ADDENDUM TO HYDROLOGY & HYDRAULICS REPORT

for

STATE ROUTE 11 AND THE OTAY MESA EAST PORT OF ENTRY

SAN DIEGO COUNTY, CALIFORNIA
DISTRICT 11–SD –ROUTE 11
PM 0.0/2.8 EA056310
DISTRICT 11–SD –ROUTE 905
PM R8.4/10.1

TIER II ENVIRONMENTAL IMPACT REPORT/ ENVIRONMENTAL IMPACT STATEMENT

November 2010

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Prepared by:
AECOM

Addendum to: Hydrology & Hydraulics Report

State Route 11 Corridor & Commercial Vehicle Enforcement Facility

Caltrans District 11 Hydraulics Department

Addendum for:
Full Interchange at
Siempre Viva Road

AECOM

August 9, 2010

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August 9, 2010

AECOM

Project Manager	Kirk Bradbury, P.E.
Project Engineers	Gerard Dalziel, P.E.
	Michael Brüning
	Gerardo Carrillo
	Glenn Yamanaka

AECOM 7807 Convoy Court, Suite 200 San Diego, CA 92111

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Project Information

Informative Abstract

This is an addendum to the Hydrology & Hydraulics Report for the State Route 11 Corridor (SR-11) & Commercial Vehicle Enforcement Facility (CVEF), dated April 14, 2010 (original report).

This addendum was prepared to analyze the hydrology and hydraulics of the proposed SR-11, specifically the two-interchange alternative with a design alternative that includes a full interchange at Siempre Viva Road, for the purpose of determining environmental footprint requirements and environmental impacts due to drainage infrastructure needs.

The following Watersheds are affected by this design alternative:

- Watershed F
- Watershed G

The following detention/retention basins are affected by this design alternative:

- Basin F
- Basin G-North
- Basin G-South

The following Culverts are affected by this design alternative:

- Culvert G

Culvert F has not changed from that of the original two-interchange design.

Pre-developed and post–developed flows and runoff volumes will be analyzed for the purpose of sizing and placing detention/retention basin.

Project Location

This addendum covers SR-11 from Alta Road to the Port of Entry (POE), specifically Stations 105+00 to 140+00 and the associated ramps at Siempre Viva Road.

The project has defined the following alignments:

- "SD11" Line, SR-11 main lanes
- "ALTA" Line, Alta Road
- "SVI1" Line, Siempre Viva Road
- "SV1" Line, Northbound on ramp from the POE for Passenger Vehicles
- "SV2" Line, Northbound on ramp from the POE for Passenger Vehicles
- "SDR2" Line, Southbound off ramp to POE for Passenger Vehicles
- "SV3A" Line, Southbound off ramp at Siempre Viva Road
- "SV3B" Line, Southbound on ramp at Siempre Viva Road for Commercial Vehicles
- "SV3C" Line, Southbound on ramp at Siempre Viva Road for Passenger Vehicles
- "SV4A" Line, Northbound off ramp at Siempre Viva Road for Passenger Vehicles
- "SV4B" Line, Northbound on ramp at Siempre Viva Road

The remainder of the SR-11 Corridor, CVEF and the POE are covered within the original report.

Project Location Map

Figure 1

Project Description

This addendum covers the addition of four ramps at Siempre Viva Road to the two-interchange design alternative.

Refer to Figures 2, 3 & 4 for a graphical overview of the design alternatives of the two-interchange and the full interchange at Siempre Viva Road.

Elements within this addendum are labeled as 'FULL' to differentiate the design from that of the original two-interchange design.

Drainage Layout and Calculations

Pre-developed conditions for the two affected watersheds (Watershed F and Watershed G) are provided in Appendix A.

Cross culverts, inlets, biofiltration swales and pipe layouts are modified to accommodate the additional ramps. Exhibits are provided in Appendix B and Appendix C along with all calculations to determine detention/retention basin sizes. Culvert F dimensions and calculations match the original two-interchange (refer to original calculations). Culvert G has been lengthened and a new calculation for that culvert is provided in Appendix C.

Figure 2 - Two Interchange Alternative – (original)

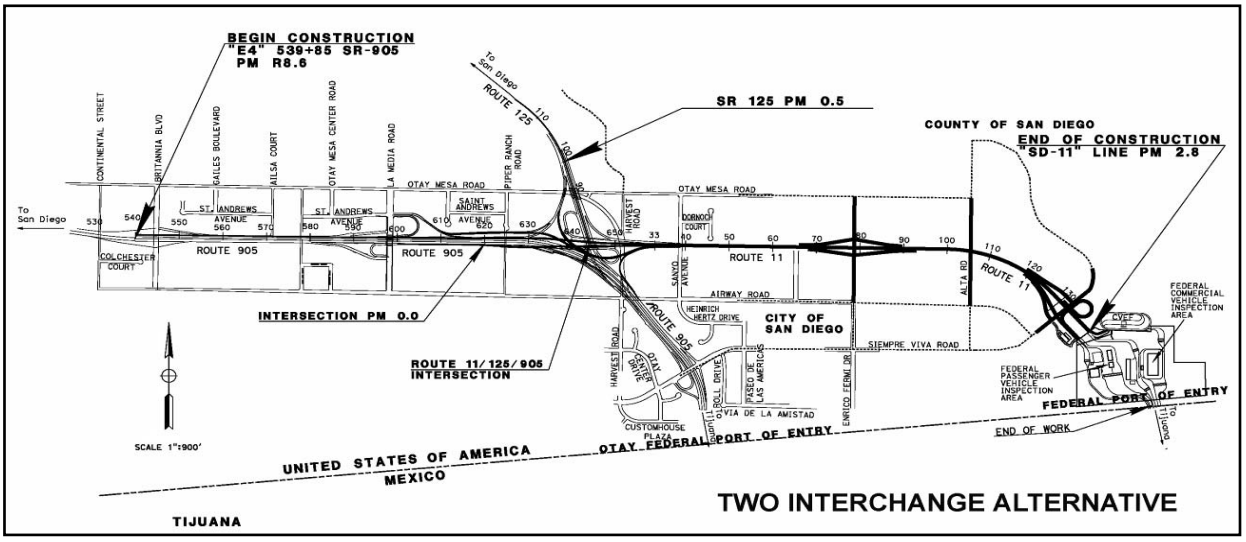


Figure 3 – Full Interchange at Siempre Viva Road – Vehicle Movements

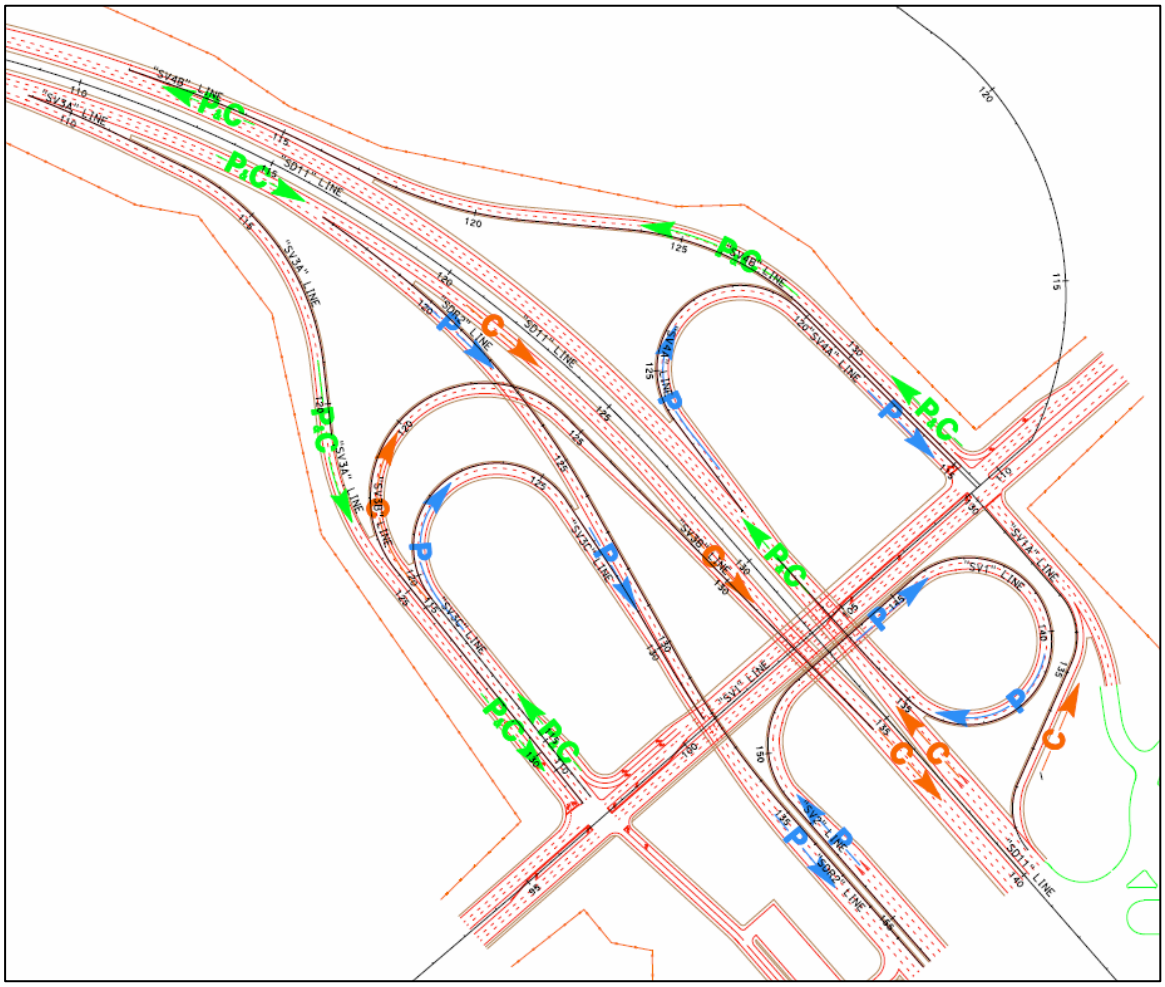
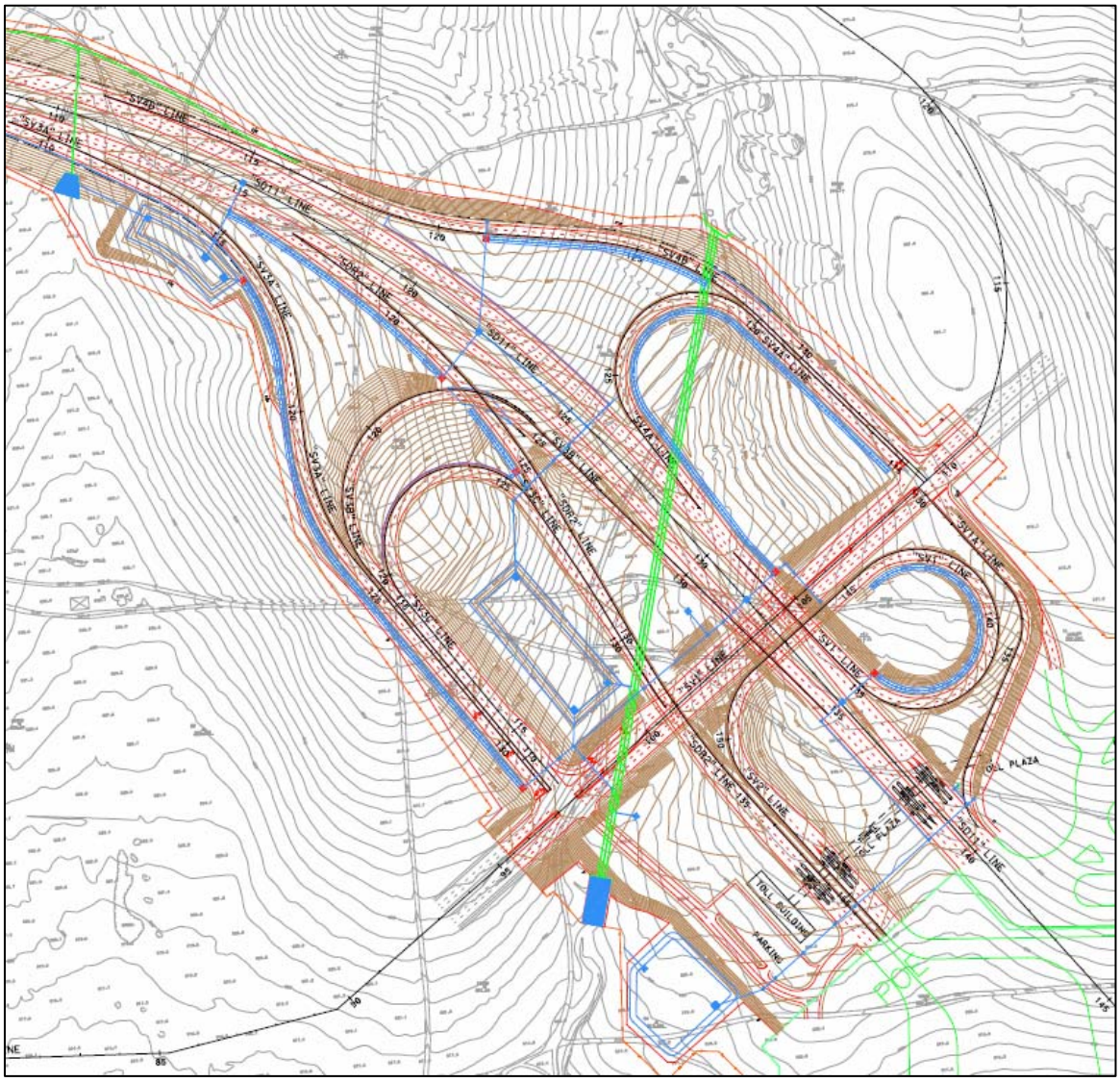


Figure 4 – Full Interchange at Siempre Viva Road – Grading and Drainage Plan



Refer to the original report for discussions regarding the following: Hydrologic Setting, Existing Conditions, Hydrologic Analysis, Watershed Nomenclature, Watershed Descriptions, Offsite Watersheds, Flow Characteristics, Watershed Delineation, Rainfall Intensities, Time of Concentrations, Runoff Coefficients, Units, Offsite Drainage, Onsite Drainage, Biofiltration Swales, Detention/Retention Basins and County of San Diego and International Border Water Commission correspondence.

Features Requiring Further Discussion

Basin G

Watershed "G" has two basins (*G-North* and *G-South*) proposed for each of the three alternatives. This arrangement was due to the Siempre Viva Road interchange complexity which limited available area to place basins within and around the interchange.

Where *G-South* has been placed, it must ultimately discharge into the flow line of an adjacent existing channel. This existing channel has been defined as a *Waters of the US*. An easement may be required to place a discharge pipe towards this channels flowline. An energy dissipation device will also be required. The final design of this drainage feature which discharges towards this existing channel's flow line must meet the criteria of the *Waters of the US.*

SR-11 Interchange Flows

Storm runoff from Alta Road and Siempre Viva Road within the two interchange alternative, that are within the proposed Caltrans right-of-way are considered in this design. Runoff from these proposed roads that are outside of the proposed Caltrans right-of-way are not considered in the proposed design.

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References

1. “Highway Design Manual”, State of California Department of Transportation (Caltrans), Sixth Edition, July 2008.

2. “District 11 Hydraulics Section – Guidelines for Consultants Performing Hydraulic Design on Caltrans Projects”, Caltrans, October 2002.

3. “Civil Engineering Reference Manual”, Michael P. Lindeburg, Eighth Edition, 2002.

4. “Urban Drainage Design Manual”, Hydraulic Engineering Circular No.22, USDT Federal Highway Administration, November 1996.

5. “Caltrans Storm Water Quality Handbooks, Project Planning and Design Guide”, State of California Department of Transportation (Caltrans), May 2007

6. “Hydrology Manual”, County of San Diego Public Works Flood Control, January 2003

7. “Preliminary Hydrology & Hydraulics Report – State Route 11 - Port of Entry (POE)”, April 14, 2010

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Appendix A PRE-Developed Conditions for Watersheds F and G

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WATERSHED F
PRE-DEVELOPED
Scale: 1"=450'
100' SHORT FLOW Ele=8.3
667' SHALLOW CONCENTRATED FLOW
318' CHANNEL FLOW
100' STORM DRAIN FLOW
311' CHANNEL FLOW
957' CHANNEL FLOW
328' CHANNEL FLOW
700' CHANNEL FLOW
"SD11" LINE
"ALTA" LINE
"SD11" LINE

F Pre-Developed TcQ

PROJECT:	SR-11			DESCRIPTION:	SR-11 Pre-Developed
JOB #:	11A1190			STATION:	110+50
BY:	M.BRUNING	DATE:	10.24.09	WATERSHED:	F
CHK:	G.DALZIEL	DATE:		SYSTEM:	

BASIN AREA:

A =	5460656	ft^2	SOURCE:	MICROSTATION/USGS
	125.36	acres		(SCALE = 1:1)

COEFFICIENT OF RUNOFF:

KEY: User Input | Designer Tool

UNDEVELOPED AREA C (FROM HDM FIG. 819.2A)

		NOTES:
RELIEF (.08-.35)	0.20	Hilly ~ 10%
INFILTRATION (.04-.16)	0.12	Negligible infiltration capacity - see Geotechnical Report
VEGETATION (.04-.16)	0.08	Fair natural cover
STORAGE (.04-.12)	0.07	Normal
TOTAL C =	0.47	

UNDEVELOPED AREA	99%	AT	0.47	0.466
PAVED SURFACE	1%	AT	0.90	0.008
COMMERCIAL AREA	0%	AT	0.85	0.000
CUT SLOPE (2:1 and 4:1)	0%	AT	0.55	0.000
TOTAL	100%			
	(100%)			

$C_{2,10}$ =	0.47
C_{25} =	0.52
C_{50} =	0.57
C_{100} =	0.59

TIME OF CONCENTRATION:

SHEET FLOW: $T_t = \frac{0.42L^{.45}n^{.45}}{P_2^{1/2}s^{.2/5}}$

NOTES: $P_{2,24}$ (in) = 1.80

HIGH PT ELEVATION	630.0	ft	Northern watershed boundary
LOW POINT ELEVATION	629.0	ft	
ELEVATION DIFF (H)	1.0	ft	
LENGTH (L)	100	ft	
SLOPE (S) = (H/L)	1.0%		
MANNING'S n	0.050		< = From Table 816.6A Fallow
T_t (SFF)=	7.16	minutes	

SHALLOW CONCENTRATED FLOW:

HIGH PT ELEVATION	629.0	ft	
LOW POINT ELEVATION	600.0	ft	
ELEVATION DIFF (H)	29.0	ft	
LENGTH (L)	667	ft	
SLOPE (S) = (H/L)	4.3%		
VELOCITY (SCF)	1.2	fps	<=V FROM FIG 816.6 Short Grass Pasture/Nearly Bare Ground
T_C (SH)=	9.26	minutes	

CHANNEL FLOW: $T_t = \frac{L}{60\,V}$

HIGH PT ELEVATION	600.0	ft	defined broad channel north of berm
LOW POINT ELEVATION	589.0	ft	CHANNEL DATA TYPE = TRAP'Z
ELEVATION DIFF (H)	11.0	ft	Z= 5 ANG-RAD 0.197
LENGTH (L)	378	ft	b = 50 ANG-DEG 11.310
SLOPE (S) = (H/L)	2.9%		d = 0.5 FLOWING FULL ASS'M
MANNING'S n	0.080		Natural channel
HYDRAULIC RADIUS R	0.5	ft	R=(bdsinA+d^2cosA)/(bsinA+2d)
VELOCITY (CHANNEL)	1.94	fps	From Manning's Equation assuming flowing full: $V=1.49/n(R^{2/3}S^{1/2})$
T_C (CH)=	3.25	minutes	

F Pre-Developed TcQ

STORMDRAIN FLOW: $T_t = \frac{L}{60\,V}$

			NOTES:
HIGH PT ELEVATION	589.0	ft	Exist Cross Culvert under berm
LOW POINT ELEVATION	587.0	ft	
ELEVATION DIFF (H)	2.0	ft	
LENGTH (L)	100	ft	
SLOPE (S) = (H/L)	2.0%		
MANNING'S n	0.013		RCP
PIPE DIAMETER d	3.0	ft	
HYDRAULIC RADIUS R	0.8	ft	R=D/4, Assume: flowing full
VELOCITY (STORMDRAIN)	13.4	fps	$V = \frac{K_u}{n} R^{2/3} S^{1/2}$
T_C (SD)=	0.12	minutes	

CHANNEL FLOW: $T_t = \frac{L}{60\,V}$

			NOTES:
HIGH PT ELEVATION	587.0	ft	defined broad channel south of berm (field verified new berm)
LOW POINT ELEVATION	576.0	ft	CHANNEL DATA / TYPE = / TRAP'Z
ELEVATION DIFF (H)	11.0	ft	Z= 5 / ANG-RAD / 0.197
LENGTH (L)	311	ft	b = 50 / ANG-DEG / 11.310
SLOPE (S) = (H/L)	3.5%		d = 1 / FLOWING FULL ASS'M
MANNING'S n	0.080		Natural channel
HYDRAULIC RADIUS R	0.9	ft	R=(bdsinA+d^2cosA)/(bsinA+2d)
VELOCITY (CHANNEL)	3.30	fps	From Manning's Equation assuming flowing full: $V=1.49/n(R^{2/3}S^{1/2})$
T_C (CH)=	1.57	minutes	

CHANNEL FLOW: $T_t = \frac{L}{60\,V}$

			NOTES:
HIGH PT ELEVATION	576.0	ft	channel begins to narrow
LOW POINT ELEVATION	555.0	ft	CHANNEL DATA / TYPE = / TRAP'Z
ELEVATION DIFF (H)	21.0	ft	Z= 2 / ANG-RAD / 0.464
LENGTH (L)	957	ft	b = 1 / ANG-DEG / 26.565
SLOPE (S) = (H/L)	2.2%		d = 1.5 / FLOWING FULL ASS'M
MANNING'S n	0.050		Natural channel
HYDRAULIC RADIUS R	0.8	ft	R=(bdsinA+d^2cosA)/(bsinA+2d)
VELOCITY (CHANNEL)	3.74	fps	From Manning's Equation assuming flowing full: $V=1.49/n(R^{2/3}S^{1/2})$
T_C (CH)=	4.27	minutes	

CHANNEL FLOW: $T_t = \frac{L}{60\,V}$

			NOTES:
HIGH PT ELEVATION	555.0	ft	channel begins to narrow
LOW POINT ELEVATION	546.0	ft	CHANNEL DATA / TYPE = / TRAP'Z
ELEVATION DIFF (H)	9.0	ft	Z= 2 / ANG-RAD / 0.464
LENGTH (L)	328	ft	b = 1 / ANG-DEG / 26.565
SLOPE (S) = (H/L)	2.7%		d = 2 / FLOWING FULL ASS'M
MANNING'S n	0.050		Natural channel
HYDRAULIC RADIUS R	1.0	ft	R=(bdsinA+d^2cosA)/(bsinA+2d)
VELOCITY (CHANNEL)	4.95	fps	From Manning's Equation assuming flowing full: $V=1.49/n(R^{2/3}S^{1/2})$
T_C (CH)=	1.10	minutes	

CHANNEL FLOW: $T_t = \frac{L}{60\,V}$

			NOTES:
HIGH PT ELEVATION	546.0	ft	channellized - natural
LOW POINT ELEVATION	536.0	ft	CHANNEL DATA / TYPE = / TRAP'Z
ELEVATION DIFF (H)	10.0	ft	Z= 2 / ANG-RAD / 0.464
LENGTH (L)	700	ft	b = 1 / ANG-DEG / 26.565
SLOPE (S) = (H/L)	1.4%		d = 2 / FLOWING FULL ASS'M
MANNING'S n	0.050		Natural channel
HYDRAULIC RADIUS R	1.0	ft	R=(bdsinA+d^2cosA)/(bsinA+2d)
VELOCITY (CHANNEL)	3.58	fps	From Manning's Equation assuming flowing full: $V=1.49/n(R^{2/3}S^{1/2})$
T_C (CH)=	3.26	minutes	

Tc (TOTAL) =	30.01	minutes
Minimum Tc =	10	minutes
USE Tc =	**30.01**	minutes

INTENSITY CHART: $I = 7.44\,P_6\,D^{-0.645}$

i_2 =	0.9	in/hr	X CA =	
i_{10} =	1.3	in/hr	X CA =	
i_{25} =	1.7	in/hr	X CA =	
i_{50} =	2.0	in/hr	X CA =	
i_{100} =	2.1	in/hr	X CA =	

FLOW RESULTS:

	cfs
Q_2 =	54.2
Q_{10} =	78.8
Q_{25} =	108.4
Q_{50} =	141.9
Q_{100} =	**154.0**

COUNTY P_6

	inches
2-year:	1.1
10-year:	1.6
25-year:	2.0
50-year:	2.4
100-year:	2.5

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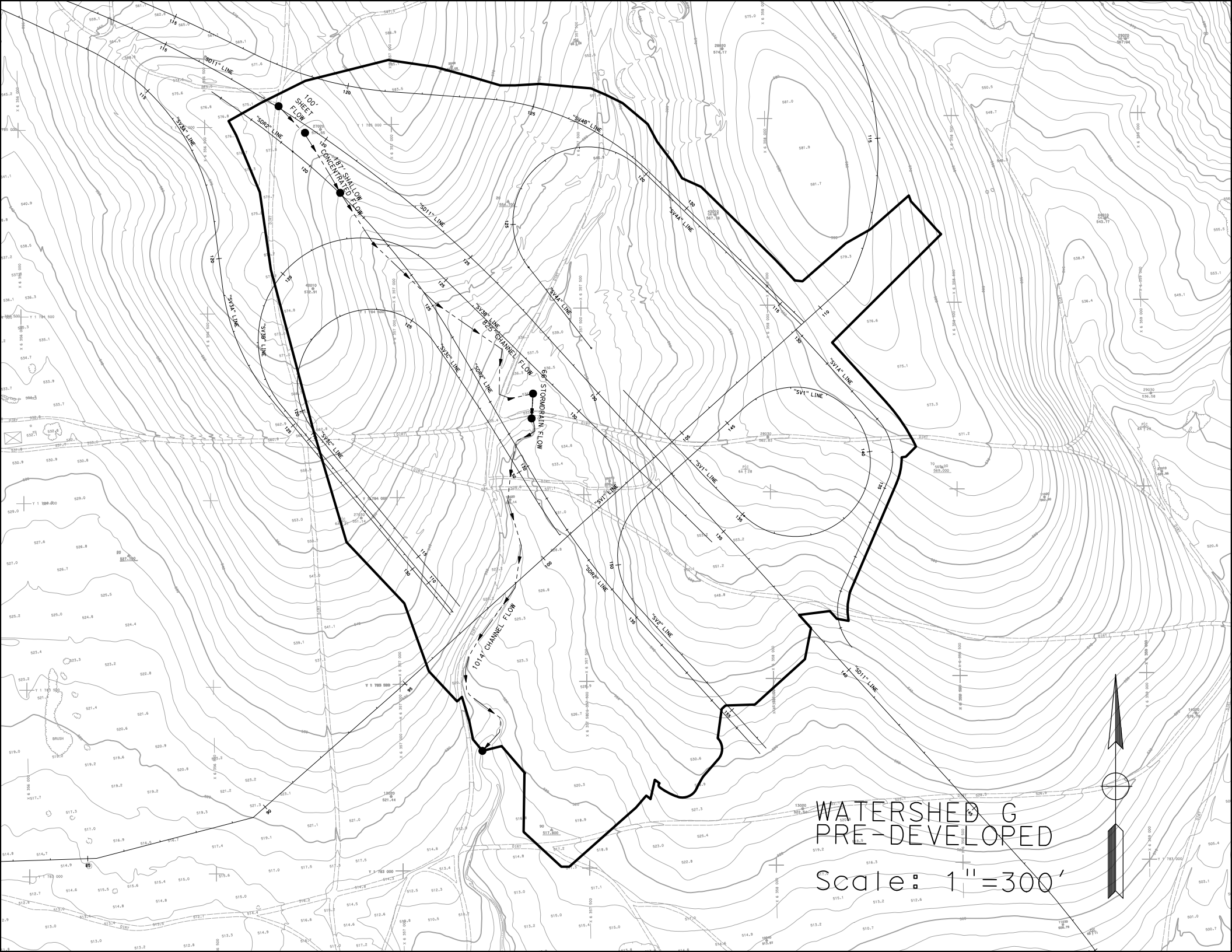
100' SHEET FLOW
187' SHALLOW CONCENTRATED FLOW
825' CHANNEL FLOW
66' STORMDRAIN FLOW
1014' CHANNEL FLOW
"SD11" LINE
"SD12" LINE
"SV3A" LINE
"SV3B" LINE
"SV3C" LINE
"SV4B" LINE
"SV4A" LINE
"SV4C" LINE
"SV1" LINE
"SV2" LINE
WATERSHED G
PRE-DEVELOPED
Scale: 1"=300'

G Pre-Developed TcQ

PROJECT:	SR-11			DESCRIPTION:	SR-11 Pre-Developed
JOB #:	11A1190			STATION:	139+00
BY:	M.BRUNING	DATE:	12.31.09	WATERSHED:	G
CHK:	G.DALZIEL	DATE:		SYSTEM:	

BASIN AREA:

A =	1789591	ft^2	SOURCE:	MICROSTATION/USGS
	41.08	acres		(SCALE = 1:1)

COEFFICIENT OF RUNOFF:

KEY: USER INPUT

UNDEVELOPED AREA C (FROM HDM FIG. 819.2A)

		NOTES:
RELIEF (.08-.35)	0.12	Relatively Flat ~ 4%
INFILTRATION (.04-.16)	0.12	Negligible infiltration capacity - see Geotechnical Report
VEGETATION (.04-.16)	0.08	Fair natural cover
STORAGE (.04-.12)	0.07	Normal
TOTAL C =	0.39	

UNDEVELOPED AREA	100%	AT	0.39	0.390
PAVED SURFACE	0%	AT	0.90	0.000
COMMERCIAL AREA	0%	AT	0.85	0.000
CUT SLOPE (2:1 and 4:1)	0%	AT	0.55	0.000
TOTAL	100%			
	(100%)			

$C_{2,10}$ =	0.39
C_{25} =	0.43
C_{50} =	0.47
C_{100} =	0.49

TIME OF CONCENTRATION:

SHEET FLOW: $T_t = \frac{0.42L^{4/5}n^{4/5}}{P_2^{1/2}s^{2/5}}$

NOTES: $P_{2,24}$ (in) = 1.80

HIGH PT ELEVATION	574.0	ft	Northern watershed boundary
LOW POINT ELEVATION	572.0	ft	
ELEVATION DIFF (H)	2.0	ft	
LENGTH (L)	100	ft	
SLOPE (S) = (H/L)	2.0%		
MANNING'S n	0.050		< = FROM TABLE 816.6A Fallow
T_t (SFF)=	5.42	minutes	

SHALLOW CONCENTRATED FLOW: $T_t = \frac{L}{60\,V}$

NOTES:

HIGH PT ELEVATION	572.0	ft	
LOW POINT ELEVATION	566.0	ft	
ELEVATION DIFF (H)	6.0	ft	
LENGTH (L)	187	ft	
SLOPE (S) = (H/L)	3.2%		
VELOCITY (SCF)	1.8	fps	<=V FROM FIG 816.6 Short Grass Pasture/Nearly Bare Ground
T_C (SH)=	1.78	minutes	

CHANNEL FLOW: $T_t = \frac{L}{60\,V}$

NOTES:

HIGH PT ELEVATION	566.0	ft	channelized
LOW POINT ELEVATION	535.4	ft	CHANNEL DATA TYPE = TRAP'Z
ELEVATION DIFF (H)	30.6	ft	Z= 4 ANG-RAD 0.245
LENGTH (L)	825	ft	b = 20 ANG-DEG 14.036
SLOPE (S) = (H/L)	3.7%		d = 1 FLOWING FULL ASS'M
MANNING'S n	0.080		Natural channel
HYDRAULIC RADIUS R	0.8	ft	R=(bdsinA+d^2cosA)/(bsinA+2d)
VELOCITY (CHANNEL)	3.22	fps	From Manning's Equation assuming flowing full: $V=1.49/n(R^{2/3}S^{1/2})$
T_C (CH)=	4.27	minutes	

G Pre-Developed TcQ

STORMDRAIN FLOW: $T_t = \frac{L}{60\,V}$

			NOTES:
HIGH PT ELEVATION	535.4	ft	Existing culvert under path
LOW POINT ELEVATION	532.0	ft	
ELEVATION DIFF (H)	3.4	ft	
LENGTH (L)	66	ft	
SLOPE (S) = (H/L)	5.2%		
MANNING'S n	0.022		CMP
PIPE DIAMETER d	3.0	ft	
HYDRAULIC RADIUS R	0.8	ft	R=D/4, Assume: flowing full
VELOCITY (STORMDRAIN)	12.7	fps	$V = \frac{K_u}{n} R^{2/3} S^{1/2}$
T_C (SD)=	0.09	minutes	

CHANNEL FLOW: $T_t = \frac{L}{60\,V}$

			NOTES:
HIGH PT ELEVATION	532.0	ft	large channel at base of watershed
LOW POINT ELEVATION	514.0	ft	CHANNEL DATA — TYPE = TRAP'Z
ELEVATION DIFF (H)	18.0	ft	Z= 2 — ANG-RAD 0.464
LENGTH (L)	1014	ft	b = 8 — ANG-DEG 26.565
SLOPE (S) = (H/L)	1.8%		d = 2 — FLOWING FULL ASS'M
MANNING'S n	0.080		Natural channel
HYDRAULIC RADIUS R	1.4	ft	R=(bdsinA+d^2cosA)/(bsinA+2d)
VELOCITY (CHANNEL)	3.13	fps	From Manning's Equation assuming flowing full: $V=1.49/n(R^{2/3}S^{1/2})$
T_C (CH)=	5.40	minutes	

Tc (TOTAL) =	16.97	minutes
Minimum Tc =	5	minutes
USE Tc =	**16.97**	minutes

INTENSITY CHART: $I = 7.44\,P_6\,D^{-0.645}$

i_2 =	1.3	in/hr	X CA =	
i_{10} =	1.9	in/hr	X CA =	
i_{25} =	2.4	in/hr	X CA =	
i_{50} =	2.9	in/hr	X CA =	
i_{100} =	3.0	in/hr	X CA =	

FLOW RESULTS:

	cfs
Q_2 =	21.1
Q_{10} =	30.7
Q_{25} =	42.2
Q_{50} =	55.3
Q_{100} =	**60.0**

COUNTY P_6

	inches
2-year:	1.1
10-year:	1.6
25-year:	2.0
50-year:	2.4
100-year:	2.5

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Appendix B POST-Developed Exhibits and Calculations

for Watershed and Basin F

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Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
11	SD	11	23.3/26.6		

REGISTERED CIVIL ENGINEER DATE

PLANS APPROVAL DATE

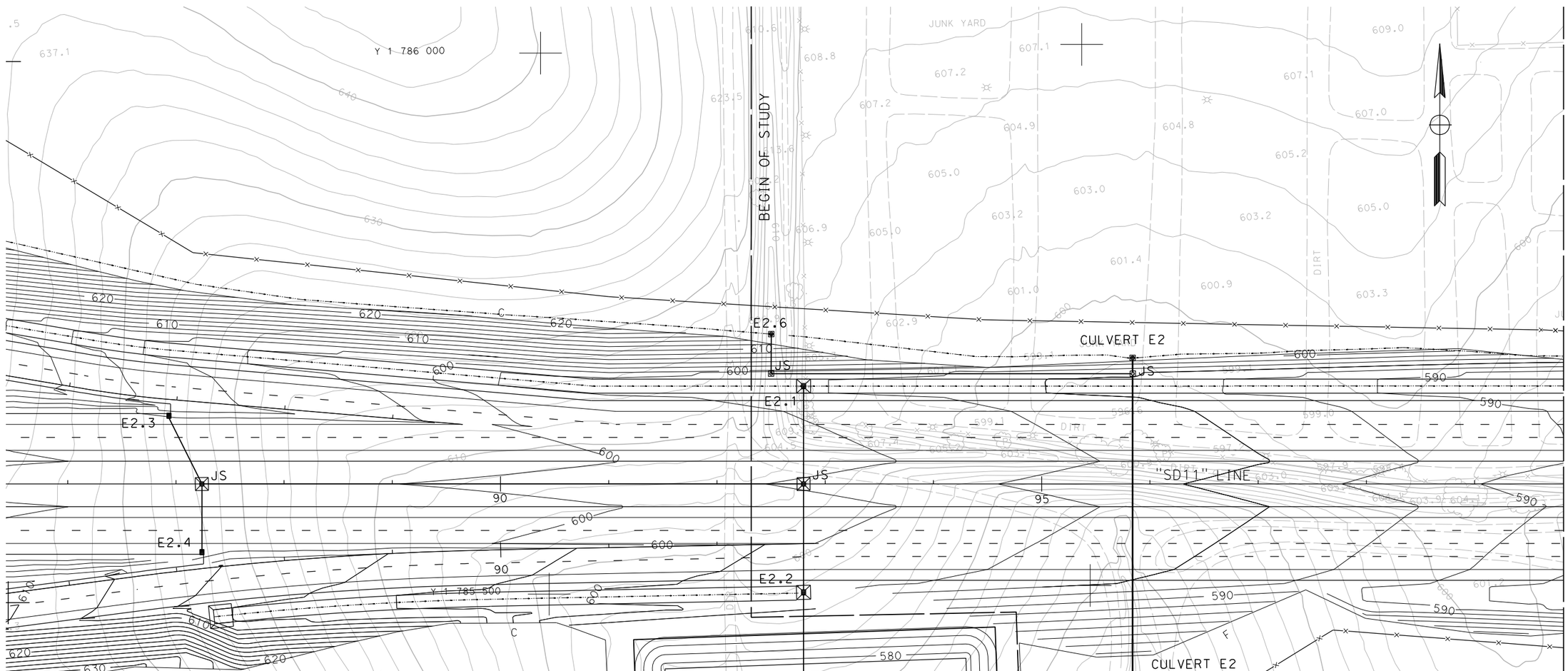
REGISTERED PROFESSIONAL ENGINEER KIRK BRADBURY No. 71673 Exp. 12/31/09 CIVIL STATE OF CALIFORNIA

THE STATE OF CALIFORNIA OR ITS OFFICERS OR AGENTS SHALL NOT BE RESPONSIBLE FOR THE ACCURACY OR COMPLETENESS OF SCANNED COPIES OF THIS PLAN SHEET.

