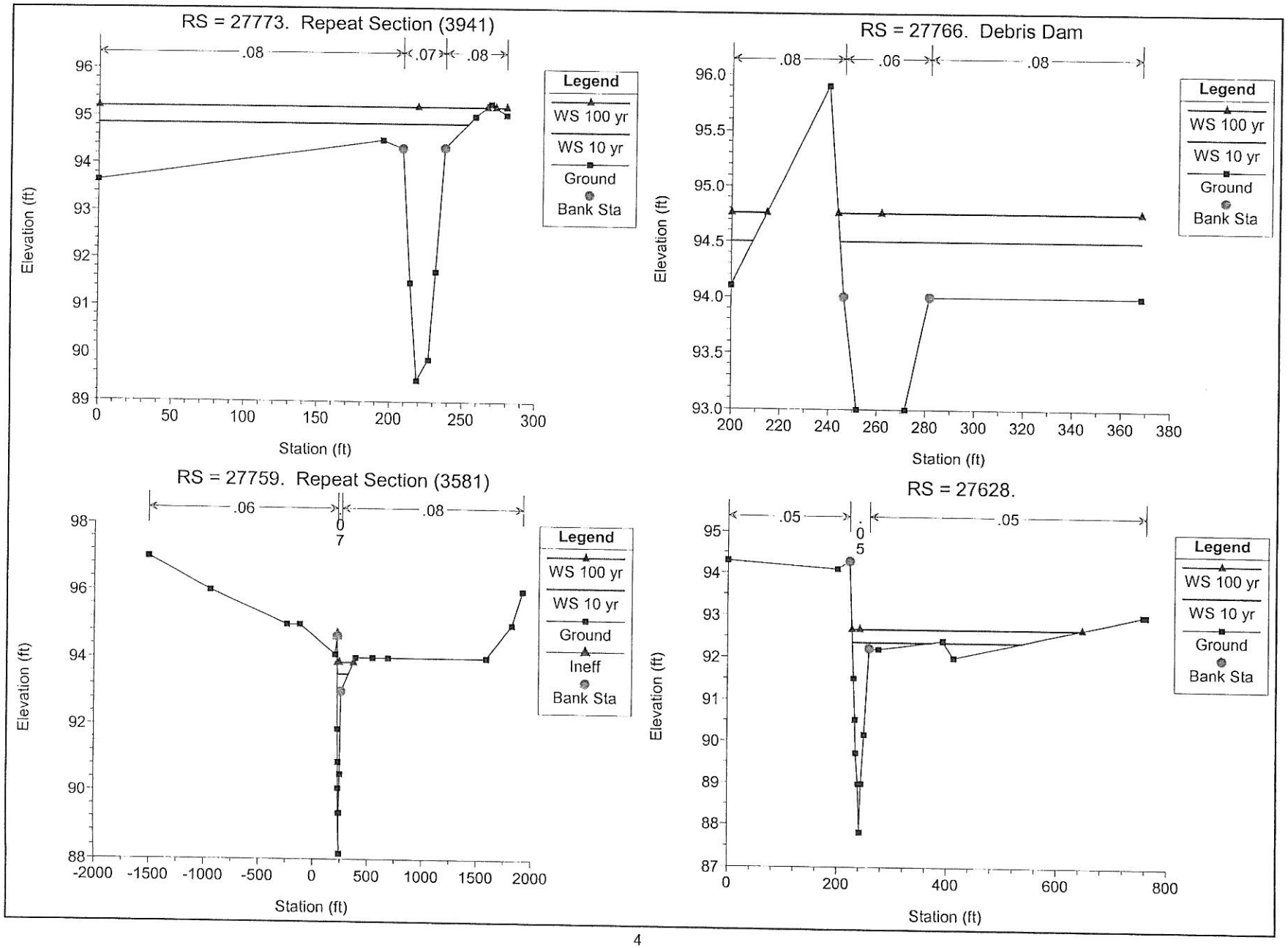
APPENDIX G

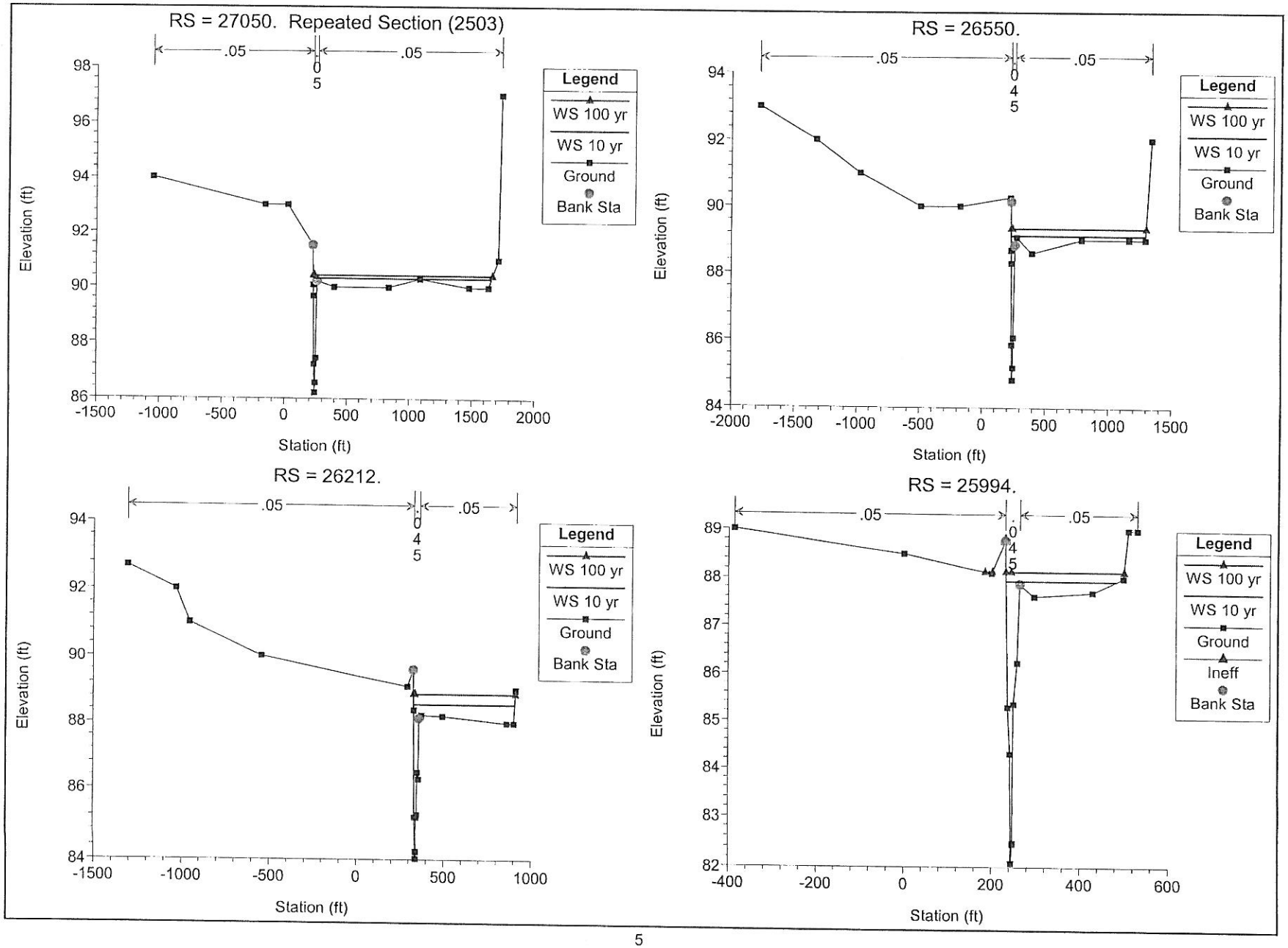
HEC-RAS Channel Cross-Sections of the Brazelton Drain (from Nut Tree Road to the Railroad Under Existing Conditions)

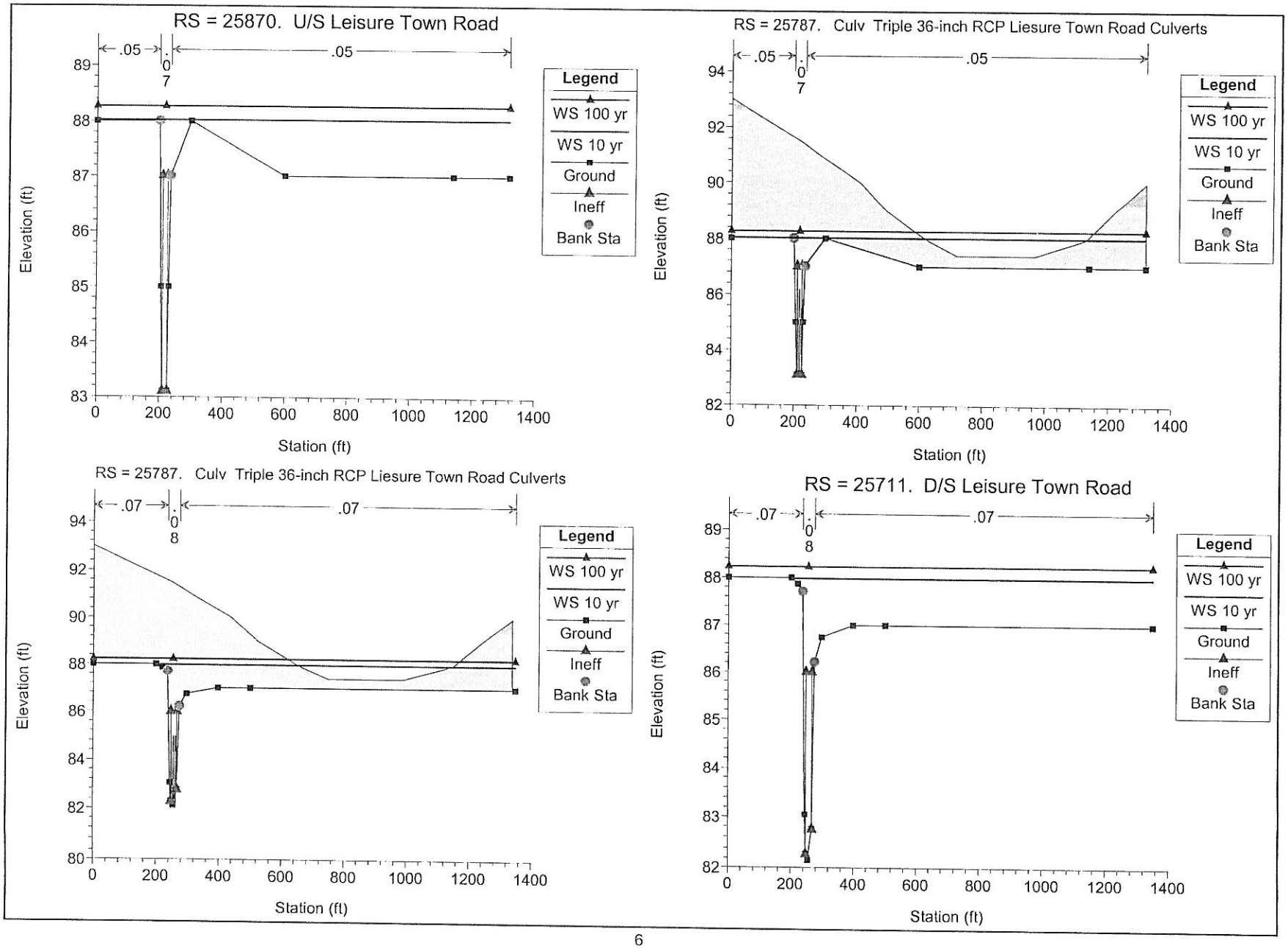

RS = 30656. Repeat Section (6504)
.045
.045
.045
Legend
WS 100 yr
WS 10 yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
RS = 30551.
.045
.045
.045
Legend
WS 100 yr
WS 10 yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
RS = 30120.
.05
.05
.045
Legend
WS 100 yr
WS 10 yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
RS = 29549.
.05
.05
.045
Legend
WS 100 yr
WS 10 yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

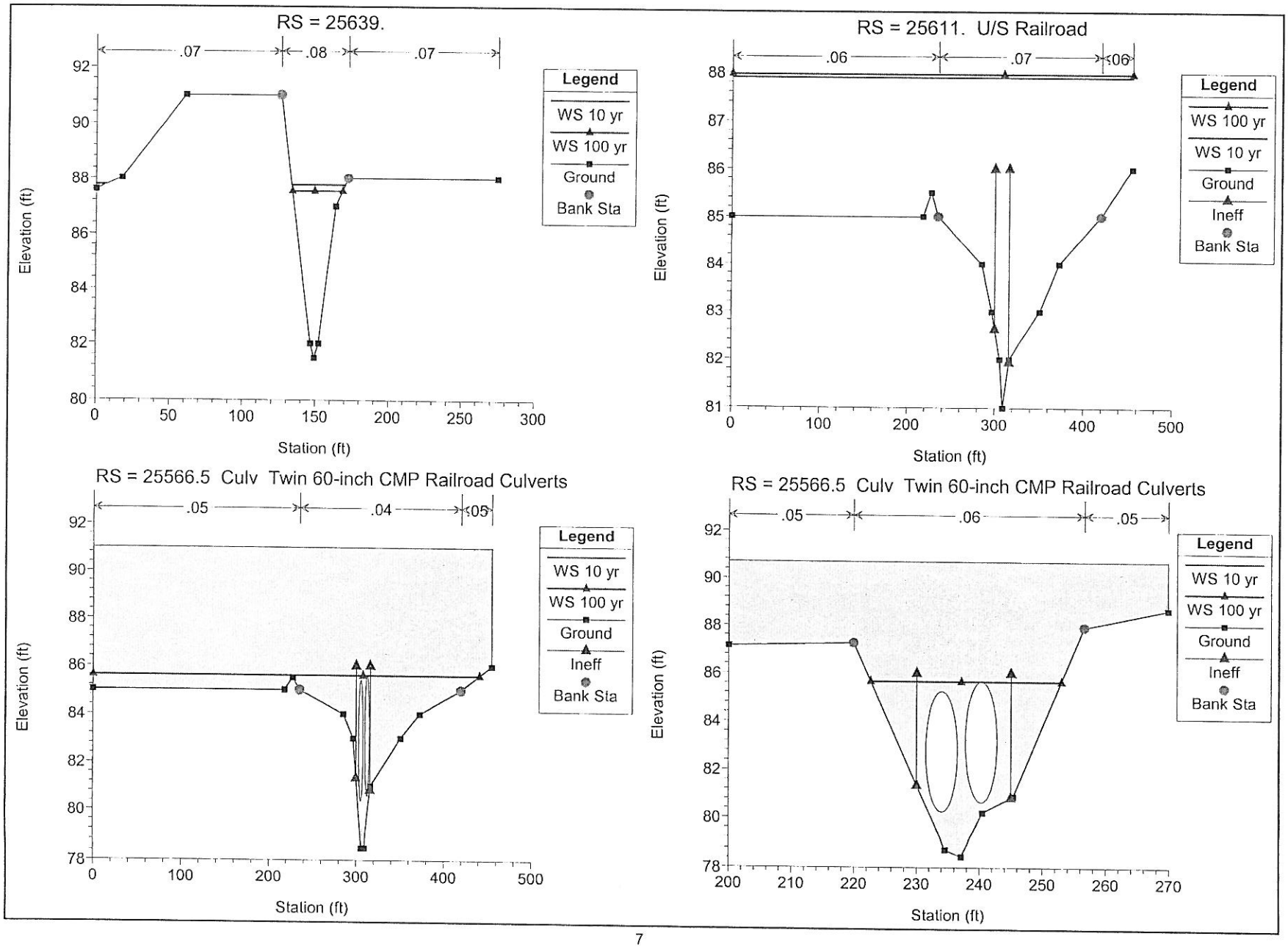

RS = 29049.
.035
.05
Elevation (ft)
Station (ft)
Legend
WS 10 yr
WS 100 yr
Ground
Ineff
Bank Sta
RS = 28605. Repeat Section (5002)
.035
.05
Elevation (ft)
Station (ft)
Legend
WS 10 yr
WS 100 yr
Ground
Ineff
Bank Sta
RS = 28161. Repeat Section (5002) - U/S Vanden RD
.04
.05
Elevation (ft)
Station (ft)
Legend
WS 10 yr
WS 100 yr
Ground
Ineff
Bank Sta
RS = 28106.5 Culv 7.5' X 4.0' Box Vanden Road Box Culvert
.04
.05
Elevation (ft)
Station (ft)
Legend
WS 10 yr
WS 100 yr
Ground
Ineff
Bank Sta

