HYDROLOGY AND HYDRAULICS REPORT: STATE ROUTE 11

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

DEPARTMENT OF TRANSPORTATION
UNITED STATES OF AMERICA

Caltrans

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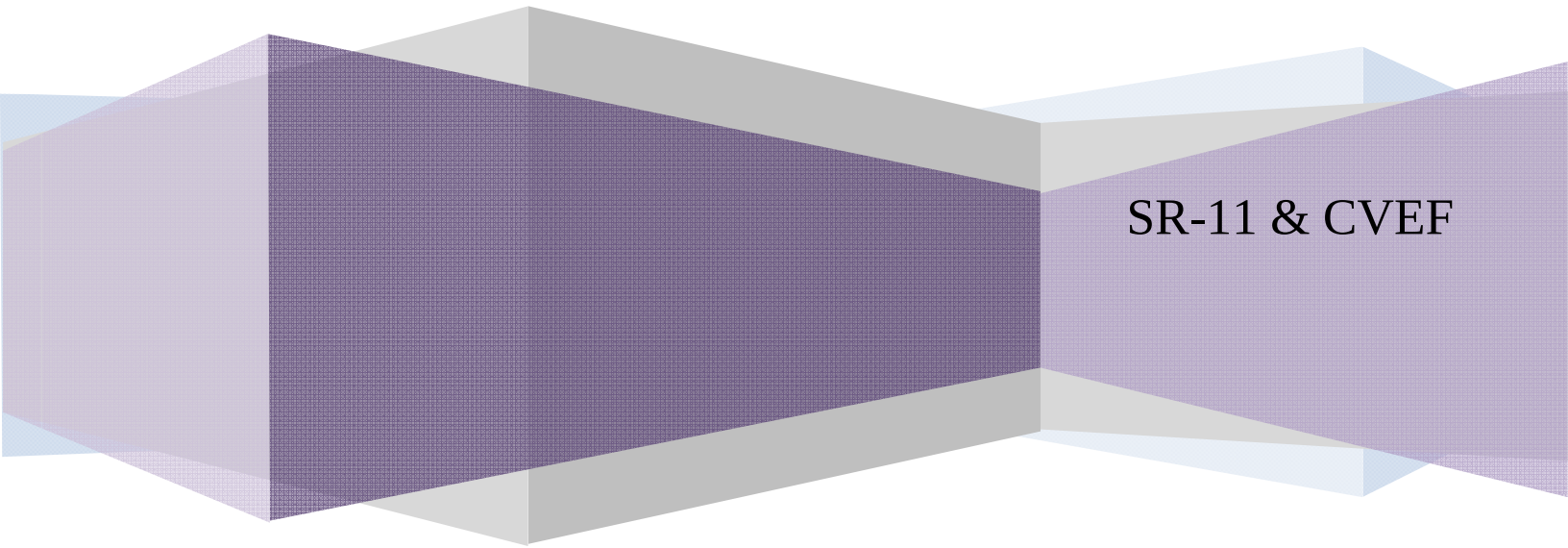
Prepared by:
AECOM

Hydrology & Hydraulics Report

State Route 11 Corridor & Commercial Vehicle Enforcement Facility

Caltrans District 11 Hydraulics Department



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April 14, 2010

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Project Information

Informative Abstract

This report was prepared to analyze the hydrology and hydraulics of the proposed State Route 11 Corridor, (SR-11) and the proposed Commercial Vehicle Enforcement Facility (CVEF) for the purpose of determining any additional environmental footprint requirements and environmental impacts due to drainage infrastructure needs.

The proposed International Port of Entry (POE) is analyzed under a separate report by AECOM, entitled Hydrology & Hydraulics Report – State Route 11 - Port of Entry (POE).

Due to the preliminary nature of this design, the ultimate design may be different. The drainage infrastructure, (inlet, pipes, basins, outlets, etc) shown herein are preliminary. A section within this report titled, "Features Requiring Additional Discussion" covers the main assumptions and unique considerations taken within this design.

This report will analyze the existing offsite flows for the purpose of sizing and placing of cross culverts. Pre-developed and post-developed peak flows and runoff volumes will be analyzed for the purpose of sizing and placing detention/retention basins.

This report will also analyze the onsite flows generated by the proposed roadway surface and adjacent cut and fill slopes for approximate placement of grated inlets in consideration of spreadwidth and conveyance requirements; and the preliminary design of biofiltration swales.

This design will provide placement location of these inlets and biofiltration swales, along with energy dissipation devices, junction structures, concrete slope ditches, high-sided super elevation ditches (HSSD) and the onsite pipe network but will not specifically size and/or analyze these elements.

The SR-11 and CVEF design must comply with Caltrans criteria as well as several jurisdictional entity criteria. The basin design designs provided in this report allow for the assumption that all the criteria could be met. The final basins design will be based on the feasibility and the reasonability of meeting all the differing criteria. The various criteria are as follows:

1. From the International Border (the Border), extending 60-feet north of the Border, the design must comply with The International Boundary Water Commission, United States and Mexico, United States Section (IBWC) standards and requirements. This agency's *mission is to provide binational solutions to issues that arise during the application of United States - Mexico treaties regarding boundary demarcation, national ownership of waters, sanitation, water quality, and flood control in the border region.*[1] IBWC correspondence specific to this project is located in Appendix G. Note; no portion of the proposed SR-11 drainage infrastructure falls within this 60-foot zone, but treated and detained runoff from the proposed SR-11 facilities will be discharged into watersheds that eventually cross into this zone.
2. From 60-feet north of the Border to the County of San Diego (County) limits, the design must comply with the County standards and requirements to the extent feasible.
3. The City of San Diego references the County of San Diego Hydrology Manual.
4. With respect to Flood Management in East Otay Mesa, all developments are subject to guidelines of the East Otay Mesa Specific Plan Comprehensive Flood Control Master Plan 1994. Essentially, developments within East Otay Mesa are required to provide local or regional detention basins. Correspondence specific to this project is located in Appendix G.

[1] http://www.ibwc.state.gov/home.html

Project Location

The project site is located within the jurisdictions of the Caltrans right-of-way in the City of San Diego, and San Diego County. The project site covered in this report consists of the following areas: The northbound, southbound lanes of SR-11 from the SR-125/SR-905 Interchange, west of Sanyo Avenue to the proposed alignment of Sempra Viva Road near the International Border with Mexico, within the Caltrans right-of-way.

Also included are improvements to SR-905 west of the SR-125/SR-905 Interchange to Britannia Boulevard.

The proposed CVEF is at the southern end of the SR-11 and along the northern end of the proposed POE. The POE will be studied within a separate report.

The approximate center location of the project is at:

Latitude:	32°33'48.00"N	Longitude:	116°55'9.00"W

This location is near the SR-11 control line and the proposed Alta Road Alignment.

The project has defined the following alignments:

- "SD11 Line", SR-11 main lanes
- "ALTA Line", Alta Road
- "ENF Line", Enrico Fermi Road
- "SVI1 Line", Siempre Viva Road
- "WN Line", West to north connector to SR-125
- "WS Line", Westbound connector to SR-905
- "WB Line", Eastbound connector from SR-905
- "NEDC7" Line, North to East connect from SR-905
- "SE Line", South to east flyover, connector from SR-125
- "E4 Line", SR-905 Line to Britannia Boulevard

and associated ramp lines.

Project Location Map

Figure 1

Project Description

The SR-11 corridor is a 2.1-mile long segment of new four (4) lane freeway, with a 42' wide unpaved median. SR-11 begins at the west with the connector ramps to the SR-905 and SR-125 interchange, and terminates at the CVEF facility (included in this study). The 4-lane freeway is analyzed with three alternative layouts as defined in Table 1:

Table 1 - Roadway Design Alternatives:

Roadway Alternative	Designation	Description
No Interchange	"0"	No interchanges within entire SR-11 corridor
One Interchange	"1"	One interchange at Alta Road
Two interchange	"2"	Interchanges at Enrico Fermi Dr. and Siempra Viva Rd.

Refer to Figures 2, 3 & 4 for a graphical overview of the three interchange options.

With implementation of SR-11, certain modifications to the approved SR-905 design would be required, and are included as part of the proposed project. Refer to Figure 5.

These include SR-11/SR-905 connector ramps (shown in red) and SR-905 outside shoulder (sliver) and inside median widening (shown in green).

The outside shoulder (sliver) widening impact is addressed in Appendix F.

The inside median widening impact, from a hydrology standpoint was previously addressed within the approved Hydrology & Hydraulics Report for SR-905. This analysis assumed for design purposes that the SR-905 was paved to the centerline. No further analysis of this segment will be performed within this report.

Report Organization

All pre-developed hydrology and hydraulics analysis are in Appendix A.

Each of the three roadway alternative designs will have a separate post-developed hydrology and hydraulics analysis within this report:

- The No-Interchange alternative design is in Appendix B
- The One-Interchange alternative design is in Appendix C
- The Two-Interchange alternative design is in Appendix D

Each of the special design facilities will have a separate post-developed hydrology and hydraulics analysis within this report:

- The CVEF design is in Appendix E
- The SR-11/SR-125/SR-905 Interchange design is in Appendix F

Figure 2 - No Interchange Alternative

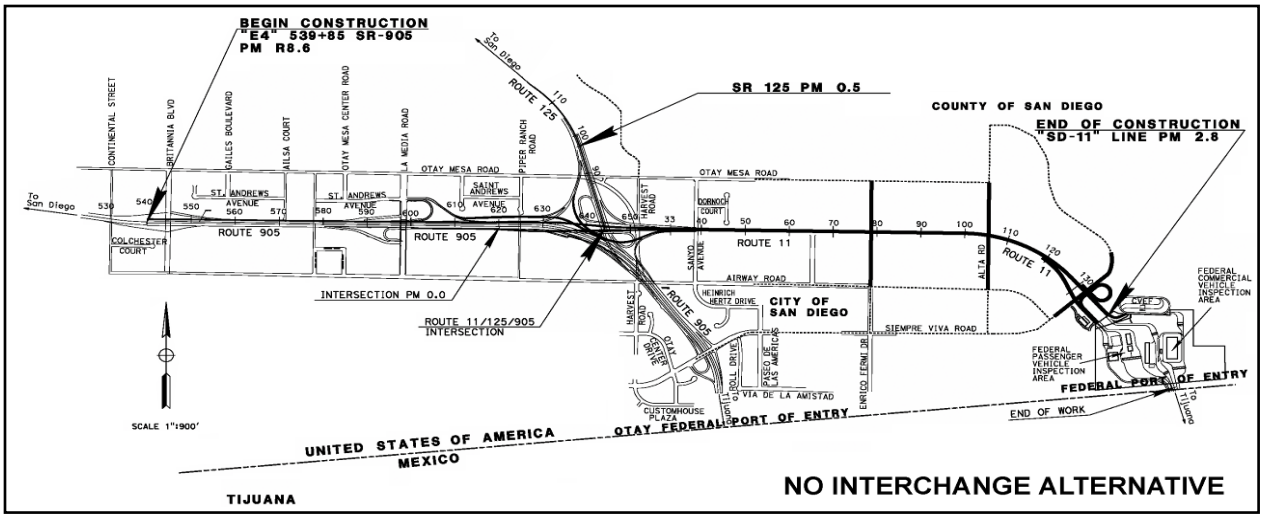


Figure 3 - One Interchange Alternative

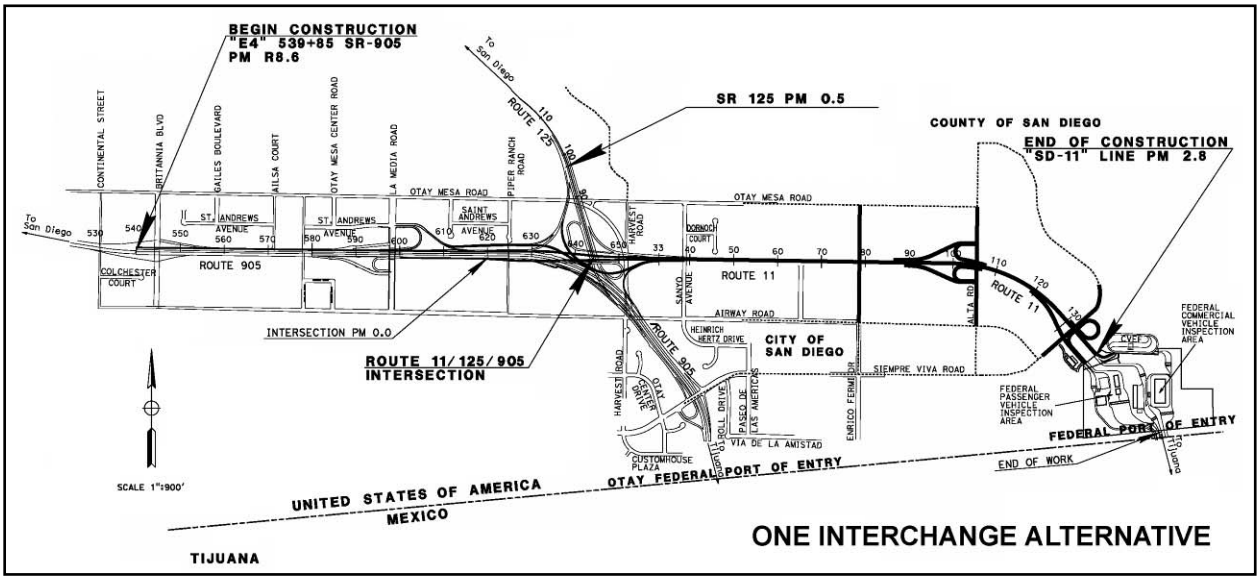


Figure 4 - Two Interchange Alternative

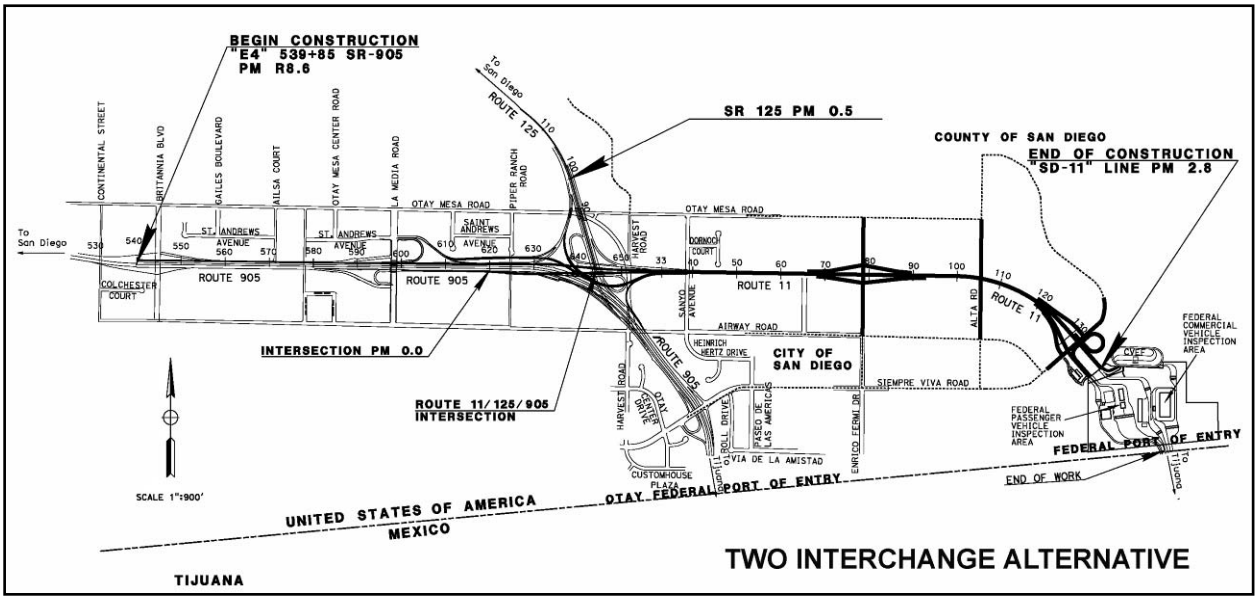
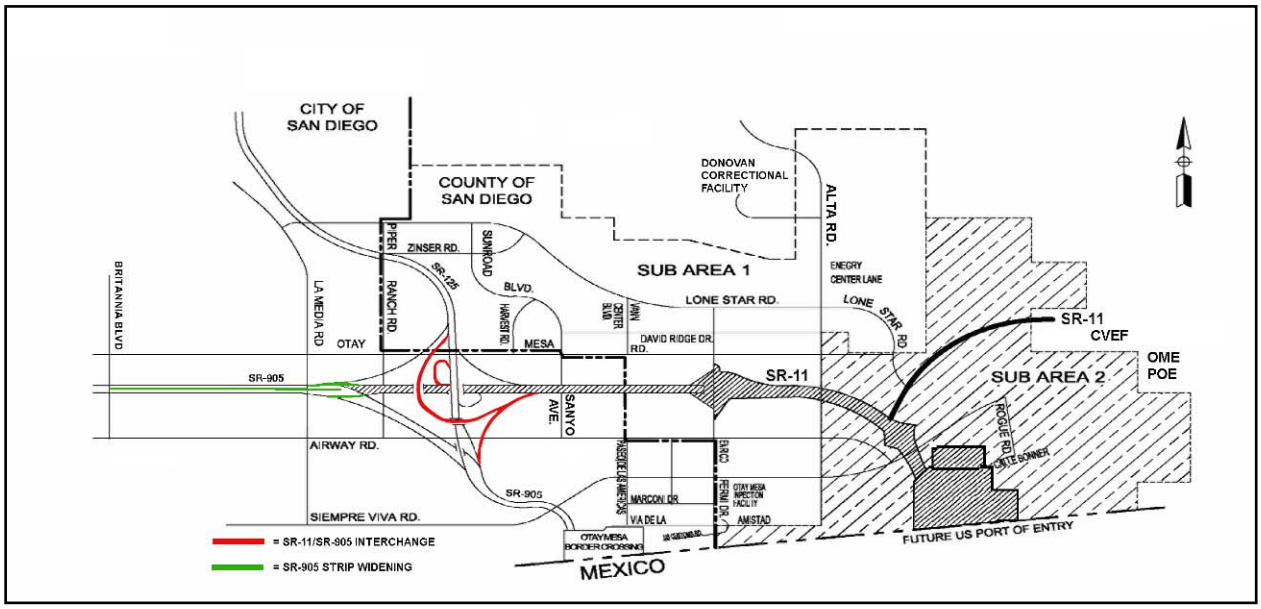


Figure 5 - SR-905 (from Britannia Boulevard to the SR-11/SR-905 Connectors)



Hydrologic Setting

Surrounding topography and soil conditions are described in a separate report entitled, Hydrogeologic Site Assessment (HSA) Report. This HSA report identifies the type of soil and the infiltration rates at the various basin locations. Topographical mapping generated from SANGIS (5' contour intervals) were utilized to define the large offsite watersheds. Where coverage was available, the use of two-foot topography contours further defined watersheds. Field investigations were conducted to further confirm the extent of each of these watersheds.

San Diego has on average 146 sunny days and 117 partly cloudy days a year. The average annual precipitation is less than 12 inches, resulting in a borderline arid climate. Rainfall is strongly concentrated in the cooler half of the year, particularly the months December through March, although precipitation is lower than any other part of the U.S. west coast. The summer months are virtually rainless. Rainfall is highly variable from year to year and from month to month, and San Diego is subject to both droughts and floods. Thunderstorms and hurricanes are very rare.[2]

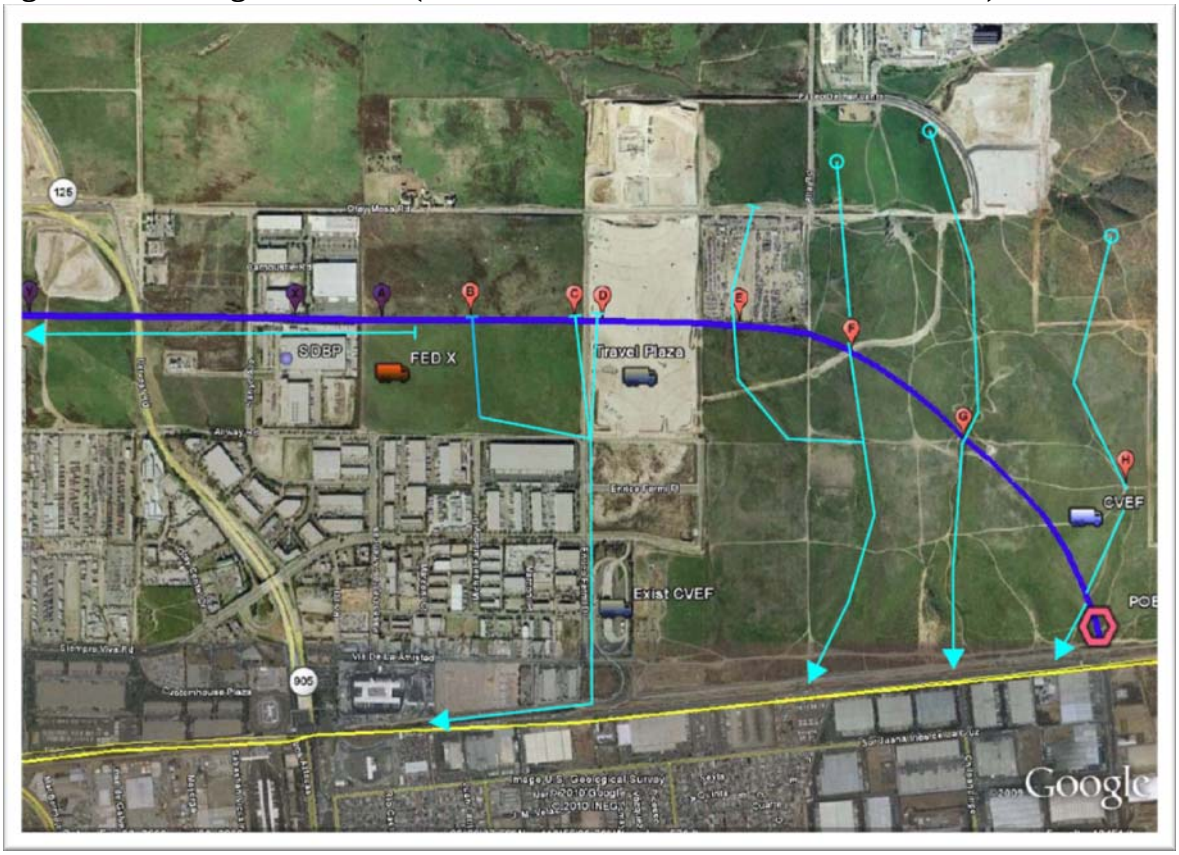
Most soils are thoroughly moistened during this period. Soil moisture however, is used up during rapid plant grown in spring, and unless irrigated, the soils are dry by June. On shallow droughty soils, there is not enough plant growth to control erosion, so some loss of soil can be expected with the first rains in November.

[2] http://en.wikipedia.org/wiki/Climate_of_San_Diego,_California

Existing Conditions

The SR-11 Corridor footprint primarily consists of undeveloped natural rolling terrain. Slopes are generally flat, (<10%) and the surface is covered with short grasses. The proposed alignment crosses three existing roads: SR-905, Sanyo Avenue and Enrico Fermi Drive, and passes over an existing concrete-lined detention basin. Refer to Appendix A for Pre-developed hydrology and exhibits.

Figure 6 - Existing Conditions (with watershed labels and flow directions)



A brief description is provided for each primary area being impacted by this project. From west to east:

Watershed Y: SR-125/SR-905 Interchange to Sanyo Avenue

This undeveloped area is bound to the west by the existing SR-905 roadway and bound to the east by Sanyo Avenue. This area is very flat (<2%) with no well defined flow line. Runoff from the developments east of Sanyo Avenue discharge via a 66" RCP under Sanyo Avenue and flow westerly overland to an existing double barreled culvert under SR-905. Flow continues west towards the future SR-11/SR-125/SR-905 interchange. This area is designated as *Watershed Y.*

Figure 7 - Watershed Y

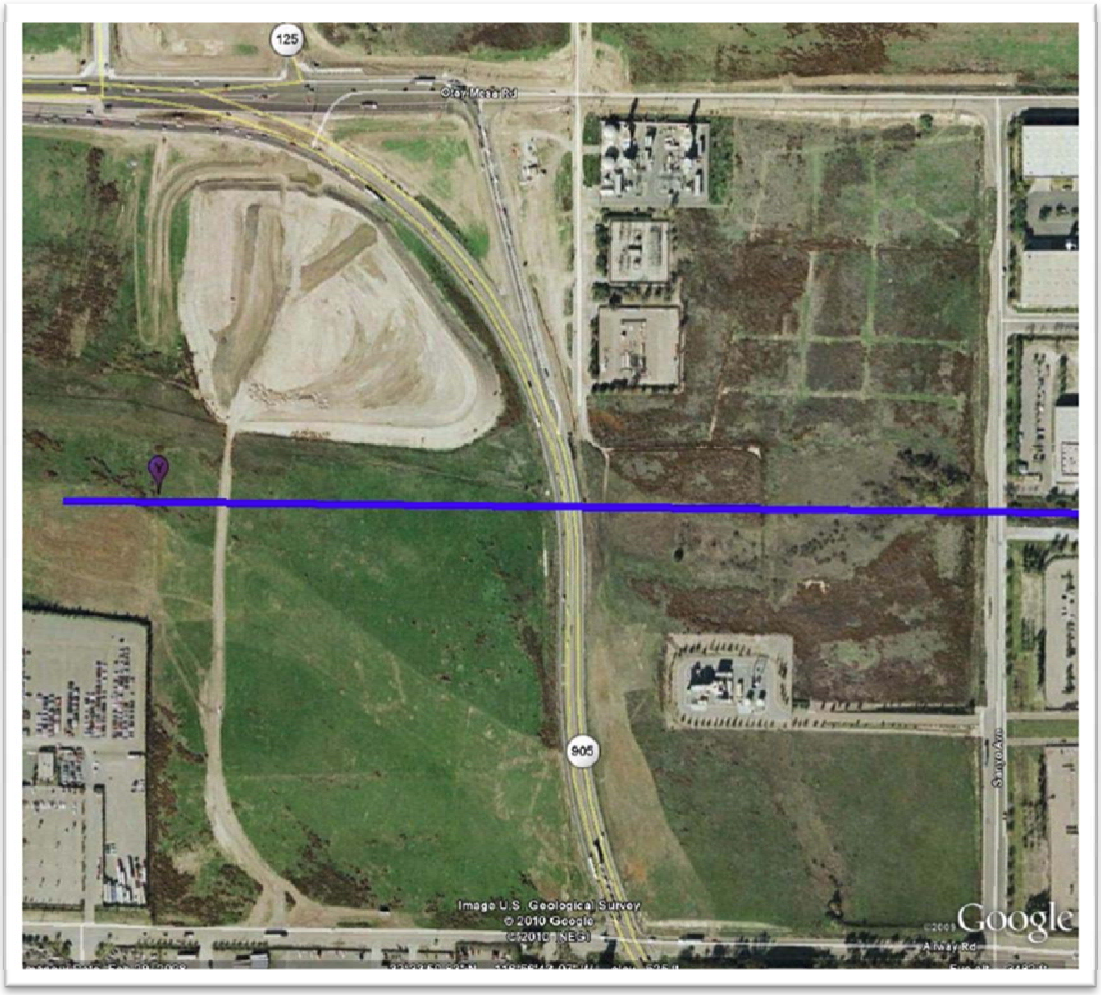


Figure 8 - Looking west from Sanyo Avenue to SR-905

Watershed X: East of Sanyo Road (San Diego Business Park Detention Basin)

This developed area is bound to the west by the Sanyo Avenue and consists primarily of the existing concrete-lined detention basin. This basin collects flow from the north and south development area known as the San Diego Business Park (SDBP) and conveys it west to the 66" RCP under Sanyo Avenue. This basin also takes flow from the east (see next section). This specific area of the SDBP Detention Basin will be referred to as *Watershed X*.

Figure 9 - Watershed X

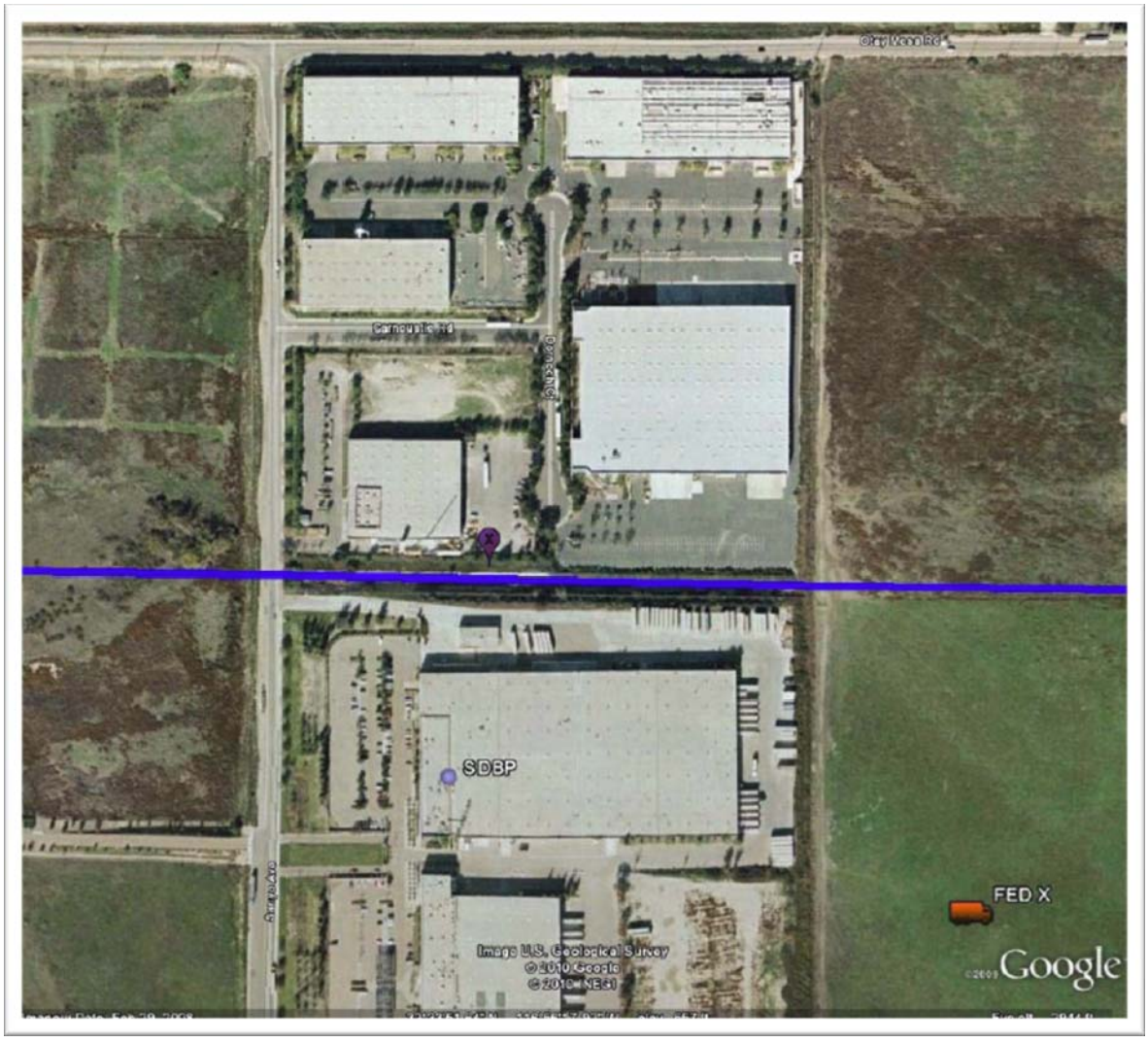


Figure 10 - Looking north/east at the SDPB Detention Basin

Watershed A, B & C: East of San Diego Business Park, west to Enrico Fermi Drive

This area is bound to the west by the San Diego Business Park development and to the east by Enrico Fermi Drive. To the south is the new construction of a Federal Express (Fed X) facility as part of the Airway Business Center (not currently shown in aerial Figures). To the north is relatively flat (5% to 10%) undeveloped natural terrain, primarily covered with short grass which extends north to Otay Mesa Road. Watershed A flows towards the west into watersheds X and Y. Watersheds B and C flow towards the south and are collected and conveyed into storm drain system which discharge just north of the Border.

Figure 11 - Watershed A

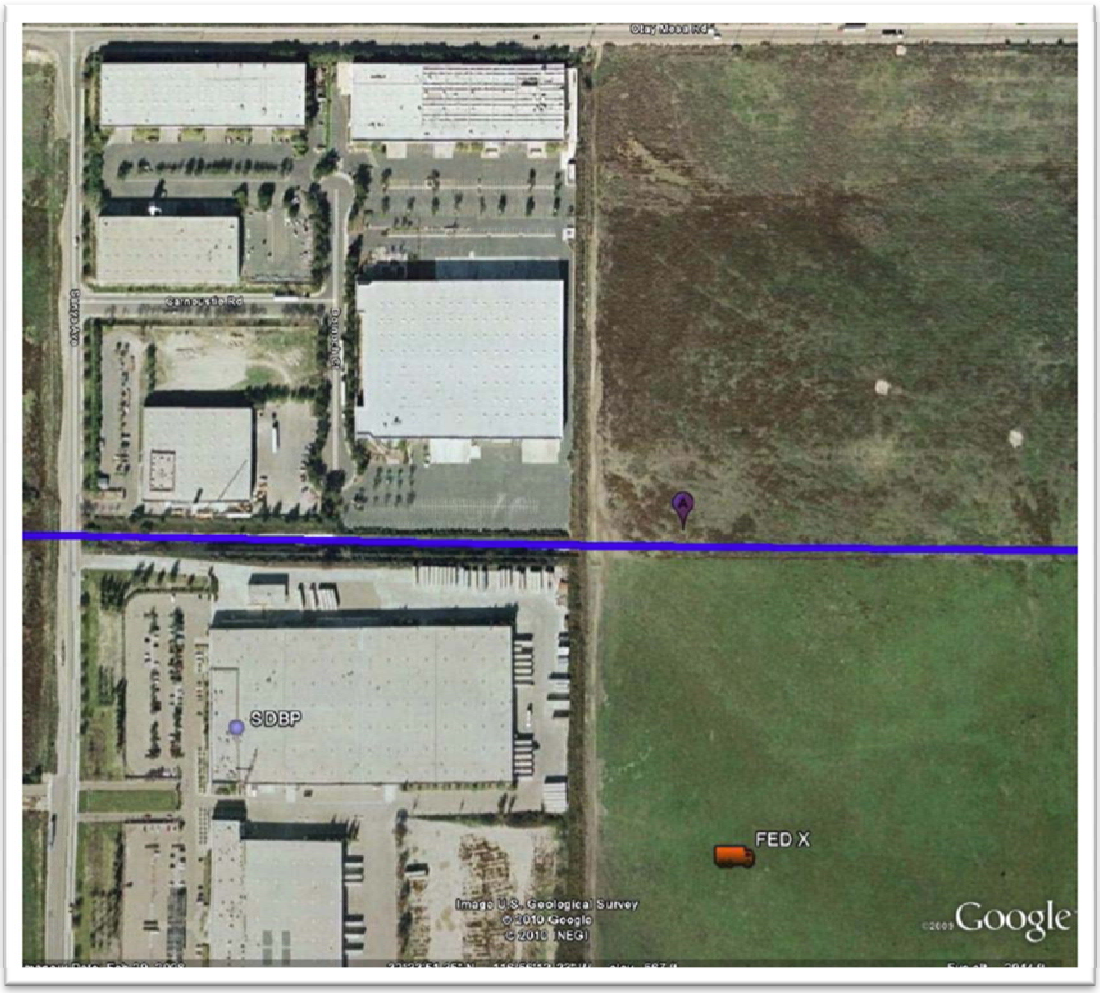


Figure 12 - Looking west towards SDBP and the Federal Express facility

Figure 13 - Watershed B and C

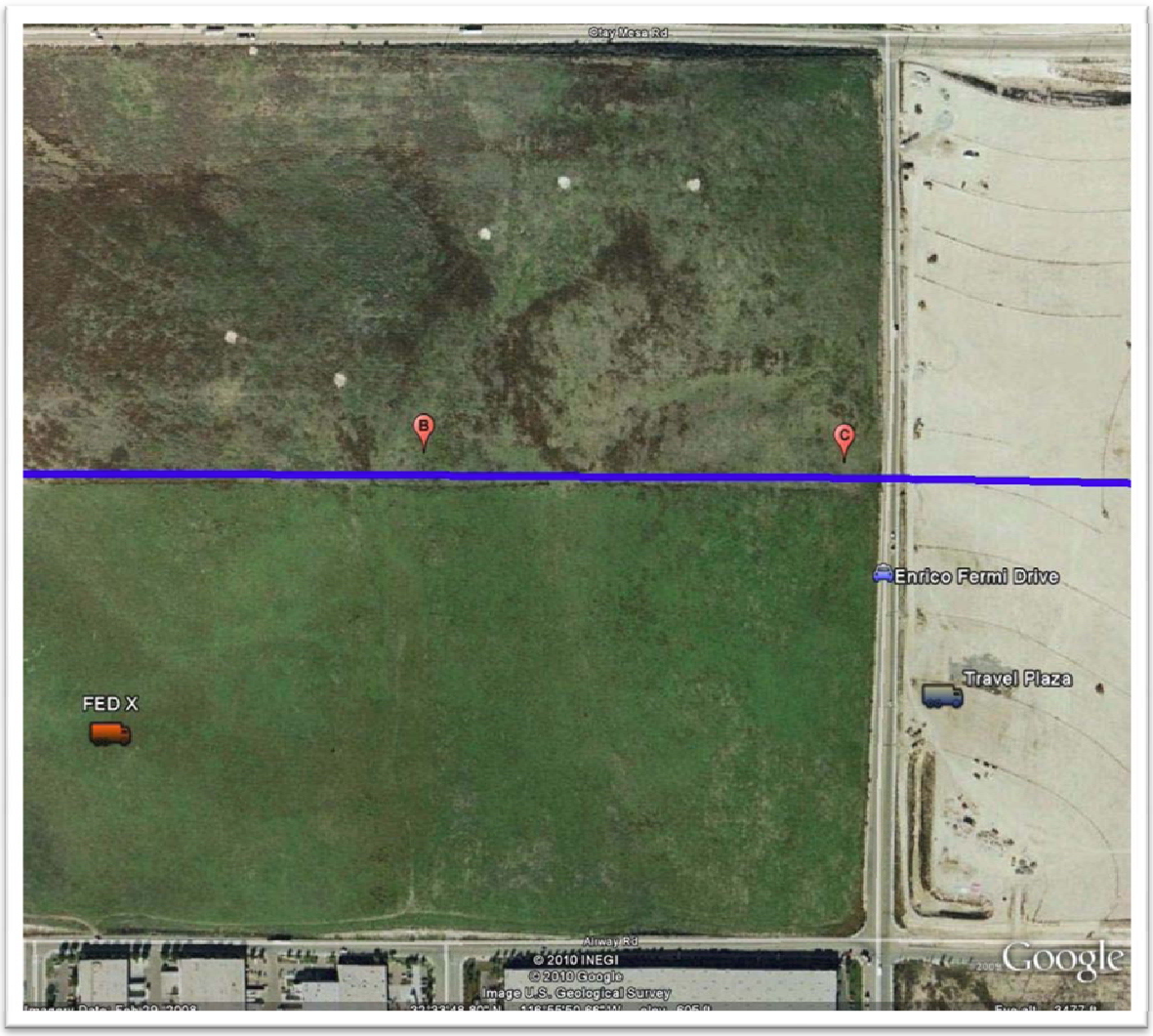


Figure 14 - Looking east towards Enrico Fermi Drive (Watersheds B and C)

Watershed D & E: East of Enrico Fermi Drive, west the future Alta Road alignment

After crossing Enrico Fermi Drive, the SR-11 alignment runs east and passes through the middle of the Transfer Station (aka: Travel Plaza) and along the southern side of the COPART Sales Lot. Both facilities are primarily flat (2% to 4%) earthen surfaced developments for temporary vehicle storage. Within this area are south flowing Watersheds D and E. (Note: Unlike this photo, the topographic mapping used later in this design does not show the regraded contours of the Travel Plaza).

Figure 15 - Watershed D

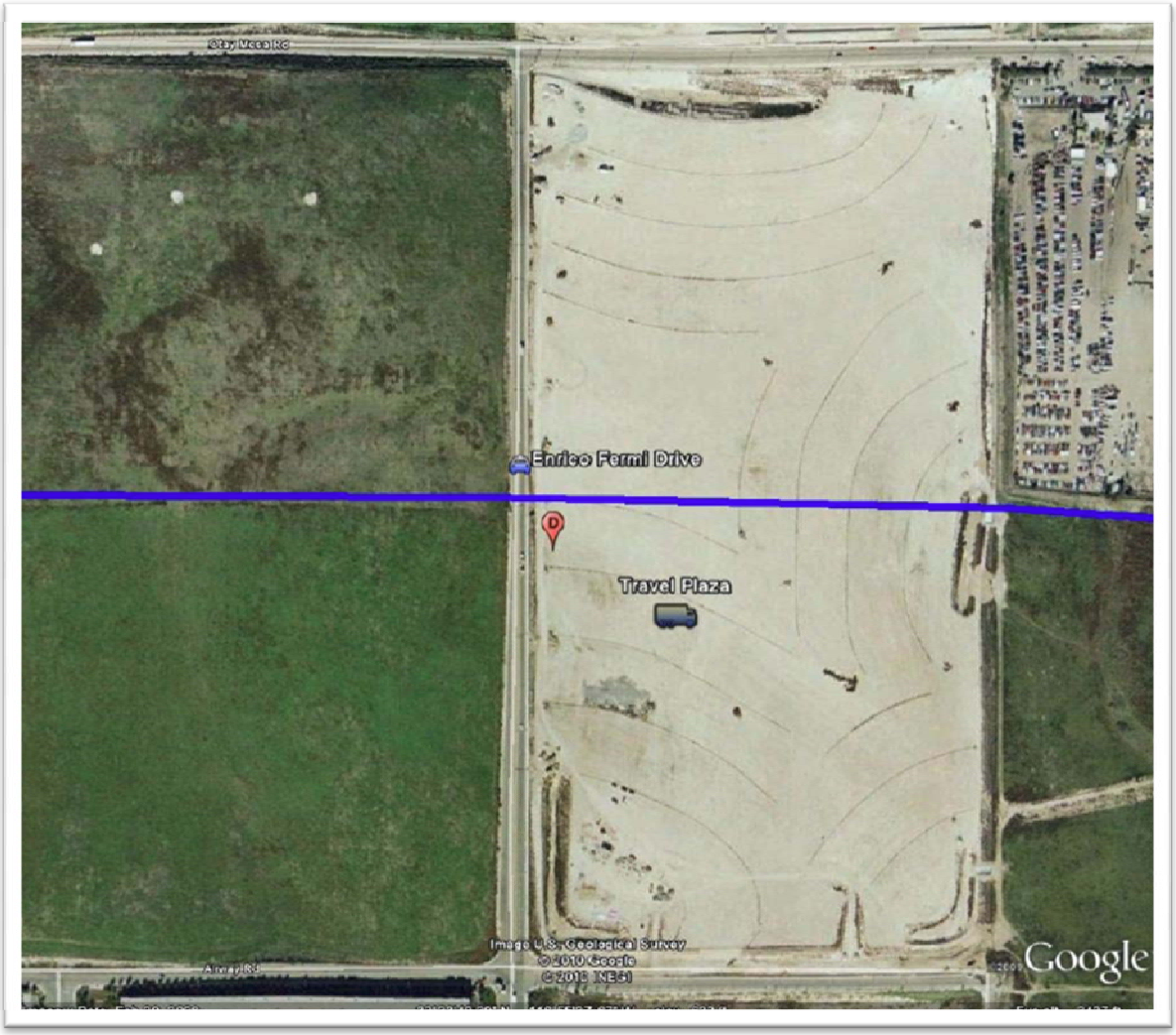


Figure 16 - Watershed E

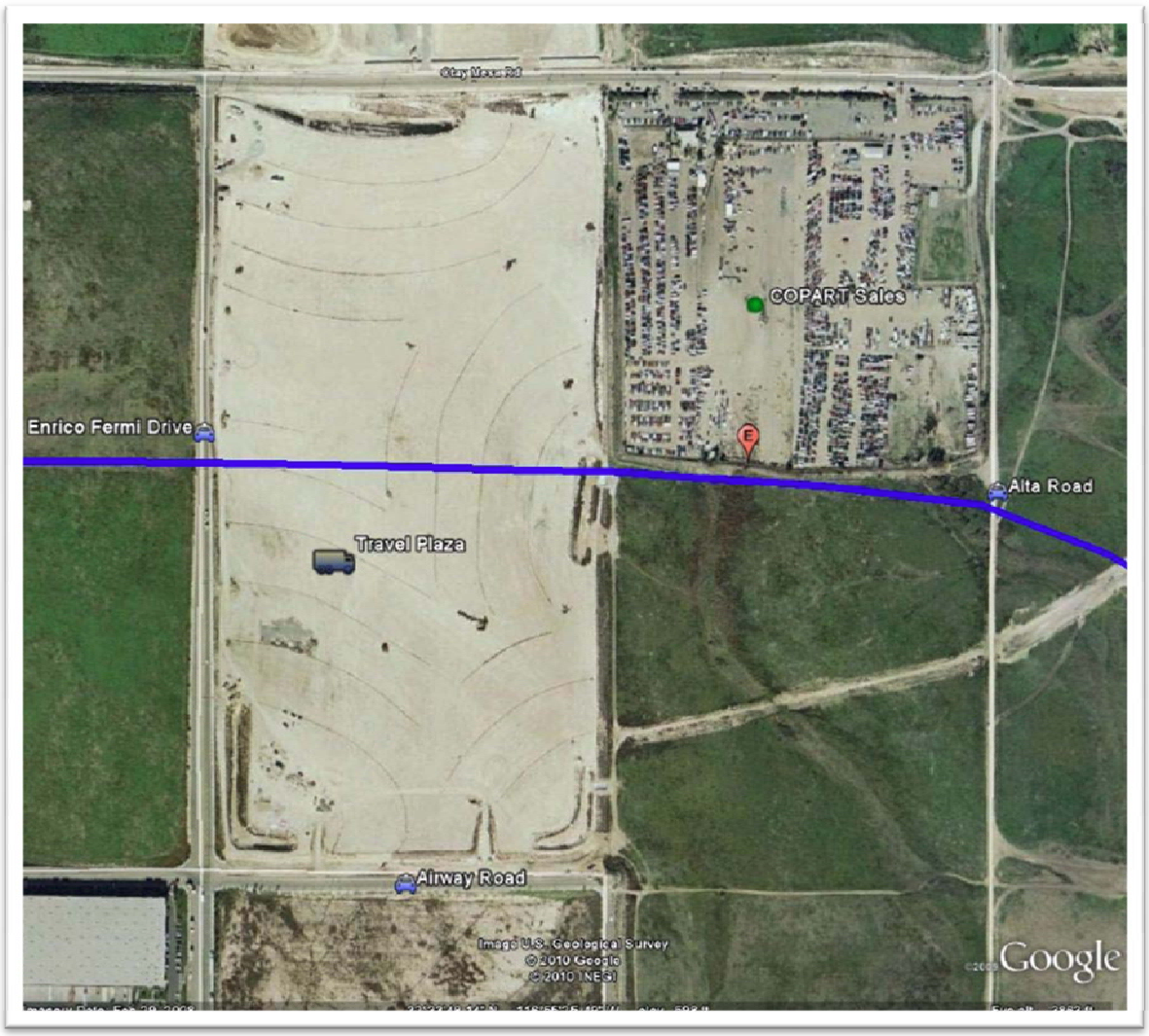


Figure 17 –Looking southeast from Enrico Fermi Drive (at Transfer Station)

Figure 18 - Looking East from Enrico Fermi Drive at COPART Sales site

Watersheds F, G & H: East of the future Alta Road alignment, southeast towards the International Border

Relatively flat (3% to 10%) undeveloped grassed land covers the remainder of the footprint of the SR-11 Corridor to the south and east towards the POE. Watersheds F, G and H are located in this stretch of SR-11. All these watersheds flow overland towards the south to existing culverts at the Border. The flow line of Watershed G is designated as a *Waters of the US.*

Figure 19 - Watershed F

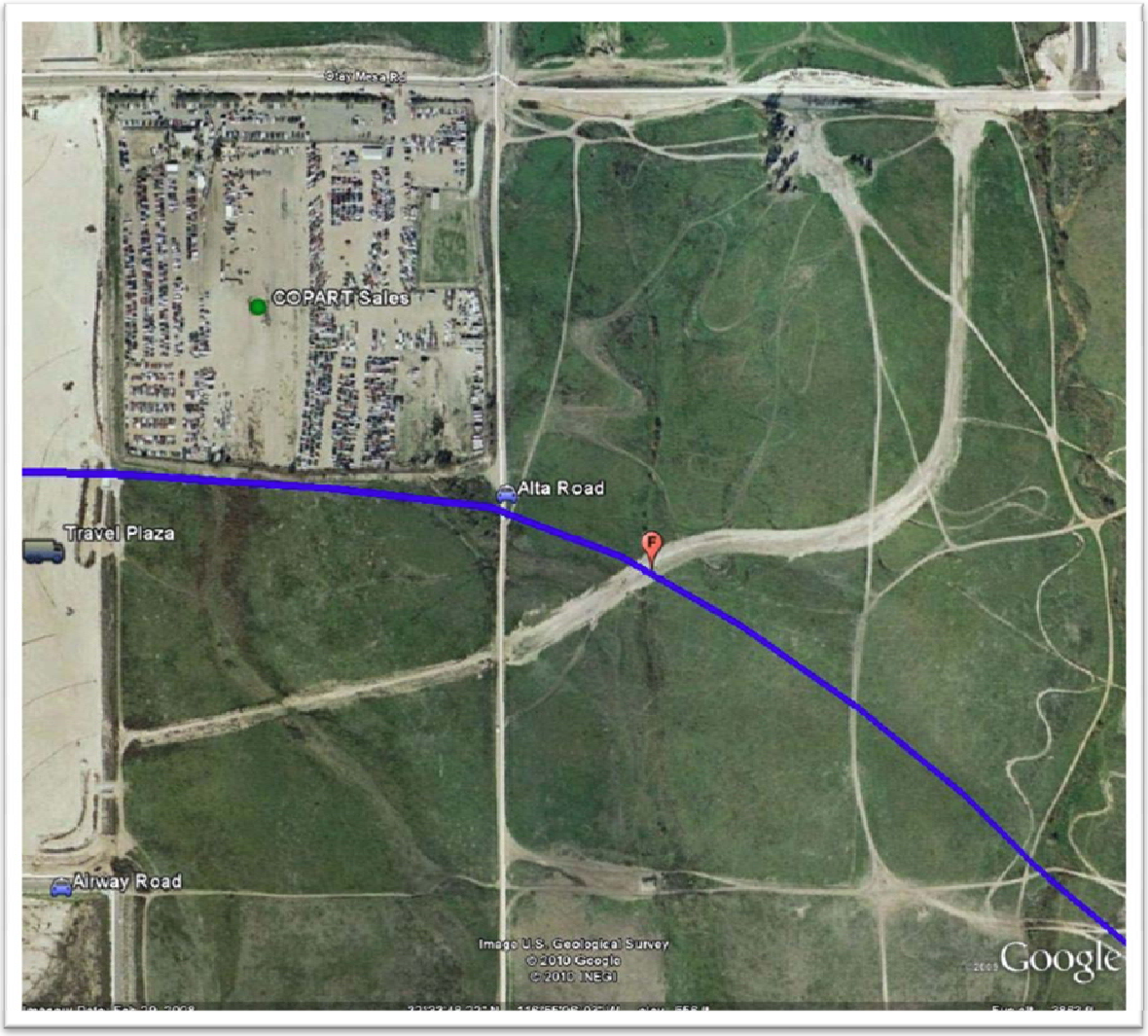


Figure 20 - Looking East at the Watershed F flow line

Figure 21 - Watershed G

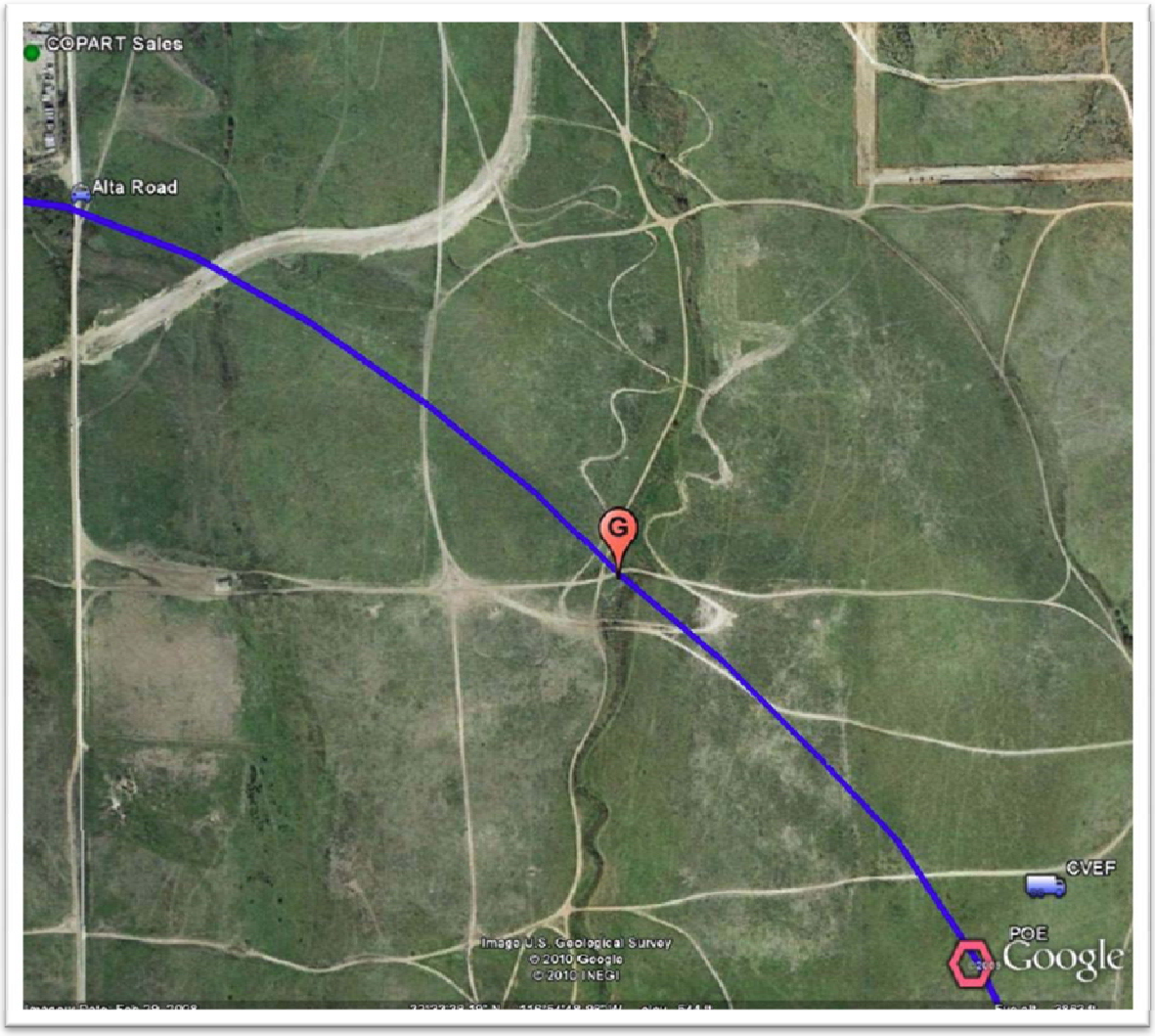


Figure 22 - Watershed H

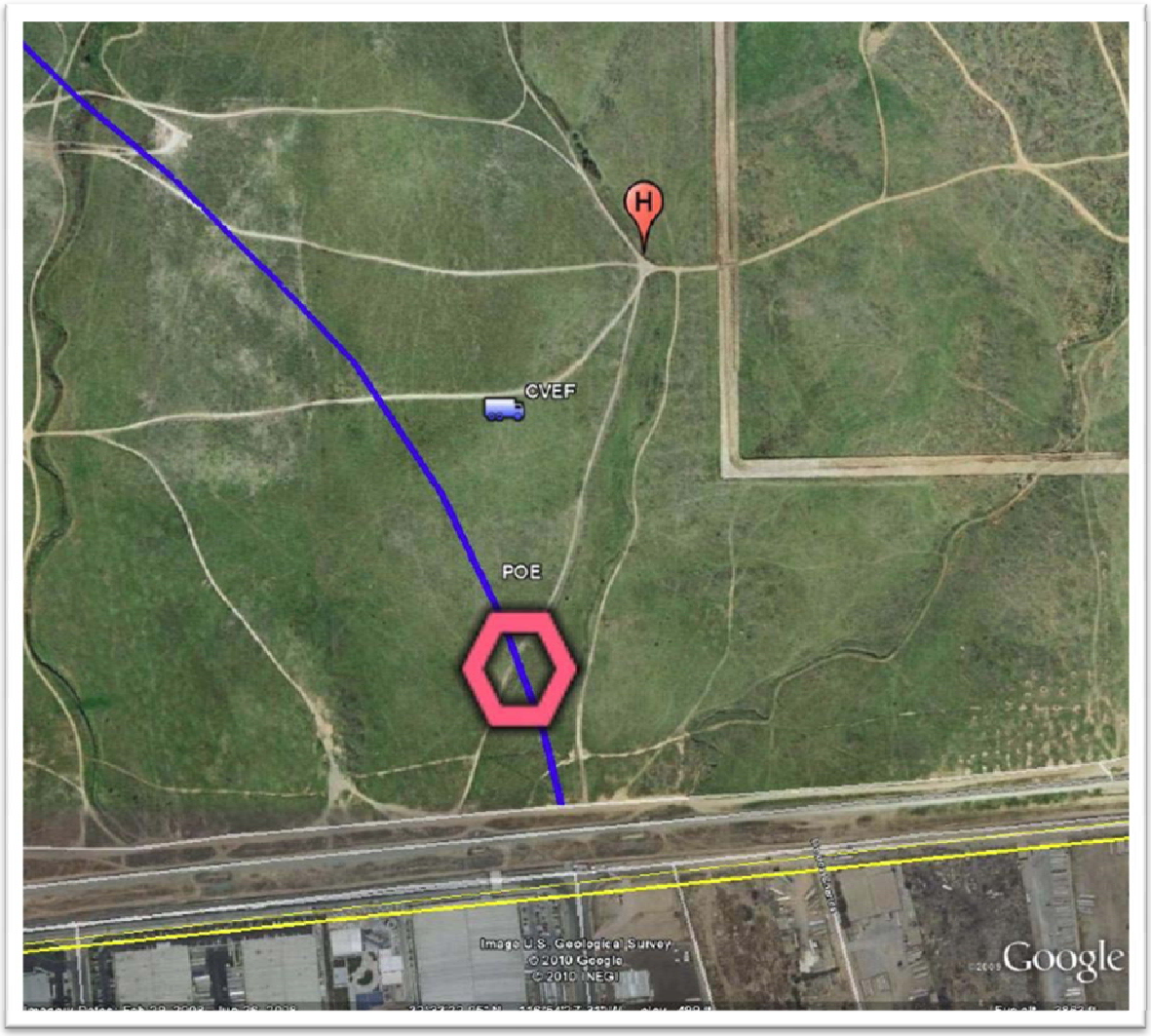


Figure 23 - Looking North up Watershed H

Figure 24 - Typical flow line for Watersheds G & H

Figure 25 – Detail of Watershed G and H (w/post developed Culvert/Basin)

Hydrologic Analysis

Watershed Nomenclature

Ten (10) watersheds were determined to be impacted by the SR-11 Corridor, CVEF and SR-11/SR-125/SR-905 Interchange.