AECOM
7807 CONVOY COURT, SUITE 200
SAN DIEGO, CA 92111

NOTE:

FOR COMPLETE RIGHT OF WAY AND ACCURATE ACCESS DATA, SEE RIGHT OF WAY RECORD MAPS AT DISTRICT OFFICE.



TWO INTERCHANGE ALTERNATIVE (FULL)

DRAINAGE PLAN

SCALE 1"=50'

D-1

THIS PLAN ACCURATE FOR DRAINAGE WORK ONLY.

ALL DIMENSIONS ARE IN FEET UNLESS OTHERWISE SHOWN

REVISED BY	DATE REVISED
MIKE BRUNING	GERARD DALZIEL

CALCULATED-DESIGNED BY
CHECKED BY

CONSULTANT FUNCTIONAL SUPERVISOR
KIRK BRADBURY

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION

Caltrans

LAST REVISION 11-13-09 DATE PLOTTED => 8/5/2010 TIME PLOTTED => 3:59:08 PM

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
11	SD	11	23.3/26.6		

REGISTERED CIVIL ENGINEER DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER KIRK BRADBURY No. 71673 Exp. 12/31/09 CIVIL STATE OF CALIFORNIA

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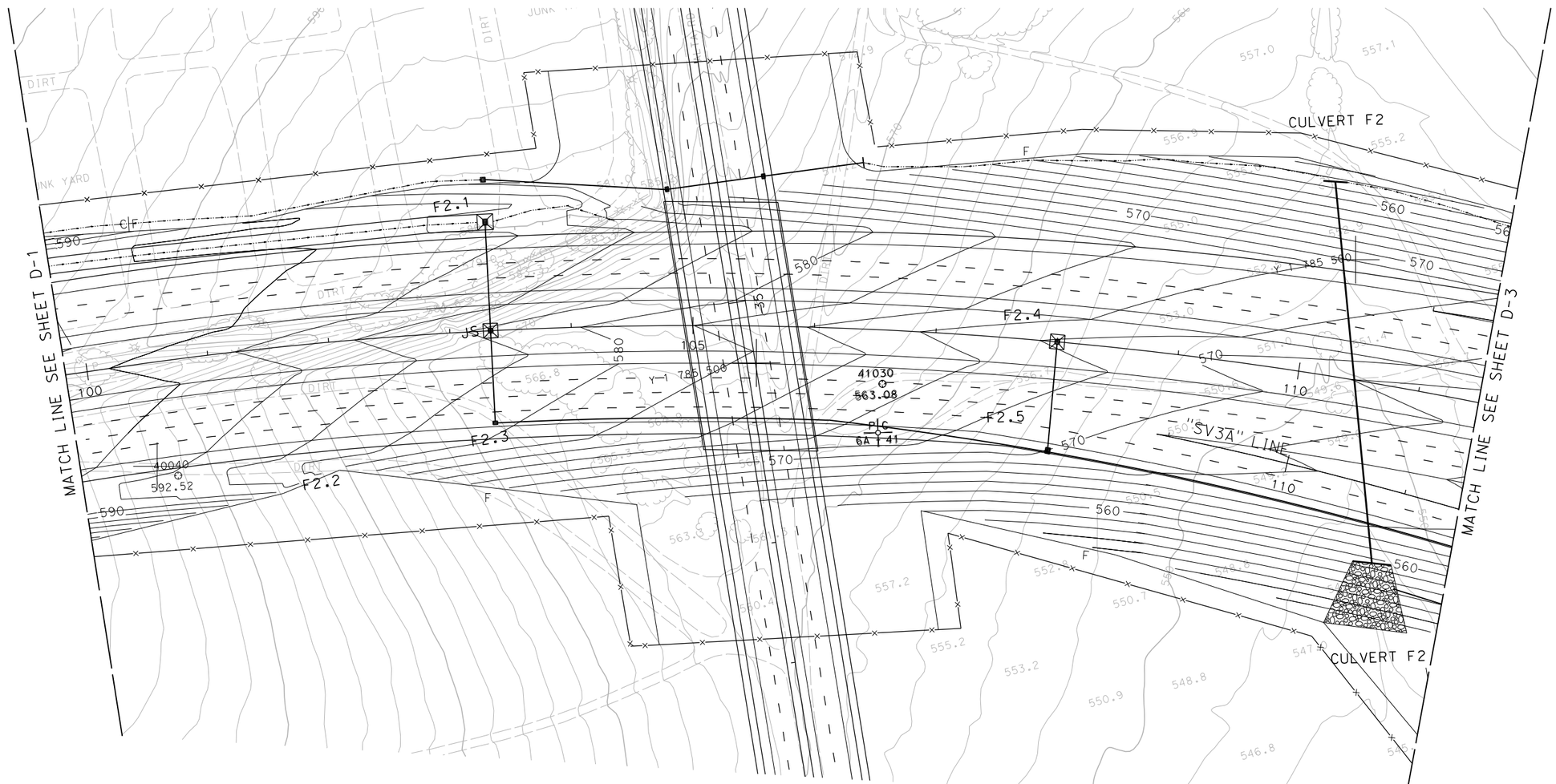

TWO INTERCHANGE ALTERNATIVE (FULL)
DRAINAGE PLAN

SCALE 1"=50'

D-2

THIS PLAN ACCURATE FOR DRAINAGE WORK ONLY.

ALL DIMENSIONS ARE IN FEET UNLESS OTHERWISE SHOWN

REVISED BY	DATE REVISED
MIKE BRUNING	GERARD DALZIEL

CALCULATED-DESIGNED BY / CHECKED BY

CONSULTANT FUNCTIONAL SUPERVISOR: KIRK BRADBURY

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Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
11	SD	11	23.3/26.6		

REGISTERED CIVIL ENGINEER DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER KIRK BRADBURY No. 71673 Exp. 12/31/09 CIVIL STATE OF CALIFORNIA

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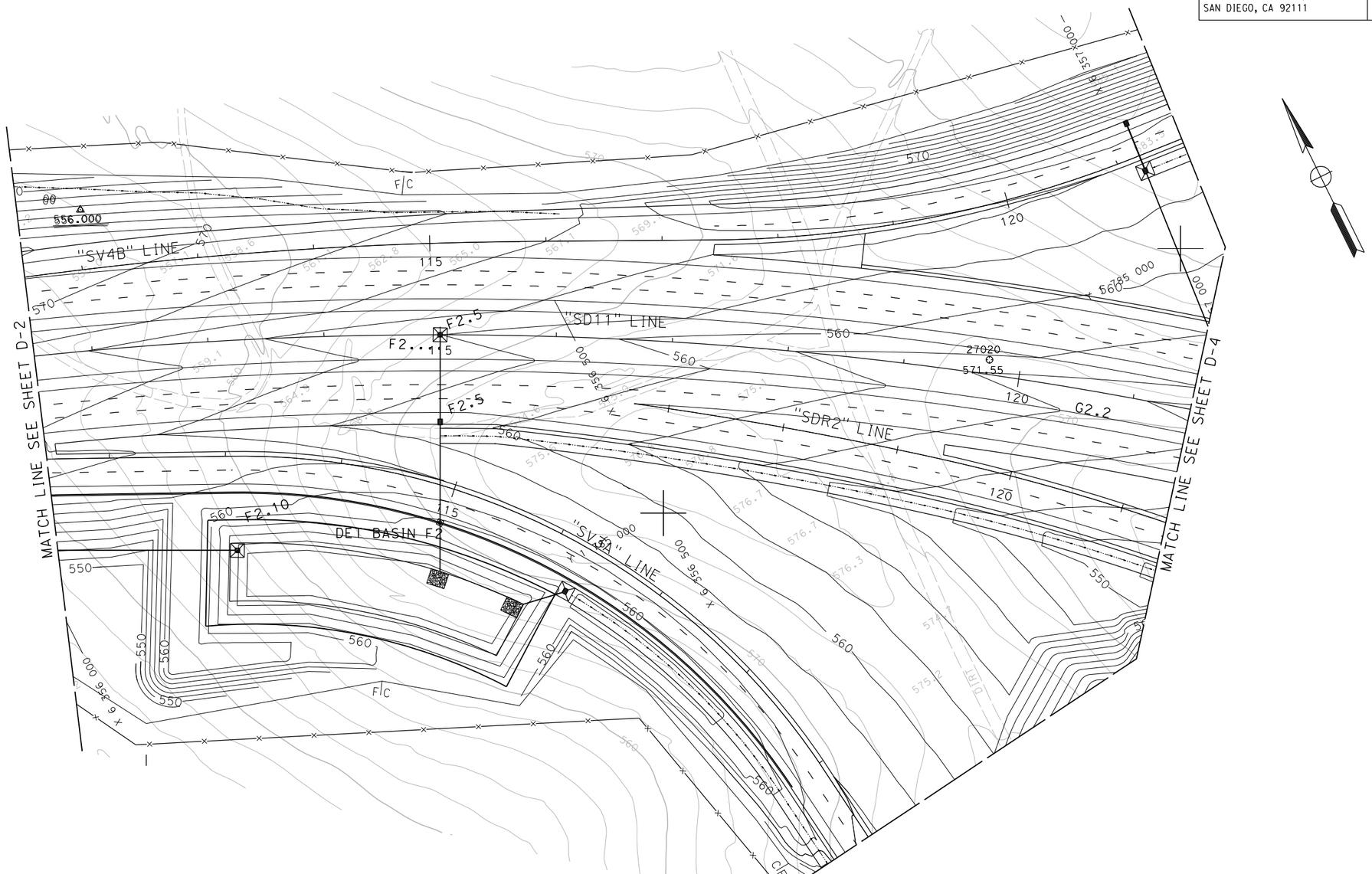

TWO INTERCHANGE ALTERNATIVE (FULL)

DRAINAGE PLAN

SCALE 1"=50'

D-3

THIS PLAN ACCURATE FOR DRAINAGE WORK ONLY.

ALL DIMENSIONS ARE IN FEET UNLESS OTHERWISE SHOWN

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EA 06002

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
11	SD	11	23.3/26.6		

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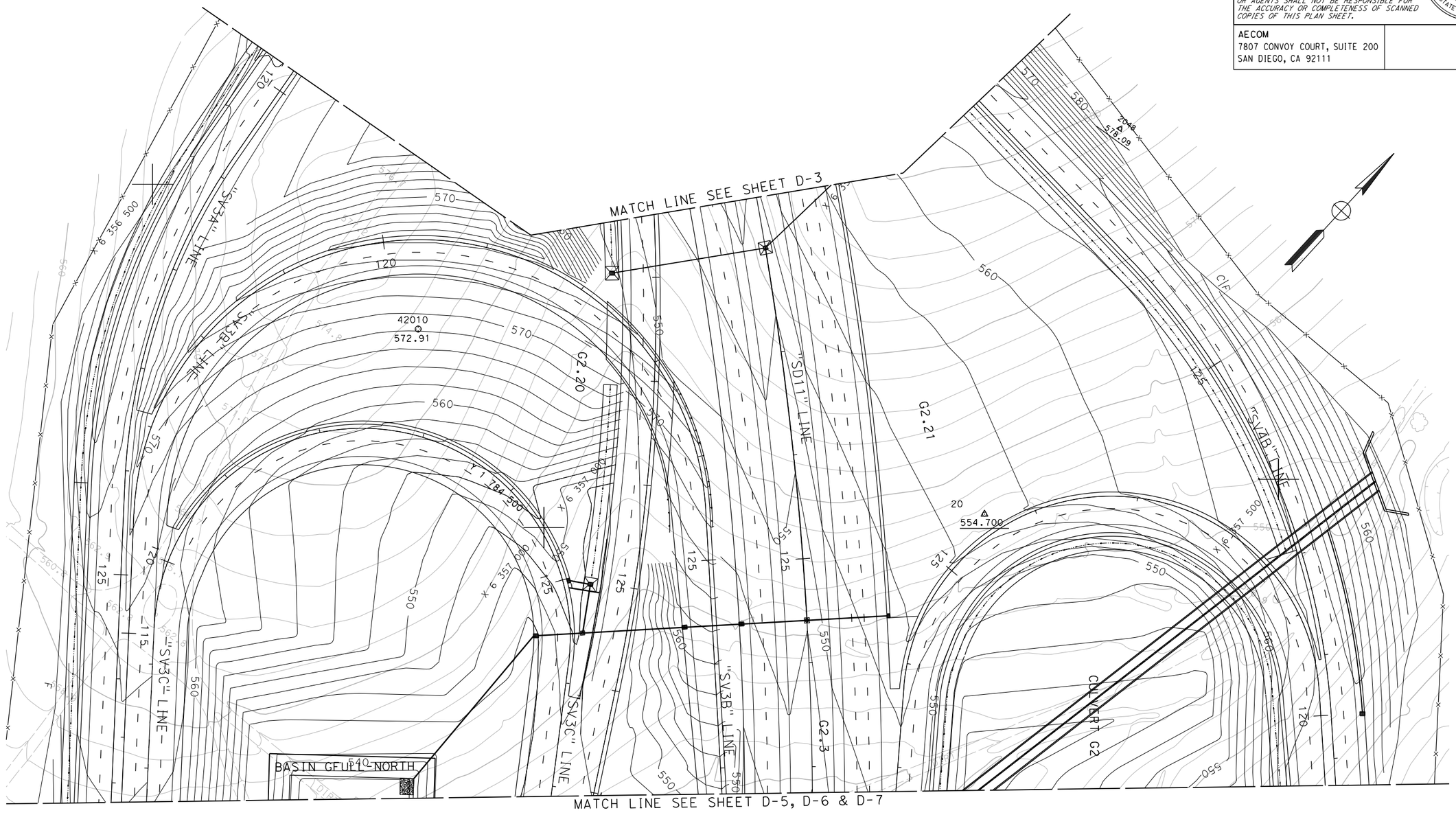

TWO INTERCHANGE ALTERNATIVE (FULL)

DRAINAGE PLAN

SCALE 1"=50'

D-4

THIS PLAN ACCURATE FOR DRAINAGE WORK ONLY.

ALL DIMENSIONS ARE IN FEET UNLESS OTHERWISE SHOWN

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CU XXXXX

EA 06002

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
11	SD	11	23.3/26.6		

REGISTERED CIVIL ENGINEER DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER KIRK BRADBURY No. 71673 Exp. 12/31/09 CIVIL STATE OF CALIFORNIA

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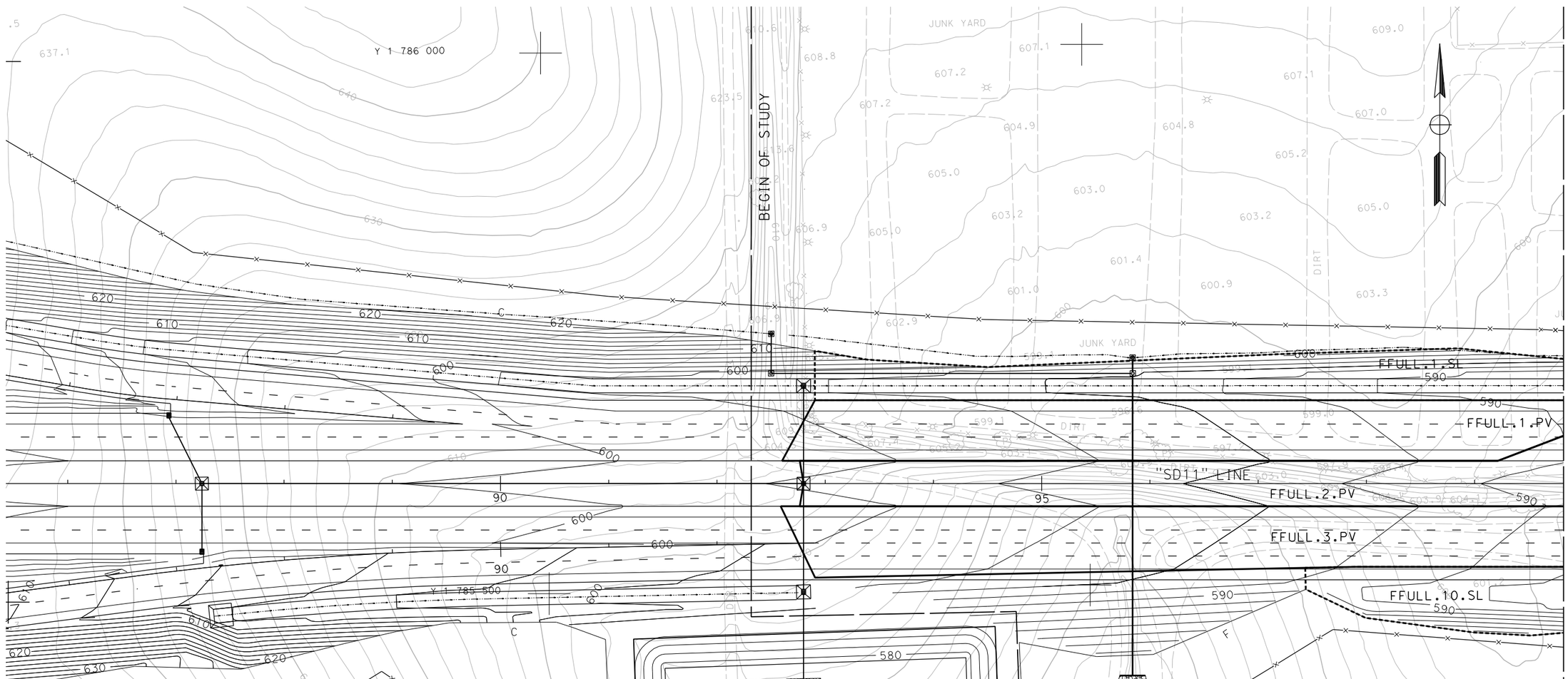

TWO INTERCHANGE ALTERNATIVE (FULL)

DRAINAGE AREA PLAN

SCALE 1"=50'

DA-1

THIS PLAN ACCURATE FOR DRAINAGE WORK ONLY.

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CALCULATED-DESIGNED BY: MIKE BRUNING
CHECKED BY: GERARD DALZIEL

CONSULTANT FUNCTIONAL SUPERVISOR: KIRK BRADBURY

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CU XXXXX

EA 06002

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
11	SD	11	23.3/26.6		

REGISTERED CIVIL ENGINEER DATE

PLANS APPROVAL DATE

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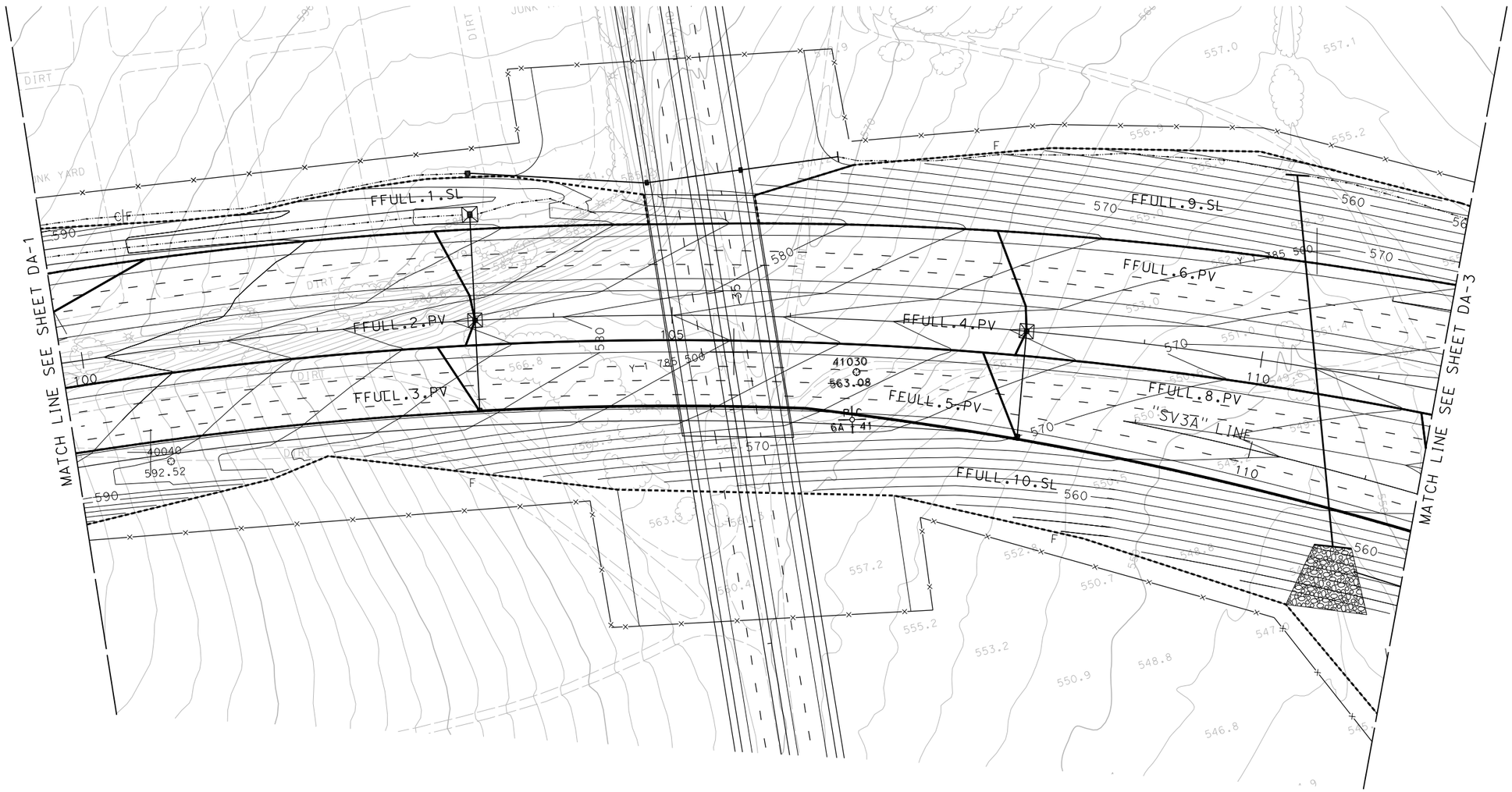

THIS PLAN ACCURATE FOR DRAINAGE WORK ONLY.

ALL DIMENSIONS ARE IN FEET UNLESS OTHERWISE SHOWN

TWO INTERCHANGE ALTERNATIVE (FULL)
DRAINAGE AREA PLAN

SCALE 1"=50'

DA-2

REVISED BY | DATE REVISED
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11	SD	11	23.3/26.6		

REGISTERED CIVIL ENGINEER DATE

PLANS APPROVAL DATE

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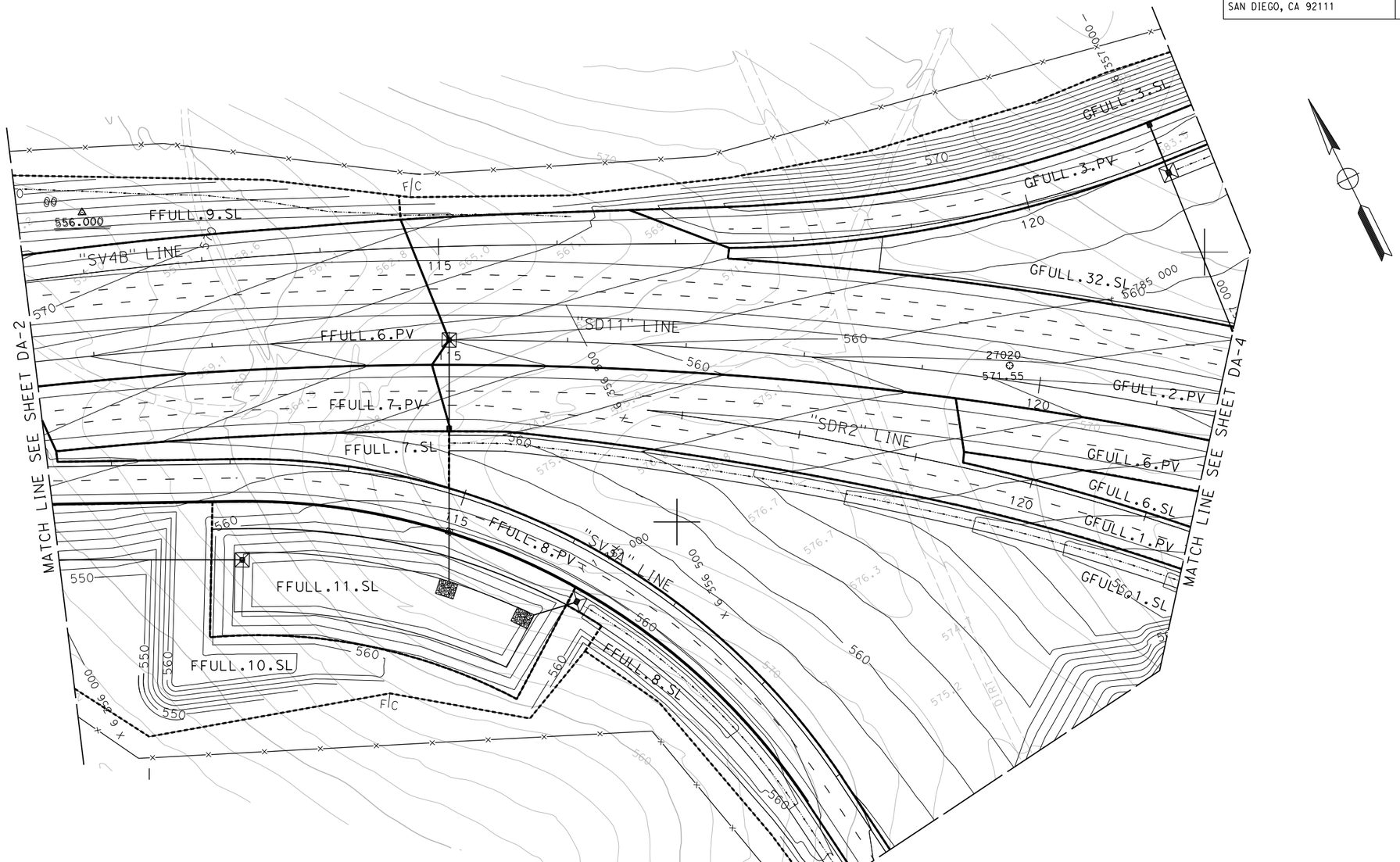

TWO INTERCHANGE ALTERNATIVE (FULL)

DRAINAGE AREA PLAN

SCALE 1"=50'

DA-3

THIS PLAN ACCURATE FOR DRAINAGE WORK ONLY.

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Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
11	SD	11	23.3/26.6		

REGISTERED CIVIL ENGINEER DATE

PLANS APPROVAL DATE

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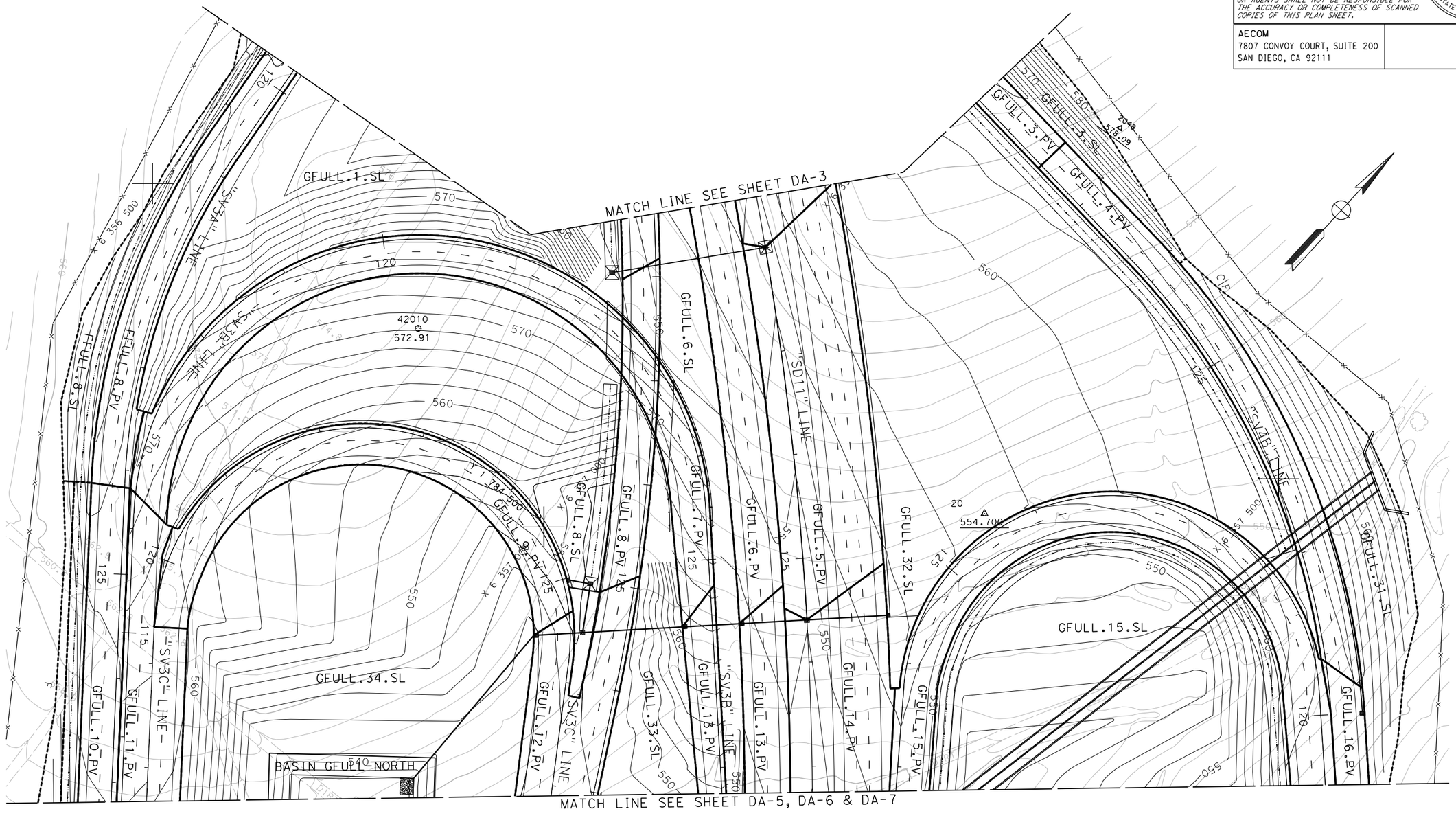

TWO INTERCHANGE ALTERNATIVE (FULL)
DRAINAGE AREA PLAN
DA-4

SCALE 1"=50'

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ALL DIMENSIONS ARE IN FEET UNLESS OTHERWISE SHOWN

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SUPERVISOR: KIRK BRADBURY

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FFULL Onsite D.A. Table

PROJECT:	**SR-11**			**DESCRIPTION:**	**On-site Drainage Areas (D.A.)**
JOB #:	**11A1190**			**STATION:**	**~**
BY:	**M.BRUNING**	**DATE:**	**04.16.10**	**WATERSHED:**	**FFULL**
CHK:	**G.DALZIEL**	**DATE:**		**SYSTEM:**	**Full Interchange Option**

PAVED

		Area		Tc	Caltrans i_{25}	Caltrans Q_{25}	County i_{100}	County Q_{100}	Drains to:				
Name	**C**	*SF*	*Acres*	*min*	*in/hr*	*cfs*	*in/hr*	*cfs*	Bioswale	Inlet	Destination	@ Station	Offset
FFULL.1.PV	0.99	40300	0.9	10	2.8	2.58	4.2	3.86	FFULL.1	FFULL.1	Basin FFULL	103+25	Lt
FFULL.2.PV	0.99	62600	1.4	5	4.0	5.67	6.6	9.37	~	FFULL.2	Basin FFULL	103+25	Center
FFULL.3.PV	0.99	60800	1.4	5	4.0	5.50	6.6	9.10	~	FFULL.3	Basin FFULL	103+25	Rt
FFULL.4.PV	0.99	47000	1.1	5	4.0	4.26	6.6	7.04	~	FFULL.4	Basin FFULL	108+00	Center
FFULL.5.PV	0.99	26800	0.6	5	4.0	2.43	6.6	4.01	~	FFULL.5	Basin FFULL	108+00	Rt
FFULL.6.PV	0.99	78500	1.8	5	4.0	7.11	6.6	11.75	~	FFULL.6	Basin FFULL	115+00	Center
FFULL.7.PV	0.99	19000	0.4	5	4.0	1.72	6.6	2.84	~	FFULL.7	Basin FFULL	115+00	Rt
FFULL.8.PV	0.99	76500	1.8	10	2.8	4.90	4.2	7.32	FFULL.8	FFULL.8	Basin FFULL	116+10	"SV3A"