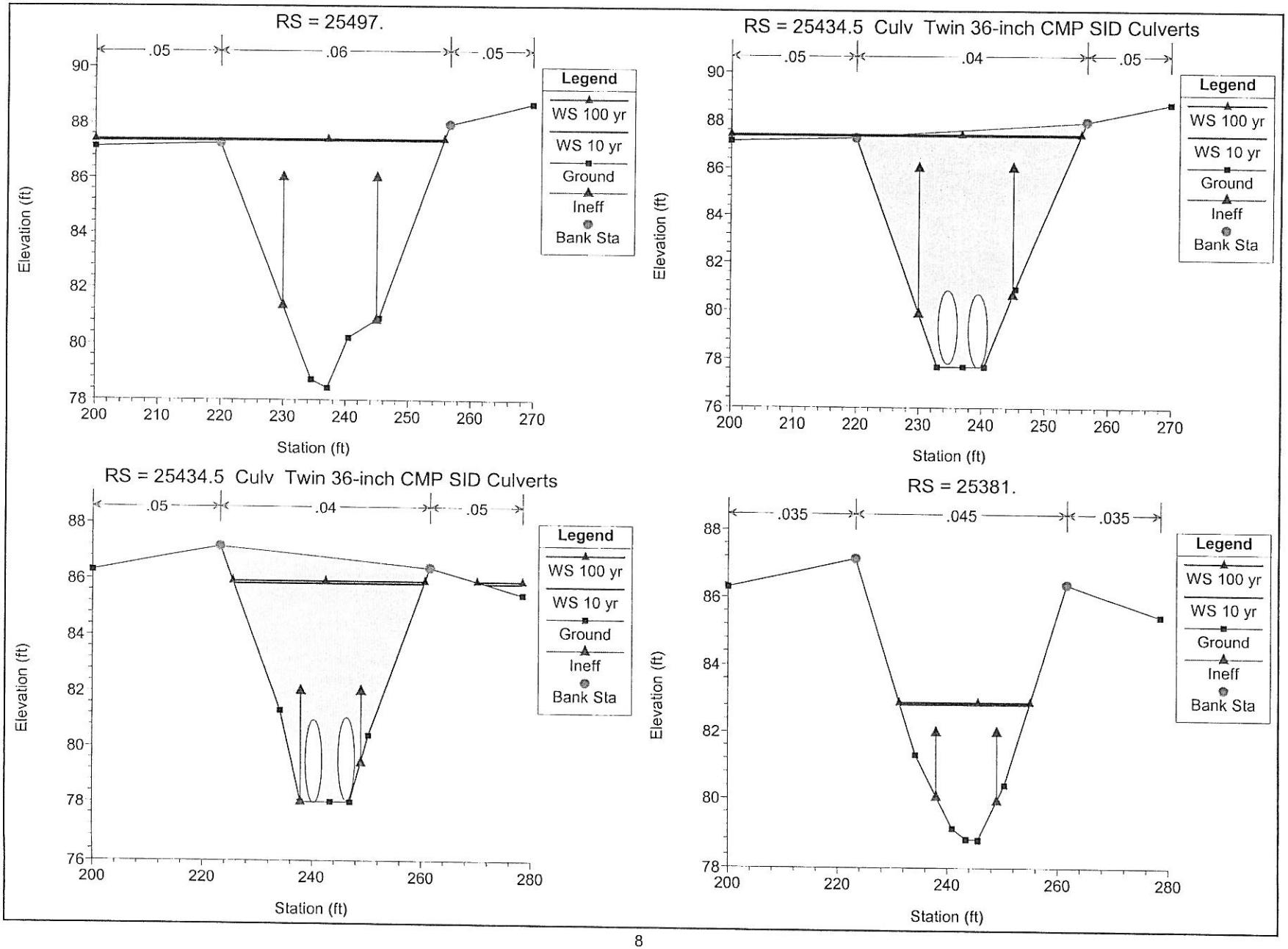

RS = 28106.5 Culv 7.5' X 4.0' Box Vanden Road Box Culvert
.045
.045
045
Legend
WS 100 yr
WS 10 yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
RS = 28066. D/S Vanden Rd
.045
.045
045
Legend
WS 100 yr
WS 10 yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
RS = 28051. Repeat Seciton (3925)
.04
.045
.045
Legend
WS 100 yr
WS 10 yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
RS = 27972.
.045
.045
.08
Legend
WS 100 yr
WS 10 yr
Ground
Bank Sta
Elevation (ft)
Station (ft)

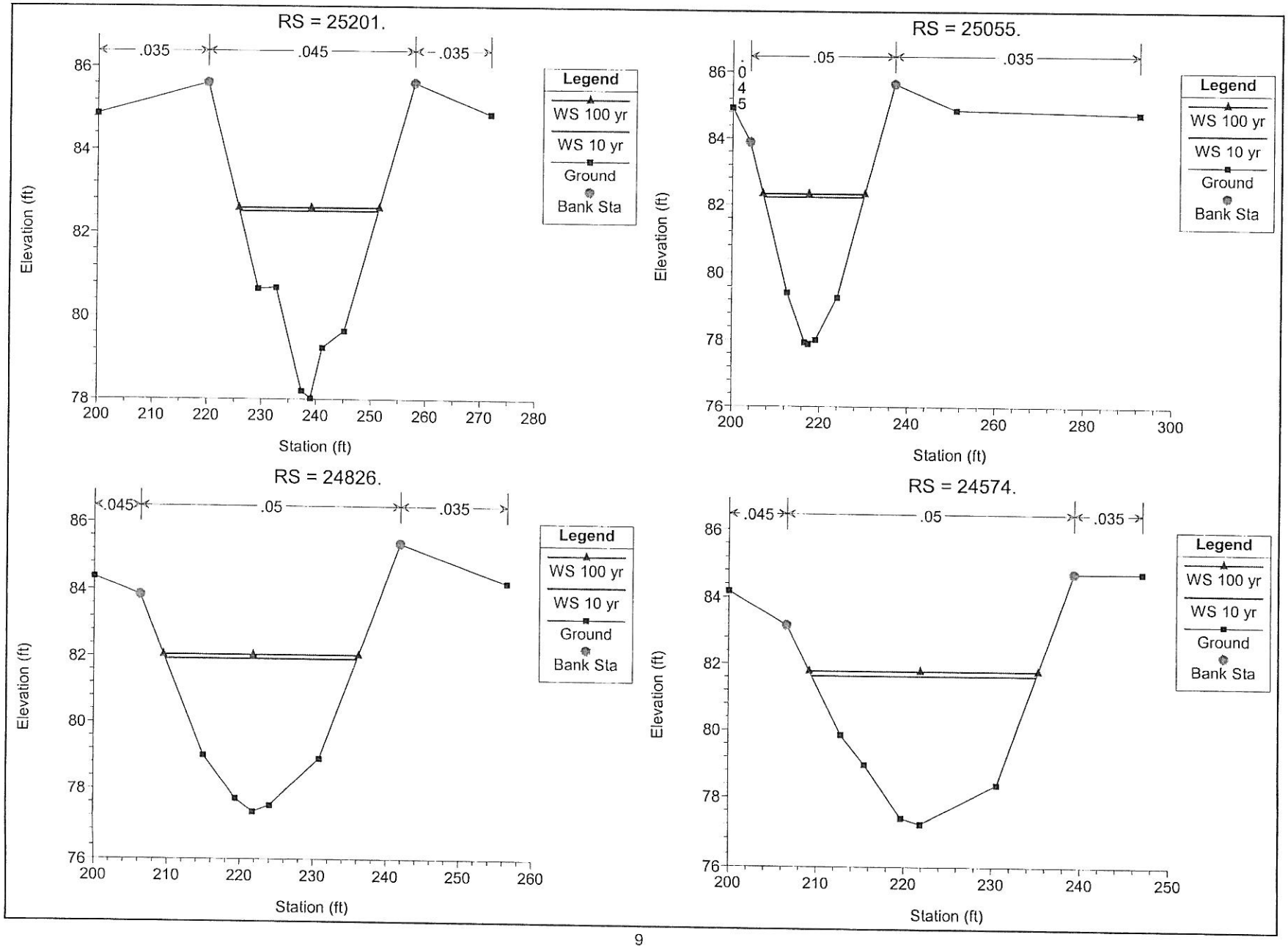

RS = 27773. Repeat Section (3941)
.08
.07
.08
Legend
WS 100 yr
WS 10 yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
RS = 27766. Debris Dam
.08
.06
.08
Legend
WS 100 yr
WS 10 yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
RS = 27759. Repeat Section (3581)
.06
.08
Legend
WS 100 yr
WS 10 yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
RS = 27628.
.05
.05
Legend
WS 100 yr
WS 10 yr
Ground
Bank Sta
Elevation (ft)
Station (ft)

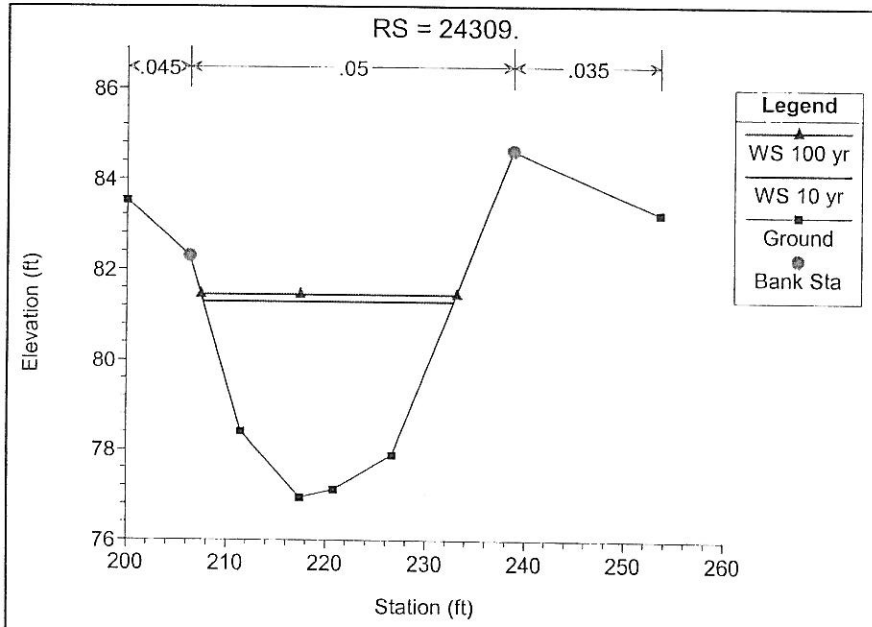

RS = 27050. Repeated Section (2503)
.05
.05
0
5
Legend
WS 100 yr
WS 10 yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
RS = 26550.
.05
.05
0
4
5
Legend
WS 100 yr
WS 10 yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
RS = 26212.
.05
.05
0
4
5
Legend
WS 100 yr
WS 10 yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
RS = 25994.
.05
.05
0
4
5
Legend
WS 100 yr
WS 10 yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

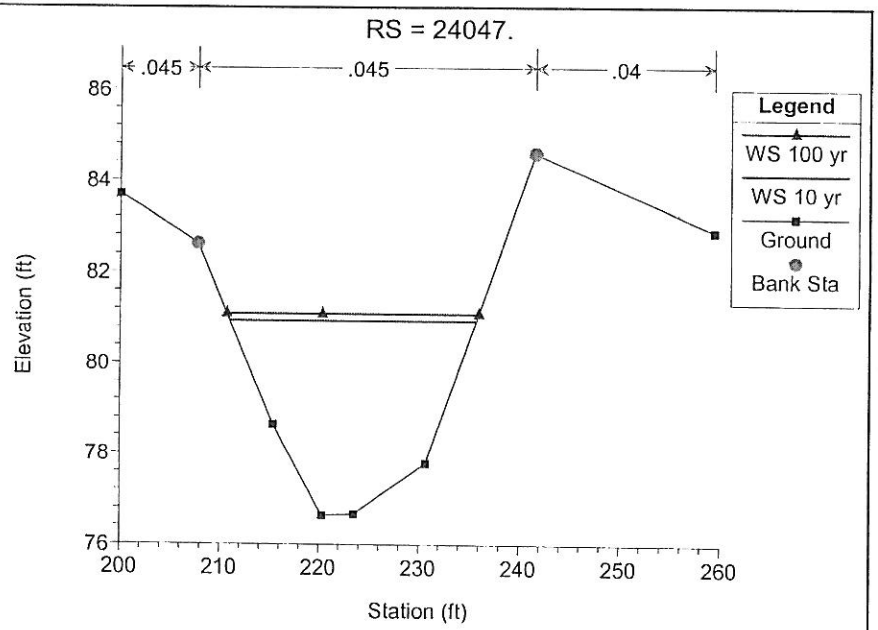

RS = 25870. U/S Leisure Town Road
.05
.05
.07
Legend
WS 100 yr
WS 10 yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
RS = 25787. Culv Triple 36-inch RCP Liesure Town Road Culverts
.05
.05
.07
Legend
WS 100 yr
WS 10 yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
RS = 25787. Culv Triple 36-inch RCP Liesure Town Road Culverts
.07
.07
.08
Legend
WS 100 yr
WS 10 yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
RS = 25711. D/S Leisure Town Road
.07
.07
.08
Legend
WS 100 yr
WS 10 yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)