They are labeled **A**, **B**, **C**, **D**, **E**, **F**, **G**, **H**, **X** and **Y**. Refer to Table 2 for approximate station, size and flow direction of the watersheds.

All post-developed watersheds and culvert watersheds are additionally labeled with the appropriate interchange alternative number, IE: Watershed B.1 refers to the post developed watershed B for the One (1) interchange alternative. This applies to all watersheds except for watersheds 'H' and 'Y' which do not have alternatives.

Watershed Description

All of the flow from the watersheds defined in this analysis eventually flow south and across the US/Mexico International Border and ultimately drain into the Tijuana River. Initial flow directions are provided in Table 2.

Table 2 - Offsite Watersheds

Name	Approximate Station	Size (in Acres)	Flow Direction
A	53+00 "SD11"	23.5	West
B	69+00 "SD11"	30.8	South
C	78+00 "SD11"	16.4	South
D	80+00 "SD11"	18.5	South
E	96+00 "SD11"	61.9	South
F	110+00 "SD11"	154.0	South
G*	139+00 "SD11"	60.0	South
H	CVEF	31.9	South
X*	40+00 "SD11"	10.4	West
Y*	33+00 "SD11"	99.9	West

* Refer to "Watershed Delineation" section for more detailed information.

Flow Characteristics

The flow from watersheds A, X and Y travels towards the west. This flow continues for 2-miles westward through a series of natural channels and cross culverts under La Media Road, Airway Road, Sempra Viva Road, ultimately discharging through a large culvert at the Border, one-half mile west of La Media Road.

The flow from watersheds B, C, and D travels south overland, then into more than 3000-feet of storm drain systems within Airway Road and Enrico Fermi Drive. This flow reaches the Border 600-feet south of the existing CVEF. Ponding in this area has been known to occur within an immense shallow man-made depression north of the Border. Installation of infiltration facilities and storm drain pumps on the US side of the Border has been done, yet the functionality, status and performance of these facilities is unknown.

The flow from watersheds E and F travels south overland to an existing culvert at the US Border Control secondary fence (125-feet north of the Border fence) and one-half mile east of Enrico Fermi Drive. There is no existing culvert at the US/Mexico Border due to the construction of Colina Del Sol in Mexico. This road runs parallel to the Border for the length of the project and has a profile that is over 2' higher than the existing ground on the US side. Thus, flow from Watersheds E and F ponds at the Border fence and is regularly pumped out of the area and towards the east to Watershed G discharge point.

The flow from Watershed G travels south overland towards a culvert at the Border, 1200-feet west of the proposed POE.

The flow from Watershed H travels south overland towards a culvert at the Border, 290-feet west of the proposed POE.

Watershed Delineation

These contributing drainage areas were determined by delineation using Microstation graphic tools.

Topographical mapping generated from SANGIS (5' contour intervals) were utilized to delineate the large offsite watersheds. Where coverage was available, the use of two-foot topography contours further defined watersheds. Field investigations were conducted to further confirm the extent of each of these watersheds including recent development within the watersheds that may not have been included in the topographical mapping.

Refer to the Existing Conditions section and the Pre-Developed Watershed Exhibits in the Appendix A.

Where offsite watersheds exceeded the 320 acre maximum for the use of the Rational Method, a separate program, HEC HMS, was used to determine the watershed flow rates. The output from these HEC HMS runs were provided in the Preliminary Existing Condition Hydrology Calculations for State Route 11 Programmatic EIR/EIS, dated August 2008. This applied to only one watershed: *Watershed G-Culvert*. The flow rates from the HEC HMS run were used to size this culvert.

Watersheds X and Y are sub-basins of much larger watershed. That watershed is approximately 470 acres with an extensive existing pipe network. Smaller, more specific sub-basins were defined and analyzed in this report for both X and Y. This conservative method was used for the purpose of comparing the pre- and post-developed conditions using a smaller detailed sub-basin area.

Watershed G is a sub-basin of a much larger 660 acre watershed, of which a majority (approximately 600 acres) is to be intercepted by a proposed headwall and conveyed beneath SR-11 through a proposed 5'x8' double box culvert. The small sub-basin portion of the larger watershed (approximately 60 acres for each of the three alternatives) is defined and analyzed in this report for the purpose of comparing the pre- and post-developed conditions in a more conservative fashion.

The downstream limits of each watershed were chosen for the purpose of analyzing flow rates and volumes at this point of reference in both pre-project and post-project conditions. For Watersheds B, C, D and E, this natural surface point was chosen slightly upstream of an extensive network of roadways, inlets, pipes, junctions, basins and other drainage infrastructure, ultimately reaching the Border. This method allowed for more accurate overland Time of Concentration values without the inclusion of these extensive existing drainage facilities.

For the onsite and offsite hydrologic design, the Rational Method was used to estimate peak runoff for drainage design purposes. Rainfall intensities were derived per the requirements from the Caltrans Highway Design Manual (HDM) and from the County of San Diego Hydrology Manual. Runoff coefficients were derived for the contributing areas using Caltrans guidelines.

Rainfall Intensity – Caltrans

Rainfall intensities derived from Caltrans methodology will be used for all on-site design of inlets and pipes and for cross culverts conveying off-site flows under the proposed SR-11 and CVEF. For Caltrans projects, it is required to use the Caltrans Intensity-Duration-Frequency Program, Version IDF 2000. IDF 2000 generated the following rainfall intensity equations:

$$i_2 = 0.49 \bullet D^{-0.500}$$
$$i_{10} = 0.92 \bullet D^{-0.500}$$
$$i_{25} = 1.15 \bullet D^{-0.500}$$
$$i_{50} = 1.33 \bullet D^{-0.500}$$
$$i_{100} = 1.50 \bullet D^{-0.500}$$

(Note: D is in hours).

For comparison purposes only, the default minimum on-site pavement Time of Concentration, T_C of 5 minutes is used to calculate the following Caltrans rainfall intensities in Table 3.

Table 3 - Caltrans Rainfall Intensity Chart

Storm Frequency (yr)	i – (inches/hour)	Applies to:
2	1.70	~
10	3.20	Offsite Culvert Design
25	4.00	Onsite Inlet and Pipe Design
50	4.60	~
100	5.20	Offsite Culvert Design

For actual Caltrans rainfall intensities used in the analysis, refer to actual T_C and intensity calculations for each on-site drainage area and offsite watershed.

Rainfall Intensity – County of San Diego

San Diego County rainfall intensities were used in the pre-developed and post-development analysis and in the design for sizing of all detention and retention basins. This was done because the San Diego County Hydrology Manual (SDCHM) Rational

Hydrograph Procedure was used to determine basins size and this procedure requires the use of County intensities.

The County intensities calculated were higher and thus more conservative that those of Caltrans. The San Diego County Hydrology Manual was used to establish the following rainfall intensity equation:

$$i_{county} = 7.44 \bullet P_6 \bullet D^{-0.645}$$ *(Note: D is in hours).*

The SD County Isopluvial Maps were utilized to obtain the 6-hour precipitation, P_6 at the following location:

Latitude:	32°33'48.00"N	Longitude:	116°55'9.00"W

The following table summarizes the County of San Diego precipitation, P_6.

Table 4 - SD County 6-Hour Precipitation

Storm Frequency (yr)	P_6 – (inches)
2	1.1
10	1.6
25	2.0
50	2.4
100	2.5

For comparison purposes only, the default minimum on-site pavement T_C of 5 minutes is used to calculate the following County of San Diego rainfall intensities in Table 5.

Table 5 - SD County Rainfall Intensity Chart

Storm Frequency (yr)	i – (inches/hour)	Applies to:
2	2.90	~
10	4.22	~
25	5.27	~
50	6.32	~
100	6.59	Detention/Retention Basins

For actual County rainfall intensities used in the analysis, refer to actual T_C and intensity calculations for each detention/retention basin.

Time of Concentration

To determine the T_C for offsite and onsite watersheds, the California Highway Design Manual, 816.6 Time of Concentration (T_c) and Travel Time (T_t) was used. Per the HDM, for all proposed paved areas, it is *recommended* that a minimum T_c of 5 minutes be used. For this preliminary design, all onsite drainage areas that are paved were assumed to have this minimum T_c. Similarly, for all small offsite watersheds, a minimum T_c of 10 minutes is to be assumed. These are conservative assumptions and will yield higher intensities and flows. Where long onsite watershed lengths are found and additional conveyance mechanism were proposed, such as biofiltration swales, specific T_c analysis should be performed to define a more appropriate T_c.

Table 6 - Design Time of Concentration T_c

Watershed Location	Minimum T_c	Notes
Offsite	10 minutes	Overland flow
Onsite	5 minutes	Pavement flow

Runoff Coefficient

The runoff coefficient was determined using the HDM, Figure 819.2A. Generally, for paved surfaces of concrete or asphalt, a value of 0.90 was used. For existing natural terrain and proposed slope areas, C values ranged between 0.40 to 0.65 depending on slope and surface material. The HDM suggests increasing the runoff coefficient by the following factors to correct the runoff coefficient for less frequent, higher intensity storms due to lower infiltration, detention and other losses affecting the total runoff.

Table 7 - Adjustments to Runoff Coefficient $C_{(f)}$

Storm Frequency (yr)	C(f)	Applies to:
2	1.00*C	~
10	1.00*C	Offsite Culvert Design
25	1.10*C	Onsite Inlet and Pipe Design
50	1.20*C	~
100	1.25*C	Offsite Culvert & Detention/Retention Basin

Units

Imperial Units were used.

Offsite Drainage

Offsite flow is to be quantified and convey under the proposed roadway to the pre-project location. At this point, the offsite flows can confluence with treated and/or detained onsite flow.

Culvert Analysis

Watershed flow rates were determined for each cross culvert location using Caltrans methodology described above. There will be no impact by this project to these watersheds that contribute flow to the culverts. It is assumed that headwalls, culverts and energy dissipation devices will be provided as needed to carry these flows under the project unaltered.

If a separate development is proposed within these contributing watersheds, it will be assumed that development will ultimately discharge equal or lesser flows at the historic/pre-project point indicated within the plans. It is also assumed that the developers will meet all NPDES and water quality requirements prior to discharging flows into the proposed Caltrans right-of-way.

For the design of offsite flows through cross culverts, the HDM, 821.3, “Selection of Design Flood”, the following events were used:

Table 8 - Design Event for Offsite Cross Culverts

Design Event	Notes
10-year	without causing headwater elevation to rise above the inlet top of culvert
100-year	without headwater rising above an elevation that would cause objectionable backwater depths or outlet velocities

Culvert sizing was determined using Bentley Culvert Master. This summary table provides preliminary culvert sizing for all the alternatives. Culverts G and H are applicable for all three roadway alternatives.

Table 9 - Offsite Cross Culvert Flows and Sizes

Location (Sta)	Culvert	10-yr Q (cfs)	100-yr Q (cfs)	Length (ft)	Slope (%)	Shape and Size
69+00	B0	7.4	15.0	226	3.8	Circular – 24” RCP
69+00	B1	7.4	15.0	226	3.8	Circular – 24” RCP
69+00	B2	6.9	13.9	272	3.5	Circular – 24” RCP
95+90	E0	16.8	34.1	195	7.2	Circular – 36” RCP
95+50	E1	15.4	31.3	571	4.6	Circular – 36” RCP
95+90	E2	14.8	30.1	292	6.5	Circular – 36" RCP
110+00	F0	63.4	128.8	326	2.8	Circular – 48” RCP
110+00	F1	57.2	116.1	326	2.8	Circular – 48” RCP
110+00	F2	63.3	128.4	326	2.8	Circular – 48” RCP
128+00	G0,G1,G2	~	658.0	1150	2.1	Box - 2 cells 8' x 4'
CVEF	H	123.9	251.6	694	1.4	Box - 2 cell 6' x 4'

The culvert sizes listed here may differ from the assumed sizes provided in the ‘Post-developed TcQ’ calculations. Note, *TcQ* is a special designation in this report which defines a calculation set for determining the Time of Concentration (Tc) and the Flows (Q). This inconsistency in culvert size does not affect the TcQ measurably.

Watersheds A, C and D have no proposed cross culverts.

Watershed X proposes 42” to 66” culverts to collect and convey pre-developed flows from adjacent existing commercial developments. The pre-developed peak flow value has not been analyzed by this report. Discharge from the proposed SR-11 footprint will be collected and routed separately from this offsite facility; therefore flows are expected to decrease into these culverts.

The existing detention basin which these existing developments discharge into will be relocated by this project from the east side of Sanyo Avenue, to the west side. Maintenance of this facility will remain with the developments.

The culvert sizes within Watershed Y have already been pre-determined from the Offsite Systems Calculations for the SR-125/SR-905 Interchange (Caltrans EA 091281).

The peak discharge used to analyze Culvert G, due to its watershed size in excess of 320 acres, was provided in the Preliminary Existing Condition Hydrology Calculations for

State Route 11 Programmatic EIR/EIS, dated November 2007. All other culvert calculations are provided in the appropriate interchange alternative Appendix.

The outlet for Culvert G is discussed in the section entitled, Features Requiring Further Discussion.

Culvert H takes flow from the undeveloped area to the north of the CVEF. This undeveloped area will not be impacted by the CVEF, or the SR-11 project. The flow will be captured and conveyed under the CVEF and will ultimately connect with the proposed culvert under the POE which discharges just north of the Border.

Onsite Drainage

All on-site flow generated from the SR-11 and the CVEF will be captured, treated, retained and/or detained prior to being released into the original watercourse or the proposed drainage facilities under the POE.

For onsite generated flows, per the Sixth Edition Caltrans Highway Design Manual (HDM), Table 831.3, "Desirable Roadway Drainage Guidelines", all drainage items are to be designed for the expected peak flows during a storm event of such magnitude that there is a 4% chance it may occur in any given year. This is also termed the '25-year storm.'

Design Storm:	**25-year**	**per HDM 831.3**

Design guidance is also provided from the Federal Highway Administration, Hydraulic Design Series (HDS) No. 2, HDS No. 5 and HEC 22. Within these key technical resources, methods and procedures are given for the hydraulic design of storm drainage systems. Design methods are presented for evaluating rainfall and runoff magnitude, pavement drainage, gutter flow, inlet design, median and roadside ditch flow, and structure design and storm drain piping. Procedures for the design of detention facilities are also presented.[3]

Caltrans Highway Design Manual design criteria were applied for this project. A brief list of the key design criteria is found below:

Table 10 - Design Criteria, per Caltrans HDM

Issue	Control	Max/Min	HDM Reference
Spreadwidth	Shoulder	8' or 10' max	Table 831.3
Flow across road	Concentrations of flow	0.1 cfs max	Section 831.4(1)
Flow across road	Hydroplanning	3 lanes max *	Section 831.4(5)
Pipe Diameter	Trunk and lateral	24" min	Caltrans Policy
Pipe Cover	Road to top of pipe	2' min	Table 854.9
Pipe Slope	Self cleaning velocity	3 fps min	Section 838.4
Manhole Spacing	Pipe diameter < 48"	300' to 700' min	Section 838.5
Manhole Spacing	Self cleaning velocity ok	700' min	Section 838.5

* exceptions to the design criteria for cross slope in Index 302.2 must be formally approved in accordance with the requirements Index 82.2, "Approvals for Nonstandard Design."

[3] FHWA-SA-96-078, Technical Report Documentation Page, 16. Abstract

Drainage Area Layout

For consideration of future built out conditions, in this design, it is assumed that the onsite pavement limits extend to the centerline of the highway and there will be no earthen median. Median inlets are provided in this design to address interim conditions and serve as junction structures, but are not analyzed for capture efficiency.

Onsite Hydrology and Hydraulic Exhibits and Calculations have been provided. Pavement drainage areas and slope drainage areas were separated due to different runoff coefficient values. Pavement areas are designated with a *PV* whereas sloped areas are designated with a *SL*. The C-value for each is defined in the following table.

Table 11 - Onsite Runoff Coefficients (25-year Design Storm)			
Type	**Designation**	**C**	**C_{25}**
Pavement	PV	0.90	0.99
Slope	SL	0.55	0.61

Drainage Area Nomenclature

Onsite drainage areas are labeled based on the following:

- the watershed basin they drain within (A through H, X and Y)
- the design alternative, (No interchange (0), One interchange (1), or Two interchange (2)), and
- the type of surface the watershed consists of (pavement (PV) or slope (SL).

For example, drainage area B1.5.PV refers to the fifth (5th) pavement area draining in the one-interchange design alternative of watershed 'B'.

Summary tables of the onsite flows for each watershed are provided.

Grated Inlet Layout

Standard Caltrans inlet types G1 and G2 are shown along the edges of pavement at key locations. A special Double G1 inlet with two grates will be shown at critical locations where additional capture was necessary. Double G1 inlets are used to capture flows from the detention basins. Where applicable, a concrete apron is used around these inlets as an elevation control device and for the ease of maintenance of the inlet.

Detailed onsite inlet calculations were not performed in this analysis. Inlets have been placed at key locations for collection of runoff and at critical locations such as at the downstream end of biofiltration swales, within basins, at gore points and superelevation transitions. The layout shown is approximate and may change in the final design stage once the appropriate alternative has been selected.

Drainage Inlet Nomenclature

Onsite drainage inlets are labeled based on the onsite drainage area which drains to the inlet. For example, inlet B1.5 refers to the inlet which drainage areas B1.5.PV and/or B1.5.SL drain into.

Median inlets are placed where they are used as junctions or where interception would normally be required. They are not analyzed in this report.

Onsite Culvert Layout

The onsite culverts sizes can be assumed to be between the minimum 24” to 36” in diameter. The specific type of culvert material will be chosen based on the allowable alternative pipe tables. The slopes of longitudinal runs of culverts generally follow the slope of the roadway. The minimum longitudinal slope will be 0.50%. This minimum constructible slope may be required in a few cases to reduce structure depths. At this slope, self-cleaning velocities are in compliance with HDM requirements.

Detailed onsite culvert calculations were not performed in this analysis. Quantities are approximate and may change in the final design stage, once the appropriate alternative has been selected.

Biofiltration Swale Design

A key drainage design approach for this new state route will be to drain roadway-generated flow from the roadway and shoulders directly into biofiltration swales (bioswales) running parallel to the road, where possible. Any adjacent cut slope flow will also be intercepted by these swales. Therefore, in smaller storm events, the traveled ways and roadway shoulders can remain free of longitudinally conveyed flow. Also, the number of shoulder inlets typically required would be reduced. Additionally, the overall length of dikes and curbs would also be reduced and shoulder slopes can vary between 2% and 5%. Caltrans maintenance of drainage facilities (bioswales/inlets) will be located further away from moving traffic.

All of the bioswales shown have a base width ranging between four (4) to thirteen (13) feet and side width slope ratio of 4:1.

The length, shape, width and placement of these bioswales as shown in this report are preliminary. A full analysis of the bioswales has not been performed at this preliminary stage.

In the 25-yr event, the bioswales at a few locations may be flowing full and the adjoining shoulders may be utilized to convey longitudinal flows. Where this is undesirable, or where bioswales are not feasible or reasonable, dikes and shoulder inlets and additional piping will be utilized to capture shoulder flow.

Where it has been determined that the flow within the bioswale exceeds any depth, velocity or location restrictions, they can be reduced in length and inlets will culverts can be installed in place.

These bioswales will capture, convey and treat highway runoff. Inlets with concrete aprons will be placed at the downstream end of the swales as needed to extract flows from the surface. In many cases, these flows will be routed to detention facilities to comply with any retention and/or peak flow attenuation criteria. In a few cases, pavement flows will be captured within bioswales, then discharged to a separate offsite cross culvert, and not routed to a detention/retention facility. Water quality, detention and retention requirements will still be met within these watersheds.

Detention/Retention Basins

Basin sizes that have been determined within this report are based on the assumption of the preliminary SR-11 Corridor layout. These basins were sized and located based on seven (7) different preliminary design criteria. These criteria being, retention volume, soil infiltration rates, water quality volume, silt accumulation volume, detention volume, freeboard and basin outlet structure. These basin sizes provided during this PA/ED phase assume that all jurisdictional criteria could be met, but that the final basin designs during the PS&E phase will be based on the feasibility and reasonability of meeting the different jurisdictional criteria.

Retention Volume

The pre-developed and post-developed watershed flow rates and times of concentration were determined using methodology described in the HDM, Section 816 (except for the use of the County of San Diego rainfall intensities). The post-developed watershed boundaries include post-project pavement and graded slope areas. Where the post developed flows and runoff volumes were increased from pre-developed conditions, retention basins were proposed to eliminate excess runoff. This is in compliance with the IBWC correspondence provided in Appendix G, "*disposal of excess water should not go into Mexico*". In a few cases, post-developed watershed runoff volumes were reduced when compared to pre-developed volumes and do not require retention basins.

The volume of retention set aside within the basin was determined using the San Diego County Hydrology Manual (SDCHM) Rational Hydrograph Procedure as described in Chapter 6-1. This procedure uses the rational method (Q=CiA) and develops pre-developed and post-developed hydrographs for the use in determining runoff volumes for use in sizing retention basins within watershed areas up to approximately 1 square mile in size.

The County's RATHYDRO computer program generates hydrograph ordinates using the formulas with the SDCHM. Peak flow rates, time of concentration, 6-hour rainfall depths, watershed area and runoff coefficients are used as the input for the RATHYDRO program.

Soil Infiltration Rates

Infiltration rates were provided in the Proposed State Route 11 Extension: Hydrogeologic Site Evaluation/Storm Water Data Report. The Percolation Rate Tests results for seven (7) locations from Alta Road to the Border ranged from 1.4 minutes per

inch to 174.5 minutes per inch. At two locations there was no percolation observed during the testing.

For purposes of this preliminary analysis, it is assumed that the volume required for retention will percolate and be disposed of via infiltration or other subsurface engineering methods. (See the section entitled: Items Requiring Further Discussion).

Basin constraints

Other than environmental constraints, there are no limitations on placement of retention basins since, according to the Hydrogeologic Site Evaluation; *no ground water was encountered in all borings during the exploration program for this project.*

A basin outlet structure will be placed at an invert elevation which allows the retention volume to remain in the basin. See Detention Volume section for more information on the outlet structure. Refer to calculations in Appendix A through F.

Water Quality Volume

Per the Caltrans Storm Water Quality Handbook: Project Planning and Design Guide (PPDG) May 2007 volume is to be set aside for the use of treatment of pavement runoff – this is the Water Quality Volume (WQV). With the use of Caltrans 'Basin Sizer' Program and the Maximized Volume Method stated in the PPDG, a volume was found for Water Quality purposes. When the WQV was less than that of required for retention of excess runoff, it was assumed treatment will occur within the retention basin and no additional volume was added to the basin. When the WQV was greater than that required for retention, the difference in volume was added to the basin. Refer to calculations in Appendix A through F.

Silt Accumulation Volume

Per the IBWC, Hydraulic and Hydrological Study reports are to include an analysis for silt accumulation within the basin. The basin design should include additional capacity for a 10-year volume of silt accumulation. See Appendix F for IBWC correspondence. Silt accumulation over a 10-year period was assumed to pass into the retention area and additional volume is to be added for this. The Universal Soil Loss Equation and methodology stated within the SDCHM, Chapter 5.2.3 were used to determine this

volume. This accommodates silt from erosion of new cut slopes within the project limits. Refer to calculations in Appendix A through F.

Detention Volume

Where the post developed peak flow rates were increased from pre-developed conditions, detention basins were required to reduce flow rates. For the purpose of peak attenuation (or peak shaving) additional volume is added above the retention, silt accumulation and WQV. With the use of a standardized engineered outlet structure, the detention basin volume will be added to reduce post-developed peak flows.

Basin Outlet Structure

In the Detention Basin Outlet calculations, a 2' reinforced concrete discharge pipe at 2% slope was placed from 1' to 3' above the basin floor allowing for retention below the invert. The appropriate calculated rating table was provided analyzing outlet flows giving a range of headwater elevations.

With the defined outlet structure and using methodology described in HEC 22, Stage Storage Relationships were developed along with the Stage-Discharge Relationship (Performance Curve). A generalized routing procedure was performed to determine the additional volume needed for attenuation of peak flows. Refer to calculations in Appendix A through F.

Freeboard

A freeboard depth was added to the final calculated depth. All freeboard depths are in excess of one (1) foot in accordance with HEC 22 9.3.9 *Allowable High Water Elevation: The allowable high water (AHW) elevation in the station should be set such that the water surface elevation at the lowest inlet in the collection system provides 0.3 to 0.6 m (1 to 2 ft) of freeboard below the roadway grate.*[4]

[4] HEC 22, 2nd Edition Urban Drainage Design Manual

Geometrics of the Basin

Rectangular and/or Trapezoidal shapes were chosen for all of the basins. HEC 22 – Equation 8-8 and Figure 8-8 (below) were used to determine basin volumes:

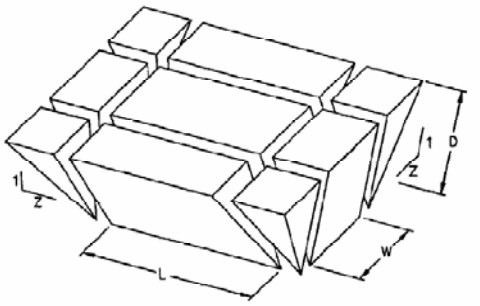


Figure 8-8. Trapezoidal Basin.

$$L = \frac{-ZD(r+1) + [(ZD)^2 (r+1)^2 - 5.33(ZD)^2 r + \frac{4rV}{D}]^{0.5}}{2r}$$

V = volume at a specific depth, m^3 (ft^3)
D = depth of ponding or basin, m (ft)
L = length of basin at base, m (ft)
W = width of basin at base, m (ft)
r = ratio of width to length of basin at the base
Z = side slope factor; ratio of horizontal to vertical components of side slope

Features Requiring Further Discussion

SR-11/CVEF Layout

It should be noted that the layouts shown for SR-11 alignment and CVEF are preliminary in nature.

For the purpose of this analysis, it is assumed that the paved and the non-paved area quantity shown herein will be similar to the final design. These areas which are shown to be paved and unpaved were used to calculate basin sizes. If the pavement area is changed from what is shown within this report, re-evaluation of the onsite hydrology and associated appurtenances will be required.

The collection and routing of the onsite flows is schematic and it is assumed that onsite flows can be collected and discharged into either detention/retention basins or other storage devices to be determined.

Basin Design

A key element of this report was to determine the retention/detention basin sizes due to the proposed SR-11. These graded basin sizes would assist in setting the right-of-way based on the unique footprint of these facilities.

IBWC requires that due to this projects proximity to the Border, (see Appendix F), the design assumes that the increase in volume from the new impervious surfaces will be retained within the Caltrans right-of-way (will not flow into Mexico).

To simplify the design at this preliminary stage, flat-bottomed basins with 1:4 side-slopes are shown. The volume below the outlet structure elevation is always calculated to be

greater than the retention, silt accumulation and water quality volume requirement. The volume above the outlet device is used for peak-shaving/attenuation requirements.

Infiltration rates have been found to be poor due to the soil type found in the area, (see: Proposed State Route 11 Extension: Hydrogeologic Site Assessment/Storm Water Data Report by the Department of Transportation Division of Engineering Services – Geotechnical Services, Office of Geotechnical Design –South 2)

Results of percolation tests revealed that the percolation rates at the project site are generally low, corresponding with the clayey (bentonite) and silty composition of the surficial soils and the dense, underlying sedimentary formation. In addition, percolation rates fluctuate from no percolation observed to the rate of 1.4 min/inch. However, the relatively fast percolation rate is attributed to the sandy nature of soils encountered only at this test location. This sandy granular soil is believed to be localized and not representative of a pervasive sedimentary stratum capable of absorbing and infiltrating runoff.[5]

To accommodate this lack of infiltration, the ultimate basin design may incorporate some or all of the following features to address the requirement for volume retention:

- subsurface soil treatments
- concrete floors
- retention vaults
- pump systems

SR-11/SR-125/SR-905 Interchange Basins

The proposed detention basin within the loop ramp of the "EN" Line as part of the SR-905 project will remain as previously designed and approved. That design assumed the basin would be taking pavement and slope flow from SR-11 to Enrico Fermi Drive. Yet, the preliminary SR-11 drainage design is to capture and redirect flow to the new Basin Y-East at the "WS" and "WN" Lines. Therefore, less flow will be entering the "EN" basin than it was originally designed for. Therefore, no further design modifications will be required for this basin.

[5] Proposed State Route 11 Extension: Hydrogeologic Site Assessment/ SWDR, 09.09.09, page 4.

Slight pavement widening along the outside of SR-905 is proposed from Stations 600+00 to 635+00. This increase in impervious cover will be added to the new Basin Y-West detention and retention requirements. The flow will be captured by proposed inlets and conveyed towards the west into the proposed storm drain system of SR-905.

Sanyo Basins

The existing concrete lined detention basin serving the existing commercial developments in the immediate vicinity will have to be relocated from Stations 40+00 to 52+00 to approximately Stations 20+00 to 32+00.

The flows from the developments that currently drain to the existing detention basin will be directed to the new basin location via a separate drainage system. This is facilitated by re-routing all of the existing culverts that currently discharge into the existing concrete bottomed detention facility between Stations 40+00 and 52+00 into one large culvert running along the north side of SR-11 and ultimately discharging into the relocated detention facility proposed west of Sanyo Avenue.

This relocated basin will be similar in shape, depth and function and will not receive any flow from SR-11. No further analysis of this basin will be required. Maintenance and ownership of this relocated basin will continue to be a requirement of the commercial site owners and not Caltrans nor the City of San Diego.

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 impacts and the 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 channel. An energy dissipation device will also be required. All drainage elements in this area must be placed within the criteria of the *Waters of the US.*

Culverts

Developers Culverts

There are several proposed commercial developments adjacent to the proposed SR-11 Corridor. The storm drain culverts proposed by these developments are shown and labeled in this design for informational purposes only. It is assumed that these developments are required to address detention and retention requirements of the appropriate jurisdictions and discharge flows and volumes that are not in excess of pre-developed conditions.

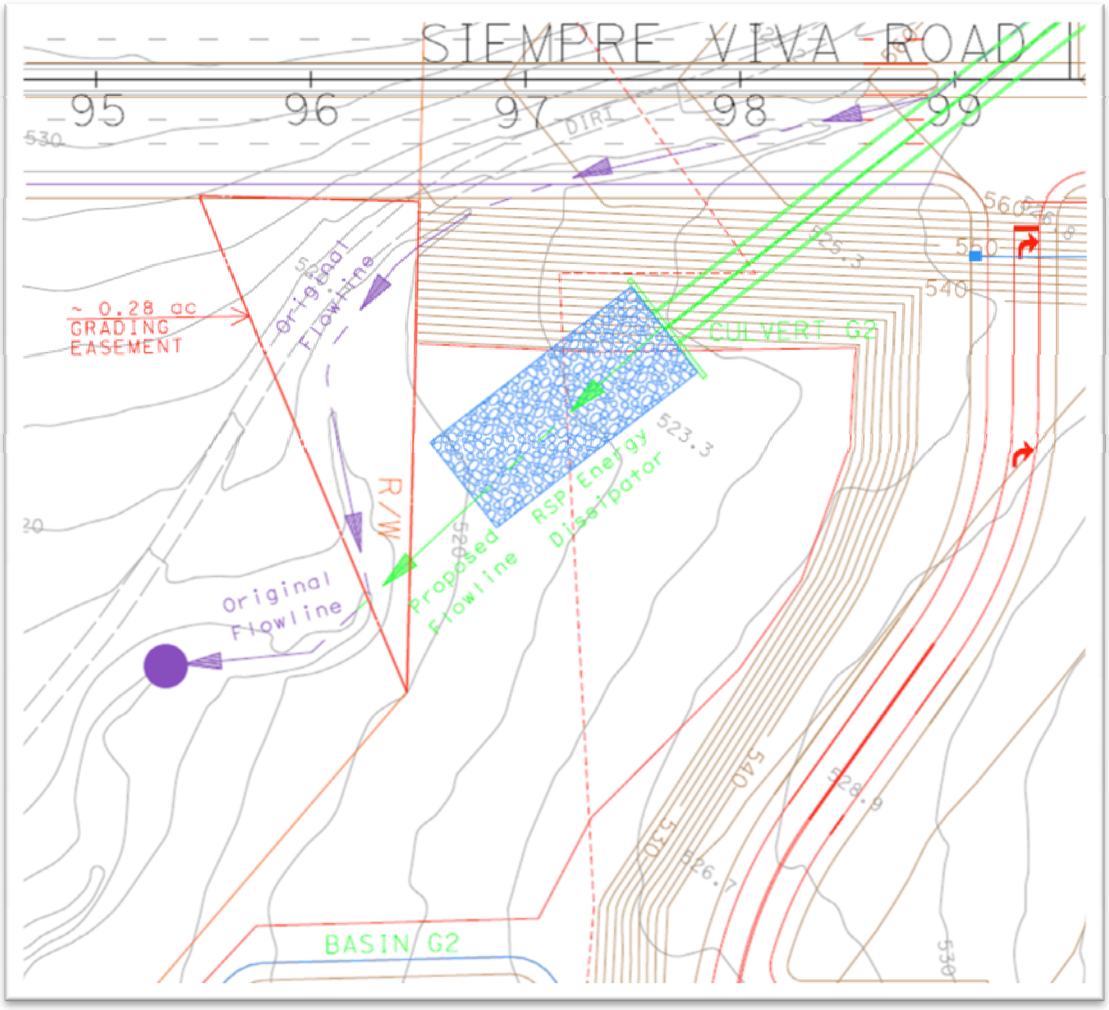
Culvert B

In all three alternatives for Culvert B, due to the low preliminary SR-11 profile, an upstream drop structure and modifications in the daylight point of the downstream end of this culvert may be required. Grading easements beyond what is shown in this report may be required to daylight the culvert.

Culvert G

The outlets for all three design alternatives of Culvert G occur along the southwest side of the proposed extension of Siempra Viva Road and the SR-11 alignment. A rock rip rap energy dissipation device is shown with an approximate size. The end of this dissipation device falls short of the confluence with the existing *Waters of the US* flow line. The proposed right-of-way line does not allow for a continuous connection of these flow lines. A grading easement will be necessary per Figure 25 to complete this drainage connection.

Figure 26 - Culvert G Outlet



SR-11 Interchange Flows

Runoff from Enrico Fermi Drive, Alta Road and Siempre Viva Road within the three Alternatives, that are within the proposed Caltrans right-of-way are considered in this design. Flows from these proposed roads that are outside of the proposed Caltrans right-of-way are not considered in the proposed design.

Watershed A, X and Y (separation of flows)

The intent of the preliminary design for these three watersheds was to separately convey the runoff from the existing commercial developments east of Sanyo Avenue, south of Otay Mesa Road and from that of the proposed SR-11 runoff. Onsite runoff from SR-11, specifically watersheds "A", "X" and "Y" will be captured and conveyed in a separate, smaller culvert along the south side of SR-11. This flow will continue west, through the proposed Sanyo Avenue Undercrossing Structure will be ultimately discharged into Detention Basin "Y-East".

Basin calculations for Watershed A indicate a need for a detention facility. A basin has been designed, sized and placed in the drainage layout. This basin may be omitted in the ultimate design if flows from Watershed "A" are to be collected and routed to Basin "Y-East".

Basin calculations for Watershed X also indicate a need for a detention basin due to increased impervious cover. A basin volume was calculated, but due to this area being entirely on an elevated structure with no possibility of placing a retention/detention facility, runoff from this structure will be captured and conveyed through a network of inlets and pipes and discharge into to Basin "Y-East".

The calculations for Basins in the "Y" watershed include flows from Watershed "A" and "X"

Commercial Vehicle Enforcement Facility (CVEF)

The Layout for the CVEF shown within this report was patterned from the layout of the existing Otay Mesa CVEF which is 1.5 miles west of the proposed CVEF, at the south east corner of Enrico Fermi Drive and Siempra Viva Road. The ultimate layout cannot be determined at this preliminary stage. However, it is anticipated that the operational footprint will be reduced in order to facilitate detention/retention basin opportunities.

In order to simplify the drainage approach to the preliminary drainage design this facility, only one basin volume was calculated. This volume was distributed over the several basins shown on the plan. In the ultimate condition, basins may be reconfigured; due to adjustments in the CVEF layout.

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

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Appendix A PRE-Developed Conditions

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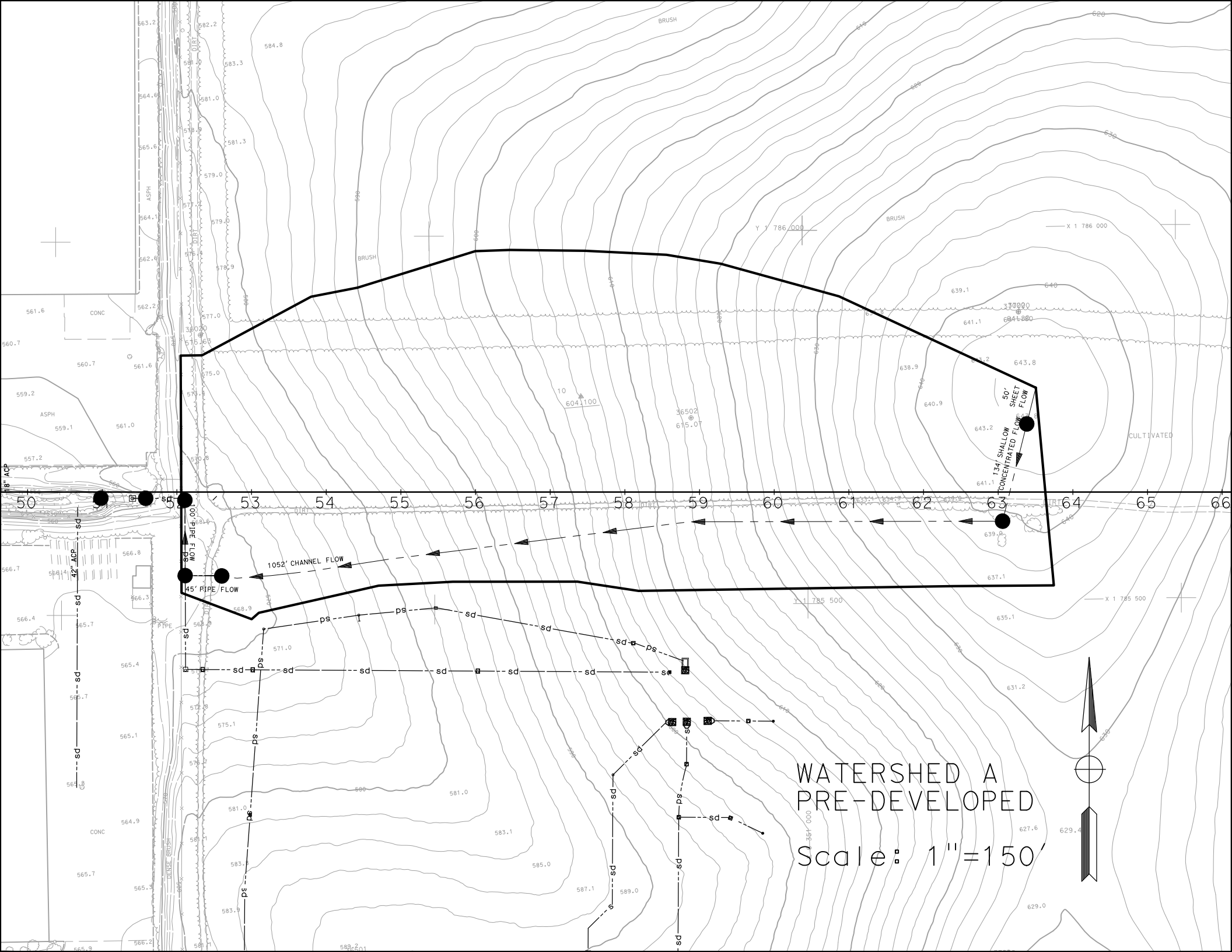
WATERSHED A
PRE-DEVELOPED
Scale: 1"=150'
1052' CHANNEL FLOW
45' PIPE FLOW
200' PIPE FLOW
134' SHALLOW CONCENTRATED FLOW
50' SHEET FLOW
42" ACP
18" ACP
BRUSH
CULTIVATED
CONC
ASPH
DIRT
DENSE BRUSH
PIPE
sd
ps

A Pre-Developed TcQ

PROJECT:	**SR-11**			**DESCRIPTION:**	**SR-11 Pre-Developed**
JOB #:	**11A1190**			**STATION:**	**52+00**
BY:	**M.BRUNING**	**DATE:**	**01.04.10**	**WATERSHED:**	**A**
CHK:	**G.DALZIEL**	**DATE:**		**SYSTEM:**	

BASIN AREA:

A = **457636** **ft^2** | **10.51** **acres**

SOURCE: **MICROSTATION/USGS** **(SCALE = 1:1)**

COEFFICIENT OF RUNOFF:

KEY: User Input | Designer Tool

UNDEVELOPED AREA C (FROM HDM FIG. 819.2A)

NOTES:

RELIEF (.08-.35)	0.14	Rolling slopes ~ 7.5%
INFILTRATION (.04-.16)	0.12	Negligible infiltration capacity - see Geotechnical Report
VEGETATION (.04-.16)	0.08	Fair natural cover
STORAGE (.04-.12)	0.08	Low
TOTAL C =	0.42	

UNDEVELOPED AREA	99%	AT	0.42	0.416
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%)			

$C_{2,10}$ =	0.42
C_{25} =	0.47
C_{50} =	0.51
C_{100} =	0.53

TIME OF CONCENTRATION:

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

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

HIGH PT ELEVATION	644.0	ft	Ridgeline
LOW POINT ELEVATION	643.0	ft	
ELEVATION DIFF (H)	1.0	ft	
LENGTH (L)	50	ft	From high point
SLOPE (S) = (H/L)	2.0%		
MANNING'S n	0.050		<=n from Table 816.6A — Fallow
T_t (SFF)=	3.12	minutes	

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

NOTES:

HIGH PT ELEVATION	643.0	ft	
LOW POINT ELEVATION	639.8	ft	
ELEVATION DIFF (H)	3.2	ft	
LENGTH (L)	134	ft	
SLOPE (S) = (H/L)	2.4%		
VELOCITY (SCF)	1.5	fps	<=V from Figure 816.6 — Nearly bare ground
T_C (SH)=	1.49	minutes	

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

NOTES:

HIGH PT ELEVATION	639.8	ft	Brow ditch
LOW POINT ELEVATION	568.0	ft	
ELEVATION DIFF (H)	71.8	ft	
LENGTH (L)	1052	ft	
SLOPE (S) = (H/L)	6.8%		
MANNING'S n	0.015		Rough concrete
HYDRAULIC RADIUS R	0.4	ft	R=(bdsinA+d^2cosA)/(bsinA+2d)
VELOCITY (CHANNEL)	12.99	fps	From Manning's Equation assuming flowing full: $V=1.49/n(R^{2/3}S^{1/2})$
T_C (CH)=	1.35	minutes	

CHANNEL DATA — TYPE = TRAP'Z

Z=	2	ANG-RAD	0.464
b =	2	ANG-DEG	26.565
d =	0.5	FLOWING FULL ASS'M	

A Pre-Developed TcQ

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

NOTES:

HIGH PT ELEVATION	564.0	ft	
LOW POINT ELEVATION	563.0	ft	
ELEVATION DIFF (H)	1.0	ft	
LENGTH (L)	45	ft	
SLOPE (S) = (H/L)	2.2%		
MANNING'S n	0.013		RCP - Exist Fed X
PIPE DIAMETER d	1.5	ft	
HYDRAULIC RADIUS R	0.4	ft	R=D/4, Assume: flowing full
VELOCITY (STORMDRAIN)	8.9	fps	$V = \frac{K_u}{n} R^{2/3} S^{1/2}$
T_C (SD)=	0.08	minutes	

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

NOTES:

HIGH PT ELEVATION	563.0	ft	
LOW POINT ELEVATION	562.0	ft	
ELEVATION DIFF (H)	1.0	ft	
LENGTH (L)	100	ft	
SLOPE (S) = (H/L)	1.0%		
MANNING'S n	0.013		RCP - Exist Fed X
PIPE DIAMETER d	3.5	ft	
HYDRAULIC RADIUS R	0.9	ft	R=D/4, Assume: flowing full
VELOCITY (STORMDRAIN)	10.5	fps	$V = \frac{K_u}{n} R^{2/3} S^{1/2}$
T_C (SD)=	0.16	minutes	

Tc (TOTAL) =	6.20	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 =	8.3
Q_{10} =	12.0
Q_{25} =	16.5
Q_{50} =	21.7
Q_{100} =	**23.5**

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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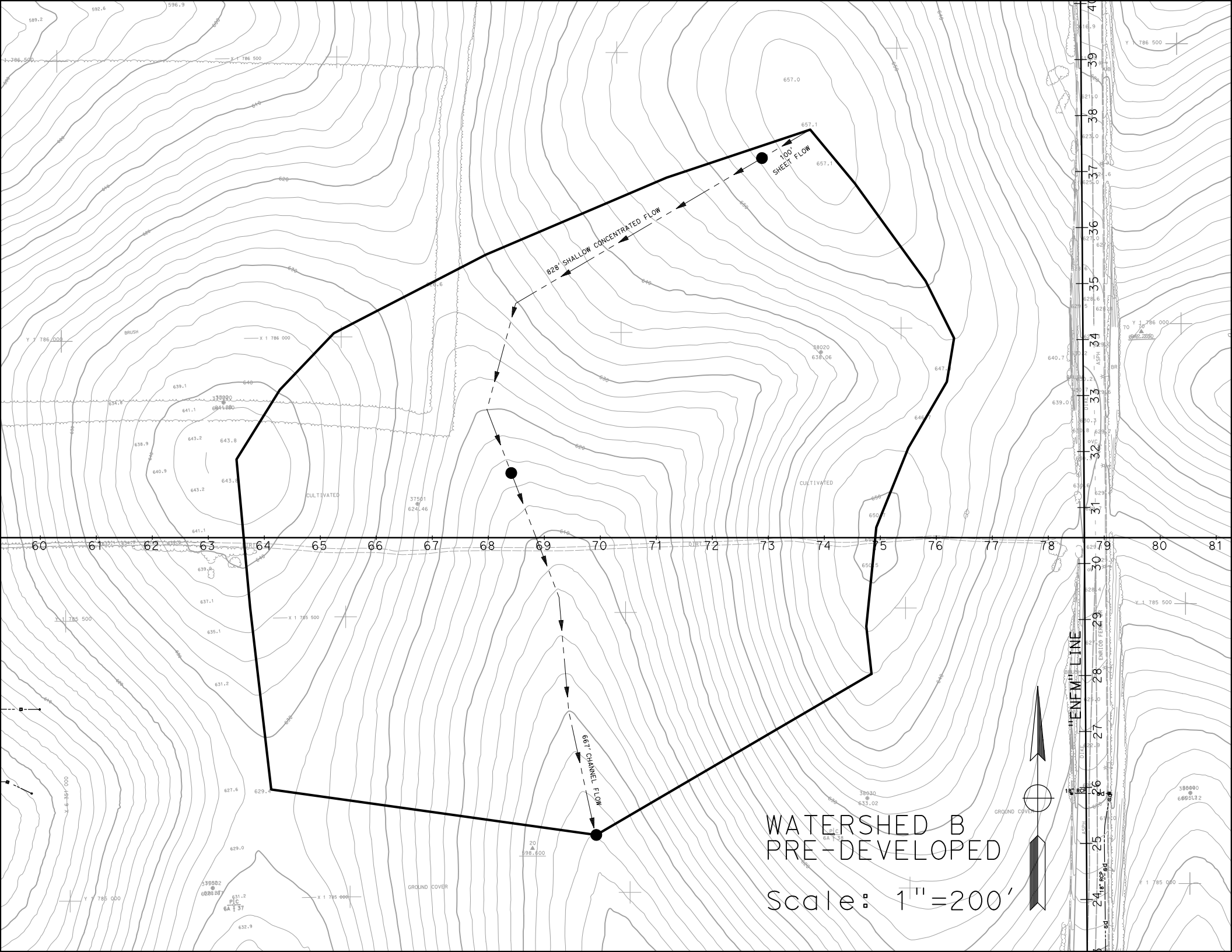
100' SHEET FLOW
828' SHALLOW CONCENTRATED FLOW
667' CHANNEL FLOW
"ENFM" LINE
CULTIVATED
DIRT
GROUND COVER
BRUSH
WATERSHED B
PRE-DEVELOPED
Scale: 1"=200'

B Pre-Developed TcQ

PROJECT:	**SR-11**			**DESCRIPTION:**	**SR-11 Pre-Developed**
JOB #:	**11A1190**			**STATION:**	**69+00**
BY:	**M.BRUNING**	**DATE:**	**01.04.10**	**WATERSHED:**	**B**
CHK:	**G.DALZIEL**	**DATE:**		**SYSTEM:**	

BASIN AREA:

A = **1129872** **ft^2** **SOURCE:** **MICROSTATION/USGS**
25.94 **acres** **(SCALE = 1:1)**

COEFFICIENT OF RUNOFF:

KEY: User Input | Designer Tool

UNDEVELOPED AREA C (FROM HDM FIG. 819.2A)

NOTES:

RELIEF (.08-.35)	0.14	Rolling Slopes ~ 5%
INFILTRATION (.04-.16)	0.12	Negligible infiltration capacity - see Geotechnical Report
VEGETATION (.04-.16)	0.08	Fair natural cover
STORAGE (.04-.12)	0.08	Low
TOTAL C =	0.42	

UNDEVELOPED AREA	100%	AT	0.42	0.420
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%)			

$C_{2,10}$ =	0.42
C_{25} =	0.46
C_{50} =	0.50
C_{100} =	0.53

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	657.1	ft	northern peak
LOW POINT ELEVATION	654.0	ft	
ELEVATION DIFF (H)	3.1	ft	
LENGTH (L)	100	ft	
SLOPE (S) = (H/L)	3.1%		
MANNING'S n	0.150		< = FROM TABLE 816.6A — short grass prarie
T_t (SFF)=	10.96	minutes	

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

NOTES:

HIGH PT ELEVATION	654.0	ft	northern peak
LOW POINT ELEVATION	615.0	ft	
ELEVATION DIFF (H)	39.0	ft	
LENGTH (L)	828	ft	
SLOPE (S) = (H/L)	4.7%		
VELOCITY (SCF)	1.5	fps	V FROM FIG 816.6 — short grass
T_C (SH)=	9.20	minutes	

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

NOTES:

HIGH PT ELEVATION	615.0	ft	Begins to form natural channel
LOW POINT ELEVATION	594.0	ft	
ELEVATION DIFF (H)	21.0	ft	
LENGTH (L)	667	ft	
SLOPE (S) = (H/L)	3.1%		
MANNING'S n	0.080		grass
HYDRAULIC RADIUS R	0.4	ft	R=(bdsinA+d^2cosA)/(bsinA+2d)
VELOCITY (CHANNEL)	1.84	fps	From Manning's Equation assuming flowing full: V=1.49/n($R^{2/3}S^{1/2}$)
T_C (CH)=	6.06	minutes	

CHANNEL DATA		TYPE =	TRAP'Z
Z=	5	ANG-RAD	0.197
b =	10	ANG-DEG	11.310
d =	0.5	FLOWING FULL ASS'M	

B Pre-Developed TcQ

Tc (TOTAL) =	26.22	minutes
Minimum Tc =	10	minutes
USE Tc =	**26.22**	minutes

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

i_2 =	1.0	in/hr	X CA =	**Q_2 =**	10.8
i_{10} =	1.4	in/hr	X CA =	**Q_{10} =**	15.8
i_{25} =	1.8	in/hr	X CA =	**Q_{25} =**	21.7
i_{50} =	2.2	in/hr	X CA =	**Q_{50} =**	28.4
i_{100} =	2.3	in/hr	X CA =	**Q_{100} =**	**30.8**

FLOW RESULTS:

	cfs
Q_2 =	10.8
Q_{10} =	15.8
Q_{25} =	21.7
Q_{50} =	28.4
Q_{100} =	**30.8**

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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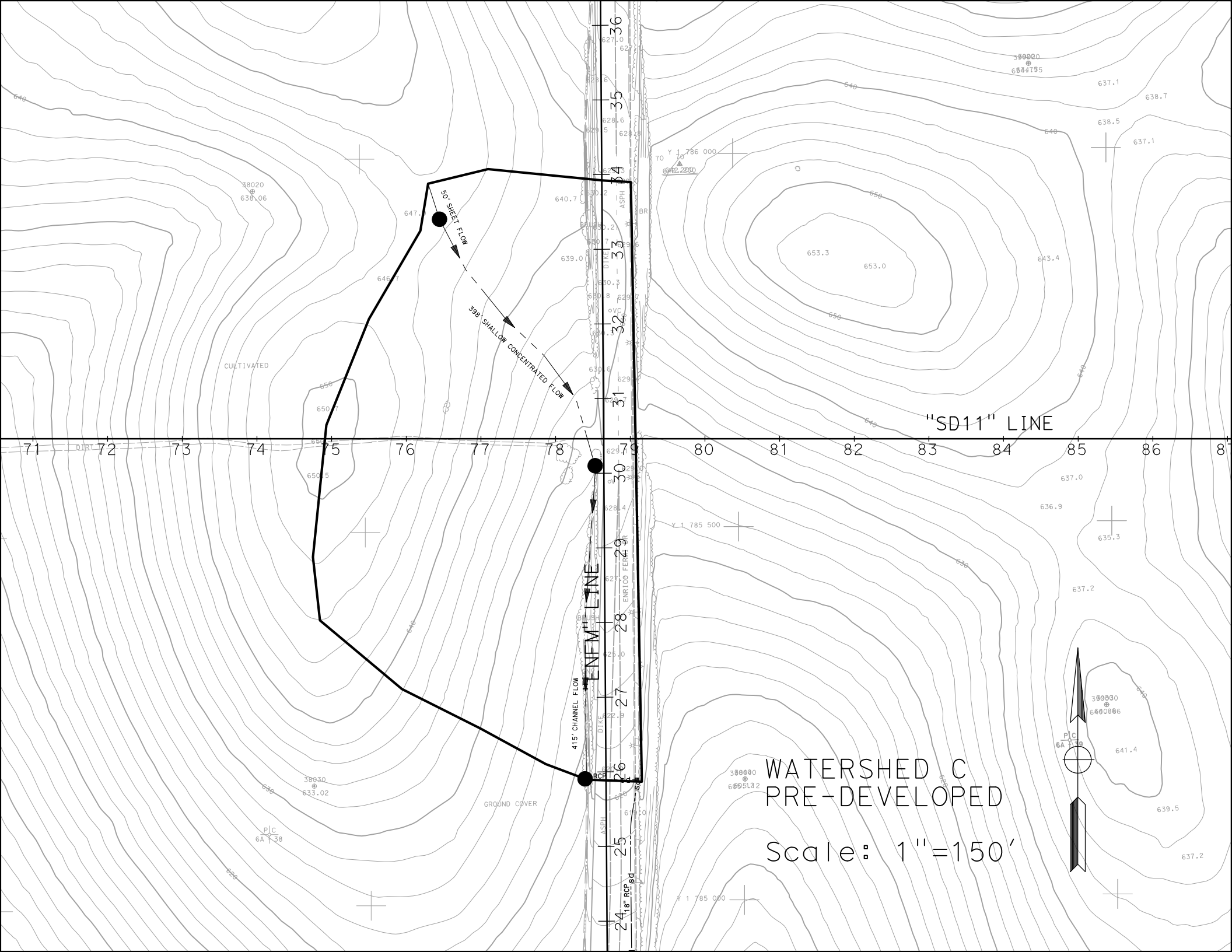