Σ 411500 *PAVED*

SLOPE

		Area		Tc	Caltrans i_{25}	Caltrans Q_{25}	County i_{100}	County Q_{100}	Drains to:				
Name	**C**	*SF*	*Acres*	*min*	*in/hr*	*cfs*	*in/hr*	*cfs*	Bioswale	Inlet	Destination	@ Station	Offset
FFULL.1.SL	0.61	45600	1.0	10	2.8	1.80	4.2	2.69	FFULL.1	FFULL.1	Basin FFULL	103+25	Lt
FFULL.7.SL	0.61	7500	0.2	10	2.8	0.30	4.2	0.44	~	FFULL.7	Basin FFULL	115+00	Rt
FFULL.8.SL	0.61	25900	0.6	10	2.8	1.02	4.2	1.53	FFULL.8	FFULL.8	Basin FFULL	116+10	"SV3A"
FFULL.9.SL	0.61	55600	1.3	10	2.8	2.19	4.2	3.28	~	FFULL.9	Culvert FFULL	110+00	"SV3A"
FFULL.10.SL	0.61	89200	2.0	10	2.8	3.52	4.2	5.26	~	FFULL.10	* BYPASS	111+00	"SV3A"
FFULL.11.SL	0.61	29100	0.7	10	2.8	1.15	4.2	1.72	~	FFULL.11	Basin FFULL	115+00	"SV3A"

Σ 252900 *SLOPE*

** flow that does not reach the basin*

Total :	664400	15.3
	SF	*ac*

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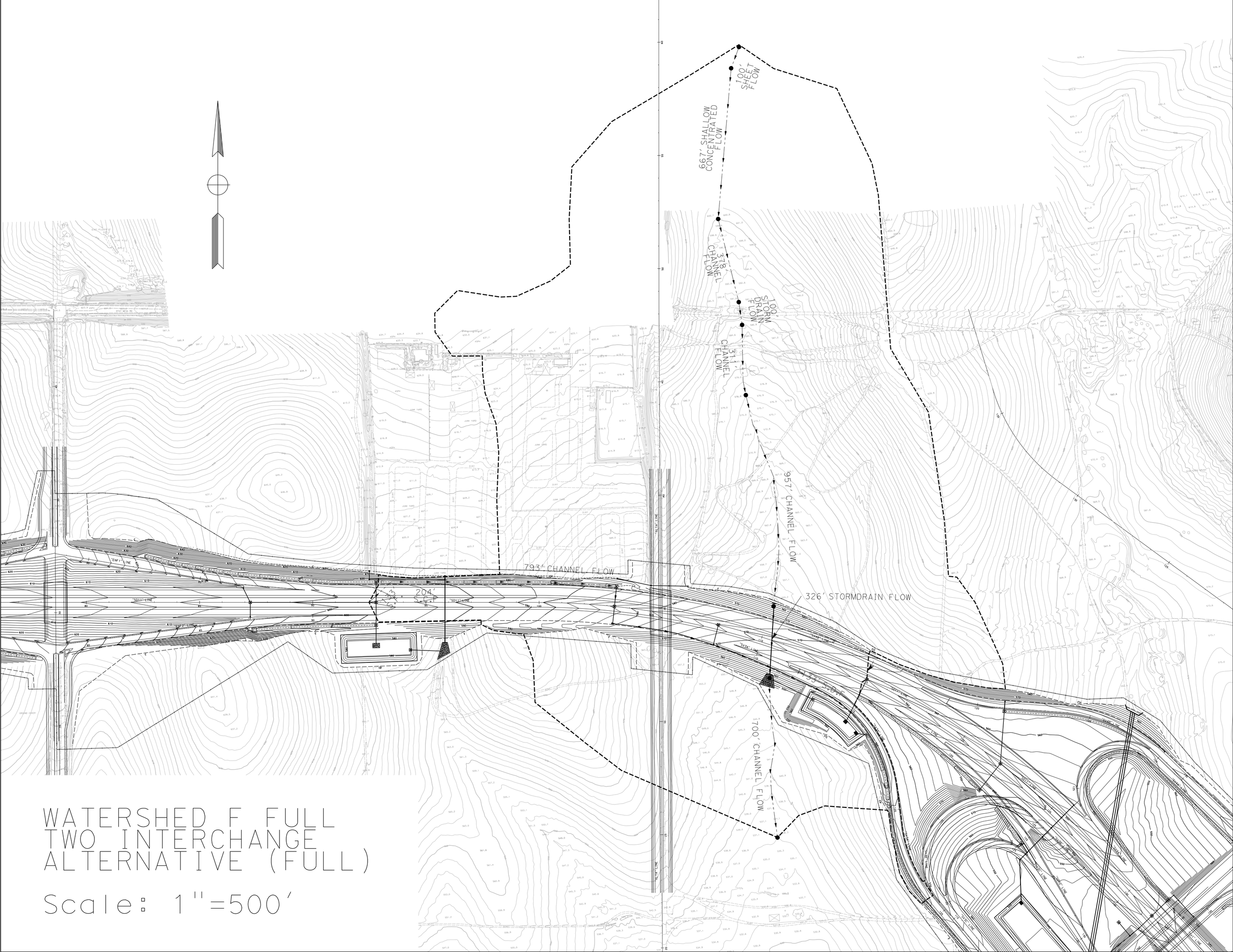

WATERSHED F FULL TWO INTERCHANGE ALTERNATIVE (FULL)

Scale: 1"=500'

FFULL Post-Developed TcQ

PROJECT:	**SR-11**			**DESCRIPTION:**	**SR-11 Post-Developed**
JOB #:	**11A1190**			**STATION:**	**110+00**
BY:	**M.BRUNING**	**DATE:**	**04.16.10**	**WATERSHED:**	**FFULL**
CHK:	**G.DALZIEL**	**DATE:**		**SYSTEM:**	**Full Interchange Option**

BASIN AREA:

A =	**5462958**	**ft^2**	**SOURCE:**	**MICROSTATION/USGS**
	125.41	**acres**		**(SCALE = 1:1)**

COEFFICIENT OF RUNOFF:

KEY: User Input | Designer Tool

UNDEVELOPED AREA C (FROM HDM FIG. 819.2A)

		NOTES:
RELIEF (.08-.35)	0.20	Hilly ~ 10%
INFILTRATION (.04-.16)	0.12	Negligible infiltration capacity - see Geotechnical Report
VEGETATION (.04-.16)	0.08	Fair natural cover
STORAGE (.04-.12)	0.07	Normal
TOTAL C =	0.47	

UNDEVELOPED AREA	88%	AT	0.47	0.413
PAVED SURFACE	8%	AT	0.90	0.068
COMMERCIAL AREA	0%	AT	0.85	0.000
CUT SLOPE (2:1 and 4:1)	5%	AT	0.55	0.025
TOTAL	100%		$C_{2,10}$ =	0.51
	(100%)		C_{25} =	0.56
			C_{50} =	0.61
			C_{100} =	0.63

TIME OF CONCENTRATION:

SHEET FLOW: $T_t = \frac{0.42L^{4/5}n^{4/5}}{P_2^{1/2}s^{2/5}}$

NOTES: $P_{2,24}$ **(in) = 1.80**

HIGH PT ELEVATION	630.0	ft	Northern watershed boundary
LOW POINT ELEVATION	629.0	ft	
ELEVATION DIFF (H)	1.0	ft	
LENGTH (L)	100	ft	
SLOPE (S) = (H/L)	1.0%		
MANNING'S n	0.050		< = From Table 816.6A Fallow
T_t (SFF)=	7.16	minutes	

SHALLOW CONCENTRATED FLOW: $T_t = \frac{L}{60\,V}$

NOTES:

HIGH PT ELEVATION	629.0	ft	
LOW POINT ELEVATION	600.0	ft	
ELEVATION DIFF (H)	29.0	ft	
LENGTH (L)	667	ft	
SLOPE (S) = (H/L)	4.3%		
VELOCITY (SCF)	1.2	fps	<=V FROM FIG 816.6 Short Grass Pasture/Nearly Bare Ground
T_C (SH)=	9.26	minutes	

CHANNEL FLOW: $T_t = \frac{L}{60\,V}$

NOTES:

HIGH PT ELEVATION	600.0	ft	defined broad channel north of berm
LOW POINT ELEVATION	589.0	ft	CHANNEL DATA TYPE = TRAP'Z
ELEVATION DIFF (H)	11.0	ft	Z= 5 ANG-RAD 0.197
LENGTH (L)	378	ft	b = 50 ANG-DEG 11.310
SLOPE (S) = (H/L)	2.9%		d = 0.5 FLOWING FULL ASS'M
MANNING'S n	0.080		Natural Channel
HYDRAULIC RADIUS R	0.5	ft	R=(bdsinA+d^2cosA)/(bsinA+2d)
VELOCITY (CHANNEL)	1.94	fps	From Manning's Equation assuming flowing full: $V=1.49/n(R^{2/3}S^{1/2})$
T_C (CH)=	3.25	minutes	

FFULL Post-Developed TcQ

STORMDRAIN FLOW: $T_t = \frac{L}{60\,V}$

			NOTES:
HIGH PT ELEVATION	589.0	ft	Exist Cross Culvert under berm
LOW POINT ELEVATION	587.0	ft	
ELEVATION DIFF (H)	2.0	ft	
LENGTH (L)	100	ft	
SLOPE (S) = (H/L)	2.0%		
MANNING'S n	0.013		RCP
PIPE DIAMETER d	3.0	ft	
HYDRAULIC RADIUS R	0.8	ft	R=D/4, Assume: flowing full
VELOCITY (STORMDRAIN)	13.4	fps	$V = \frac{K_u}{n} R^{2/3} S^{1/2}$
T_C (SD)=	0.12	minutes	

CHANNEL FLOW: $T_t = \frac{L}{60\,V}$

			NOTES:
HIGH PT ELEVATION	587.0	ft	defined broad channel south of berm (field verified new berm)
LOW POINT ELEVATION	576.0	ft	CHANNEL DATA / TYPE = / TRAP'Z
ELEVATION DIFF (H)	11.0	ft	Z= 5 / ANG-RAD / 0.197
LENGTH (L)	311	ft	b = 50 / ANG-DEG / 11.310
SLOPE (S) = (H/L)	3.5%		d = 1 / FLOWING FULL ASS'M
MANNING'S n	0.080		Natural Channel
HYDRAULIC RADIUS R	0.9	ft	R=(bdsinA+d^2cosA)/(bsinA+2d)
VELOCITY (CHANNEL)	3.30	fps	From Manning's Equation assuming flowing full: $V=1.49/n(R^{2/3}S^{1/2})$
T_C (CH)=	1.57	minutes	

CHANNEL FLOW: $T_t = \frac{L}{60\,V}$

			NOTES:
HIGH PT ELEVATION	576.0	ft	channel begins to narrow
LOW POINT ELEVATION	555.0	ft	CHANNEL DATA / TYPE = / TRAP'Z
ELEVATION DIFF (H)	21.0	ft	Z= 2 / ANG-RAD / 0.464
LENGTH (L)	957	ft	b = 1 / ANG-DEG / 26.565
SLOPE (S) = (H/L)	2.2%		d = 1.5 / FLOWING FULL ASS'M
MANNING'S n	0.050		Natural Channel
HYDRAULIC RADIUS R	0.8	ft	R=(bdsinA+d^2cosA)/(bsinA+2d)
VELOCITY (CHANNEL)	3.74	fps	From Manning's Equation assuming flowing full: $V=1.49/n(R^{2/3}S^{1/2})$
T_C (CH)=	4.27	minutes	

STORMDRAIN FLOW: $T_t = \frac{L}{60\,V}$

			NOTES:
HIGH PT ELEVATION	555.0	ft	Proposed Cross Culvert under SR-11
LOW POINT ELEVATION	546.0	ft	Outfall/Rip Rap Pad
ELEVATION DIFF (H)	9.0	ft	
LENGTH (L)	326	ft	
SLOPE (S) = (H/L)	2.8%		
MANNING'S n	0.013		RCP
PIPE DIAMETER d	4.0	ft	
HYDRAULIC RADIUS R	1.0	ft	R=D/4, Assume: flowing full
VELOCITY (STORMDRAIN)	19.0	fps	$V = \frac{K_u}{n} R^{2/3} S^{1/2}$
T_C (SD)=	0.29	minutes	

CHANNEL FLOW: $T_t = \frac{L}{60\,V}$

			NOTES:
HIGH PT ELEVATION	546.0	ft	channellized - natural
LOW POINT ELEVATION	536.0	ft	CHANNEL DATA / TYPE = / TRAP'Z
ELEVATION DIFF (H)	10.0	ft	Z= 2 / ANG-RAD / 0.464
LENGTH (L)	700	ft	b = 1 / ANG-DEG / 26.565
SLOPE (S) = (H/L)	1.4%		d = 2 / FLOWING FULL ASS'M
MANNING'S n	0.050		Natural Channel
HYDRAULIC RADIUS R	1.0	ft	R=(bdsinA+d^2cosA)/(bsinA+2d)
VELOCITY (CHANNEL)	3.58	fps	From Manning's Equation assuming flowing full: $V=1.49/n(R^{2/3}S^{1/2})$
T_C (CH)=	3.26	minutes	

Tc (TOTAL) =	29.19	minutes
Minimum Tc =	10	minutes
USE Tc =	**29.19**	minutes

INTENSITY CHART: $I = 7.44\,P_6\,D^{-0.645}$

i_2 =	0.9	in/hr	X CA =	
i_{10} =	1.4	in/hr	X CA =	
i_{25} =	1.7	in/hr	X CA =	
i_{50} =	2.0	in/hr	X CA =	
i_{100} =	2.1	in/hr	X CA =	

FLOW RESULTS:

	cfs
Q_2 =	59.0
Q_{10} =	85.7
Q_{25} =	117.9
Q_{50} =	154.3
Q_{100} =	**167.5**

COUNTY P_6

	inches
2-year:	1.1
10-year:	1.6
25-year:	2.0
50-year:	2.4
100-year:	2.5

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Basin FFULL Retention

PROJECT:	**SR-11**			**DESCRIPTION:**	**SR-11 Basin**
JOB #:	**11A1190**			**STATION:**	**110+00**
BY:	**M.BRUNING**	**DATE:**	**04.16.10**	**WATERSHED:**	**FFULL**
CHK:	**G.DALZIEL**	**DATE:**		**SYSTEM:**	**Full Interchange Option**

Notes:

* The difference between pre-developed and post-developed values gives the volume to retain.

RETENTION VOLUME

100-year, 6 hour duration storm event, use the Rational Method Hydrograph Procedure (SDCHM 6-1) ~ RatHydro

Pre-Developed volume calculations

Q_{100}=	154.0	cfs			
Tc=	30.0	min	C=	0.59	
$P_{100,6}$=	2.5	in	A=	125.36	acres

$T_{T(N)}$ (MIN)	VOL (CF)	ORDINATE (CFS)
0	0	0
30	20340	11.3
60	21600	12
90	24660	13.7
120	26820	14.9
150	32760	18.2
180	37260	20.7
210	54720	30.4
240	75960	42.2
270	277200	154
300	43920	24.4
330	29340	16.3
360	23040	12.8
390	0	0

SUM= 667620 ft^3
15.33 acre-feet

Check: V = C*A*P_6
V= 15.47 acre-feet
OK

Example of Steps:

$T_{T(N)}$ (MIN)	VOL (CF)	ORDINATE (CFS)
0	0	0
14	1260	1.5
28	1344	1.6
42	1344	1.6
56	1428	1.7
70	1512	1.8
84	1596	1.9

Basin FFULL Retention

Post-Developed volume calculations

Q_{100}=	167.5	cfs			
Tc=	29.2	min	C=	0.63	
$P_{100,6}$=	2.5	in	A=	125.41	acres

$T_{T(N)}$ (MIN)	VOL (CF)	ORDINATE (CFS)
0	0	0
29	21402	12.3
58	22794	13.1
87	26100	15
116	28188	16.2
145	34452	19.8
174	39324	22.6
203	57768	33.2
232	81258	46.7
261	291450	167.5
290	46284	26.6
319	30972	17.8
348	24186	13.9
377	0	0

Example of Steps:

$T_{T(N)}$ (MIN)	VOL (CF)	ORDINATE (CFS)
0	0	0
14	1260	1.5
28	1344	1.6
42	1344	1.6
56	1428	1.7
70	1512	1.8
84	1596	1.9

SUM= 704178 ft^3
16.17 acre-feet

Check: $V = C*A*P_6$
V= 16.53 acre-feet
OK

		16.17	*(Post)*		
	-	**15.33**	*(Pre)*		
Retention volume =		**0.84**	**acre-feet**	**=**	**36558 ft^3** **Basin Required**

Basin FFULL Retention

WATER QUALITY VOLUME (WQV) CALCULATION

Per the Caltrans Storm Water Quality Handbook: Project Planning and Design Guide (PPDG) (May 2007)
Provide additional capacity for Water Quality

Output from Basin Sizer

Water Quality Volumes

Maximized Volume Method (in/area)*

Basin Drainage Time (hrs)	Runoff Coefficient 0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
12	0.13	0.16	0.21	0.25	0.28	0.33	0.37	0.4
24	0.16	0.21	0.27	0.31	0.37	0.42	0.46	0.52
48	0.2	0.26	0.32	0.38	0.44	0.51	0.57	0.58
72	0.22	0.29	0.37	0.43	0.51	0.58	0.66	0.73

C_{100}= 1.00
A= 11.93 acres

WQ_{72}: 0.73 in/area

Water Quality Volume (WQV) = **31609** **ft^3**

WQV to be added to retention volume = **0** **ft^3** **WQV is within Retention**

Add difference between WQV and Retention Volume

SILT ACCUMULATION ANALYSIS (Long Term)

Per the United States International Boundary and Water Commission (IBWC)
Provide additional capacity for a 10-year volume of silt accumulation

Universal Soil Loss Equation (SDCHM 5.2.3)

$A_s = RKLsCP$

where:

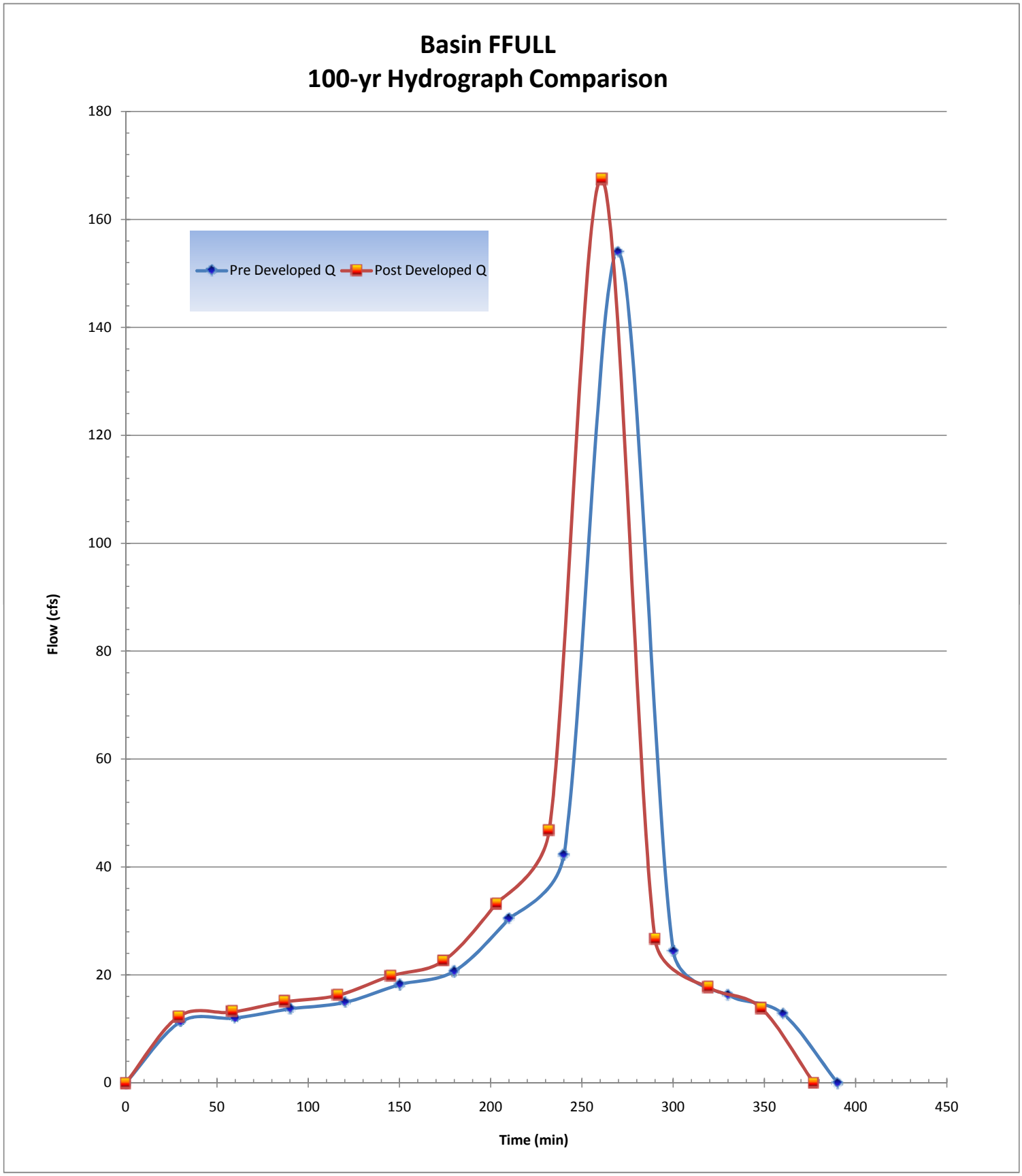
A_s = the computed soil loss in tons (dry weight)
R = the rainfall erosion index for the given storm period
K = the soil erodibility factor
L = the slope length factor
s = the slope gradient factor
C = cropping management (vegetation) factor
P = erosion control practice factor

Onsite Highway *Sloped* runoff area, A:		108100	ft^2
	A:	2.48	acres
		10.00	years
where:	R=	30.00	
	K=	0.24	
	Ls=	18.00	
	C=	0.012	
	P=	1.00	
	As	1.56	tons/yr.Ac

Volume for 10-year Silt Accumulation = 38.59 tons

Silt Accumulation Basin volume = **858** **ft^3**

Add this volume to Basin volume due to silts from cut slopes


Basin FFULL
100-yr Hydrograph Comparison
Pre Developed Q
Post Developed Q
Flow (cfs)
Time (min)
0
20
40
60
80
100
120
140
160
180
0
50
100
150
200
250
300
350
400
450

Basin FFULL Inflow TcQ

PROJECT:	SR-11			DESCRIPTION:	SR-11 Basin
JOB #:	11A1190			STATION:	110+00
BY:	M.BRUNING	DATE:	04.16.10	WATERSHED:	FFULL
CHK:	G.DALZIEL	DATE:		SYSTEM:	Full Interchange Option

BASIN AREA:

A =	519600	ft^2	SOURCE:	MICROSTATION/USGS
	11.93	acres		(SCALE = 1:1)

COEFFICIENT OF RUNOFF:

KEY: User Input | Designer Tool

UNDEVELOPED AREA C (FROM HDM FIG. 819.2A)

NOTES:

RELIEF (.08-.35)	0.00	
INFILTRATION (.04-.16)	0.00	
VEGETATION (.04-.16)	0.00	
STORAGE (.04-.12)	0.00	
TOTAL C =	0.00	

UNDEVELOPED AREA	0%	AT	0.00	0.000
PAVED SURFACE	79%	AT	0.90	0.713
COMMERCIAL AREA	0%	AT	0.85	0.000
CUT SLOPE (2:1 and 4:1)	21%	AT	0.55	0.114
TOTAL	100%			
	(100%)			

$C_{2,10}$ =	0.83
C_{25} =	0.91
C_{50} =	1.00
C_{100} =	1.00

TIME OF CONCENTRATION:

SHEET FLOW: $T_t = \frac{0.42L^{4/5}n^{4/5}}{P_2^{1/2}s^{2/5}}$

NOTES: $P_{2,24}$ (in) = 1.80

HIGH PT ELEVATION	598.0	ft	Median to ES
LOW POINT ELEVATION	595.0	ft	
ELEVATION DIFF (H)	3.0	ft	
LENGTH (L)	133	ft	to ES
SLOPE (S) = (H/L)	2.3%		
MANNING'S n	0.016		AC < = FROM FIG 816.6A
T_t (SFF)=	2.61	minutes	

SHALLOW CONCENTRATED FLOW: $T_t = \frac{L}{60\,V}$

NOTES:

HIGH PT ELEVATION	595.0	ft	Flow in Bioswale
LOW POINT ELEVATION	593.0	ft	
ELEVATION DIFF (H)	2.0	ft	
LENGTH (L)	204	ft	assumed SCF and not channelized or flowing full yet
SLOPE (S) = (H/L)	1.0%		
VELOCITY (SCF)	1.0	fps	1.0% , V FROM FIG 816.6 grass lined
T_C (SH)=	3.40	minutes	

CHANNEL FLOW: $T_t = \frac{L}{60\,V}$

NOTES:

HIGH PT ELEVATION	593.0	ft	Flow in Bioswale
LOW POINT ELEVATION	585.0	ft	CHANNEL DATA TYPE = TRAP'Z
ELEVATION DIFF (H)	8.0	ft	Z= 4 ANG-RAD 0.245
LENGTH (L)	793	ft	b = 13 ANG-DEG 14.036
SLOPE (S) = (H/L)	1.0%		d = 1 FLOWING FULL ASS'M
MANNING'S n	0.050		HDM Table 864.3A, Depressed Median - Earth (with growth)
HYDRAULIC RADIUS R	0.80	ft	R=(bdsinA+d^2cosA)/(bsinA+2d)
VELOCITY (CHANNEL)	2.58	fps	From Manning's Equation assuming flowing full: $V=1.49/n(R^{2/3}S^{1/2})$
T_C (CH)=	5.12	minutes	

Basin FFULL Inflow TcQ

STORMDRAIN FLOW: $T_t = \frac{L}{60\,V}$

			NOTES:
HIGH PT ELEVATION	580.0	ft	Proposed onsite pipe (assumed 5' drop to invert)
LOW POINT ELEVATION	560.0	ft	Proposed Rip Rap Pad in Basin floor
ELEVATION DIFF (H)	20.0	ft	
LENGTH (L)	1133	ft	
SLOPE (S) = (H/L)	1.8%		
MANNING'S n	0.013		RCP
PIPE DIAMETER d	2.0	ft	
HYDRAULIC RADIUS R	0.5	ft	R=D/4, Assume: flowing full
VELOCITY (STORMDRAIN)	9.6	fps	$V = \frac{K_u}{n} R^{2/3} S^{1/2}$
T_C (SD)=	1.97	minutes	

Tc (TOTAL) =	13.10	minutes
Minimum Tc =	10	minutes
USE T_C =	**13.10**	minutes

INTENSITY CHART: $I = 7.44\,P_6\,D^{-0.645}$

				FLOW RESULTS	cfs
i_2 =	1.6	in/hr	X CA =	**Q_2 =**	15.4
i_{10} =	2.3	in/hr	X CA =	**Q_{10} =**	22.3
i_{25} =	2.8	in/hr	X CA =	**Q_{25} =**	30.7
i_{50} =	3.4	in/hr	X CA =	**Q_{50} =**	40.5
i_{100} =	3.5	in/hr	X CA =	**Q_{100} =**	**42.2**

COUNTY P_6

	inches
2-year:	1.1
10-year:	1.6
25-year:	2.0
50-year:	2.4
100-year:	2.5

Basin FFULL Inflow Hydrograph

PROJECT:	**SR-11**			**DESCRIPTION:**	**SR-11 Basin**
JOB #:	**11A1190**			**STATION:**	**110+00**
BY:	**M.BRUNING**	**DATE:**	**04.16.10**	**WATERSHED:**	**FFULL**
CHK:	**G.DALZIEL**	**DATE:**		**SYSTEM:**	**Basin**

Notes:

* This is the actual flow entering the detention basin.

ONSITE RUNOFF VOLUME

100-year, 6 hour duration storm event, use the Rational Method Hydrograph Procedure (SDCHM 6-1) ~ RatHydro

Basin Inflow Hydrograph

Basin Inflow Q

Q_{100}=	42.2	cfs			
Tc=	13.1	min	C_{100}=	1.00	
$P_{100,6}$=	2.5	in	A=	11.93	acres

$T_{T(N)}$ (MIN)	VOL (CF)	ORDINATE (CFS)
0	0	0
13	936	1.2
26	1404	1.8
39	1482	1.9
52	1560	2
65	1560	2
78	1638	2.1
91	1716	2.2
104	1872	2.4
117	1950	2.5
130	2106	2.7
143	2184	2.8
156	2418	3.1
169	2574	3.3
182	2964	3.8
195	3198	4.1
208	3900	5
221	4446	5.7
234	6552	8.4
247	9438	12.1
260	32916	42.2
273	5226	6.7
286	3510	4.5
299	2730	3.5
312	2340	3
325	2028	2.6
338	1794	2.3
351	1638	2.1
364	1482	1.9
377	0	0

Example of Steps:

$T_{T(N)}$ (MIN)	VOL (CF)	ORDINATE (CFS)
0	0	0
14	1260	1.5
28	1344	1.6
42	1344	1.6
56	1428	1.7
70	1512	1.8
84	1596	1.9

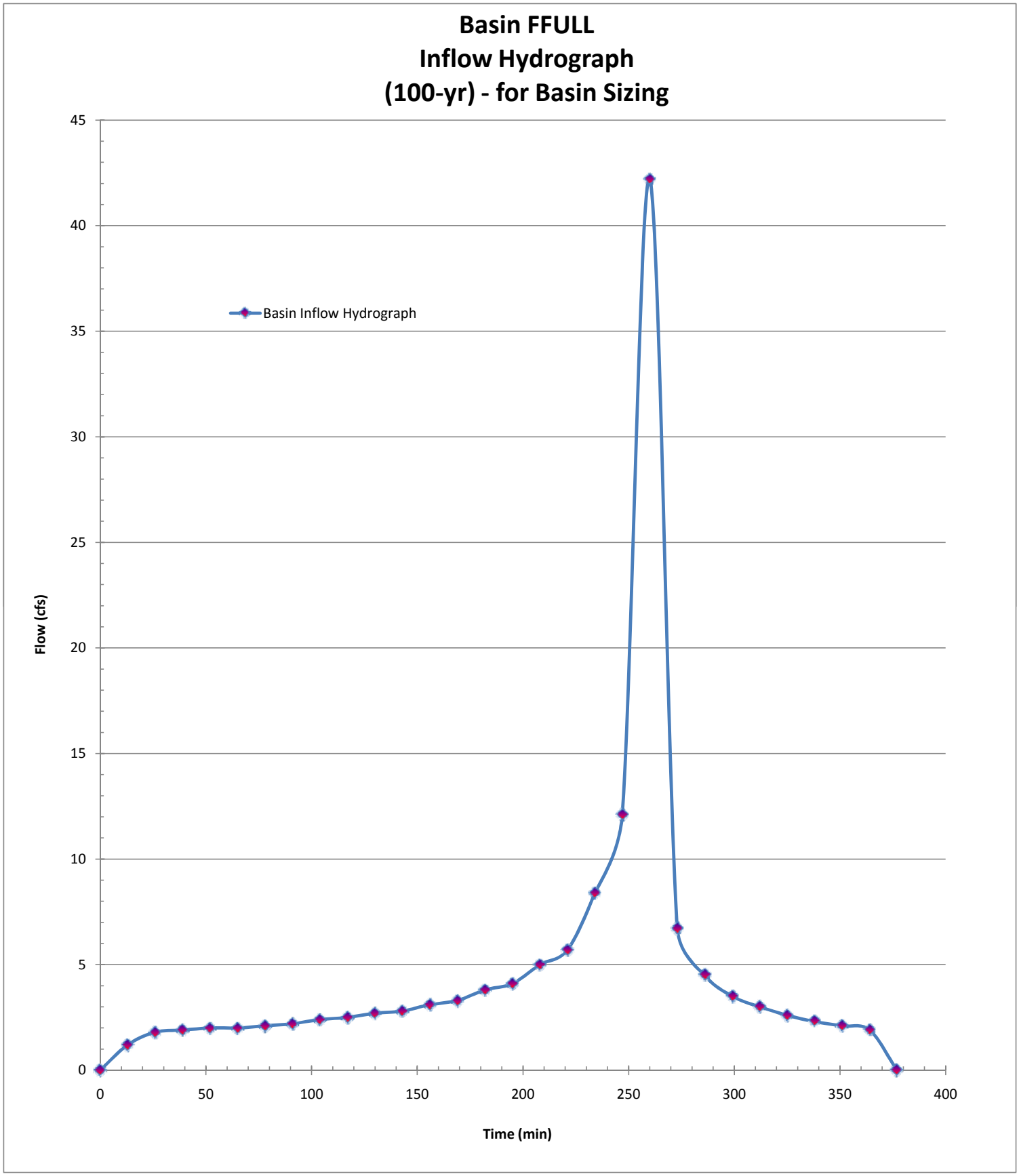
SUM= 107562 ft^3
2.47 acre-feet

Onsite Runoff Volume

Check: V = C*A*P_6

V= 2.49 acre-feet

OK


Basin FFULL
Inflow Hydrograph
(100-yr) - for Basin Sizing
Basin Inflow Hydrograph
Flow (cfs)
Time (min)
0
5
10
15
20
25
30
35
40
45
0
50
100
150
200
250
300
350
400

Basin FFULL Outlet

PROJECT:	**SR-11**			**DESCRIPTION:**	**SR-11 Basin**
JOB #:	**11A1190**			**STATION:**	**113+00**
BY:	**M.BRUNING**	**DATE:**	**04.16.10**	**WATERSHED:**	**FFULL**
CHK:	**G.DALZIEL**	**DATE:**		**SYSTEM:**	**Basin Outlet**

Notes:

Required Retention Basin Volume = 37416 ft^3

Actual Basin Inflow = 107562 ft^3 *OK*

Flow Balance - determine maximum flow from basin

Predeveloped Peak 100-year Flow:	154.0	cfs			
Post-Developed Peak Flow through Cross Culvert:	126.6	cfs	~	Includes:	FFULL.8.SL
Flow that does not reach detention basin (bypass per DA table):	5.3	cfs	~	Q_{100} from:	FFULL.10.SL
Maximum flow allowed to be released by this detention basin:	22.2	cfs			

Outlet Pipe

Assume: trapezoid basin/flat bottom, one outlet pipe set above basin invert

Basin - Top of basin berm elevation =			560.00	ft
Basin flowline elevation =			551.00	ft
Maximum Basin Depth =			9.00	ft

Assume Culvert Design: free outfall, square-edge w/headwall

Outlet pipe invert from basin floor =	3.00	ft	554.00	ft
Outlet pipe diameter =	2	ft		

Basin Characteristics

Base Length (L)	230	ft
Base Width (W)	40	ft
W/L Ratio ®	0.17	
Side Slopes (Z)	1: 4	
Total Volume (V):	192801	ft^2

Infiltration Rate: Rate (min/inch): 71.1 Location: PT-C2 *~ assume no infiltration*