RS = 25639.
.07
.08
.07
Legend
WS 10 yr
WS 100 yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
RS = 25611. U/S Railroad
.06
.07
.06
Legend
WS 100 yr
WS 10 yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
RS = 25566.5 Culv Twin 60-inch CMP Railroad Culverts
.05
.04
.05
Legend
WS 10 yr
WS 100 yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
RS = 25566.5 Culv Twin 60-inch CMP Railroad Culverts
.05
.06
.05
Legend
WS 10 yr
WS 100 yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)


RS = 25497.
.05
.06
.05
Legend
WS 100 yr
WS 10 yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
RS = 25434.5 Culv Twin 36-inch CMP SID Culverts
.05
.04
.05
Legend
WS 100 yr
WS 10 yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
RS = 25434.5 Culv Twin 36-inch CMP SID Culverts
.05
.04
.05
Legend
WS 100 yr
WS 10 yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
RS = 25381.
.035
.045
.035
Legend
WS 100 yr
WS 10 yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

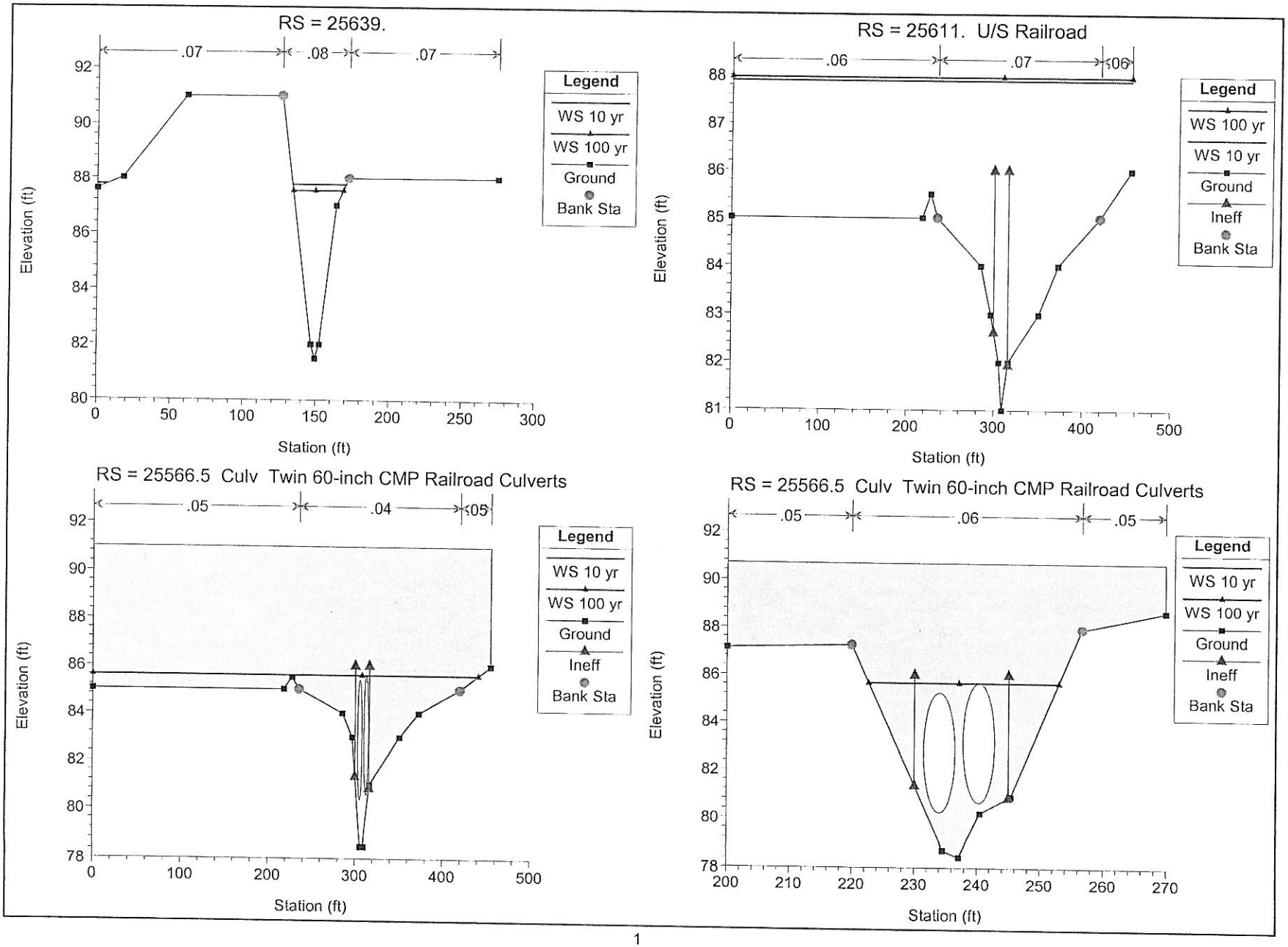

RS = 25201.
.035
.045
.035
Legend
WS 100 yr
WS 10 yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
RS = 25055.
.05
.035
Legend
WS 100 yr
WS 10 yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
RS = 24826.
.045
.05
.035
Legend
WS 100 yr
WS 10 yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
RS = 24574.
.045
.05
.035
Legend
WS 100 yr
WS 10 yr
Ground
Bank Sta
Elevation (ft)
Station (ft)

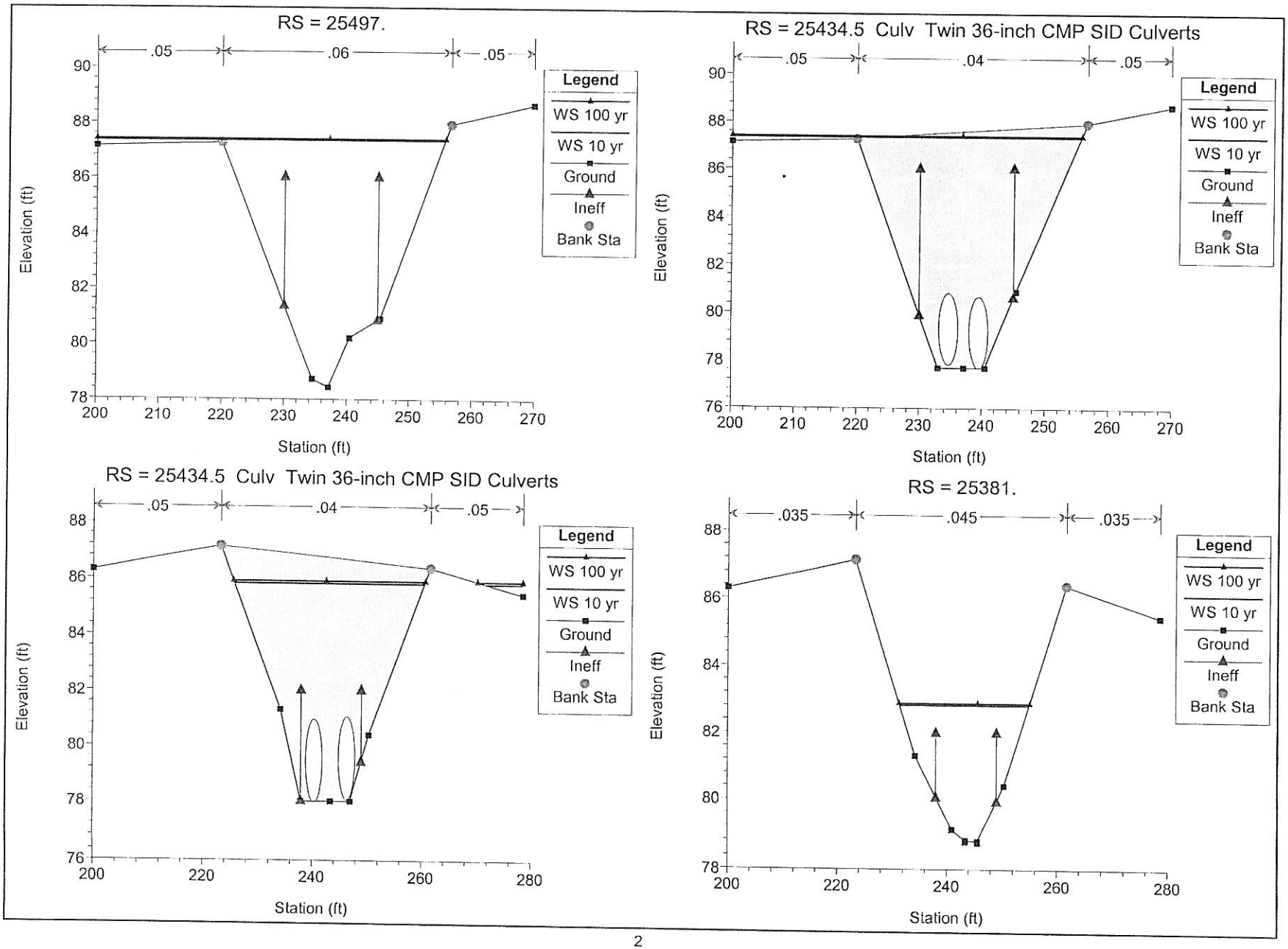

RS = 24309.
.045
.05
.035
Legend
WS 100 yr
WS 10 yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
86
84
82
80
78
76
200
210
220
230
240
250
260

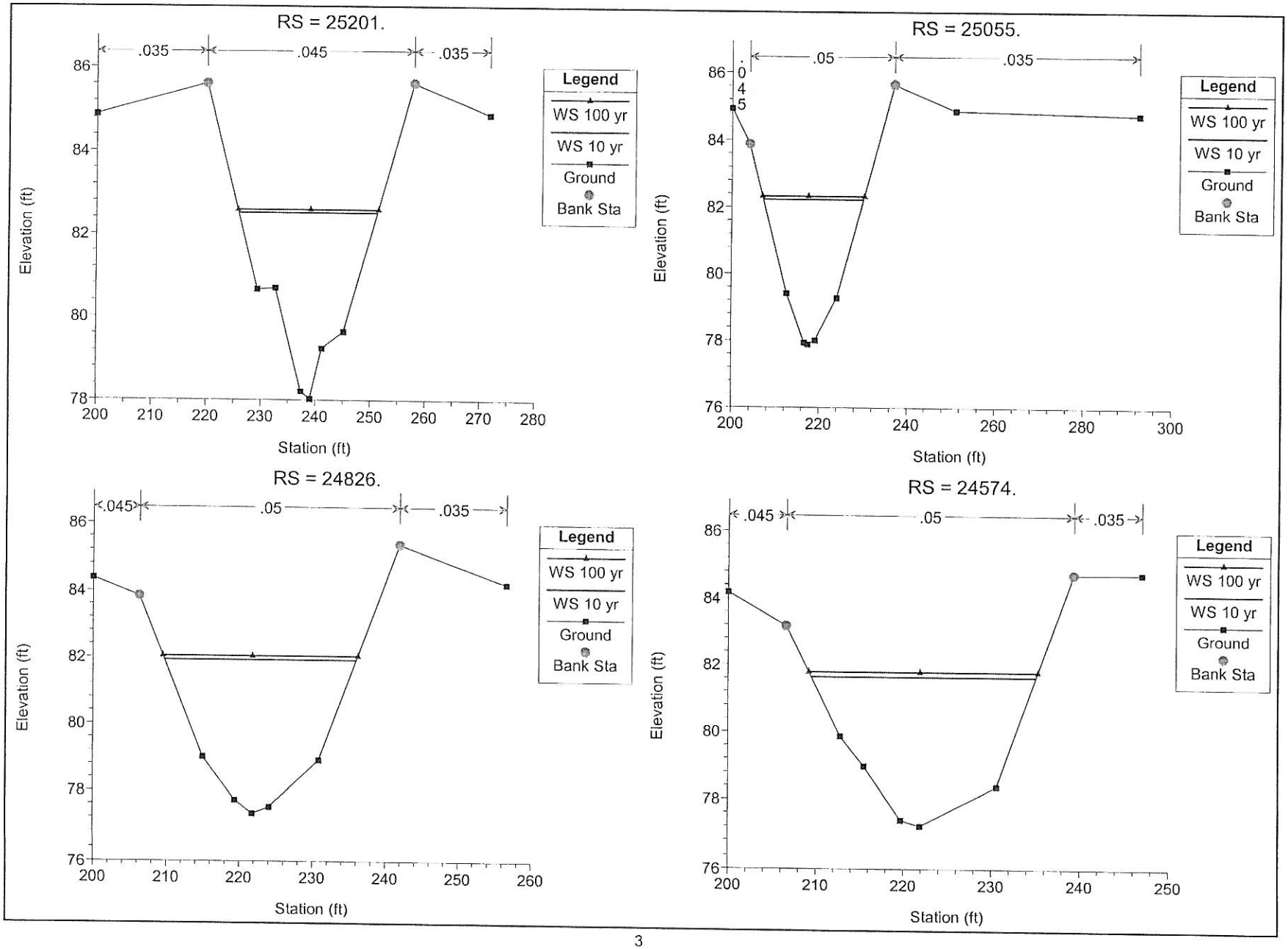

RS = 24047.
.045
.045
.04
Legend
WS 100 yr
WS 10 yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
86
84
82
80
78
76
200
210
220
230
240
250
260