50' SHEET FLOW
398' SHALLOW CONCENTRATED FLOW
415' CHANNEL FLOW
"ENFM" LINE
"SD11" LINE
18" RCP sd
RCP
CULTIVATED
GROUND COVER
WATERSHED C
PRE-DEVELOPED
Scale: 1"=150'

C Pre-Developed TcQ

PROJECT:	**SR-11**			**DESCRIPTION:**	**SR-11 Pre-Developed**
JOB #:	**11A1190**			**STATION:**	**78+00**
BY:	**M.BRUNING**	**DATE:**	**01.04.10**	**WATERSHED:**	**C**
CHK:	**G.DALZIEL**	**DATE:**		**SYSTEM:**	

BASIN AREA:

A =	**282823**	**ft^2**	**SOURCE:**	**MICROSTATION/USGS**
	6.49	**acres**		**(SCALE = 1:1)**

COEFFICIENT OF RUNOFF:

KEY: User Input | Designer Tool

UNDEVELOPED AREA C (FROM HDM FIG. 819.2A)

		NOTES:
RELIEF (.08-.35)	0.14	Rolling Slopes ~ 7.5%
INFILTRATION (.04-.16)	0.12	Negligible infiltration capacity - See Geotechnical Report
VEGETATION (.04-.16)	0.08	Poor natural cover
STORAGE (.04-.12)	0.08	Low
TOTAL C =	0.42	

UNDEVELOPED AREA	88%	AT	0.42	0.368
PAVED SURFACE	12%	AT	0.90	0.111
COMMERCIAL AREA	0%	AT	0.85	0.000
CUT SLOPE (2:1 and 4:1)	0%	AT	0.55	0.000
TOTAL	100%			
	(100%)			

$C_{2,10}$ =	0.48
C_{25} =	0.53
C_{50} =	0.58
C_{100} =	0.60

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	647.0	ft	High Point in Watershed, north of alignment
LOW POINT ELEVATION	646.5	ft	
ELEVATION DIFF (H)	0.5	ft	
LENGTH (L)	50	ft	
SLOPE (S) = (H/L)	1.0%		
MANNING'S n	0.050		< = From Table 816.6A Fallow
T_t (SFF)=	4.11	minutes	

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

NOTES:

HIGH PT ELEVATION	646.5	ft	
LOW POINT ELEVATION	628.0	ft	origin of existing concrete ditch along west side of Enrico Ferm
ELEVATION DIFF (H)	18.5	ft	
LENGTH (L)	398	ft	
SLOPE (S) = (H/L)	4.6%		
VELOCITY (SCF)	1.5	fps	V FROM FIG 816.6 nearly bare ground
T_c (SH)=	4.42	minutes	

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

NOTES:

HIGH PT ELEVATION	628.0	ft	Existing concrete ditch along west side of Enrico Fermi
LOW POINT ELEVATION	619.0	ft	CHANNEL DATA TYPE = TRAP'Z
ELEVATION DIFF (H)	9.0	ft	Z= 1 ANG-RAD 0.785
LENGTH (L)	415	ft	b = 1.5 ANG-DEG 45.000
SLOPE (S) = (H/L)	2.2%		d = 0.5 FLOWING FULL ASS'M
MANNING'S n	0.015		rough concrete
HYDRAULIC RADIUS R	0.3	ft	R=(bdsinA+d^2cosA)/(bsinA+2d)
VELOCITY (CHANNEL)	7.17	fps	From Manning's Equation assuming flowing full: $V=1.49/n(R^{2/3}S^{1/2})$
T_c (CH)=	0.96	minutes	

Tc (TOTAL) =	9.50	minutes
Minimum Tc =	10	minutes
USE Tc =	**10.00**	minutes

INTENSITY CHART:

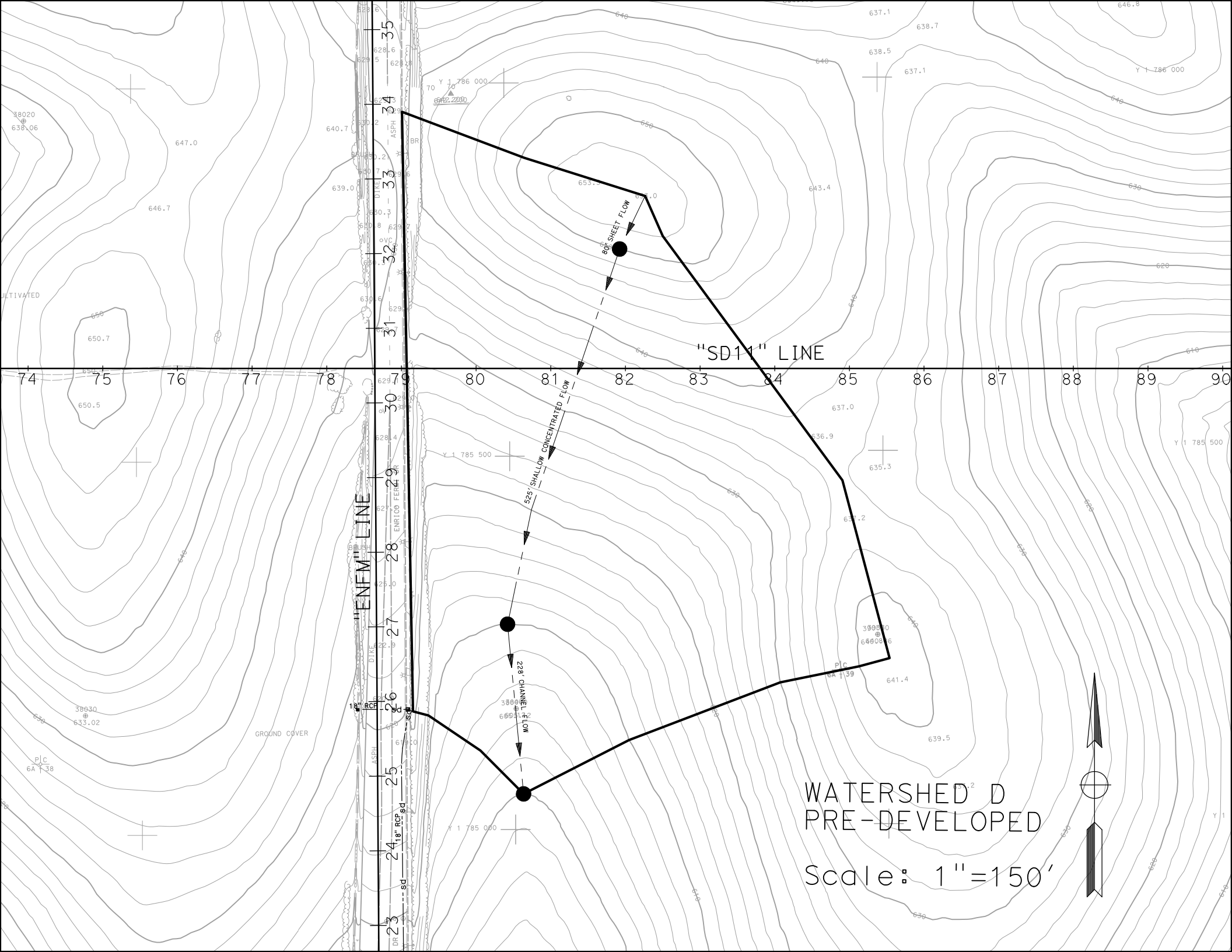
$I = 7.44\,P_6\,D^{-0.645}$

i_2 =	1.9	in/hr	X CA =	**Q_2 =**	5.8
i_{10} =	2.7	in/hr	X CA =	**Q_{10} =**	8.4
i_{25} =	3.4	in/hr	X CA =	**Q_{25} =**	11.5
i_{50} =	4.0	in/hr	X CA =	**Q_{50} =**	15.1
i_{100} =	4.2	in/hr	X CA =	**Q_{100} =**	**16.4**

FLOW RESULTS:

COUNTY P_6

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


"SD11" LINE
"ENFM" LINE
80' SHEET FLOW
525' SHALLOW CONCENTRATED FLOW
228' CHANNEL FLOW
18" RCP sd
WATERSHED D
PRE-DEVELOPED
Scale: 1"=150'

D Pre-Developed TcQ

PROJECT:	**SR-11**			**DESCRIPTION:**	**SR-11 Pre-Developed**
JOB #:	**11A1190**			**STATION:**	**80+00**
BY:	**M.BRUNING**	**DATE:**	**01.04.10**	**WATERSHED:**	**D**
CHK:	**G.DALZIEL**	**DATE:**		**SYSTEM:**	

BASIN AREA:

A =	**387314**	**ft^2**	**SOURCE:**	**MICROSTATION/USGS**
	8.89	**acres**		**(SCALE = 1:1)**

COEFFICIENT OF RUNOFF:

KEY: User Input | Designer Tool

UNDEVELOPED AREA C (FROM HDM FIG. 819.2A)

		NOTES:
RELIEF (.08-.35)	0.14	Rolling Slopes ~ 5%
INFILTRATION (.04-.16)	0.12	Negligible infiltration capacity - see Geotechnical Report
VEGETATION (.04-.16)	0.08	Fair natural cover
STORAGE (.04-.12)	0.08	Low
TOTAL C =	0.42	

UNDEVELOPED AREA	100%	AT	0.42	0.420
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%)			

$C_{2,10}$ =	0.42
C_{25} =	0.46
C_{50} =	0.50
C_{100} =	0.53

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	653.0	ft	High Point in Watershed, north of SR-11
LOW POINT ELEVATION	650.0	ft	
ELEVATION DIFF (H)	3.0	ft	
LENGTH (L)	80	ft	
SLOPE (S) = (H/L)	3.8%		
MANNING'S n	0.050		< = From Table 816.6A — Fallow
T_t (SFF)=	3.53	minutes	

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

NOTES:

HIGH PT ELEVATION	650.0	ft	
LOW POINT ELEVATION	610.0	ft	
ELEVATION DIFF (H)	40.0	ft	
LENGTH (L)	525	ft	
SLOPE (S) = (H/L)	7.6%		
VELOCITY (SCF)	2.5	fps	V FROM FIG 816.6 — nearly bare ground
T_C (SH)=	3.50	minutes	

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

NOTES:

HIGH PT ELEVATION	610.0	ft	begins to channelize
LOW POINT ELEVATION	600.0	ft	CHANNEL DATA — TYPE = TRAP'Z
ELEVATION DIFF (H)	10.0	ft	Z= 5 — ANG-RAD 0.197
LENGTH (L)	228	ft	b = 2 — ANG-DEG 11.310
SLOPE (S) = (H/L)	4.4%		d = 0.5 — FLOWING FULL ASS'M
MANNING'S n	0.150		short prairie grass
HYDRAULIC RADIUS R	0.3	ft	R=(bdsinA+d^2cosA)/(bsinA+2d)
VELOCITY (CHANNEL)	0.97	fps	From Manning's Equation assuming flowing full: $V=1.49/n(R^{2/3}S^{1/2})$
T_C (CH)=	3.93	minutes	

D Pre-Developed TcQ

Tc (TOTAL) =	10.96	minutes
Minimum Tc =	10	minutes
USE Tc =	**10.96**	minutes

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

i_2 =	1.7	in/hr	X CA =	**Q_2 =**	6.5
i_{10} =	2.5	in/hr	X CA =	**Q_{10} =**	9.5
i_{25} =	3.2	in/hr	X CA =	**Q_{25} =**	13.0
i_{50} =	3.8	in/hr	X CA =	**Q_{50} =**	17.1
i_{100} =	4.0	in/hr	X CA =	**Q_{100} =**	**18.5**

FLOW RESULTS:

	cfs
Q_2 =	6.5
Q_{10} =	9.5
Q_{25} =	13.0
Q_{50} =	17.1
Q_{100} =	**18.5**

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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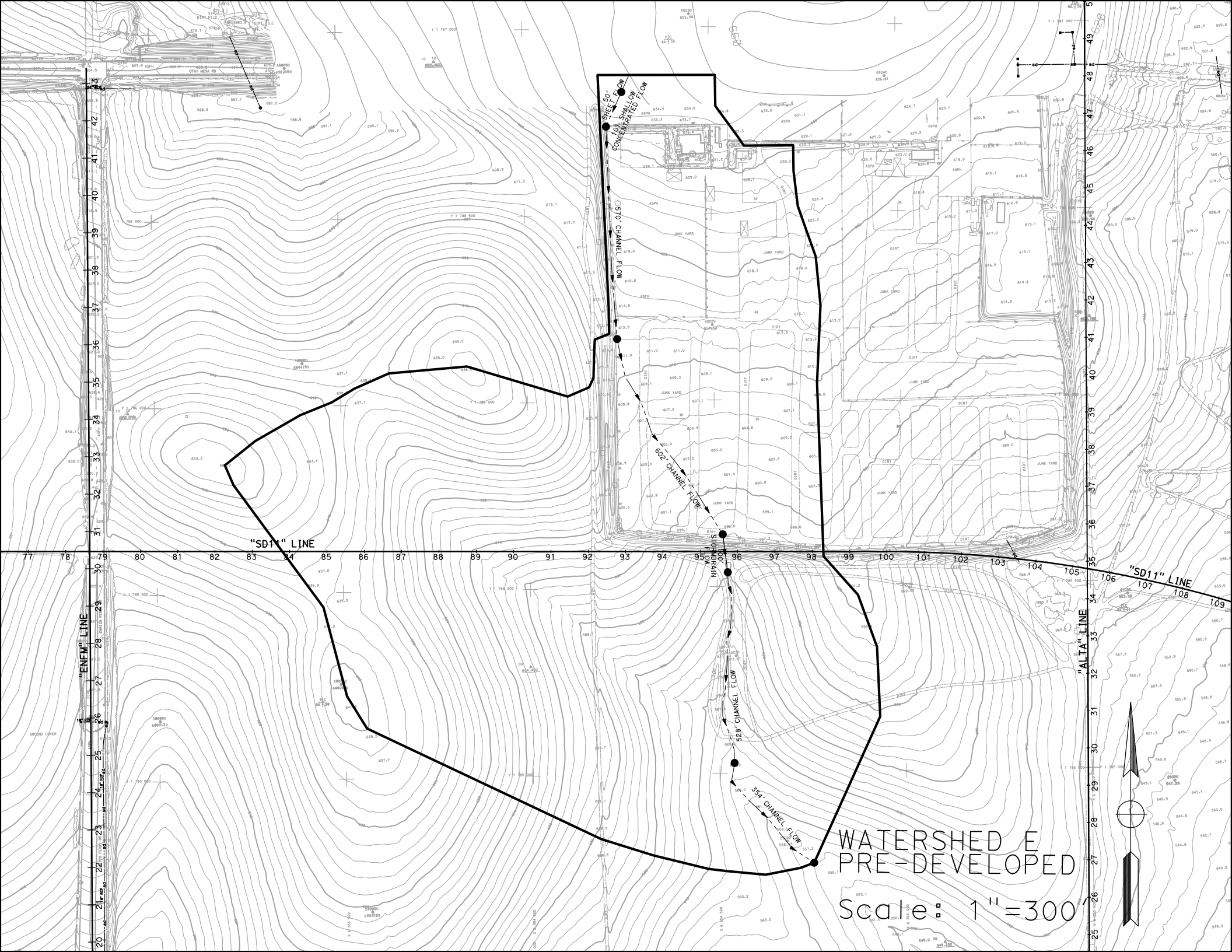
SHEET FLOW
50'
SHALLOW CONCENTRATED FLOW
510' CHANNEL FLOW
602' CHANNEL FLOW
528' CHANNEL FLOW
354' CHANNEL FLOW
"SD11" LINE
"ENFM" LINE
"ALTA" LINE
WATERSHED E
PRE-DEVELOPED
Scale: 1"=300'

E Pre-Developed TcQ

PROJECT:	**SR-11**			**DESCRIPTION:**	**SR-11 Pre-Developed**
JOB #:	**11A1190**			**STATION:**	**96+00**
BY:	**M.BRUNING**	**DATE:**	**01.05.10**	**WATERSHED:**	**E**
CHK:	**G.DALZIEL**	**DATE:**		**SYSTEM:**	

BASIN AREA:

A = **2097450** **ft^2** **SOURCE:** **MICROSTATION/USGS**
48.15 **acres** **(SCALE = 1:1)**

COEFFICIENT OF RUNOFF:

KEY: User Input | Designer Tool

UNDEVELOPED AREA C (FROM HDM FIG. 819.2A)

NOTES:

RELIEF (.08-.35)	0.15	Rolling Slopes ~ 7.5%
INFILTRATION (.04-.16)	0.12	Negligible infiltration capacity - see Geotechnical Report
VEGETATION (.04-.16)	0.08	Fair natural cover
STORAGE (.04-.12)	0.08	Low
TOTAL C =	0.43	

UNDEVELOPED AREA	99%	AT	0.43	0.426
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%)			

$C_{2,10}$ =	0.43
C_{25} =	0.48
C_{50} =	0.52
C_{100} =	0.54

TIME OF CONCENTRATION:

SHEET FLOW: $T_t = \frac{0.42L^{.8}n^{.8}}{P_2^{.5}s^{.2}}$

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

HIGH PT ELEVATION	635.0	ft	South of Otay Mesa Road - Driveway Area
LOW POINT ELEVATION	634.7	ft	
ELEVATION DIFF (H)	0.3	ft	
LENGTH (L)	50	ft	
SLOPE (S) = (H/L)	0.6%		
MANNING'S n	0.016		< = From Table 816.6A Asphalt
T_t (SFF)=	2.03	minutes	

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

NOTES:

HIGH PT ELEVATION	634.7	ft	Mid-driveway
LOW POINT ELEVATION	633.0	ft	North end of Junk Yard
ELEVATION DIFF (H)	1.7	ft	
LENGTH (L)	101	ft	
SLOPE (S) = (H/L)	1.7%		
VELOCITY (SCF)	1.5	fps	<=V FROM FIG 816.5 Asphalt
T_C (SH)=	1.12	minutes	

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

NOTES:

HIGH PT ELEVATION	633.0	ft	channel along western side of junk yard
LOW POINT ELEVATION	612.0	ft	CHANNEL DATA TYPE = TRAP'Z
ELEVATION DIFF (H)	21.0	ft	Z= 2 ANG-RAD 0.464
LENGTH (L)	570	ft	b = 1 ANG-DEG 26.565
SLOPE (S) = (H/L)	3.7%		d = 0.5 FLOWING FULL ASS'M
MANNING'S n	0.050		earthen/dirt
HYDRAULIC RADIUS R	0.3	ft	R=(bdsinA+d^2cosA)/(bsinA+2d)
VELOCITY (CHANNEL)	2.61	fps	From Manning's Equation assuming flowing full: $V=1.49/n(R^{2/3}S^{1/2})$
T_C (CH)=	3.63	minutes	

E Pre-Developed TcQ

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

HIGH PT ELEVATION	612.0	ft
LOW POINT ELEVATION	596.0	ft
ELEVATION DIFF (H)	16.0	ft
LENGTH (L)	602	ft
SLOPE (S) = (H/L)	2.7%	
MANNING'S n	0.100	
HYDRAULIC RADIUS R	0.3	ft
VELOCITY (CHANNEL)	1.06	fps
T_C (CH)=	9.49	minutes

NOTES:

Begins to broaden across junk yard

CHANNEL DATA		TYPE =	TRAP'Z
Z=	5	ANG-RAD	0.197
b =	1	ANG-DEG	11.310
d =	0.5	FLOWING FULL ASS'M	

dirt with junk yard obstructions

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	596.0	ft
LOW POINT ELEVATION	580.0	ft
ELEVATION DIFF (H)	16.0	ft
LENGTH (L)	100	ft
SLOPE (S) = (H/L)	16.0%	
MANNING'S n	0.013	
PIPE DIAMETER d	2.0	ft
HYDRAULIC RADIUS R	0.5	ft
VELOCITY (STORMDRAIN)	28.9	fps
T_C (SD)=	0.06	minutes

NOTES:

Existing down drain at southern end of junk yard

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	580.0	ft
LOW POINT ELEVATION	565.2	ft
ELEVATION DIFF (H)	14.8	ft
LENGTH (L)	528	ft
SLOPE (S) = (H/L)	2.8%	
MANNING'S n	0.100	
HYDRAULIC RADIUS R	0.6	ft
VELOCITY (CHANNEL)	1.81	fps
T_C (CH)=	4.86	minutes

NOTES:

Natural Channel

CHANNEL DATA		TYPE =	TRAP'Z
Z=	2	ANG-RAD	0.464
b =	2	ANG-DEG	26.565
d =	1	FLOWING FULL ASS'M	

grass

R=(bdsinA+d^2cosA)/(bsinA+2d)

From Manning's Equation assuming flowing full: $V=1.49/n(R^{2/3}S^{1/2})$

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

HIGH PT ELEVATION	565.2	ft
LOW POINT ELEVATION	556.0	ft
ELEVATION DIFF (H)	9.2	ft
LENGTH (L)	354	ft
SLOPE (S) = (H/L)	2.6%	
MANNING'S n	0.100	
HYDRAULIC RADIUS R	0.7	ft
VELOCITY (CHANNEL)	1.81	fps
T_C (CH)=	3.26	minutes

NOTES:

Begins to broaden

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

grass

R=(bdsinA+d^2cosA)/(bsinA+2d)

From Manning's Equation assuming flowing full: $V=1.49/n(R^{2/3}S^{1/2})$

Tc (TOTAL) =	24.46	minutes
Minimum Tc =	10	minutes
USE Tc =	**24.46**	minutes

Total Length of Run (ft) = 2305

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

i_2 =	1.0	in/hr	X CA =
i_{10} =	1.5	in/hr	X CA =
i_{25} =	1.9	in/hr	X CA =
i_{50} =	2.3	in/hr	X CA =
i_{100} =	2.4	in/hr	X CA =

FLOW RESULTS:

	cfs
Q_2 =	21.8
Q_{10} =	31.7
Q_{25} =	43.6
Q_{50} =	57.0
Q_{100} =	**61.9**

COUNTY P_6

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

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WATERSHED F
PRE-DEVELOPED

Scale: 1"=450'

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: $T_t = \frac{0.42L^{.45}n^{.45}}{P_2^{.12}s^{.25}}$

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:

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 816.5 — 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	

F Pre-Developed TcQ

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

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

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

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

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

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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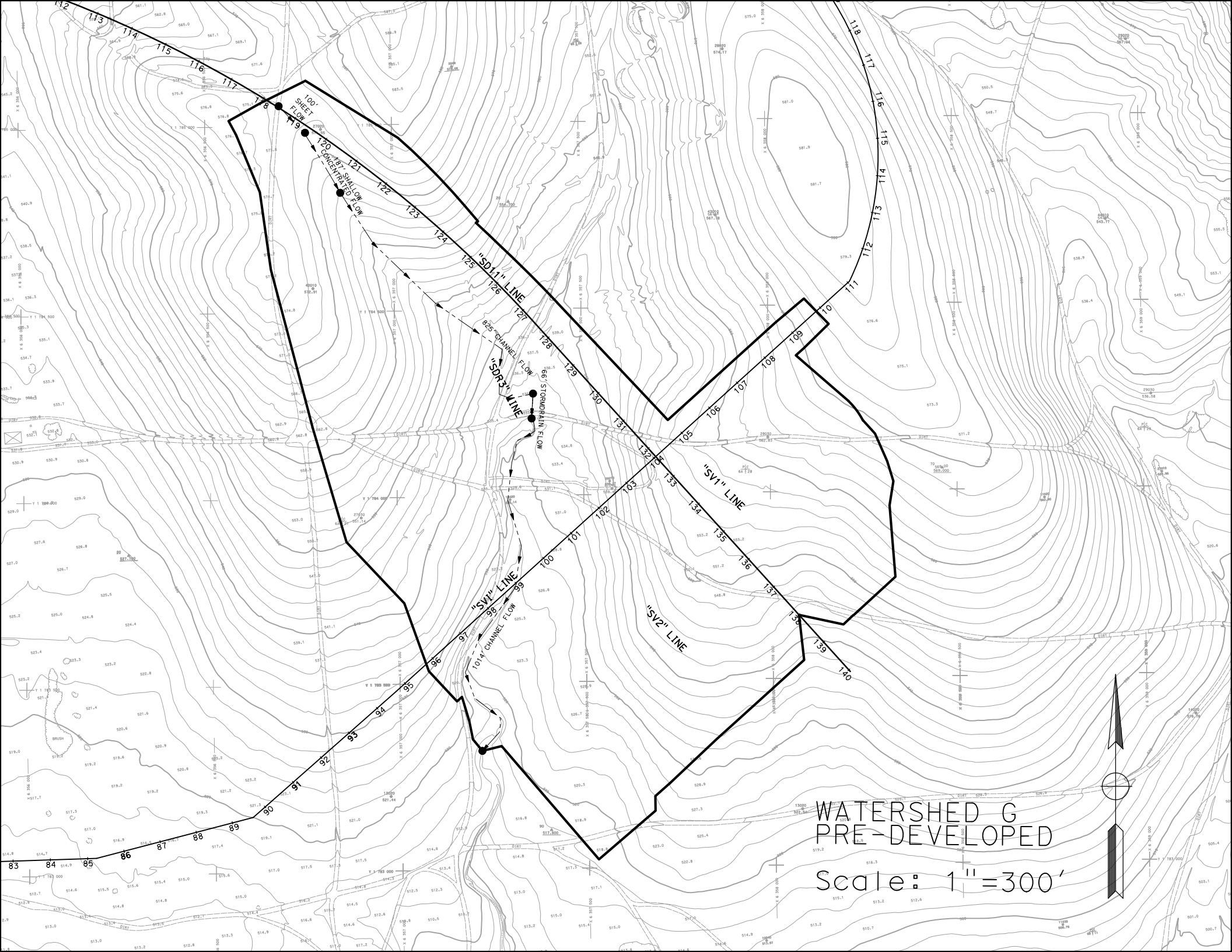
100' SHEET FLOW
487' SHALLOW CONCENTRATED FLOW
825' CHANNEL FLOW
"SD1.1" LINE
"SDR3" LINE
66" STORMDRAIN FLOW
"SV1" LINE
"SV1" LINE
1014' CHANNEL FLOW
"SV2" LINE
WATERSHED G
PRE-DEVELOPED
Scale: 1"=300'

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 816.5 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	
LENGTH (L)	825	ft	
SLOPE (S) = (H/L)	3.7%		
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	

Z=	4	ANG-RAD	0.245
b =	20	ANG-DEG	14.036
d =	1	FLOWING FULL ASS'M	

G Pre-Developed TcQ

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

HIGH PT ELEVATION	535.4	ft
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	
PIPE DIAMETER d	3.0	ft
HYDRAULIC RADIUS R	0.8	ft
VELOCITY (STORMDRAIN)	12.7	fps
T_C (SD)=	0.09	minutes

NOTES:

Existing culvert under path

CMP

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	532.0	ft
LOW POINT ELEVATION	514.0	ft
ELEVATION DIFF (H)	18.0	ft
LENGTH (L)	1014	ft
SLOPE (S) = (H/L)	1.8%	
MANNING'S n	0.080	
HYDRAULIC RADIUS R	1.4	ft
VELOCITY (CHANNEL)	3.13	fps
T_C (CH)=	5.40	minutes

NOTES:

large channel at base of watershed

CHANNEL DATA		TYPE =	TRAP'Z
Z=	2	ANG-RAD	0.464
b =	8	ANG-DEG	26.565
d =	2	FLOWING FULL ASS'M	

Natural channel

R=(bdsinA+d^2cosA)/(bsinA+2d)

From Manning's Equation assuming flowing full: $V=1.49/n(R^{2/3}S^{1/2})$

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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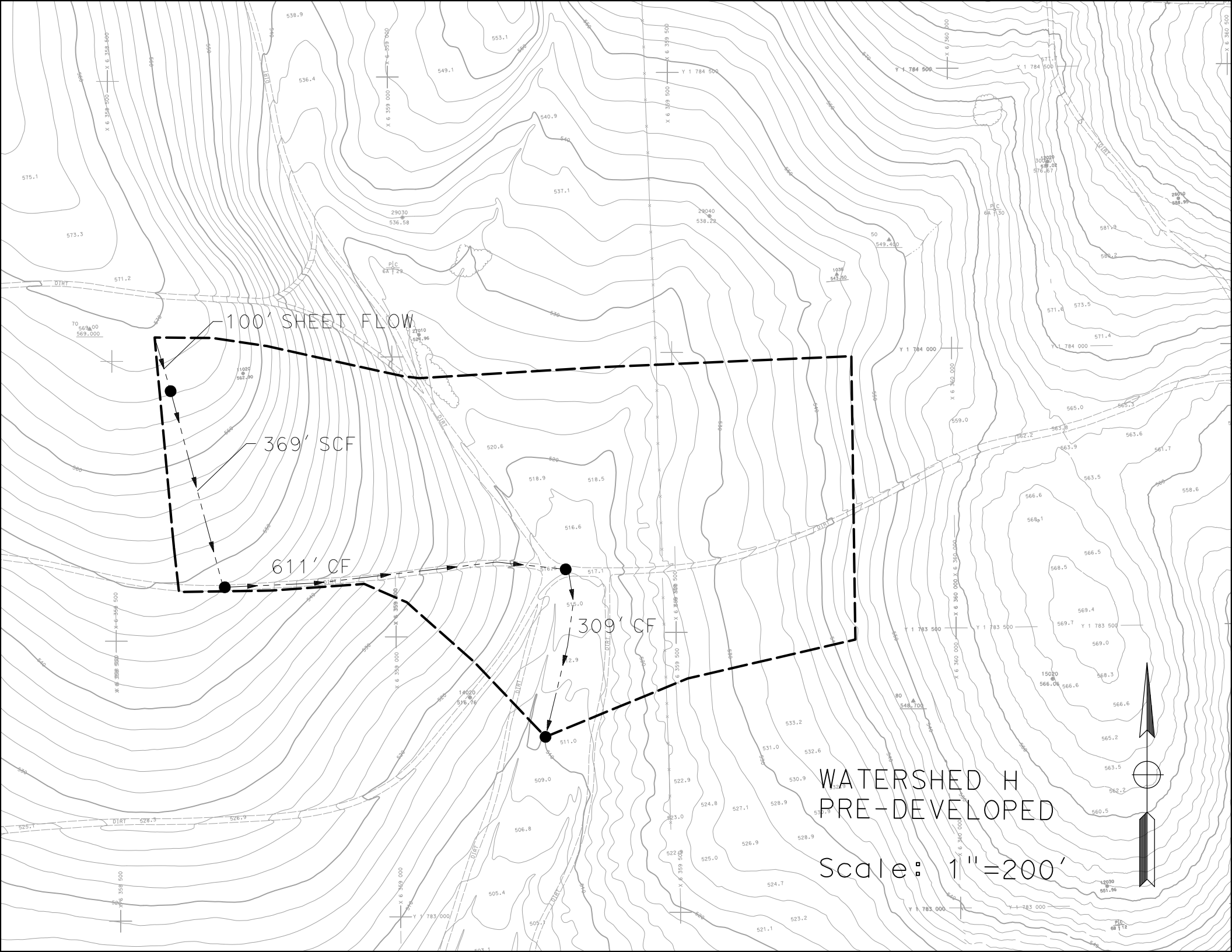
100' SHEET FLOW
369' SCF
611' CF
309' CF
WATERSHED H
PRE-DEVELOPED
Scale: 1"=200'

H Pre-Developed TcQ

PROJECT:	**SR-11**			**DESCRIPTION:**	**SR-11 Pre-Developed**
JOB #:	**11A1190**			**STATION:**	**CVEF**
BY:	**M.BRUNING**	**DATE:**	**01.12.10**	**WATERSHED:**	**H**
CHK:	**G.DALZIEL**	**DATE:**		**SYSTEM:**	

BASIN AREA:

A = **624154** **ft^2** **SOURCE:** **MICROSTATION/USGS**
14.33 **acres** **(SCALE = 1:1)**

COEFFICIENT OF RUNOFF:

KEY: User Input | Designer Tool

UNDEVELOPED AREA C (FROM HDM FIG. 819.2A)

RELIEF (.08-.35)	0.22	Hilly Slopes ~ 15%
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 =	0.49	

UNDEVELOPED AREA	100%	AT	0.49	0.490
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%)			

$C_{2,10}$ =	0.49
C_{25} =	0.54
C_{50} =	0.59
C_{100} =	0.61

TIME OF CONCENTRATION:

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

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

HIGH PT ELEVATION	569.0	ft	Northern watershed boundary
LOW POINT ELEVATION	566.0	ft	
ELEVATION DIFF (H)	3.0	ft	
LENGTH (L)	100	ft	
SLOPE (S) = (H/L)	3.0%		
MANNING'S n	0.050		< = From Table 816.6A — Fallow
T_t (SFF)=	4.61	minutes	

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

NOTES:

HIGH PT ELEVATION	566.0	ft	down slope
LOW POINT ELEVATION	548.0	ft	
ELEVATION DIFF (H)	18.0	ft	
LENGTH (L)	369	ft	
SLOPE (S) = (H/L)	4.9%		
VELOCITY (SCF)	1.5	fps	<=V From Figure 816.6 — Short Grass Pasture/Nearly Bare Ground
T_c (SH)=	4.10	minutes	

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

NOTES:

HIGH PT ELEVATION	548.0	ft	channelizes in dirt trail
LOW POINT ELEVATION	516.0	ft	
ELEVATION DIFF (H)	32.0	ft	
LENGTH (L)	611	ft	
SLOPE (S) = (H/L)	5.2%		
MANNING'S n	0.050		Natural Channel
HYDRAULIC RADIUS R	0.4	ft	R=(bdsinA+d^2cosA)/(bsinA+2d)
VELOCITY (CHANNEL)	4.00	fps	From Manning's Equation assuming flowing full: $V=1.49/n(R^{2/3}S^{1/2})$
T_c (CH)=	2.54	minutes	

CHANNEL DATA — TYPE = TRAP'Z

Z=	2	ANG-RAD	0.464
b =	10	ANG-DEG	26.565
d =	0.5	FLOWING FULL ASS'M	

H Pre-Developed TcQ

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

HIGH PT ELEVATION	516.0	ft
LOW POINT ELEVATION	510.0	ft
ELEVATION DIFF (H)	6.0	ft
LENGTH (L)	309	ft
SLOPE (S) = (H/L)	1.9%	
MANNING'S n	0.080	
HYDRAULIC RADIUS R	1.9	ft
VELOCITY (CHANNEL)	3.92	fps
T_C (CH)=	1.31	minutes

NOTES:

broader channel at confluence

CHANNEL DATA		TYPE =	TRAP'Z
Z=	4	ANG-RAD	0.245
b =	100	ANG-DEG	14.036
d =	2	FLOWING FULL ASS'M	

Natural Channel

R=(bdsinA+d^2cosA)/(bsinA+2d)

From Manning's Equation assuming flowing full: $V=1.49/n(R^{2/3}S^{1/2})$

Tc (TOTAL) =	12.57	minutes
Minimum Tc =	10	minutes
USE Tc =	**12.57**	minutes

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

i_2 =	1.6	in/hr	X CA =	
i_{10} =	2.3	in/hr	X CA =	
i_{25} =	2.9	in/hr	X CA =	
i_{50} =	3.5	in/hr	X CA =	
i_{100} =	3.6	in/hr	X CA =	

FLOW RESULTS:

	cfs
Q_2 =	11.2
Q_{10} =	16.3
Q_{25} =	22.5
Q_{50} =	29.4
Q_{100} =	**31.9**

COUNTY P_6

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

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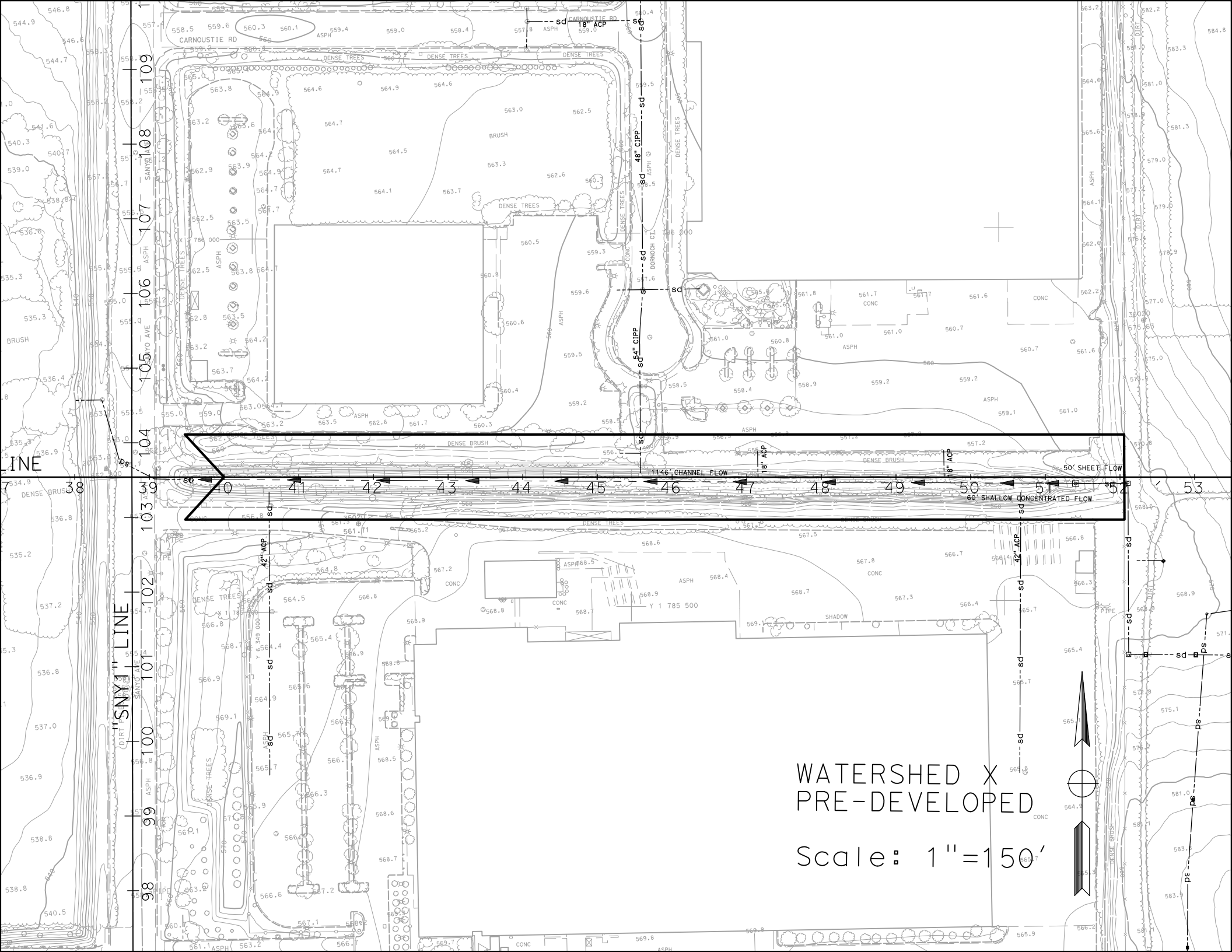

WATERSHED X
PRE-DEVELOPED
Scale: 1"=150'
1146' CHANNEL FLOW
50' SHEET FLOW
60' SHALLOW CONCENTRATED FLOW
18" ACP
42" ACP
48" CIPP
54" CIPP
CARNOUSTIE RD
SANYO AVE
DORNOCH CT
DENSE TREES
DENSE BRUSH
BRUSH
ASPH
CONC
SHADOW
SNY11" LINE

X Pre-Developed TcQ

PROJECT:	**SR-11**			**DESCRIPTION:**	**SR-11 Pre-Developed**
JOB #:	**11A1190**			**STATION:**	**40+00**
BY:	**M.BRUNING**	**DATE:**	**01.25.10**	**WATERSHED:**	**X**
CHK:	**G.DALZIEL**	**DATE:**		**SYSTEM:**	**X**

BASIN AREA:

A = 140433 ft^2 / 3.22 acres

SOURCE: MICROSTATION/USGS (SCALE = 1:1)

COEFFICIENT OF RUNOFF:

KEY: User Input | Designer Tool

UNDEVELOPED AREA C (FROM HDM FIG. 819.2A)

RELIEF (.08-.35)	0.30	Steep, Rugged Slopes ~ 30%
INFILTRATION (.04-.16)	0.12	Negligible infiltration capacity - See Geotechnical Report
VEGETATION (.04-.16)	0.06	Good natural cover
STORAGE (.04-.12)	0.04	High
TOTAL C =	0.52	

UNDEVELOPED AREA	76%	AT	0.52	0.395
PAVED SURFACE	24%	AT	0.90	0.217
COMMERCIAL AREA	0%	AT	0.85	0.000
CUT SLOPE (2:1 and 4:1)	0%	AT	0.55	0.000
TOTAL	100%			
	(100%)			

$C_{2,10}$ =	0.61
C_{25} =	0.67
C_{50} =	0.73
C_{100} =	0.76

TIME OF CONCENTRATION:

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

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

HIGH PT ELEVATION	568.0	ft	Upstream end of existing detention facility
LOW POINT ELEVATION	560.0	ft	
ELEVATION DIFF (H)	8.0	ft	
LENGTH (L)	50	ft	
SLOPE (S) = (H/L)	16.0%		
MANNING'S n	0.150		< = from Table 816.6A Grass
T_t (SFF)=	3.27	minutes	

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

NOTES:

HIGH PT ELEVATION	560.0	ft	slope towards detention facility
LOW POINT ELEVATION	550.0	ft	
ELEVATION DIFF (H)	10.0	ft	
LENGTH (L)	60	ft	
SLOPE (S) = (H/L)	16.7%		
VELOCITY (SCF)	2.5	fps	<=V FROM FIG 816.6 Grass
T_C (SH)=	0.40	minutes	

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

NOTES:

HIGH PT ELEVATION	550.0	ft	channelizes towards Sanyo
LOW POINT ELEVATION	542.0	ft	CHANNEL DATA TYPE = TRAP'Z
ELEVATION DIFF (H)	8.0	ft	Z= 1.5 ANG-RAD 0.588
LENGTH (L)	1146	ft	b = 15 ANG-DEG 33.690
SLOPE (S) = (H/L)	0.7%		d = 5 FLOWING FULL ASS'M
MANNING'S n	0.015		concrete - per as-builts
HYDRAULIC RADIUS R	3.4	ft	R=(bdsinA+d^2cosA)/(bsinA+2d)
VELOCITY (CHANNEL)	18.79	fps	From Manning's Equation assuming flowing full: $V=1.49/n(R^{2/3}S^{1/2})$
T_C (CH)=	1.02	minutes	

Tc (TOTAL) =	4.68	minutes
Minimum Tc =	10	minutes
USE Tc =	**10.00**	minutes

INTENSITY CHART:

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

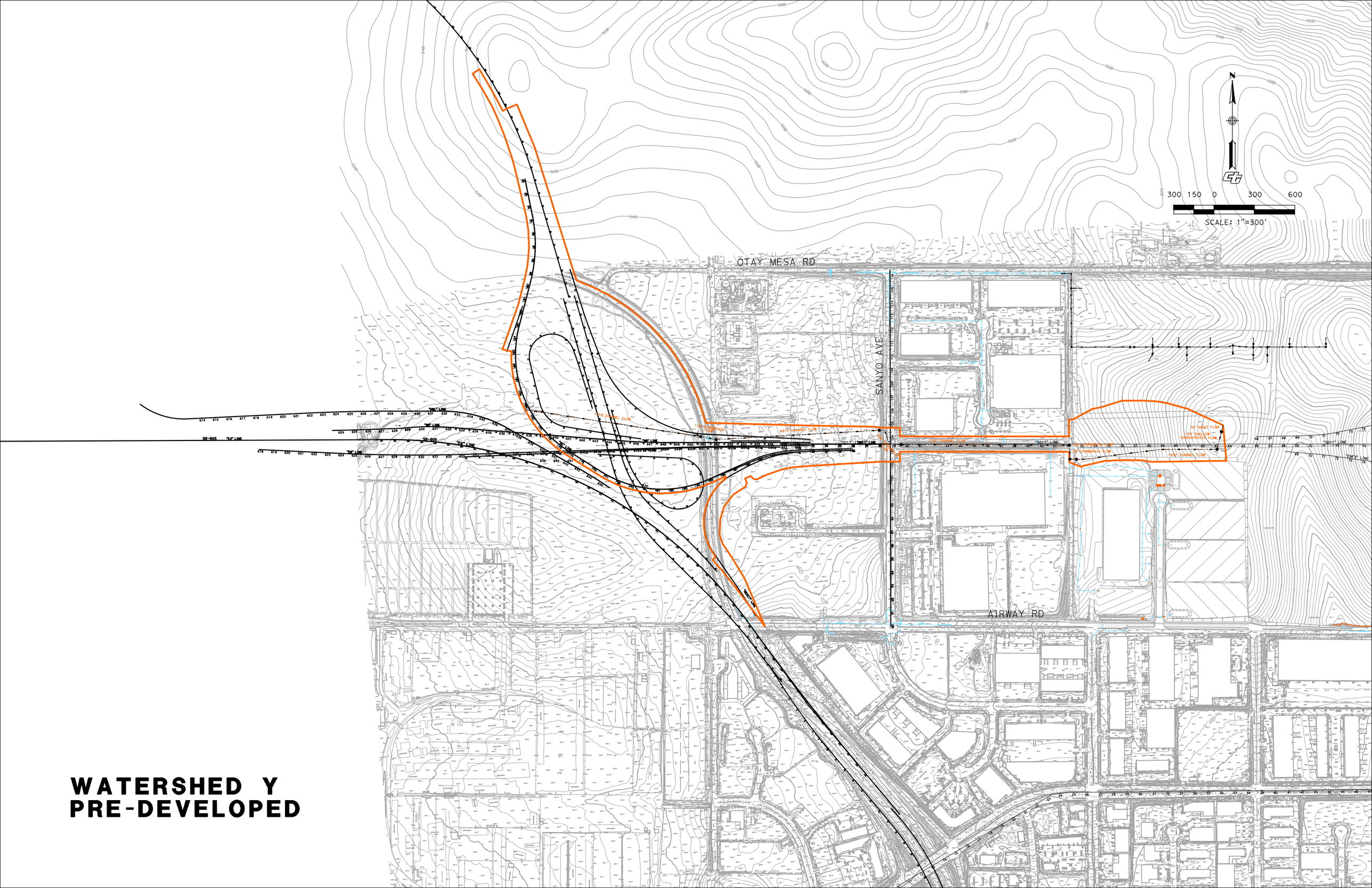
i_2 =	1.9	in/hr	X CA =	Q_2 =	3.7
i_{10} =	2.7	in/hr	X CA =	Q_{10} =	5.3
i_{25} =	3.4	in/hr	X CA =	Q_{25} =	7.3
i_{50} =	4.0	in/hr	X CA =	Q_{50} =	9.6
i_{100} =	4.2	in/hr	X CA =	Q_{100} =	**10.4**

FLOW RESULTS:

cfs

COUNTY P_6

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



WATERSHED Y
PRE-DEVELOPED

Y Pre-Developed TcQ

PROJECT:	**SR-11**			**DESCRIPTION:**	**SR-11 Pre-Developed**
JOB #:	**11A1190**			**STATION:**	**125/905**
BY:	**M.BRUNING**	**DATE:**	**02.19.10**	**WATERSHED:**	**Y**
CHK:	**G.DALZIEL**	**DATE:**		**SYSTEM:**	

BASIN AREA:

A =	**3170368**	**ft^2**	**SOURCE:**	**MICROSTATION/USGS**
	72.78	**acres**		**(SCALE = 1:1)**

COEFFICIENT OF RUNOFF:

KEY: User Input | Designer Tool

UNDEVELOPED AREA C (FROM HDM FIG. 819.2A)

RELIEF (.08-.35)	0.09	Average Slopes ~ 1%
INFILTRATION (.04-.16)	0.12	Negligible Infiltration Capacity - See Geotechnical Report
VEGETATION (.04-.16)	0.12	Poor Natural Cover
STORAGE (.04-.12)	0.10	Low Surface Storage
TOTAL C =	0.43	

UNDEVELOPED AREA	93%	AT	0.43	0.398
PAVED SURFACE	7%	AT	0.90	0.067
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} =	0.51
C_{50} =	0.56
C_{100} =	0.58

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	644.0	ft	Ridgeline at Watershed A
LOW POINT ELEVATION	643.0	ft	
ELEVATION DIFF (H)	1.0	ft	
LENGTH (L)	50	ft	From HP
SLOPE (S) = (H/L)	2.0%		
MANNING'S n	0.050		<=n From Table 816.6A — Fallow
T_t (SFF)=	3.12	minutes	

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

NOTES:

HIGH PT ELEVATION	643.0	ft	Watershed A
LOW POINT ELEVATION	639.8	ft	
ELEVATION DIFF (H)	3.2	ft	
LENGTH (L)	134	ft	
SLOPE (S) = (H/L)	2.4%		
VELOCITY (SCF)	1.5	fps	<=V From Figure 816.6 — Nearly Bare Ground
T_c (SH)=	1.49	minutes	

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

NOTES:

HIGH PT ELEVATION	639.8	ft	Brow Ditch
LOW POINT ELEVATION	568.0	ft	CHANNEL DATA — TYPE = TRAP'Z
ELEVATION DIFF (H)	71.8	ft	Z= 2 — ANG-RAD 0.464
LENGTH (L)	1052	ft	b = 2 — ANG-DEG 26.565
SLOPE (S) = (H/L)	6.8%		d = 0.5 — FLOWING FULL ASS'M
MANNING'S n	0.015		Rough Concrete
HYDRAULIC RADIUS R	0.4	ft	R=(bdsinA+d^2cosA)/(bsinA+2d)
VELOCITY (CHANNEL)	12.99	fps	From Manning's Equation assuming flowing full: $V=1.49/n(R^{2/3}S^{1/2})$
T_c (CH)=	1.35	minutes	

Y Pre-Developed TcQ

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

HIGH PT ELEVATION	564.0	ft
LOW POINT ELEVATION	563.0	ft
ELEVATION DIFF (H)	1.0	ft
LENGTH (L)	45	ft
SLOPE (S) = (H/L)	2.2%	
MANNING'S n	0.013	
PIPE DIAMETER d	1.5	ft
HYDRAULIC RADIUS R	0.4	ft
VELOCITY (STORMDRAIN)	8.9	fps
T_C (SD)=	0.08	minutes

NOTES:

Watershed A

RCP - Exist Fed X

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	563.0	ft
LOW POINT ELEVATION	562.0	ft
ELEVATION DIFF (H)	1.0	ft
LENGTH (L)	100	ft
SLOPE (S) = (H/L)	1.0%	
MANNING'S n	0.013	
PIPE DIAMETER d	3.5	ft
HYDRAULIC RADIUS R	0.9	ft
VELOCITY (STORMDRAIN)	10.5	fps
T_C (SD)=	0.16	minutes

NOTES:

Watershed A

RCP - Exist Fed X

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	562.0	ft
LOW POINT ELEVATION	542.0	ft
ELEVATION DIFF (H)	20.0	ft
LENGTH (L)	1252	ft
SLOPE (S) = (H/L)	1.6%	
MANNING'S n	0.015	
HYDRAULIC RADIUS R	3.4	ft
VELOCITY (CHANNEL)	28.42	fps
T_C (CH)=	0.73	minutes

NOTES:

Detention Facilty X

CHANNEL DATA		TYPE =	TRAP'Z
Z=	1.5	ANG-RAD	0.588
b =	15	ANG-DEG	33.690
d =	5	FLOWING FULL ASS'M	

Concrete per as-builts

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	542.0	ft
LOW POINT ELEVATION	538.0	ft
ELEVATION DIFF (H)	4.0	ft
LENGTH (L)	228	ft
SLOPE (S) = (H/L)	1.8%	
MANNING'S n	0.013	
PIPE DIAMETER d	5.5	ft
HYDRAULIC RADIUS R	1.4	ft
VELOCITY (STORMDRAIN)	18.8	fps
T_C (SD)=	0.20	minutes

NOTES:

Under Sanyo

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	538.0	ft
LOW POINT ELEVATION	522.0	ft
ELEVATION DIFF (H)	16.0	ft
LENGTH (L)	1215	ft
SLOPE (S) = (H/L)	1.3%	
MANNING'S n	0.080	
HYDRAULIC RADIUS R	1.7	ft
VELOCITY (CHANNEL)	3.03	fps
T_C (CH)=	6.68	minutes

NOTES:

West of Sanyo

CHANNEL DATA		TYPE =	TRAP'Z
Z=	20	ANG-RAD	0.588
b =	20	ANG-DEG	33.690
d =	2	FLOWING FULL ASS'M	

Dirt/Grass

R=(bdsinA+d^2cosA)/(bsinA+2d)

From Manning's Equation assuming flowing full: $V=1.49/n(R^{2/3}S^{1/2})$

Y Pre-Developed TcQ

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

HIGH PT ELEVATION	522.0	ft
LOW POINT ELEVATION	520.0	ft
ELEVATION DIFF (H)	2.0	ft
LENGTH (L)	116	ft
SLOPE (S) = (H/L)	1.7%	
MANNING'S n	0.013	
PIPE DIAMETER d	6.0	ft
HYDRAULIC RADIUS R	1.5	ft
VELOCITY (STORMDRAIN)	19.7	fps
T_C (SD)=	0.10	minutes

NOTES:

Under Existing SR905

RCP BOX

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	510.0	ft
ELEVATION DIFF (H)	10.0	ft
LENGTH (L)	1319	ft
SLOPE (S) = (H/L)	0.8%	
MANNING'S n	0.080	
HYDRAULIC RADIUS R	1.7	ft
VELOCITY (CHANNEL)	2.30	fps
T_C (CH)=	9.55	minutes

NOTES:

West of Existing SR905

CHANNEL DATA		TYPE =	TRAP'Z
Z=	20	ANG-RAD	0.588
b =	20	ANG-DEG	33.690
d =	2	FLOWING FULL ASS'M	

Dirt/Grass

R=(bdsinA+d^2cosA)/(bsinA+2d)

From Manning's Equation assuming flowing full: $V=1.49/n(R^{2/3}S^{1/2})$

Tc (TOTAL) =	23.46	minutes
Minimum Tc =	10	minutes
USE Tc =	**23.46**	minutes

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

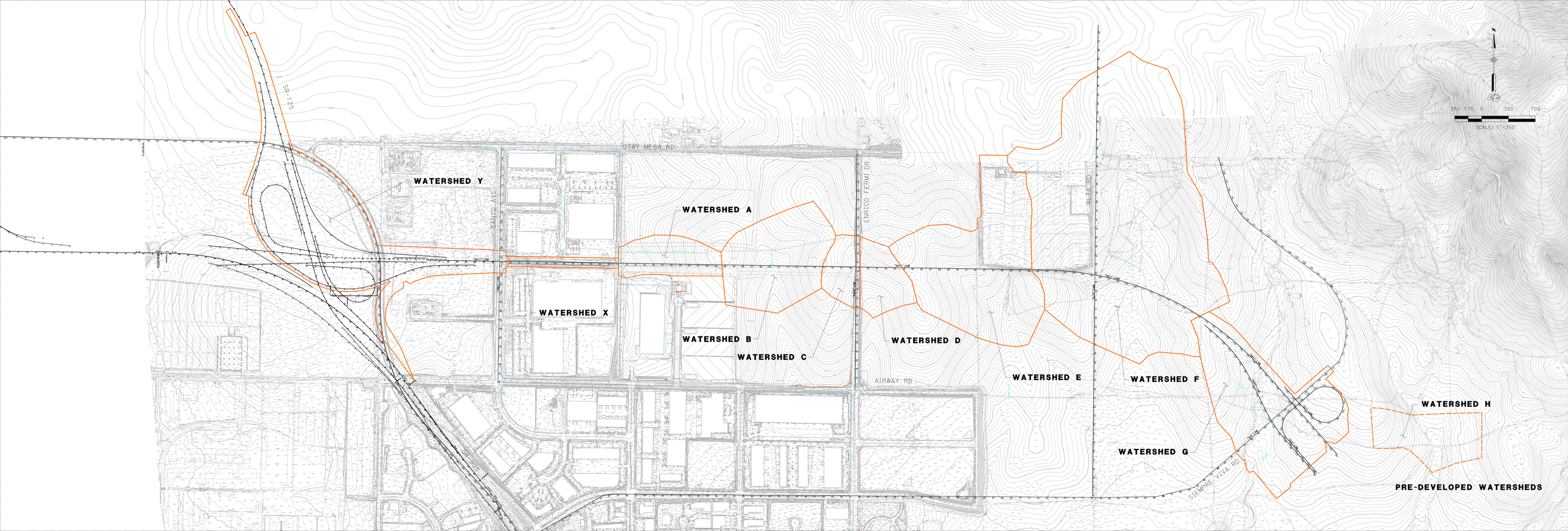
i_2 =	1.1	in/hr	X CA =
i_{10} =	1.6	in/hr	X CA =
i_{25} =	1.9	in/hr	X CA =
i_{50} =	2.3	in/hr	X CA =
i_{100} =	2.4	in/hr	X CA =

FLOW RESULTS:

	cfs
Q_2 =	36.2
Q_{10} =	52.6
Q_{25} =	72.4
Q_{50} =	94.8
Q_{100} =	**102.8**

COUNTY P_6

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


SR-125
OTAY MESA RD
SANYO AVE
ENRICO FERMI DR
ALTA RD
AIRWAY RD
SIEMPRE VIVA RD
WATERSHED Y
WATERSHED A
WATERSHED X
WATERSHED B
WATERSHED C
WATERSHED D
WATERSHED E
WATERSHED F
WATERSHED G
WATERSHED H
PRE-DEVELOPED WATERSHEDS
350 175 0 350 700
SCALE: 1"=350'

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Appendix B NO-Interchange Alternative

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NOTE:

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

LEGEND:

- JS
- PIPE
- INLET W/APRON
- RSP
- HEADWALL
- ---sd--- EXISTING STORMDRAIN

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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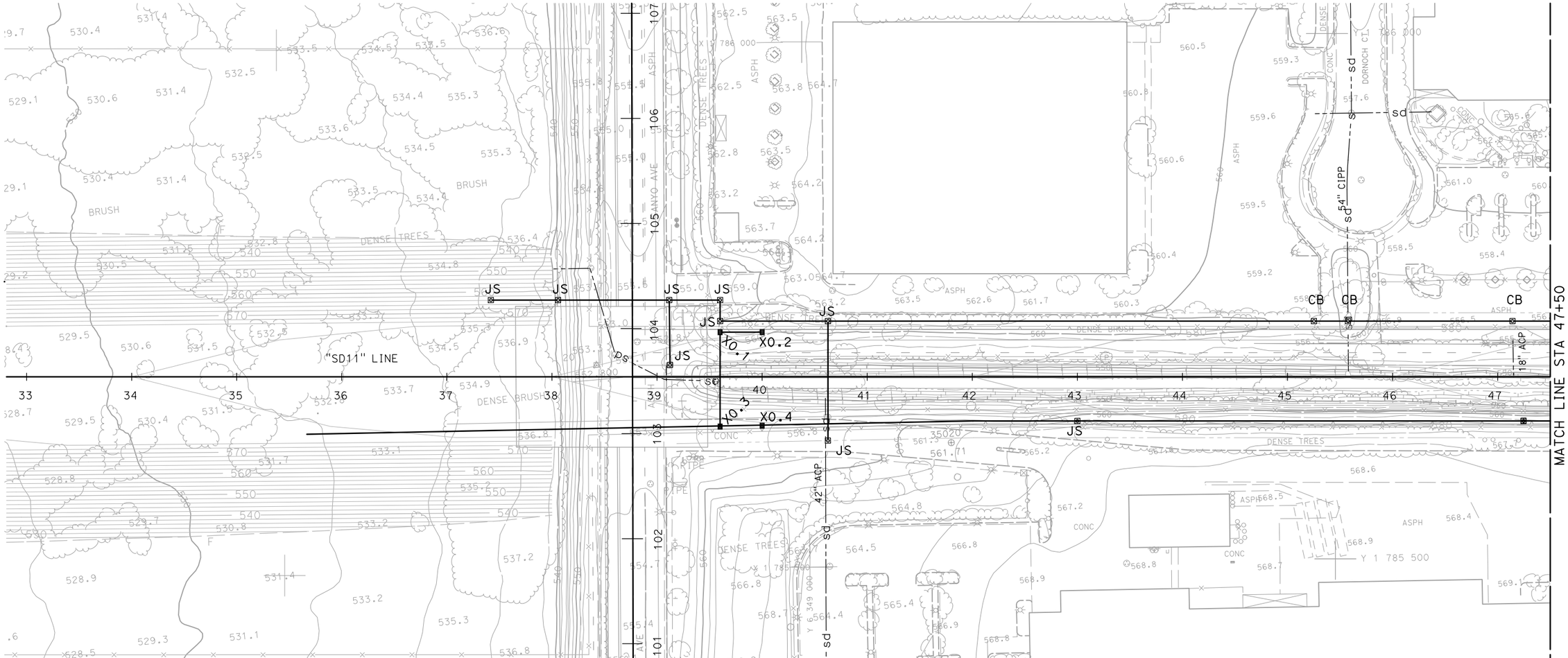

NO INTERCHANGE ALTERNATIVE
DRAINAGE PLAN

SCALE 1"=50'

D-1

THIS PLAN ACCURATE FOR DRAINAGE WORK ONLY.