Detention Basin Data						Outlet Pipe		Infiltration	Total
Stage	Water Surface Elevation (ft)	Depth	V_{avg} staged (ft3)	V_{avg} cumm. (ft3)		HW Elev. (ft)	Discharge Q_{out} (cfs)	Q_{inf} (cfs)	Q_{total} (cfs)
0	551.00	0.00	0	0		551.00	0.00		0.00
1	551.20	0.20	1883	1883		551.20	0.00		0.00
2	551.40	0.40	1971	3854		551.40	0.00		0.00
3	551.60	0.60	2059	5913		551.60	0.00		0.00
4	551.80	0.80	2150	8063		551.80	0.00		0.00
5	552.00	1.00	2242	10304		552.00	0.00		0.00
6	552.20	1.20	2335	12640		552.20	0.00		0.00
7	552.40	1.40	2430	15070		552.40	0.00		0.00
8	552.60	1.60	2527	17596		552.60	0.00		0.00
9	552.80	1.80	2625	20221		552.80	0.00		0.00
10	553.00	2.00	2724	22945		553.00	0.00		0.00
11	553.20	2.20	2825	25770		553.20	0.00		0.00
12	553.40	2.40	2928	28697		553.40	0.00		0.00
13	553.60	2.60	3032	31729		553.60	0.00		0.00
14	553.80	2.80	3137	34866		553.80	0.00		0.00
15	554.00	3.00	3244	38111	*	554.00	0.00	0.00	0.00
16	554.20	3.20	3353	41464		554.20	0.15		0.15
17	554.40	3.40	3463	44927		554.40	0.59		0.59
18	554.60	3.60	3575	48502		554.60	1.30		1.30
19	554.80	3.80	3688	52190		554.80	2.25		2.25
20	555.00	4.00	3803	55993		555.00	3.42		3.42
21	555.20	4.20	3919	59912		555.20	4.79		4.79
22	555.40	4.40	4037	63949		555.40	6.32		6.32
23	555.60	4.60	4156	68105		555.60	7.99		7.99
24	555.80	4.80	4277	72382		555.80	9.77		9.77
25	556.00	5.00	4399	76782		556.00	11.63		11.63
26	556.20	5.20	4523	81305		556.20	13.53		13.53
27	556.40	5.40	4649	85953		556.40	15.46		15.46
28	556.60	5.60	4775	90729		556.60	17.37		17.37
29	556.80	5.80	4904	95633		556.80	19.16		19.16
30	557.00	6.00	5034	100666		557.00	20.41		20.41

Basin FFULL Routing

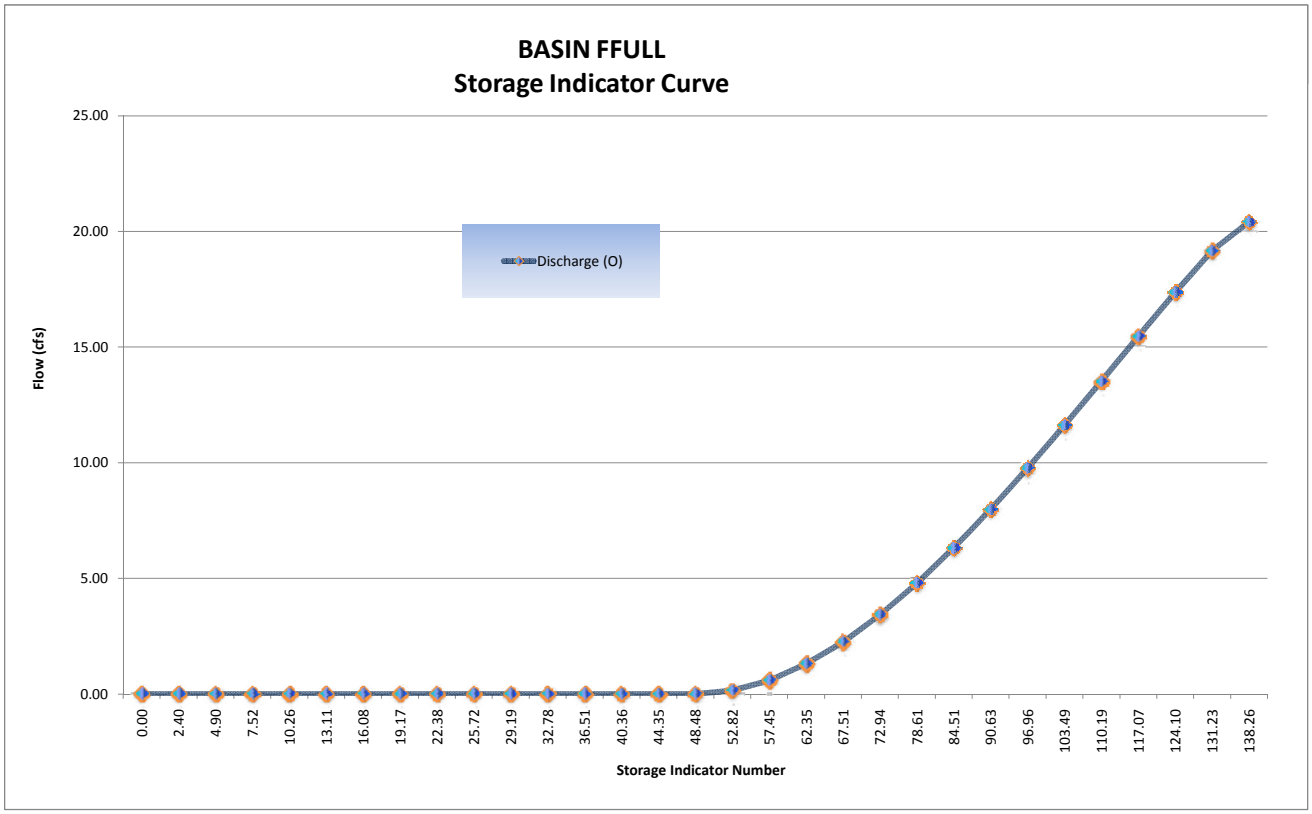
PROJECT:	SR-11			DESCRIPTION:	SR-11 Basin
JOB #:	11A1190			STATION:	110+00
BY:	M.BRUNING	DATE:	04.16.10	WATERSHED:	FFULL
CHK:	G.DALZIEL	DATE:		SYSTEM:	Basin FFULL

user input
linked input

STORAGE INDICATOR NUMBERS TABLE

(1) Stage (ft)	(2) Discharge (O) (cfs)	(3) Storage (S) (ft^3)	(4) $O_2/2$ (cfs)	(5) S_2/delta t (cfs)	(6) S_2/delta t + $O_2/2$ (cfs)
					Storage Indicator #
551.00	0.00	0	0.00	0.00	0.00
551.20	0.00	1883	0.00	2.40	2.40
551.40	0.00	3854	0.00	4.90	4.90
551.60	0.00	5913	0.00	7.52	7.52
551.80	0.00	8063	0.00	10.26	10.26
552.00	0.00	10304	0.00	13.11	13.11
552.20	0.00	12640	0.00	16.08	16.08
552.40	0.00	15070	0.00	19.17	19.17
552.60	0.00	17596	0.00	22.38	22.38
552.80	0.00	20221	0.00	25.72	25.72
553.00	0.00	22945	0.00	29.19	29.19
553.20	0.00	25770	0.00	32.78	32.78
553.40	0.00	28697	0.00	36.51	36.51
553.60	0.00	31729	0.00	40.36	40.36
553.80	0.00	34866	0.00	44.35	44.35
554.00	0.00	38111	0.00	48.48	48.48
554.20	0.15	41464	0.08	52.74	52.82
554.40	0.59	44927	0.30	57.15	57.45
554.60	1.30	48502	0.65	61.70	62.35
554.80	2.25	52190	1.13	66.39	67.51
555.00	3.42	55993	1.71	71.23	72.94
555.20	4.79	59912	2.40	76.21	78.61
555.40	6.32	63949	3.16	81.35	84.51
555.60	7.99	68105	4.00	86.63	90.63
555.80	9.77	72382	4.89	92.08	96.96
556.00	11.63	76782	5.82	97.67	103.49
556.20	13.53	81305	6.77	103.43	110.19
556.40	15.46	85953	7.73	109.34	117.07
556.60	17.37	90729	8.69	115.41	124.10
556.80	19.16	95633	9.58	121.65	131.23
557.00	20.41	100666	10.21	128.05	138.26

delta t =	0.22	hrs
delta t =	13	min
delta t =	786.1219	sec

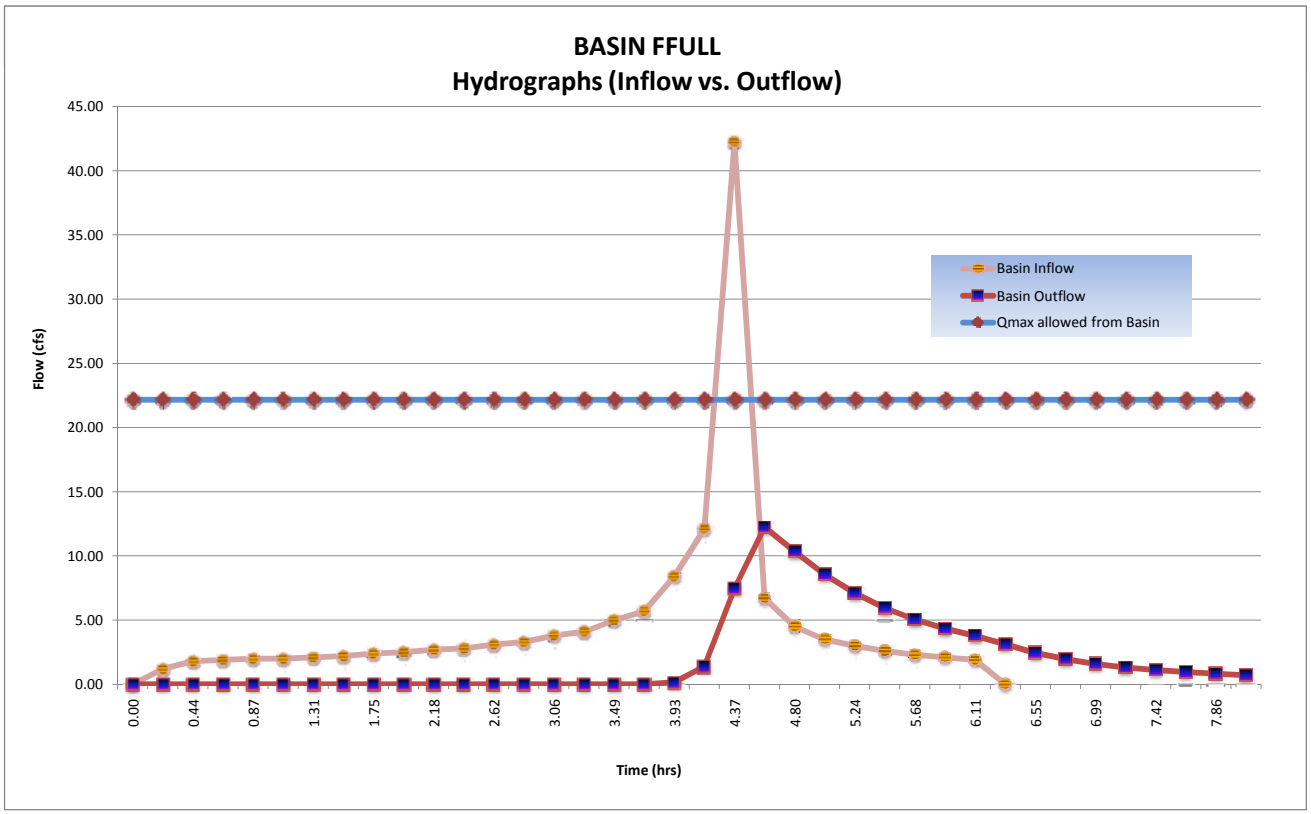


Basin FFULL Routing

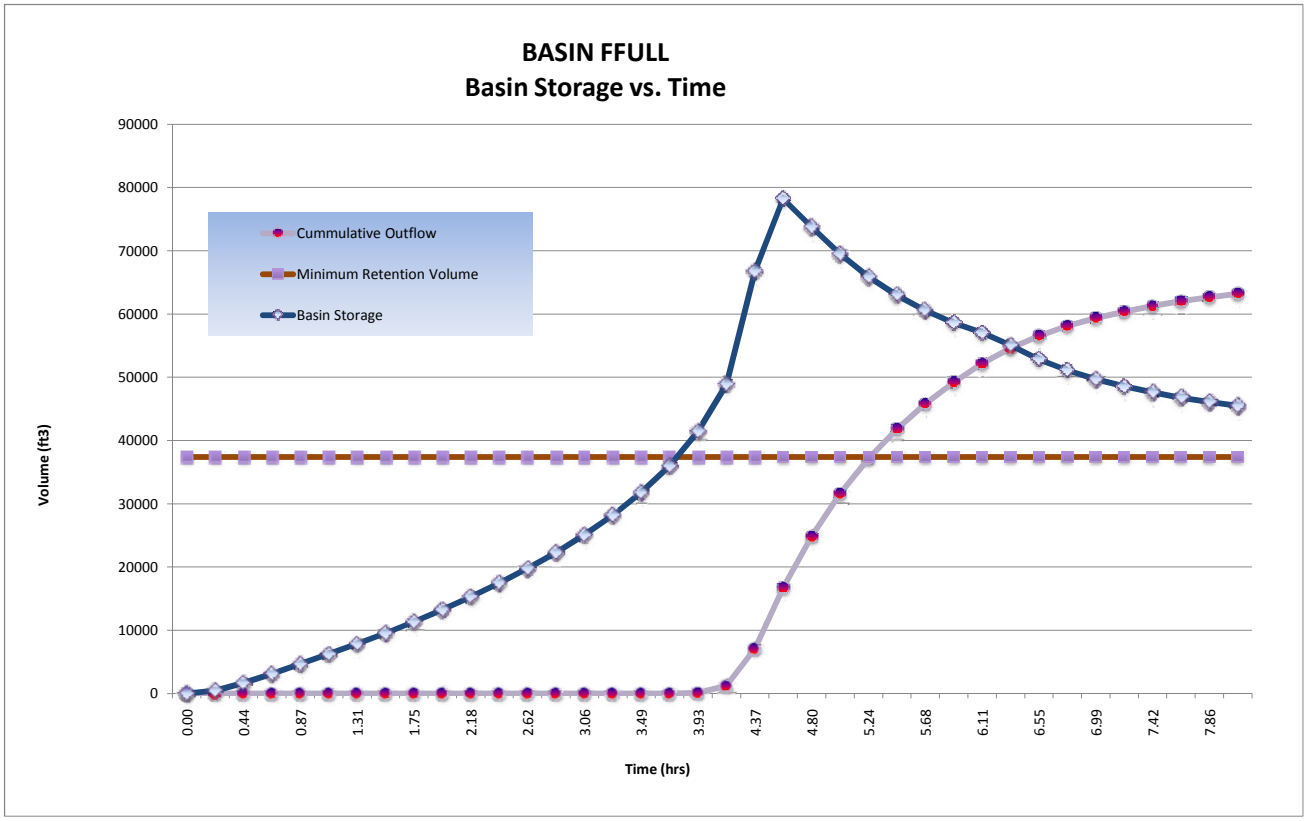
$$\frac{I_1 + I_2}{2} + \left(\frac{S_1}{\Delta t} - \frac{O_1}{2}\right) = O_1 + \left(\frac{S_2}{\Delta t} + \frac{O_2}{2}\right)$$

FINAL ROUTING TABLE

(1) Time (hrs)	(2) Inflow (cfs) (Q_{post})	(3) $(I_1+I_2)/2$ (cfs)	(4) $(S_1/\text{delta t} + O_1/2)$ (cfs) *col (6) from prev row*	(5) O_1 (cfs) *col (7) from prev row*	*Storage Indicator #* (6) $S_2/\text{delta t} + O_2/2$ (cfs) *col (3)+(4)-(5)*	(7) O_2 (cfs) *(Hard input)*	Volumes (ft3) Basin Storage *Volume*	Incremental Outflow *Volume*	Cummulative Outflow *Volume*
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
0.22	1.20	0.60	0.00	0.00	0.60	0.00	472	0	0
0.44	1.80	1.50	0.60	0.00	2.10	0.00	1651	0	0
0.66	1.90	1.85	2.10	0.00	3.95	0.00	3105	0	0
0.87	2.00	1.95	3.95	0.00	5.90	0.00	4638	0	0
1.09	2.00	2.00	5.90	0.00	7.90	0.00	6210	0	0
1.31	2.10	2.05	7.90	0.00	9.95	0.00	7822	0	0
1.53	2.20	2.15	9.95	0.00	12.10	0.00	9512	0	0
1.75	2.40	2.30	12.10	0.00	14.40	0.00	11320	0	0
1.97	2.50	2.45	14.40	0.00	16.85	0.00	13246	0	0
2.18	2.70	2.60	16.85	0.00	19.45	0.00	15290	0	0
2.40	2.80	2.75	19.45	0.00	22.20	0.00	17452	0	0
2.62	3.10	2.95	22.20	0.00	25.15	0.00	19771	0	0
2.84	3.30	3.20	25.15	0.00	28.35	0.00	22287	0	0
3.06	3.80	3.55	28.35	0.00	31.90	0.00	25077	0	0
3.28	4.10	3.95	31.90	0.00	35.85	0.00	28182	0	0
3.49	5.00	4.55	35.85	0.00	40.40	0.00	31759	0	0
3.71	5.70	5.35	40.40	0.00	45.75	0.00	35965	0	0
3.93	8.40	7.05	45.75	0.00	52.80	0.15	41448	118	118
4.15	12.10	10.25	52.80	0.15	62.90	1.40	48897	1101	1218
4.37	42.20	27.15	62.90	1.40	88.65	7.45	66761	5857	7075
4.59	6.70	24.45	88.65	7.45	105.65	12.24	78243	9622	16697
4.80	4.50	5.60	105.65	12.24	99.01	10.35	73766	8136	24834
5.02	3.50	4.00	99.01	10.35	92.66	8.56	69477	6729	31563
5.24	3.00	3.25	92.66	8.56	87.35	7.10	65877	5581	37144
5.46	2.60	2.80	87.35	7.10	83.05	5.94	62953	4670	41814
5.68	2.30	2.45	83.05	5.94	79.56	5.04	60563	3962	45776
5.90	2.10	2.20	79.56	5.04	76.72	4.33	58609	3404	49180
6.11	1.90	2.00	76.72	4.33	74.39	3.77	56998	2964	52143
6.33	0.00	0.95	74.39	3.77	71.57	3.13	55032	2461	54604
6.55		0.00	71.57	3.13	68.44	2.45	52839	1926	56530
6.77		0.00	68.44	2.45	65.99	1.97	51102	1549	58079
6.99		0.00	65.99	1.97	64.02	1.61	49695	1266	59344
7.21		0.00	64.02	1.61	62.41	1.31	48547	1030	60374
7.42		0.00	62.41	1.31	61.10	1.12	47592	880	61255
7.64		0.00	61.10	1.12	59.98	0.96	46774	755	62009
7.86		0.00	59.98	0.96	59.02	0.82	46075	645	62654
8.08		0.00	59.02	0.82	58.20	0.70	45477	550	63204



Basin FFULL Routing



Detention/Retention Basin Volume Required:	**78,243**	**ft^3**	
@ Stage:	**556.20**	**ft**	
Freeboard:	**3.8**	**ft**	> 1' Freeboard
Final Total Basin Volume Provided:	**192,801**	**ft^3**	Basin **FFULL**
Maximum flow rate released from this basin:	**12.24**	**cfs**	

FFULL Culvert TcQ

PROJECT:	**SR-11**			**DESCRIPTION:**	**SR-11 Culvert**
JOB #:	**11A1190**			**STATION:**	**110+00**
BY:	**M.BRUNING**	**DATE:**	**04.16.10**	**WATERSHED:**	**FFULL**
CHK:	**G.DALZIEL**	**DATE:**		**SYSTEM:**	**Culvert**

BASIN AREA:

A =	**4052076**	**ft^2**	**SOURCE:**	**MICROSTATION/USGS**
	93.02	**acres**		**(SCALE = 1:1)**

COEFFICIENT OF RUNOFF:

KEY: User Input | Designer Tool

UNDEVELOPED AREA C (FROM HDM FIG. 819.2A)

RELIEF (.08-.35)	0.20	Hilly ~ 10%
INFILTRATION (.04-.16)	0.12	Negligible infiltration capacity - see Geotechnical Report
VEGETATION (.04-.16)	0.08	Fair natural cover
STORAGE (.04-.12)	0.07	Normal
TOTAL C =	0.47	

UNDEVELOPED AREA	99%	AT	0.47	0.465
PAVED SURFACE	1%	AT	0.90	0.009
COMMERCIAL AREA	0%	AT	0.85	0.000
CUT SLOPE (2:1 and 4:1)	0%	AT	0.55	0.000
TOTAL	100%			
	(100%)			

$C_{2,10}$ =	0.47
C_{25} =	0.52
C_{50} =	0.57
C_{100} =	0.59

TIME OF CONCENTRATION:

SHEET FLOW: $T_t = \frac{0.42L^{4/5}n^{4/5}}{P_2^{1/2}s^{2/5}}$

NOTES: **$P_{2,24}$ (in) = 1.80**

HIGH PT ELEVATION	630.0	ft	Northern watershed boundary
LOW POINT ELEVATION	629.0	ft	
ELEVATION DIFF (H)	1.0	ft	
LENGTH (L)	100	ft	
SLOPE (S) = (H/L)	1.0%		
MANNING'S n	0.050		< = From Table 816.6A Fallow
T_t (SFF)=	7.16	minutes	

SHALLOW CONCENTRATED FLOW: $T_t = \frac{L}{60\,V}$

NOTES:

HIGH PT ELEVATION	629.0	ft	
LOW POINT ELEVATION	600.0	ft	
ELEVATION DIFF (H)	29.0	ft	
LENGTH (L)	667	ft	
SLOPE (S) = (H/L)	4.3%		
VELOCITY (SCF)	1.2	fps	<=V FROM FIG 816.6 Short Grass Pasture/Nearly Bare Ground
T_C (SH)=	9.26	minutes	

CHANNEL FLOW: $T_t = \frac{L}{60\,V}$

NOTES:

HIGH PT ELEVATION	600.0	ft	defined broad channel north of berm
LOW POINT ELEVATION	589.0	ft	CHANNEL DATA TYPE = TRAP'Z
ELEVATION DIFF (H)	11.0	ft	Z= 5 ANG-RAD 0.197
LENGTH (L)	378	ft	b = 50 ANG-DEG 11.310
SLOPE (S) = (H/L)	2.9%		d = 0.5 FLOWING FULL ASS'M
MANNING'S n	0.080		Natural Channel
HYDRAULIC RADIUS R	0.5	ft	R=(bdsinA+d^2cosA)/(bsinA+2d)
VELOCITY (CHANNEL)	1.94	fps	From Manning's Equation assuming flowing full: $V=1.49/n(R^{2/3}S^{1/2})$
T_C (CH)=	3.25	minutes	

FFULL Culvert TcQ

STORMDRAIN FLOW: $T_t = \frac{L}{60\,V}$

			NOTES:
HIGH PT ELEVATION	589.0	ft	Exist Cross Culvert under berm
LOW POINT ELEVATION	587.0	ft	
ELEVATION DIFF (H)	2.0	ft	
LENGTH (L)	100	ft	
SLOPE (S) = (H/L)	2.0%		
MANNING'S n	0.013		RCP
PIPE DIAMETER d	3.0	ft	
HYDRAULIC RADIUS R	0.8	ft	R=D/4, Assume: flowing full
VELOCITY (STORMDRAIN)	13.4	fps	$V = \frac{K_u}{n} R^{2/3} S^{1/2}$
T_C (SD)=	0.12	minutes	

CHANNEL FLOW: $T_t = \frac{L}{60\,V}$

			NOTES:
HIGH PT ELEVATION	587.0	ft	defined broad channel south of berm (field verified new berm)
LOW POINT ELEVATION	576.0	ft	CHANNEL DATA / TYPE = / TRAP'Z
ELEVATION DIFF (H)	11.0	ft	Z= 5 / ANG-RAD / 0.197
LENGTH (L)	311	ft	b = 50 / ANG-DEG / 11.310
SLOPE (S) = (H/L)	3.5%		d = 1 / FLOWING FULL ASS'M
MANNING'S n	0.080		Natural Channel
HYDRAULIC RADIUS R	0.9	ft	R=(bdsinA+d^2cosA)/(bsinA+2d)
VELOCITY (CHANNEL)	3.30	fps	From Manning's Equation assuming flowing full: $V=1.49/n(R^{2/3}S^{1/2})$
T_C (CH)=	1.57	minutes	

CHANNEL FLOW: $T_t = \frac{L}{60\,V}$

			NOTES:
HIGH PT ELEVATION	576.0	ft	channel begins to narrow
LOW POINT ELEVATION	555.0	ft	CHANNEL DATA / TYPE = / TRAP'Z
ELEVATION DIFF (H)	21.0	ft	Z= 2 / ANG-RAD / 0.464
LENGTH (L)	957	ft	b = 1 / ANG-DEG / 26.565
SLOPE (S) = (H/L)	2.2%		d = 1.5 / FLOWING FULL ASS'M
MANNING'S n	0.050		Natural Channel
HYDRAULIC RADIUS R	0.8	ft	R=(bdsinA+d^2cosA)/(bsinA+2d)
VELOCITY (CHANNEL)	3.74	fps	From Manning's Equation assuming flowing full: $V=1.49/n(R^{2/3}S^{1/2})$
T_C (CH)=	4.27	minutes	

Tc (TOTAL) =	25.64	minutes
Minimum Tc =	10	minutes
USE T_C =	**25.64**	minutes

INTENSITY CHART: Caltrans IDF2000

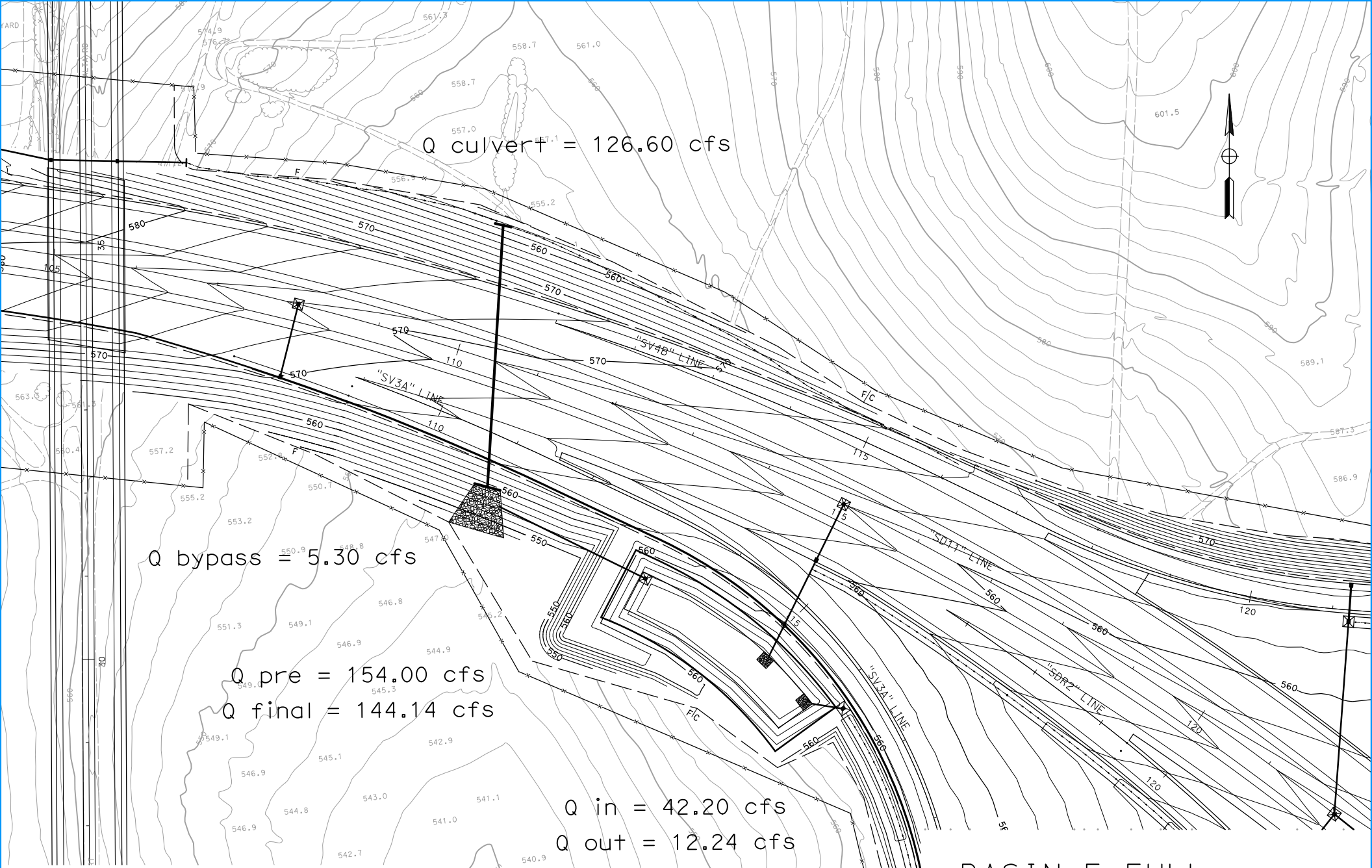
				FLOW RESULTS:	cfs	
i_2 =	0.8	in/hr	X CA =	**Q_2 =**	33.2	
i_{10} =	1.4	in/hr	X CA =	**Q_{10} =**	62.4	
i_{25} =	1.8	in/hr	X CA =	**Q_{25} =**	85.7	
i_{50} =	2.0	in/hr	X CA =	**Q_{50} =**	107.6	
i_{100} =	2.3	in/hr	X CA =	**Q_{100} =**	**126.6**	~Use Caltrans 'i' for culvert sizing

INTENSITY CHART: $I = 7.44\,P_6\,D^{-0.645}$

				FLOW RESULTS	cfs	
i_2 =	1.0	in/hr	X CA =	**Q_2 =**	44.6	
i_{10} =	1.5	in/hr	X CA =	**Q_{10} =**	64.8	
i_{25} =	1.8	in/hr	X CA =	**Q_{25} =**	89.1	
i_{50} =	2.2	in/hr	X CA =	**Q_{50} =**	116.6	
i_{100} =	2.3	in/hr	X CA =	**Q_{100} =**	**126.6**	~Use County of SD 'i' for detention basin design

COUNTY P_6

	inches
2-year:	1.1
10-year:	1.6
25-year:	2.0
50-year:	2.4
100-year:	2.5



Notes:
Q in (Onsite TcQ)
Q out (Basin Routing)
Q culvert (Culvert TcQ)
Q bypass (Onsite D.A. Table)
Q pre (Pre-Developed TcQ)
Q final = Q culvert + Q out + Q bypass

BASIN F FULL
TWO INTERCHANGE ALTERNATIVE (FULL) FLOW SUMMARY

Scale: 1"=150'

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Detention/Retention Basin Flows and Sizes – Two Interchange Alternative (FULL)

Watershed	Location	Flow			Runoff Volume			Basin Volume - Breakdown			Basin Data					
		Pre-Developed	Post-Developed	Increase	Pre-Developed	Post-Developed	Increase	Retention Provided	Detention	1' Freeboard (minimum)	Final Volume	Length	Width	Depth	Free-board	Name
Name	(Sta)	(cfs)	(cfs)	(cfs)	(ft^3)	(ft^3)	(ft^3)	(ft^3)	(ft^3)	(ft^3)	(ft^3)	(ft)	(ft)	(ft)	(ft)	
F FULL	110+00	154.00	167.47	13.48	667,620	704,178	36,558	38,111	40,132	114,559	192,801	230	40	9.0	3.8	F

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Appendix C POST-Developed Exhibits and Calculations

for Watershed and Basin G

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Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
11	SD	11	23.3/26.6		

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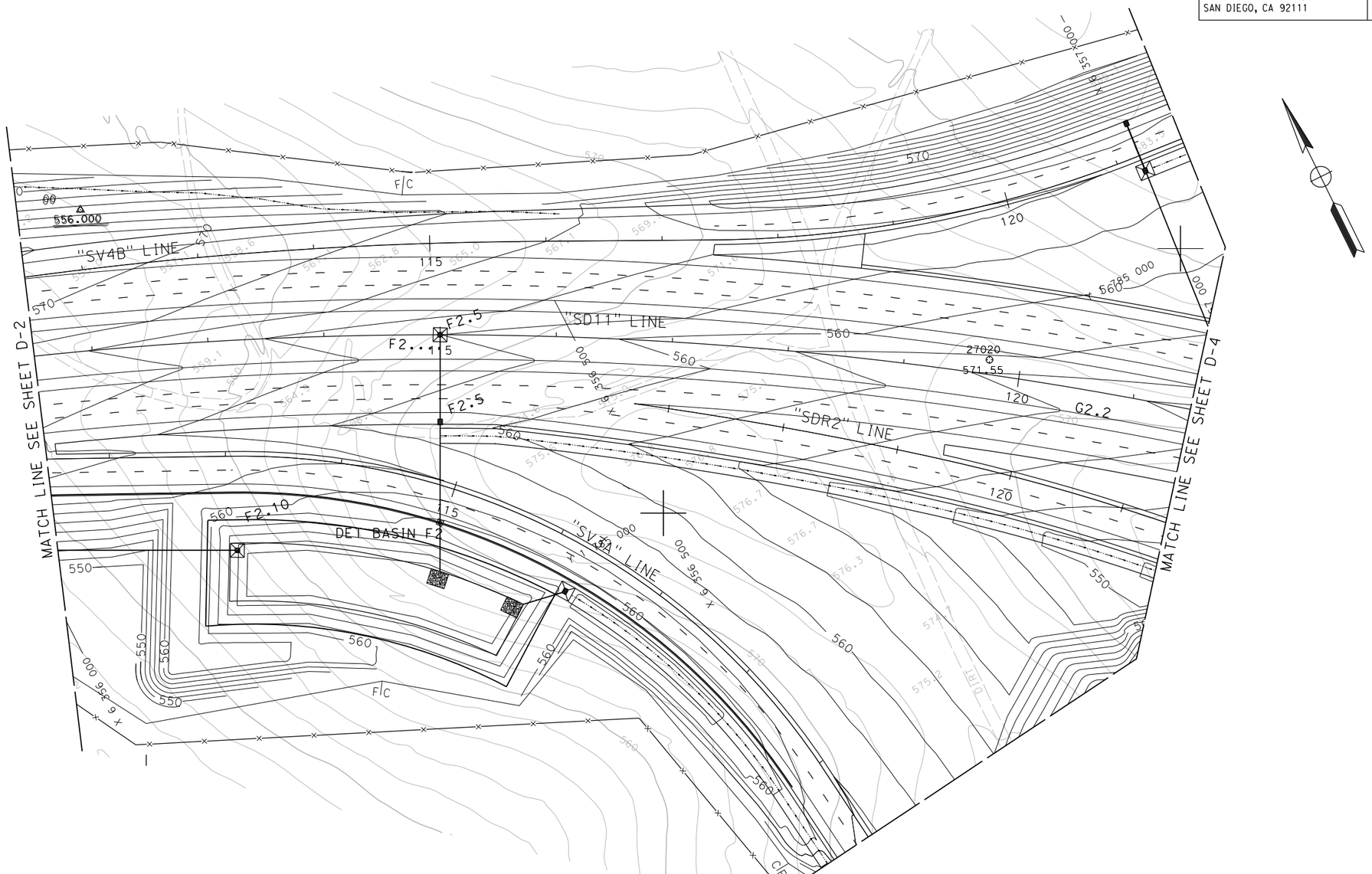

TWO INTERCHANGE ALTERNATIVE (FULL)

DRAINAGE PLAN

SCALE 1"=50'

D-3

THIS PLAN ACCURATE FOR DRAINAGE WORK ONLY.