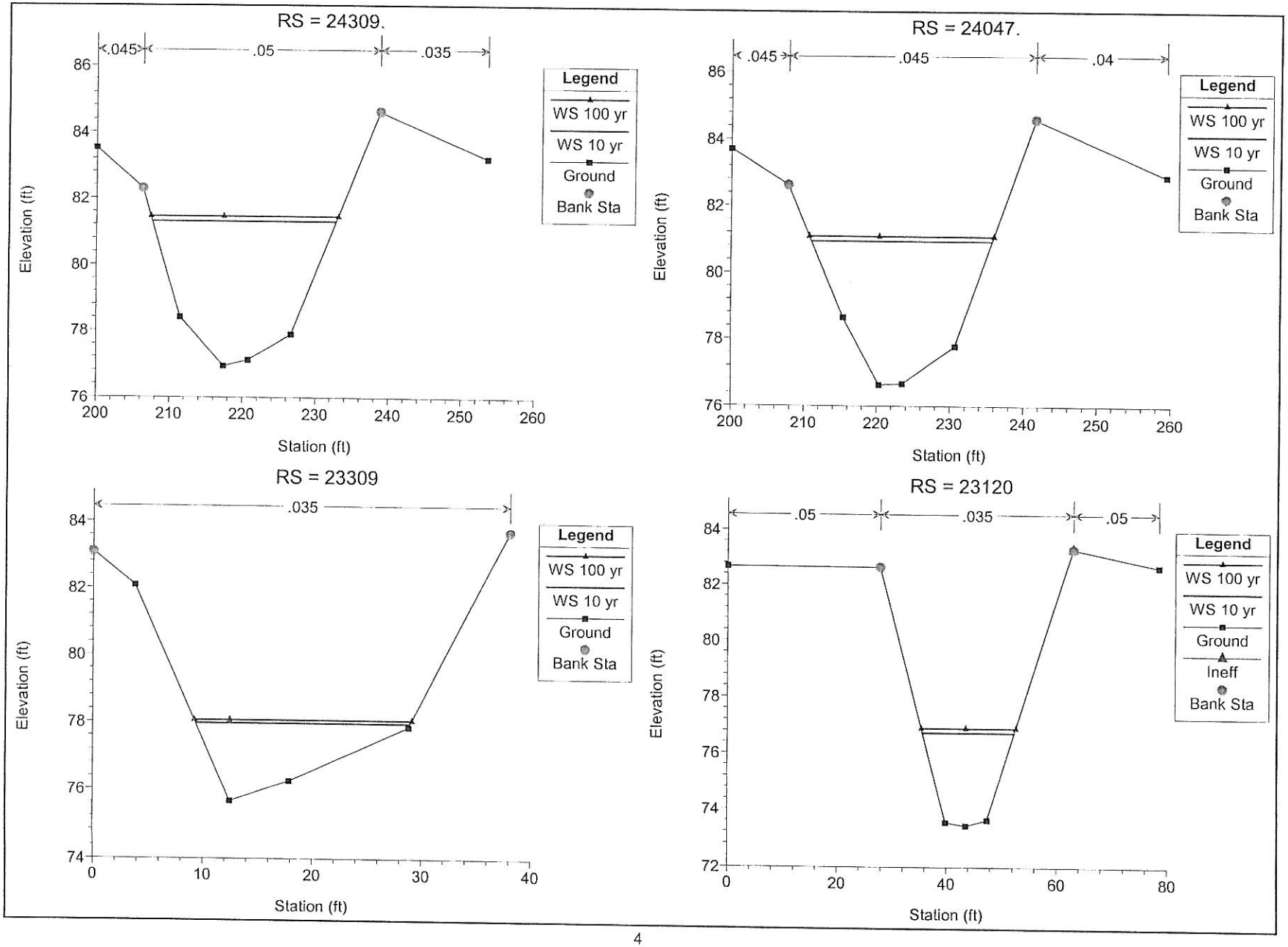
APPENDIX H

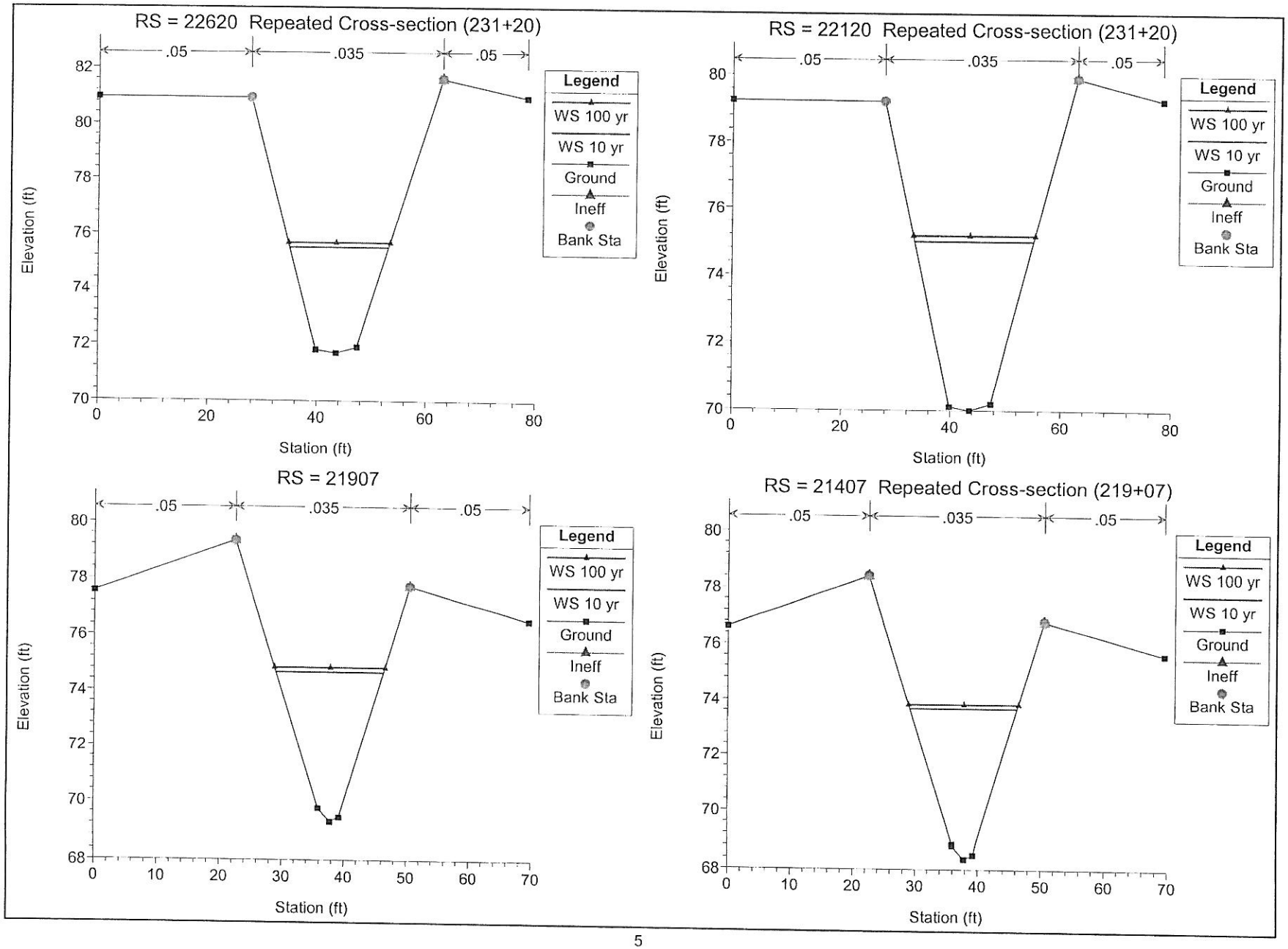
HEC-RAS Channel Cross-Section of the Noonan Drain/D-1-C Spill

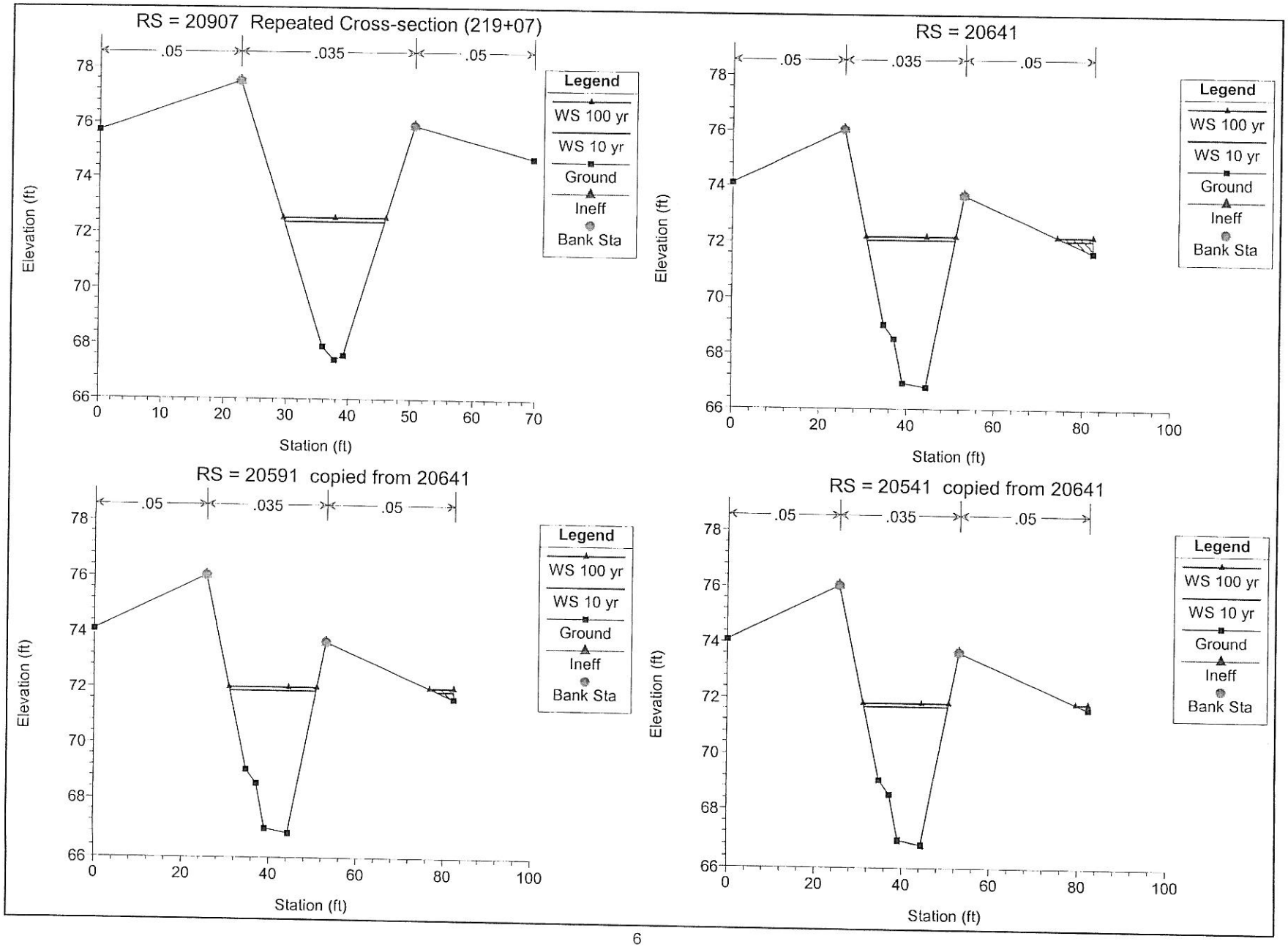

RS = 25639.
.07
.08
.07
Legend
WS 10 yr
WS 100 yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
RS = 25611. U/S Railroad
.06
.07
.06
Legend
WS 100 yr
WS 10 yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
RS = 25566.5 Culv Twin 60-inch CMP Railroad Culverts
.05
.04
.05
Legend
WS 10 yr
WS 100 yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
RS = 25566.5 Culv Twin 60-inch CMP Railroad Culverts
.05
.06
.05
Legend
WS 10 yr
WS 100 yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

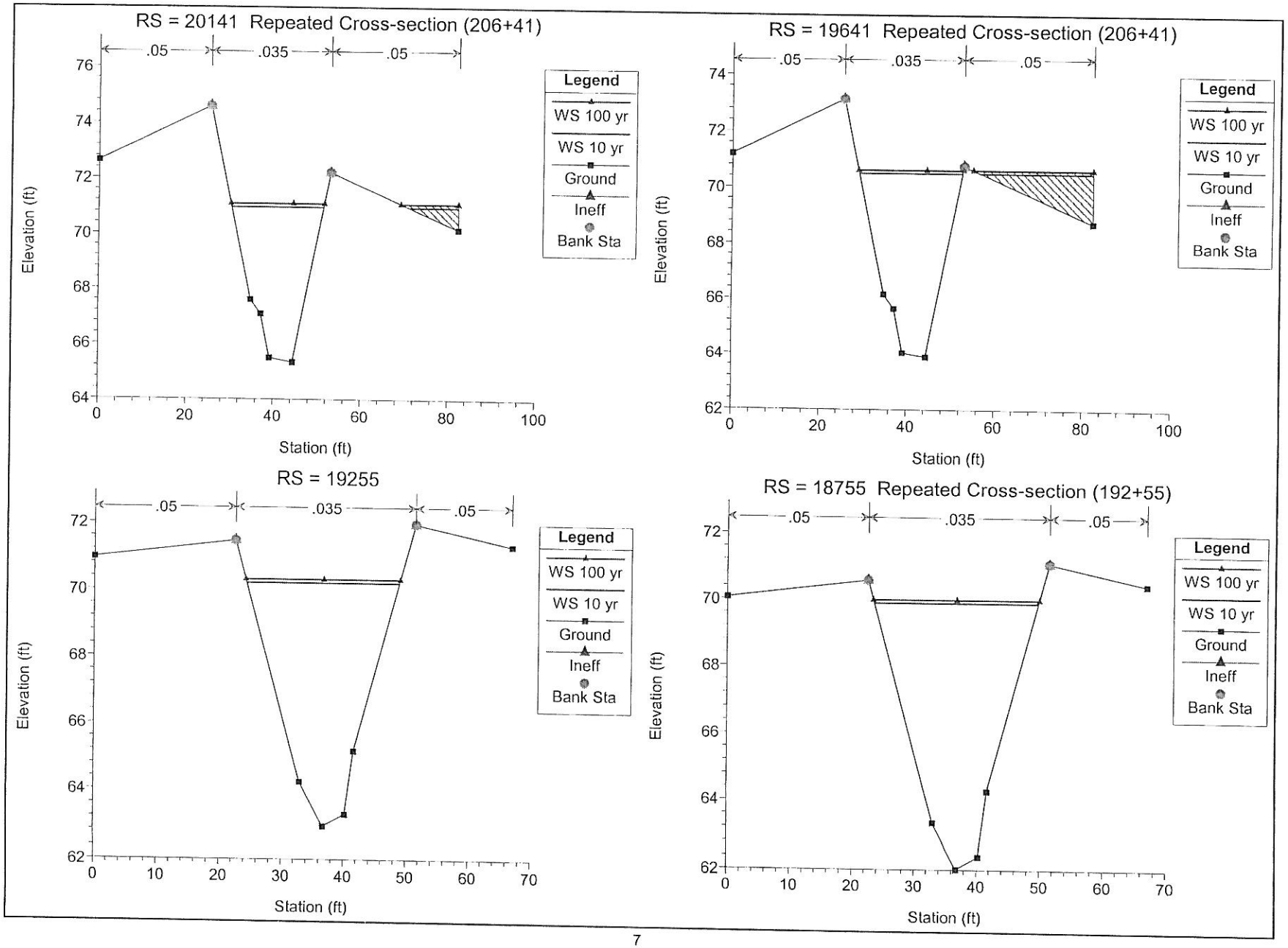

RS = 25497.
.05
.06
.05
Legend
WS 100 yr
WS 10 yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
RS = 25434.5 Culv Twin 36-inch CMP SID Culverts
.05
.04
.05
Legend
WS 100 yr
WS 10 yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
RS = 25434.5 Culv Twin 36-inch CMP SID Culverts
.05
.04
.05
Legend
WS 100 yr
WS 10 yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
RS = 25381.
.035
.045
.035
Legend
WS 100 yr
WS 10 yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