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REVISED BY | DATE REVISED

MIKE BRUNING | GERARD DALZIEL

CALCULATED-DESIGNED BY | CHECKED BY

CONSULTANT FUNCTIONAL SUPERVISOR: KIRK BRADBURY

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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
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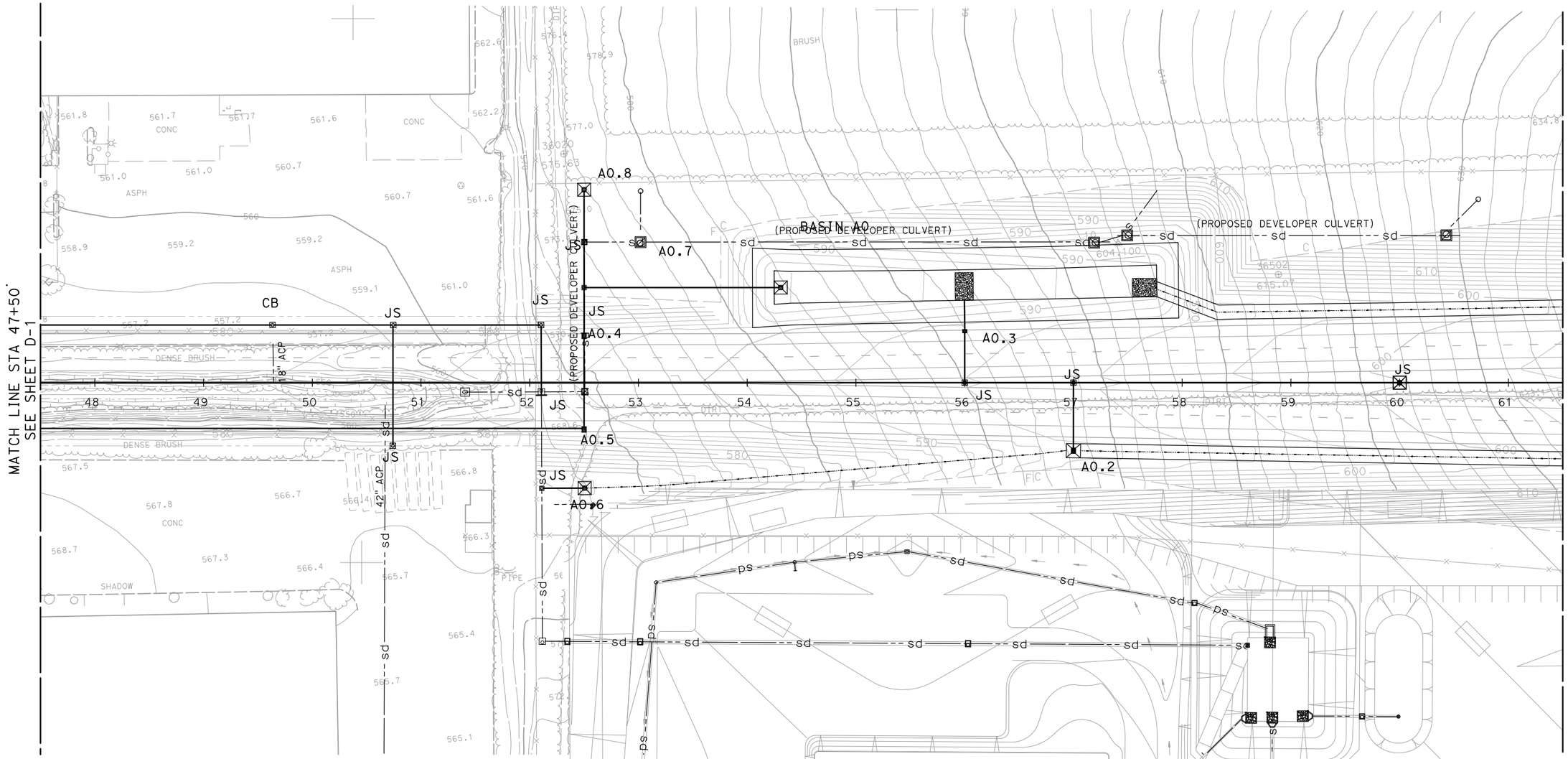

NO INTERCHANGE ALTERNATIVE
DRAINAGE PLAN
D-2

SCALE 1"=50'

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REVISED BY	DATE REVISED

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CHECKED BY: GERARD DALZIEL
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
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STATE OF CALIFORNIA

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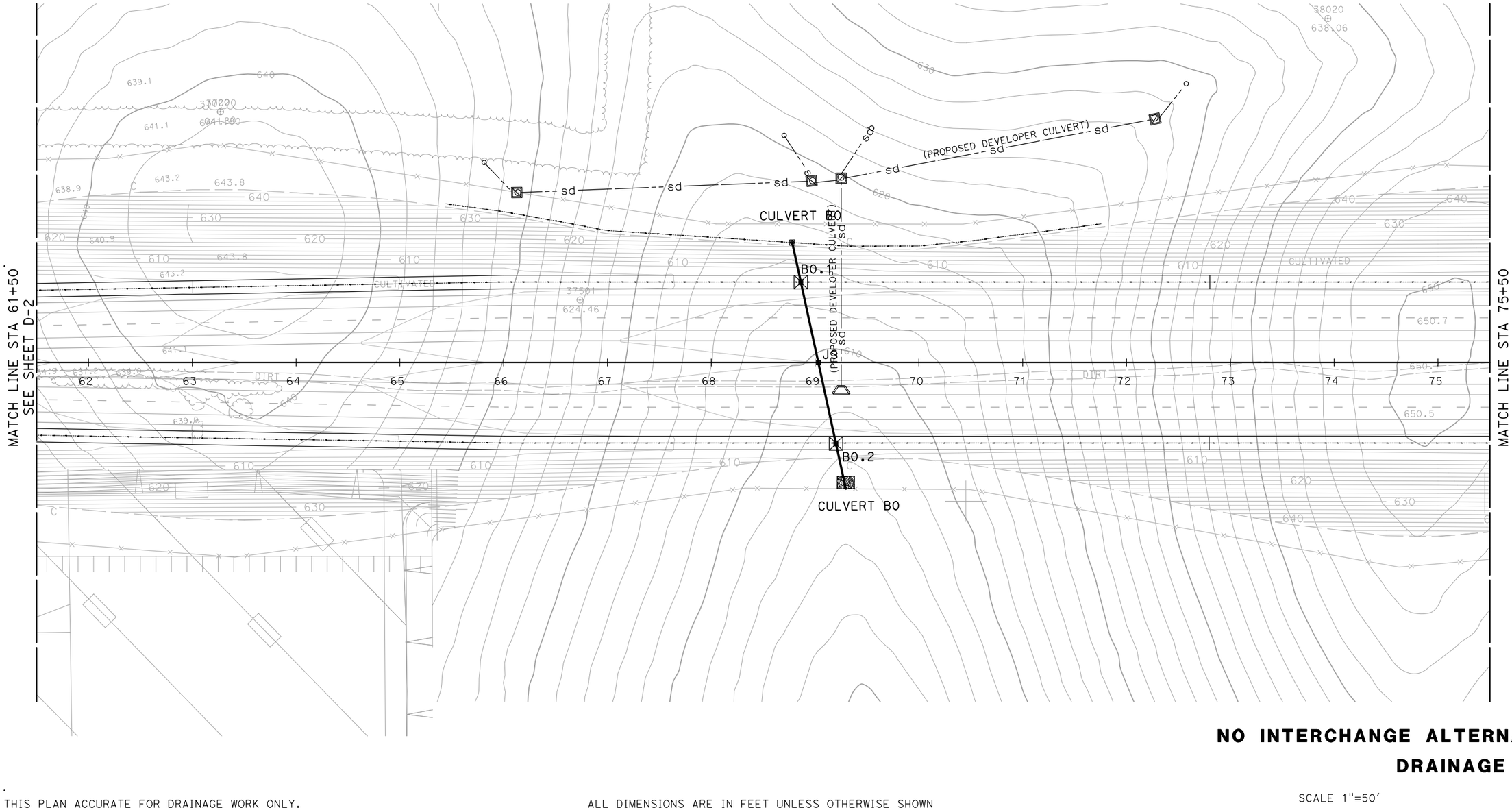

NO INTERCHANGE ALTERNATIVE
DRAINAGE PLAN

SCALE 1"=50'

D-3

THIS PLAN ACCURATE FOR DRAINAGE WORK ONLY.

ALL DIMENSIONS ARE IN FEET UNLESS OTHERWISE SHOWN

REVISED BY | DATE REVISED

MIKE BRUNING | GERARD DALZIEL

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CONSULTANT FUNCTIONAL SUPERVISOR: KIRK BRADBURY

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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
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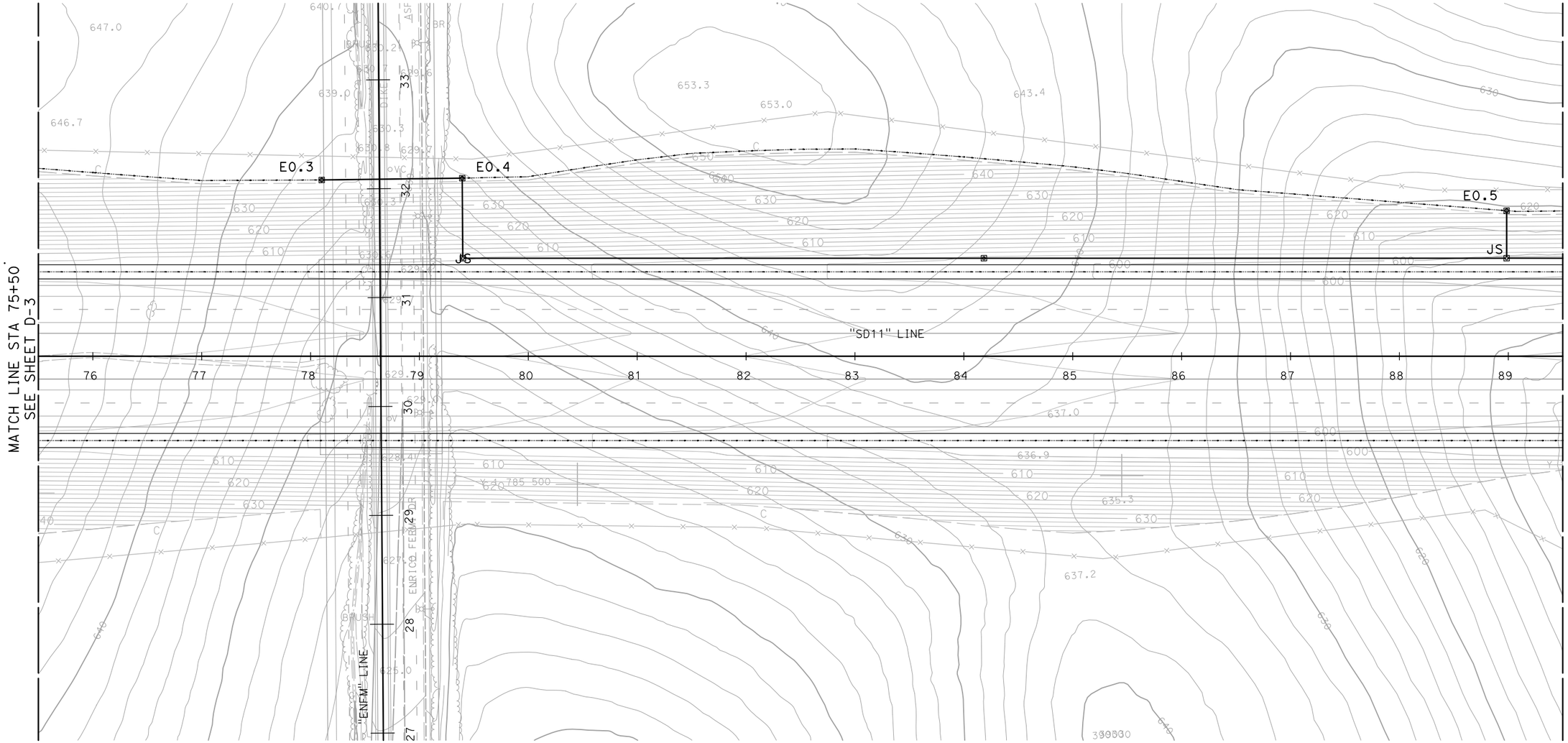

NO INTERCHANGE ALTERNATIVE
DRAINAGE PLAN
D-4

SCALE 1"=50'

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ALL DIMENSIONS ARE IN FEET UNLESS OTHERWISE SHOWN

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CHECKED BY: GERARD DALZIEL
CONSULTANT FUNCTIONAL SUPERVISOR: KIRK BRADBURY

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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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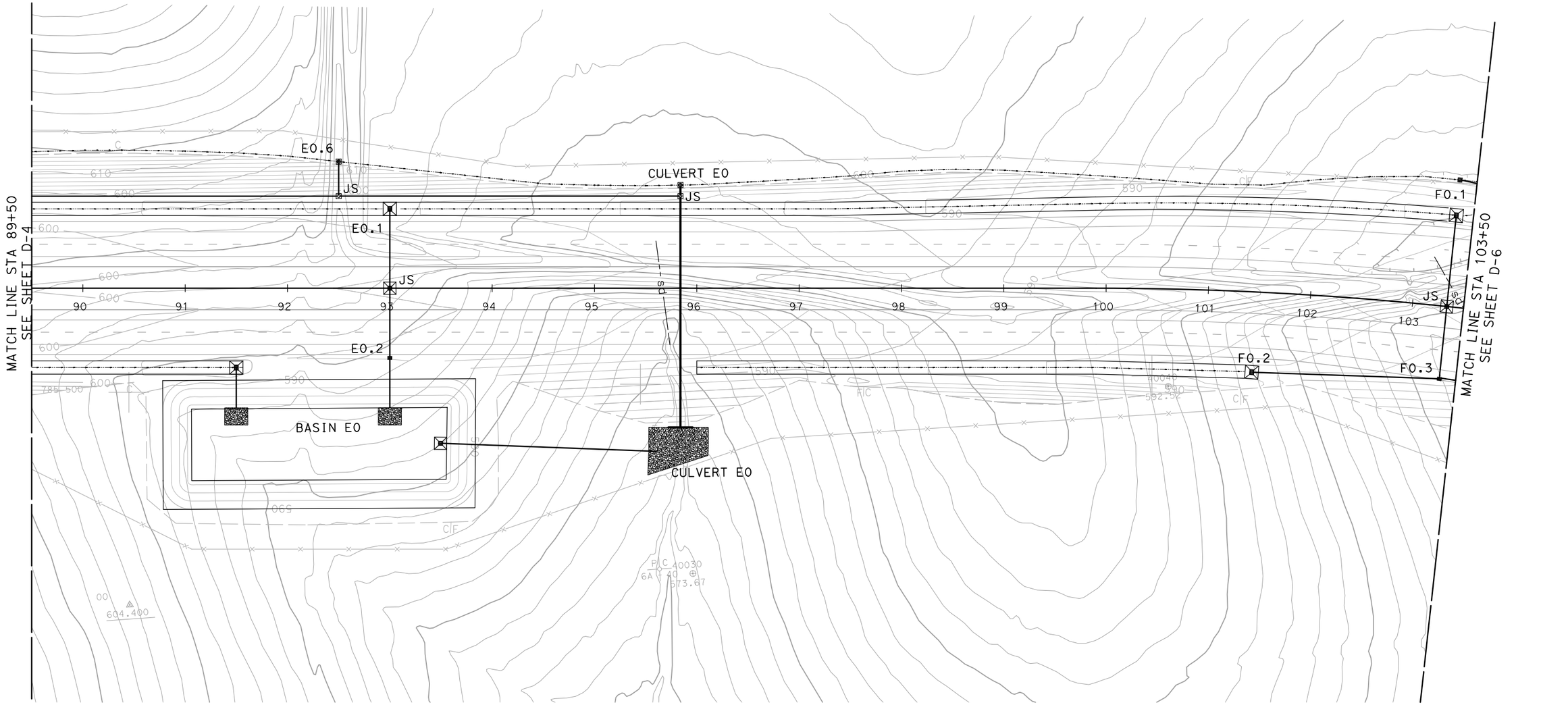

NO INTERCHANGE ALTERNATIVE DRAINAGE PLAN

SCALE 1"=50'

D-5

THIS PLAN ACCURATE FOR DRAINAGE WORK ONLY.

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CONSULTANT FUNCTIONAL SUPERVISOR: KIRK BRADBURY

CALCULATED-DESIGNED BY: MIKE BRUNING

CHECKED BY: GERARD DALZIEL

REVISED BY

DATE REVISED

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TIME PLOTTED => 8:53:13 AM

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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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SAN DIEGO, CA 92111

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THIS PLAN ACCURATE FOR DRAINAGE WORK ONLY.

ALL DIMENSIONS ARE IN FEET UNLESS OTHERWISE SHOWN

NO INTERCHANGE ALTERNATIVE
DRAINAGE PLAN
D-6

SCALE 1"=50'

REVISED BY	DATE REVISED

CALCULATED-DESIGNED BY: MIKE BRUNING
CHECKED BY: GERARD DALZIEL
CONSULTANT FUNCTIONAL SUPERVISOR: KIRK BRADBURY

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION
Caltrans

60099859

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BORDER LAST REVISED 4/11/2008

RELATIVE BORDER SCALE IS IN INCHES 0 1 2 3

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CU XXXXX

EA 06002

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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

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KIRK BRADBURY
No. 71673
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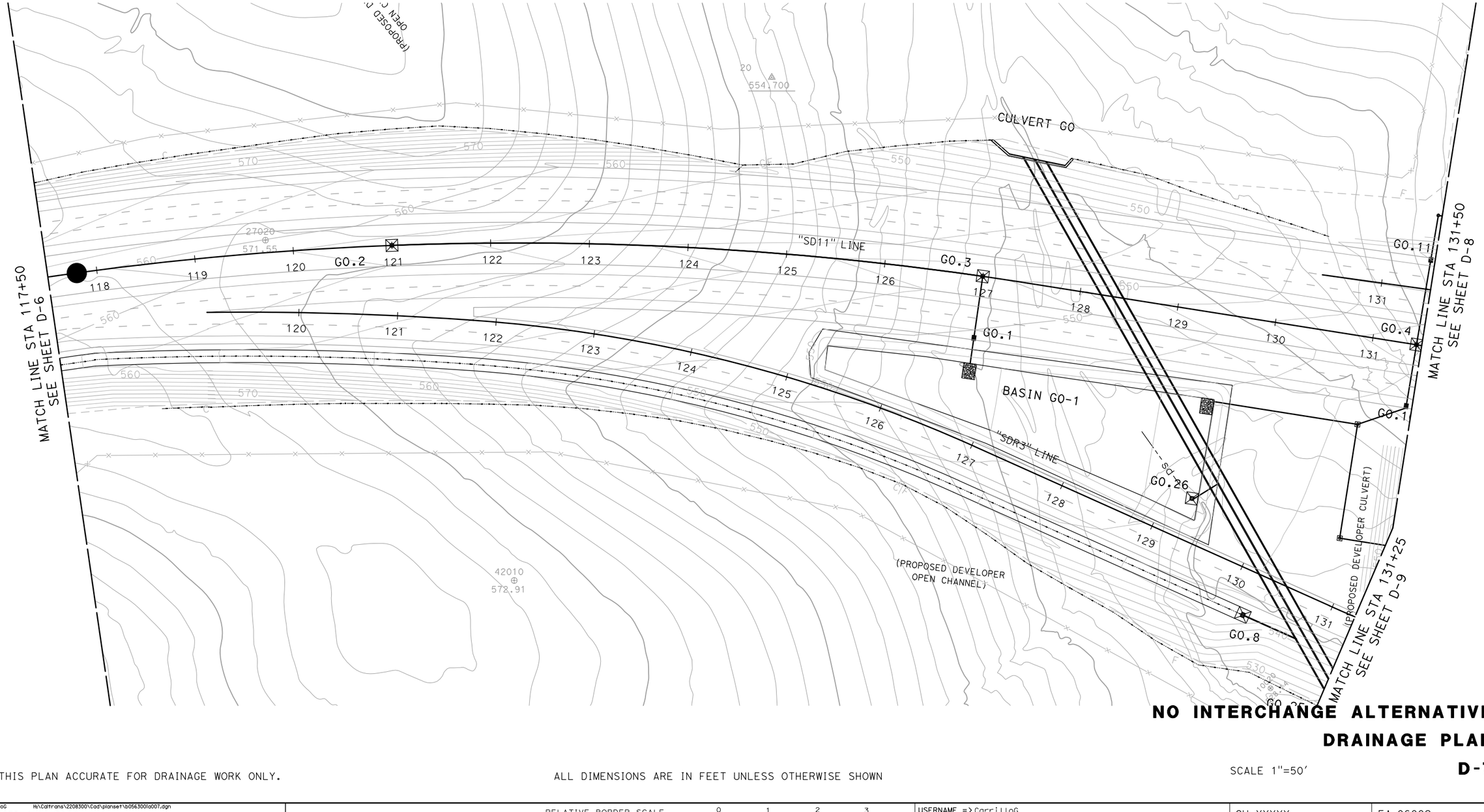

NO INTERCHANGE ALTERNATIVE
DRAINAGE PLAN
D-7

SCALE 1"=50'

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REVISED BY	DATE REVISED

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

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

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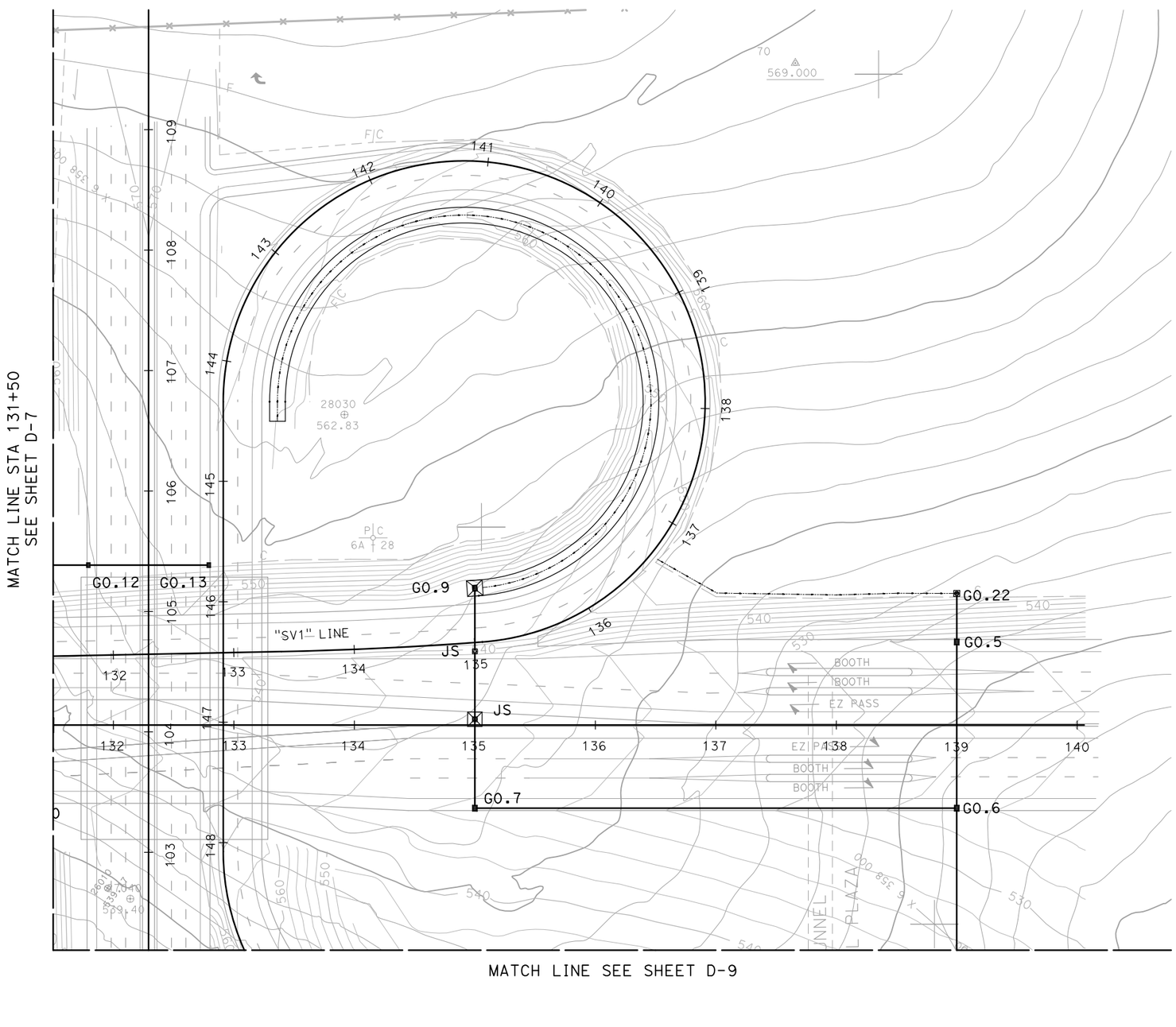

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NO INTERCHANGE ALTERNATIVE
DRAINAGE PLAN

SCALE 1"=50'

D-8

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CONSULTANT FUNCTIONAL SUPERVISOR: KIRK BRADBURY
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LAST REVISION 11-13-09
DATE PLOTTED => 2/3/2010
TIME PLOTTED => 5:51:57 PM

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CU XXXXX

EA 06002

NOTE:

FOR COMPLETE RIGHT OF WAY AND ACCURATE ACCESS DATA,
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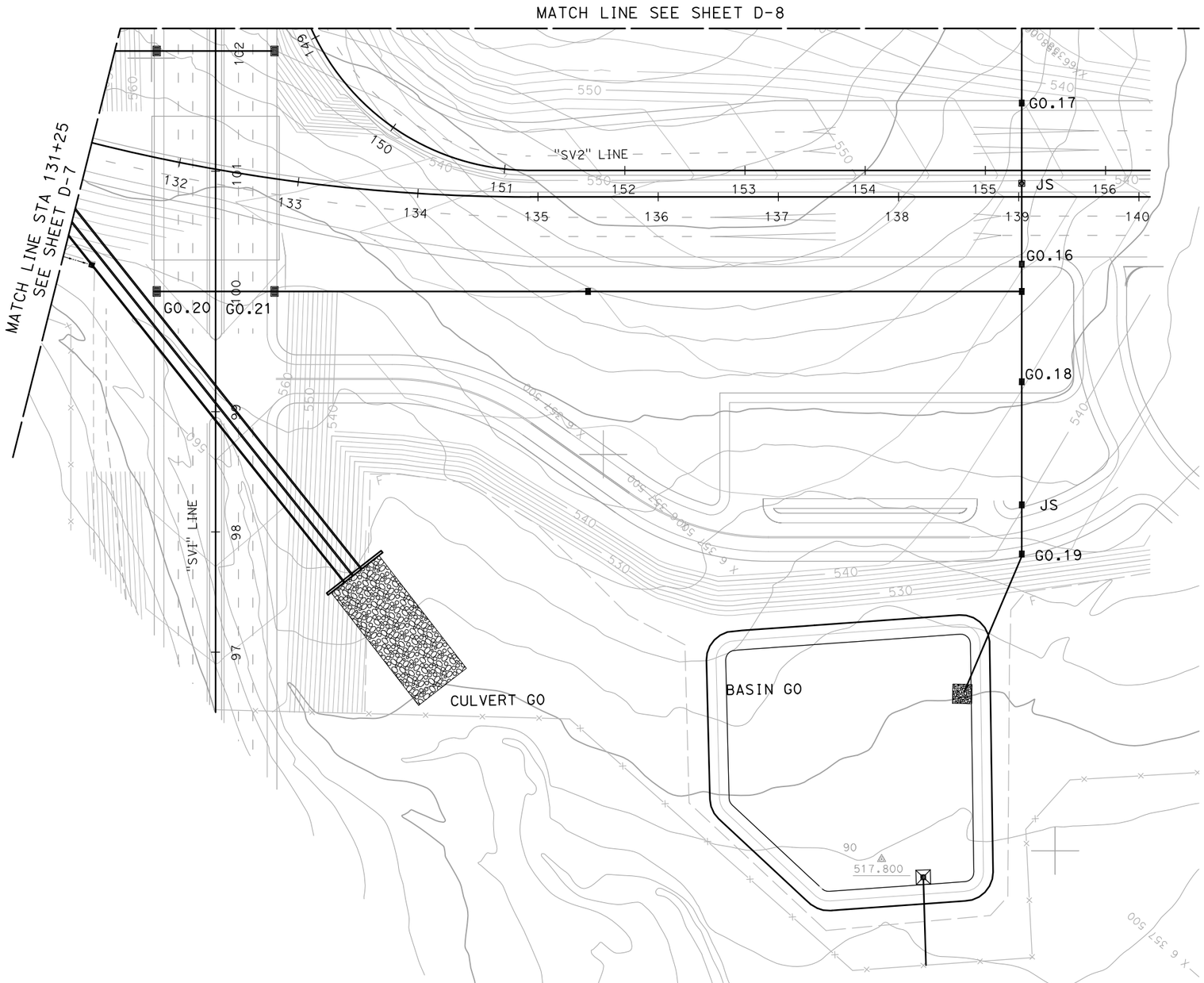

THIS PLAN ACCURATE FOR DRAINAGE WORK ONLY.

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NO INTERCHANGE ALTERNATIVE
DRAINAGE PLAN

SCALE 1"=50'

D-9

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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CONSULTANT FUNCTIONAL SUPERVISOR | KIRK BRADBURY
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EA 06002

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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

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REGISTERED PROFESSIONAL ENGINEER
KIRK BRADBURY
No. 71673
Exp. 12/31/09
CIVIL
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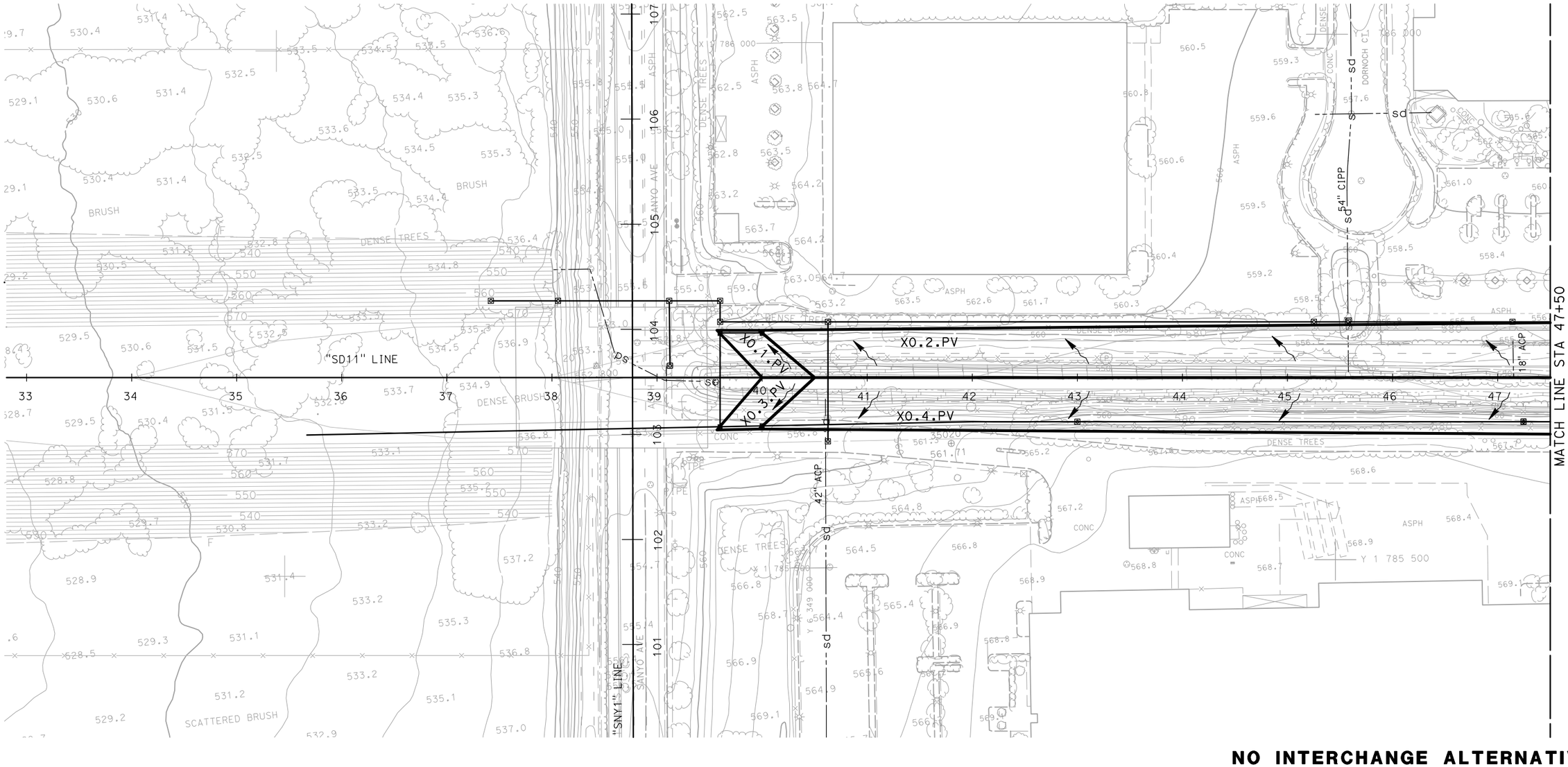
LEGEND:

- JS
- PIPE
- INLET W/APRON
- RSP
- HEADWALL
- ---sd--- EXISTING STORMDRAIN



NO INTERCHANGE ALTERNATIVE
DRAINAGE AREA PLAN
DA-1

SCALE 1"=50'

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CONSULTANT FUNCTIONAL SUPERVISOR: KIRK BRADBURY

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RELATIVE BORDER SCALE IS IN INCHES 0 1 2 3

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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
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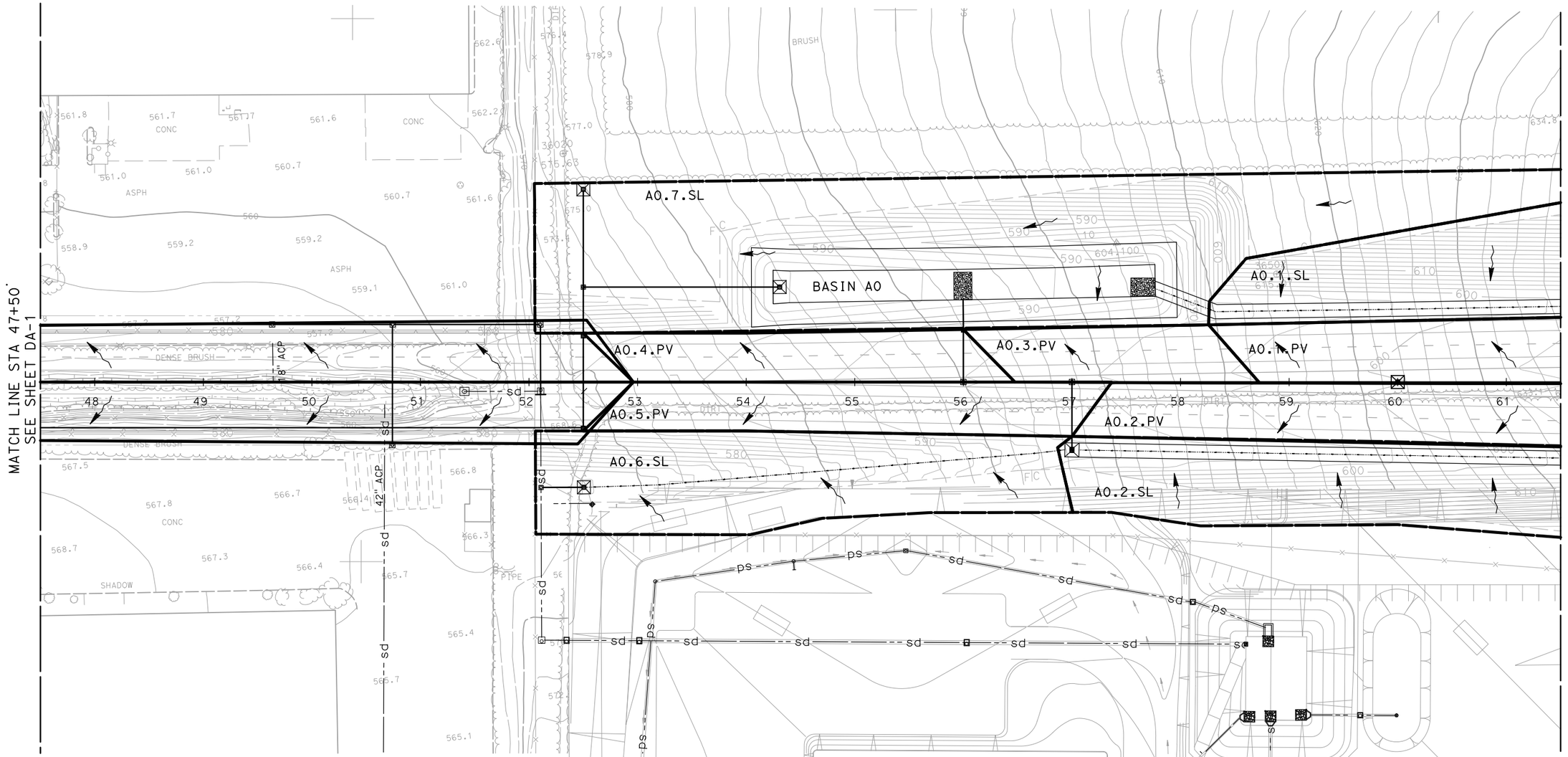

NO INTERCHANGE ALTERNATIVE
DRAINAGE AREA PLAN
DA-2

SCALE 1"=50'

THIS PLAN ACCURATE FOR DRAINAGE WORK ONLY.

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EA 06002

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

REGISTERED CIVIL ENGINEER DATE

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KIRK BRADBURY
No. 71673
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SAN DIEGO, CA 92111

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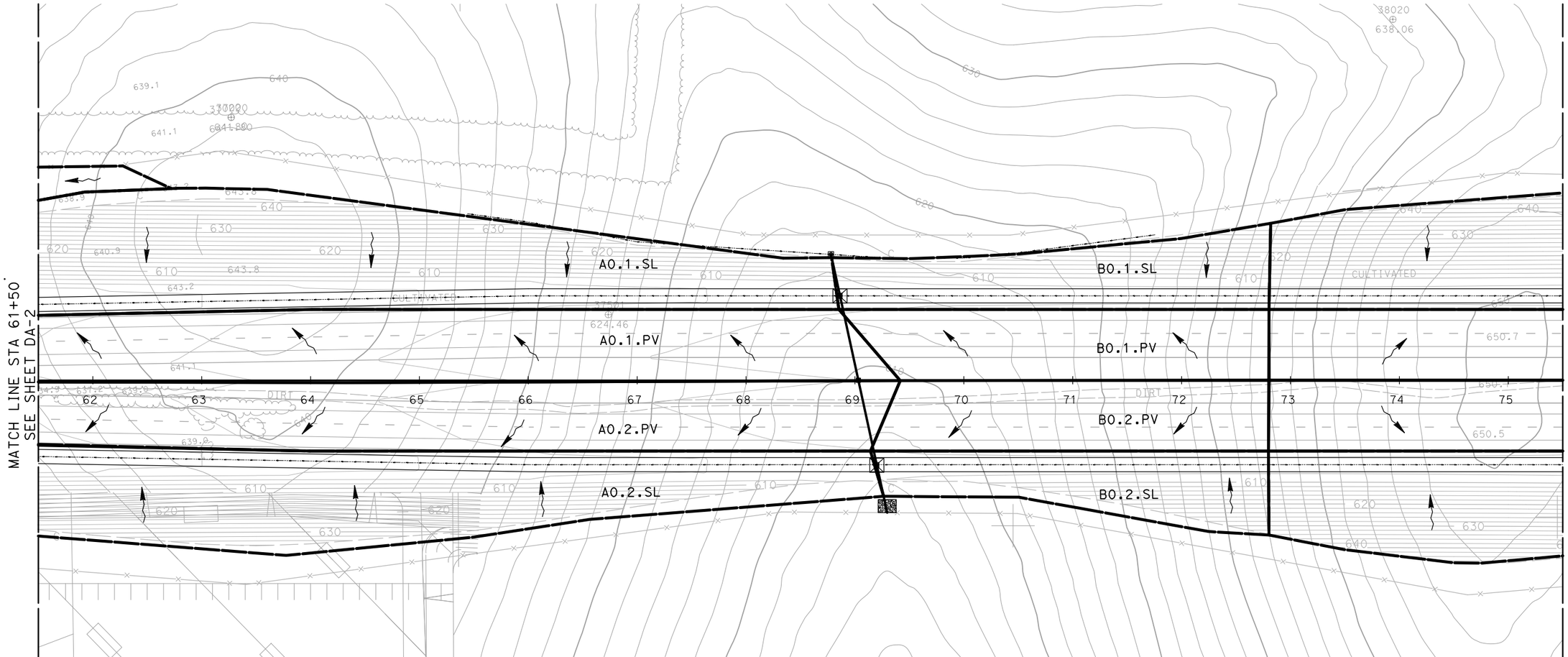

NO INTERCHANGE ALTERNATIVE
DRAINAGE AREA PLAN

SCALE 1"=50'

DA-3

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EA 06002

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

REGISTERED CIVIL ENGINEER DATE

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KIRK BRADBURY
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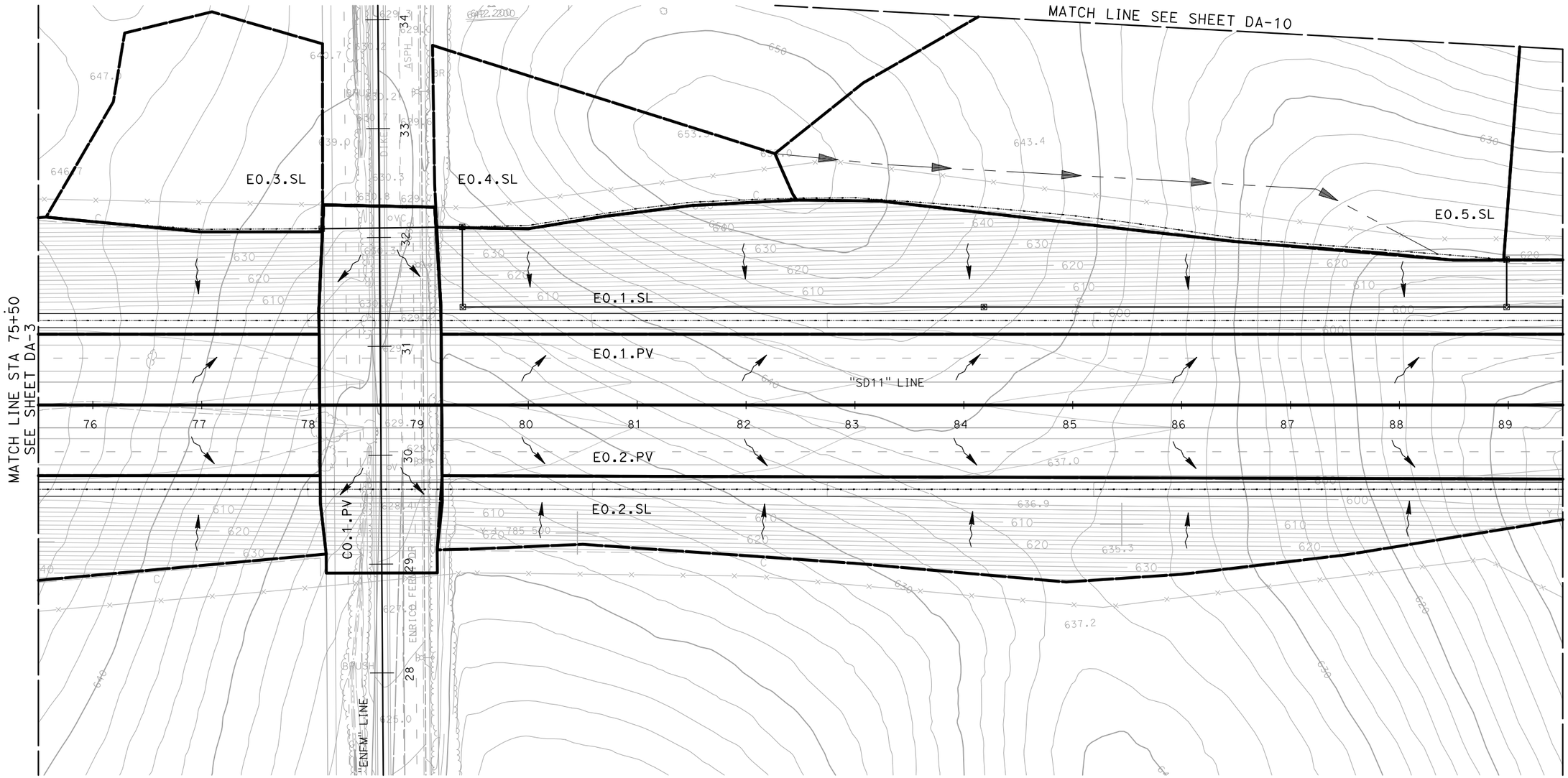

NO INTERCHANGE ALTERNATIVE
DRAINAGE AREA PLAN
DA-4

SCALE 1"=50'

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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

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REGISTERED PROFESSIONAL ENGINEER
KIRK BRADBURY
No. 71673
Exp. 12/31/09
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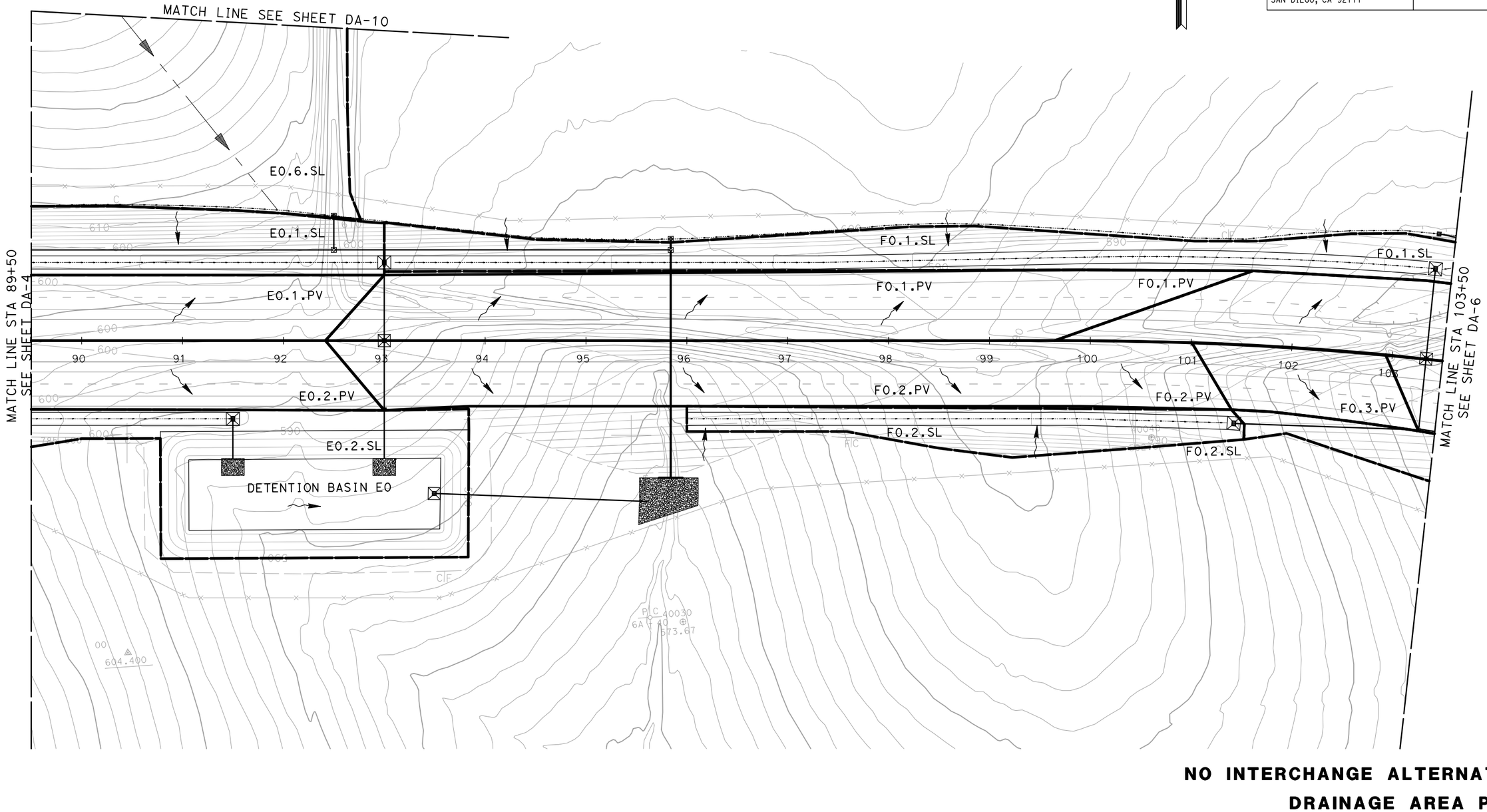

NO INTERCHANGE ALTERNATIVE
DRAINAGE AREA PLAN
DA-5

SCALE 1"=50'

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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		

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

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SAN DIEGO, CA 92111

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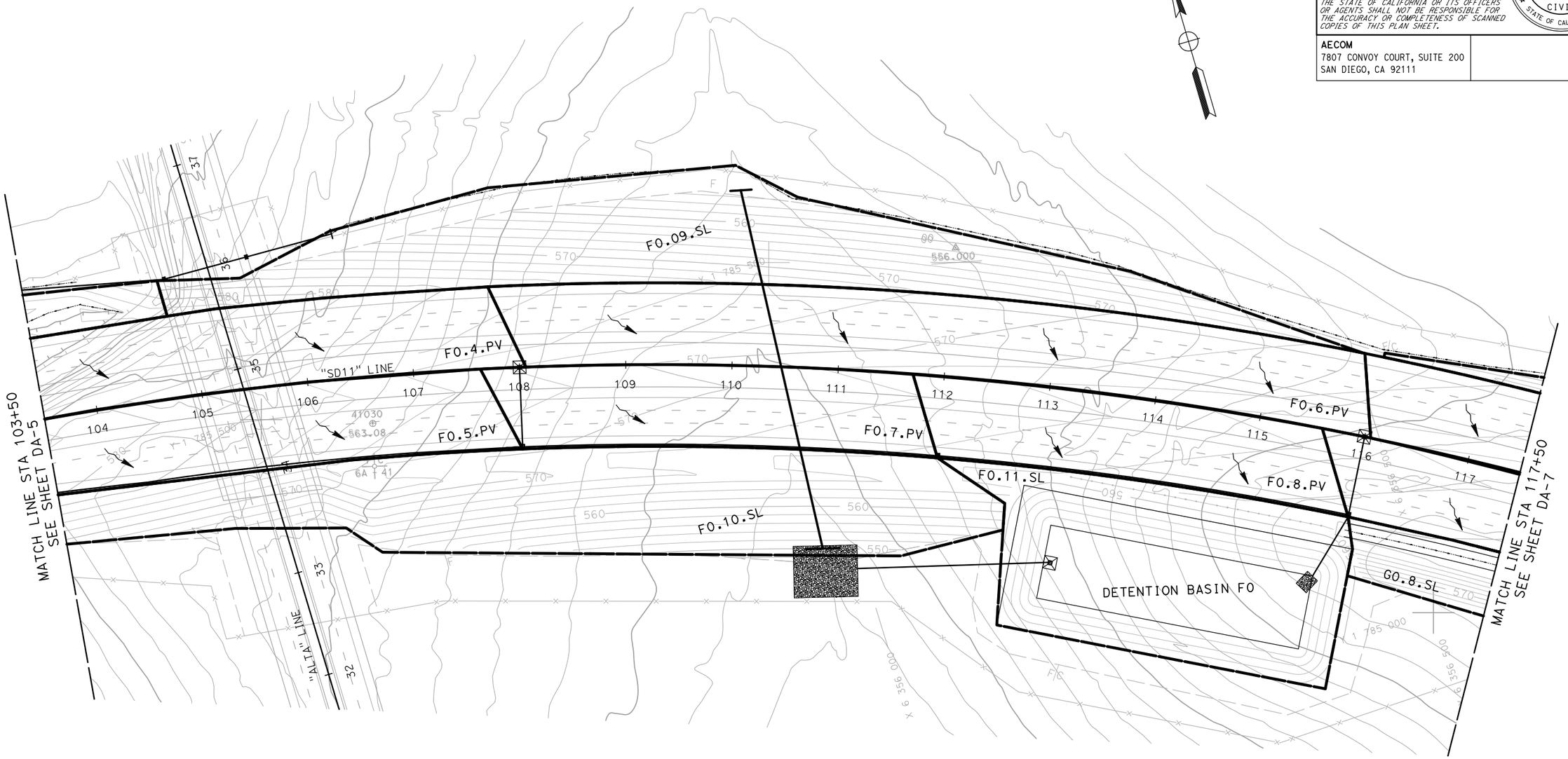

THIS PLAN ACCURATE FOR DRAINAGE WORK ONLY.