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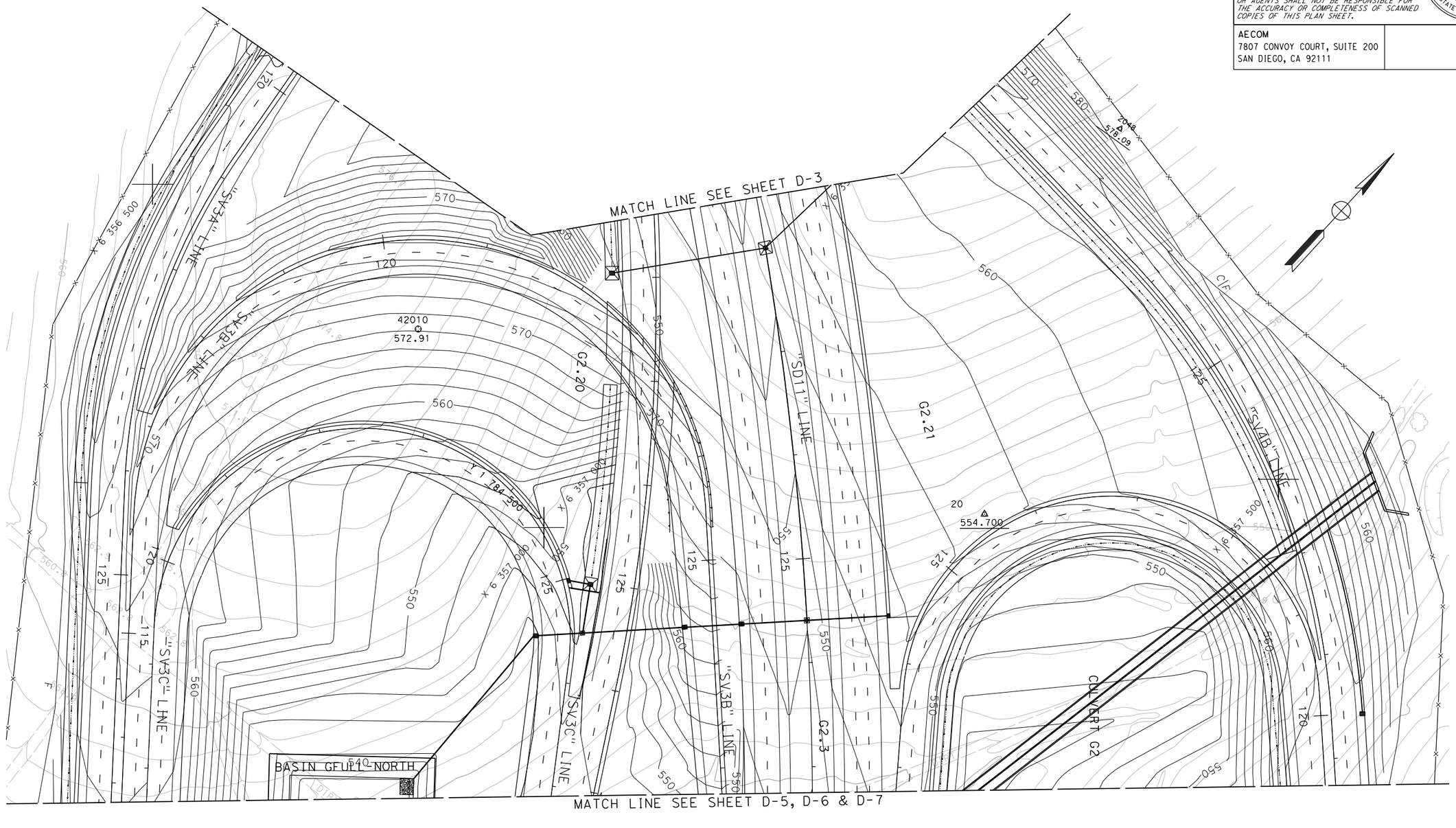

TWO INTERCHANGE ALTERNATIVE (FULL)

DRAINAGE PLAN

SCALE 1"=50'

D-4

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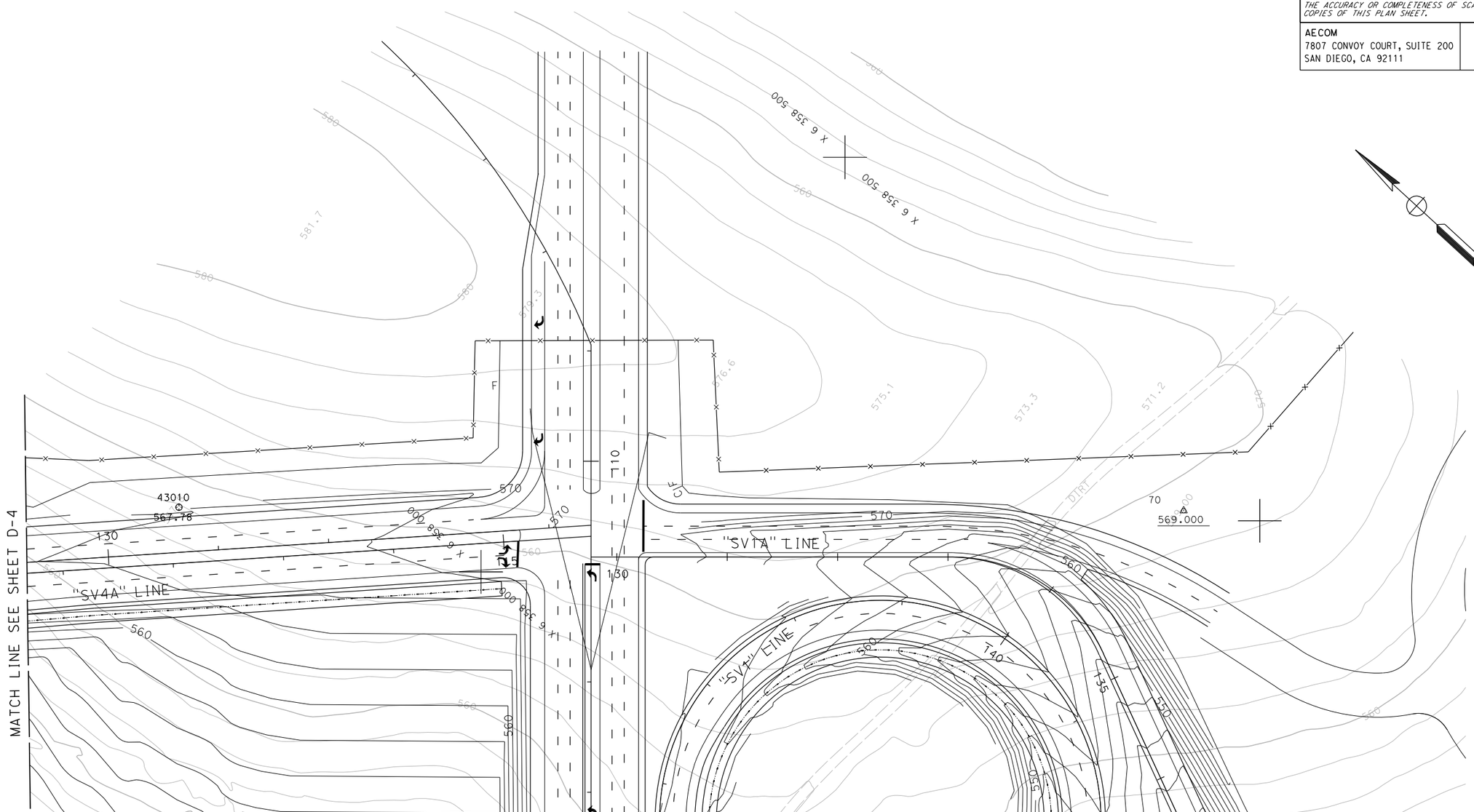

TWO INTERCHANGE ALTERNATIVE (FULL)

DRAINAGE PLAN

D-5

SCALE 1"=50'

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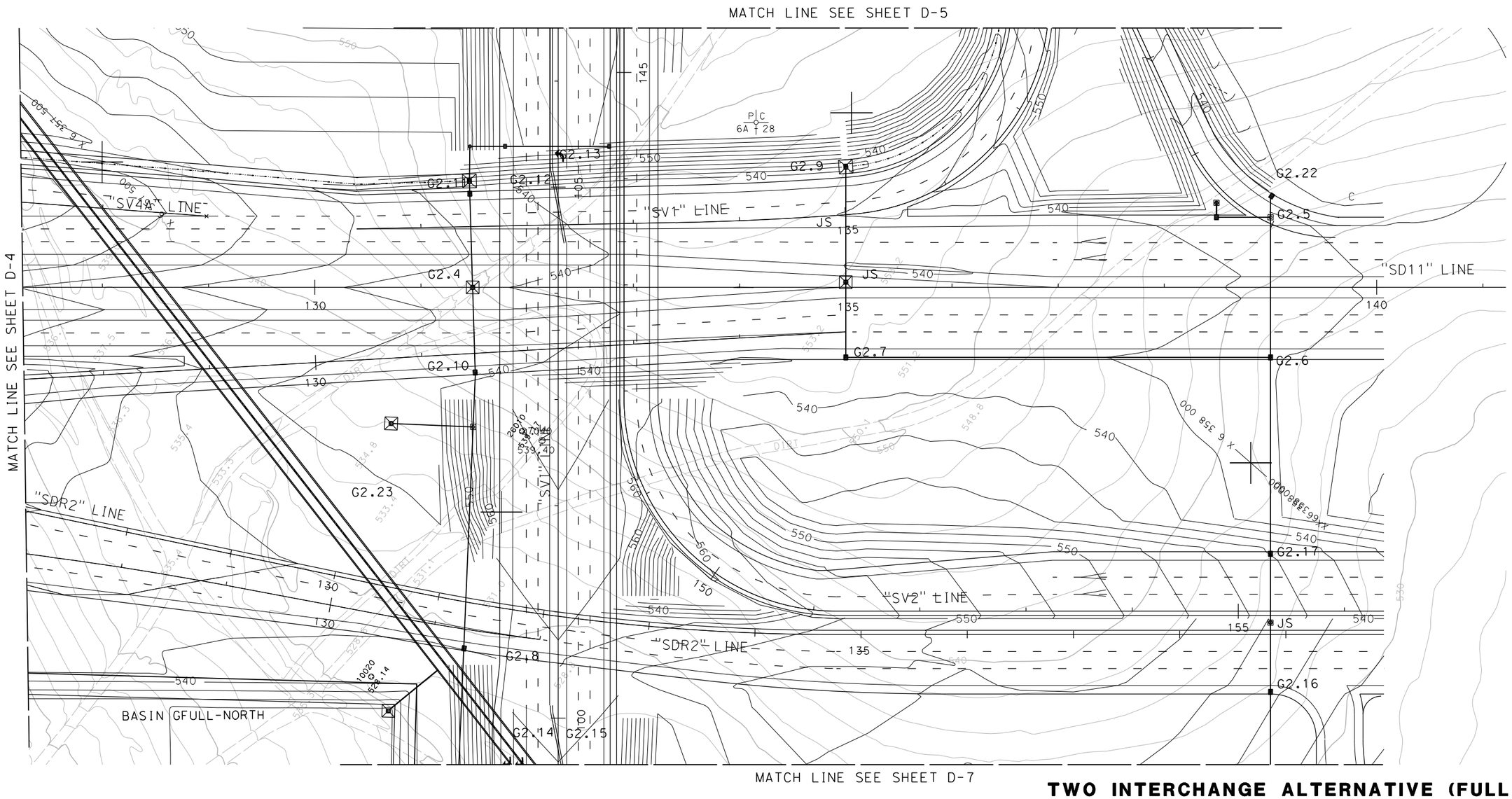

TWO INTERCHANGE ALTERNATIVE (FULL)

DRAINAGE PLAN

SCALE 1"=50'

D-6

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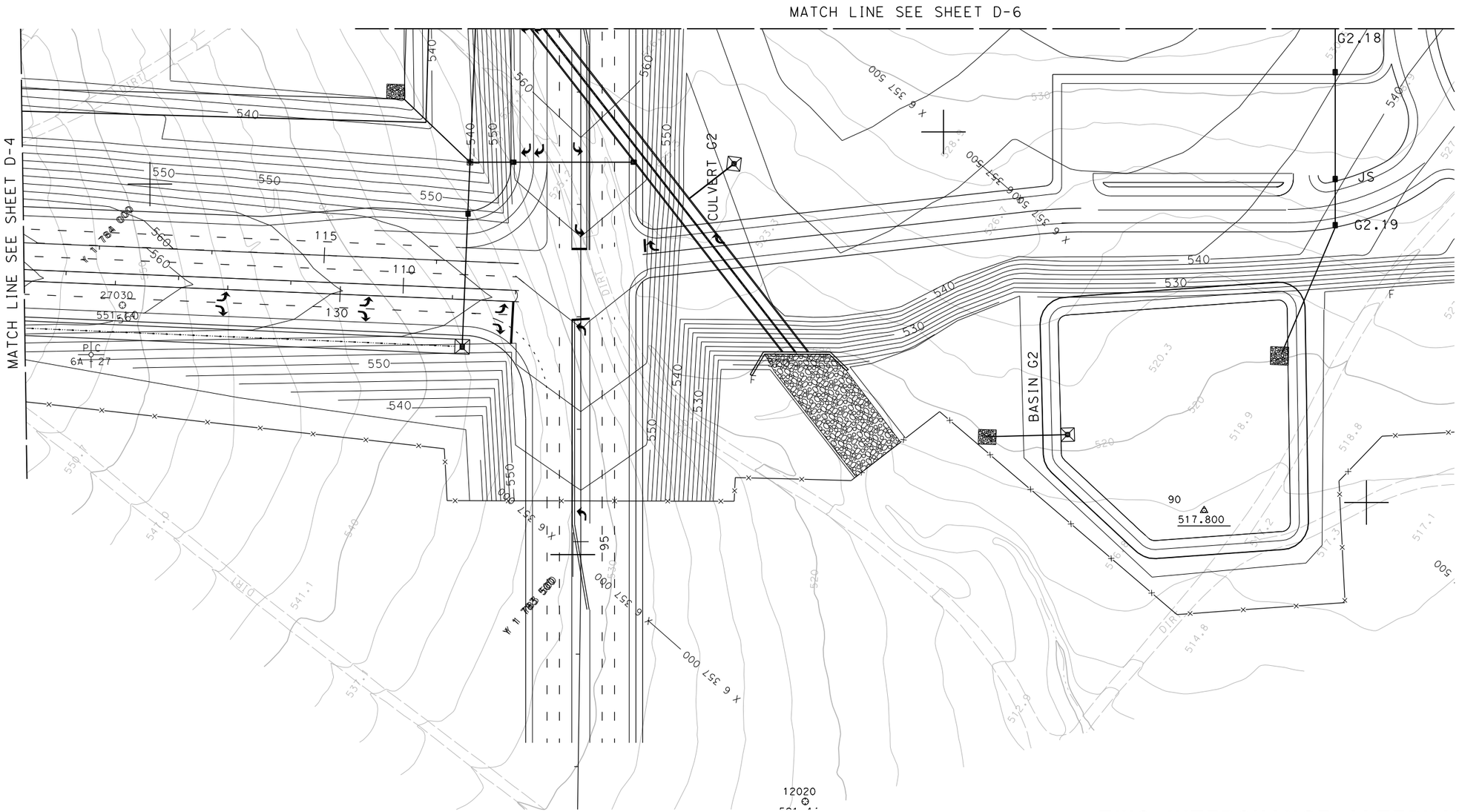

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TWO INTERCHANGE ALTERNATIVE (FULL)
DRAINAGE PLAN

SCALE 1"=50'

D-7

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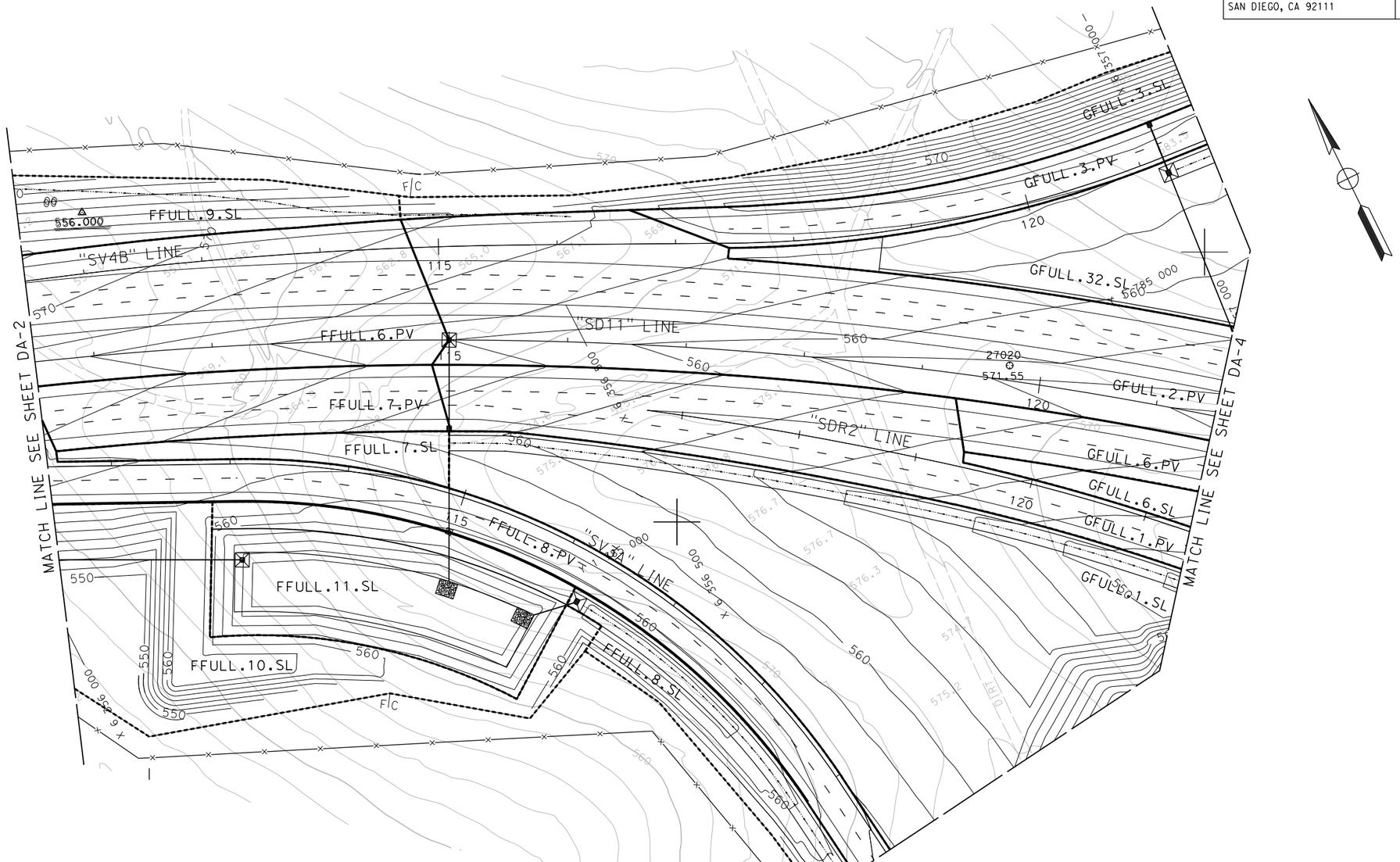

TWO INTERCHANGE ALTERNATIVE (FULL)

DRAINAGE AREA PLAN

SCALE 1"=50'

DA-3

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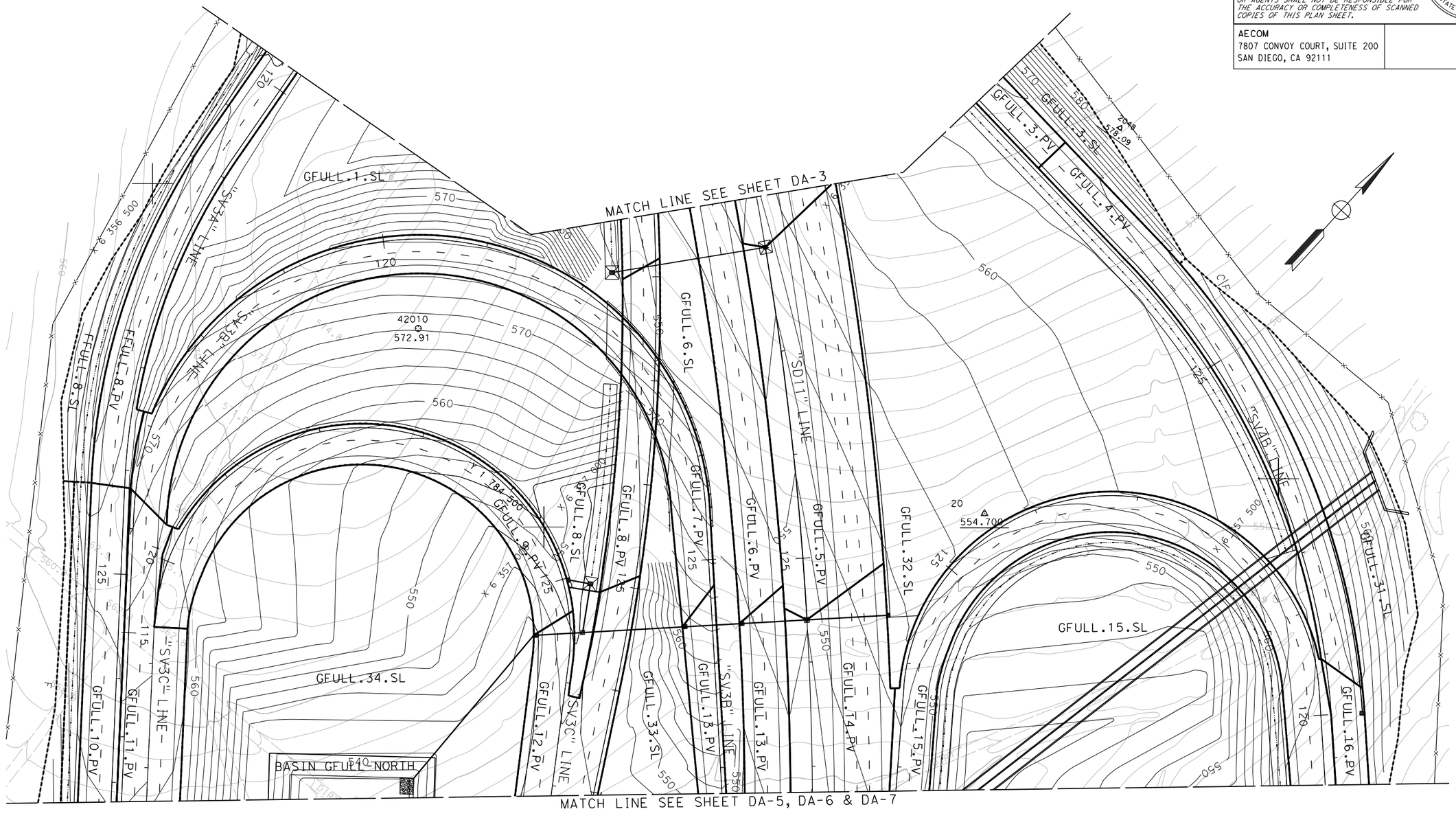

TWO INTERCHANGE ALTERNATIVE (FULL)
DRAINAGE AREA PLAN
DA-4

SCALE 1"=50'

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SUPERVISOR: KIRK BRADBURY

CONSULTANT FUNCTIONAL SUPERVISOR

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION

Caltrans

LAST REVISION 11-13-09

DATE PLOTTED => 8/6/2010
TIME PLOTTED => 11:32:40 AM

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
11	SD	11	23.3/26.6		

REGISTERED CIVIL ENGINEER DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER KIRK BRADBURY No. 71673 Exp. 12/31/09 CIVIL STATE OF CALIFORNIA

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SAN DIEGO, CA 92111

NOTE:

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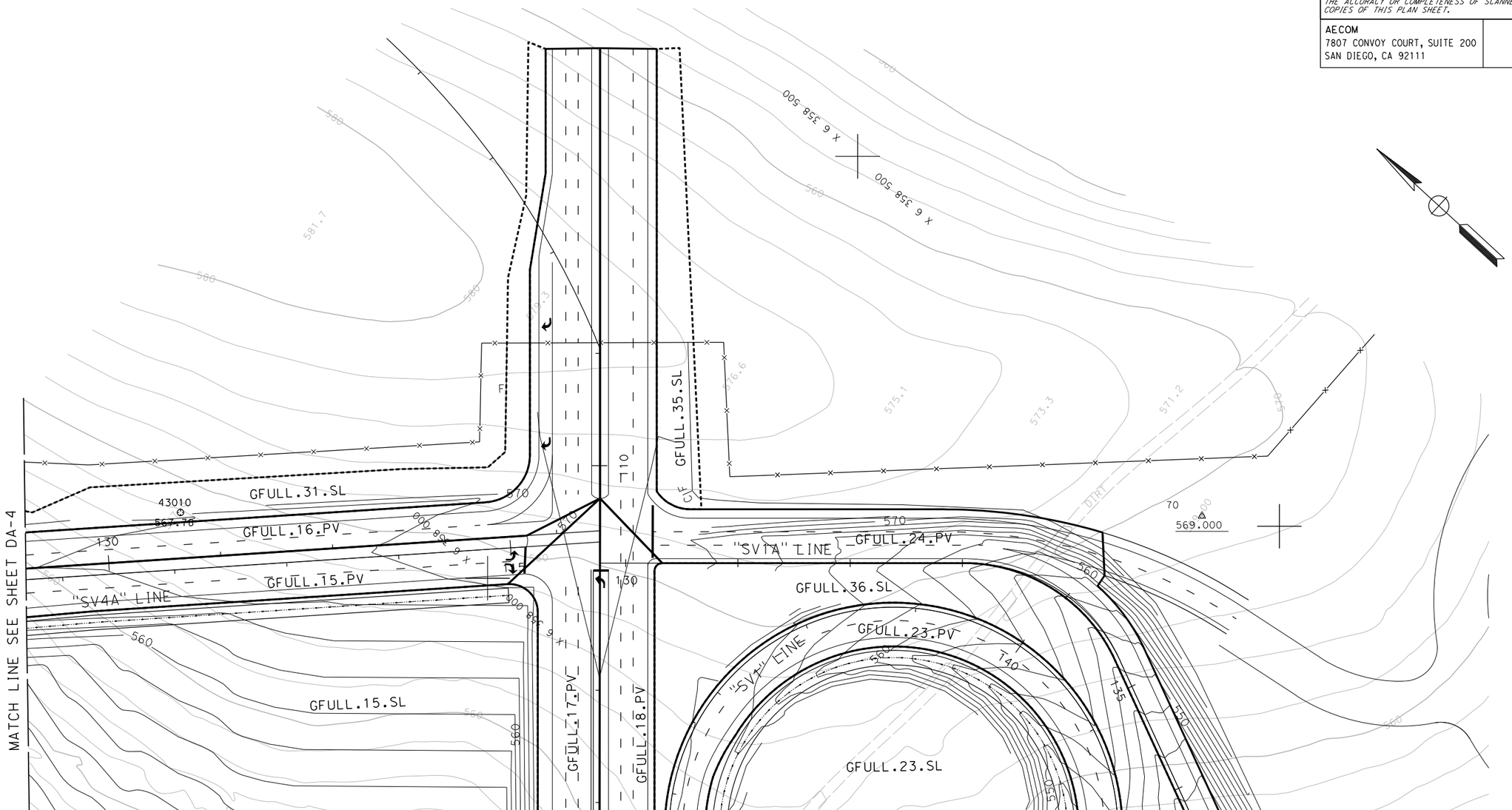

TWO INTERCHANGE ALTERNATIVE (FULL)
DRAINAGE AREA PLAN

SCALE 1"=50'

DA-5

THIS PLAN ACCURATE FOR DRAINAGE WORK ONLY.

ALL DIMENSIONS ARE IN FEET UNLESS OTHERWISE SHOWN

REVISED BY	MIKE BRUNING	CALCULATED-DESIGNED BY	
DATE REVISED	GERARD DALZIEL	CHECKED BY	

CONSULTANT FUNCTIONAL SUPERVISOR: KIRK BRADBURY

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION

Caltrans

LAST REVISION 11-13-09 DATE PLOTTED => 8/6/2010 TIME PLOTTED => 11:32:08 AM

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
11	SD	11	23.3/26.6		

REGISTERED CIVIL ENGINEER DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER KIRK BRADBURY No. 71673 Exp. 12/31/09 CIVIL STATE OF CALIFORNIA

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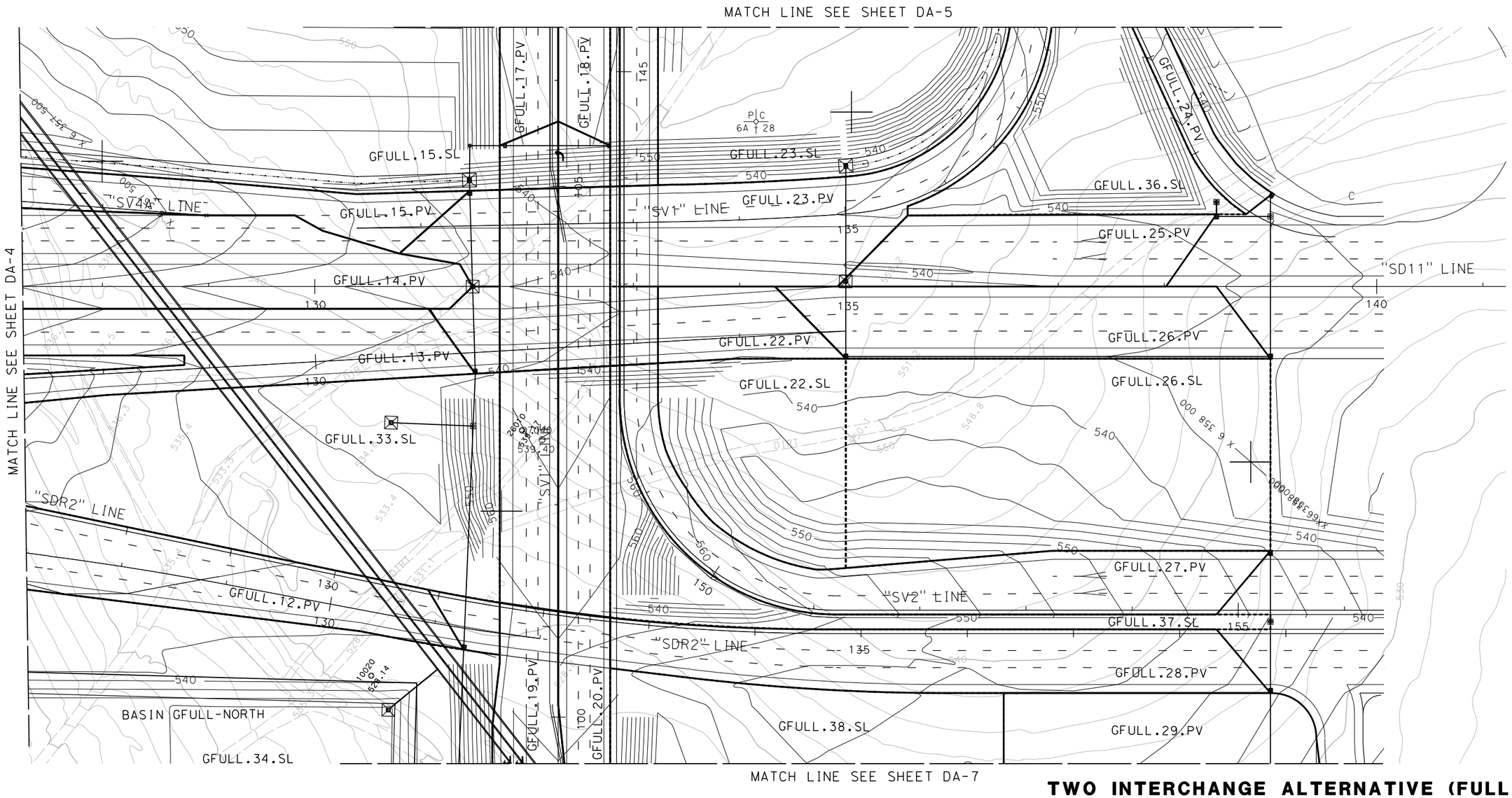

TWO INTERCHANGE ALTERNATIVE (FULL)

DRAINAGE AREA PLAN

SCALE 1"=50'

DA-6

THIS PLAN ACCURATE FOR DRAINAGE WORK ONLY.

ALL DIMENSIONS ARE IN FEET UNLESS OTHERWISE SHOWN

REVISED BY	DATE REVISED
MIKE BRUNING	GERARD DALZIEL

CALCULATED-DESIGNED BY / CHECKED BY

CONSULTANT FUNCTIONAL SUPERVISOR: KIRK BRADBURY

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION

Caltrans

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8/6/2010 11:35:41 AM YamanakaG H:\Caltrans\2208300\Cad\planset\b056300ia006_2fullDA.dgn

BORDER LAST REVISED 4/11/2008

RELATIVE BORDER SCALE IS IN INCHES 0 1 2 3

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DGN FILE => ...\b056300ia006_2fullDA.dgn

CU XXXXX | EA 06002

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
11	SD	11	23.3/26.6		

REGISTERED CIVIL ENGINEER DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER KIRK BRADBURY No. 71673 Exp. 12/31/09 CIVIL STATE OF CALIFORNIA

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NOTE:

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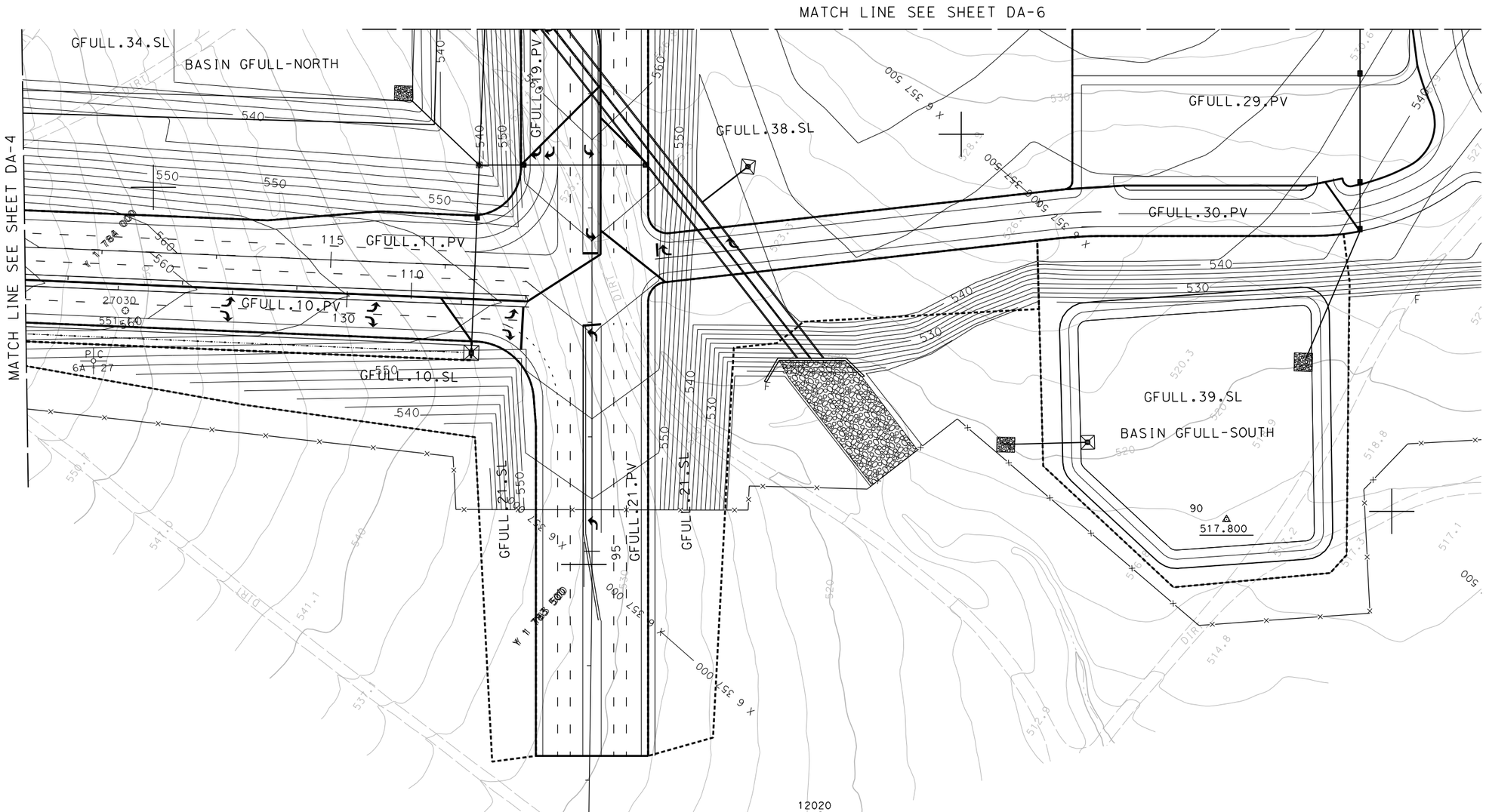

THIS PLAN ACCURATE FOR DRAINAGE WORK ONLY.