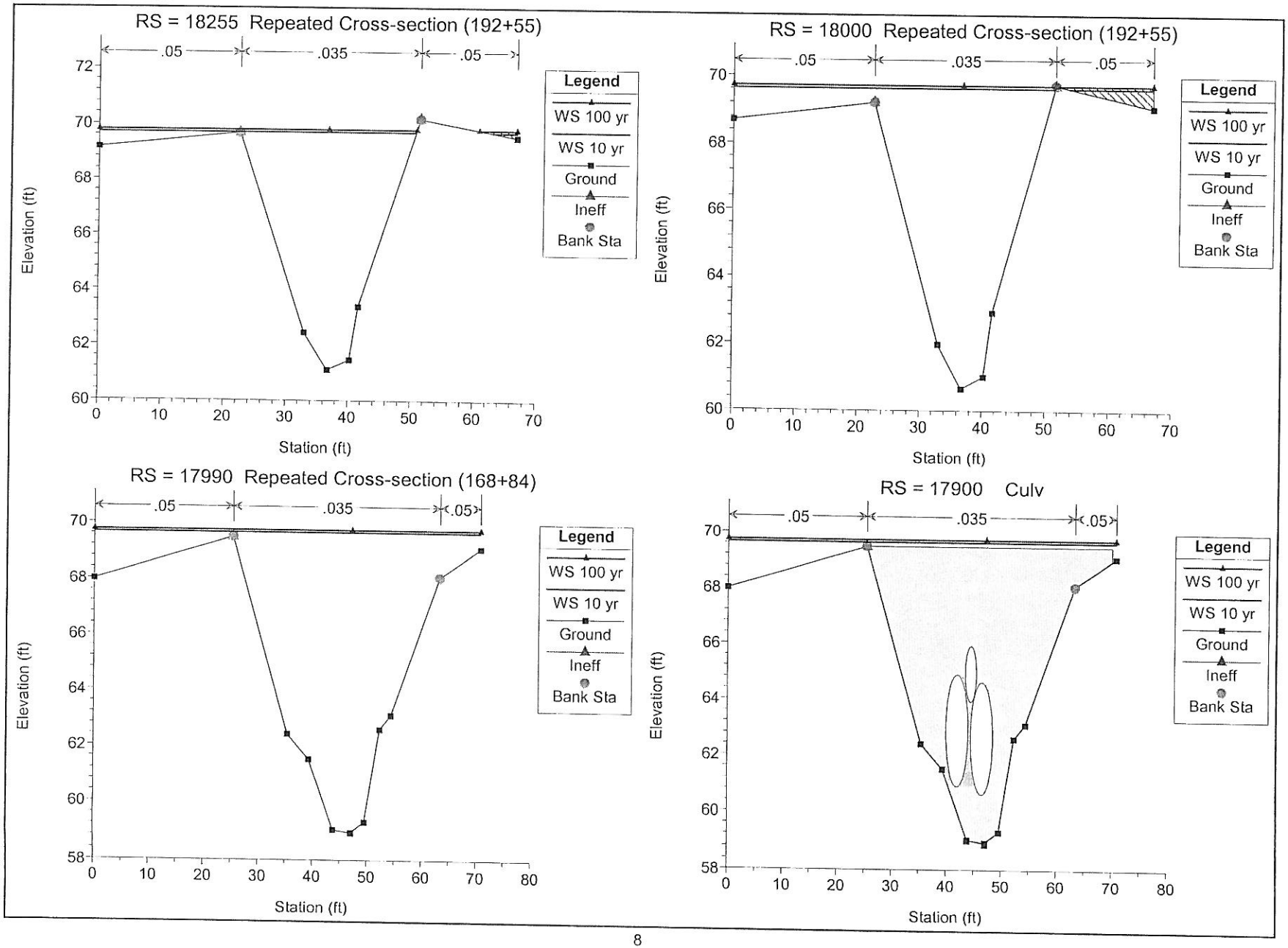

RS = 25201.
.035
.045
.035
Legend
WS 100 yr
WS 10 yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
RS = 25055.
.05
.035
.045
Legend
WS 100 yr
WS 10 yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
RS = 24826.
.045
.05
.035
Legend
WS 100 yr
WS 10 yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
RS = 24574.
.045
.05
.035
Legend
WS 100 yr
WS 10 yr
Ground
Bank Sta
Elevation (ft)
Station (ft)

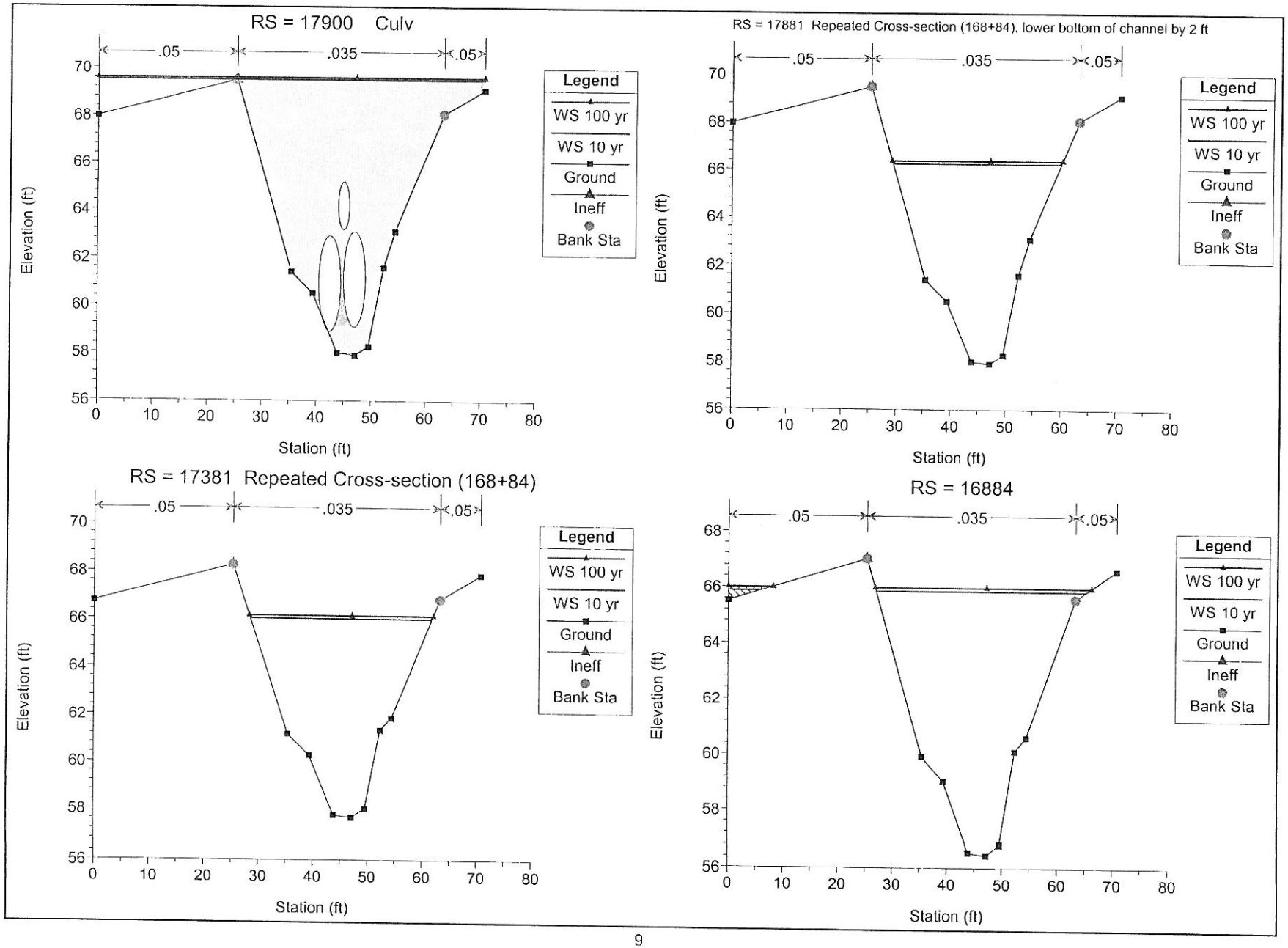

RS = 24309.
.045
.05
.035
Legend
WS 100 yr
WS 10 yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
RS = 24047.
.045
.045
.04
Legend
WS 100 yr
WS 10 yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
RS = 23309
.035
Legend
WS 100 yr
WS 10 yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
RS = 23120
.05
.035
.05
Legend
WS 100 yr
WS 10 yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

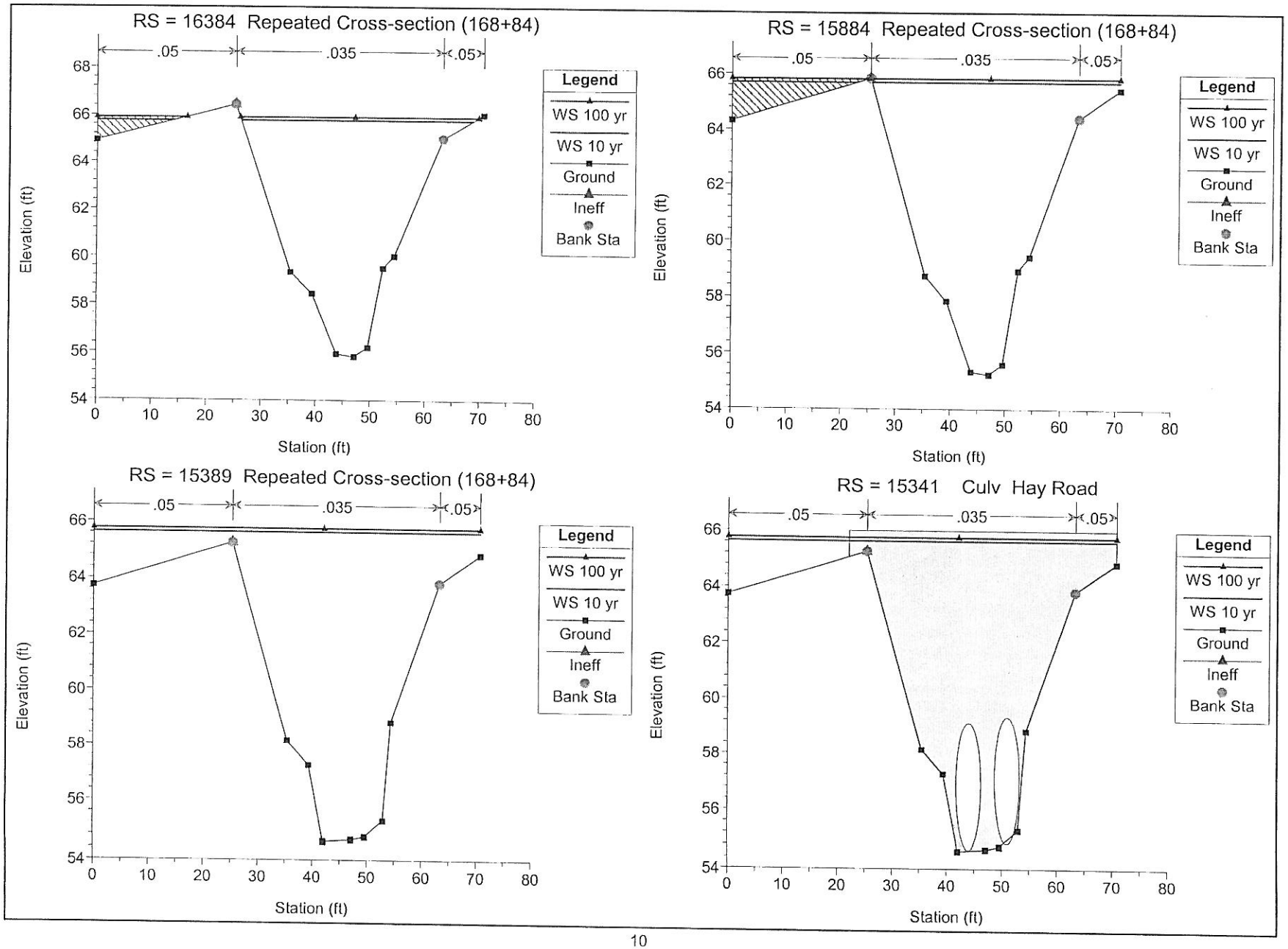

RS = 22620 Repeated Cross-section (231+20)
.05
.035
.05
Legend
WS 100 yr
WS 10 yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
RS = 22120 Repeated Cross-section (231+20)
RS = 21907
RS = 21407 Repeated Cross-section (219+07)

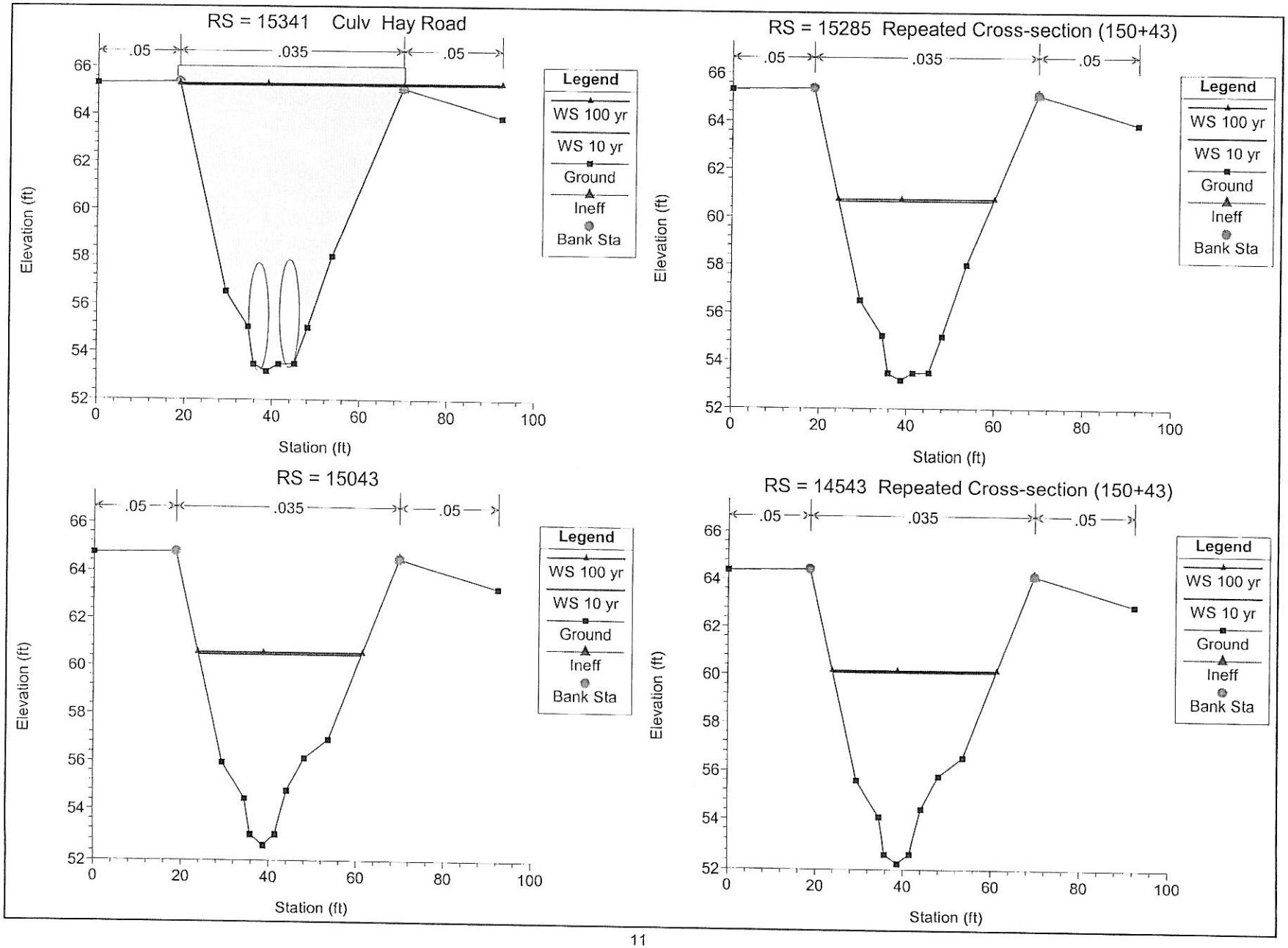

RS = 20907 Repeated Cross-section (219+07)
.05
.035
.05
Legend
WS 100 yr
WS 10 yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
RS = 20641
RS = 20591 copied from 20641
RS = 20541 copied from 20641