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NO INTERCHANGE ALTERNATIVE
DRAINAGE AREA PLAN
DA-6

SCALE 1"=50'

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MIKE BRUNING | GERARD DALZIEL

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EA 06002

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
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REGISTERED PROFESSIONAL ENGINEER
KIRK BRADBURY
No. 71673
Exp. 12/31/09
CIVIL
STATE OF CALIFORNIA

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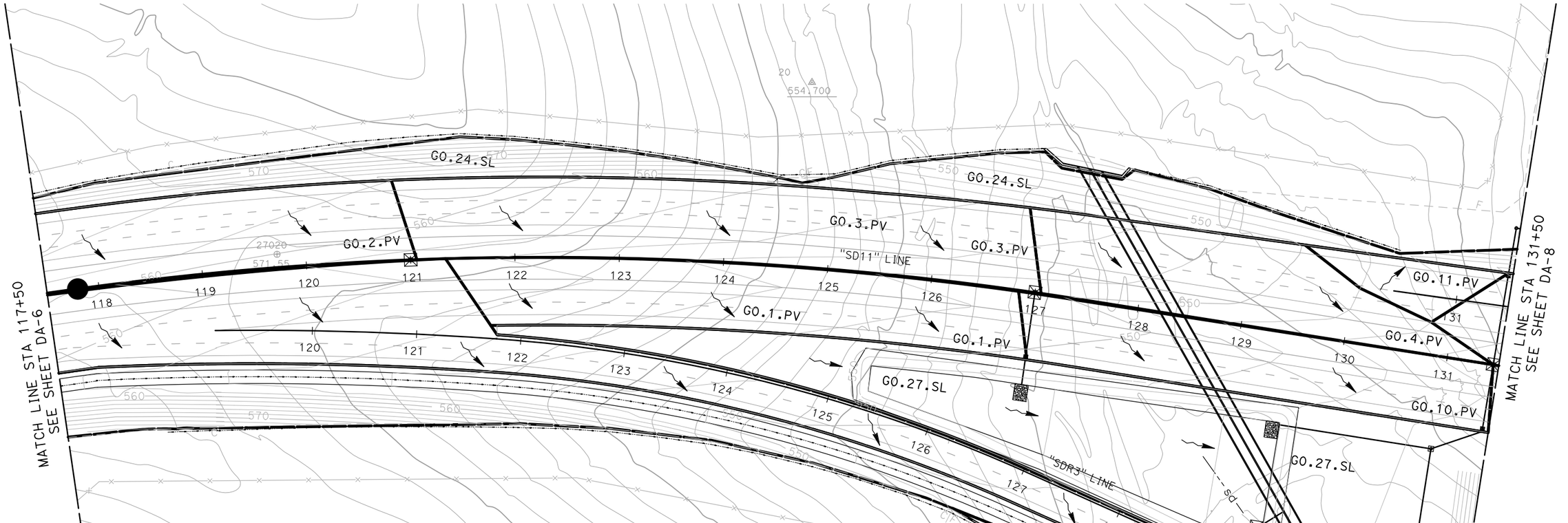

NO INTERCHANGE ALTERNATIVE
DRAINAGE AREA PLAN

SCALE 1"=50'

DA-7

THIS PLAN ACCURATE FOR DRAINAGE WORK ONLY.

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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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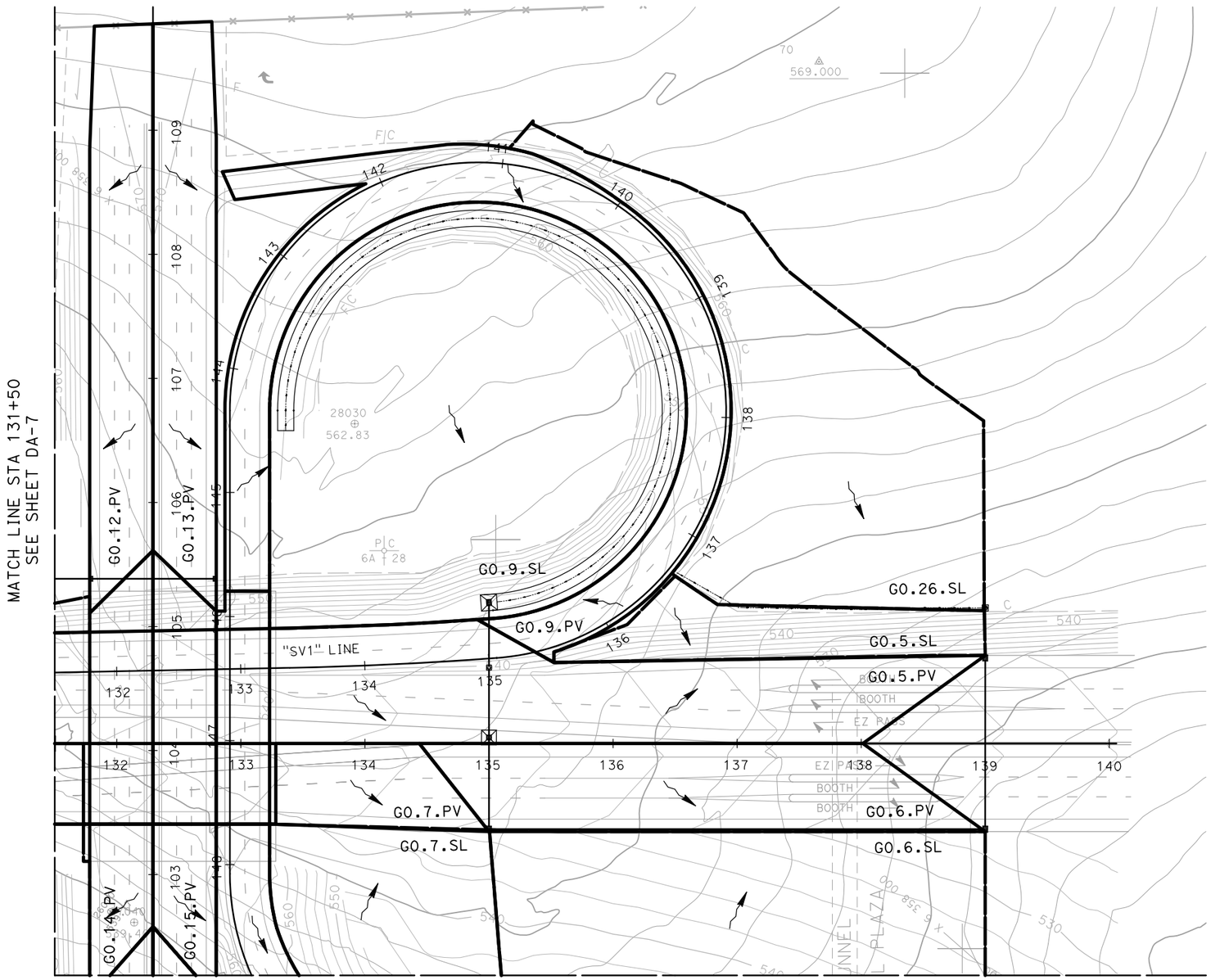

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NO INTERCHANGE ALTERNATIVE
DRAINAGE AREA PLAN

SCALE 1"=50'

DA-8

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CONSULTANT FUNCTIONAL SUPERVISOR: KIRK BRADBURY

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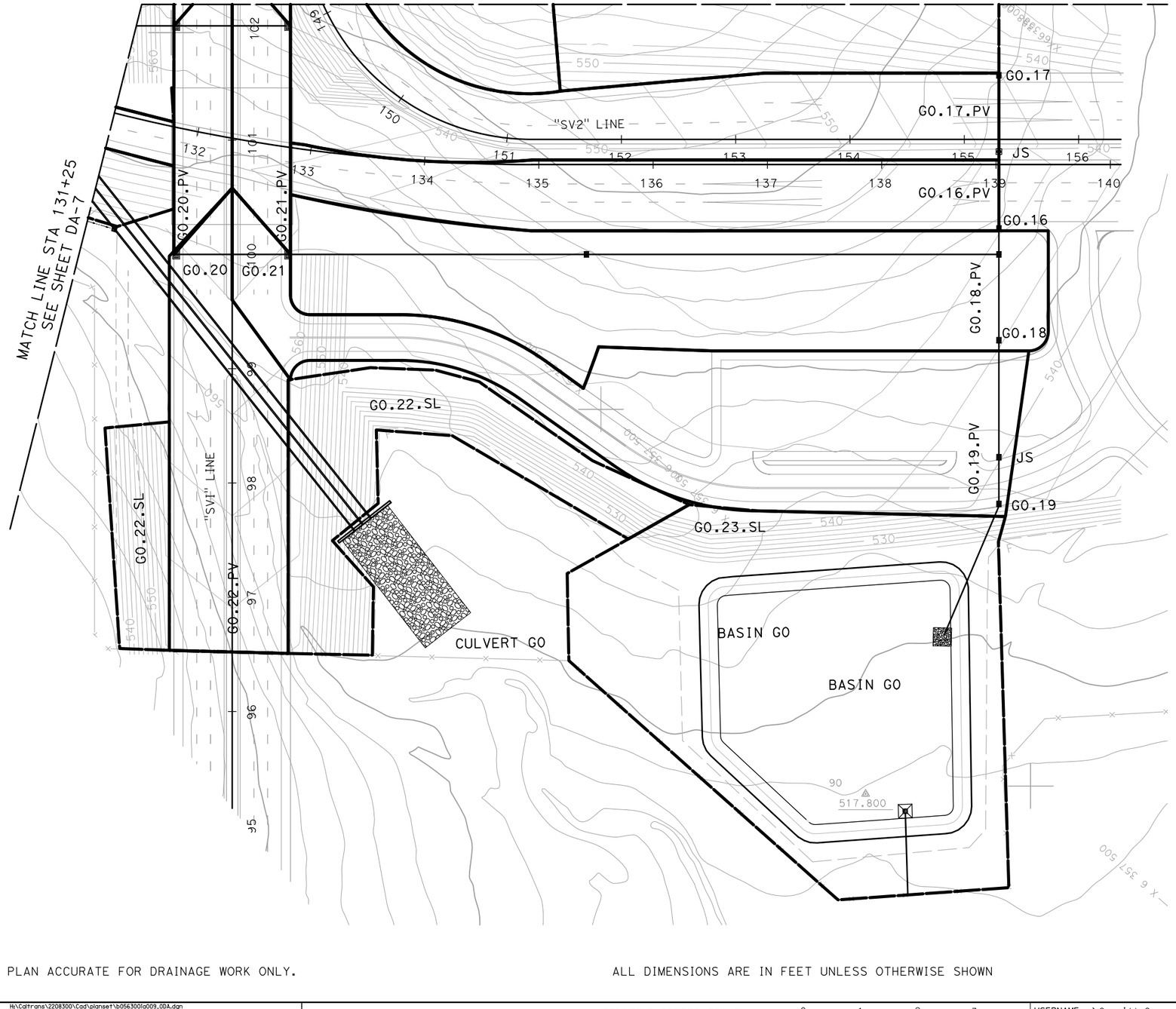

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NO INTERCHANGE ALTERNATIVE
DRAINAGE AREA PLAN
DA-9

SCALE 1"=50'

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

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 DATE PLOTTED => 2/3/2010
TIME PLOTTED => 9:08:52 AM

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2/3/2010 9:08:52 AM CarrilloG H:\Caltrans\2208300\Cad\planset\b056300ia009_0DA.dgn
BORDER LAST REVISED 4/11/2008

RELATIVE BORDER SCALE IS IN INCHES 0 1 2 3

USERNAME => CarrilloG
DGN FILE => ...\b056300ia009_0DA.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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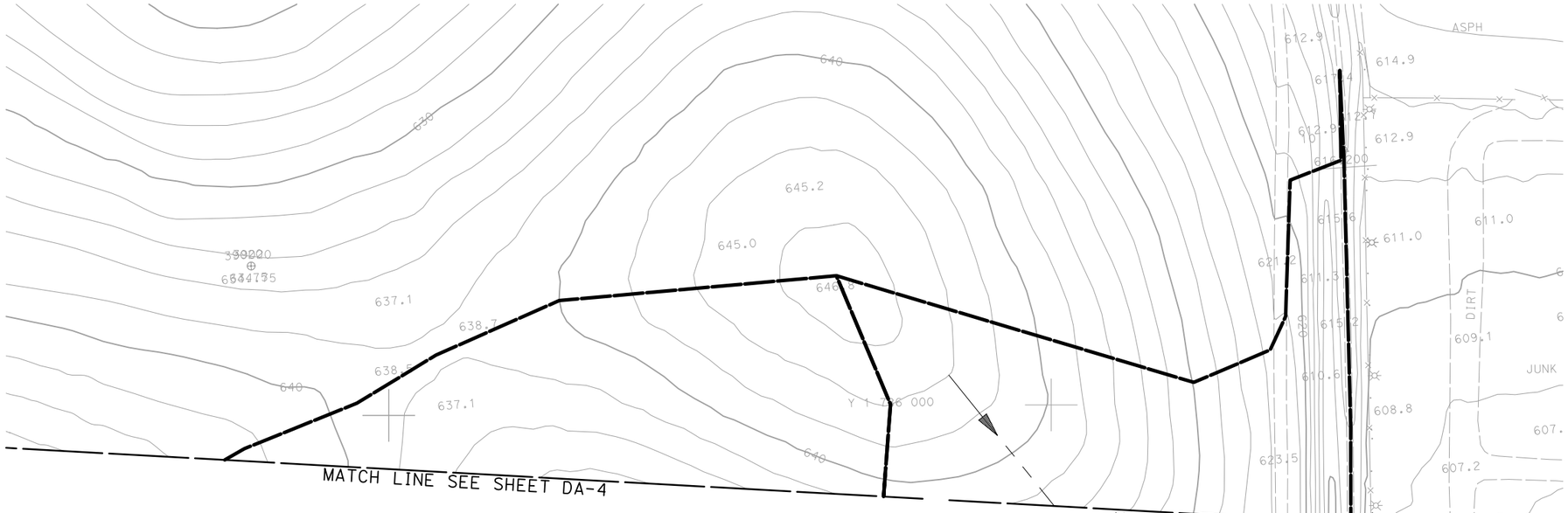
NOTE:

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



THIS PLAN ACCURATE FOR DRAINAGE WORK ONLY.

ALL DIMENSIONS ARE IN FEET UNLESS OTHERWISE SHOWN

NO INTERCHANGE ALTERNATIVE
DRAINAGE AREA PLAN

SCALE 1"=50'

DA-10

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 => 2/3/2010 | TIME PLOTTED => 5:52:28 PM

60098859

2/3/2010 5:52:28 PM YamanakaG h:\caltrans\2208300\cad\planset\b056300ia010_0da.dgn

BORDER LAST REVISED 4/11/2008

RELATIVE BORDER SCALE IS IN INCHES 0 1 2 3

USERNAME => YamanakaG
DGN FILE => ...\b056300ia010_0da.dgn

CU XXXXX

EA 06002

A0 Onsite D.A. Table

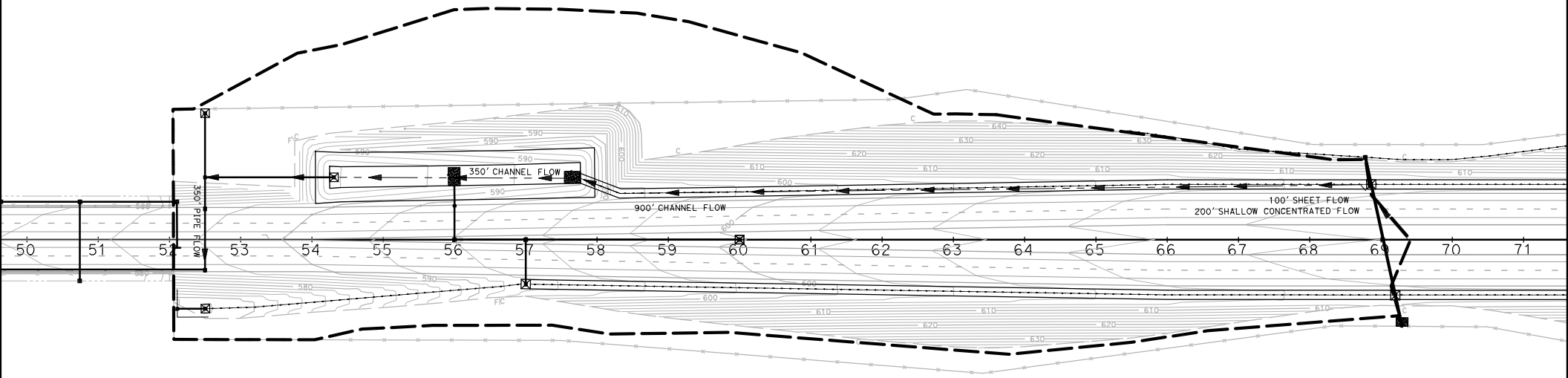
PROJECT:	**SR-11**	**DESCRIPTION:**	**Onsite Drainage Areas (D.A.)**
JOB #:	**11A1190**	**STATION:**	**~**
BY:	**M.BRUNING** **DATE:** **01.04.10**	**WATERSHED:**	**A0**
CHK:	**G.DALZIEL** **DATE:**	**SYSTEM:**	**No Interchange Option**

			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
PAVED	A0.1.PV	0.99	67400	1.5	10	2.8	4.33	4.2	6.45	A0.1	~	Basin A0	57+75	Lt
	A0.2.PV	0.99	72100	1.7	10	2.8	4.64	4.2	6.90	A0.2	A0.2	Basin A0	57+00	Rt
	A0.3.PV	0.99	11600	0.3	5	4.0	1.05	6.6	1.74	~	A0.3	Basin A0	56+00	Lt
	A0.4.PV	0.99	16200	0.4	5	4.0	1.47	6.6	2.43	~	A0.4	*bypass**	52+50	Lt
	A0.5.PV	0.99	20900	0.5	5	4.0	1.90	6.6	3.13	~	A0.5	*bypass**	52+50	Rt
		Σ	188200	*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
SLOPE	A0.1.SL	0.61	88600	2.0	10	2.8	3.51	4.2	5.23	A0.1	~	Basin A0	57+75	Lt
	A0.2.SL	0.61	92400	2.1	10	2.8	3.66	4.2	5.45	A0.2	A0.2	Basin A0	57+00	Rt
	A0.6.SL	0.61	41100	0.9	10	2.8	1.63	4.2	2.42	~	A0.6	*bypass**	52+50	Rt
	A0.7.SL	0.61	107500	2.5	10	2.8	4.26	4.2	6.34	~	A0.7	Basin A0	54+25	Lt
		Σ	329600	*SLOPE*										

** flow that does not reach the basin*

Total :	517800	11.9
	SF	*ac*



WATERSHED A0
NO INTERCHANGE ALTERNATIVE

Scale: 1"=200'

A0 Post-Developed TcQ

PROJECT:	**SR-11**			**DESCRIPTION:**	**SR-11 Post-Developed**
JOB #:	**11A1190**			**STATION:**	**52+00**
BY:	**M.BRUNING**	**DATE:**	**01.04.10**	**WATERSHED:**	**A0**
CHK:	**G.DALZIEL**	**DATE:**		**SYSTEM:**	**No Interchange Option**

BASIN AREA:

A =	**613381**	**ft^2**	**SOURCE:**	**MICROSTATION/USGS**
	14.08	**acres**		**(SCALE = 1:1)**

COEFFICIENT OF RUNOFF:

KEY: User Input | Designer Tool

UNDEVELOPED AREA C (FROM HDM FIG. 819.2A)

NOTES:

RELIEF (.08-.35)	0.14	Rolling slopes ~ 5%
INFILTRATION (.04-.16)	0.12	Negligible infiltration capacity - see Geotechnical Report
VEGETATION (.04-.16)	0.08	Fair natural cover
STORAGE (.04-.12)	0.08	Low
TOTAL C =	0.42	

UNDEVELOPED AREA	16%	AT	0.42	0.065
PAVED SURFACE	31%	AT	0.90	0.276
COMMERCIAL AREA	0%	AT	0.85	0.000
CUT SLOPE (2:1 and 4:1)	54%	AT	0.55	0.296
TOTAL	100%			
	(100%)			

$C_{2,10}$ =	0.64
C_{25} =	0.70
C_{50} =	0.76
C_{100} =	0.80

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	608.5	ft	SR-11 CL
LOW POINT ELEVATION	607.8	ft	SR-11 ES
ELEVATION DIFF (H)	0.7	ft	
LENGTH (L)	100	ft	To Bioswale
SLOPE (S) = (H/L)	0.7%		
MANNING'S n	0.016		<=n from Table 816.6A AC
T_t (SFF)=	3.32	minutes	

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

NOTES:

HIGH PT ELEVATION	607.8	ft	Origin of Bioswale
LOW POINT ELEVATION	606.0	ft	
ELEVATION DIFF (H)	1.8	ft	
LENGTH (L)	200	ft	Assumed bioswale does not have enough flow to be channelized
SLOPE (S) = (H/L)	0.9%		
VELOCITY (SCF)	1.8	fps	<=V from Figure 816.6 Grassed waterway
T_C (SH)=	1.90	minutes	

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

NOTES:

HIGH PT ELEVATION	606.0	ft	Begin channel flow in bioswale
LOW POINT ELEVATION	590.0	ft	CHANNEL DATA TYPE = TRAP'Z
ELEVATION DIFF (H)	16.0	ft	Z= 4 ANG-RAD 0.245
LENGTH (L)	900	ft	b = 13 ANG-DEG 14.036
SLOPE (S) = (H/L)	1.8%		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)	3.42	fps	From Manning's Equation assuming flowing full: $V=1.49/n(R^{2/3}S^{1/2})$
T_C (CH)=	4.38	minutes	

A0 Post-Developed TcQ

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

HIGH PT ELEVATION	590.0	ft
LOW POINT ELEVATION	584.0	ft
ELEVATION DIFF (H)	6.0	ft
LENGTH (L)	350	ft
SLOPE (S) = (H/L)	1.7%	
MANNING'S n	0.050	
HYDRAULIC RADIUS R	0.80	ft
VELOCITY (CHANNEL)	3.36	fps
T_C (CH)=	1.73	minutes

NOTES:

Assume basin floor has same dimensions of bioswale			
CHANNEL DATA		TYPE =	TRAP'Z
Z=	4	ANG-RAD	0.245
b =	13	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	584.0	ft
LOW POINT ELEVATION	583.0	ft
ELEVATION DIFF (H)	1.0	ft
LENGTH (L)	350	ft
SLOPE (S) = (H/L)	0.3%	
MANNING'S n	0.013	
PIPE DIAMETER d	2.0	ft
HYDRAULIC RADIUS R	0.5	ft
VELOCITY (STORMDRAIN)	3.9	fps
T_C (SD)=	1.51	minutes

NOTES:

Proposed basin outlet pipe
Discharge at watershed end (Sta 52+00)
RCP
R=D/4, Assume: flowing full
$V = \frac{K_u}{n} R^{2/3} S^{1/2}$

Tc (TOTAL) =	12.85	minutes
Minimum Tc =	10	minutes
USE Tc =	**12.85**	minutes

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

i_2 =	1.6	in/hr	X CA =	**Q_2 =**	14.1
i_{10} =	2.3	in/hr	X CA =	**Q_{10} =**	20.6
i_{25} =	2.9	in/hr	X CA =	**Q_{25} =**	28.3
i_{50} =	3.4	in/hr	X CA =	**Q_{50} =**	37.0
i_{100} =	3.6	in/hr	X CA =	**Q_{100} =**	**40.2**

FLOW RESULTS:

cfs

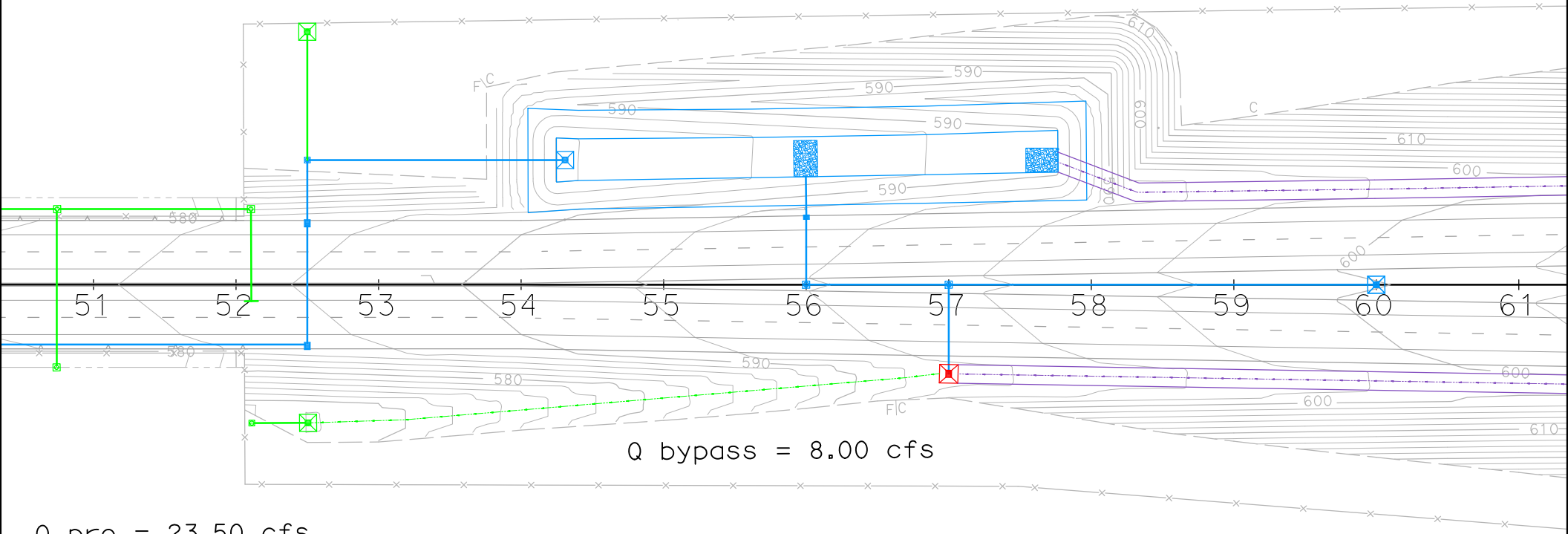
COUNTY P_6

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

Q in = 35.60 cfs
Q out = 1.32 cfs



Q bypass = 8.00 cfs

Q pre = 23.50 cfs
Q final = 9.32 cfs

BASIN A0
FLOW SUMMARY

Scale: 1"=100'

Basin A0 Retention

PROJECT:	SR-11			**DESCRIPTION:**	SR-11 Basin
JOB #:	11A1190			**STATION:**	54+25 - 58+00
BY:	M.BRUNING	**DATE:**	01.04.10	**WATERSHED:**	A0
CHK:	G.DALZIEL	**DATE:**		**SYSTEM:**	No Interchange Option

Notes:

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

RETENTION BASIN VOLUME

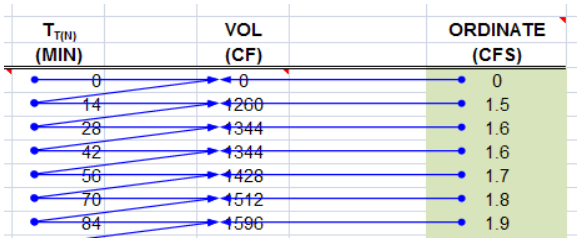
100-year, 6 hour duration storm event, use the Rational Method Hydrograph Procedure (SDCHM 6-1) ~ RatHydro

Pre-Developed volume calculations

Q_{100}=	23.5	cfs			
Tc=	10.0	min	C=	0.53	
$P_{100,6}$=	2.5	in	A=	10.51	acres

$T_{T(N)}$ (MIN)	VOL (CF)	ORDINATE (CFS)
0	0	0
10	480	0.8
20	480	0.8
30	540	0.9
40	540	0.9
50	540	0.9
60	600	1
70	600	1
80	600	1
90	660	1.1
100	660	1.1
110	720	1.2
120	720	1.2
130	780	1.3
140	840	1.4
150	900	1.5
160	960	1.6
170	1020	1.7
180	1080	1.8
190	1260	2.1
200	1380	2.3
210	1680	2.8
220	1920	3.2
230	2760	4.6
240	3900	6.5
250	14100	23.5
260	2220	3.7
270	1500	2.5
280	1140	1.9
290	960	1.6
300	840	1.4
310	780	1.3
320	720	1.2
330	660	1.1
340	600	1
350	540	0.9
360	540	0.9
370	0	0

Example of Steps:



SUM= 50220 ft^3
1.15 acre-feet

Check: $V = C*A*P_6$
V= 1.16 acre-feet
OK

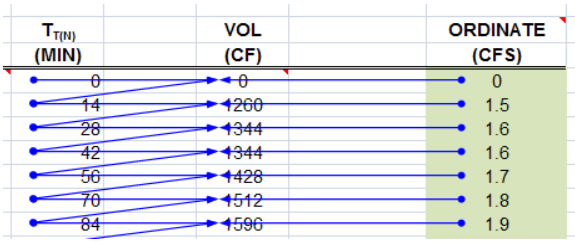
Basin A0 Retention

Post-Developed volume calculations

Q_{100}=	40.2	cfs			
Tc=	12.8	min	C=	0.80	
$P_{100,6}$=	2.5	in	A=	14.08	acres

$T_{T(N)}$ (MIN)	VOL (CF)	ORDINATE (CFS)
0	0	0
13	1092	1.4
26	1326	1.7
39	1404	1.8
52	1482	1.9
65	1482	1.9
78	1560	2
91	1638	2.1
104	1716	2.2
117	1794	2.3
130	1950	2.5
143	2106	2.7
156	2262	2.9
169	2418	3.1
182	2808	3.6
195	3042	3.9
208	3666	4.7
221	4212	5.4
234	6162	7.9
247	8580	11
260	31356	40.2
273	4992	6.4
286	3354	4.3
299	2574	3.3
312	2184	2.8
325	1872	2.4
338	1716	2.2
351	1560	2
364	1404	1.8
377	0	0

Example of Steps:



SUM= 101712 ft^3
2.33 acre-feet

Check: V = C*A*P_6
V= 2.34 acre-feet
OK

		2.33	*(Post)*		
	-	**1.15**	*(Pre)*		
Retention volume =		**1.18**	**acre-feet**	**=**	**51492 ft^3**

Basin Required

Basin A0 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}= 0.84
A= 10.09 acres

WQ_{72}: 0.66 in/area

Water Quality Volume (WQV) = **24178** **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

Onsite Highway *Sloped* runoff area, A: 288500 ft^2
A: 6.62 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 = 103.00 tons

Silt Accumulation Basin volume = **2289** **ft^3**

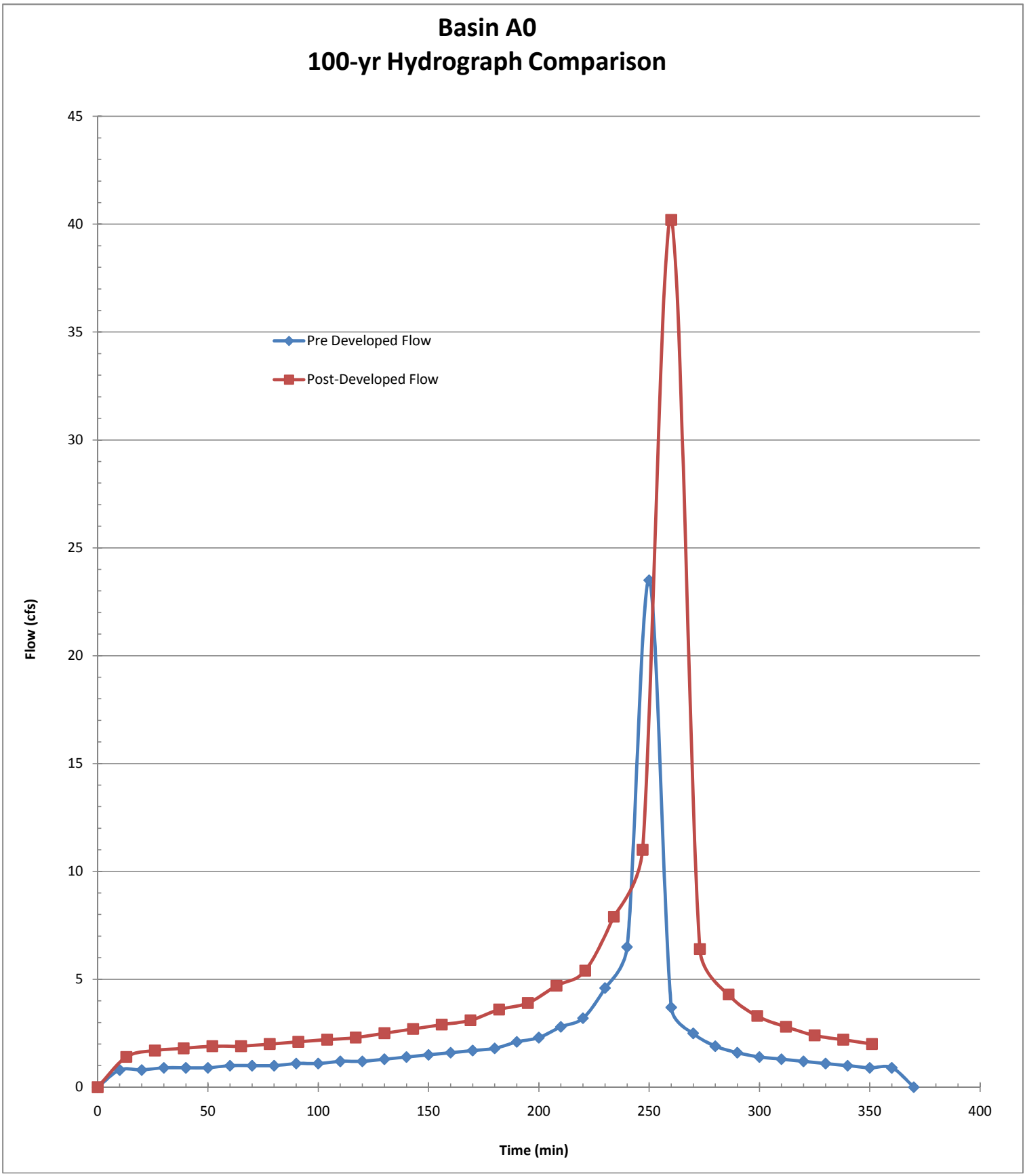
Add this volume to Basin volume due to silts from cut slopes

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


Basin A0
100-yr Hydrograph Comparison
Pre Developed Flow
Post-Developed Flow
Flow (cfs)
Time (min)
0
5
10
15
20
25
30
35
40
45
0
50
100
150
200
250
300
350
400

Basin A0 Inflow TcQ

PROJECT:	**SR-11**			**DESCRIPTION:**	**SR-11 Basin**
JOB #:	**11A1190**			**STATION:**	**57+75**
BY:	**M.BRUNING**	**DATE:**	**01.04.10**	**WATERSHED:**	**A0**
CHK:	**G.DALZIEL**	**DATE:**		**SYSTEM:**	**No Interchange Option**

BASIN AREA:

A = 439600 ft^2 | 10.09 acres

SOURCE: MICROSTATION/USGS (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	34%	AT	0.90	0.309
COMMERCIAL AREA	0%	AT	0.85	0.000
CUT SLOPE (2:1 and 4:1)	66%	AT	0.55	0.361
TOTAL	100%			
	(100%)			

$C_{2,10}$ =	0.67
C_{25} =	0.74
C_{50} =	0.80
C_{100} =	0.84

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	608.5	ft	SR-11 CL
LOW POINT ELEVATION	607.8	ft	SR-11 ES
ELEVATION DIFF (H)	0.7	ft	
LENGTH (L)	100	ft	To Bioswale
SLOPE (S) = (H/L)	0.7%		
MANNING'S n	0.016		<=n from Table 816.6A AC
T_t (SFF)=	3.32	minutes	

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

NOTES:

HIGH PT ELEVATION	607.8	ft	Origin of Bioswale
LOW POINT ELEVATION	606.0	ft	
ELEVATION DIFF (H)	1.8	ft	
LENGTH (L)	200	ft	Assumed bioswale does not have enough flow to be channelized
SLOPE (S) = (H/L)	0.9%		
VELOCITY (SCF)	1.8	fps	<=V from Figure 816.6 Grassed waterway
T_C (SH)=	1.90	minutes	

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

NOTES:

HIGH PT ELEVATION	606.0	ft	Begin channel flow in bioswale
LOW POINT ELEVATION	590.0	ft	CHANNEL DATA TYPE = TRAP'Z
ELEVATION DIFF (H)	16.0	ft	Z= 4 ANG-RAD 0.245
LENGTH (L)	900	ft	b = 13 ANG-DEG 14.036
SLOPE (S) = (H/L)	1.8%		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)	3.42	fps	From Manning's Equation assuming flowing full: $V=1.49/n(R^{2/3}S^{1/2})$
T_C (CH)=	4.38	minutes	

Basin A0 Inflow TcQ

Tc (TOTAL) =	9.60	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 =	**Q_2 =** 12.5
i_{10} =	2.7	in/hr	X CA =	**Q_{10} =** 18.2
i_{25} =	3.4	in/hr	X CA =	**Q_{25} =** 25.1
i_{50} =	4.0	in/hr	X CA =	**Q_{50} =** 32.8
i_{100} =	4.2	in/hr	X CA =	**Q_{100} =** **35.6**

FLOW RESULTS:

	cfs
Q_2 =	12.5
Q_{10} =	18.2
Q_{25} =	25.1
Q_{50} =	32.8
Q_{100} =	**35.6**

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 A0 Inflow Hydrograph

PROJECT:	**SR-11**			**DESCRIPTION:**	**SR-11 Basin**
JOB #:	**11A1190**			**STATION:**	**54+25 - 58+00**
BY:	**M.BRUNING**	**DATE:**	**01.04.10**	**WATERSHED:**	**A0**
CHK:	**G.DALZIEL**	**DATE:**		**SYSTEM:**	**No Interchange Option**

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

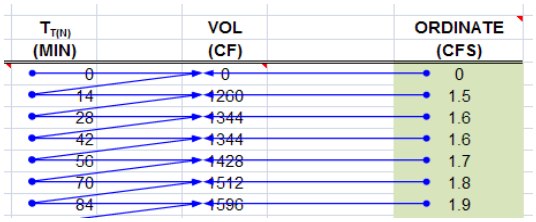
Basin Inflow Hydrograph

Basin Inflow Q

Q_{100}=	35.6	cfs	C_{100}=	0.84	
Tc=	10.0	min	A=	10.09	acres
$P_{100,6}$=	2.5	in			

$T_{T(N)}$ (MIN)	VOL (CF)	ORDINATE (CFS)
0	0	0
10	780	1.3
20	780	1.3
30	780	1.3
40	840	1.4
50	840	1.4
60	900	1.5
70	900	1.5
80	960	1.6
90	1020	1.7
100	1020	1.7
110	1080	1.8
120	1140	1.9
130	1200	2
140	1260	2.1
150	1380	2.3
160	1440	2.4
170	1560	2.6
180	1680	2.8
190	1920	3.2
200	2100	3.5
210	2520	4.2
220	2880	4.8
230	4260	7.1
240	6060	10.1
250	21360	35.6
260	3420	5.7
270	2280	3.8
280	1800	3
290	1500	2.5
300	1320	2.2
310	1140	1.9
320	1080	1.8
330	960	1.6
340	900	1.5
350	840	1.4
360	780	1.3
370	0	0

Example of Steps:



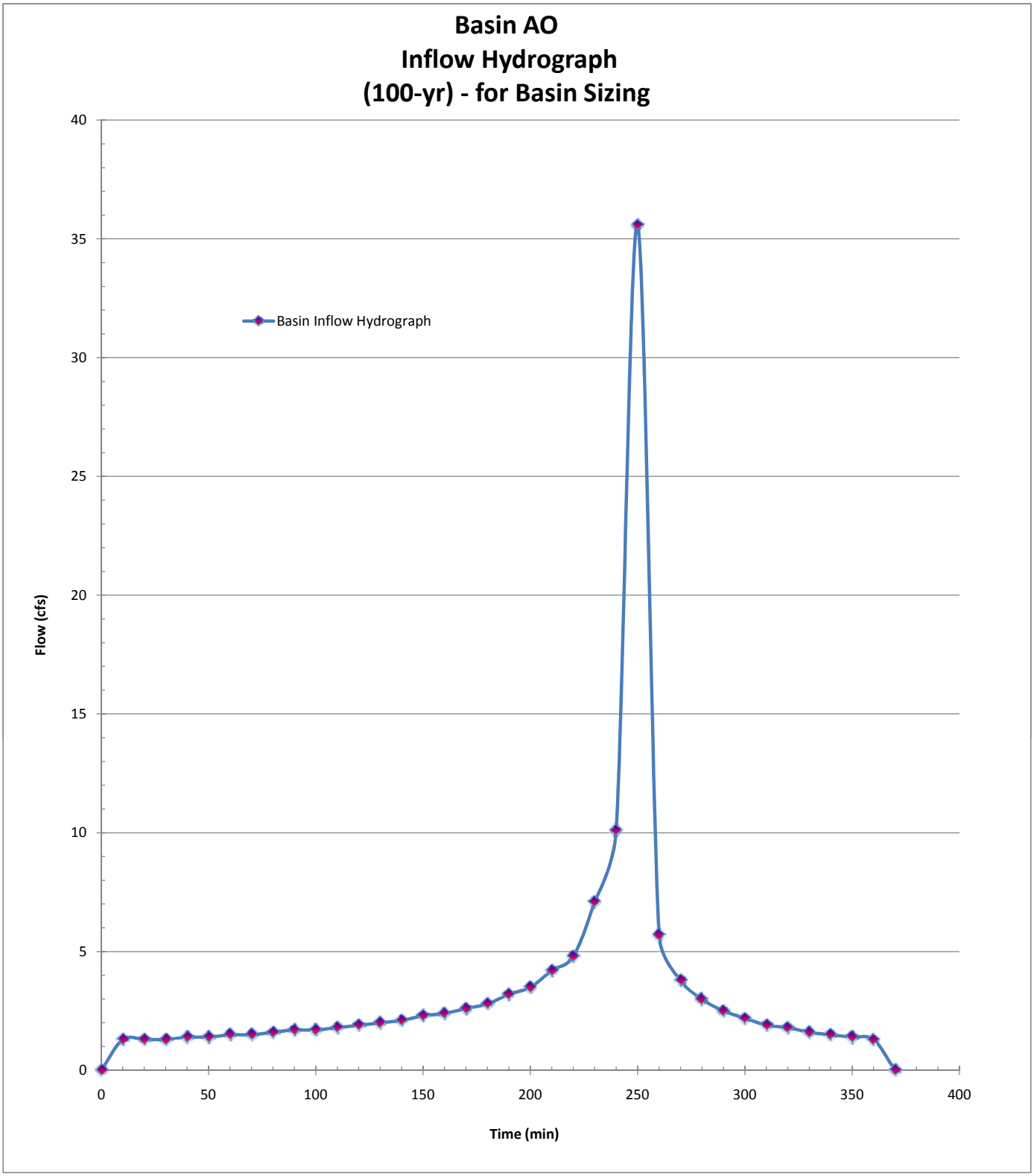
SUM= 76680 ft^3
1.76 acre-feet

Onsite Runoff Volume

Check: $V = C*A*P_6$

V= 1.76 acre-feet

OK


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

Basin A0 Outlet

PROJECT:	**SR-11**			**DESCRIPTION:**	**SR-11 Basin**
JOB #:	**11A1190**			**STATION:**	**54+25**
BY:	**M.BRUNING**	**DATE:**	**02.19.10**	**WATERSHED:**	**A0**
CHK:	**G.DALZIEL**	**DATE:**		**SYSTEM:**	**No Interchange Option**

Notes:

Required Retention Basin Volume = 53781 ft^3
Actual Basin Inflow = 76680 ft^4 *OK*

Flow Balance - determine maximum flow from basin

Predeveloped Peak 100-year Flow: 23.5 cfs
Post-Developed Peak Flow through Cross Culvert: 0.0 cfs
Flow that does not reach detention basin (bypass per DA table): 8.0 cfs ~ Q_{100} of: A0.4.PVA0.5.PVA0.6.SL
Maximum flow allowed to be released by this detention basin: 15.5 cfs

Outlet Pipe

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

Basin - Top of basin berm elevation = 589.20 ft
Basin flowline elevation = 584.00 ft
Maximum Basin Depth = 5.20 ft

Outlet Pipe

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

Outlet pipe invert from basin floor = 3.40 ft 587.40 ft
Outlet pipe diameter = 2 ft

Basin Characteristics

Base Length (L) 350 ft
Base Width (W) 30 ft
W/L Ratio ® 0.09
Side Slopes (Z) 1: 4
Total Volume (V): 103123 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)	Q_{out} (cfs)	Q_{inf} (cfs)	Q_{total} (cfs)
0	584.00	0.00	0	0		584.00	0.00		0.00
1	584.20	0.20	2161	2161		584.20	0.00		0.00
2	584.40	0.40	2284	4445		584.40	0.00		0.00
3	584.60	0.60	2410	6855		584.60	0.00		0.00
4	584.80	0.80	2539	9394		584.80	0.00		0.00
5	585.00	1.00	2670	12063		585.00	0.00		0.00
6	585.20	1.20	2804	14867		585.20	0.00		0.00
7	585.40	1.40	2940	17808		585.40	0.00		0.00
8	585.60	1.60	3079	20887		585.60	0.00		0.00
9	585.80	1.80	3221	24108		585.80	0.00		0.00
10	586.00	2.00	3366	27474		586.00	0.00		0.00
11	586.20	2.20	3513	30987		586.20	0.00		0.00
12	586.40	2.40	3662	34649		586.40	0.00		0.00
13	586.60	2.60	3815	38464		586.60	0.00	0.00	0.00
14	586.80	2.80	3970	42434		586.80	0.00		0.00
15	587.00	3.00	4127	46561		587.00	0.00		0.00
16	587.20	3.20	4288	50849		587.20	0.00		0.00
17	587.40	3.40	4451	55300	*	587.40	0.00		0.00
18	587.60	3.60	4616	59916		587.60	0.15		0.15
19	587.80	3.80	4784	64700		587.80	0.59		0.59
20	588.00	4.00	4955	69656		588.00	1.30		1.30
21	588.20	4.20	5129	74785		588.20	2.25		2.25
22	588.40	4.40	5305	80090		588.40	3.42		3.42
23	588.60	4.60	5484	85573		588.60	4.79		4.79
24	588.80	4.80	5665	91238		588.80	6.32		6.32
25	589.00	5.00	5849	97087		589.00	7.99		7.99
26	589.20	5.20	6036	103123		589.20	9.77		9.77

Basin A0 Routing

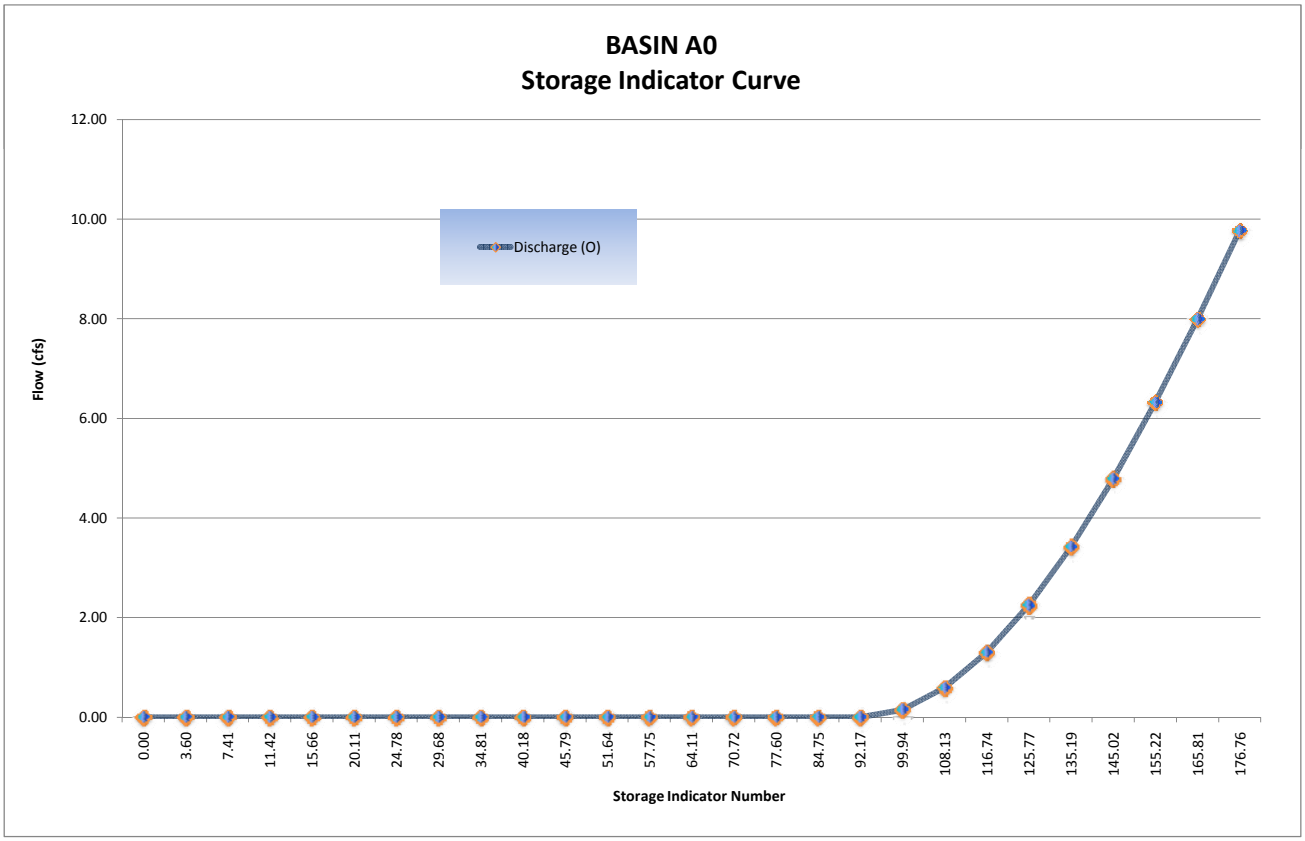
PROJECT:	SR-11			DESCRIPTION:	SR-11 Basin
JOB #:	11A1190			STATION:	54+25
BY:	M.BRUNING	DATE:	02.19.10	WATERSHED:	A
CHK:	G.DALZIEL	DATE:		SYSTEM:	No Interchange Option

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)	*Storage Indicator #* (6) $S_2/delta\ t + O_2/2$ (cfs)
584.00	0.00	0	0.00	0.00	0.00
584.20	0.00	2161	0.00	3.60	3.60
584.40	0.00	4445	0.00	7.41	7.41
584.60	0.00	6855	0.00	11.42	11.42
584.80	0.00	9394	0.00	15.66	15.66
585.00	0.00	12063	0.00	20.11	20.11
585.20	0.00	14867	0.00	24.78	24.78
585.40	0.00	17808	0.00	29.68	29.68
585.60	0.00	20887	0.00	34.81	34.81
585.80	0.00	24108	0.00	40.18	40.18
586.00	0.00	27474	0.00	45.79	45.79
586.20	0.00	30987	0.00	51.64	51.64
586.40	0.00	34649	0.00	57.75	57.75
586.60	0.00	38464	0.00	64.11	64.11
586.80	0.00	42434	0.00	70.72	70.72
587.00	0.00	46561	0.00	77.60	77.60
587.20	0.00	50849	0.00	84.75	84.75
587.40	0.00	55300	0.00	92.17	92.17
587.60	0.15	59916	0.08	99.86	99.94
587.80	0.59	64700	0.30	107.83	108.13
588.00	1.30	69656	0.65	116.09	116.74
588.20	2.25	74785	1.13	124.64	125.77
588.40	3.42	80090	1.71	133.48	135.19
588.60	4.79	85573	2.40	142.62	145.02
588.80	6.32	91238	3.16	152.06	155.22
589.00	7.99	97087	4.00	161.81	165.81
589.20	9.77	103123	4.89	171.87	176.76

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



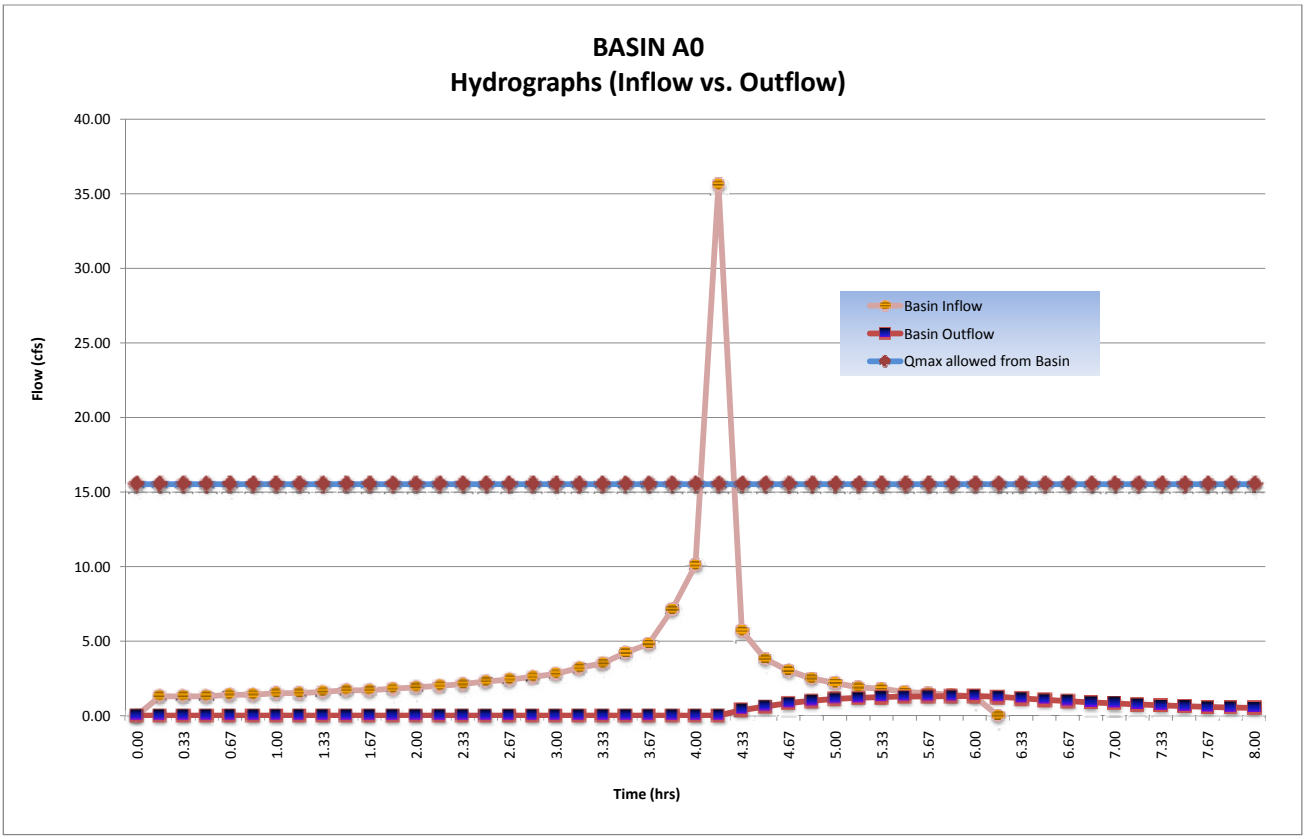
Basin A0 Routing

FINAL ROUTING TABLE

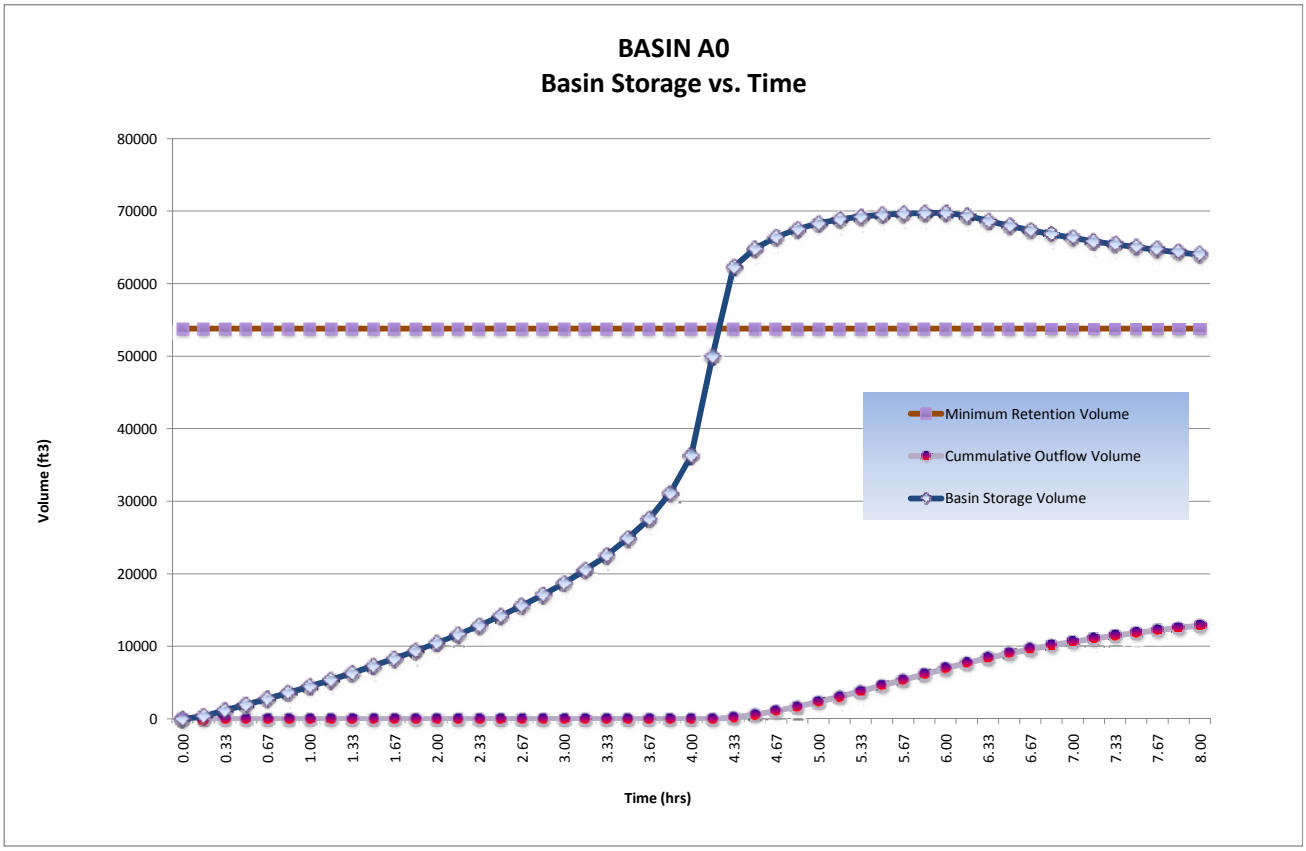
$$\frac{I_1 + I_2}{2} + \left(\frac{S_1}{\Delta t} - \frac{O_1}{2}\right) - O_1 = \left(\frac{S_2}{\Delta t} + \frac{O_2}{2}\right)$$