ALL DIMENSIONS ARE IN FEET UNLESS OTHERWISE SHOWN

TWO INTERCHANGE ALTERNATIVE (FULL)
DRAINAGE AREA PLAN

SCALE 1"=50'

DA-7

REVISED BY | DATE REVISED
MIKE BRUNING | GERARD DALZIEL
CALCULATED-DESIGNED BY | CHECKED BY
SUPERVISOR | KIRK BRADBURY
CONSULTANT FUNCTIONAL SUPERVISOR
STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION
Caltrans

LAST REVISION 11-13-09
DATE PLOTTED => 8/6/2010
TIME PLOTTED => 3:30:13 PM

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8/6/2010 3:30:13 PM YamanakaG H:\Caltrans\2208300\Cad\planset\b056300ia007_2fullDA.dgn
BORDER LAST REVISED 4/11/2008

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DGN FILE => ...\b056300ia007_2fullDA.dgn

CU XXXXX

EA 06002

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GFULL Onsite D.A. Table

PROJECT:	SR-11			DESCRIPTION:	Onsite Drainage Areas (D.A.)
JOB #:	11A1190			STATION:	~
BY:	M.BRUNING	DATE:	04.13.10	WATERSHED:	GFULL
CHK:	G.DALZIEL	DATE:		SYSTEM:	Full Interchange Option

PAVED

Name	C	Area SF	Area Acres	Tc min	Caltrans i_{25} in/hr	Caltrans Q_{25} cfs	County i_{100} in/hr	County Q_{100} cfs	Drains to: Bioswale	Inlet	Destination	@ Station	Offset
GFULL.1.PV	0.99	40000	0.9	10	2.8	2.57	4.2	3.83	GFULL.1	GFULL.1	Basin GFULL North	122+00	"SDR2"
GFULL.2.PV	0.99	76000	1.7	5	4.0	6.91	6.6	11.38	~	GFULL.2	Basin GFULL North	122+00	Lt
GFULL.3.PV	0.99	19300	0.4	5	4.0	1.75	6.6	2.89	~	GFULL.3	Basin GFULL North	121+00	"SV4B"
GFULL.4.PV	0.99	21000	0.5	10	2.8	1.35	4.2	2.01	GFULL.4	GFULL.4	Basin GFULL North	121+00	"SV4B"
GFULL.5.PV	0.99	35700	0.8	5	4.0	3.25	6.6	5.34	~	GFULL.5	Basin GFULL North	125+50	Center
GFULL.6.PV	0.99	26400	0.6	5	4.0	2.40	6.6	3.95	~	GFULL.6	Basin GFULL North	125+50	Rt
GFULL.7.PV	0.99	32600	0.7	5	4.0	2.96	6.6	4.88	~	GFULL.7	Basin GFULL North	125+50	"SV3B"
GFULL.8.PV	0.99	8800	0.2	10	2.8	0.57	4.2	0.84	GFULL.8	GFULL.8	Basin GFULL North	125+00	"SDR2"
GFULL.9.PV	0.99	21800	0.5	5	4.0	1.98	6.6	3.26	~	GFULL.9	Basin GFULL North	125+25	"SV3C"
GFULL.10.PV	0.99	25400	0.6	10	2.8	1.63	4.2	2.43	GFULL.10	GFULL.10	Basin GFULL North	131+00	SV3A"
GFULL.11.PV	0.99	52400	1.2	5	4.0	4.76	6.6	7.84	~	GFULL.11	Basin GFULL North	113+75	"SV3C"
GFULL.12.PV	0.99	39500	0.9	5	4.0	3.59	6.6	5.91	~	GFULL.12	Basin GFULL North	131+00	"SV3C"
GFULL.13.PV	0.99	41400	1.0	5	4.0	3.76	6.6	6.20	~	GFULL.13	Basin GFULL North	131+00	"SV3B"
GFULL.14.PV	0.99	51100	1.2	5	4.0	4.65	6.6	7.65	~	GFULL.14	Basin GFULL North	131+00	Center
GFULL.15.PV	0.99	63600	1.5	10	2.8	4.09	4.2	6.09	GFULL.15	GFULL.15	Basin GFULL North	131+00	"SV1"
GFULL.16.PV	0.99	42200	1.0	5	4.0	3.84	6.6	6.32	~	GFULL.16	Culvert GFULL	128+50	"SV4B"
GFULL.17.PV	0.99	22300	0.5	5	4.0	2.03	6.6	3.34	~	GFULL.17	Basin GFULL North	105+50	"SVI"
GFULL.18.PV	0.99	19400	0.4	5	4.0	1.76	6.6	2.90	~	GFULL.18	Basin GFULL North	105+50	"SVI"
GFULL.19.PV	0.99	39100	0.9	5	4.0	3.56	6.6	5.85	~	GFULL.19	Basin GFULL North	95+25	"SVI"
GFULL.20.PV	0.99	33100	0.8	5	4.0	3.01	6.6	4.96	~	GFULL.20	Basin GFULL North	98+25	"SVI"
GFULL.21.PV	0.99	45500	1.0	5	4.0	4.14	6.6	6.81	~	GFULL.21	* BYPASS	93+00	"SVI"
GFULL.22.PV	0.99	13500	0.3	5	4.0	1.23	6.6	2.02	~	GFULL.22	Basin GFULL South	135+00	Rt
GFULL.23.PV	0.99	67300	1.5	5	4.0	6.12	6.6	10.07	GFULL.23	GFULL.23	Basin GFULL South	135+00	"SV1"
GFULL.24.PV	0.99	54900	1.3	5	4.0	4.99	6.6	8.22	~	GFULL.24	Basin GFULL South	139+00	"SV1A"
GFULL.25.PV	0.99	20300	0.5	5	4.0	1.85	6.6	3.04	~	GFULL.25	Basin GFULL South	138+50	Lt
GFULL.26.PV	0.99	27800	0.6	5	4.0	2.53	6.6	4.16	~	GFULL.26	Basin GFULL South	139+00	Rt
GFULL.27.PV	0.99	36500	0.8	5	4.0	3.32	6.6	5.46	~	GFULL.27	Basin GFULL South	155+00	"SV2"
GFULL.28.PV	0.99	36400	0.8	5	4.0	3.31	6.6	5.45	~	GFULL.28	Basin GFULL South	139+00	"SDR2"
GFULL.29.PV	0.99	60600	1.4	5	4.0	5.51	6.6	9.07	~	GFULL.29	Basin GFULL South	~	~
GFULL.30.PV	0.99	30000	0.7	5	4.0	2.73	6.6	4.49	~	GFULL.30	Basin GFULL South	~	~

Σ 1103900 *PAVED*

SLOPE

Name	C	Area SF	Area Acres	Tc min	Caltrans i_{25} in/hr	Caltrans Q_{25} cfs	County i_{100} in/hr	County Q_{100} cfs	Drains to: Bioswale	Inlet	Destination	@ Station	Offset
GFULL.1.SL	0.61	140800	3.2	10	2.8	5.58	4.2	8.31	GFULL.1	GFULL.1	Basin GFULL North	122+00	"SDR2"
GFULL.3.SL	0.61	29300	0.7	10	2.8	1.16	4.2	1.73	GFULL.3	GFULL.4	Basin GFULL North	121+00	"SV4B"
GFULL.6.SL	0.61	21800	0.5	10	2.8	0.86	4.2	1.29	~	GFULL.6	Basin GFULL North	125+50	Rt
GFULL.8.SL	0.61	67000	1.5	10	2.8	2.65	4.2	3.95	GFULL.8	GFULL.3	Basin GFULL North	125+00	"SDR2"
GFULL.10.SL	0.61	11600	0.3	10	2.8	0.46	4.2	0.68	GFULL.10	GFULL.10	Basin GFULL North	131+00	SV3A"
GFULL.15.SL	0.61	242000	5.6	10	2.8	9.59	4.2	14.27	GFULL.15	GFULL.15	Basin GFULL North	131+00	"SV1"
GFULL.21.SL	0.61	80000	1.8	10	2.8	3.17	4.2	4.72	~	GFULL.21	* BYPASS	93+00	"SVI"
GFULL.22.SL	0.61	29200	0.7	10	2.8	1.16	4.2	1.72	~	GFULL.22	Basin GFULL South	135+00	Rt
GFULL.23.SL	0.61	92900	2.1	10	2.8	3.68	4.2	5.48	GFULL.23	GFULL.23	Basin GFULL South	135+00	"SV1"
GFULL.26.SL	0.61	74000	1.7	10	2.8	2.93	4.2	4.37	~	GFULL.26	Basin GFULL South	139+00	Rt
GFULL.31.SL	0.61	47100	1.1	10	2.8	1.87	4.2	2.78	~	GFULL.31	Culvert GFULL	126+50	"SV4B"
GFULL.32.SL	0.61	142900	3.3	10	2.8	5.66	4.2	8.43	~	GFULL.32	Basin GFULL North	125+50	Lt
GFULL.33.SL	0.61	87500	2.0	10	2.8	3.47	4.2	5.16	~	GFULL.33	Basin GFULL North	130+50	"SV3B"
GFULL.34.SL	0.61	223800	5.1	10	2.8	8.87	4.2	13.20	~	GFULL.34	Basin GFULL North	130+50	"SV3C"
GFULL.35.SL	0.61	12200	0.3	10	2.8	0.48	4.2	0.72	~	GFULL.35	* BYPASS	110+00	"SVI"
GFULL.36.SL	0.61	68000	1.6	10	2.8	2.69	4.2	4.01	~	GFULL.36	Basin GFULL South	138+50	Lt
GFULL.37.SL	0.61	19700	0.5	10	2.8	0.78	4.2	1.16	~	GFULL.37	Basin GFULL South	155+00	"SV2"
GFULL.38.SL	0.61	86300	2.0	10	2.8	3.42	4.2	5.09	~	GFULL.38	Culvert GFULL	~	~
GFULL.39.SL	0.61	75000	1.7	10	2.8	2.97	4.2	4.42	~	GFULL.39	Basin GFULL South	~	~

Σ 1551100 *SLOPE*

* flow that does not reach the basin

Total :	2655000	61.0
	SF	*ac*

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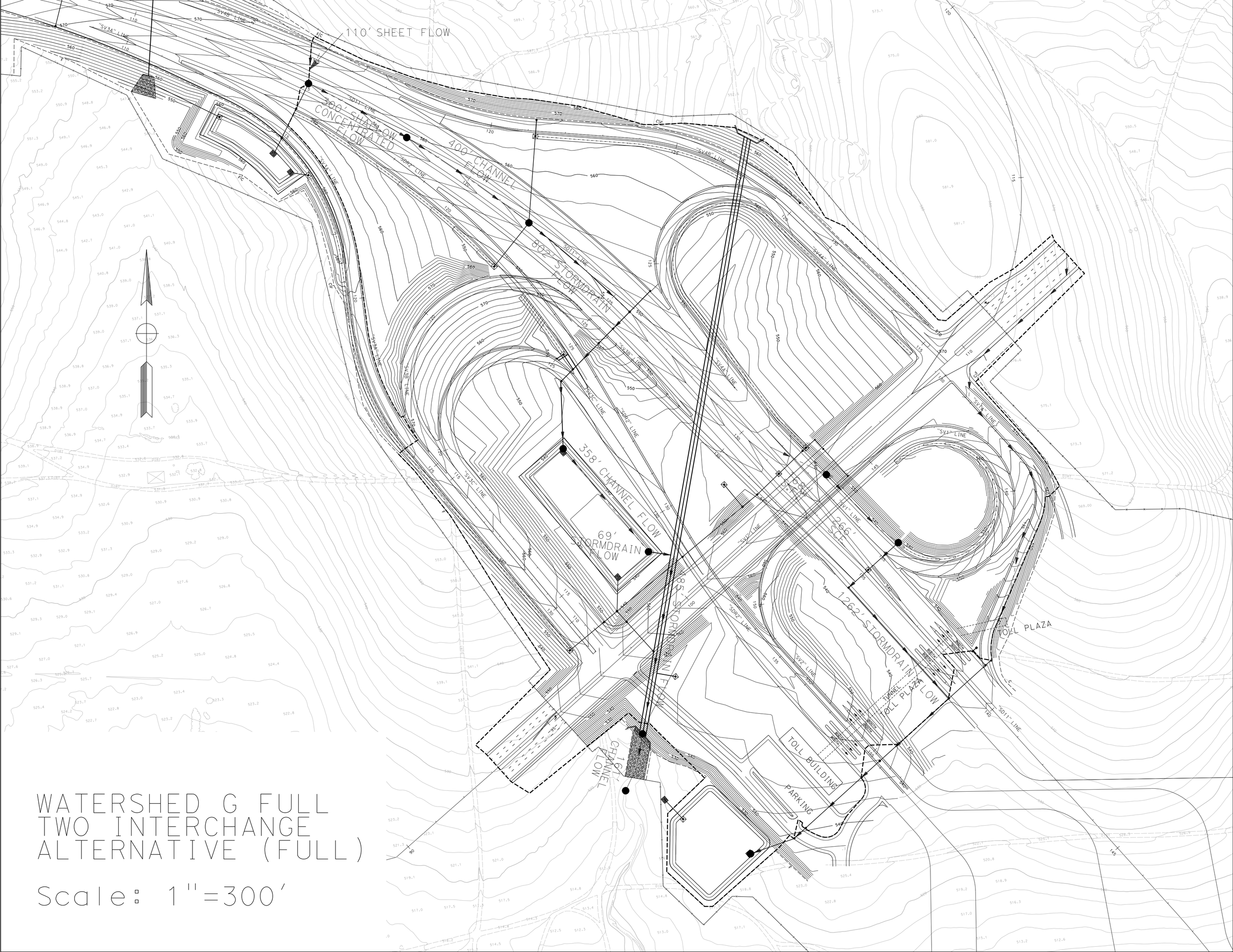


WATERSHED G FULL TWO INTERCHANGE ALTERNATIVE (FULL)

Scale: 1"=300'

GFULL Post-Developed TcQ

PROJECT:	SR-11			DESCRIPTION:	SR-11 Post-Developed
JOB #:	11A1190			STATION:	139+00
BY:	M.BRUNING	DATE:	04.13.10	WATERSHED:	GFULL
CHK:	G.DALZIEL	DATE:		SYSTEM:	Full Interchange Option

BASIN AREA:

A =	2655000	ft^2	SOURCE:	MICROSTATION/USGS
	60.95	acres		(SCALE = 1:1)

COEFFICIENT OF RUNOFF:

KEY: USER INPUT

UNDEVELOPED AREA C (FROM HDM FIG. 819.2A)

		NOTES:
RELIEF (.08-.35)	0.12	Relatively Flat ~ 4%
INFILTRATION (.04-.16)	0.12	Negligible infiltration capacity - see Geotechnical Report
VEGETATION (.04-.16)	0.08	Fair natural cover
STORAGE (.04-.12)	0.07	Normal
TOTAL C =	0.39	

UNDEVELOPED AREA	0%	AT	0.39	0.000
PAVED SURFACE	42%	AT	0.90	0.374
COMMERCIAL AREA	0%	AT	0.85	0.000
CUT SLOPE (2:1 and 4:1)	58%	AT	0.55	0.321
TOTAL	100%			
	(100%)			

$C_{2,10}$ =	0.70
C_{25} =	0.77
C_{50} =	0.83
C_{100} =	0.87

TIME OF CONCENTRATION:

SHEET FLOW: $T_t = \frac{0.42L^{4/5}n^{4/5}}{P_2^{1/2}s^{2/5}}$

NOTES: $P_{2,24}$ (in) = 1.80

HIGH PT ELEVATION	568.5	ft	From asphalt, superelevation
LOW POINT ELEVATION	562.0	ft	
ELEVATION DIFF (H)	6.5	ft	
LENGTH (L)	110	ft	
SLOPE (S) = (H/L)	5.9%		
MANNING'S n	0.016		< = FROM TABLE 816.6A Asphalt Paving
T_t (SFF)=	1.53	minutes	

SHALLOW CONCENTRATED FLOW: $T_t = \frac{L}{60\,V}$

NOTES:

HIGH PT ELEVATION	562.0	ft	within median, low flows, not 'channel'
LOW POINT ELEVATION	558.0	ft	
ELEVATION DIFF (H)	4.0	ft	
LENGTH (L)	300	ft	
SLOPE (S) = (H/L)	1.3%		
VELOCITY (SCF)	1.4	fps	<=V FROM FIG 816.6 nearly bare ground
T_C (SH)=	3.70	minutes	

CHANNEL FLOW: $T_t = \frac{L}{60\,V}$

NOTES:

HIGH PT ELEVATION	558.0	ft	median ditch
LOW POINT ELEVATION	553.0	ft	CHANNEL DATA TYPE = TRAP'Z
ELEVATION DIFF (H)	5.0	ft	Z= 4 ANG-RAD 0.245
LENGTH (L)	400	ft	b = 0 ANG-DEG 14.036
SLOPE (S) = (H/L)	1.3%		d = 1 FLOWING FULL ASS'M
MANNING'S n	0.050		HDM Table 864.3A, Depressed Median - Earth (with growth)
HYDRAULIC RADIUS R	0.5	ft	R=(bdsinA+d^2cosA)/(bsinA+2d)
VELOCITY (CHANNEL)	2.06	fps	From Manning's Equation assuming flowing full: $V=1.49/n(R^{2/3}S^{1/2})$
T_C (CH)=	3.24	minutes	

GFULL Post-Developed TcQ

STORMDRAIN FLOW: $T_t = \frac{L}{60\,V}$

HIGH PT ELEVATION	548.0	ft
LOW POINT ELEVATION	536.0	ft
ELEVATION DIFF (H)	12.0	ft
LENGTH (L)	802	ft
SLOPE (S) = (H/L)	1.5%	
MANNING'S n	0.013	
PIPE DIAMETER d	2.0	ft
HYDRAULIC RADIUS R	0.5	ft
VELOCITY (STORMDRAIN)	8.8	fps
T_C (SD)=	1.51	minutes

NOTES:

Proposed storm drain through median (elev at pipe invert)
Sta 125+60

RCP

R=D/4, Assume: flowing full

$V = \frac{K_u}{n} R^{2/3} S^{1/2}$

CHANNEL FLOW: $T_t = \frac{L}{60\,V}$

HIGH PT ELEVATION	536.0	ft
LOW POINT ELEVATION	532.0	ft
ELEVATION DIFF (H)	4.0	ft
LENGTH (L)	358	ft
SLOPE (S) = (H/L)	1.1%	
MANNING'S n	0.050	
HYDRAULIC RADIUS R	0.5	ft
VELOCITY (CHANNEL)	1.94	fps
T_C (CH)=	3.07	minutes

NOTES:

Detention basin (low flow channel)

CHANNEL DATA		TYPE =	TRAP'Z
Z=	4	ANG-RAD	0.245
b =	0	ANG-DEG	14.036
d =	1	FLOWING FULL ASS'M	

HDM Table 864.3A, Depressed Median - Earth (with growth)
R=(bdsinA+d^2cosA)/(bsinA+2d)
From Manning's Equation assuming flowing full: $V=1.49/n(R^{2/3}S^{1/2})$

STORMDRAIN FLOW: $T_t = \frac{L}{60\,V}$

HIGH PT ELEVATION	532.0	ft
LOW POINT ELEVATION	526.0	ft
ELEVATION DIFF (H)	6.0	ft
LENGTH (L)	69	ft
SLOPE (S) = (H/L)	8.7%	
MANNING'S n	0.013	
PIPE DIAMETER d	2.0	ft
HYDRAULIC RADIUS R	0.5	ft
VELOCITY (STORMDRAIN)	21.3	fps
T_C (SD)=	0.05	minutes

NOTES:

Proposed storm drain connecting to cross culvert
Sta 131+00

RCP

R=D/4, Assume: flowing full

$V = \frac{K_u}{n} R^{2/3} S^{1/2}$

STORMDRAIN FLOW: $T_t = \frac{L}{60\,V}$

HIGH PT ELEVATION	526.0	ft
LOW POINT ELEVATION	520.0	ft
ELEVATION DIFF (H)	6.0	ft
LENGTH (L)	485	ft
SLOPE (S) = (H/L)	1.2%	
MANNING'S n	0.013	
PIPE DIAMETER d	4.0	ft
HYDRAULIC RADIUS R	1.0	ft
VELOCITY (STORMDRAIN)	12.7	fps
T_C (SD)=	0.63	minutes

NOTES:

Proposed RCB
Outlet

RCP

R=D/4, Assume: flowing full

$V = \frac{K_u}{n} R^{2/3} S^{1/2}$

CHANNEL FLOW: $T_t = \frac{L}{60\,V}$

HIGH PT ELEVATION	520.0	ft
LOW POINT ELEVATION	514.0	ft
ELEVATION DIFF (H)	6.0	ft
LENGTH (L)	161	ft
SLOPE (S) = (H/L)	3.7%	
MANNING'S n	0.055	
HYDRAULIC RADIUS R	0.6	ft
VELOCITY (CHANNEL)	3.66	fps
T_C (CH)=	0.73	minutes

NOTES:

RCP to confluence point

CHANNEL DATA		TYPE =	TRAP'Z
Z=	4	ANG-RAD	0.245
b =	2	ANG-DEG	14.036
d =	1	FLOWING FULL ASS'M	

HDM Table 864.3A, Depressed Median - Earth (with growth) and RCP
R=(bdsinA+d^2cosA)/(bsinA+2d)
From Manning's Equation assuming flowing full: $V=1.49/n(R^{2/3}S^{1/2})$

GFULL Post-Developed TcQ

Tc (TOTAL) =	14.47	minutes
Minimum Tc =	10	minutes
USE Tc =	**14.47**	minutes

INTENSITY CHART:

$$I = 7.44\ P_6\ D^{-0.645}$$

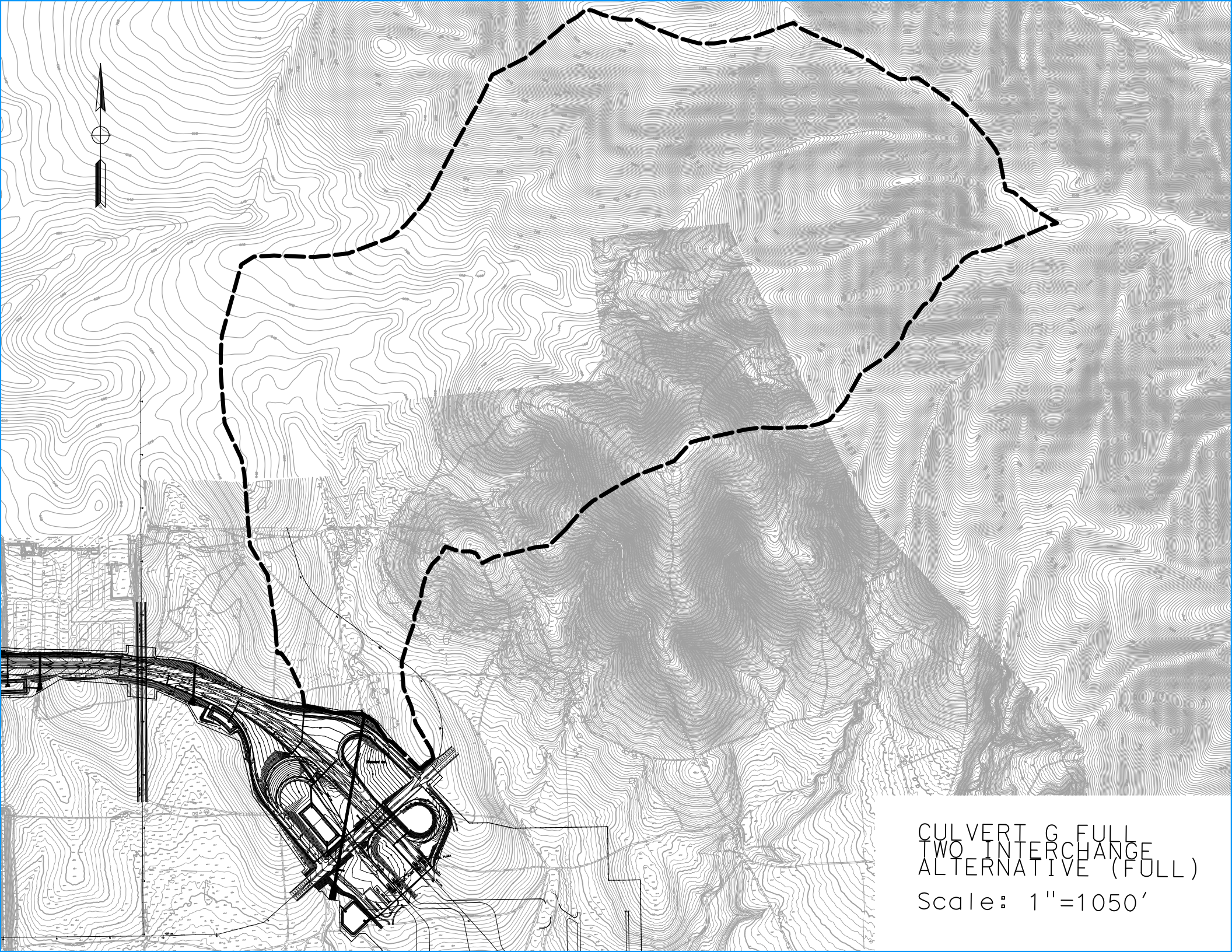
i_2 =	1.5	in/hr	X CA =
i_{10} =	2.1	in/hr	X CA =
i_{25} =	2.7	in/hr	X CA =
i_{50} =	3.2	in/hr	X CA =
i_{100} =	3.3	in/hr	X CA =

FLOW RESULTS:

	cfs
Q_2 =	61.9
Q_{10} =	90.0
Q_{25} =	123.8
Q_{50} =	162.1
Q_{100} =	**175.9**

COUNTY P_6

	inches
2-year:	1.1
10-year:	1.6
25-year:	2.0
50-year:	2.4
100-year:	2.5



CULVERT G FULL
TWO INTERCHANGE
ALTERNATIVE (FULL)

Scale: 1"=1050'

Culvert Calculator Report
G2 (FULL) 100-yr

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	558.00	ft	Headwater Depth/Height	1.85	
Computed Headwater Eleva	557.39	ft	Discharge	658.00	cfs
Inlet Control HW Elev.	557.39	ft	Tailwater Elevation	518.04	ft
Outlet Control HW Elev.	556.56	ft	Control Type	Inlet Control	

Grades					
Upstream Invert	550.00	ft	Downstream Invert	516.00	ft
Length	1,621.00	ft	Constructed Slope	2.1	%

Hydraulic Profile					
Profile	S2		Depth, Downstream	2.04	ft
Slope Type	Steep		Normal Depth	2.04	ft
Flow Regime	Supercritical		Critical Depth	3.75	ft
Velocity Downstream	20.21	ft/s	Critical Slope	0.4	%

Section					
Section Shape	Box		Mannings Coefficient	0.013	
Section Material	Concrete		Span	8.00	ft
Section Size	8 x 4 ft		Rise	4.00	ft
Number Sections	2				

Outlet Control Properties					
Outlet Control HW Elev.	556.56	ft	Upstream Velocity Head	1.87	ft
Ke	0.50		Entrance Loss	0.94	ft

Inlet Control Properties					
Inlet Control HW Elev.	557.39	ft	Flow Control	Submerged	
Inlet Type	90 and 15° wingwall flares		Area Full	64.0	ft²
K	0.06100		HDS 5 Chart	8	
M	0.75000		HDS 5 Scale	2	
C	0.04000		Equation Form	1	
Y	0.80000				

Basin GFULL Retention

PROJECT:	**SR-11**			**DESCRIPTION:**	**SR-11 Basin**
JOB #:	**11A1190**			**STATION:**	**139+00**
BY:	**M.BRUNING**	**DATE:**	**04.21.10**	**WATERSHED:**	**GFULL**
CHK:	**G.DALZIEL**	**DATE:**		**SYSTEM:**	**Full Interchange Option**

Notes:

* The difference between pre-developed and post-developed values gives the volume to retain.

RETENTION VOLUME

100-year, 6 hour duration storm event, use the Rational Method Hydrograph Procedure (SDCHM 6-1) ~ RatHydro

Pre-Developed volume calculations

Q_{100}=	80.8	cfs			
Tc=	17.0	min	C=	0.49	
$P_{100,6}$=	2.5	in	A=	55.33	acres

$T_{T(N)}$ (MIN)	VOL (CF)	ORDINATE (CFS)
0	0	0
17	4182	4.1
34	4284	4.2
51	4590	4.5
68	4794	4.7
85	5202	5.1
102	5508	5.4
119	6120	6
136	6426	6.3
153	7344	7.2
170	8058	7.9
187	9792	9.6
204	11118	10.9
221	16422	16.1
238	23358	22.9
255	82416	80.8
272	13158	12.9
289	8772	8.6
306	6834	6.7
323	5712	5.6
340	4998	4.9
357	4488	4.4
374	0	0

Example of Steps:

$T_{T(N)}$ (MIN)	VOL (CF)	ORDINATE (CFS)
0	0	0
14	1260	1.5
28	1344	1.6
42	1344	1.6
56	1428	1.7
70	1512	1.8
84	1596	1.9

SUM= 243576 ft^3
5.59 acre-feet

Check: V = C*A*P_6
V= 5.62 acre-feet
OK

Basin GFULL Retention

Post-Developed volume calculations

Q_{100}=	175.9	cfs			
Tc=	14.5	min	C=	0.87	
$P_{100,6}$=	2.5	in	A=	60.95	acres

$T_{T(N)}$ (MIN)	VOL (CF)	ORDINATE (CFS)
0	0	0
15	7200	8
30	7380	8.2
45	7830	8.7
60	8100	9
75	8640	9.6
90	9000	10
105	9810	10.9
120	10260	11.4
135	11340	12.6
150	12060	13.4
165	13860	15.4
180	15030	16.7
195	18360	20.4
210	20880	23.2
225	30600	34
240	39600	44
255	158310	175.9
270	24570	27.3
285	16470	18.3
300	12870	14.3
315	10800	12
330	9360	10.4
345	8370	9.3
360	7560	8.4
375	0	0

Example of Steps:

$T_{T(N)}$ (MIN)	VOL (CF)	ORDINATE (CFS)
0	0	0
14	1260	1.5
28	1344	1.6
42	1344	1.6
56	1428	1.7
70	1512	1.8
84	1596	1.9

SUM= 478260 ft^3
10.98 acre-feet

Check: V = C*A*P_6
V= 11.04 acre-feet
OK

10.98
- 5.59

Retention volume = 5.39 acre-feet = 234684 ft^3 Basin Required

Basin GFULL Retention

WATER QUALITY VOLUME CALCULATION

Per the Caltrans Storm Water Quality Handbook: Project Planning and Design Guide (PPDG) (May 2007)
Provide additional capacity for Water Quality

Output from Basin Sizer

Water Quality Volumes

Maximized Volume Method (in/area)*

Basin Drainage Time (hrs)	Runoff Coefficient 0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
12	0.13	0.16	0.21	0.25	0.28	0.33	0.37	0.4
24	0.16	0.21	0.27	0.31	0.37	0.42	0.46	0.52
48	0.2	0.26	0.32	0.38	0.44	0.51	0.57	0.58
72	0.22	0.29	0.37	0.43	0.51	0.58	0.66	0.73

C_{100}=	0.90		Max C from North/South Onsite
A=	53.76	acres	Sum of North/South Onsite Area
WQ_{72}:	0.66	in/area	

Water Quality Volume (WQV) = **128794** **ft^3**

WQV to be added to retention volume = **0** **ft^3** **WQV is within Retention**

If this volume is less than retention requirement, do not add volume since WQ is addressed in Retention

SILT ACCUMULATION ANALYSIS (Long Term)

Per the United States International Boundary and Water Commission (IBWC)
Provide additional capacity for a 10-year volume of silt accumulation

Onsite Highway *Sloped* runoff area, A:		1325500	ft^2
	A:	30.43	acres
		10.00	years
where:	R=	30.00	
	K=	0.24	
	Ls=	18.00	
	C=	0.012	
	P=	1.00	
	As	1.56	tons/yr.Ac

Volume for 10-year Silt Accumulation = 473.24 tons

Universal Soil Loss Equation (SDCHM 5.2.3)