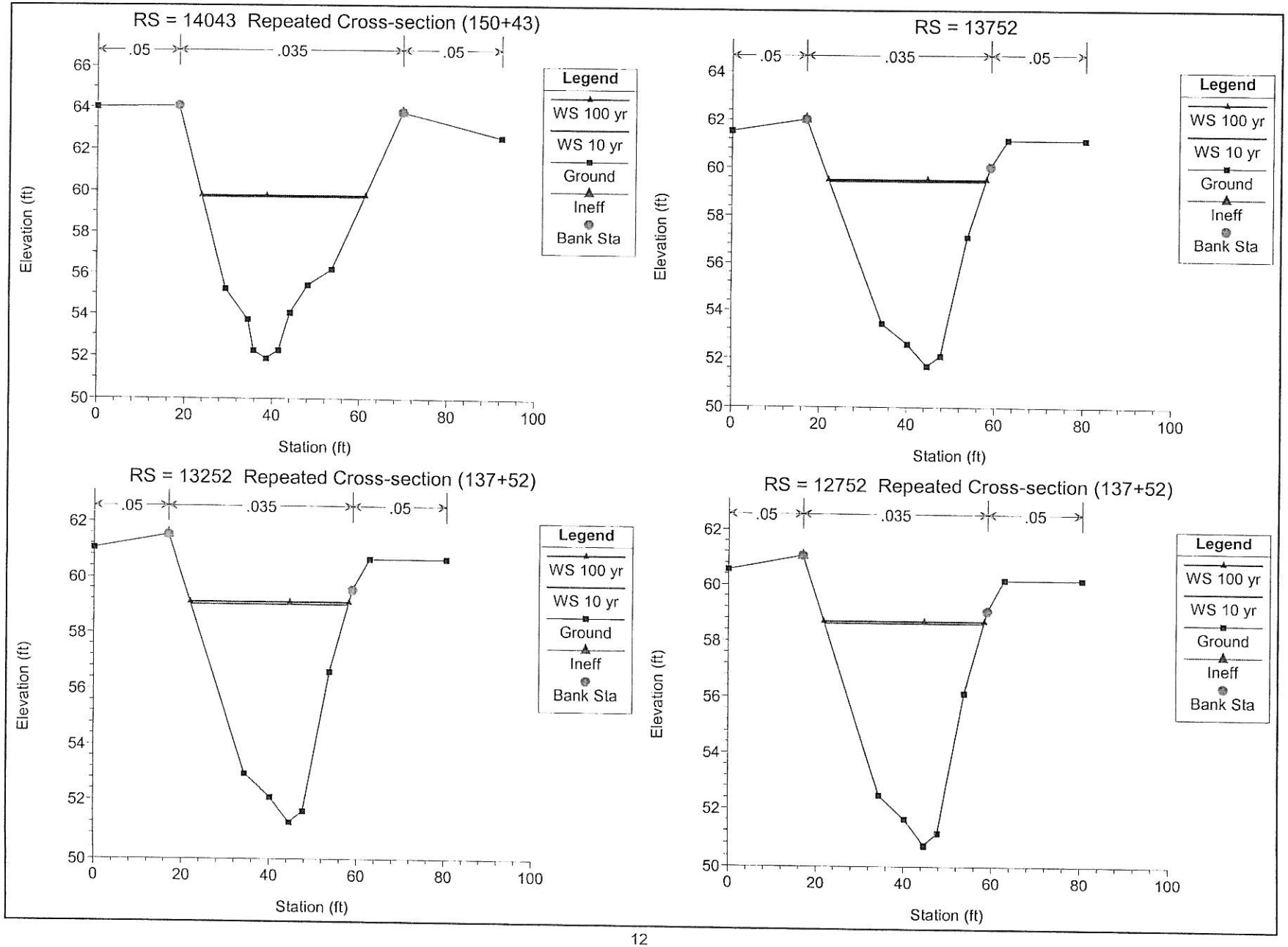

RS = 20141 Repeated Cross-section (206+41)
.05
.035
.05
Legend
WS 100 yr
WS 10 yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
RS = 19641 Repeated Cross-section (206+41)
RS = 19255
RS = 18755 Repeated Cross-section (192+55)

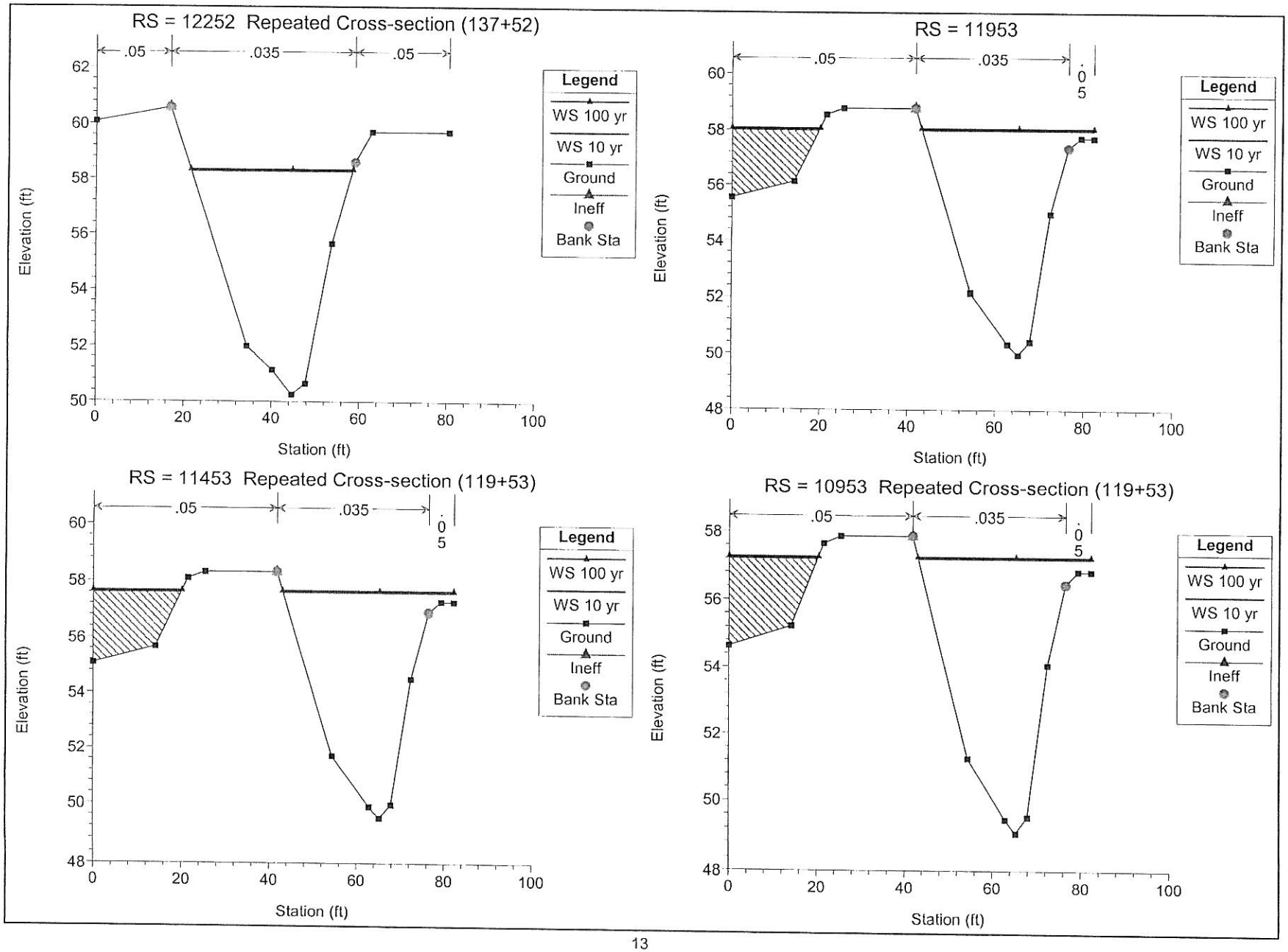

RS = 18255 Repeated Cross-section (192+55)
.05
.035
.05
Legend
WS 100 yr
WS 10 yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
RS = 18000 Repeated Cross-section (192+55)
.05
.035
.05
Legend
WS 100 yr
WS 10 yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
RS = 17990 Repeated Cross-section (168+84)
.05
.035
.05
Legend
WS 100 yr
WS 10 yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
RS = 17900 Culv
.05
.035
.05
Legend
WS 100 yr
WS 10 yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

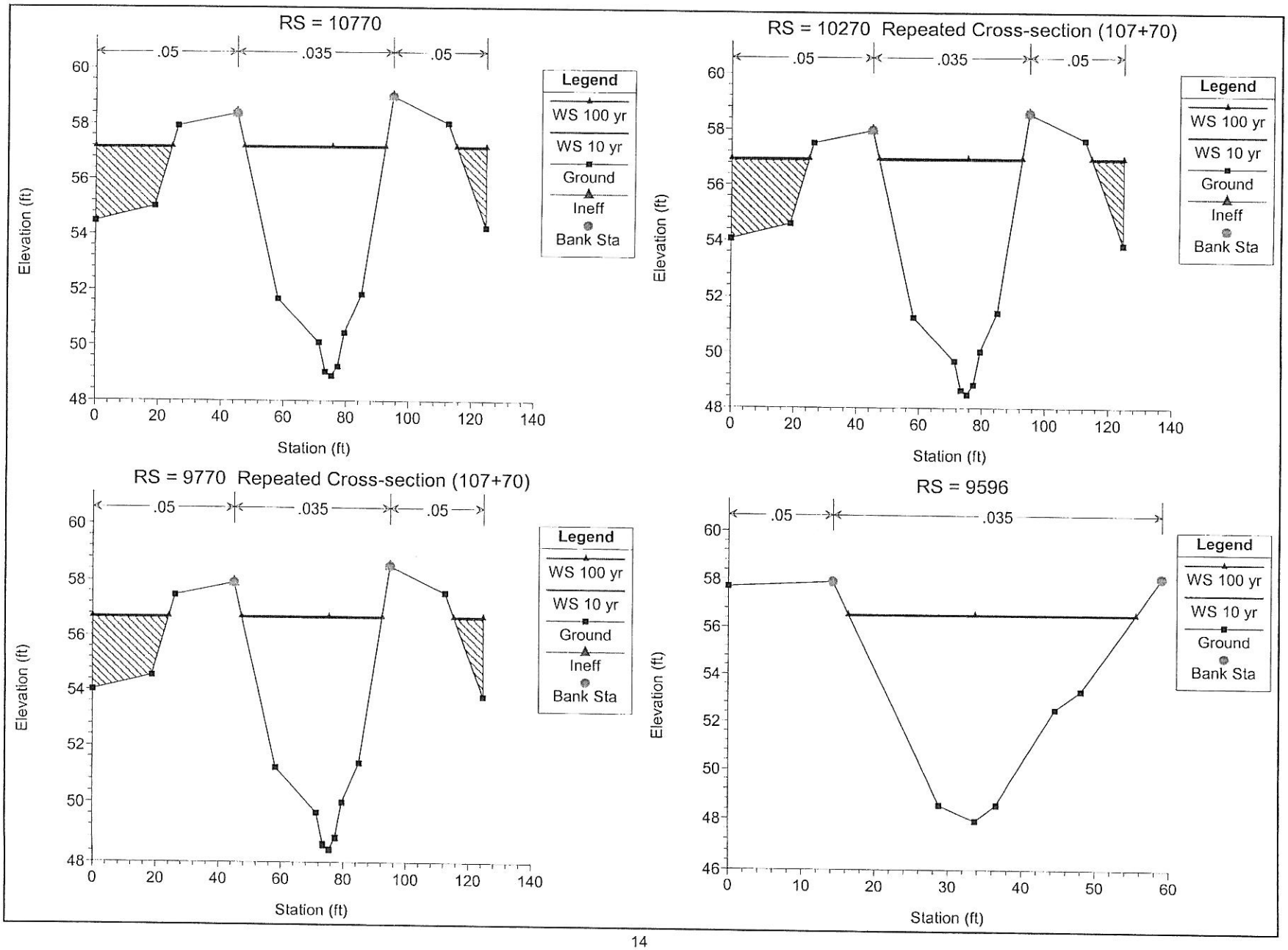

RS = 17900 Culv
RS = 17881 Repeated Cross-section (168+84), lower bottom of channel by 2 ft
RS = 17381 Repeated Cross-section (168+84)
RS = 16884
.05
.035
.05
Legend
WS 100 yr
WS 10 yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