					Storage Indicator #				
(1)	(2)	(3)	(4)	(5)	(6)	(7)		Volumes (ft3)	
Time	Inflow	$(I_1+I_2)/2$	$(S_1/\Delta t + O_1/2)$	O_1	$S_2/\Delta t + O_2/2$	O_2	Basin	Incremental	Cummulative
(hrs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	Storage	Outflow	Outflow
	(Q_{post})		*col (6) from prev row*	*col (7) from prev row*	*col (3)+(4)-(5)*	*(Hard input)*	*Volume*	*Volume*	*Volume*
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
0.17	1.30	0.65	0.00	0.00	0.65	0.00	390	0	0
0.33	1.30	1.30	0.65	0.00	1.95	0.00	1170	0	0
0.50	1.30	1.30	1.95	0.00	3.25	0.00	1950	0	0
0.67	1.40	1.35	3.25	0.00	4.60	0.00	2760	0	0
0.83	1.40	1.40	4.60	0.00	6.00	0.00	3600	0	0
1.00	1.50	1.45	6.00	0.00	7.45	0.00	4470	0	0
1.17	1.50	1.50	7.45	0.00	8.95	0.00	5370	0	0
1.33	1.60	1.55	8.95	0.00	10.50	0.00	6300	0	0
1.50	1.70	1.65	10.50	0.00	12.15	0.00	7290	0	0
1.67	1.70	1.70	12.15	0.00	13.85	0.00	8310	0	0
1.83	1.80	1.75	13.85	0.00	15.60	0.00	9360	0	0
2.00	1.90	1.85	15.60	0.00	17.45	0.00	10470	0	0
2.17	2.00	1.95	17.45	0.00	19.40	0.00	11640	0	0
2.33	2.10	2.05	19.40	0.00	21.45	0.00	12870	0	0
2.50	2.30	2.20	21.45	0.00	23.65	0.00	14190	0	0
2.67	2.40	2.35	23.65	0.00	26.00	0.00	15600	0	0
2.83	2.60	2.50	26.00	0.00	28.50	0.00	17100	0	0
3.00	2.80	2.70	28.50	0.00	31.20	0.00	18720	0	0
3.17	3.20	3.00	31.20	0.00	34.20	0.00	20520	0	0
3.33	3.50	3.35	34.20	0.00	37.55	0.00	22530	0	0
3.50	4.20	3.85	37.55	0.00	41.40	0.00	24840	0	0
3.67	4.80	4.50	41.40	0.00	45.90	0.00	27540	0	0
3.83	7.10	5.95	45.90	0.00	51.85	0.00	31110	0	0
4.00	10.10	8.60	51.85	0.00	60.45	0.00	36270	0	0
4.17	35.60	22.85	60.45	0.00	83.30	0.00	49980	0	0
4.33	5.70	20.65	83.30	0.00	103.95	0.37	62259	222	222
4.50	3.80	4.75	103.95	0.37	108.33	0.61	64815	366	588
4.67	3.00	3.40	108.33	0.61	111.12	0.84	66420	504	1092
4.83	2.50	2.75	111.12	0.84	113.03	0.99	67521	594	1686
5.00	2.20	2.35	113.03	0.99	114.39	1.11	68301	666	2352
5.17	1.90	2.05	114.39	1.11	115.33	1.18	68844	708	3060
5.33	1.80	1.85	115.33	1.18	116.00	1.24	69228	744	3804
5.50	1.60	1.70	116.00	1.24	116.46	1.28	69492	768	4572
5.67	1.50	1.55	116.46	1.28	116.73	1.30	69648	780	5352
5.83	1.40	1.45	116.73	1.30	116.88	1.31	69735	786	6138
6.00	1.30	1.35	116.88	1.31	116.92	1.32	69756	792	6930
6.17	0.00	0.65	116.92	1.32	116.25	1.26	69372	756	7686
6.33		0.00	116.25	1.26	114.99	1.16	68646	696	8382
6.50		0.00	114.99	1.16	113.83	1.06	67980	636	9018
6.67		0.00	113.83	1.06	112.77	0.97	67371	582	9600
6.83		0.00	112.77	0.97	111.80	0.89	66813	534	10134
7.00		0.00	111.80	0.89	110.91	0.82	66300	492	10626
7.17		0.00	110.91	0.82	110.09	0.75	65829	450	11076
7.33		0.00	110.09	0.75	109.34	0.69	65397	414	11490
7.50		0.00	109.34	0.69	108.65	0.63	65001	378	11868
7.67		0.00	108.65	0.63	108.02	0.58	64638	348	12216
7.83		0.00	108.02	0.58	107.44	0.55	64299	330	12546
8.00		0.00	107.44	0.55	106.89	0.52	63978	312	12858

Basin A0 Routing



Basin A0 Routing



Detention / Retention Basin Volume Required:	**69,756**	**ft³**	
@ Stage:	**588.20**	**ft**	
Freeboard:	**1.0**	**ft**	>1' Freeboard
Final Total Basin Volume Provided:	**103,123**	**ft³**	Basin **A0**
Maximum flow rate released from this basin:	**1.32**	**cfs**	

B0 Onsite D.A. Table

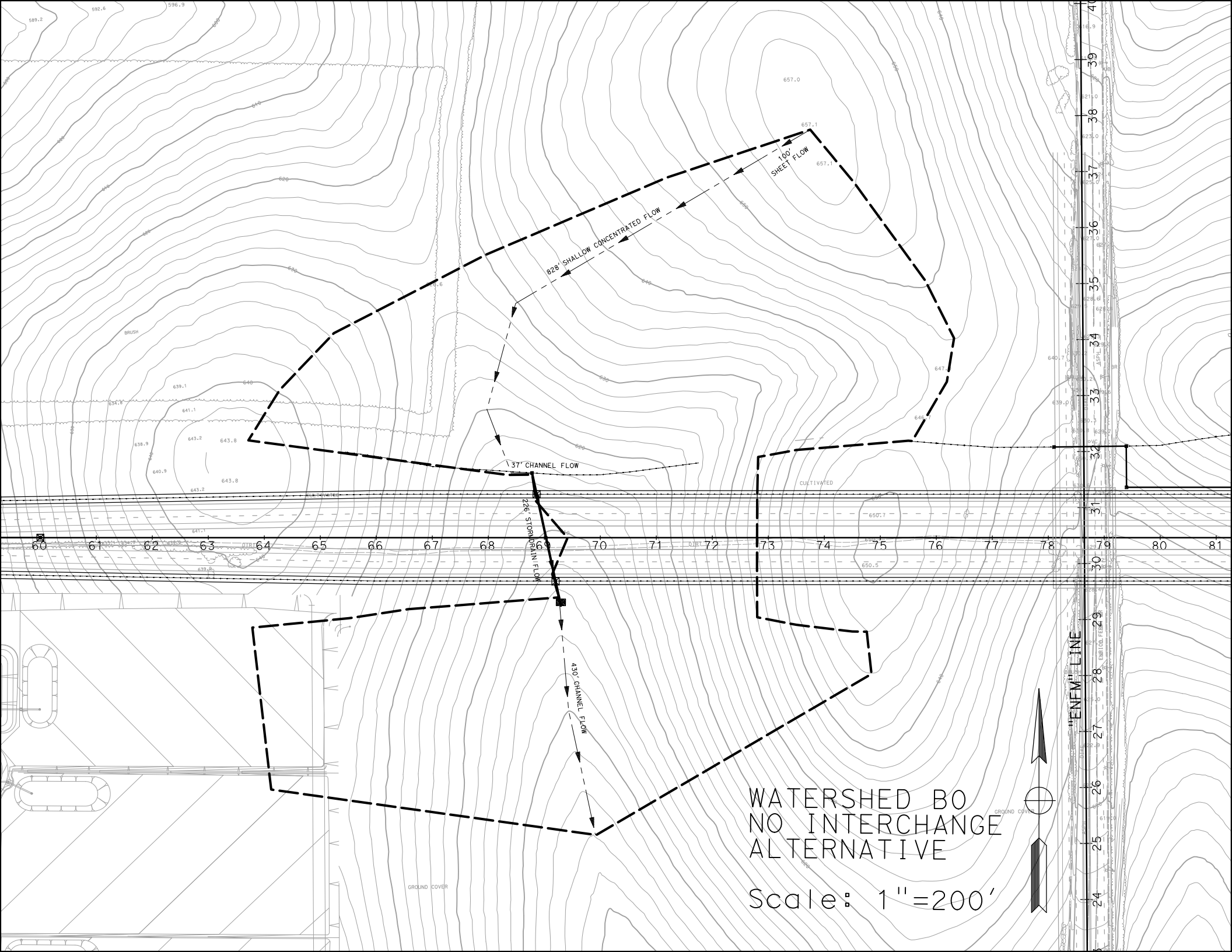
PROJECT:	**SR-11**	**DESCRIPTION:**	**On-site Drainage Areas (D.A.)**
JOB #:	**11A1190**	**STATION:**	**~**
BY:	**M.BRUNING** **DATE:** **01.04.10**	**WATERSHED:**	**B0**
CHK:	**G.DALZIEL** **DATE:**	**SYSTEM:**	**No Interchange Option**

						Caltrans	Caltrans	County	County					
			Area		Tc	i_{25}	Q_{25}	i_{100}	Q_{100}	Drains to:				
	Name	C	*SF*	*Acres*	*min*	*in/hr*	*cfs*	*in/hr*	*cfs*	Bioswale	Inlet	Destination	@ Station	Offset
PAVED	B0.1.PV	0.99	23900	0.5	10	2.8	1.54	4.2	2.29	B0.1	B0.1	*bypass**	69+00	Lt
	B0.2.PV	0.99	22900	0.5	10	2.8	1.47	4.2	2.19	B0.2	B0.2	*bypass**	69+00	Rt
		Σ	46800	*PAVED*										

						Caltrans	Caltrans	County	County					
			Area		Tc	i_{25}	Q_{25}	i_{100}	Q_{100}	Drains to:				
	Name	C	*SF*	*Acres*	*min*	*in/hr*	*cfs*	*in/hr*	*cfs*	Bioswale	Inlet	Destination	@ Station	Offset
SLOPE	B0.1.SL	0.61	22700	0.5	10	2.8	0.90	4.2	6.98	B0.1	B0.1	*bypass**	69+00	Lt
	B0.2.SL	0.61	19800	0.5	10	2.8	0.78	4.2	7.98	B0.2	B0.2	*bypass**	69+00	Rt
		Σ	42500	*SLOPE*										

**flow that does not reach the basin*

Total :	89300	2.1
	SF	*ac*


160' SHEET FLOW
828' SHALLOW CONCENTRATED FLOW
37' CHANNEL FLOW
226' STORM DRAIN FLOW
430' CHANNEL FLOW
"ENFM" LINE
WATERSHED B0
NO INTERCHANGE
ALTERNATIVE
Scale: 1"=200'

B0 Post-Developed TcQ

PROJECT:	**SR-11**			**DESCRIPTION:**	**SR-11 Post-Developed**
JOB #:	**11A1190**			**STATION:**	**69+00**
BY:	**M.BRUNING**	**DATE:**	**01.04.10**	**WATERSHED:**	**B0**
CHK:	**G.DALZIEL**	**DATE:**		**SYSTEM:**	**No Interchange Option**

BASIN AREA:

A =	**910258**	**ft^2**	**SOURCE:**	**MICROSTATION/USGS**
	20.90	**acres**		**(SCALE = 1:1)**

COEFFICIENT OF RUNOFF:

KEY: User Input | Designer Tool

UNDEVELOPED AREA C (FROM HDM FIG. 819.2A)

NOTES:

RELIEF (.08-.35)	0.14	Rolling Slopes ~ 5%
INFILTRATION (.04-.16)	0.12	Negligible infiltration capacity - see Geotechnical Report
VEGETATION (.04-.16)	0.08	Fair natural cover
STORAGE (.04-.12)	0.08	Low
TOTAL C =	0.42	

UNDEVELOPED AREA	90%	AT	0.42	0.379
PAVED SURFACE	5%	AT	0.90	0.046
COMMERCIAL AREA	0%	AT	0.85	0.000
CUT SLOPE (2:1 and 4:1)	5%	AT	0.55	0.026
TOTAL	100%			
	(100%)			

$C_{2,10}$ =	0.45
C_{25} =	0.50
C_{50} =	0.54
C_{100} =	0.56

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	657.1	ft	northern peak
LOW POINT ELEVATION	654.0	ft	
ELEVATION DIFF (H)	3.1	ft	
LENGTH (L)	100	ft	
SLOPE (S) = (H/L)	3.1%		
MANNING'S n	0.150		< = FROM TABLE 816.6A — short grass - prairie
T_t (SFF)=	10.96	minutes	

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

NOTES:

HIGH PT ELEVATION	654.0	ft	northern peak
LOW POINT ELEVATION	615.0	ft	
ELEVATION DIFF (H)	39.0	ft	
LENGTH (L)	828	ft	
SLOPE (S) = (H/L)	4.7%		
VELOCITY (SCF)	1.5	fps	V FROM FIG 816.5 — short grass
T_C (SH)=	9.20	minutes	

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

NOTES:

HIGH PT ELEVATION	615.0	ft	Slope Ditch
LOW POINT ELEVATION	614.5	ft	CHANNEL DATA — TYPE = TRAP'Z
ELEVATION DIFF (H)	0.5	ft	Z= 2 — ANG-RAD 0.464
LENGTH (L)	37	ft	b = 2 — ANG-DEG 26.565
SLOPE (S) = (H/L)	1.4%		d = 0.5 — FLOWING FULL ASS'M
MANNING'S n	0.015		Concrete-rough
HYDRAULIC RADIUS R	0.35	ft	R=(bdsinA+d^2cosA)/(bsinA+2d)
VELOCITY (CHANNEL)	5.78	fps	From Manning's Equation assuming flowing full: $V=1.49/n(R^{2/3}S^{1/2})$
T_C (CH)=	0.11	minutes	

B0 Post-Developed TcQ

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

			NOTES:
HIGH PT ELEVATION	614.5	ft	Cross Culvert
LOW POINT ELEVATION	606.0	ft	
ELEVATION DIFF (H)	8.5	ft	
LENGTH (L)	226	ft	
SLOPE (S) = (H/L)	3.8%		
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)	18.3	fps	$V = \frac{K_u}{n} R^{2/3} S^{1/2}$
T_C (SD)=	0.21	minutes	

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

			NOTES:
HIGH PT ELEVATION	606.0	ft	Begins to form natural channel
LOW POINT ELEVATION	594.0	ft	
ELEVATION DIFF (H)	12.0	ft	
LENGTH (L)	430	ft	
SLOPE (S) = (H/L)	2.8%		
MANNING'S n	0.080		grass
HYDRAULIC RADIUS R	0.4	ft	R=(bdsinA+d^2cosA)/(bsinA+2d)
VELOCITY (CHANNEL)	1.73	fps	From Manning's Equation assuming flowing full: $V=1.49/n(R^{2/3}S^{1/2})$
T_C (CH)=	4.15	minutes	

CHANNEL DATA		TYPE =	TRAP'Z
Z=	5	ANG-RAD	0.197
b =	10	ANG-DEG	11.310
d =	0.5	FLOWING FULL ASS'M	

Tc (TOTAL) =	24.62	minutes
Minimum Tc =	10	minutes
USE Tc =	**24.62**	minutes

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

i_2 =	1.0	in/hr	X CA =	**Q_2 =**	9.8
i_{10} =	1.5	in/hr	X CA =	**Q_{10} =**	14.2
i_{25} =	1.9	in/hr	X CA =	**Q_{25} =**	19.5
i_{50} =	2.3	in/hr	X CA =	**Q_{50} =**	25.6
i_{100} =	2.4	in/hr	X CA =	**Q_{100} =**	**27.7**

FLOW RESULTS: cfs

COUNTY P_6 inches

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

100' SHEET FLOW
625' SHALLOW CONCENTRATED FLOW
Culvert BO
37' CHANNEL FLOW
"ENFM" LINE
CULVERT BO
NO INTERCHANGE
ALTERNATIVE
Scale: 1"=200'

Culvert Calculator Report
B0 10-yr

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	616.50	ft	Headwater Depth/Height	0.77	
Computed Headwater Elevation	616.03	ft	Discharge	7.40	cfs
Inlet Control HW Elev.	615.86	ft	Tailwater Elevation	606.56	ft
Outlet Control HW Elev.	616.03	ft	Control Type	Entrance Control	

Grades					
Upstream Invert	614.50	ft	Downstream Invert	606.00	ft
Length	226.00	ft	Constructed Slope	3.8	%

Hydraulic Profile					
Profile	S2		Depth, Downstream	0.56	ft
Slope Type	Steep		Normal Depth	0.56	ft
Flow Regime	Supercritical		Critical Depth	0.97	ft
Velocity Downstream	10.39	ft/s	Critical Slope	0.5	%

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	2.00	ft
Section Size	24 inch		Rise	2.00	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	616.03	ft	Upstream Velocity Head	0.38	ft
Ke	0.50		Entrance Loss	0.19	ft

Inlet Control Properties					
Inlet Control HW Elev.	615.86	ft	Flow Control	Unsubmerged	
Inlet Type	Square edge w/headwall		Area Full	3.1	ft²
K	0.00980		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	1	
C	0.03980		Equation Form	1	
Y	0.67000				

Culvert Calculator Report
B0 100-yr

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	617.00	ft	Headwater Depth/Height	1.18	
Computed Headwater Elevation	616.85	ft	Discharge	15.00	cfs
Inlet Control HW Elev.	616.72	ft	Tailwater Elevation	606.81	ft
Outlet Control HW Elev.	616.85	ft	Control Type	Entrance Control	

Grades					
Upstream Invert	614.50	ft	Downstream Invert	606.00	ft
Length	226.00	ft	Constructed Slope	3.8	%

Hydraulic Profile					
Profile	S2		Depth, Downstream	0.81	ft
Slope Type	Steep		Normal Depth	0.81	ft
Flow Regime	Supercritical		Critical Depth	1.40	ft
Velocity Downstream	12.65	ft/s	Critical Slope	0.6	%

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	2.00	ft
Section Size	24 inch		Rise	2.00	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	616.85	ft	Upstream Velocity Head	0.64	ft
Ke	0.50		Entrance Loss	0.32	ft

Inlet Control Properties					
Inlet Control HW Elev.	616.72	ft	Flow Control	Unsubmerged	
Inlet Type	Square edge w/headwall		Area Full	3.1	ft²
K	0.00980		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	1	
C	0.03980		Equation Form	1	
Y	0.67000				

B0 Culvert TcQ

PROJECT:	**SR-11**			**DESCRIPTION:**	**SR-11 Post-Developed**
JOB #:	**11A1190**			**STATION:**	**69+00**
BY:	**M.BRUNING**	**DATE:**	**01.04.10**	**WATERSHED:**	**B0 Culvert**
CHK:	**G.DALZIEL**	**DATE:**		**SYSTEM:**	**B0 Culvert**

BASIN AREA:

A =	**483334**	**ft^2**	**SOURCE:**	**MICROSTATION/USGS**
	11.10	**acres**		**(SCALE = 1:1)**

COEFFICIENT OF RUNOFF:

KEY: User Input | Designer Tool

UNDEVELOPED AREA C (FROM HDM FIG. 819.2A)

NOTES:

RELIEF (.08-.35)	0.14	Rolling Slopes ~ 5%
INFILTRATION (.04-.16)	0.12	Negligible infiltration capacity - see Geotechnical Report
VEGETATION (.04-.16)	0.08	Fair natural cover
STORAGE (.04-.12)	0.08	Low
TOTAL C =	0.42	

UNDEVELOPED AREA	100%	AT	0.42	0.420
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%)			

$C_{2,10}$ =	0.42
C_{25} =	0.46
C_{50} =	0.50
C_{100} =	0.53

TIME OF CONCENTRATION:

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

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

HIGH PT ELEVATION	657.1	ft	northern peak
LOW POINT ELEVATION	654.0	ft	
ELEVATION DIFF (H)	3.1	ft	
LENGTH (L)	100	ft	
SLOPE (S) = (H/L)	3.1%		
MANNING'S n	0.150		< = FROM TABLE 816.6A — short grass prarie
T_t (SFF)=	10.96	minutes	

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

NOTES:

HIGH PT ELEVATION	657.1	ft	northern peak
LOW POINT ELEVATION	615.0	ft	
ELEVATION DIFF (H)	42.1	ft	
LENGTH (L)	828	ft	
SLOPE (S) = (H/L)	5.1%		
VELOCITY (SCF)	1.5	fps	V FROM FIG 816.6 — short grass
T_C (SH)=	9.20	minutes	

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

NOTES:

HIGH PT ELEVATION	615.0	ft	Slope Ditch
LOW POINT ELEVATION	614.5	ft	CHANNEL DATA — TYPE = TRAP'Z
ELEVATION DIFF (H)	0.5	ft	Z= 2 — ANG-RAD 0.464
LENGTH (L)	37	ft	b = 2 — ANG-DEG 26.565
SLOPE (S) = (H/L)	1.4%		d = 0.5 — FLOWING FULL ASS'M
MANNING'S n	0.015		Concrete-rough
HYDRAULIC RADIUS R	0.35	ft	R=(bdsinA+d^2cosA)/(bsinA+2d)
VELOCITY (CHANNEL)	5.78	fps	From Manning's Equation assuming flowing full: $V=1.49/n(R^{2/3}S^{1/2})$
T_C (CH)=	0.11	minutes	

B0 Culvert TcQ

Tc (TOTAL) =	20.27	minutes
Minimum Tc =	10	minutes
USE T_C =	**20.27**	minutes

INTENSITY CHART: Caltrans IDF2000

i_2 =	0.8	in/hr	X CA =	**Q_2 =**	3.9
i_{10} =	1.6	in/hr	X CA =	**Q_{10} =**	7.4
i_{25} =	2.0	in/hr	X CA =	**Q_{25} =**	10.2
i_{50} =	2.3	in/hr	X CA =	**Q_{50} =**	12.8
i_{100} =	2.6	in/hr	X CA =	**Q_{100} =**	**15.0**

FLOW RESULTS

cfs

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 B0 Retention

PROJECT:	**SR-11**			**DESCRIPTION:**	**SR-11 Basin**
JOB #:	**11A1190**			**STATION:**	**69+00**
BY:	**M.BRUNING**	**DATE:**	**01.04.10**	**WATERSHED:**	**B0**
CHK:	**G.DALZIEL**	**DATE:**		**SYSTEM:**	**No Interchange Option**

Notes:

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

RETENTION VOLUME

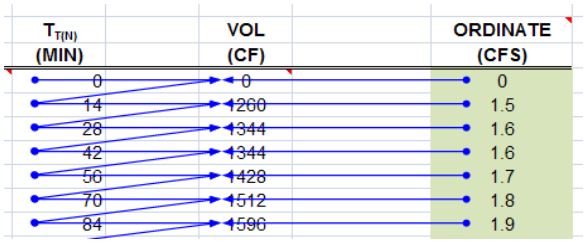
100-year, 6 hour duration storm event, use the Rational Method Hydrograph Procedure (SDCHM 6-1) ~ RatHydro

Pre-Developed volume calculations

Q_{100}=	30.8	cfs			
Tc=	26.2	min	C=	0.53	
$P_{100,6}$=	2.5	in	A=	25.94	acres

$T_{T(N)}$ (MIN)	VOL (CF)	ORDINATE (CFS)
0	0	0
26	3276	2.1
52	3588	2.3
78	3744	2.4
104	4368	2.8
130	4680	3
156	5772	3.7
182	6552	4.2
208	9672	6.2
234	14352	9.2
260	48048	30.8
286	7800	5
312	5148	3.3
338	4056	2.6
364	3432	2.2
390	0	0

Example of Steps:



SUM= 124488 ft^3
2.86 acre-feet

Check: $V = C*A*P_6$
V= 2.84 acre-feet
OK

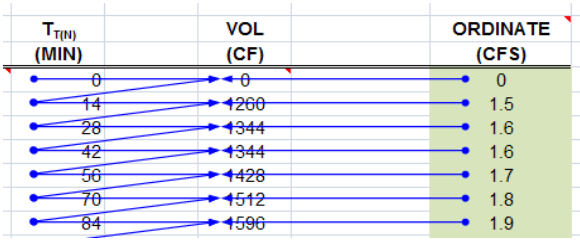
Basin B0 Retention

Post-Developed volume calculations

Q_{100}=	27.7	cfs			
Tc=	24.6	min	C=	0.56	
$P_{100,6}$=	2.5	in	A=	20.90	acres

$T_{T(N)}$ (MIN)	VOL (CF)	ORDINATE (CFS)
0	0	0
25	2700	1.8
50	3000	2
75	3150	2.1
100	3600	2.4
125	3900	2.6
150	4800	3.2
175	5550	3.7
200	8100	5.4
225	10800	7.2
250	41550	27.7
275	6450	4.3
300	4350	2.9
325	3450	2.3
350	2850	1.9
375	0	0

Example of Steps:



SUM= 104250 ft^3
2.39 acre-feet

Check: $V = C*A*P_6$
V= 2.45 acre-feet
OK

		2.39	*(Post)*		
	-	**2.86**	*(Pre)*		
Retention volume =		**-0.46**	**acre-feet**	=	**-20238 ft^3**

No Basin Required

Basin B0 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}= 0.99
A= 1.07 acres

WQ_{72}: 0.73 in/area

Water Quality Volume (WQV) = **2847** **ft^3**

Treatment within biofiltration swales

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

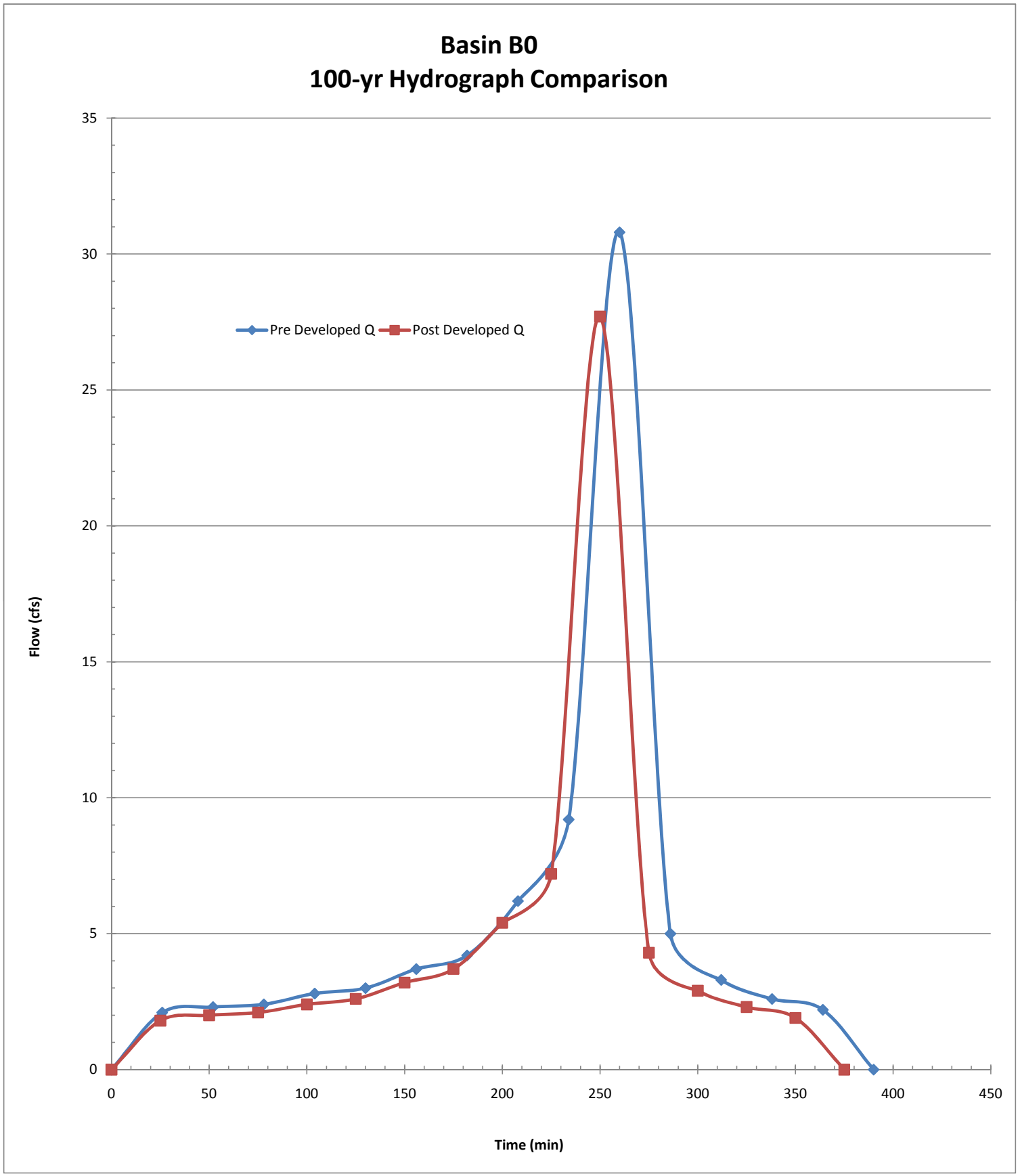
Onsite Highway *Sloped* runoff area, A:		42500	ft^2
	A:	0.98	acres
		10.00	years
where:	R=	30.00	
	K=	0.24	
	Ls=	18.00	
	C=	0.012	
	P=	1.00	
	As	1.56	tons/yr*Ac

Volume for 10-year Silt Accumulation = 15.17 tons

Silt Accumulation Basin volume = **337** **ft^3**

Silt extracted within biofiltration swale

.


Basin B0
100-yr Hydrograph Comparison
Pre Developed Q
Post Developed Q
Flow (cfs)
Time (min)
0
5
10
15
20
25
30
35
0
50
100
150
200
250
300
350
400
450

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C0 Onsite D.A. Table

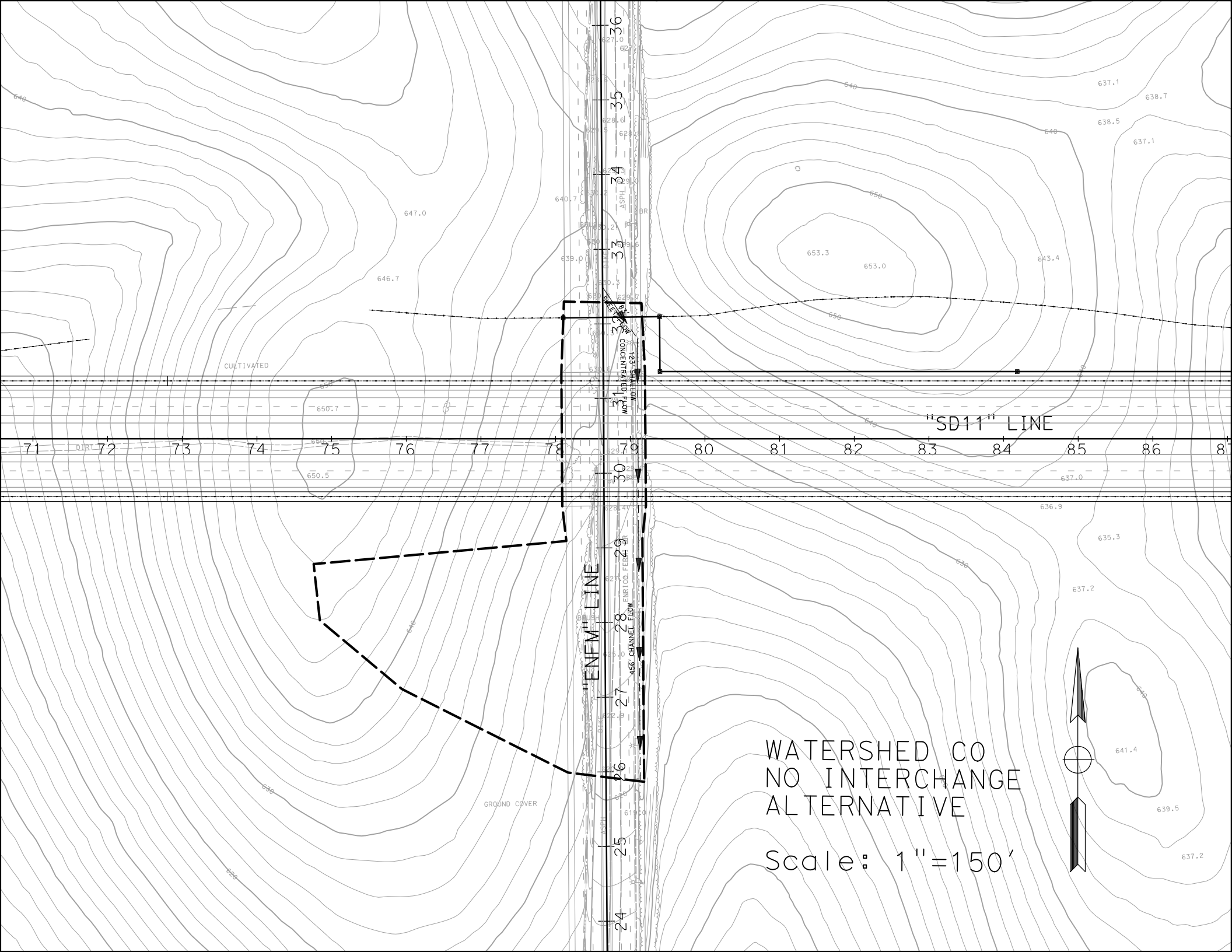
PROJECT:	**SR-11**	**DESCRIPTION:**	**On-site Drainage Areas (D.A.)**
JOB #:	**11A1190**	**STATION:**	**~**
BY:	**M.BRUNING** **DATE:** **01.04.10**	**WATERSHED:**	**C0**
CHK:	**G.DALZIEL** **DATE:**	**SYSTEM:**	**No Interchange Option**

						Caltrans	Caltrans	County	County					
PAVED			Area		Tc	i_{25}	Q_{25}	i_{100}	Q_{100}	Drains to:				
	Name	C	*SF*	*Acres*	*min*	*in/hr*	*cfs*	*in/hr*	*cfs*	Bioswale	Inlet	Destination	@ Station	Offset
	C0.1.PV	0.99	36900	0.8	10	2.8	2.37	4.2	3.53	~	C0.1	*bypass**	29+00	ENFM
	Σ		36900	*PAVED*										

						Caltrans	Caltrans	County	County					
SLOPE			Area		Tc	i_{25}	Q_{25}	i_{100}	Q_{100}	Drains to:				
	Name	C	*SF*	*Acres*	*min*	*in/hr*	*cfs*	*in/hr*	*cfs*	Bioswale	Inlet	Destination	@ Station	Offset
	C0.1.SL	0.61	98800	2.3	10	2.8	3.91	4.2	5.83	~	C0.1	*bypass**	26+00	ENFM
	Σ		98800	*SLOPE*										

**flow that does not reach the basin*

Total :	135700	3.12
	SF	*ac*


"SD11" LINE
"ENEM" LINE
CONCENTRATED FLOW
456' CHANNEL FLOW
CULTIVATED
GROUND COVER
WATERSHED CO
NO INTERCHANGE
ALTERNATIVE
Scale: 1"=150'

C0 Post-Developed TcQ

PROJECT:	**SR-11**			**DESCRIPTION:**	**SR-11 Post-Developed**
JOB #:	**11A1190**			**STATION:**	**78+00**
BY:	**M.BRUNING**	**DATE:**	**01.04.10**	**WATERSHED:**	**C0**
CHK:	**G.DALZIEL**	**DATE:**		**SYSTEM:**	**No Interchange Option**

BASIN AREA:

A =	**135700**	**ft^2**	**SOURCE:**	**MICROSTATION/USGS**
	3.12	**acres**		**(SCALE = 1:1)**

COEFFICIENT OF RUNOFF:

KEY: User Input | Designer Tool

UNDEVELOPED AREA C (FROM HDM FIG. 819.2A)

NOTES:

RELIEF (.08-.35)	0.14	Rolling Slopes ~ 5%
INFILTRATION (.04-.16)	0.12	Negligible infiltration capacity - see Geotechnical Report
VEGETATION (.04-.16)	0.08	Fair natural cover
STORAGE (.04-.12)	0.08	Low
TOTAL C =	0.42	

UNDEVELOPED AREA	73%	AT	0.42	0.306
PAVED SURFACE	27%	AT	0.90	0.245
COMMERCIAL AREA	0%	AT	0.85	0.000
CUT SLOPE (2:1 and 4:1)	0%	AT	0.55	0.000
TOTAL	100%			
	(100%)			

$C_{2,10}$ =	0.55
C_{25} =	0.61
C_{50} =	0.66
C_{100} =	0.69

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	630.8	ft	High Point on Enrico Fermi, north of SR-11
LOW POINT ELEVATION	630.0	ft	
ELEVATION DIFF (H)	0.8	ft	
LENGTH (L)	83	ft	
SLOPE (S) = (H/L)	1.0%		
MANNING'S n	0.016		< = From Table 816.6A Asphalt
T_t (SFF)=	2.47	minutes	

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

NOTES:

HIGH PT ELEVATION	630.0	ft	Eastern Gutter of Enrico Fermi, north of SR-11
LOW POINT ELEVATION	629.0	ft	Caltrans ROW
ELEVATION DIFF (H)	1.0	ft	
LENGTH (L)	123	ft	
SLOPE (S) = (H/L)	0.8%		
VELOCITY (SCF)	1.5	fps	V FROM FIG 816.6 nearly bare ground
T_C (SH)=	1.37	minutes	

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

NOTES:

HIGH PT ELEVATION	629.0	ft	Enrico Fermi Gutter - east
LOW POINT ELEVATION	620.0	ft	CHANNEL DATA TYPE = TRAP'Z
ELEVATION DIFF (H)	9.0	ft	Z= 12 ANG-RAD 0.083
LENGTH (L)	456	ft	b = 2 ANG-DEG 4.764
SLOPE (S) = (H/L)	2.0%		d = 0.25 FLOWING FULL ASS'M
MANNING'S n	0.015		Gutter
HYDRAULIC RADIUS R	0.16	ft	R=(bdsinA+d^2cosA)/(bsinA+2d)
VELOCITY (CHANNEL)	4.04	fps	From Manning's Equation assuming flowing full: $V=1.49/n(R^{2/3}S^{1/2})$
T_C (CH)=	1.88	minutes	

C0 Post-Developed TcQ

Tc (TOTAL) =	5.71	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 =	3.2
Q_{10} =	4.6
Q_{25} =	6.4
Q_{50} =	8.3
Q_{100} =	**9.0**

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 C0 Retention

PROJECT:	SR-11			**DESCRIPTION:**	SR-11 Basin
JOB #:	11A1190			**STATION:**	78+00
BY:	M.BRUNING	**DATE:**	01.04.10	**WATERSHED:**	C0
CHK:	G.DALZIEL	**DATE:**		**SYSTEM:**	No Interchange Option

Notes:

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

RETENTION VOLUME

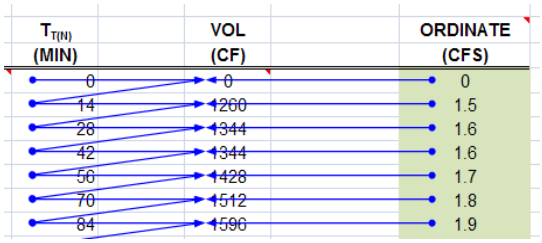
100-year, 6 hour duration storm event, use the Rational Method Hydrograph Procedure (SDCHM 6-1) ~ RatHydro

Pre-Developed volume calculations

Q_{100}=	16.4	cfs			
Tc=	10.0	min	C=	0.60	
$P_{100,6}$=	2.5	in	A=	6.49	acres

$T_{T(N)}$ (MIN)	VOL (CF)	ORDINATE (CFS)
0	0	0
10	360	0.6
20	360	0.6
30	360	0.6
40	360	0.6
50	420	0.7
60	420	0.7
70	420	0.7
80	420	0.7
90	480	0.8
100	480	0.8
110	480	0.8
120	540	0.9
130	540	0.9
140	600	1
150	600	1
160	660	1.1
170	720	1.2
180	780	1.3
190	900	1.5
200	960	1.6
210	1140	1.9
220	1320	2.2
230	1920	3.2
240	2760	4.6
250	9840	16.4
260	1560	2.6
270	1020	1.7
280	840	1.4
290	660	1.1
300	600	1
310	540	0.9
320	480	0.8
330	420	0.7
340	420	0.7
350	360	0.6
360	360	0.6
370	0	0

Example of Steps:



SUM= 35100 ft^3

0.81 acre-feet

Check: $V = C*A*P_6$

V= 0.81 acre-feet

OK

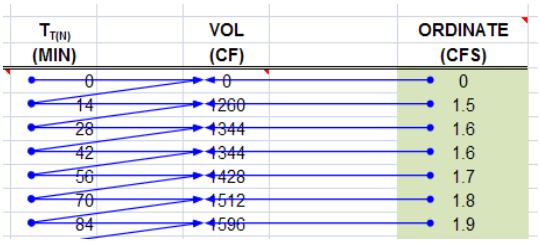
Basin C0 Retention

Post-Developed volume calculations

Q_{100}=	9.0	cfs			
Tc=	10.0	min	C=	0.69	
$P_{100,6}$=	2.5	in	A=	3.12	acres

$T_{T(N)}$ (MIN)	VOL (CF)	ORDINATE (CFS)
0	0	0
10	180	0.3
20	180	0.3
30	180	0.3
40	180	0.3
50	240	0.4
60	240	0.4
70	240	0.4
80	240	0.4
90	240	0.4
100	240	0.4
110	300	0.5
120	300	0.5
130	300	0.5
140	300	0.5
150	360	0.6
160	360	0.6
170	420	0.7
180	420	0.7
190	480	0.8
200	540	0.9
210	660	1.1
220	720	1.2
230	1080	1.8
240	1560	2.6
250	5400	9
260	840	1.4
270	600	1.0
280	480	0.8
290	360	0.6
300	300	0.5
310	300	0.5
320	240	0.4
330	240	0.4
340	240	0.4
350	240	0.4
360	180	0.3
370	0	0

Example of Steps:



SUM= 19380 ft^3
0.44 acre-feet

Check: $V = C*A*P_6$
V= 0.45 acre-feet
OK

	0.44	*(Post)*			
-	**0.81**	*(Pre)*			
Retention volume =	**-0.36**	**acre-feet**	**=**	**-15720 ft^3**	**No Basin Required**

Basin C0 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}= 0.99
A= 0.85 acres

WQ_{72}: 0.73 in/area

Water Quality Volume (WQV) = **2245** **ft^3**

Treatment within biofiltration swales

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

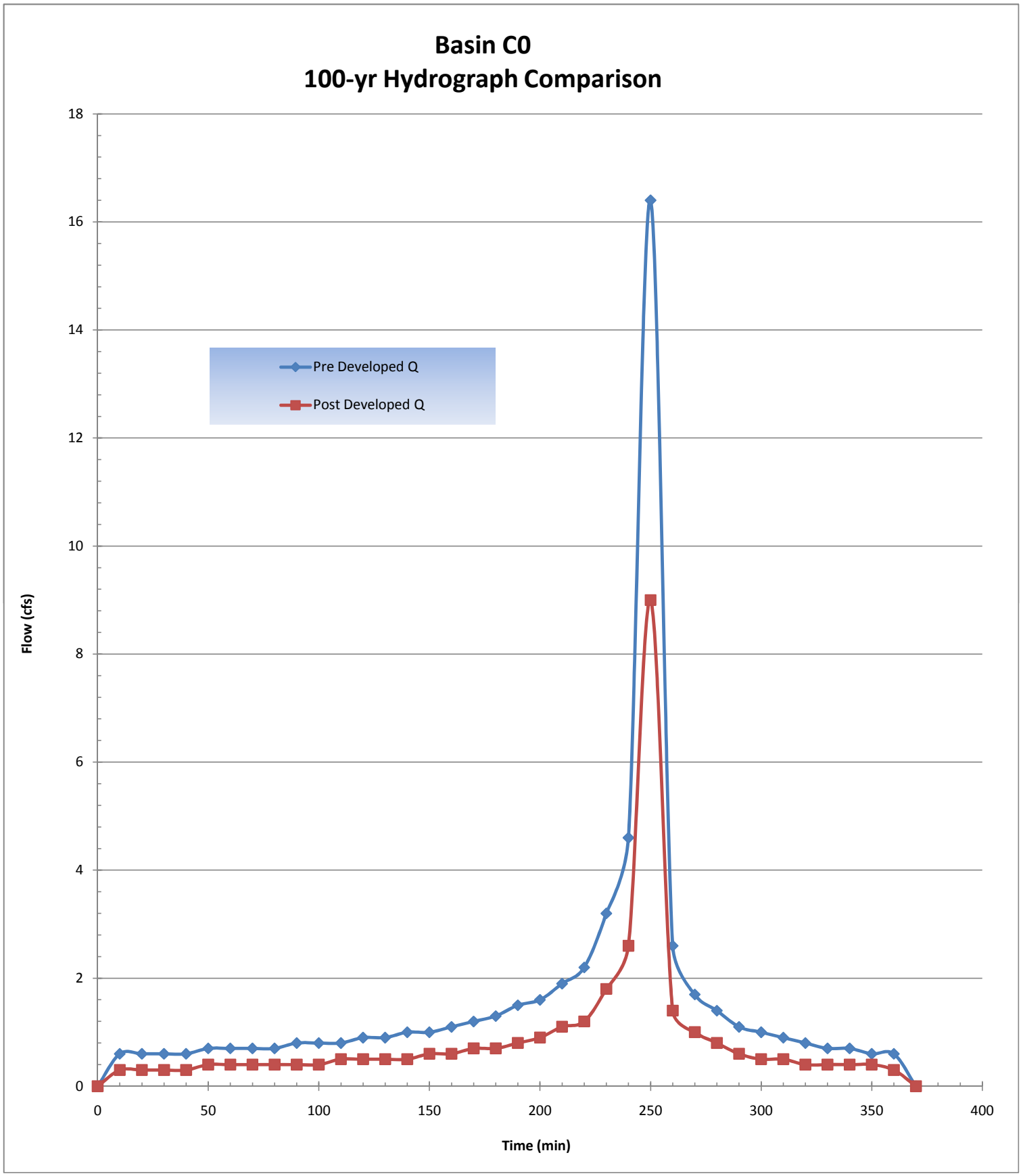
Onsite Highway *Sloped* runoff area, A:		98800	ft^2
	A:	2.27	acres
		10.00	years
where:	R=	30.00	
	K=	0.24	
	Ls=	18.00	
	C=	0.012	
	P=	1.00	
	As	1.56	tons/yr*Ac

Volume for 10-year Silt Accumulation = 35.27 tons

Silt Accumulation Basin volume = **784** **ft^3**

Silt extracted within biofiltration swale

.


Basin C0
100-yr Hydrograph Comparison
Pre Developed Q
Post Developed Q
Flow (cfs)
Time (min)
0
2
4
6
8
10
12
14
16
18
0
50
100
150
200
250
300
350
400

D0 Onsite D.A. Table

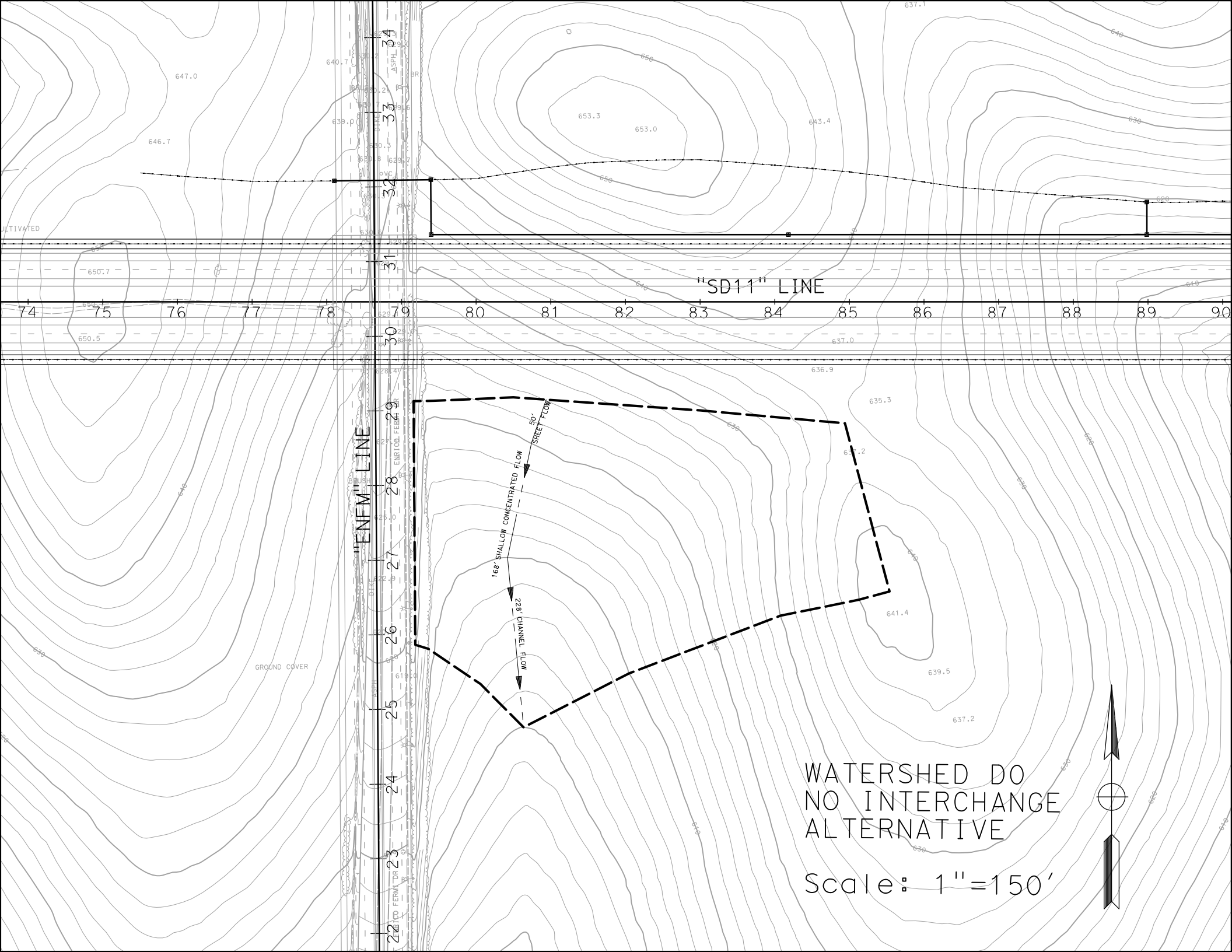
PROJECT:	**SR-11**			**DESCRIPTION:**	**On-site Drainage Areas (D.A.)**
JOB #:	**11A1190**			**STATION:**	**~**
BY:	**M.BRUNING**	**DATE:**	**01.04.10**	**WATERSHED:**	**D0**
CHK:	**G.DALZIEL**	**DATE:**		**SYSTEM:**	**No Interchange Option**

						Caltrans	Caltrans	County	County					
PAVED			Area		Tc	i_{25}	Q_{25}	i_{100}	Q_{100}	Drains to:				
	Name	C	*SF*	*Acres*	*min*	*in/hr*	*cfs*	*in/hr*	*cfs*	Bioswale	Inlet	Destination	@ Station	Offset
	~	0.99	0	0.0	~	~	~	~	~	~	~	~	~	~
		Σ	0	*PAVED*										

						Caltrans	Caltrans	County	County					
SLOPE			Area		Tc	i_{25}	Q_{25}	i_{100}	Q_{100}	Drains to:				
	Name	C	*SF*	*Acres*	*min*	*in/hr*	*cfs*	*in/hr*	*cfs*	Bioswale	Inlet	Destination	@ Station	Offset
	D0.1.SL	0.61	203800	4.7	10	2.8	8.04	4.2	12.02	~	D0.1	**bypass*	26+00	ENFM
		Σ	203800	*SLOPE*										

**flow that does not reach the basin*

Total :	203800	4.7
	SF	*ac*


"SD11" LINE
"ENFM" LINE
50' SHEET FLOW
168' SHALLOW CONCENTRATED FLOW
228' CHANNEL FLOW
WATERSHED DO
NO INTERCHANGE
ALTERNATIVE
Scale: 1"=150'

D0 Post-Developed TcQ

PROJECT:	**SR-11**			**DESCRIPTION:**	**SR-11 Post-Developed**
JOB #:	**11A1190**			**STATION:**	**81+00**
BY:	**M.BRUNING**	**DATE:**	**01.04.10**	**WATERSHED:**	**D0**
CHK:	**G.DALZIEL**	**DATE:**		**SYSTEM:**	**No Interchange Option**

BASIN AREA:

A =	**203800**	**ft^2**	**SOURCE:**	**MICROSTATION/USGS**
	4.68	**acres**		**(SCALE = 1:1)**

COEFFICIENT OF RUNOFF:

KEY: User Input | Designer Tool

UNDEVELOPED AREA C (FROM HDM FIG. 819.2A)

		NOTES:
RELIEF (.08-.35)	0.14	Rolling Slopes ~ 5%
INFILTRATION (.04-.16)	0.12	Negligible infiltration capacity - see Geotechnical Report
VEGETATION (.04-.16)	0.08	Fair natural cover
STORAGE (.04-.12)	0.08	Low
TOTAL C =	0.42	

UNDEVELOPED AREA	100%	AT	0.42	0.420
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%)			

$C_{2,10}$ =	0.42
C_{25} =	0.46
C_{50} =	0.50
C_{100} =	0.53

TIME OF CONCENTRATION:

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

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

HIGH PT ELEVATION	624.0	ft	High Point in Watershed, south of SR-11
LOW POINT ELEVATION	621.0	ft	
ELEVATION DIFF (H)	3.0	ft	
LENGTH (L)	50	ft	
SLOPE (S) = (H/L)	6.0%		
MANNING'S n	0.100		< = From Table 816.6A — nearly bare ground
T_t (SFF)=	3.50	minutes	

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

NOTES:

HIGH PT ELEVATION	621.0	ft	
LOW POINT ELEVATION	610.0	ft	
ELEVATION DIFF (H)	11.0	ft	
LENGTH (L)	168	ft	
SLOPE (S) = (H/L)	6.5%		
VELOCITY (SCF)	2.4	fps	V FROM FIG 816.6 — nearly bare ground
T_C (SH)=	1.17	minutes	

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

NOTES:

HIGH PT ELEVATION	610.0	ft	begins to channelize
LOW POINT ELEVATION	600.0	ft	CHANNEL DATA — TYPE = TRAP'Z
ELEVATION DIFF (H)	10.0	ft	Z= 5 — ANG-RAD 0.197
LENGTH (L)	228	ft	b = 2 — ANG-DEG 11.310
SLOPE (S) = (H/L)	4.4%		d = 0.5 — FLOWING FULL ASS'M
MANNING'S n	0.150		short prairie grass
HYDRAULIC RADIUS R	0.3	ft	R=(bdsinA+d^2cosA)/(bsinA+2d)
VELOCITY (CHANNEL)	0.97	fps	From Manning's Equation assuming flowing full: $V=1.49/n(R^{2/3}S^{1/2})$
T_C (CH)=	3.93	minutes	

D0 Post-Developed TcQ

Tc (TOTAL) =	8.59	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 =	3.6
Q_{10} =	5.3
Q_{25} =	7.3
Q_{50} =	9.5
Q_{100} =	**10.3**

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 D0 Retention

PROJECT:	**SR-11**			**DESCRIPTION:**	**SR-11 Basin**
JOB #:	**11A1190**			**STATION:**	**81+00**
BY:	**M.BRUNING**	**DATE:**	**01.04.10**	**WATERSHED:**	**D0**
CHK:	**G.DALZIEL**	**DATE:**		**SYSTEM:**	**No Interchange Option**

Notes:

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

RETENTION VOLUME

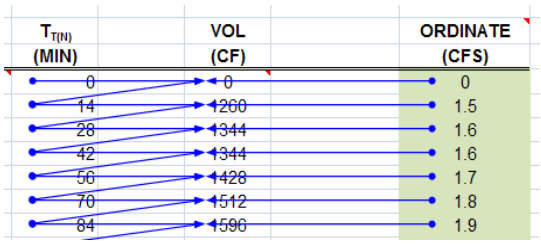
100-year, 6 hour duration storm event, use the Rational Method Hydrograph Procedure (SDCHM 6-1) ~ RatHydro

Pre-Developed volume calculations

Q_{100}=	18.5	cfs			
Tc=	11.0	min	C=	0.53	
$P_{100,6}$=	2.5	in	A=	8.89	acres

$T_{T(N)}$ (MIN)	VOL (CF)	ORDINATE (CFS)
0	0	0
11	462	0.7
22	462	0.7
33	462	0.7
44	528	0.8
55	528	0.8
66	528	0.8
77	594	0.9
88	594	0.9
99	594	0.9
110	660	1
121	660	1
132	726	1.1
143	792	1.2
154	792	1.2
165	924	1.4
176	990	1.5
187	1122	1.7
198	1188	1.8
209	1452	2.2
220	1650	2.5
231	2442	3.7
242	3564	5.4
253	12210	18.5
264	1980	3
275	1320	2
286	1056	1.6
297	858	1.3
308	726	1.1
319	660	1
330	594	0.9
341	528	0.8
352	528	0.8
363	462	0.7
374	0	0

Example of Steps:



SUM= 42636 ft^3
0.98 acre-feet

Check: $V = C*A*P_6$
V= 0.97 acre-feet
OK

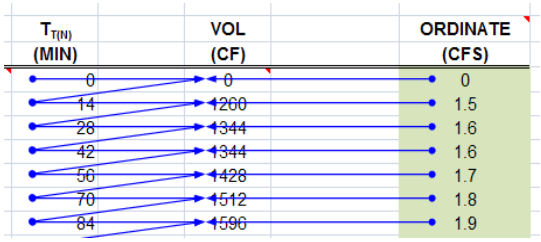
Basin D0 Retention

Post-Developed volume calculations

Q_{100}=	10.3	cfs			
Tc=	10.0	min	C=	0.53	
$P_{100,6}$=	2.5	in	A=	4.68	acres

$T_{T(N)}$ (MIN)	VOL (CF)	ORDINATE (CFS)
0	0	0
10	240	0.4
20	240	0.4
30	240	0.4
40	240	0.4
50	240	0.4
60	240	0.4
70	240	0.4
80	300	0.5
90	300	0.5
100	300	0.5
110	300	0.5
120	300	0.5
130	360	0.6
140	360	0.6
150	420	0.7
160	420	0.7
170	480	0.8
180	480	0.8
190	540	0.9
200	600	1
210	720	1.2
220	840	1.4
230	1260	2.1
240	1800	3
250	6180	10.3
260	960	1.6
270	660	1.1
280	540	0.9
290	420	0.7
300	360	0.6
310	360	0.6
320	300	0.5
330	300	0.5
340	240	0.4
350	240	0.4
360	240	0.4
370	0	0

Example of Steps:



SUM= 22260 ft^3
0.51 acre-feet

Check: $V = C*A*P_6$
V= 0.51 acre-feet
OK

		0.51	*(Post)*		
	-	**0.98**	*(Pre)*		
Retention volume =		**-0.47**	**acre-feet**	=	**-20376 ft^3**

No Basin Required

Basin D0 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= 0.00 acres

WQ_{72}: 0.73 in/area

Water Quality Volume (WQV) = **0** **ft^3**

No pavement areas proposed in this watershed

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

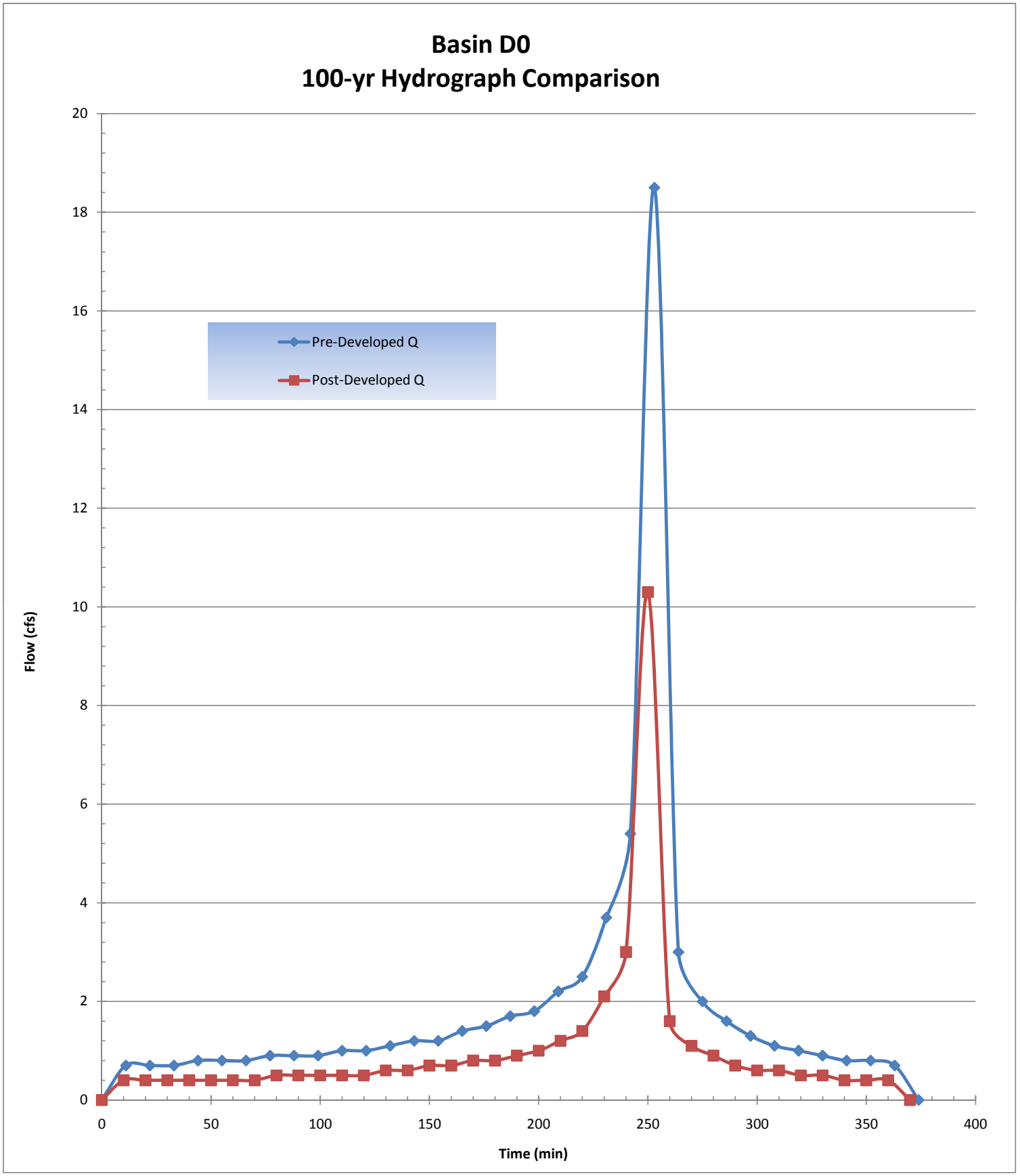
Onsite Highway *Sloped* runoff area, A:		203800	ft^2
	A:	4.68	acres
		10.00	years
where:	R=	30.00	
	K=	0.24	
	Ls=	18.00	
	C=	0.012	
	P=	1.00	
	As	1.56	tons/yr*Ac

Volume for 10-year Silt Accumulation = 72.76 tons

Silt Accumulation Basin volume = **1617** **ft^3**

These are existing Sloped Areas to remain

.