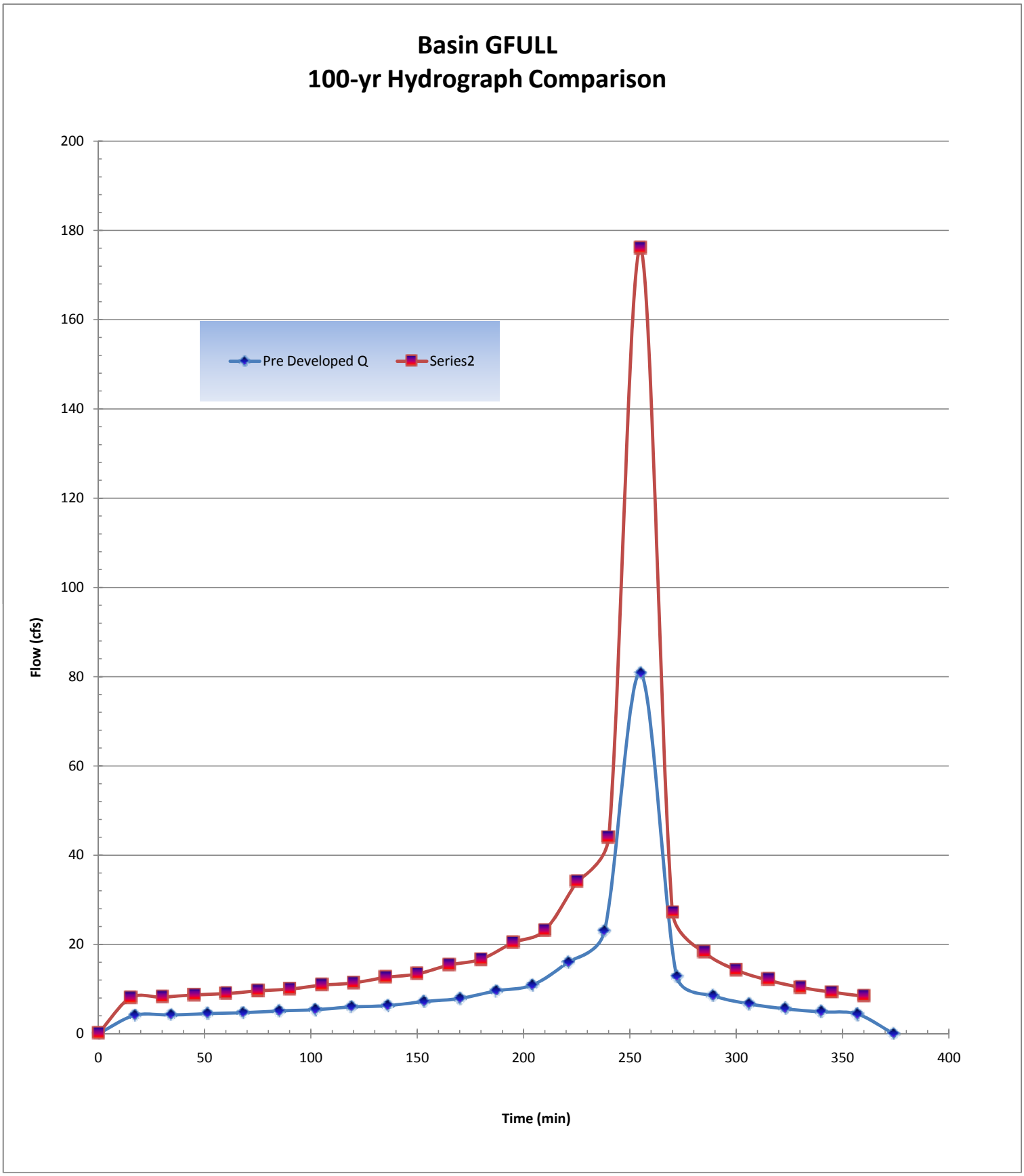
$A_s = RKLsCP$

where:

A_s = the computed soil loss in tons (dry weight)
R = the rainfall erosion index for the given storm period
K = the soil erodibility factor
L = the slope length factor
s = the slope gradient factor
C = cropping management (vegetation) factor
P = erosion control practice factor

Silt Accumulation Basin volume = **10516** **ft^3**

Add this volume to Basin volume due to silts from cut slopes


Basin GFULL
100-yr Hydrograph Comparison
Pre Developed Q
Series2
Flow (cfs)
Time (min)
0
20
40
60
80
100
120
140
160
180
200
0
50
100
150
200
250
300
350
400

Basin GFULL-North Inflow TcQ

PROJECT:	SR-11			DESCRIPTION:	SR-11 Basin
JOB #:	11A1190			STATION:	127+00
BY:	M.BRUNING	DATE:	04.13.10	WATERSHED:	GFULL
CHK:	G.DALZIEL	DATE:		SYSTEM:	Basin GFULL-North

BASIN AREA:

A =	1635600	ft^2	SOURCE:	MICROSTATION/USGS
	37.55	acres		(SCALE = 1:1)

COEFFICIENT OF RUNOFF:

KEY: USER INPUT

UNDEVELOPED AREA C (FROM HDM FIG. 819.2A)

		NOTES:
RELIEF (.08-.35)	0.00	
INFILTRATION (.04-.16)	0.00	
VEGETATION (.04-.16)	0.00	
STORAGE (.04-.12)	0.00	
TOTAL C =	0.00	

UNDEVELOPED AREA	0%	AT	0.00	0.000
PAVED SURFACE	41%	AT	0.90	0.368
COMMERCIAL AREA	0%	AT	0.85	0.000
CUT SLOPE (2:1 and 4:1)	59%	AT	0.55	0.325
TOTAL	100%			
	(100%)			

$C_{2,10}$ =	0.69
C_{25} =	0.76
C_{50} =	0.83
C_{100} =	0.87

TIME OF CONCENTRATION:

SHEET FLOW: $T_t = \frac{0.42L^{4/5}n^{4/5}}{P_2^{1/2}s^{2/5}}$

NOTES: $P_{2,24}$ (in) = 1.80

HIGH PT ELEVATION	568.5	ft	From asphalt, superelevation
LOW POINT ELEVATION	562.0	ft	
ELEVATION DIFF (H)	6.5	ft	
LENGTH (L)	110	ft	
SLOPE (S) = (H/L)	5.9%		
MANNING'S n	0.016		< = FROM TABLE 816.6A Asphalt Paving
T_t (SFF)=	1.53	minutes	

SHALLOW CONCENTRATED FLOW: $T_t = \frac{L}{60\,V}$

NOTES:

HIGH PT ELEVATION	562.0	ft	within median, low flows, not 'channel'
LOW POINT ELEVATION	558.0	ft	
ELEVATION DIFF (H)	4.0	ft	
LENGTH (L)	300	ft	
SLOPE (S) = (H/L)	1.3%		
VELOCITY (SCF)	1.4	fps	<=V FROM FIG 816.5 nearly bare ground
T_C (SH)=	3.70	minutes	

CHANNEL FLOW: $T_t = \frac{L}{60\,V}$

NOTES:

HIGH PT ELEVATION	558.0	ft	median ditch
LOW POINT ELEVATION	553.0	ft	CHANNEL DATA TYPE = TRAP'Z
ELEVATION DIFF (H)	5.0	ft	Z= 4 ANG-RAD 0.245
LENGTH (L)	400	ft	b = 0 ANG-DEG 14.036
SLOPE (S) = (H/L)	1.3%		d = 1 FLOWING FULL ASS'M
MANNING'S n	0.050		HDM Table 864.3A, Depressed Median - Earth (with growth)
HYDRAULIC RADIUS R	0.5	ft	R=(bdsinA+d^2cosA)/(bsinA+2d)
VELOCITY (CHANNEL)	2.06	fps	From Manning's Equation assuming flowing full: $V=1.49/n(R^{2/3}S^{1/2})$
T_C (CH)=	3.24	minutes	

Basin GFULL-North Inflow TcQ

STORMDRAIN FLOW: $T_t = \frac{L}{60\,V}$

			NOTES:
HIGH PT ELEVATION	548.0	ft	Proposed storm drain through median (elev at pipe invert)
LOW POINT ELEVATION	536.0	ft	Sta 125+60
ELEVATION DIFF (H)	12.0	ft	
LENGTH (L)	802	ft	
SLOPE (S) = (H/L)	1.5%		
MANNING'S n	0.013		RCP
PIPE DIAMETER d	2.0	ft	
HYDRAULIC RADIUS R	0.5	ft	R=D/4, Assume: flowing full
VELOCITY (STORMDRAIN)	8.8	fps	$V = \frac{K_u}{n} R^{2/3} S^{1/2}$
T_C (SD)=	1.51	minutes	

Tc (TOTAL) =	9.98	minutes
Minimum Tc =	10	minutes
USE Tc =	**10.00**	minutes

INTENSITY CHART: $I = 7.44\,P_6\,D^{-0.645}$

i_2 =	1.9	in/hr	X CA =	
i_{10} =	2.7	in/hr	X CA =	
i_{25} =	3.4	in/hr	X CA =	
i_{50} =	4.0	in/hr	X CA =	
i_{100} =	4.2	in/hr	X CA =	

FLOW RESULTS:

	cfs
Q_2 =	48.2
Q_{10} =	70.2
Q_{25} =	96.5
Q_{50} =	126.3
Q_{100} =	**137.0**

COUNTY P_6

	inches
2-year:	1.1
10-year:	1.6
25-year:	2.0
50-year:	2.4
100-year:	2.5

Basin GFULL-North Inflow Hydrog

PROJECT:	**SR-11**			**DESCRIPTION:**	**SR-11 Basin**
JOB #:	**11A1190**			**STATION:**	**127+00**
BY:	**M.BRUNING**	**DATE:**	**04.13.10**	**WATERSHED:**	**GFULL**
CHK:	**G.DALZIEL**	**DATE:**		**SYSTEM:**	**Basin GFULL-North**

Notes:

* This is the actual flow entering the detention basin.

ONSITE RUNOFF VOLUME

100-year, 6 hour duration storm event, use the Rational Method Hydrograph Procedure (SDCHM 6-1) ~ RatHydro

Basin Inflow Hydrograph

Basin Inflow Q

Q_{100}=	137.0	cfs	C_{100}=	0.87	
Tc=	10.0	min	A=	37.55	acres
$P_{100,6}$=	2.5	in			

$T_{T(N)}$ (MIN)	VOL (CF)	ORDINATE (CFS)
0	0	0
10	2940	4.9
20	3000	5
30	3120	5.2
40	3180	5.3
50	3300	5.5
60	3360	5.6
70	3540	5.9
80	3600	6
90	3840	6.4
100	3960	6.6
110	4200	7
120	4320	7.2
130	4620	7.7
140	4800	8
150	5220	8.7
160	5460	9.1
170	6060	10.1
180	6420	10.7
190	7380	12.3
200	7980	13.3
210	9780	16.3
220	11160	18.6
230	16320	27.2
240	23400	39
250	82200	137
260	13140	21.9
270	8760	14.6
280	6840	11.4
290	5760	9.6
300	4980	8.3
310	4440	7.4
320	4080	6.8
330	3720	6.2
340	3480	5.8
350	3240	5.4
360	3060	5.1
370	0	0

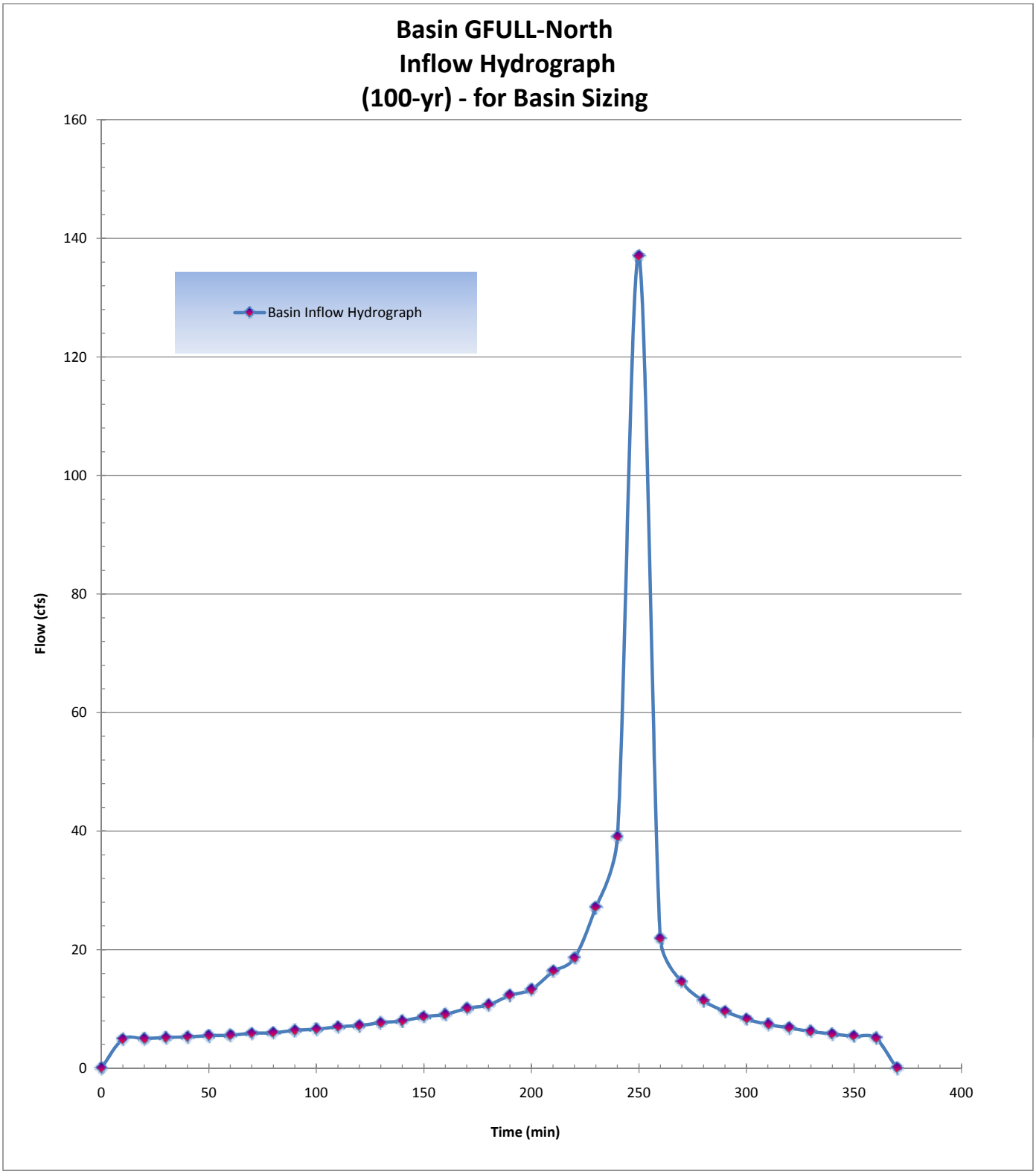
Example of Steps:

$T_{T(N)}$ (MIN)	VOL (CF)	ORDINATE (CFS)
0	0	0
14	1260	1.5
28	1344	1.6
42	1344	1.6
56	1428	1.7
70	1512	1.8
84	1596	1.9

SUM= 294660 ft^3
6.76 acre-feet

Onsite Runoff Volume

Check: $V = C*A*P_6$
V= 6.78 acre-feet
OK


Basin GFULL-North
Inflow Hydrograph
(100-yr) - for Basin Sizing
Basin Inflow Hydrograph
Flow (cfs)
Time (min)
0
20
40
60
80
100
120
140
160
0
50
100
150
200
250
300
350
400

Basin GFULL-North Outlet

PROJECT:	**SR-11**			**DESCRIPTION:**	**SR-11 Basin**
JOB #:	**11A1190**			**STATION:**	**127+00**
BY:	**M.BRUNING**	**DATE:**	**04.21.10**	**WATERSHED:**	**GFULL**
CHK:	**G.DALZIEL**	**DATE:**		**SYSTEM:**	**Basin GFULL-North**

Notes:

Volumes:

Required Retention Basin Volume =	245200	ft^3	from GFULL-ALL
Retention volume from this basin =	150381		at 3.6' depth, see GFULL-South for remainder of storage
Actual Basin Inflow =	294660	ft^3	*OK*

Flow Balance - determine maximum flow from basin

Predeveloped Peak 100-year Flow:	80.8	cfs	from GFULL-ALL
Post-Developed Peak Flow through Cross Culvert:	0.0	cfs	Independent of Culvert GFULL
Flow that does not reach detention basin (bypass per DA table):	12.2	cfs	Q_{100} from: GFULL.21.PVGFULL.21.SLGFULL.35.SL
Maximum flow allowed to be released by this detention basin:	42.0	cfs	*61%* of GFULL-A (per retention ratios)

Outlet Pipe

Assume: trapezoid basin/flat bottom, one outlet pipe set above basin invert

Basin - Top of basin berm elevation =			540.00	ft
Basin flowline elevation =			532.00	ft
Maximum Basin Depth =			8.00	ft

Assume Culvert Design: free outfall, square-edge w/headwall

Outlet pipe invert from basin floor =	3.60	ft	535.60	ft
Outlet pipe diameter =	2	ft		

Basin Characteristics

Base Length (L)		350	ft
Base Width (W)		100	ft
W/L Ratio ®		0.29	
Side Slopes (Z)	1:	4	
Total Volume (V):		406916	ft^2

Infiltration Rate: Rate (min/inch): 71.1 Location: PT-C2 *~ assume no infiltration*

Detention Basin Data						Outlet Pipe		Infiltration	Total
Stage	Water Surface Elevation (ft)	Depth	V_{avg} staged (ft3)	V_{avg} cumm. (ft3)		HW Elev. (ft)	Discharge Q_{out} (cfs)	Q_{inf} (cfs)	Q_{total} (cfs)
0	532.00	0.00	0	0		532.00	0.00		0.00
1	532.20	0.20	7072	7072		532.20	0.00		0.00
2	532.40	0.40	7217	14289		532.40	0.00		0.00
3	532.60	0.60	7363	21652		532.60	0.00		0.00
4	532.80	0.80	7510	29163		532.80	0.00		0.00
5	533.00	1.00	7659	36821		533.00	0.00		0.00
6	533.20	1.20	7808	44629		533.20	0.00		0.00
7	533.40	1.40	7958	52587		533.40	0.00		0.00
8	533.60	1.60	8110	60697		533.60	0.00		0.00
9	533.80	1.80	8263	68960		533.80	0.00		0.00
10	534.00	2.00	8417	77377		534.00	0.00		0.00
11	534.20	2.20	8572	85948		534.20	0.00		0.00
12	534.40	2.40	8728	94676		534.40	0.00		0.00
13	534.60	2.60	8885	103561		534.60	0.00		0.00
14	534.80	2.80	9043	112604		534.80	0.00		0.00
15	535.00	3.00	9202	121806		535.00	0.00		0.00
16	535.20	3.20	9363	131169		535.20	0.00		0.00
17	535.40	3.40	9525	140694		535.40	0.00		0.00
18	535.60	3.60	9687	150381	*	535.60	0.00	0.00	0.00
19	535.80	3.80	9851	160232		535.80	0.15		0.15
20	536.00	4.00	10016	170248		536.00	0.59		0.59
21	536.20	4.20	10182	180430		536.20	1.30		1.30
22	536.40	4.40	10349	190779		536.40	2.25		2.25
23	536.60	4.60	10517	201297		536.60	3.42		3.42
24	536.80	4.80	10687	211983		536.80	4.79		4.79
25	537.00	5.00	10857	222841		537.00	6.32		6.32
26	537.20	5.20	11029	233870		537.20	7.99		7.99
27	537.40	5.40	11202	245071		537.40	9.77		9.77
28	537.60	5.60	11376	256447		537.60	11.63		11.63
29	537.80	5.80	11550	267997		537.80	13.53		13.53
30	538.00	6.00	11726	279724		538.00	15.46		15.46
31	538.20	6.20	11904	291628		538.20	17.37		17.37
32	538.40	6.40	12082	303709		538.40	19.16		19.16
33	538.60	6.60	12261	315971		538.60	20.41		20.41
34	538.80	6.80	12442	328413		538.80	21.59		21.59
35	539.00	7.00	12623	341036		539.00	22.71		22.71

Basin GFULL-North Routing

PROJECT:	SR-11			DESCRIPTION:	SR-11 Basin
JOB #:	11A1190			STATION:	127+00
BY:	M.BRUNING	DATE:	04.21.10	WATERSHED:	GFULL
CHK:	G.DALZIEL	DATE:		SYSTEM:	Basin GFULL-North

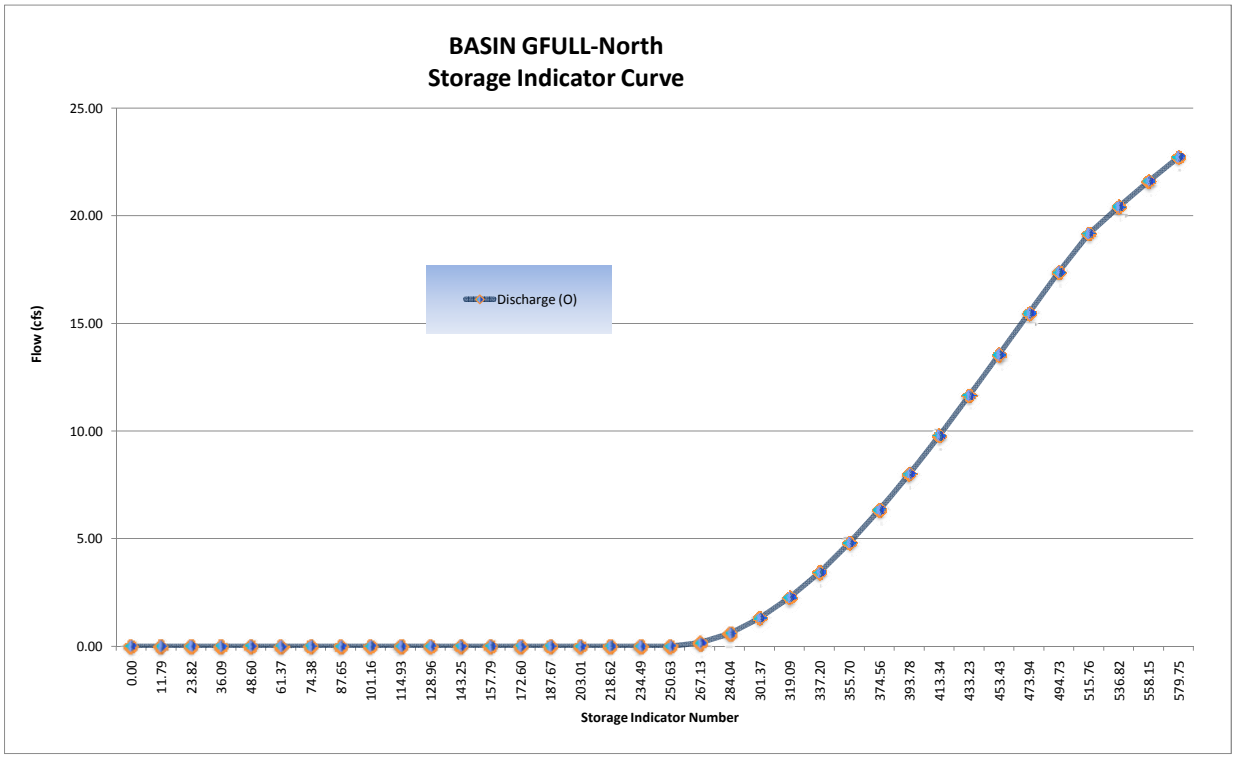
user input
linked input

STORAGE INDICATOR NUMBERS TABLE

(1) Stage (ft)	(2) Discharge (O) (cfs)	(3) Storage (S) (ft^3)	(4) $O_2/2$ (cfs)	(5) S_2/delta t (cfs)	(6) S_2/delta t + $O_2/2$ (cfs)
					Storage Indicator #
532.00	0.00	0	0.00	0.00	0.00
532.20	0.00	7072	0.00	11.79	11.79
532.40	0.00	14289	0.00	23.82	23.82
532.60	0.00	21652	0.00	36.09	36.09
532.80	0.00	29163	0.00	48.60	48.60
533.00	0.00	36821	0.00	61.37	61.37
533.20	0.00	44629	0.00	74.38	74.38
533.40	0.00	52587	0.00	87.65	87.65
533.60	0.00	60697	0.00	101.16	101.16
533.80	0.00	68960	0.00	114.93	114.93
534.00	0.00	77377	0.00	128.96	128.96
534.20	0.00	85948	0.00	143.25	143.25
534.40	0.00	94676	0.00	157.79	157.79
534.60	0.00	103561	0.00	172.60	172.60
534.80	0.00	112604	0.00	187.67	187.67
535.00	0.00	121806	0.00	203.01	203.01
535.20	0.00	131169	0.00	218.62	218.62
535.40	0.00	140694	0.00	234.49	234.49
535.60	0.00	150381	0.00	250.63	250.63
535.80	0.15	160232	0.08	267.05	267.13
536.00	0.59	170248	0.30	283.75	284.04
536.20	1.30	180430	0.65	300.72	301.37
536.40	2.25	190779	1.13	317.97	319.09
536.60	3.42	201297	1.71	335.49	337.20
536.80	4.79	211983	2.40	353.31	355.70
537.00	6.32	222841	3.16	371.40	374.56
537.20	7.99	233870	4.00	389.78	393.78
537.40	9.77	245071	4.89	408.45	413.34
537.60	11.63	256447	5.82	427.41	433.23
537.80	13.53	267997	6.77	446.66	453.43
538.00	15.46	279724	7.73	466.21	473.94
538.20	17.37	291628	8.69	486.05	494.73
538.40	19.16	303709	9.58	506.18	515.76
538.60	20.41	315971	10.21	526.62	536.82
538.80	21.59	328413	10.80	547.35	558.15
539.00	22.71	341036	11.36	568.39	579.75

delta t =	0.17	hrs
delta t =	10	min
delta t =	600	sec

Basin GFULL-North Routing



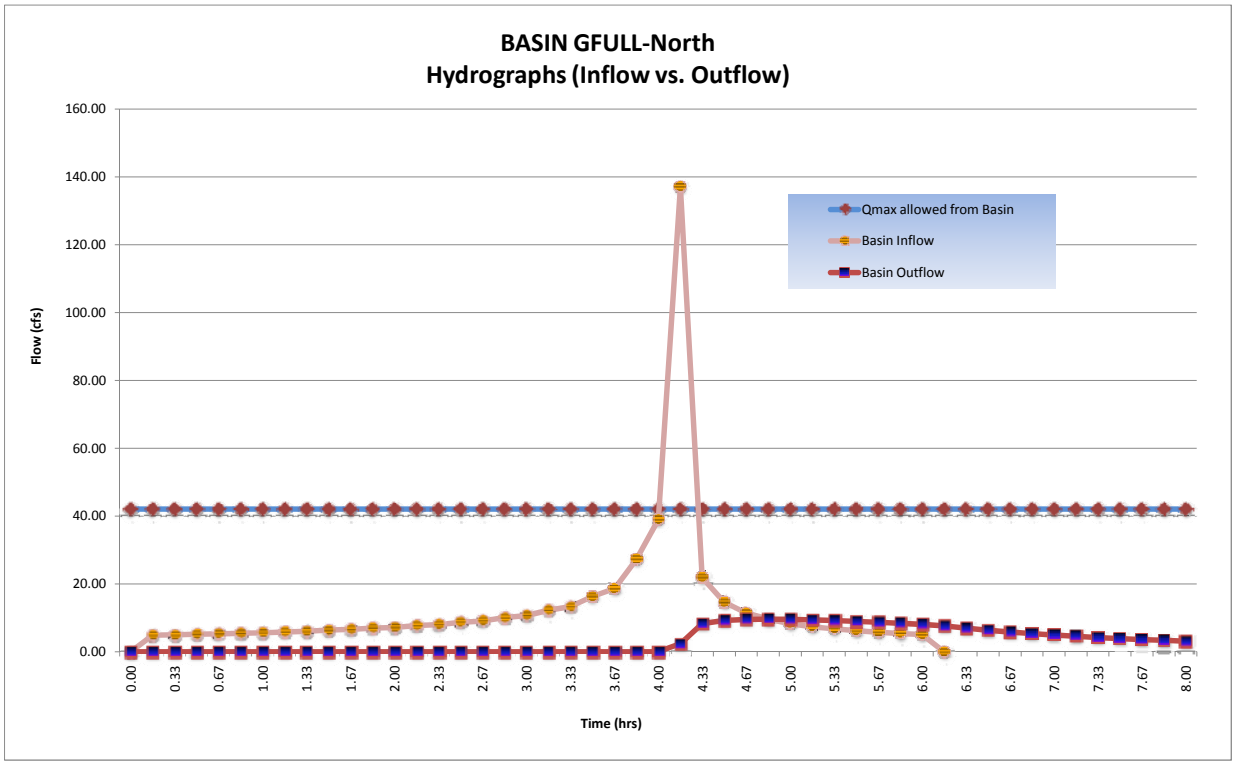
Basin GFULL-North Routing

$$\frac{I_1 + I_2}{2} + \left(\frac{S_1}{\Delta t} + \frac{O_1}{2}\right) - O_1 = \left(\frac{S_2}{\Delta t} + \frac{O_2}{2}\right)$$

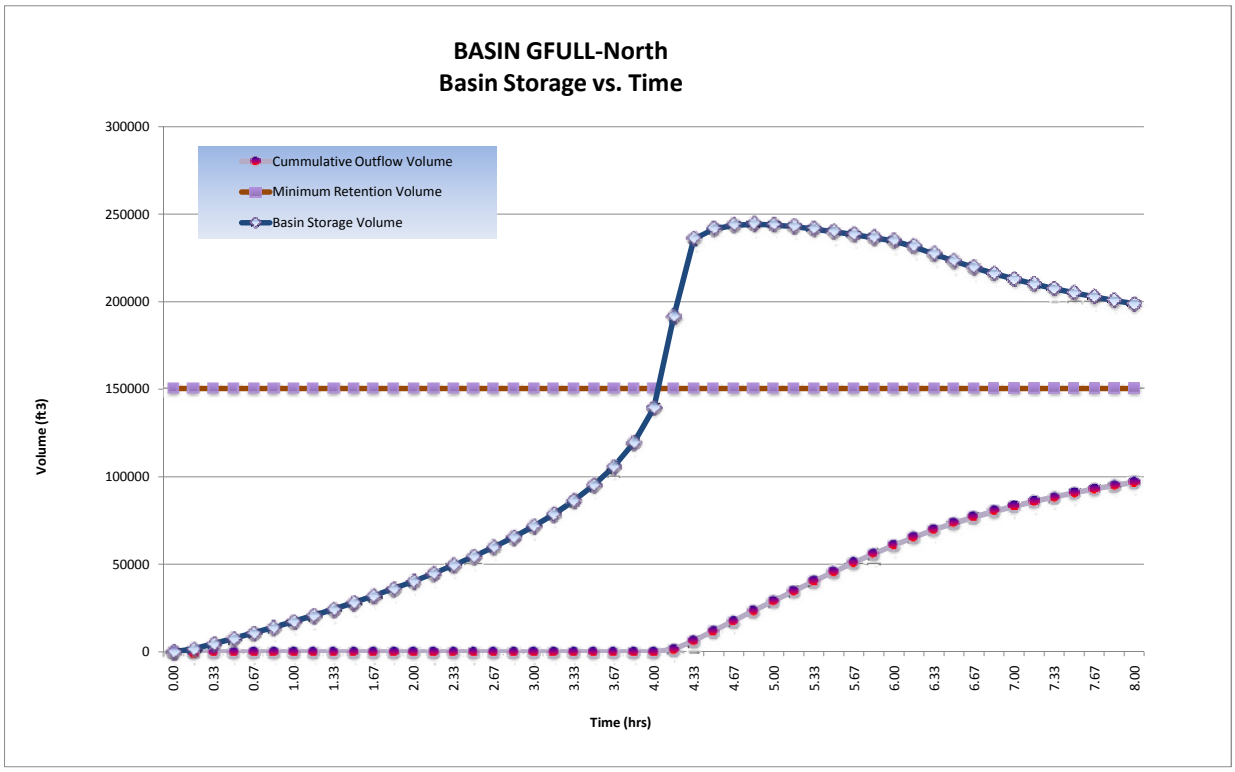
FINAL ROUTING TABLE

(1) Time (hrs)	(2) Inflow (cfs) (Q_{post})	(3) $(I_1+I_2)/2$ (cfs)	(4) (S_1/delta t + O_1/2) (cfs) *col (6) from prev row*	(5) O_1 (cfs) *col (7) from prev row*	*Storage Indicator #* (6) S_2/delta t + O_2/2 (cfs) *col (3)+(4)-(5)*	(7) O_2 (cfs) *(Hard input)*	Volumes (ft3) Basin Storage *Volume*	Incremental Outflow *Volume*	Cummulative Outflow *Volume*
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
0.17	4.90	2.45	0.00	0.00	2.45	0.00	1470	0	0
0.33	5.00	4.95	2.45	0.00	7.40	0.00	4440	0	0
0.50	5.20	5.10	7.40	0.00	12.50	0.00	7500	0	0
0.67	5.30	5.25	12.50	0.00	17.75	0.00	10650	0	0
0.83	5.50	5.40	17.75	0.00	23.15	0.00	13890	0	0
1.00	5.60	5.55	23.15	0.00	28.70	0.00	17220	0	0
1.17	5.90	5.75	28.70	0.00	34.45	0.00	20670	0	0
1.33	6.00	5.95	34.45	0.00	40.40	0.00	24240	0	0
1.50	6.40	6.20	40.40	0.00	46.60	0.00	27960	0	0
1.67	6.60	6.50	46.60	0.00	53.10	0.00	31860	0	0
1.83	7.00	6.80	53.10	0.00	59.90	0.00	35940	0	0
2.00	7.20	7.10	59.90	0.00	67.00	0.00	40200	0	0
2.17	7.70	7.45	67.00	0.00	74.45	0.00	44670	0	0
2.33	8.00	7.85	74.45	0.00	82.30	0.00	49380	0	0
2.50	8.70	8.35	82.30	0.00	90.65	0.00	54390	0	0
2.67	9.10	8.90	90.65	0.00	99.55	0.00	59730	0	0
2.83	10.10	9.60	99.55	0.00	109.15	0.00	65490	0	0
3.00	10.70	10.40	109.15	0.00	119.55	0.00	71730	0	0
3.17	12.30	11.50	119.55	0.00	131.05	0.00	78630	0	0
3.33	13.30	12.80	131.05	0.00	143.85	0.00	86310	0	0
3.50	16.30	14.80	143.85	0.00	158.65	0.00	95190	0	0
3.67	18.60	17.45	158.65	0.00	176.10	0.00	105660	0	0
3.83	27.20	22.90	176.10	0.00	199.00	0.00	119400	0	0
4.00	39.00	33.10	199.00	0.00	232.10	0.00	139260	0	0
4.17	137.00	88.00	232.10	0.00	320.10	2.32	191364	1392	1392
4.33	21.90	79.45	320.10	2.32	397.23	8.30	235848	4980	6372
4.50	14.60	18.25	397.23	8.30	407.18	9.21	241545	5526	11898
4.67	11.40	13.00	407.18	9.21	410.97	9.55	243717	5730	17628
4.83	9.60	10.50	410.97	9.55	411.92	9.64	244260	5784	23412
5.00	8.30	8.95	411.92	9.64	411.23	9.58	243864	5748	29160
5.17	7.40	7.85	411.23	9.58	409.50	9.42	242874	5652	34812
5.33	6.80	7.10	409.50	9.42	407.18	9.21	241545	5526	40338
5.50	6.20	6.50	407.18	9.21	404.47	8.96	239994	5376	45714
5.67	5.80	6.00	404.47	8.96	401.51	8.69	238299	5214	50928
5.83	5.40	5.60	401.51	8.69	398.42	8.41	236529	5046	55974
6.00	5.10	5.25	398.42	8.41	395.26	8.12	234720	4872	60846
6.17	0.00	2.55	395.26	8.12	389.69	7.63	231525	4578	65424
6.33		0.00	389.69	7.63	382.06	6.97	227145	4182	69606
6.50		0.00	382.06	6.97	375.09	6.37	223143	3822	73428
6.67		0.00	375.09	6.37	368.72	5.85	219477	3510	76938
6.83		0.00	368.72	5.85	362.87	5.37	216111	3222	80160
7.00		0.00	362.87	5.37	357.50	4.94	213018	2964	83124
7.17		0.00	357.50	4.94	352.56	4.56	210168	2736	85860
7.33		0.00	352.56	4.56	348.00	4.22	207534	2532	88392
7.50		0.00	348.00	4.22	343.78	3.91	205095	2346	90738
7.67		0.00	343.78	3.91	339.87	3.62	202836	2172	92910
7.83		0.00	339.87	3.62	336.25	3.36	200742	2016	94926
8.00		0.00	336.25	3.36	332.89	3.14	198792	1884	96810

Basin GFULL-North Routing



Basin GFULL-North Routing



Detention/Retention Basin Volume Required:	**244,260**	**ft^3**	
@ Stage:	**537.40**	**ft**	
Freeboard:	**2.6**	**ft**	> 1' Freeboard
Final Total Basin Volume Provided:	**406,916**	**ft^3**	Basin **GFULL-North**
Maximum flow rate released from this basin:	**9.64**	**cfs**	

Basin GFULL-South Inflow TcQ

PROJECT:	SR-11			DESCRIPTION:	SR-11 Basin
JOB #:	11A1190			STATION:	139+00
BY:	M.BRUNING	DATE:	04.13.10	WATERSHED:	GFULL
CHK:	G.DALZIEL	DATE:		SYSTEM:	Basin GFULL-South

BASIN AREA:

A =	706100	ft^2	SOURCE:	MICROSTATION/USGS
	16.21	acres		(SCALE = 1:1)

COEFFICIENT OF RUNOFF:

KEY: USER INPUT

UNDEVELOPED AREA C (FROM HDM FIG. 819.2A)

		NOTES:
RELIEF (.08-.35)	0.00	
INFILTRATION (.04-.16)	0.00	
VEGETATION (.04-.16)	0.00	
STORAGE (.04-.12)	0.00	
TOTAL C =	0.00	

UNDEVELOPED AREA	0%	AT	0.00	0.000
PAVED SURFACE	49%	AT	0.90	0.443
COMMERCIAL AREA	0%	AT	0.85	0.000
CUT SLOPE (2:1 and 4:1)	51%	AT	0.55	0.279
TOTAL	100%			
	(100%)			

$C_{2,10}$ =	0.72
C_{25} =	0.79
C_{50} =	0.87
C_{100} =	0.90

TIME OF CONCENTRATION:

SHEET FLOW: $T_t = \frac{0.42L^{4/5}n^{4/5}}{P_2^{1/2}s^{2/5}}$

NOTES: $P_{2,24}$ (in) = 1.80

HIGH PT ELEVATION	543.0	ft	From median, north of SV Line
LOW POINT ELEVATION	540.0	ft	
ELEVATION DIFF (H)	3.0	ft	
LENGTH (L)	168	ft	
SLOPE (S) = (H/L)	1.8%		
MANNING'S n	0.016		< = FROM TABLE 816.6A Asphalt Paving
T_t (SFF)=	3.45	minutes	

SHALLOW CONCENTRATED FLOW: $T_t = \frac{L}{60\,V}$

NOTES:

HIGH PT ELEVATION	540.0	ft	assumed SCF and not channelized or flowing full yet
LOW POINT ELEVATION	539.0	ft	
ELEVATION DIFF (H)	1.0	ft	
LENGTH (L)	266	ft	
SLOPE (S) = (H/L)	0.4%		
VELOCITY (SCF)	1.3	fps	<=V FROM FIG 816.5 nearly bare ground
T_c (SH)=	3.41	minutes	

STORMDRAIN FLOW: $T_t = \frac{L}{60\,V}$

NOTES:

HIGH PT ELEVATION	534.0	ft	Proposed storm to basin
LOW POINT ELEVATION	512.0	ft	
ELEVATION DIFF (H)	22.0	ft	
LENGTH (L)	1262	ft	
SLOPE (S) = (H/L)	1.7%		
MANNING'S n	0.013		RCP
PIPE DIAMETER d	3.0	ft	
HYDRAULIC RADIUS R	0.8	ft	R=D/4, Assume: flowing full
VELOCITY (STORMDRAIN)	12.5	fps	$V = \frac{K_u}{n} R^{2/3} S^{1/2}$
T_c (SD)=	1.68	minutes	

Basin GFULL-South Inflow TcQ

Tc (TOTAL) =	8.55	minutes
Minimum Tc =	10	minutes
USE Tc =	**10.00**	minutes

INTENSITY CHART:

$$I = 7.44\ P_6\ D^{-0.645}$$

i_2 =	1.9	in/hr	X CA =
i_{10} =	2.7	in/hr	X CA =
i_{25} =	3.4	in/hr	X CA =
i_{50} =	4.0	in/hr	X CA =
i_{100} =	4.2	in/hr	X CA =

FLOW RESULTS:

	cfs
Q_2 =	21.7
Q_{10} =	31.6
Q_{25} =	43.4
Q_{50} =	56.8
Q_{100} =	**61.6**

COUNTY P_6

	inches
2-year:	1.1
10-year:	1.6
25-year:	2.0
50-year:	2.4
100-year:	2.5

Basin GFULL-South Inflow Hydrog

PROJECT:	**SR-11**			**DESCRIPTION:**	**SR-11 Basin**
JOB #:	**11A1190**			**STATION:**	**139+00**
BY:	**M.BRUNING**	**DATE:**	**04.13.10**	**WATERSHED:**	**GFULL**
CHK:	**G.DALZIEL**	**DATE:**		**SYSTEM:**	**Basin GFULL-South**

Notes:

* This is the actual flow entering the detention basin.