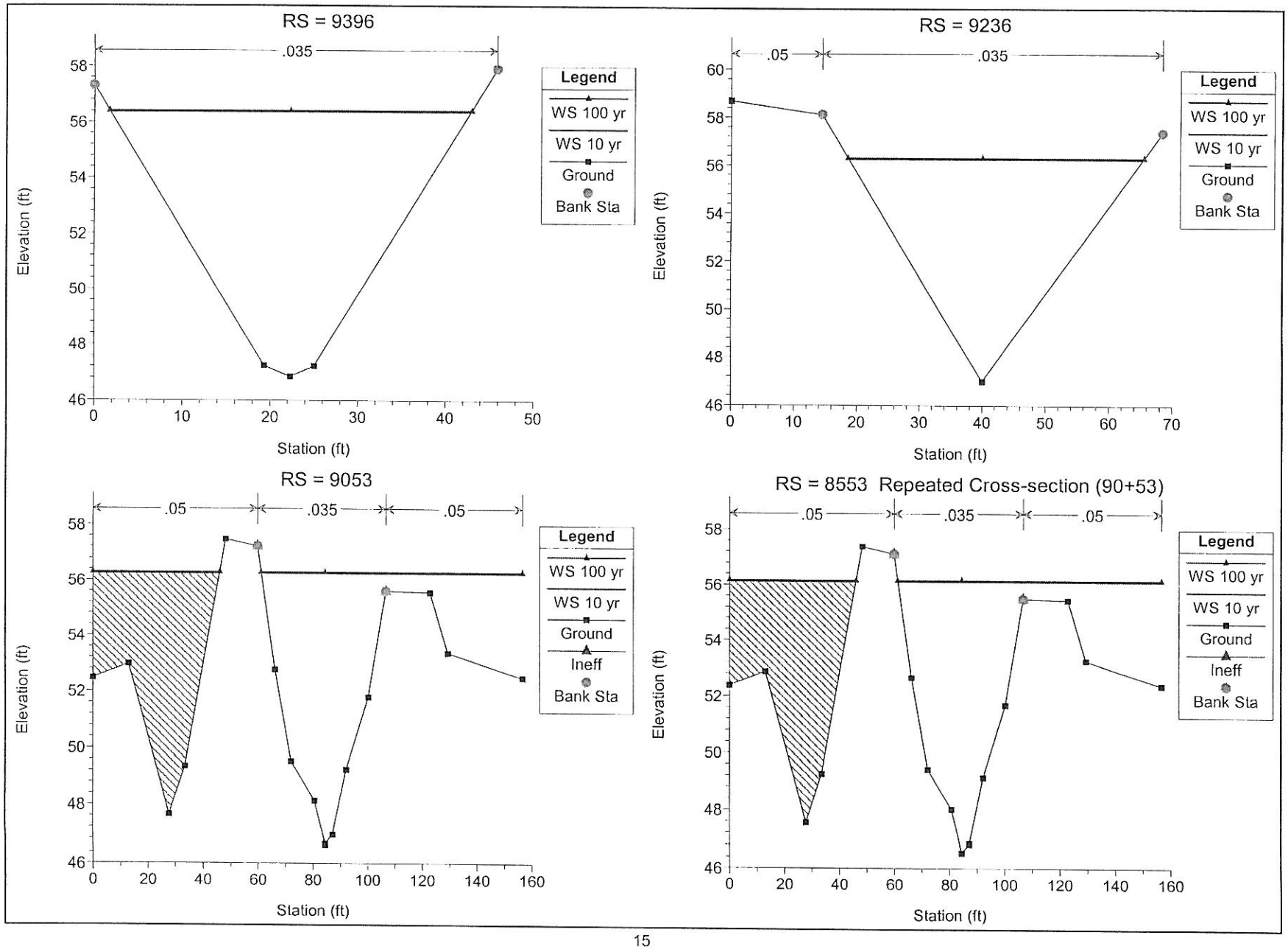

RS = 16384 Repeated Cross-section (168+84)
.05
.035
.05
Legend
WS 100 yr
WS 10 yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
RS = 15884 Repeated Cross-section (168+84)
RS = 15389 Repeated Cross-section (168+84)
RS = 15341 Culv Hay Road

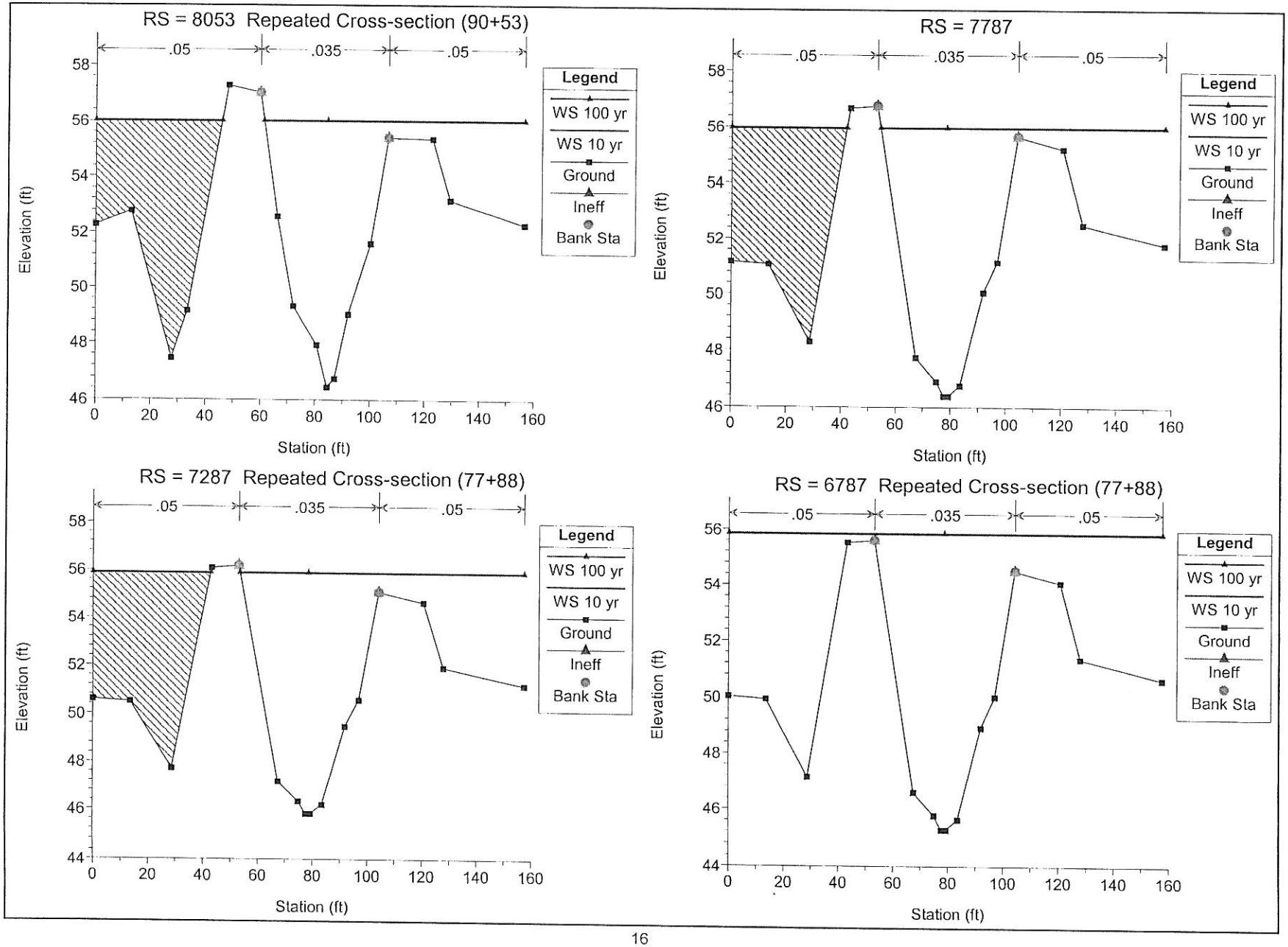

RS = 15341 Culv Hay Road
RS = 15285 Repeated Cross-section (150+43)
RS = 15043
RS = 14543 Repeated Cross-section (150+43)
.05
.035
.05
Legend
WS 100 yr
WS 10 yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
52
54
56
58
60
62
64
66
0
20
40
60
80
100

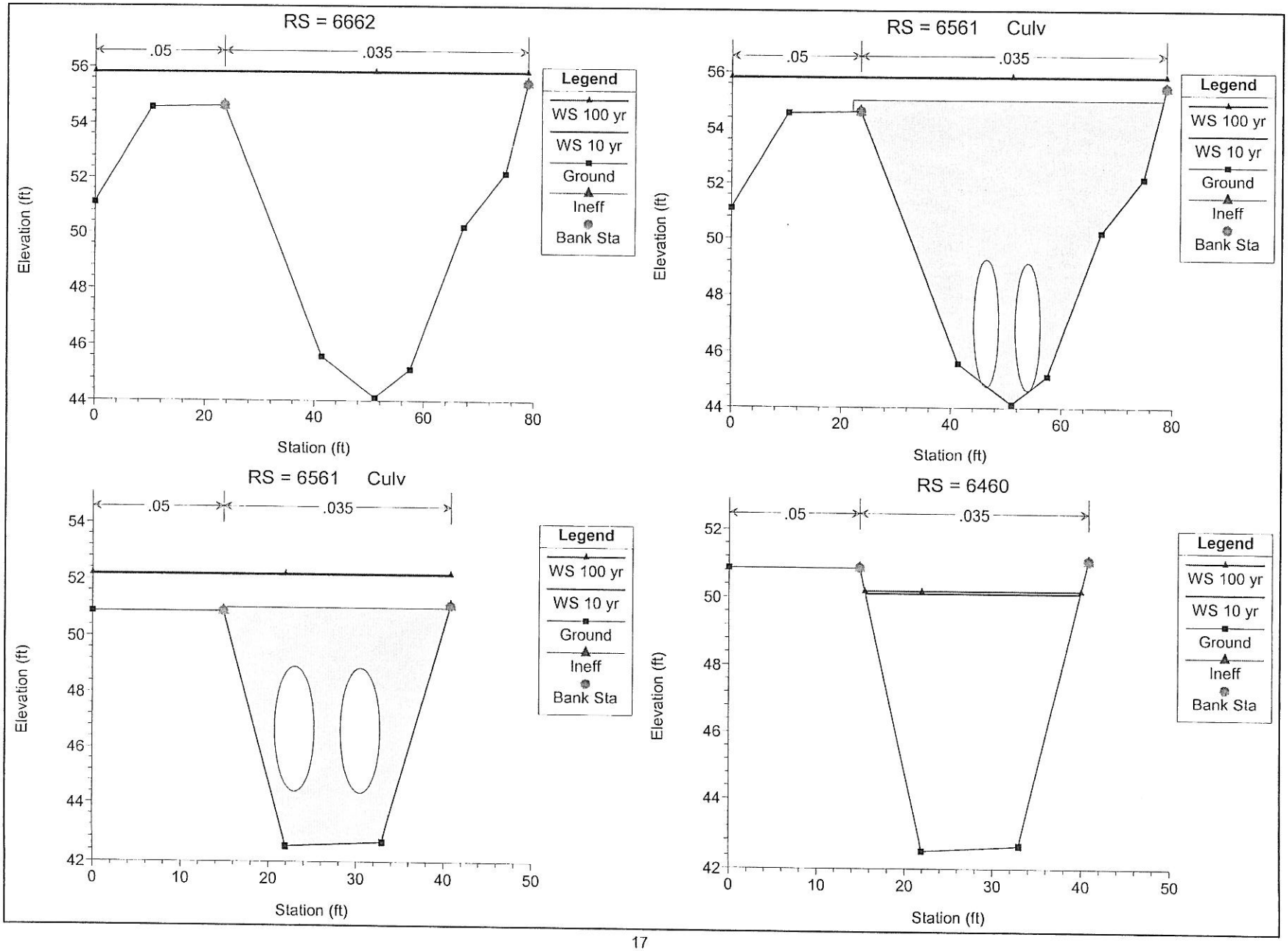

RS = 14043 Repeated Cross-section (150+43)
.05
.035
.05
Elevation (ft)
Station (ft)
Legend
WS 100 yr
WS 10 yr
Ground
Ineff
Bank Sta
RS = 13752
RS = 13252 Repeated Cross-section (137+52)
RS = 12752 Repeated Cross-section (137+52)

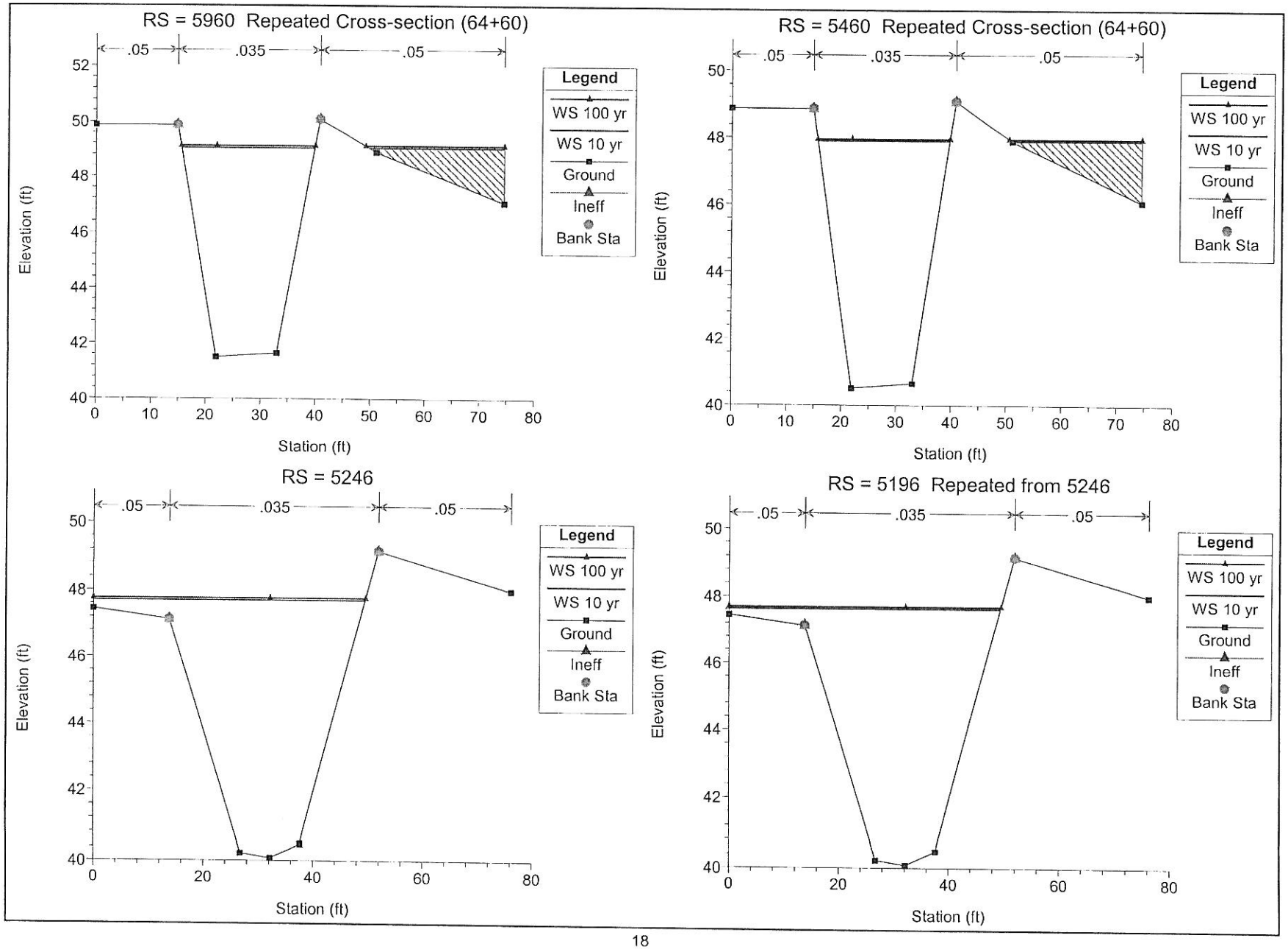

RS = 12252 Repeated Cross-section (137+52)
.05
.035
.05
Elevation (ft)
Station (ft)
Legend
WS 100 yr
WS 10 yr
Ground
Ineff
Bank Sta
RS = 11953
.05
.035
.05
Elevation (ft)
Station (ft)
Legend
WS 100 yr
WS 10 yr
Ground
Ineff
Bank Sta
RS = 11453 Repeated Cross-section (119+53)
.05
.035
.05
Elevation (ft)
Station (ft)
Legend
WS 100 yr
WS 10 yr
Ground
Ineff
Bank Sta
RS = 10953 Repeated Cross-section (119+53)
.05
.035
.05
Elevation (ft)
Station (ft)
Legend
WS 100 yr
WS 10 yr
Ground
Ineff
Bank Sta