Basin D0
100-yr Hydrograph Comparison
Pre-Developed Q
Post-Developed Q
Flow (cfs)
Time (min)
0
2
4
6
8
10
12
14
16
18
20
0
50
100
150
200
250
300
350
400

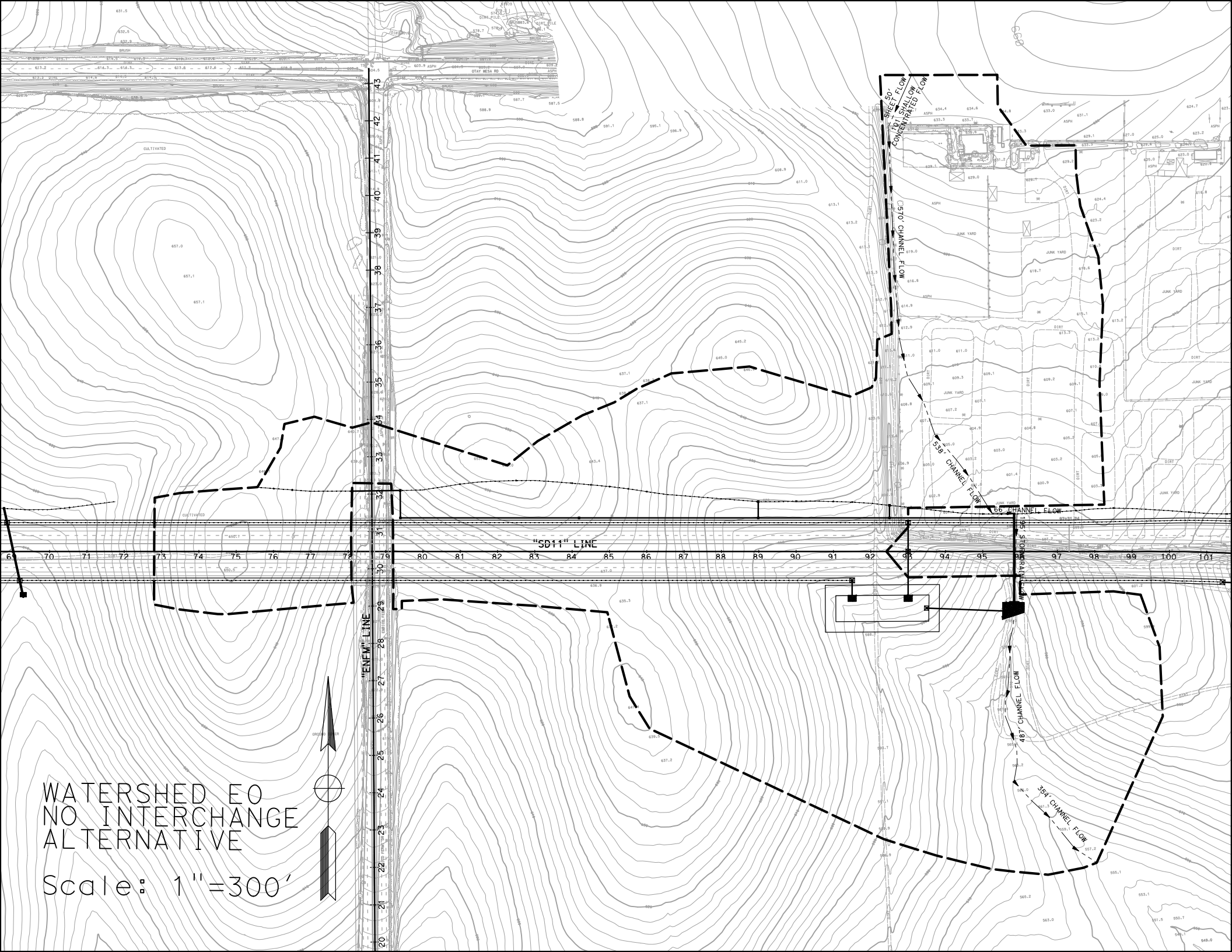
E0 Onsite D.A. Table

PROJECT:	**SR-11**	**DESCRIPTION:**	**Onsite Drainage Areas (D.A.)**
JOB #:	**11A1190**	**STATION:**	**~**
BY:	**M.BRUNING** **DATE:** **01.05.10**	**WATERSHED:**	**E0**
CHK:	**G.DALZIEL** **DATE:**	**SYSTEM:**	**No Interchange Option**

						Caltrans	Caltrans	County	County					
			Area		Tc	i_{25}	Q_{25}	i_{100}	Q_{100}	Drains to:				
	Name	C	SF	Acres	min	in/hr	cfs	in/hr	cfs	Bioswale	Inlet	Destination	@ Station	Offset
PAVED	E0.1.PV	0.99	122200	2.8	10	2.8	7.86	4.2	11.70	E0.1	E0.1	Basin E0	93+00	Lt
	E0.2.PV	0.99	124900	2.9	10	2.8	8.03	4.2	11.96	E0.2	E0.2	Basin E0	93+00	Rt
	Σ		247100	*PAVED*										

						Caltrans	Caltrans	County	County					
			Area		Tc	i_{25}	Q_{25}	i_{100}	Q_{100}	Drains to:				
	Name	C	SF	Acres	min	in/hr	cfs	in/hr	cfs	Bioswale	Inlet	Destination	@ Station	Offset
SLOPE	E0.1.SL	0.61	174800	4.0	10	2.8	6.92	4.2	10.31	E0.1	E0.1	Basin E0	93+00	Lt
	E0.2.SL	0.61	172100	4.0	10	2.8	6.82	4.2	10.15	E0.2	E0.2	Basin E0	93+00	Rt
	E0.3.SL	0.61	39200	0.9	10	2.8	1.55	4.2	2.31	~	E0.3	Culvert	78+00	Lt
	E0.4.SL	0.61	34000	0.8	10	2.8	1.35	4.2	2.01	~	E0.4	Culvert	79+50	Lt
	E0.5.SL	0.61	167600	3.8	10	2.8	6.64	4.2	9.89	~	E0.5	Culvert	89+00	Lt
	E0.6.SL	0.61	120100	2.8	10	3.3	5.47	4.2	7.08	~	E0.6	Culvert	92+50	Lt
	Σ		707800	*SLOPE*										

Total :	954900	21.9
	SF	*ac*



WATERSHED EO
NO INTERCHANGE ALTERNATIVE

Scale: 1"=300'

E0 Post-Developed TcQ

PROJECT:	**SR-11**			**DESCRIPTION:**	**SR-11 Post-Developed**
JOB #:	**11A1190**			**STATION:**	**96+00**
BY:	**M.BRUNING**	**DATE:**	**01.05.10**	**WATERSHED:**	**E0**
CHK:	**G.DALZIEL**	**DATE:**		**SYSTEM:**	**No Interchange Option**

BASIN AREA:

A = **2378044** **ft^2** **SOURCE:** **MICROSTATION/USGS**
54.59 **acres** **(SCALE = 1:1)**

COEFFICIENT OF RUNOFF:

KEY: User Input | Designer Tool

UNDEVELOPED AREA C (FROM HDM FIG. 819.2A)

NOTES:

RELIEF (.08-.35)	0.15	Rolling Slopes ~ 7.5%
INFILTRATION (.04-.16)	0.12	Negligible infiltration capacity - see Geotechnical Report
VEGETATION (.04-.16)	0.08	Fair natural cover
STORAGE (.04-.12)	0.08	Low
TOTAL C =	0.43	

UNDEVELOPED AREA	60%	AT	0.43	0.257
PAVED SURFACE	10%	AT	0.90	0.094
COMMERCIAL AREA	0%	AT	0.85	0.000
CUT SLOPE (2:1 and 4:1)	30%	AT	0.55	0.164
TOTAL	100%			
	(100%)			

$C_{2,10}$ =	0.51
C_{25} =	0.57
C_{50} =	0.62
C_{100} =	0.64

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	635.0	ft	South of Otay Mesa Road - Driveway Area
LOW POINT ELEVATION	634.7	ft	
ELEVATION DIFF (H)	0.3	ft	
LENGTH (L)	50	ft	
SLOPE (S) = (H/L)	0.6%		
MANNING'S n	0.016		< = From Table 816.6A Asphalt
T_t (SFF)=	2.03	minutes	

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

NOTES:

HIGH PT ELEVATION	634.7	ft	Mid-driveway
LOW POINT ELEVATION	633.0	ft	North end of Junk Yard
ELEVATION DIFF (H)	1.7	ft	
LENGTH (L)	101	ft	
SLOPE (S) = (H/L)	1.7%		
VELOCITY (SCF)	1.5	fps	<=V FROM FIG 816.6 Asphalt
T_C (SH)=	1.12	minutes	

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

NOTES:

HIGH PT ELEVATION	633.0	ft	channel along western side of junk yard
LOW POINT ELEVATION	612.0	ft	CHANNEL DATA TYPE = TRAP'Z
ELEVATION DIFF (H)	21.0	ft	Z= 2 ANG-RAD 0.464
LENGTH (L)	570	ft	b = 1 ANG-DEG 26.565
SLOPE (S) = (H/L)	3.7%		d = 0.5 FLOWING FULL ASS'M
MANNING'S n	0.050		earthen/dirt
HYDRAULIC RADIUS R	0.3	ft	R=(bdsinA+d^2cosA)/(bsinA+2d)
VELOCITY (CHANNEL)	2.61	fps	From Manning's Equation assuming flowing full: $V=1.49/n(R^{2/3}S^{1/2})$
T_C (CH)=	3.63	minutes	

E0 Post-Developed TcQ

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

HIGH PT ELEVATION	612.0	ft
LOW POINT ELEVATION	599.0	ft
ELEVATION DIFF (H)	13.0	ft
LENGTH (L)	538	ft
SLOPE (S) = (H/L)	2.4%	
MANNING'S n	0.100	
HYDRAULIC RADIUS R	0.3	ft
VELOCITY (CHANNEL)	1.01	fps
T_C (CH)=	8.90	minutes

NOTES:

Begins to broaden across junk yard

CHANNEL DATA		TYPE =	TRAP'Z
Z=	5	ANG-RAD	0.197
b =	1	ANG-DEG	11.310
d =	0.5	FLOWING FULL ASS'M	

dirt with junk yard obstructions

R=(bdsinA+d^2cosA)/(bsinA+2d)

From Manning's Equation assuming flowing full: $V=1.49/n(R^{2/3}S^{1/2})$

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

HIGH PT ELEVATION	599.0	ft
LOW POINT ELEVATION	598.0	ft
ELEVATION DIFF (H)	1.0	ft
LENGTH (L)	66	ft
SLOPE (S) = (H/L)	1.5%	
MANNING'S n	0.015	
HYDRAULIC RADIUS R	0.3	ft
VELOCITY (CHANNEL)	5.59	fps
T_C (CH)=	0.20	minutes

NOTES:

Proposed Slope Ditch

CHANNEL DATA		TYPE =	TRAP'Z
Z=	2	ANG-RAD	0.464
b =	1	ANG-DEG	26.565
d =	0.5	FLOWING FULL ASS'M	

concrete - rough

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	592.0	ft
LOW POINT ELEVATION	578.0	ft
ELEVATION DIFF (H)	14.0	ft
LENGTH (L)	195	ft
SLOPE (S) = (H/L)	7.2%	
MANNING'S n	0.013	
PIPE DIAMETER d	3.5	ft
HYDRAULIC RADIUS R	0.9	ft
VELOCITY (STORMDRAIN)	28.1	fps
T_C (SD)=	0.12	minutes

NOTES:

Proposed Cross Culvert (assumed 6' drop to invert)

Proposed Rip Rap Pad

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	578.0	ft
LOW POINT ELEVATION	565.2	ft
ELEVATION DIFF (H)	12.8	ft
LENGTH (L)	487	ft
SLOPE (S) = (H/L)	2.6%	
MANNING'S n	0.100	
HYDRAULIC RADIUS R	0.6	ft
VELOCITY (CHANNEL)	1.75	fps
T_C (CH)=	4.63	minutes

NOTES:

Natural Channel

CHANNEL DATA		TYPE =	TRAP'Z
Z=	2	ANG-RAD	0.464
b =	2	ANG-DEG	26.565
d =	1	FLOWING FULL ASS'M	

grass

R=(bdsinA+d^2cosA)/(bsinA+2d)

From Manning's Equation assuming flowing full: $V=1.49/n(R^{2/3}S^{1/2})$

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

HIGH PT ELEVATION	565.2	ft
LOW POINT ELEVATION	556.0	ft
ELEVATION DIFF (H)	9.2	ft
LENGTH (L)	354	ft
SLOPE (S) = (H/L)	2.6%	
MANNING'S n	0.100	
HYDRAULIC RADIUS R	0.7	ft
VELOCITY (CHANNEL)	1.81	fps
T_C (CH)=	3.26	minutes

NOTES:

Begins to broaden

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

grass

R=(bdsinA+d^2cosA)/(bsinA+2d)

From Manning's Equation assuming flowing full: $V=1.49/n(R^{2/3}S^{1/2})$

Tc (TOTAL) =	23.89	minutes
Minimum Tc =	10	minutes
USE Tc =	**23.89**	minutes

Total Length of Run (ft) = 2361

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

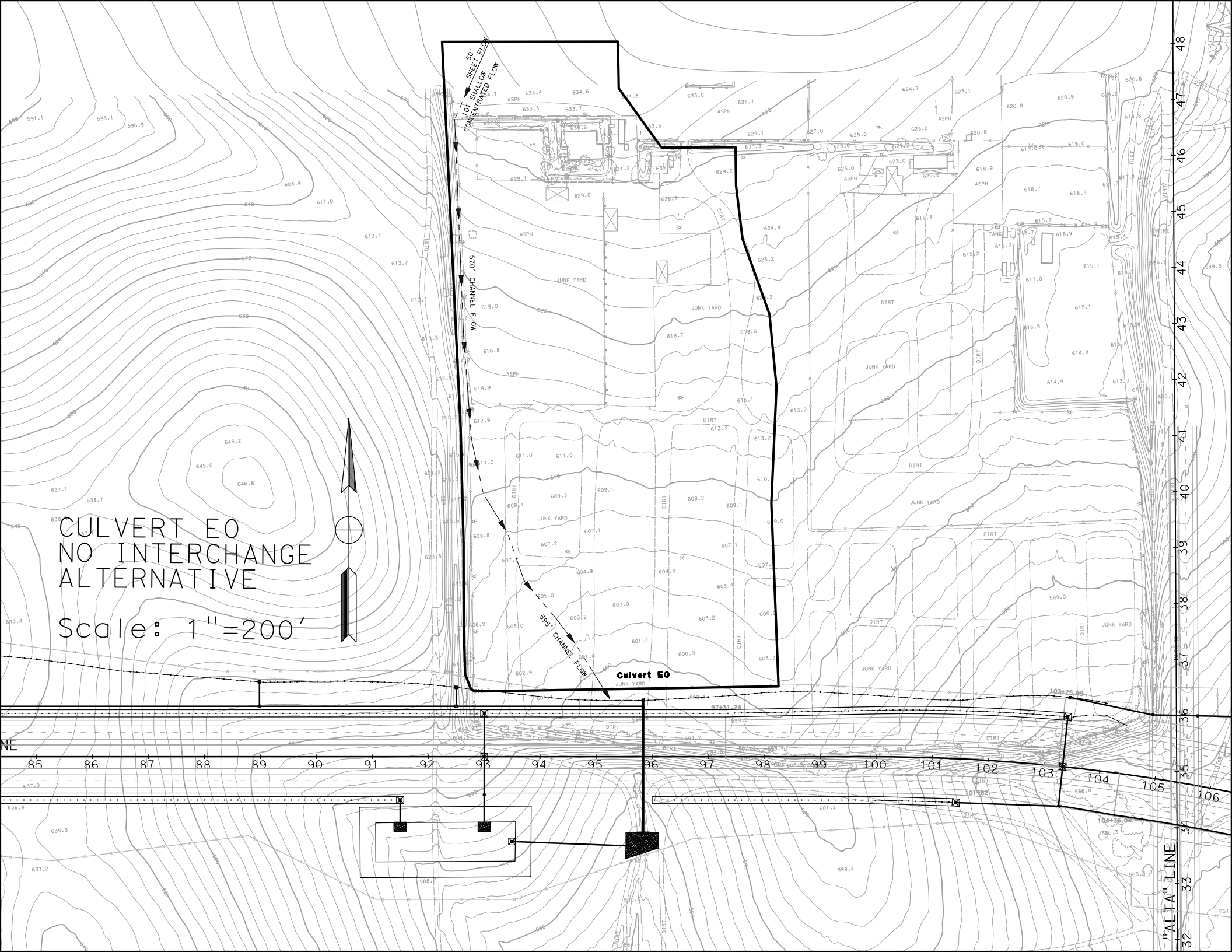
i_2 =	1.1	in/hr	X CA =
i_{10} =	1.5	in/hr	X CA =
i_{25} =	1.9	in/hr	X CA =
i_{50} =	2.3	in/hr	X CA =
i_{100} =	2.4	in/hr	X CA =

FLOW RESULTS:

	cfs
Q_2 =	29.7
Q_{10} =	43.2
Q_{25} =	59.4
Q_{50} =	77.7
Q_{100} =	**84.3**

COUNTY P_6

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


SHEET FLOW 50'
SHALLOW CONCENTRATED FLOW 101'
570' CHANNEL FLOW
595' CHANNEL FLOW
Culvert EO
JUNK YARD
ASPH
DIRT
TANK
"ALTA" LINE
CULVERT EO
NO INTERCHANGE
ALTERNATIVE
Scale: 1"=200'

Culvert Calculator Report
E0 10-yr

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	595.00	ft	Headwater Depth/Height	0.69	
Computed Headwater Elevation	594.06	ft	Discharge	16.80	cfs
Inlet Control HW Elev.	593.76	ft	Tailwater Elevation	578.62	ft
Outlet Control HW Elev.	594.06	ft	Control Type	Entrance Control	

Grades					
Upstream Invert	592.00	ft	Downstream Invert	578.00	ft
Length	195.00	ft	Constructed Slope	7.2	%

Hydraulic Profile					
Profile	S2		Depth, Downstream	0.62	ft
Slope Type	Steep		Normal Depth	0.62	ft
Flow Regime	Supercritical		Critical Depth	1.31	ft
Velocity Downstream	15.88	ft/s	Critical Slope	0.4	%

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	3.00	ft
Section Size	36 inch		Rise	3.00	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	594.06	ft	Upstream Velocity Head	0.50	ft
Ke	0.50		Entrance Loss	0.25	ft

Inlet Control Properties					
Inlet Control HW Elev.	593.76	ft	Flow Control	Unsubmerged	
Inlet Type	Square edge w/headwall		Area Full	7.1	ft²
K	0.00980		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	1	
C	0.03980		Equation Form	1	
Y	0.67000				

Culvert Calculator Report
E0 100-yr

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	596.00	ft	Headwater Depth/Height	1.04	
Computed Headwater Elevation	595.12	ft	Discharge	34.10	cfs
Inlet Control HW Elev.	594.83	ft	Tailwater Elevation	578.89	ft
Outlet Control HW Elev.	595.12	ft	Control Type	Entrance Control	

Grades					
Upstream Invert	592.00	ft	Downstream Invert	578.00	ft
Length	195.00	ft	Constructed Slope	7.2	%

Hydraulic Profile					
Profile	S2		Depth, Downstream	0.89	ft
Slope Type	Steep		Normal Depth	0.89	ft
Flow Regime	Supercritical		Critical Depth	1.90	ft
Velocity Downstream	19.48	ft/s	Critical Slope	0.5	%

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	3.00	ft
Section Size	36 inch		Rise	3.00	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	595.12	ft	Upstream Velocity Head	0.81	ft
Ke	0.50		Entrance Loss	0.41	ft

Inlet Control Properties					
Inlet Control HW Elev.	594.83	ft	Flow Control	Unsubmerged	
Inlet Type	Square edge w/headwall		Area Full	7.1	ft²
K	0.00980		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	1	
C	0.03980		Equation Form	1	
Y	0.67000				

E0 Culvert TcQ

PROJECT:	SR-11			**DESCRIPTION:**	SR-11 Culvert
JOB #:	11A1190			**STATION:**	95+90
BY:	M.BRUNING	**DATE:**	01.05.10	**WATERSHED:**	E0.Culvert
CHK:	G.DALZIEL	**DATE:**		**SYSTEM:**	Culvert

BASIN AREA:

A =	953896	ft^2	**SOURCE:**	MICROSTATION/USGS
	21.90	acres		(SCALE = 1:1)

COEFFICIENT OF RUNOFF:

KEY: User Input | Designer Tool

UNDEVELOPED AREA C (FROM HDM FIG. 819.2A)

		NOTES:
RELIEF (.08-.35)	0.15	Rolling Slopes ~ 7.5%
INFILTRATION (.04-.16)	0.12	Negligible infiltration capacity - see Geotechnical Report
VEGETATION (.04-.16)	0.08	Fair natural cover
STORAGE (.04-.12)	0.08	Low
TOTAL C =	0.43	

UNDEVELOPED AREA	99%	AT	0.43	0.426
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%)			

$C_{2,10}$ =	0.43
C_{25} =	0.48
C_{50} =	0.52
C_{100} =	0.54

TIME OF CONCENTRATION:

SHEET FLOW: $T_t = \frac{0.42L^{.8}n^{.8}}{P_2^{.5}s^{.2}}$

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

HIGH PT ELEVATION	635.0	ft	South of Otay Mesa Road - Driveway Area
LOW POINT ELEVATION	634.7	ft	
ELEVATION DIFF (H)	0.3	ft	
LENGTH (L)	50	ft	
SLOPE (S) = (H/L)	0.6%		
MANNING'S n	0.016		< = FROM TABLE 816.6A Asphalt
T_t (SFF)=	2.03	minutes	

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

NOTES:

HIGH PT ELEVATION	634.7	ft	Mid-driveway
LOW POINT ELEVATION	633.0	ft	North end of Junk Yard
ELEVATION DIFF (H)	1.7	ft	
LENGTH (L)	101	ft	
SLOPE (S) = (H/L)	1.7%		
VELOCITY (SCF)	1.5	fps	<=V FROM FIG 816.6 Asphalt
T_C (SH)=	1.12	minutes	

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

NOTES:

HIGH PT ELEVATION	633.0	ft	channel along western side of junk yard
LOW POINT ELEVATION	612.0	ft	CHANNEL DATA TYPE = TRAP'Z
ELEVATION DIFF (H)	21.0	ft	Z= 2 ANG-RAD 0.464
LENGTH (L)	570	ft	b = 1 ANG-DEG 26.565
SLOPE (S) = (H/L)	3.7%		d = 0.5 FLOWING FULL ASS'M
MANNING'S n	0.050		earthen/dirt
HYDRAULIC RADIUS R	0.3	ft	R=(bdsinA+d^2cosA)/(bsinA+2d)
VELOCITY (CHANNEL)	2.61	fps	From Manning's Equation assuming flowing full: $V=1.49/n(R^{2/3}S^{1/2})$
T_C (CH)=	3.63	minutes	

E0 Culvert TcQ

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

HIGH PT ELEVATION	612.0	ft
LOW POINT ELEVATION	597.0	ft
ELEVATION DIFF (H)	15.0	ft
LENGTH (L)	595	ft
SLOPE (S) = (H/L)	2.5%	
MANNING'S n	0.100	
HYDRAULIC RADIUS R	0.3	ft
VELOCITY (CHANNEL)	1.03	fps
T_C (CH)=	9.64	minutes

NOTES:

Begins to broaden across junk yard

CHANNEL DATA		TYPE =	TRAP'Z
Z=	5	ANG-RAD	0.197
b =	1	ANG-DEG	11.310
d =	0.5	FLOWING FULL ASS'M	

dirt with junk yard obstructions

R=(bdsinA+d^2cosA)/(bsinA+2d)

From Manning's Equation assuming flowing full: $V=1.49/n(R^{2/3}S^{1/2})$

Tc (TOTAL) =	16.42	minutes
Minimum Tc =	10	minutes
USE T_C =	**16.42**	minutes

INTENSITY CHART: Caltrans IDF2000

FLOW RESULTS

				cfs
i_2 =	0.9	in/hr	X CA =	**Q_2 =** 8.9
i_{10} =	1.8	in/hr	X CA =	**Q_{10} =** 16.8
i_{25} =	2.2	in/hr	X CA =	**Q_{25} =** 23.1
i_{50} =	2.5	in/hr	X CA =	**Q_{50} =** 29.0
i_{100} =	2.9	in/hr	X CA =	**Q_{100} =** **34.1**

COUNTY P_6

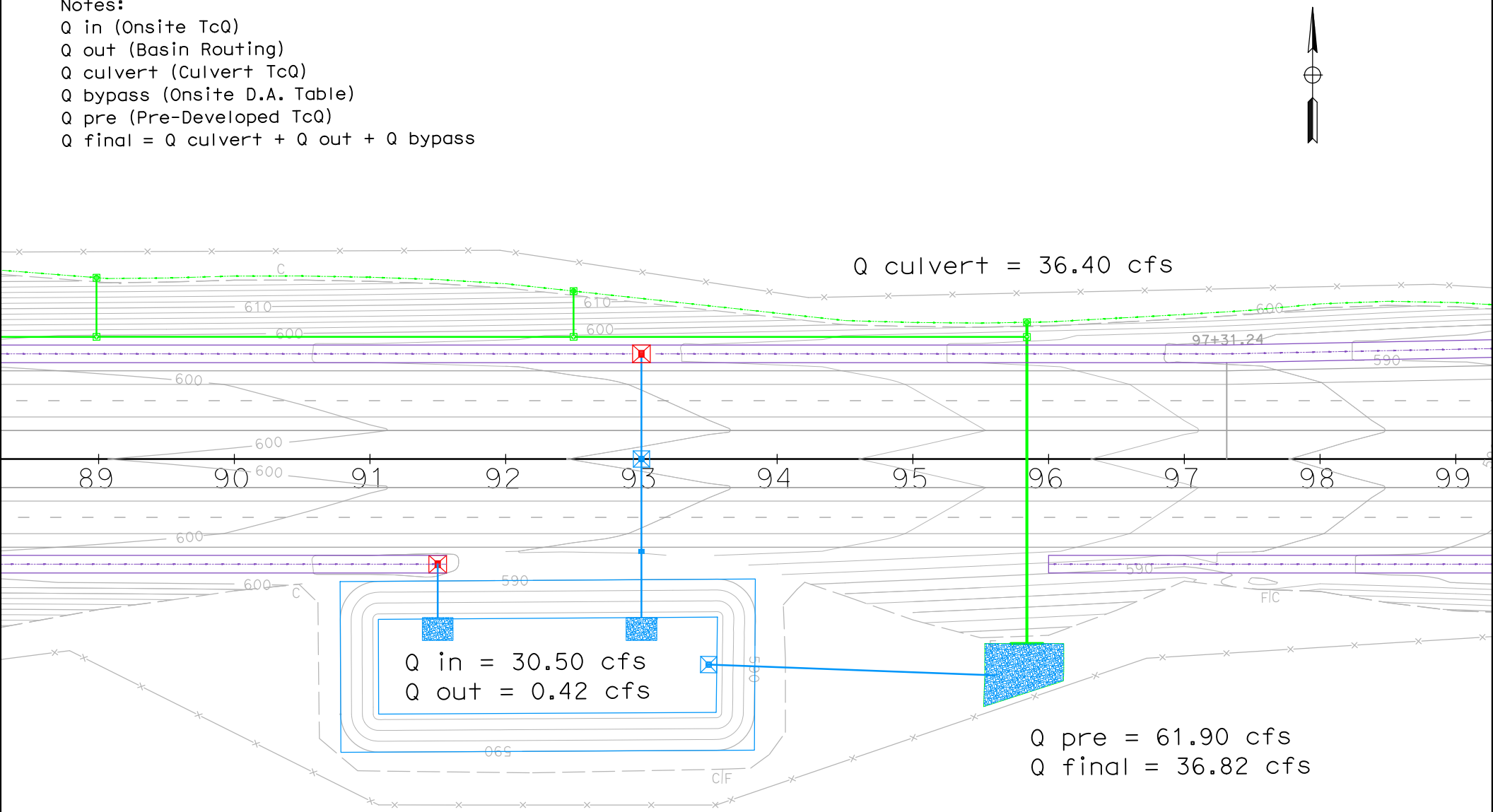
	inches
2-year:	1.1
10-year:	1.6
25-year:	2.0
50-year:	2.4
100-year:	2.5

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

FLOW RESULTS

				cfs
i_2 =	1.3	in/hr	X CA =	**Q_2 =** 12.8
i_{10} =	2.0	in/hr	X CA =	**Q_{10} =** 18.6
i_{25} =	2.4	in/hr	X CA =	**Q_{25} =** 25.6
i_{50} =	2.9	in/hr	X CA =	**Q_{50} =** 33.5
i_{100} =	3.1	in/hr	X CA =	**Q_{100} =** **36.4**

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 E0
FLOW SUMMARY

Scale: 1"=100'

Basin E0 Retention

PROJECT:	**SR-11**			**DESCRIPTION:**	**SR-11 Basin**
JOB #:	**11A1190**			**STATION:**	**96+00**
BY:	**M.BRUNING**	**DATE:**	**01.05.10**	**WATERSHED:**	**E0**
CHK:	**G.DALZIEL**	**DATE:**		**SYSTEM:**	**Basin**

Notes:

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

RETENTION BASIN VOLUME

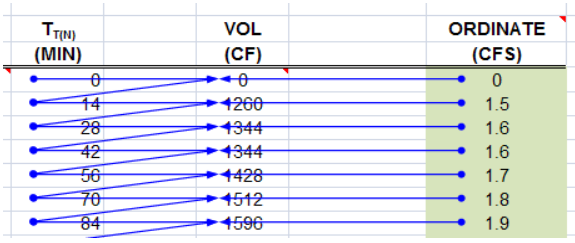
100-year, 6 hour duration storm event, use the Rational Method Hydrograph Procedure (SDCHM 6-1) ~ RatHydro

Pre-Developed volume calculations

Q_{100}=	61.9	cfs			
Tc=	24.5	min	C=	0.54	
$P_{100,6}$=	2.5	in	A=	48.15	acres

$T_{T(N)}$ (MIN)	VOL (CF)	ORDINATE (CFS)
0	0	0
25	6000	4
50	6750	4.5
75	7050	4.7
100	8100	5.4
125	8850	5.9
150	10800	7.2
175	12300	8.2
200	18000	12
225	23550	15.7
250	92850	61.9
275	14400	9.6
300	9600	6.4
325	7500	5
350	6300	4.2
375	0	0

Example of Steps:



SUM= 232050 ft^3
5.33 acre-feet

Check: $V = C*A*P_6$
V= 5.45 acre-feet
OK

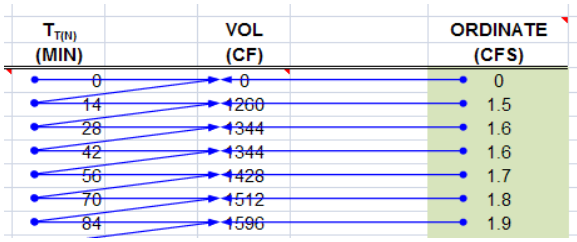
Basin E0 Retention

Post-Developed volume calculations

Q_{100}=	84.3	cfs			
Tc=	23.9	min	C=	0.64	
$P_{100,6}$=	2.5	in	A=	54.59	acres

$T_{T(N)}$ (MIN)	VOL (CF)	ORDINATE (CFS)
0	0	0
24	7632	5.3
48	7920	5.5
72	8784	6.1
96	9360	6.5
120	10800	7.5
144	11664	8.1
168	14256	9.9
192	16272	11.3
216	23904	16.6
240	32688	22.7
264	121392	84.3
288	19152	13.3
312	12816	8.9
336	10080	7
360	8352	5.8
384	0	0

Example of Steps:



SUM= 315072 ft^3
7.23 acre-feet

Check: $V = C*A*P_6$
V= 7.32 acre-feet
OK

	7.23	*(Post)*			
	- **5.33**	*(Pre)*			
Retention volume =	**1.91**	**acre-feet**	**=**	**83022 ft^3**	**Basin Required**

Basin E0 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}= 0.87
A= 13.64 acres

WQ_{72}: 0.66 in/area

Water Quality Volume (WQV) = **32670** 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:

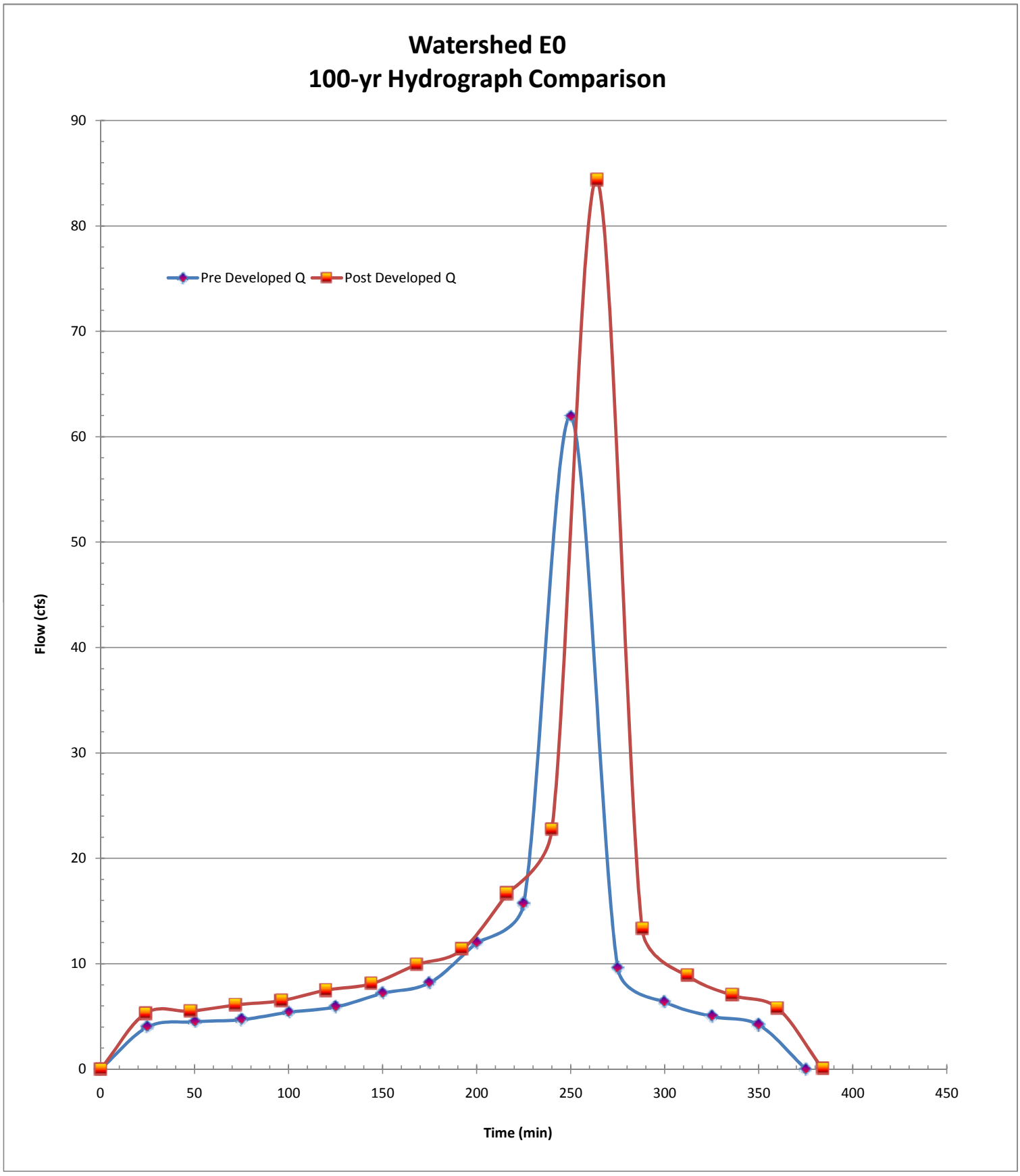
A_s = the computed soil loss in tons (dry weight)
R = the rainfall erosion index for the given storm period
K = the soil erodibility factor
L = the slope length factor
s = the slope gradient factor
C = cropping management (vegetation) factor
P = erosion control practice factor

Onsite Highway *Sloped* runoff area, A:		346900	ft^2
	A:	7.96	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 = 123.85 tons

Silt Accumulation Basin volume = **2752** ft^3

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


Watershed E0
100-yr Hydrograph Comparison
Pre Developed Q
Post Developed Q
Flow (cfs)
Time (min)
0
10
20
30
40
50
60
70
80
90
0
50
100
150
200
250
300
350
400
450

Basin E0 Inflow TcQ

PROJECT:	**SR-11**			**DESCRIPTION:**	**SR-11 Basin**
JOB #:	**11A1190**			**STATION:**	**96+00**
BY:	**M.BRUNING**	**DATE:**	**01.05.10**	**WATERSHED:**	**E0**
CHK:	**G.DALZIEL**	**DATE:**		**SYSTEM:**	**No Interchange Option**

BASIN AREA:

A = 594000 ft^2 | 13.64 acres

SOURCE: MICROSTATION/USGS (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	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: $T_t = \frac{0.42 L^{4/5} n^{4/5}}{P_2^{1/2} s^{2/5}}$

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

HIGH PT ELEVATION	608.5	ft	SR-11 HP
LOW POINT ELEVATION	607.8	ft	
ELEVATION DIFF (H)	0.7	ft	
LENGTH (L)	117	ft	to Bioswale
SLOPE (S) = (H/L)	0.6%		
MANNING'S n	0.016		AC < = From Table 816.6A
T_t (SFF)=	4.01	minutes	

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

NOTES:

HIGH PT ELEVATION	607.8	ft	origin of Bioswale
LOW POINT ELEVATION	606.0	ft	
ELEVATION DIFF (H)	1.8	ft	
LENGTH (L)	200	ft	assumed SCF and not channelized or flowing full yet
SLOPE (S) = (H/L)	0.9%		
VELOCITY (SCF)	1.8	fps	0.9% , V FROM FIG 816.6 grassed waterway
T_C (SH)=	1.90	minutes	

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

NOTES:

HIGH PT ELEVATION	606.0	ft	
LOW POINT ELEVATION	597.0	ft	CHANNEL DATA TYPE = TRAP'Z
ELEVATION DIFF (H)	9.0	ft	Z= 4 ANG-RAD 0.245
LENGTH (L)	1717	ft	b = 13 ANG-DEG 14.036
SLOPE (S) = (H/L)	0.5%		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)	1.86	fps	From Manning's Equation assuming flowing full: $V=1.49/n(R^{2/3}S^{1/2})$
T_C (CH)=	15.39	minutes	

Basin E0 Inflow TcQ

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

HIGH PT ELEVATION	592.0	ft	Proposed onsite pipe (assumed 5' drop to invert)
LOW POINT ELEVATION	585.0	ft	Proposed Rip Rap Pad in Basin floor
ELEVATION DIFF (H)	7.0	ft	
LENGTH (L)	194	ft	
SLOPE (S) = (H/L)	3.6%		
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)	13.7	fps	$V = \frac{K_u}{n} R^{2/3} S^{1/2}$
T_C (SD)=	0.24	minutes	

NOTES:

Tc (TOTAL) =	21.54	minutes
Minimum Tc =	5	minutes
USE T_C =	**21.54**	minutes

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

i_2 =	1.1	in/hr	X CA =	**Q_2 =**	10.7
i_{10} =	1.6	in/hr	X CA =	**Q_{10} =**	15.6
i_{25} =	2.1	in/hr	X CA =	**Q_{25} =**	21.4
i_{50} =	2.5	in/hr	X CA =	**Q_{50} =**	28.1
i_{100} =	2.6	in/hr	X CA =	**Q_{100} =**	**30.5**

FLOW RESULTS

	cfs
Q_2 =	10.7
Q_{10} =	15.6
Q_{25} =	21.4
Q_{50} =	28.1
Q_{100} =	**30.5**

COUNTY P_6

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

Basin E0 Inflow Hydrograph

PROJECT:	**SR-11**			**DESCRIPTION:**	**SR-11 Basin**
JOB #:	**11A1190**			**STATION:**	**96+00**
BY:	**M.BRUNING**	**DATE:**	**01.05.10**	**WATERSHED:**	**E0**
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}=	30.5	cfs	C_{100}=	0.87	
Tc=	21.5	min	A=	13.64	acres
$P_{100,6}$=	2.5	in			

$T_{T(N)}$ (MIN)	VOL (CF)	ORDINATE (CFS)
0	0	0
22	396	0.3
44	2508	1.9
66	2640	2
88	2904	2.2
110	3036	2.3
132	3564	2.7
154	3828	2.9
176	4752	3.6
198	5412	4.1
220	7920	6
242	10428	7.9
264	40260	30.5
286	6336	4.8
308	4224	3.2
330	3300	2.5
352	2772	2.1
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

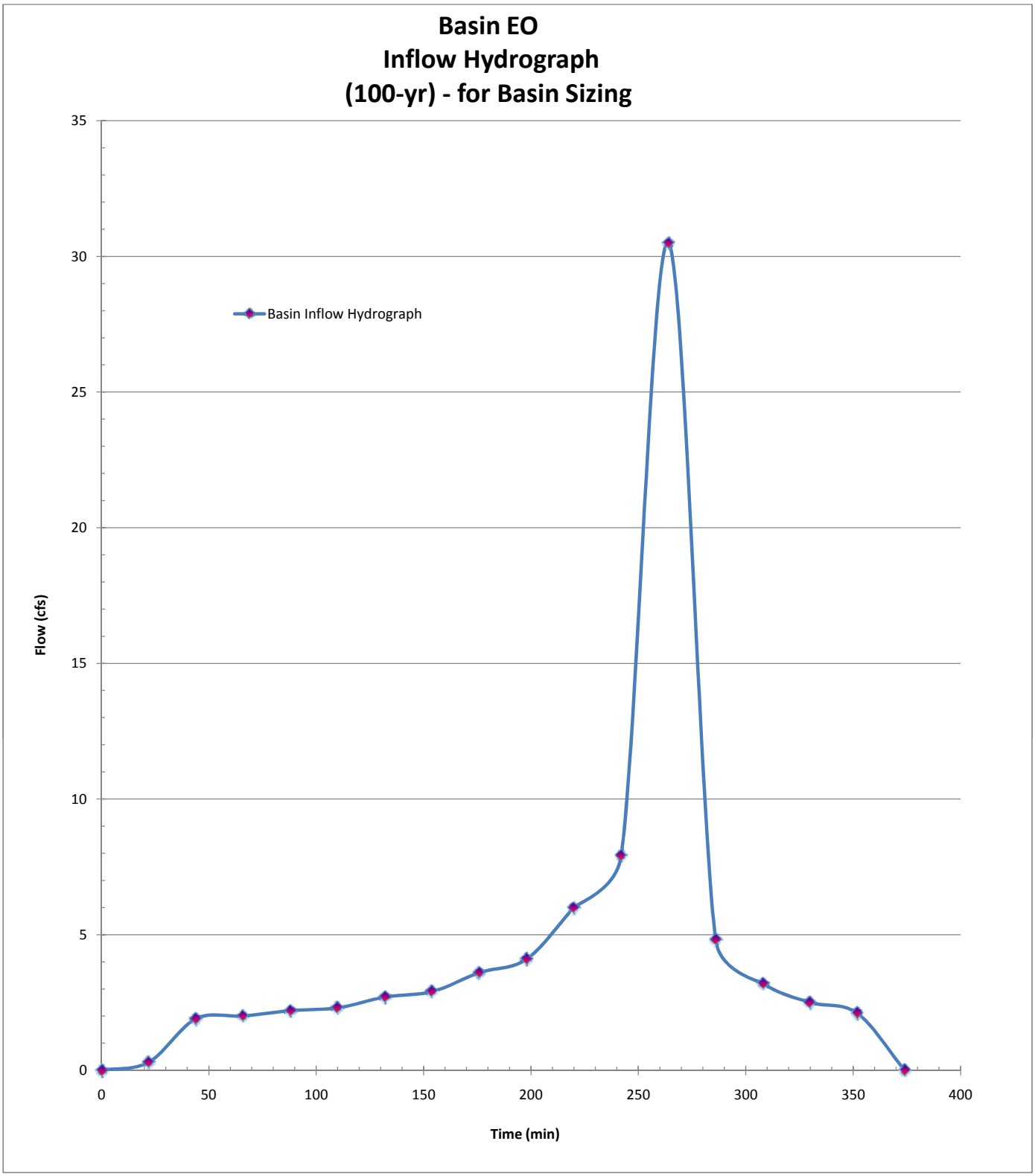
Onsite Runoff Volume

SUM=	**104280**	**ft^3**
	2.39	**acre-feet**

Check: $V = C*A*P_6$

V= 2.47 acre-feet

OK


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

Basin E0 Outlet

PROJECT:	**SR-11**			**DESCRIPTION:**	**SR-11 Basin**
JOB #:	**11A1190**			**STATION:**	**96+00**
BY:	**M.BRUNING**	**DATE:**	**02.19.10**	**WATERSHED:**	**E0**
CHK:	**G.DALZIEL**	**DATE:**		**SYSTEM:**	**Basin Outlet**

Notes:

Required Retention Basin Volume = 85774 ft^3
Actual Basin Inflow = 104280 ft^4 *OK*

Flow Balance - determine maximum flow from basin

Predeveloped Peak 100-year Flow:	61.9	cfs		
Post-Developed Peak Flow through Cross Culvert:	36.4	cfs		Includes: E0.3.SL E0.4.SL E0.5.SL E0.6.SL
Flow that does not reach detention basin (bypass per DA table):	0.0	cfs	~	Q_{100} of:
Maximum flow allowed to be released by this detention basin:	25.5	cfs		

Outlet Pipe

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

Basin - Top of basin berm elevation =	590.00	ft
Basin flowline elevation =	584.00	ft
Maximum Basin Depth =	6.00	ft

Outlet Pipe

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

Outlet pipe invert from basin floor =	3.60 ft	587.60	ft
Outlet pipe diameter =	2 ft		

Basin Characteristics

Base Length (L)	250	ft
Base Width (W)	75	ft
W/L Ratio ®	0.30	
Side Slopes (Z)	1: 4	
Total Volume (V):	164115	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)	Q_{out} (cfs)	Q_{inf} (cfs)	Q_{total} (cfs)
0	584.00	0.00	0	0		584.00	0.00		0.00
1	584.20	0.20	3802	3802		584.20	0.00		0.00
2	584.40	0.40	3907	7709		584.40	0.00		0.00
3	584.60	0.60	4013	11722		584.60	0.00		0.00
4	584.80	0.80	4120	15843		584.80	0.00		0.00
5	585.00	1.00	4228	20071		585.00	0.00		0.00
6	585.20	1.20	4338	24409		585.20	0.00		0.00
7	585.40	1.40	4448	28857		585.40	0.00		0.00
8	585.60	1.60	4560	33417		585.60	0.00		0.00
9	585.80	1.80	4672	38089		585.80	0.00		0.00
10	586.00	2.00	4786	42874		586.00	0.00		0.00
11	586.20	2.20	4900	47775		586.20	0.00		0.00
12	586.40	2.40	5016	52791		586.40	0.00		0.00
13	586.60	2.60	5133	57924		586.60	0.00		0.00
14	586.80	2.80	5251	63175		586.80	0.00		0.00
15	587.00	3.00	5370	68545		587.00	0.00	0.00	0.00
16	587.20	3.20	5490	74035		587.20	0.00		0.00
17	587.40	3.40	5611	79647		587.40	0.00		0.00
18	587.60	3.60	5734	85380		587.60	0.00		0.00
19	587.80	3.80	5857	91237	*	587.80	0.00		0.00
20	588.00	4.00	5981	97219		588.00	0.15		0.15
21	588.20	4.20	6107	103326		588.20	0.59		0.59
22	588.40	4.40	6234	109559		588.40	1.30		1.30
23	588.60	4.60	6361	115920		588.60	2.25		2.25
24	588.80	4.80	6490	122410		588.80	3.42		3.42
25	589.00	5.00	6620	129030		589.00	4.79		4.79
26	589.20	5.20	6751	135781		589.20	6.32		6.32
27	589.40	5.40	6883	142664		589.40	7.99		7.99
28	589.60	5.60	7016	149680		589.60	9.77		9.77
29	589.80	5.80	7150	156830		589.80	11.63		11.63
30	590.00	6.00	7285	164115		590.00	13.53		13.53

Basin E0 Routing

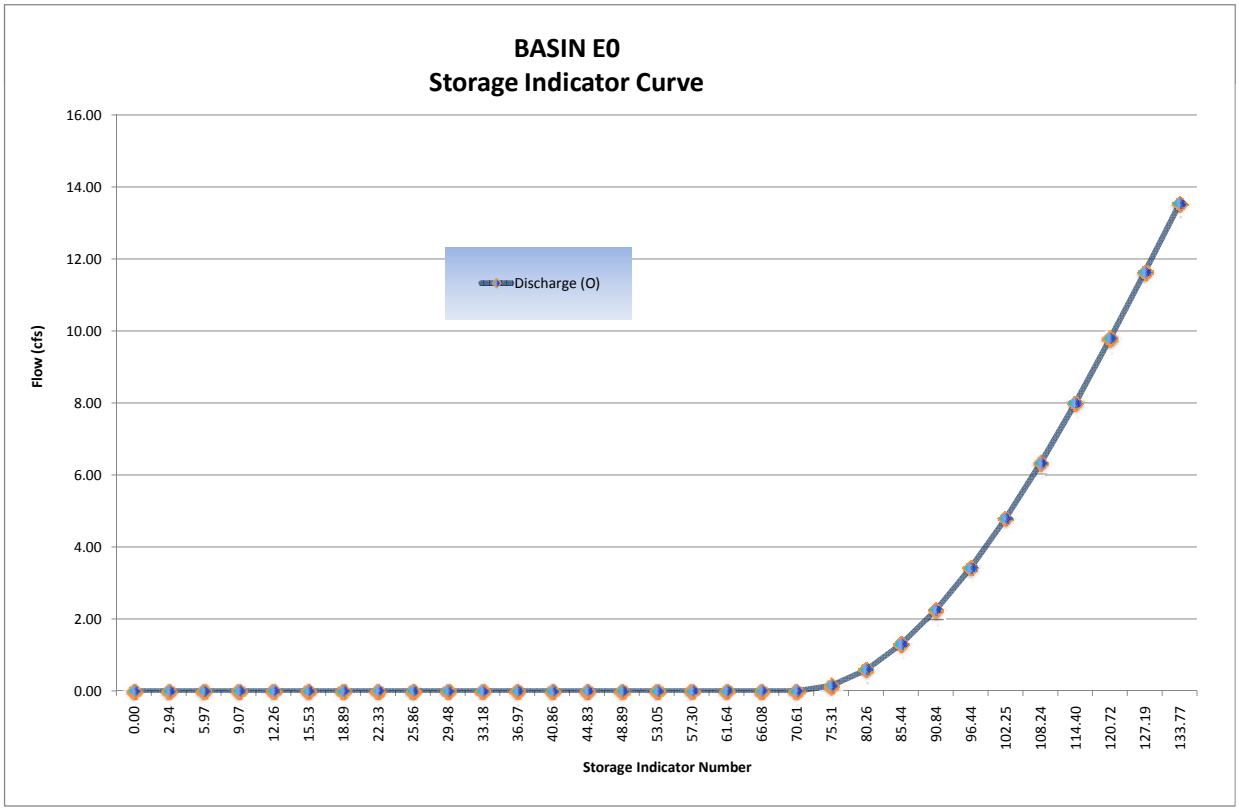
PROJECT:	SR-11			DESCRIPTION:	SR-11 Basin
JOB #:	11A1190			STATION:	96+00
BY:	M.BRUNING	DATE:	02.19.10	WATERSHED:	E0
CHK:	G.DALZIEL	DATE:		SYSTEM:	Basin E0