ONSITE RUNOFF VOLUME

100-year, 6 hour duration storm event, use the Rational Method Hydrograph Procedure (SDCHM 6-1) ~ RatHydro

Basin Inflow Hydrograph

Basin Inflow Q

Q_{100}=	61.6	cfs			
Tc=	10.0	min	C_{100}=	0.90	
$P_{100,6}$=	2.5	in	A=	16.21	acres

$T_{T(N)}$ (MIN)	VOL (CF)	ORDINATE (CFS)
0	0	0
10	1320	2.2
20	1320	2.2
30	1380	2.3
40	1440	2.4
50	1500	2.5
60	1500	2.5
70	1560	2.6
80	1620	2.7
90	1680	2.8
100	1740	2.9
110	1860	3.1
120	1920	3.2
130	2040	3.4
140	2160	3.6
150	2340	3.9
160	2460	4.1
170	2700	4.5
180	2880	4.8
190	3300	5.5
200	3600	6
210	4380	7.3
220	4980	8.3
230	7320	12.2
240	10200	17
250	36960	61.6
260	5880	9.8
270	3900	6.5
280	3060	5.1
290	2580	4.3
300	2220	3.7
310	1980	3.3
320	1800	3
330	1680	2.8
340	1560	2.6
350	1440	2.4
360	1380	2.3
370	0	0

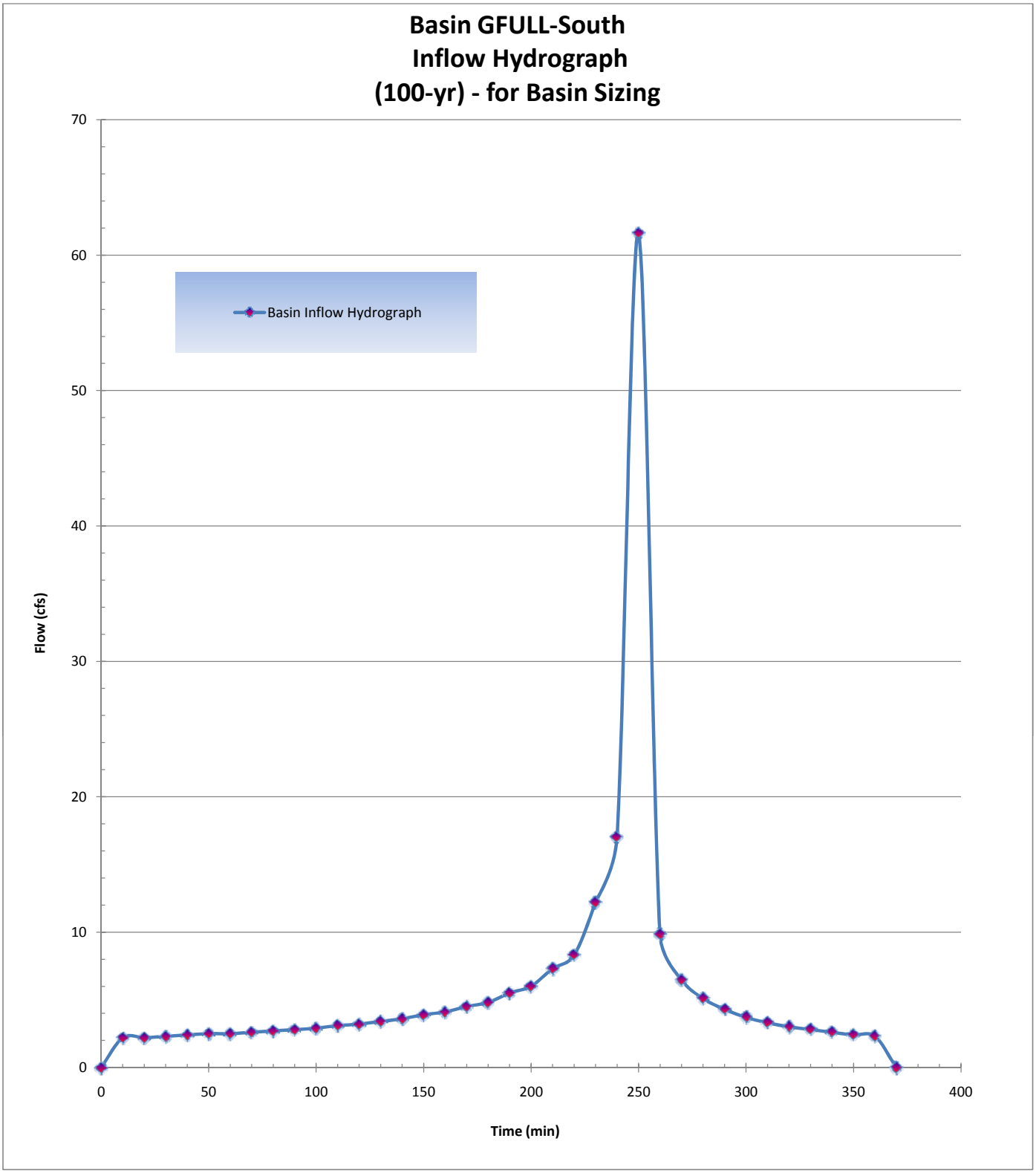
Example of Steps:

$T_{T(N)}$ (MIN)	VOL (CF)	ORDINATE (CFS)
0	0	0
14	1260	1.5
28	1344	1.6
42	1344	1.6
56	1428	1.7
70	1512	1.8
84	1596	1.9

SUM= 131640 ft^3
3.02 acre-feet

Onsite Runoff Volume

Check: V = C*A*P_6
V= 3.05 acre-feet
OK


Basin GFULL-South
Inflow Hydrograph
(100-yr) - for Basin Sizing
Basin Inflow Hydrograph
Flow (cfs)
Time (min)
0
10
20
30
40
50
60
70
0
50
100
150
200
250
300
350
400

Basin GFULL-South Outlet

PROJECT:	**SR-11**			**DESCRIPTION:**	**SR-11 Basin**
JOB #:	**11A1190**			**STATION:**	**139+00**
BY:	**M.BRUNING**	**DATE:**	**04.21.10**	**WATERSHED:**	**GFULL**
CHK:	**G.DALZIEL**	**DATE:**		**SYSTEM:**	**Basin GFULL-South**

Notes:

Volumes:

Required Retention Basin Volume =	245200	ft^3	from GFULL-ALL
Retention volume from GFULL-North Basin =	150381	ft^4	
Minimum Retention volume from this basin =	94820		balance of required retention for GFULL-ALL
Actual Basin Inflow =	131640	ft^4	*OK*

Flow Balance - determine maximum flow from basin

Predeveloped Peak 100-year Flow:	80.8	cfs	from GFULL-ALL
Post-Developed Peak Flow through Cross Culvert:	0.0	cfs	Independent of Culvert GFULL
Flow that does not reach detention basin (bypass per DA table):	12.2	cfs	Q_{100} from: GFULL.21.PVGFULL.21.SLGFULL.35.SL
Maximum flow to be released by GFULL-North basin:	9.6	cfs	
Maximum flow allowed to be released by this detention basin:	58.9	cfs	

Outlet Pipe

Assume: trapezoid basin/flat bottom, one outlet pipe set above basin invert

Basin - Top of basin berm elevation =	517.00	ft
Basin flowline elevation =	512.00	ft
Maximum Basin Depth =	5.00	ft

Assume Culvert Design: free outfall, square-edge w/headwall

Outlet pipe invert from basin floor =	2.80	ft	514.80	ft
Outlet pipe diameter =	2	ft		

Basin Characteristics

Base Length (L)	180	ft
Base Width (W)	180	ft
W/L Ratio ®	1.00	
Side Slopes (Z)	1: 4	
Total Volume (V):	200532	ft^2

Infiltration Rate: Rate (min/inch): 71.1 Location: PT-C2 ~ *assume no infiltration*

Detention Basin Data						Outlet Pipe		Infiltration	Total
Stage	Water Surface Elevation (ft)	Depth	V_{avg} staged (ft3)	V_{avg} cumm. (ft3)		HW Elev. (ft)	Discharge Q_{out} (cfs)	Q_{inf} (cfs)	Q_{total} (cfs)
0	512.00	0.00	0	0		512.00	0.00	0.00	0.00
1	512.20	0.20	6539	6539		512.20	0.00		0.00
2	512.40	0.40	6656	13195		512.40	0.00		0.00
3	512.60	0.60	6775	19970		512.60	0.00		0.00
4	512.80	0.80	6894	26863		512.80	0.00		0.00
5	513.00	1.00	7014	33877		513.00	0.00		0.00
6	513.20	1.20	7135	41012		513.20	0.00		0.00
7	513.40	1.40	7256	48268		513.40	0.00		0.00
8	513.60	1.60	7378	55646		513.60	0.00		0.00
9	513.80	1.80	7501	63148		513.80	0.00		0.00
10	514.00	2.00	7625	70773		514.00	0.00		0.00
11	514.20	2.20	7750	78523		514.20	0.00		0.00
12	514.40	2.40	7875	86398		514.40	0.00		0.00
13	514.60	2.60	8001	94399		514.60	0.00	0.00	0.00
14	514.80	2.80	8128	102528	*	514.80	0.00		0.00
15	515.00	3.00	8256	110784		515.00	0.15		0.15
16	515.20	3.20	8384	119168		515.20	0.59		0.59
17	515.40	3.40	8513	127681		515.40	1.30		1.30
18	515.60	3.60	8643	136325		515.60	2.25		2.25
19	515.80	3.80	8774	145099		515.80	3.42		3.42
20	516.00	4.00	8906	154004		516.00	4.79		4.79
21	516.20	4.20	9038	163042		516.20	6.32		6.32
22	516.40	4.40	9171	172213		516.40	7.99		7.99
23	516.60	4.60	9305	181518		516.60	9.77		9.77
24	516.80	4.80	9439	190957		516.80	11.63		11.63
25	517.00	5.00	9575	200532		517.00	13.53		13.53

Basin GFULL-South Routing

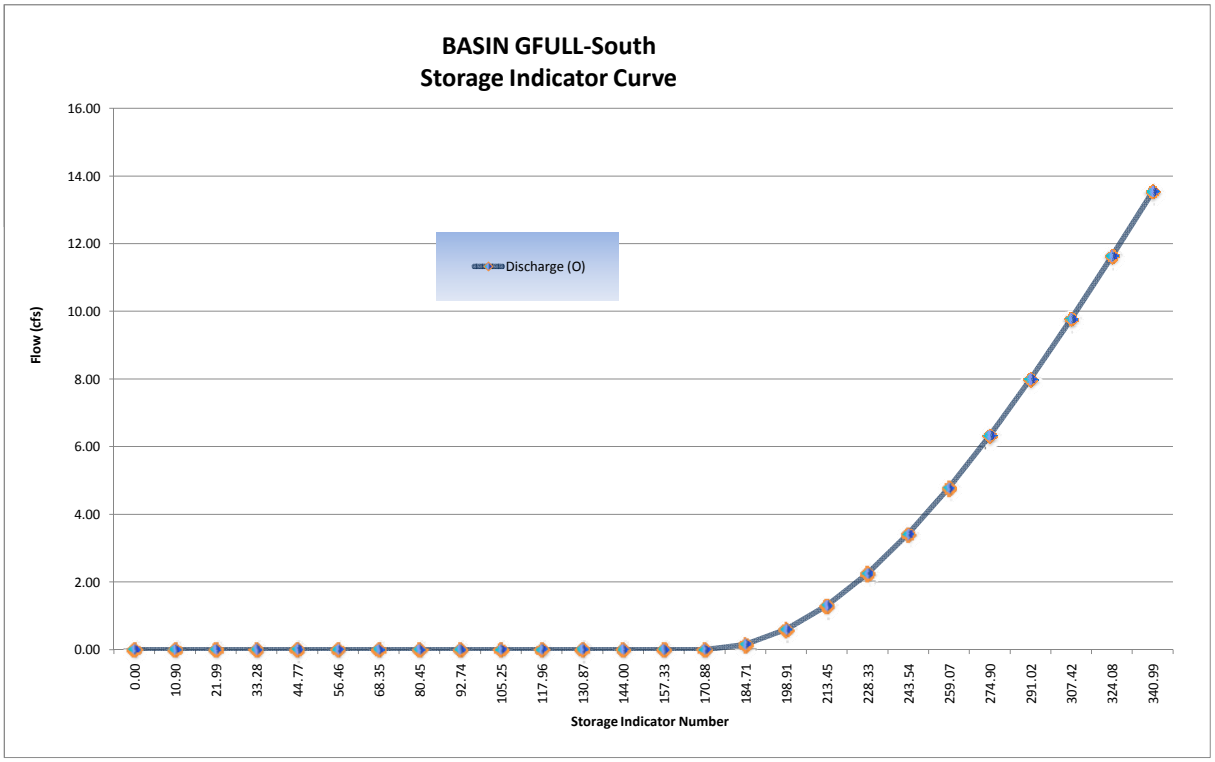
PROJECT:	SR-11			DESCRIPTION:	SR-11 Basin
JOB #:	11A1190			STATION:	139+00
BY:	M.BRUNING	DATE:	04.21.10	WATERSHED:	GFULL
CHK:	G.DALZIEL	DATE:		SYSTEM:	Basin GFULL-South

user input
linked input

STORAGE INDICATOR NUMBERS TABLE

(1) Stage (ft)	(2) Discharge (O) (cfs)	(3) Storage (S) (ft^3)	(4) $O_2/2$ (cfs)	(5) S_2/delta t (cfs)	(6) S_2/delta t + $O_2/2$ (cfs)
					Storage Indicator #
512.00	0.00	0	0.00	0.00	0.00
512.20	0.00	6539	0.00	10.90	10.90
512.40	0.00	13195	0.00	21.99	21.99
512.60	0.00	19970	0.00	33.28	33.28
512.80	0.00	26863	0.00	44.77	44.77
513.00	0.00	33877	0.00	56.46	56.46
513.20	0.00	41012	0.00	68.35	68.35
513.40	0.00	48268	0.00	80.45	80.45
513.60	0.00	55646	0.00	92.74	92.74
513.80	0.00	63148	0.00	105.25	105.25
514.00	0.00	70773	0.00	117.96	117.96
514.20	0.00	78523	0.00	130.87	130.87
514.40	0.00	86398	0.00	144.00	144.00
514.60	0.00	94399	0.00	157.33	157.33
514.80	0.00	102528	0.00	170.88	170.88
515.00	0.15	110784	0.08	184.64	184.71
515.20	0.59	119168	0.30	198.61	198.91
515.40	1.30	127681	0.65	212.80	213.45
515.60	2.25	136325	1.13	227.21	228.33
515.80	3.42	145099	1.71	241.83	243.54
516.00	4.79	154004	2.40	256.67	259.07
516.20	6.32	163042	3.16	271.74	274.90
516.40	7.99	172213	4.00	287.02	291.02
516.60	9.77	181518	4.89	302.53	307.42
516.80	11.63	190957	5.82	318.26	324.08
517.00	13.53	200532	6.77	334.22	340.99

delta t =	0.17	hrs
delta t =	10	min
delta t =	600	sec



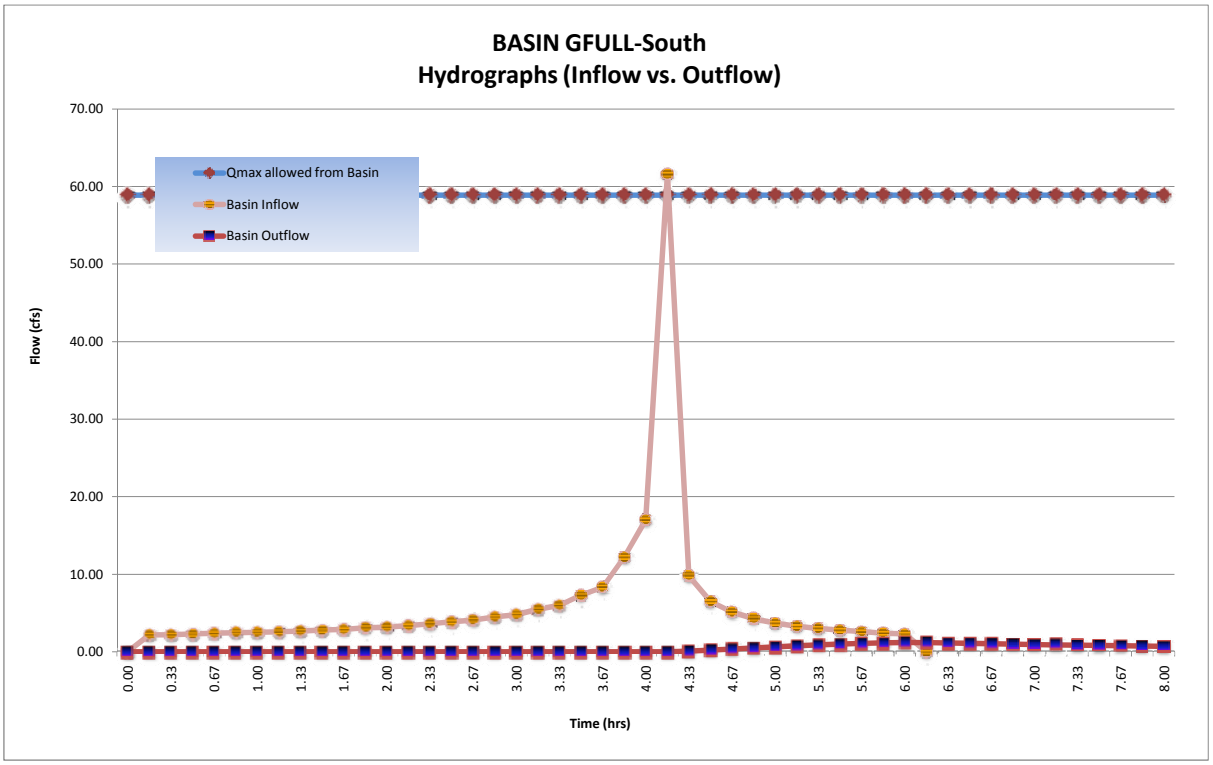
Basin GFULL-South Routing

$$\frac{I_1 + I_2}{2} - \left(\frac{S_1}{\Delta t} + \frac{O_1}{2}\right) = O_1 = \left(\frac{S_2}{\Delta t} + \frac{O_2}{2}\right)$$

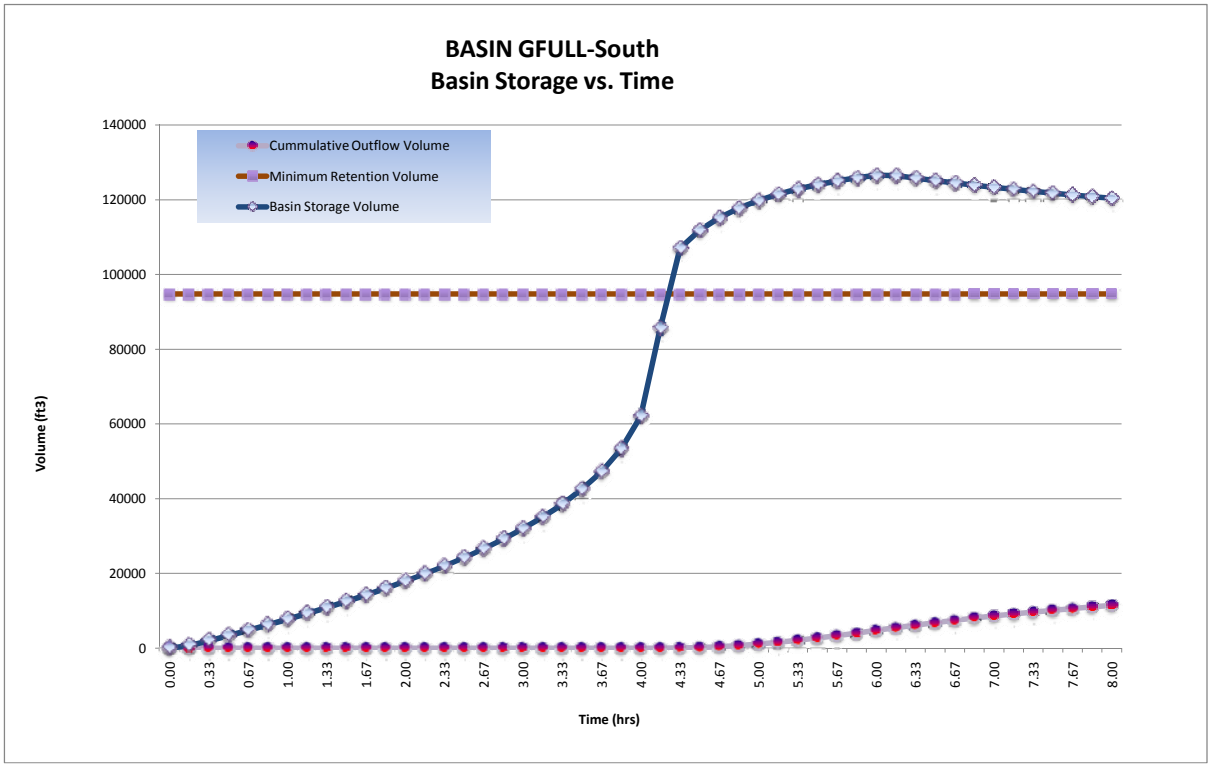
FINAL ROUTING TABLE

(1) Time (hrs)	(2) Inflow (cfs) (Q_{post})	(3) $(I_1+I_2)/2$ (cfs)	(4) (S_1/delta t + O_1/2) (cfs) *col (6) from prev row*	(5) O_1 (cfs) *col (7) from prev row*	*Storage Indicator #* (6) S_2/delta t + O_2/2 (cfs) *col (3)+(4)-(5)*	(7) O_2 (cfs) *(Hard input)*	Volumes (ft3) Basin Storage *Volume*	Incremental Outflow *Volume*	Cummulative Outflow *Volume*
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
0.17	2.20	1.10	0.00	0.00	1.10	0.00	660	0	0
0.33	2.20	2.20	1.10	0.00	3.30	0.00	1980	0	0
0.50	2.30	2.25	3.30	0.00	5.55	0.00	3330	0	0
0.67	2.40	2.35	5.55	0.00	7.90	0.00	4740	0	0
0.83	2.50	2.45	7.90	0.00	10.35	0.00	6210	0	0
1.00	2.50	2.50	10.35	0.00	12.85	0.00	7710	0	0
1.17	2.60	2.55	12.85	0.00	15.40	0.00	9240	0	0
1.33	2.70	2.65	15.40	0.00	18.05	0.00	10830	0	0
1.50	2.80	2.75	18.05	0.00	20.80	0.00	12480	0	0
1.67	2.90	2.85	20.80	0.00	23.65	0.00	14190	0	0
1.83	3.10	3.00	23.65	0.00	26.65	0.00	15990	0	0
2.00	3.20	3.15	26.65	0.00	29.80	0.00	17880	0	0
2.17	3.40	3.30	29.80	0.00	33.10	0.00	19860	0	0
2.33	3.60	3.50	33.10	0.00	36.60	0.00	21960	0	0
2.50	3.90	3.75	36.60	0.00	40.35	0.00	24210	0	0
2.67	4.10	4.00	40.35	0.00	44.35	0.00	26610	0	0
2.83	4.50	4.30	44.35	0.00	48.65	0.00	29190	0	0
3.00	4.80	4.65	48.65	0.00	53.30	0.00	31980	0	0
3.17	5.50	5.15	53.30	0.00	58.45	0.00	35070	0	0
3.33	6.00	5.75	58.45	0.00	64.20	0.00	38520	0	0
3.50	7.30	6.65	64.20	0.00	70.85	0.00	42510	0	0
3.67	8.30	7.80	70.85	0.00	78.65	0.00	47190	0	0
3.83	12.20	10.25	78.65	0.00	88.90	0.00	53340	0	0
4.00	17.00	14.60	88.90	0.00	103.50	0.00	62100	0	0
4.17	61.60	39.30	103.50	0.00	142.80	0.00	85680	0	0
4.33	9.80	35.70	142.80	0.00	178.50	0.08	107076	48	48
4.50	6.50	8.15	178.50	0.08	186.57	0.21	111879	126	174
4.67	5.10	5.80	186.57	0.21	192.16	0.38	115182	228	402
4.83	4.30	4.70	192.16	0.38	196.48	0.51	117735	306	708
5.00	3.70	4.00	196.48	0.51	199.97	0.64	119790	384	1092
5.17	3.30	3.50	199.97	0.64	202.83	0.78	121464	468	1560
5.33	3.00	3.15	202.83	0.78	205.20	0.90	122850	540	2100
5.50	2.80	2.90	205.20	0.90	207.20	0.99	124023	594	2694
5.67	2.60	2.70	207.20	0.99	208.91	1.08	125022	648	3342
5.83	2.40	2.50	208.91	1.08	210.33	1.15	125853	690	4032
6.00	2.30	2.35	210.33	1.15	211.53	1.21	126555	726	4758
6.17	0.00	1.15	211.53	1.21	211.47	1.20	126522	720	5478
6.33		0.00	211.47	1.20	210.27	1.14	125820	684	6162
6.50		0.00	210.27	1.14	209.13	1.09	125151	654	6816
6.67		0.00	209.13	1.09	208.04	1.04	124512	624	7440
6.83		0.00	208.04	1.04	207.00	0.99	123903	594	8034
7.00		0.00	207.00	0.99	206.01	0.94	123324	564	8598
7.17		0.00	206.01	0.94	205.07	0.89	122775	534	9132
7.33		0.00	205.07	0.89	204.18	0.85	122253	510	9642
7.50		0.00	204.18	0.85	203.33	0.81	121755	486	10128
7.67		0.00	203.33	0.81	202.52	0.77	121281	462	10590
7.83		0.00	202.52	0.77	201.75	0.73	120831	438	11028
8.00		0.00	201.75	0.73	201.02	0.69	120405	414	11442

Basin GFULL-South Routing



Basin GFULL-South Routing



Detention / Retention Basin Volume Required:	**126,555**	**ft^3**	
@ Stage:	**515.40**	**ft**	
Freeboard:	**1.6**	**ft**	> 1' Freeboard
Final Total Basin Volume Provided:	**200,532**	**ft^3**	Basin **GFULL-South**
Maximum flow rate released from this basin:	**1.21**	**cfs**	

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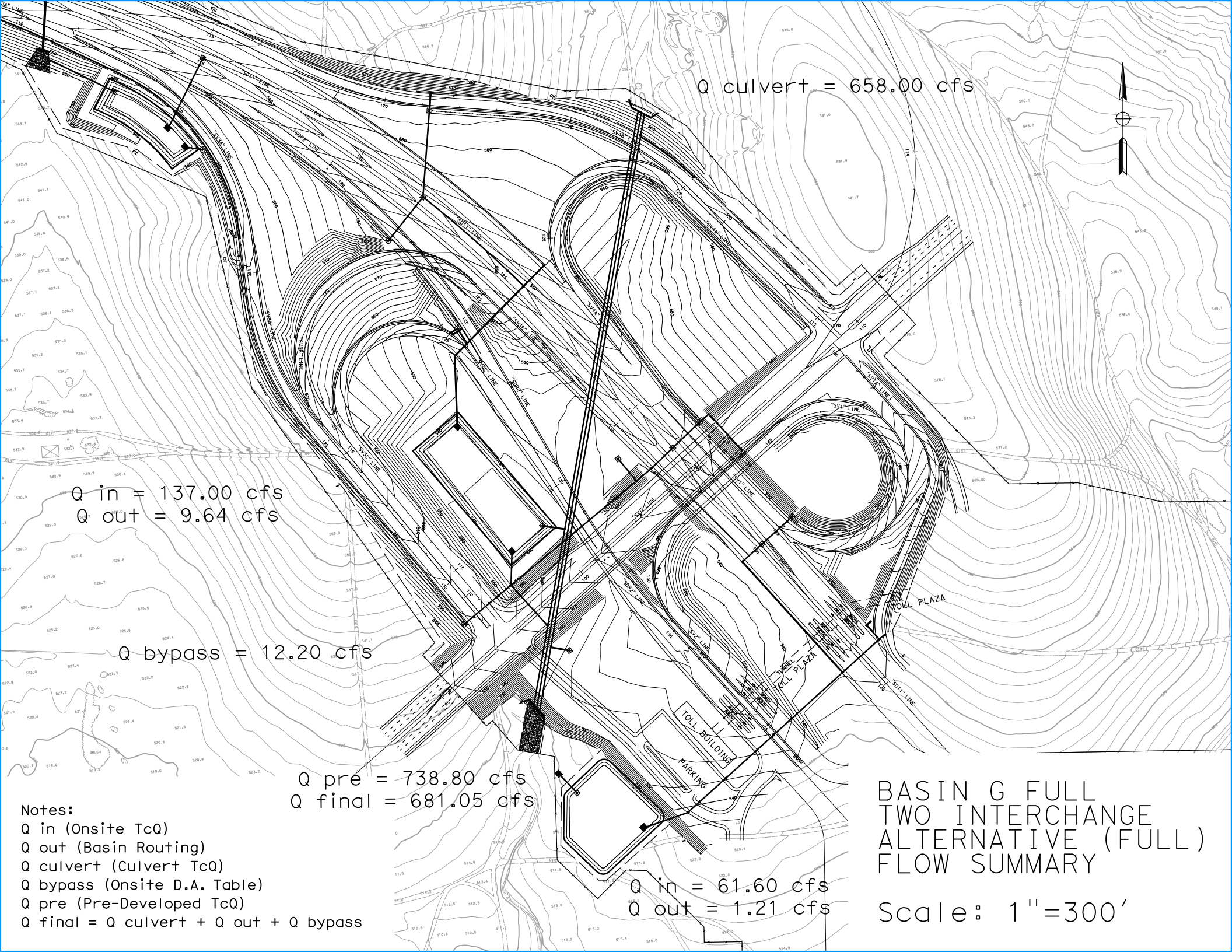

Notes:
Q in (Onsite TcQ)
Q out (Basin Routing)
Q culvert (Culvert TcQ)
Q bypass (Onsite D.A. Table)
Q pre (Pre-Developed TcQ)
Q final = Q culvert + Q out + Q bypass

BASIN G FULL TWO INTERCHANGE ALTERNATIVE (FULL) FLOW SUMMARY

Scale: 1"=300'

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Detention/Retention Basin Flows and Sizes – Two Interchange Alternative (FULL)

Watershed	Location	Flow			Runoff Volume			Basin Volume - Breakdown			Basin Data					
		Pre-Developed	Post-Developed	Increase	Pre-Developed	Post-Developed	Increase	Retention Provided	Detention	1' Freeboard (minimum)	Final Volume	Length	Width	Depth	Free-board	Name
Name	(Sta)	(cfs)	(cfs)	(cfs)	(ft^3)	(ft^3)	(ft^3)	(ft^3)	(ft^3)	(ft^3)	(ft^3)	(ft)	(ft)	(ft)	(ft)	
G	127+00	80.80	175.86	95.06	243,576	478,260	234,684	150,381	93,879	162,656	406,916	350	100	8.0	2.6	GFULL-North
	139+00							102,528	24,027	73,977	200,532	180	180	5.0	1.6	GFULL-South

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