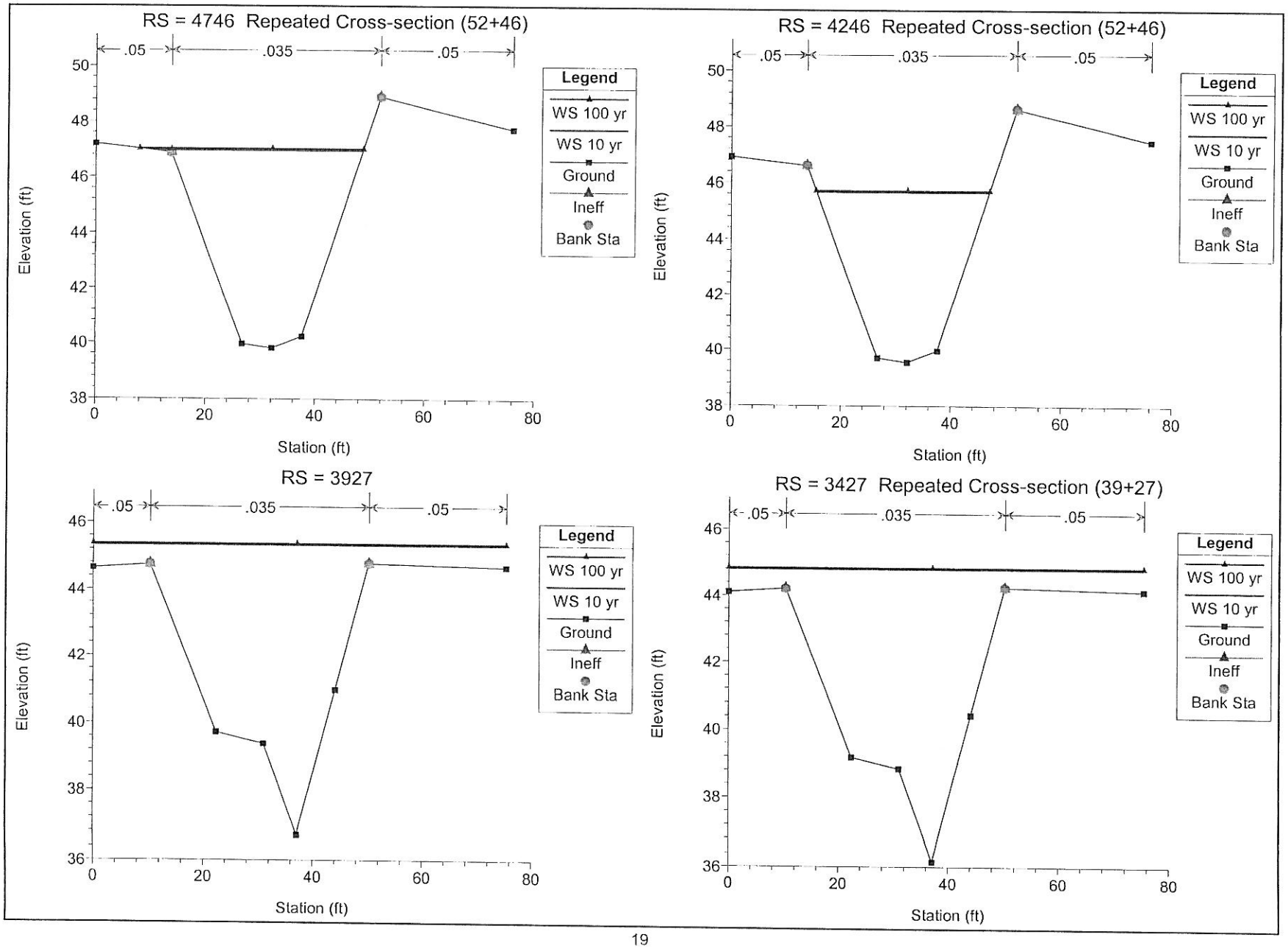

RS = 10770
.05
.035
.05
Legend
WS 100 yr
WS 10 yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
RS = 10270 Repeated Cross-section (107+70)
.05
.035
.05
Legend
WS 100 yr
WS 10 yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
RS = 9770 Repeated Cross-section (107+70)
.05
.035
.05
Legend
WS 100 yr
WS 10 yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
RS = 9596
.05
.035
Legend
WS 100 yr
WS 10 yr
Ground
Bank Sta
Elevation (ft)
Station (ft)

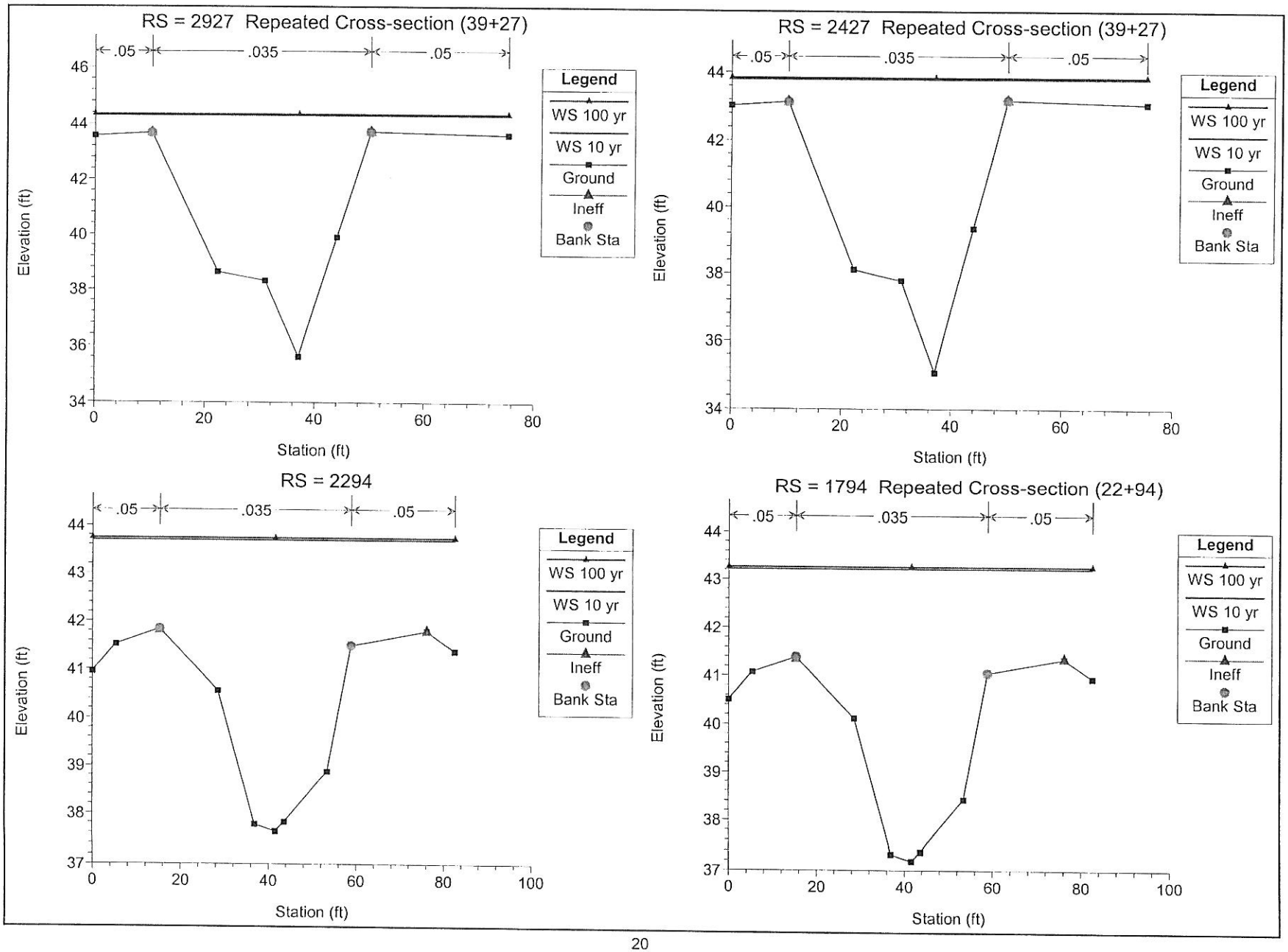

RS = 9396
.035
Legend
WS 100 yr
WS 10 yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
RS = 9236
.05
.035
Legend
WS 100 yr
WS 10 yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
RS = 9053
.05
.035
.05
Legend
WS 100 yr
WS 10 yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
RS = 8553 Repeated Cross-section (90+53)
.05
.035
.05
Legend
WS 100 yr
WS 10 yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

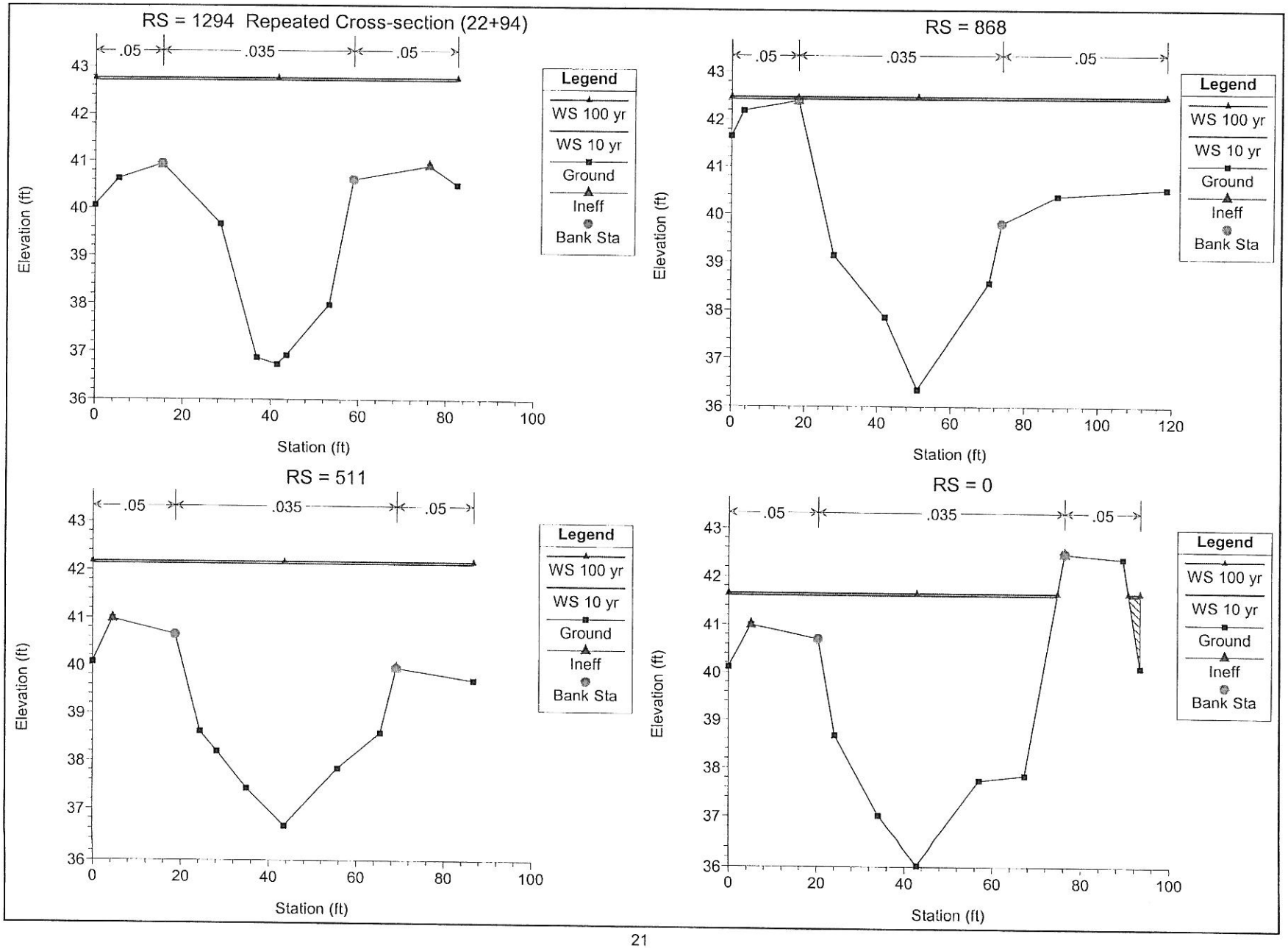

RS = 8053 Repeated Cross-section (90+53)
.05
.035
.05
Legend
WS 100 yr
WS 10 yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
RS = 7787
RS = 7287 Repeated Cross-section (77+88)
RS = 6787 Repeated Cross-section (77+88)


RS = 6662
.05
.035
Elevation (ft)
Station (ft)
Legend
WS 100 yr
WS 10 yr
Ground
Ineff
Bank Sta
RS = 6561 Culv
.05
.035
Elevation (ft)
Station (ft)
Legend
WS 100 yr
WS 10 yr
Ground
Ineff
Bank Sta
RS = 6561 Culv
.05
.035
Elevation (ft)
Station (ft)
Legend
WS 100 yr
WS 10 yr
Ground
Ineff
Bank Sta
RS = 6460
.05
.035
Elevation (ft)
Station (ft)
Legend
WS 100 yr
WS 10 yr
Ground
Ineff
Bank Sta


RS = 5960 Repeated Cross-section (64+60)
.05
.035
.05
Legend
WS 100 yr
WS 10 yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
RS = 5460 Repeated Cross-section (64+60)
RS = 5246
RS = 5196 Repeated from 5246


RS = 4746 Repeated Cross-section (52+46)
.05
.035
.05
Elevation (ft)
Station (ft)
Legend
WS 100 yr
WS 10 yr
Ground
Ineff
Bank Sta
RS = 4246 Repeated Cross-section (52+46)
RS = 3927
RS = 3427 Repeated Cross-section (39+27)


RS = 2927 Repeated Cross-section (39+27)
.05
.035
.05
Legend
WS 100 yr
WS 10 yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
RS = 2427 Repeated Cross-section (39+27)
RS = 2294
RS = 1794 Repeated Cross-section (22+94)


RS = 1294 Repeated Cross-section (22+94)
.05
.035
.05
Elevation (ft)
Station (ft)
Legend
WS 100 yr
WS 10 yr
Ground
Ineff
Bank Sta
RS = 868
RS = 511
RS = 0