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)	*Storage Indicator #* (6) S_2/delta t + $O_2/2$ (cfs)
584.00	0.00	0	0.00	0.00	0.00
584.20	0.00	3802	0.00	2.94	2.94
584.40	0.00	7709	0.00	5.97	5.97
584.60	0.00	11722	0.00	9.07	9.07
584.80	0.00	15843	0.00	12.26	12.26
585.00	0.00	20071	0.00	15.53	15.53
585.20	0.00	24409	0.00	18.89	18.89
585.40	0.00	28857	0.00	22.33	22.33
585.60	0.00	33417	0.00	25.86	25.86
585.80	0.00	38089	0.00	29.48	29.48
586.00	0.00	42874	0.00	33.18	33.18
586.20	0.00	47775	0.00	36.97	36.97
586.40	0.00	52791	0.00	40.86	40.86
586.60	0.00	57924	0.00	44.83	44.83
586.80	0.00	63175	0.00	48.89	48.89
587.00	0.00	68545	0.00	53.05	53.05
587.20	0.00	74035	0.00	57.30	57.30
587.40	0.00	79647	0.00	61.64	61.64
587.60	0.00	85380	0.00	66.08	66.08
587.80	0.00	91237	0.00	70.61	70.61
588.00	0.15	97219	0.08	75.24	75.31
588.20	0.59	103326	0.30	79.96	80.26
588.40	1.30	109559	0.65	84.79	85.44
588.60	2.25	115920	1.13	89.71	90.84
588.80	3.42	122410	1.71	94.73	96.44
589.00	4.79	129030	2.40	99.86	102.25
589.20	6.32	135781	3.16	105.08	108.24
589.40	7.99	142664	4.00	110.41	114.40
589.60	9.77	149680	4.89	115.84	120.72
589.80	11.63	156830	5.82	121.37	127.19
590.00	13.53	164115	6.77	127.01	133.77

delta t = 0.36 hrs
delta t = 22 min
delta t = 1292.145 sec

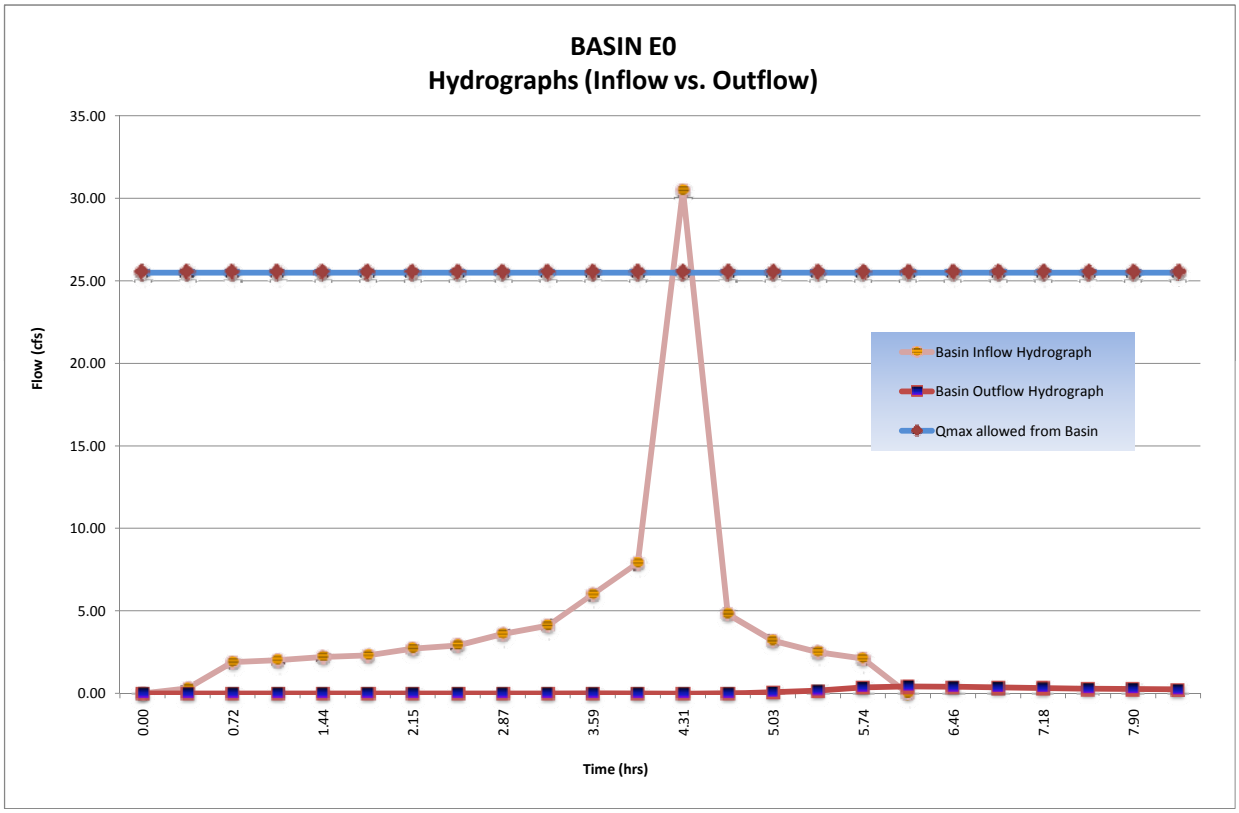


Basin E0 Routing

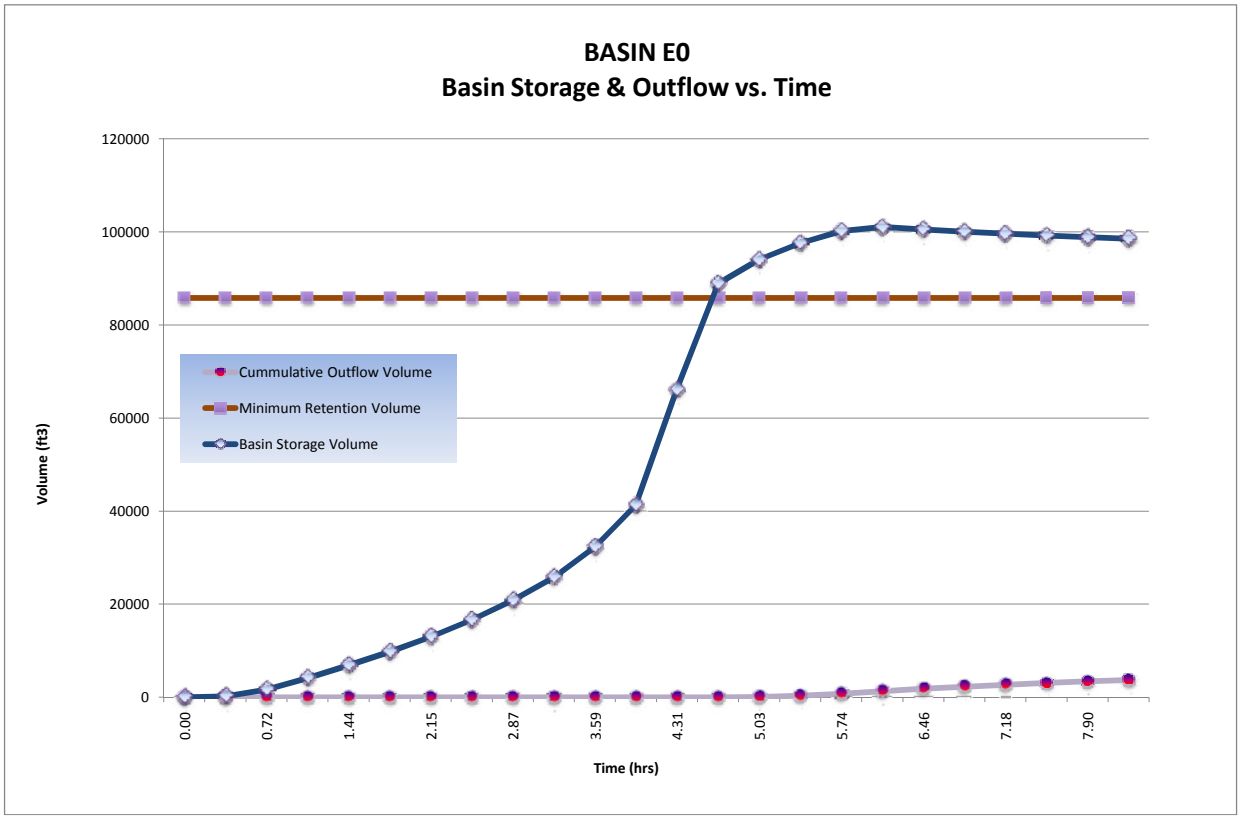
FINAL ROUTING TABLE

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

					Storage Indicator #			Volumes (ft3)		
(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*	(6) $S_2/\text{delta t} + O_2/2$ (cfs) *col (3)+(4)-(5)*	(7) O_2 (cfs) *(Hard input)*		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
0.36	0.30	0.15	0.00	0.00	0.15	0.00		194	0	0
0.72	1.90	1.10	0.15	0.00	1.25	0.00		1615	0	0
1.08	2.00	1.95	1.25	0.00	3.20	0.00		4135	0	0
1.44	2.20	2.10	3.20	0.00	5.30	0.00		6848	0	0
1.79	2.30	2.25	5.30	0.00	7.55	0.00		9756	0	0
2.15	2.70	2.50	7.55	0.00	10.05	0.00		12986	0	0
2.51	2.90	2.80	10.05	0.00	12.85	0.00		16604	0	0
2.87	3.60	3.25	12.85	0.00	16.10	0.00		20804	0	0
3.23	4.10	3.85	16.10	0.00	19.95	0.00		25778	0	0
3.59	6.00	5.05	19.95	0.00	25.00	0.00		32304	0	0
3.95	7.90	6.95	25.00	0.00	31.95	0.00		41284	0	0
4.31	30.50	19.20	31.95	0.00	51.15	0.00		66093	0	0
4.67	4.80	17.65	51.15	0.00	68.80	0.00		88900	0	0
5.03	3.20	4.00	68.80	0.00	72.80	0.07		94023	90	90
5.38	2.50	2.85	72.80	0.07	75.58	0.17		97551	220	310
5.74	2.10	2.30	75.58	0.17	77.71	0.36		100180	465	775
6.10	0.00	1.05	77.71	0.36	78.40	0.42		101033	543	1318
6.46		0.00	78.40	0.42	77.98	0.39		100510	504	1822
6.82		0.00	77.98	0.39	77.59	0.35		100031	452	2274
7.18		0.00	77.59	0.35	77.24	0.32		99599	413	2688
7.54		0.00	77.24	0.32	76.92	0.29		99204	375	3062
7.90		0.00	76.92	0.29	76.63	0.27		98843	349	3411
8.26		0.00	76.63	0.27	76.36	0.24		98513	310	3721



Basin E0 Routing



Detention/Retention Basin Volume Required:	**101,033**	ft^3	
@ Stage:	**588.20**	ft	
Freeboard	**1.8**	ft	>1' Freeboard
Final Total Basin Volume Provided:	**164,115**	ft^3	Basin **E0**
Maximum flow rate released from this basin:	**0.42**	cfs	

F0 Onsite D.A. Table

PROJECT:	**SR-11**			**DESCRIPTION:**	**On-site Drainage Areas (D.A.)**
JOB #:	**11A1190**			**STATION:**	**92+50 to 116+00**
BY:	**M.BRUNING**	**DATE:**	**12.31.09**	**WATERSHED:**	**F0**
CHK:	**G.DALZIEL**	**DATE:**		**SYSTEM:**	**No Interchange Option**

			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
PAVED	F0.1.PV	0.99	53800	1.2	10	2.8	3.44	4.2	5.15	F0.1	F0.1	Basin F0	101+50	Lt
	F0.2.PV	0.99	55600	1.3	10	2.8	3.56	4.2	5.32	F0.2	F0.2	Basin F0	101+50	Rt
	F0.3.PV	0.99	12800	0.3	5	4.0	1.16	6.6	1.92	~	F0.3	Basin F0	103+35	Rt
	F0.4.PV	0.99	56100	1.3	5	4.0	5.08	6.6	8.40	~	F0.4	Basin F0	108+00	Center
	F0.5.PV	0.99	35300	0.8	5	4.0	3.20	6.6	5.28	~	F0.5	Basin F0	108+00	Rt
	F0.6.PV	0.99	62700	1.4	5	4.0	5.68	6.6	9.39	~	F0.6	Basin F0	116+00	Center
	F0.7.PV	0.99	30700	0.7	5	4.0	2.78	6.6	4.60	~	F0.7	Basin F0	112+00	Rt
	F0.8.PV	0.99	30000	0.7	5	4.0	2.72	6.6	4.49	~	F0.8	Basin F0	116+00	Rt
		Σ	337000	*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
SLOPE	F0.1.SL	0.61	43700	1.0	10	2.8	1.72	4.2	2.58	F0.1	F0.1	Basin F0	101+50	Lt
	F0.2.SL	0.61	19000	0.4	10	2.8	0.75	4.2	1.12	F0.2	F0.2	Basin F0	101+50	Rt
	F0.9.SL	0.61	69600	1.6	10	2.8	2.75	4.2	4.11	~	Culvert	Culvert	110+00	Lt
	F0.10.SL	0.61	77200	1.8	10	2.8	3.05	4.2	4.55	~	~	bypass*	110+00	Rt
	F0.11.SL	0.61	53000	1.2	10	2.8	2.09	4.2	3.13	~	F0.11	Basin F0	113+00	Rt
		Σ	262500	*SLOPE*										

** flow that does not reach the basin*

Total :	599500	13.8
	SF	*ac*

WATERSHED F0
NO INTERCHANGE ALTERNATIVE

Scale: 1"=450'

F0 Post-Developed TcQ

PROJECT:	**SR-11**			**DESCRIPTION:**	**SR-11 Post-Developed**
JOB #:	**11A1190**			**STATION:**	**110+50**
BY:	**M.BRUNING**	**DATE:**	**10.24.09**	**WATERSHED:**	**F0**
CHK:	**G.DALZIEL**	**DATE:**		**SYSTEM:**	**No Interchange Option**

BASIN AREA:

A =	**5551010**	**ft^2**	**SOURCE:**	**MICROSTATION/USGS**
	127.43	**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	89%	AT	0.47	0.419
PAVED SURFACE	6%	AT	0.90	0.055
COMMERCIAL AREA	0%	AT	0.85	0.000
CUT SLOPE (2:1 and 4:1)	5%	AT	0.55	0.026
TOTAL	100%			
	(100%)			

$C_{2,10}$ =	0.50
C_{25} =	0.55
C_{50} =	0.60
C_{100} =	0.62

TIME OF CONCENTRATION:

SHEET FLOW:

$$T_t = \frac{0.42 L^{.5} n^{.5}}{P_2^{.5} s^{.25}}$$

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 816.5 — 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	

F0 Post-Developed TcQ

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

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	

NOTES:

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

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	

NOTES:

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

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	

NOTES:

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

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	

NOTES:

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

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 =	**Q_2 =**	59.2
i_{10} =	1.4	in/hr	X CA =	**Q_{10} =**	86.1
i_{25} =	1.7	in/hr	X CA =	**Q_{25} =**	118.3
i_{50} =	2.0	in/hr	X CA =	**Q_{50} =**	154.9
i_{100} =	2.1	in/hr	X CA =	**Q_{100} =**	**168.1**

FLOW RESULTS: (cfs)

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 F0
NO INTERCHANGE ALTERNATIVE

Scale: 1"=450'

Culvert Calculator Report
F0 10-yr

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	559.00	ft	Headwater Depth/Height	0.98	
Computed Headwater Elevation	558.91	ft	Discharge	63.40	cfs
Inlet Control HW Elev.	558.60	ft	Tailwater Elevation	547.41	ft
Outlet Control HW Elev.	558.91	ft	Control Type	Entrance Control	

Grades					
Upstream Invert	555.00	ft	Downstream Invert	546.00	ft
Length	326.00	ft	Constructed Slope	2.8	%

Hydraulic Profile					
Profile	S2		Depth, Downstream	1.41	ft
Slope Type	Steep		Normal Depth	1.41	ft
Flow Regime	Supercritical		Critical Depth	2.40	ft
Velocity Downstream	16.06	ft/s	Critical Slope	0.4	%

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	4.00	ft
Section Size	48 inch		Rise	4.00	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	558.91	ft	Upstream Velocity Head	1.01	ft
Ke	0.50		Entrance Loss	0.50	ft

Inlet Control Properties					
Inlet Control HW Elev.	558.60	ft	Flow Control	Unsubmerged	
Inlet Type	Square edge w/headwall		Area Full	12.6	ft²
K	0.00980		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	1	
C	0.03980		Equation Form	1	
Y	0.67000				

Culvert Calculator Report
F0 100-yr

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	562.00	ft	Headwater Depth/Height	1.70	
Computed Headwater Elevation	561.81	ft	Discharge	128.80	cfs
Inlet Control HW Elev.	561.81	ft	Tailwater Elevation	548.11	ft
Outlet Control HW Elev.	561.38	ft	Control Type	Inlet Control	

Grades					
Upstream Invert	555.00	ft	Downstream Invert	546.00	ft
Length	326.00	ft	Constructed Slope	2.8	%

Hydraulic Profile					
Profile	S2		Depth, Downstream	2.11	ft
Slope Type	Steep		Normal Depth	2.09	ft
Flow Regime	Supercritical		Critical Depth	3.40	ft
Velocity Downstream	19.12	ft/s	Critical Slope	0.8	%

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	4.00	ft
Section Size	48 inch		Rise	4.00	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	561.38	ft	Upstream Velocity Head	1.99	ft
Ke	0.50		Entrance Loss	1.00	ft

Inlet Control Properties					
Inlet Control HW Elev.	561.81	ft	Flow Control	Submerged	
Inlet Type	Square edge w/headwall		Area Full	12.6	ft²
K	0.00980		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	1	
C	0.03980		Equation Form	1	
Y	0.67000				

F0 Culvert TcQ

PROJECT:	**SR-11**			**DESCRIPTION:**	**SR-11 Culvert**
JOB #:	**11A1190**			**STATION:**	**110+00**
BY:	**M.BRUNING**	**DATE:**	**11.17.09**	**WATERSHED:**	**F0**
CHK:	**G.DALZIEL**	**DATE:**		**SYSTEM:**	**Culvert**

BASIN AREA:

A =	**4121961**	**ft^2**	**SOURCE:**	**MICROSTATION/USGS**
	94.63	**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	0.465
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: $T_t = \frac{0.42 L^{4/5} n^{4/5}}{P_2^{1/2} s^{2/5}}$

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	

F0 Culvert TcQ

STORMDRAIN FLOW: $T_t = \frac{L}{60\,V}$ $\frac{L}{,30\,V}$

HIGH PT ELEVATION	589.0	ft
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	
PIPE DIAMETER d	3.0	ft
HYDRAULIC RADIUS R	0.8	ft
VELOCITY (STORMDRAIN)	13.4	fps
T_C (SD)=	0.12	minutes

NOTES:

Exist Cross Culvert under berm

RCP

R=D/4, Assume: flowing full

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

CHANNEL FLOW: $T_t = \frac{L}{60\,V} = \frac{L}{60\,V}$ $V = \frac{K_u}{n} R^{2/3} S^{1/2}$

HIGH PT ELEVATION	587.0	ft
LOW POINT ELEVATION	576.0	ft
ELEVATION DIFF (H)	11.0	ft
LENGTH (L)	311	ft
SLOPE (S) = (H/L)	3.5%	
MANNING'S n	0.080	
HYDRAULIC RADIUS R	0.9	ft
VELOCITY (CHANNEL)	3.30	fps
T_C (CH)=	1.57	minutes

NOTES:

defined broad channel south of berm (field verified new berm)

CHANNEL DATA		TYPE =	TRAP'Z
Z=	5	ANG-RAD	0.197
b =	50	ANG-DEG	11.310
d =	1	FLOWING FULL ASS'M	

Natural channel

R=(bdsinA+d^2cosA)/(bsinA+2d)

From Manning's Equation assuming flowing full: $V=1.49/n(R^{2/3}S^{1/2})$

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

HIGH PT ELEVATION	576.0	ft
LOW POINT ELEVATION	555.0	ft
ELEVATION DIFF (H)	21.0	ft
LENGTH (L)	957	ft
SLOPE (S) = (H/L)	2.2%	
MANNING'S n	0.050	
HYDRAULIC RADIUS R	0.8	ft
VELOCITY (CHANNEL)	3.74	fps
T_C (CH)=	4.27	minutes

NOTES:

channel begins to narrow

CHANNEL DATA		TYPE =	TRAP'Z
Z=	2	ANG-RAD	0.464
b =	1	ANG-DEG	26.565
d =	1.5	FLOWING FULL ASS'M	

Natural channel

R=(bdsinA+d^2cosA)/(bsinA+2d)

From Manning's Equation assuming flowing full: $V=1.49/n(R^{2/3}S^{1/2})$

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

INTENSITY CHART: Caltrans IDF2000

i_2 =	0.8	in/hr	X CA =	
i_{10} =	1.4	in/hr	X CA =	
i_{25} =	1.8	in/hr	X CA =	
i_{50} =	2.0	in/hr	X CA =	
i_{100} =	2.3	in/hr	X CA =	

FLOW RESULTS:

	cfs
Q_2 =	33.8
Q_{10} =	63.4
Q_{25} =	87.2
Q_{50} =	109.4
Q_{100} =	**128.8**

~Use Caltrans 'i' for culvert sizing

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

i_2 =	1.0	in/hr	X CA =	
i_{10} =	1.5	in/hr	X CA =	
i_{25} =	1.8	in/hr	X CA =	
i_{50} =	2.2	in/hr	X CA =	
i_{100} =	2.3	in/hr	X CA =	

FLOW RESULTS

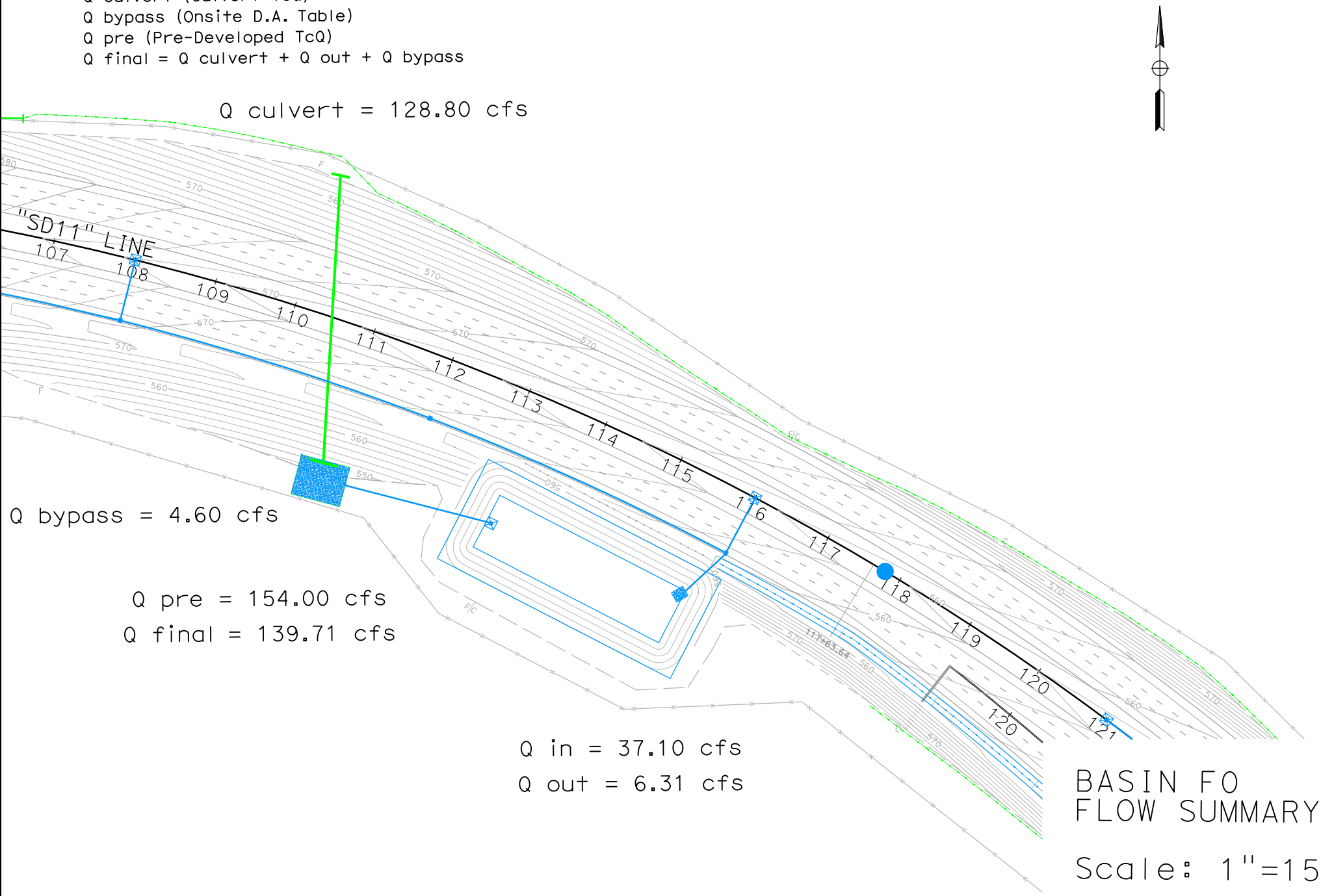
	cfs
Q_2 =	45.3
Q_{10} =	65.9
Q_{25} =	90.6
Q_{50} =	118.7
Q_{100} =	**128.8**

~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 F0
FLOW SUMMARY

Scale: 1"=150'

Basin F0 Retention

PROJECT:	**SR-11**			**DESCRIPTION:**	**SR-11 Basin**
JOB #:	**11A1190**			**STATION:**	**110+50**
BY:	**M.BRUNING**	**DATE:**	**12.31.09**	**WATERSHED:**	**F0**
CHK:	**G.DALZIEL**	**DATE:**		**SYSTEM:**	**Basin**

Notes:

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

RETENTION BASIN VOLUME

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

Pre-Developed volume calculations

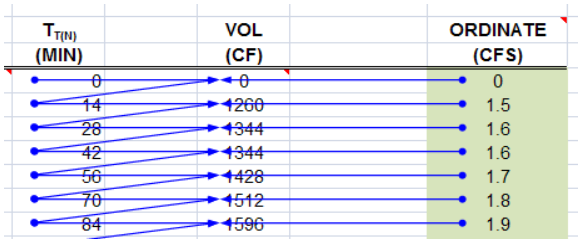
Q_{100}=	154.0	cfs			
Tc=	30.0	min	C=	0.59	
$P_{100,6}$=	2.5	in	A=	125.36	acres

$T_{T(N)}$ (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:



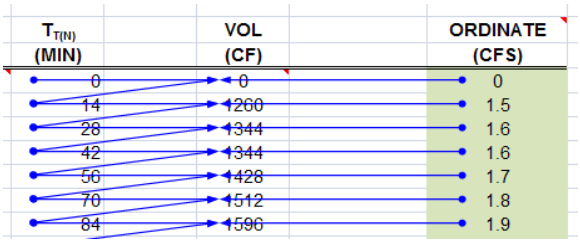
Basin F0 Retention

Post-Developed volume calculations

Q_{100}=	168.1	cfs			
Tc=	29.2	min	C=	0.62	
$P_{100,6}$=	2.5	in	A=	127.43	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	80214	46.1
261	292494	168.1
290	46284	26.6
319	30972	17.8
348	24186	13.9
377	0	0

Example of Steps:



SUM= 704178 ft^3
16.17 acre-feet

Check: $V = C*A*P_6$
V= 16.59 acre-feet
OK

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

Basin F0 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= 10.39 acres

WQ_{72}: 0.73 in/area

Water Quality Volume (WQV) = **27539** 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)

Onsite Highway *Sloped* runoff area, A:		115700	ft^2
	A:	2.66	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

$A_s = RKLsCP$

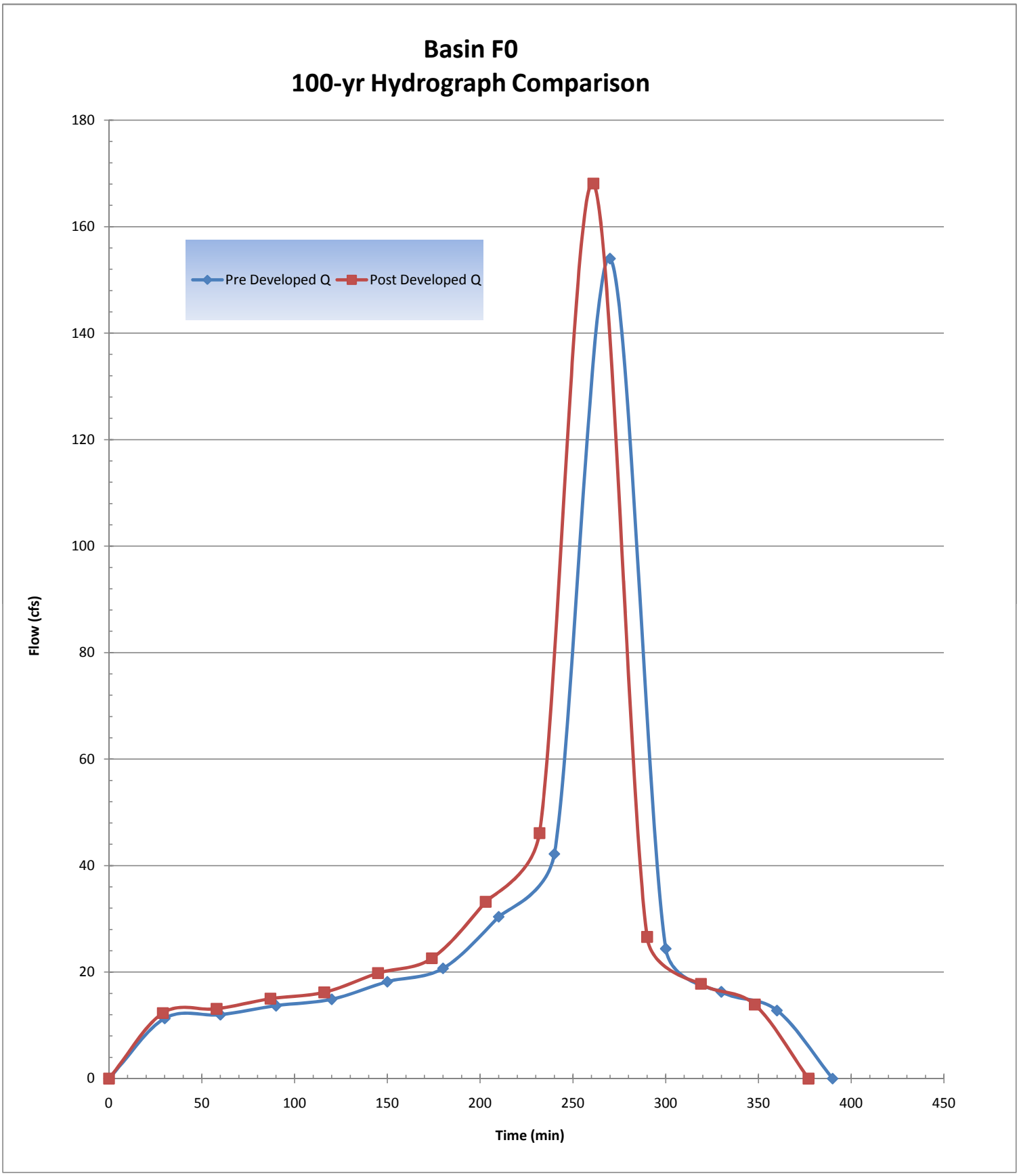
where:

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

Volume for 10-year Silt Accumulation = 41.31 tons

Silt Accumulation Basin volume = **918** ft^3

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


Basin F0
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 F0 Inflow TcQ

PROJECT:	**SR-11**			**DESCRIPTION:**	**SR-11 Basin**
JOB #:	**11A1190**			**STATION:**	**113+00 to 116+00**
BY:	**M.BRUNING**	**DATE:**	**12.31.09**	**WATERSHED:**	**F0**
CHK:	**G.DALZIEL**	**DATE:**		**SYSTEM:**	**No Interchange Option**

BASIN AREA:

A = **452700** **ft^2** **SOURCE:** **MICROSTATION/USGS**
10.39 **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	74%	AT	0.90	0.670
COMMERCIAL AREA	0%	AT	0.85	0.000
CUT SLOPE (2:1 and 4:1)	26%	AT	0.55	0.141
TOTAL	100%			
	(100%)			

$C_{2,10}$ =	0.81
C_{25} =	0.89
C_{50} =	0.97
C_{100} =	1.00

TIME OF CONCENTRATION:

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

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

HIGH PT ELEVATION	599.0	ft	Median to ES
LOW POINT ELEVATION	597.0	ft	
ELEVATION DIFF (H)	2.0	ft	
LENGTH (L)	113	ft	to ES
SLOPE (S) = (H/L)	1.8%		
MANNING'S n	0.016		AC < = From Table 816.6A
T_t (SFF)=	2.52	minutes	

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

NOTES:

HIGH PT ELEVATION	597.0	ft	Flow in Bioswale
LOW POINT ELEVATION	596.0	ft	
ELEVATION DIFF (H)	1.0	ft	
LENGTH (L)	200	ft	assumed SCF and not channelized or flowing full yet
SLOPE (S) = (H/L)	0.5%		
VELOCITY (SCF)	1.0	fps	0.5% , V FROM FIG 816.6 grass lined
T_C (SH)=	3.33	minutes	

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

NOTES:

HIGH PT ELEVATION	596.0	ft	Flow in Bioswale
LOW POINT ELEVATION	585.0	ft	CHANNEL DATA TYPE = TRAP'Z
ELEVATION DIFF (H)	11.0	ft	Z= 4 ANG-RAD 0.245
LENGTH (L)	823	ft	b = 13 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	0.80	ft	R=(bdsinA+d^2cosA)/(bsinA+2d)
VELOCITY (CHANNEL)	2.97	fps	From Manning's Equation assuming flowing full: $V=1.49/n(R^{2/3}S^{1/2})$
T_C (CH)=	4.62	minutes	

Basin F0 Inflow TcQ

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

HIGH PT ELEVATION	580.0	ft	Proposed onsite pipe (assumed 5' drop to invert)
LOW POINT ELEVATION	552.0	ft	Proposed Rip Rap Pad in Basin floor
ELEVATION DIFF (H)	28.0	ft	
LENGTH (L)	1465	ft	to basin
SLOPE (S) = (H/L)	1.9%		
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)	10.0	fps	$V = \frac{K_u}{n} R^{2/3} S^{1/2}$
T_C (SD)=	2.45	minutes	

NOTES:

Tc (TOTAL) =	12.92	minutes
Minimum Tc =	5	minutes
USE T_C =	**12.92**	minutes

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

i_2 =	1.6	in/hr	X CA =
i_{10} =	2.3	in/hr	X CA =
i_{25} =	2.9	in/hr	X CA =
i_{50} =	3.4	in/hr	X CA =
i_{100} =	3.6	in/hr	X CA =

FLOW RESULTS

	cfs
Q_2 =	13.2
Q_{10} =	19.2
Q_{25} =	26.5
Q_{50} =	34.6
Q_{100} =	**37.1**

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 F0 Inflow Hydrograph

PROJECT:	**SR-11**			**DESCRIPTION:**	**SR-11 Basin**
JOB #:	**11A1190**			**STATION:**	**116+00**
BY:	**M.BRUNING**	**DATE:**	**12.31.09**	**WATERSHED:**	**F0**
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}=	37.1	cfs	C_{100}=	1.00	
Tc=	12.9	min	A=	10.39	acres
$P_{100,6}$=	2.5	in			

$T_{T(N)}$ (MIN)	VOL (CF)	ORDINATE (CFS)
0	0	0
13	9594	12.3
26	1248	1.6
39	1248	1.6
52	1326	1.7
65	1404	1.8
78	1482	1.9
91	1482	1.9
104	1638	2.1
117	1716	2.2
130	1794	2.3
143	1872	2.4
156	2106	2.7
169	2262	2.9
182	2574	3.3
195	2808	3.6
208	3432	4.4
221	3900	5
234	5694	7.3
247	7956	10.2
260	28938	37.1
273	4602	5.9
286	3042	3.9
299	2418	3.1
312	2028	2.6
325	1716	2.2
338	1560	2
351	1404	1.8
364	1326	1.7
377	0	0

Onsite Runoff Volume

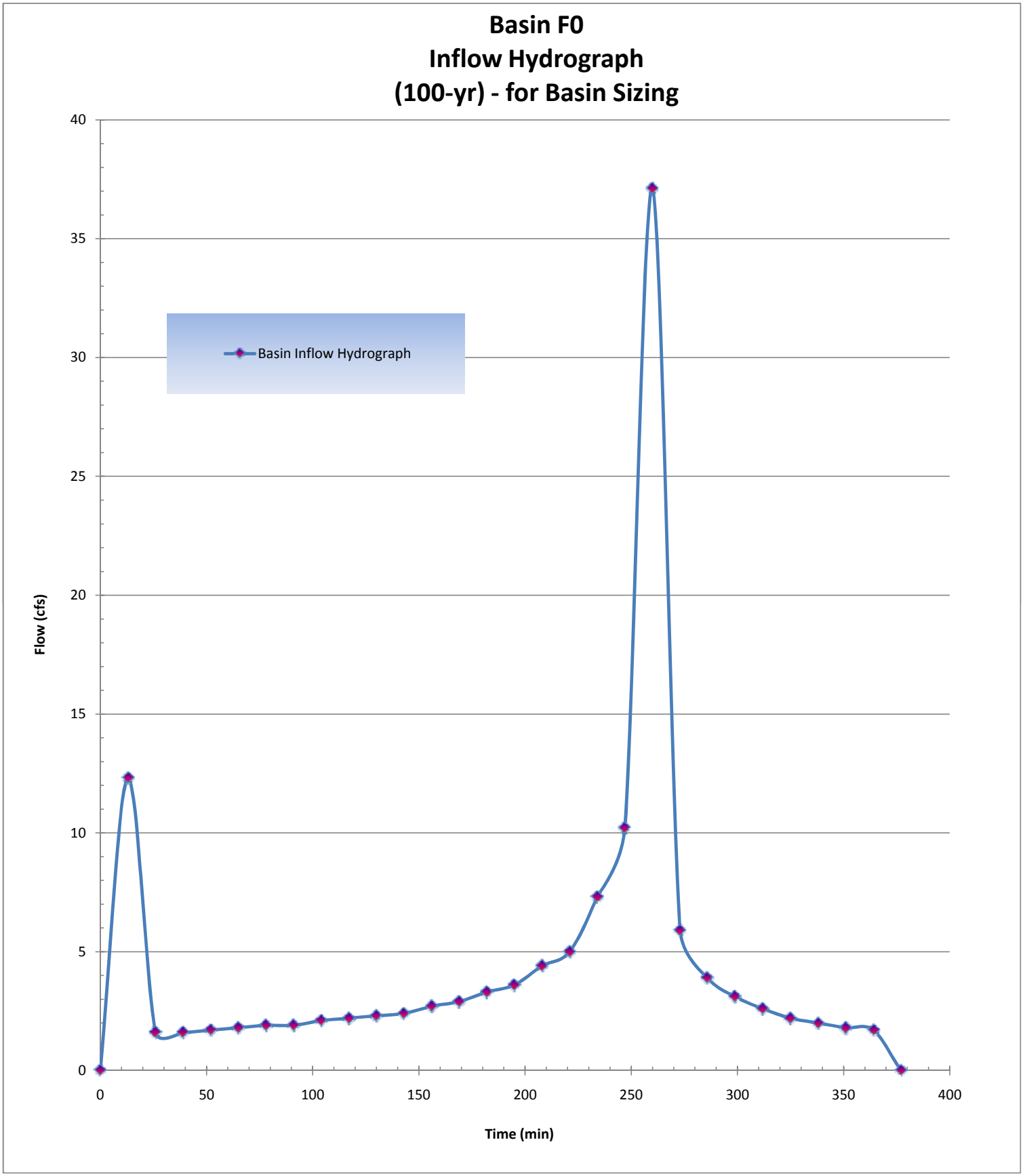
SUM= 102570 ft^3

2.35 acre-feet

Check: $V = C*A*P_6$

V= 2.17 acre-feet

OK


Basin F0
Inflow Hydrograph
(100-yr) - for Basin Sizing
Basin Inflow Hydrograph
Flow (cfs)
Time (min)
0
5
10
15
20
25
30
35
40
0
50
100
150
200
250
300
350
400

Basin F0 Outlet

PROJECT:	**SR-11**			**DESCRIPTION:**	**SR-11 Basin**
JOB #:	**11A1190**			**STATION:**	**110+00**
BY:	**M.BRUNING**	**DATE:**	**02.19.10**	**WATERSHED:**	**F0**
CHK:	**G.DALZIEL**	**DATE:**		**SYSTEM:**	**Basin Outlet**

Notes:

Required Retention Basin Volume = 37476 ft^3

Actual Basin Inflow = 102570 ft^4 *OK*

Flow Balance - determine maximum flow from basin

Predeveloped Peak 100-year Flow:	154.0	cfs		
Post-Developed Peak Flow through Cross Culvert:	128.8	cfs	~	Includes: F0.9.SL
Flow that does not reach detention basin (bypass per DA table):	4.6	cfs	~	Q_{100} from: F0.10.SL
Maximum flow allowed to be released by this detention basin:	20.7	cfs		

Outlet Pipe

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

Basin - Top of basin berm elevation =		558.00	ft
Basin flowline elevation =		552.00	ft
Maximum Basin Depth =		6.00	ft
Assume Culvert Design: free outfall, square-edge w/headwall			
Outlet pipe invert from basin floor =	1.60 ft	553.60	ft
Outlet pipe diameter =	2 ft		

Basin Characteristics

Base Length (L)	265	ft
Base Width (W)	85	ft
W/L Ratio ®	0.32	
Side Slopes (Z)	1: 4	
Total Volume (V):	190229	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	552.00	0.00	0	0		552.00	0.00		0.00
1	552.20	0.20	4561	4561		552.20	0.00		0.00
2	552.40	0.40	4674	9235		552.40	0.00		0.00
3	552.60	0.60	4788	14023		552.60	0.00		0.00
4	552.80	0.80	4903	18927		552.80	0.00		0.00
5	553.00	1.00	5019	23946		553.00	0.00		0.00
6	553.20	1.20	5137	29083		553.20	0.00		0.00
7	553.40	1.40	5255	34338		553.40	0.00		0.00
8	553.60	1.60	5374	39712	*	553.60	0.00		0.00
9	553.80	1.80	5494	45206		553.80	0.15		0.15
10	554.00	2.00	5616	50822		554.00	0.59	0.00	0.59
11	554.20	2.20	5738	56560		554.20	1.30		1.30
12	554.40	2.40	5862	62422		554.40	2.25		2.25
13	554.60	2.60	5986	68408		554.60	3.42		3.42
14	554.80	2.80	6112	74519		554.80	4.79		4.79
15	555.00	3.00	6238	80757		555.00	6.32		6.32
16	555.20	3.20	6366	87123		555.20	7.99		7.99
17	555.40	3.40	6494	93618		555.40	9.77		9.77
18	555.60	3.60	6624	100242		555.60	11.63		11.63
19	555.80	3.80	6755	106997		555.80	13.56		13.56
20	556.00	4.00	6887	113883		556.00	15.46		15.46

Basin F0 Routing

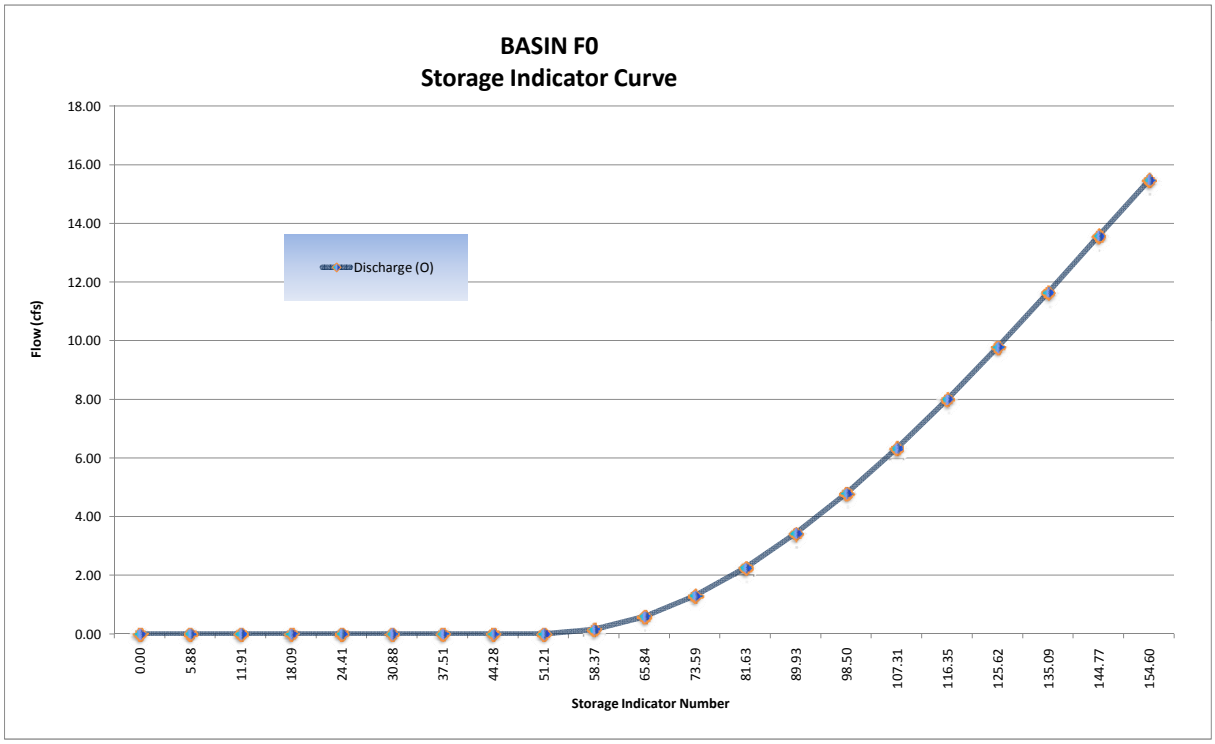
PROJECT:	SR-11			DESCRIPTION:	SR-11 Basin
JOB #:	11A1190			STATION:	110+00
BY:	M.BRUNING	DATE:	02.19.10	WATERSHED:	F
CHK:	G.DALZIEL	DATE:		SYSTEM:	Basin F0

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)	*Storage Indicator #* (6) $S_2/delta\ t + O_2/2$ (cfs)
552.00	0.00	0	0.00	0.00	0.00
552.20	0.00	4561	0.00	5.88	5.88
552.40	0.00	9235	0.00	11.91	11.91
552.60	0.00	14023	0.00	18.09	18.09
552.80	0.00	18927	0.00	24.41	24.41
553.00	0.00	23946	0.00	30.88	30.88
553.20	0.00	29083	0.00	37.51	37.51
553.40	0.00	34338	0.00	44.28	44.28
553.60	0.00	39712	0.00	51.21	51.21
553.80	0.15	45206	0.08	58.30	58.37
554.00	0.59	50822	0.30	65.54	65.84
554.20	1.30	56560	0.65	72.94	73.59
554.40	2.25	62422	1.13	80.50	81.63
554.60	3.42	68408	1.71	88.22	89.93
554.80	4.79	74519	2.40	96.10	98.50
555.00	6.32	80757	3.16	104.15	107.31
555.20	7.99	87123	4.00	112.36	116.35
555.40	9.77	93618	4.89	120.73	125.62
555.60	11.63	100242	5.82	129.28	135.09
555.80	13.56	106997	6.78	137.99	144.77
556.00	15.46	113883	7.73	146.87	154.60

delta t =	0.22	hrs
delta t =	13	min
delta t =	775.408	sec

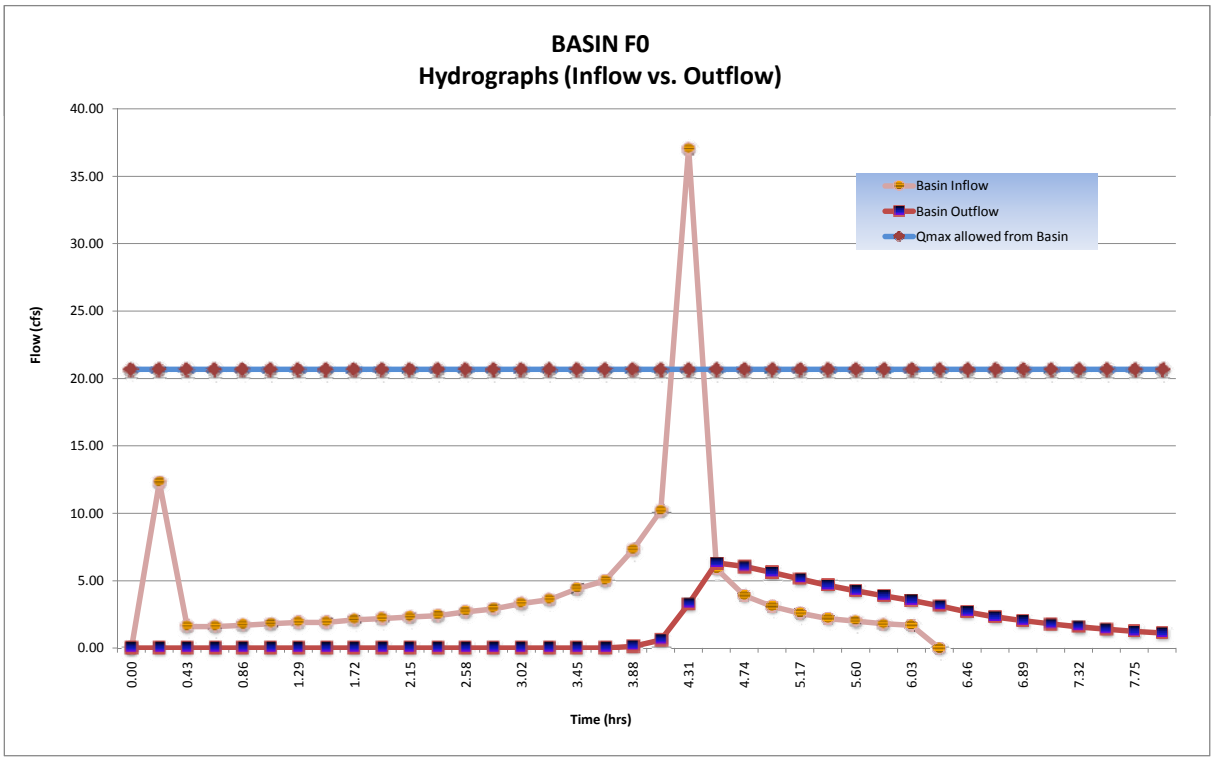


Basin F0 Routing

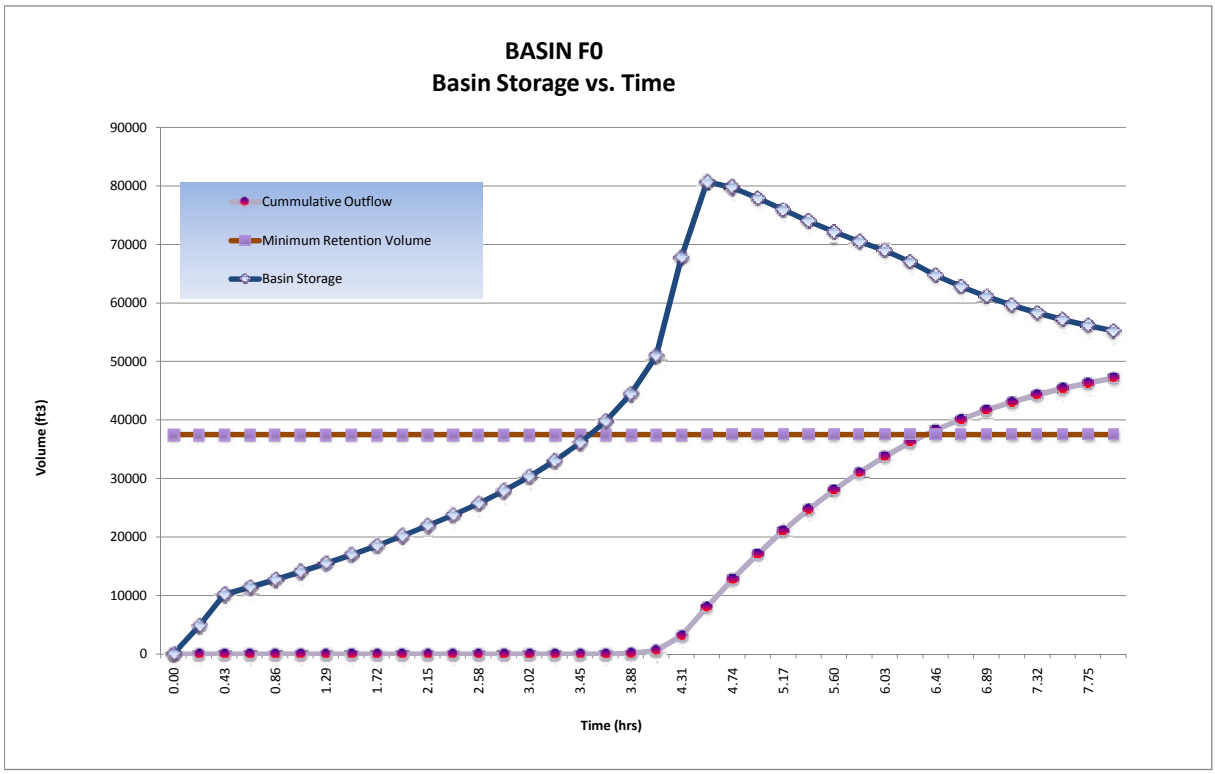
FINAL ROUTING TABLE

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

(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	12.30	6.15	0.00	0.00	6.15	0.00	4769	0	0
0.43	1.60	6.95	6.15	0.00	13.10	0.00	10158	0	0
0.65	1.60	1.60	13.10	0.00	14.70	0.00	11398	0	0
0.86	1.70	1.65	14.70	0.00	16.35	0.00	12678	0	0
1.08	1.80	1.75	16.35	0.00	18.10	0.00	14035	0	0
1.29	1.90	1.85	18.10	0.00	19.95	0.00	15469	0	0
1.51	1.90	1.90	19.95	0.00	21.85	0.00	16943	0	0
1.72	2.10	2.00	21.85	0.00	23.85	0.00	18493	0	0
1.94	2.20	2.15	23.85	0.00	26.00	0.00	20161	0	0
2.15	2.30	2.25	26.00	0.00	28.25	0.00	21905	0	0
2.37	2.40	2.35	28.25	0.00	30.60	0.00	23727	0	0
2.58	2.70	2.55	30.60	0.00	33.15	0.00	25705	0	0
2.80	2.90	2.80	33.15	0.00	35.95	0.00	27876	0	0
3.02	3.30	3.10	35.95	0.00	39.05	0.00	30280	0	0
3.23	3.60	3.45	39.05	0.00	42.50	0.00	32955	0	0
3.45	4.40	4.00	42.50	0.00	46.50	0.00	36056	0	0
3.66	5.00	4.70	46.50	0.00	51.20	0.00	39701	0	0
3.88	7.30	6.15	51.20	0.00	57.35	0.13	44419	101	101
4.09	10.20	8.75	57.35	0.13	65.97	0.60	50921	465	566
4.31	37.10	23.65	65.97	0.60	89.02	3.29	67751	2551	3117
4.52	5.90	21.50	89.02	3.29	107.23	6.31	80701	4893	8010
4.74	3.90	4.90	107.23	6.31	105.82	6.06	79704	4699	12709
4.95	3.10	3.50	105.82	6.06	103.26	5.62	77890	4358	17067
5.17	2.60	2.85	103.26	5.62	100.49	5.14	75928	3986	21052
5.38	2.20	2.40	100.49	5.14	97.75	4.67	73986	3621	24673
5.60	2.00	2.10	97.75	4.67	95.18	4.26	72152	3303	27977
5.82	1.80	1.90	95.18	4.26	92.82	3.88	70469	3009	30985
6.03	1.70	1.75	92.82	3.88	90.69	3.54	68949	2745	33730
6.25	0.00	0.85	90.69	3.54	88.00	3.15	67015	2443	36173
6.46		0.00	88.00	3.15	84.85	2.70	64747	2094	38266
6.68		0.00	84.85	2.70	82.15	2.32	62800	1799	40065
6.89		0.00	82.15	2.32	79.83	2.04	61110	1582	41647
7.11		0.00	79.83	2.04	77.79	1.80	59621	1396	43043
7.32		0.00	77.79	1.80	75.99	1.58	58311	1225	44268
7.54		0.00	75.99	1.58	74.41	1.40	57155	1086	45354
7.75		0.00	74.41	1.40	73.01	1.25	56128	969	46323
7.97		0.00	73.01	1.25	71.76	1.13	55205	876	47199
8.18		0.00	71.76	1.13	70.63	1.03	54368	799	47998



Basin F0 Routing



Detention/Retention Basin Volume Required:	**80,701**	ft^3	
@ Stage:	**555.00**	ft	
Freeboard:	**3.0**	ft	> 1' Freeboard
Final Total Basin Volume Provided:	**190,229**	ft^3	Basin **F0**
Maximum flow rate released from this basin:	**6.31**	cfs	

G0 Onsite D.A. Table

PROJECT:	**SR-11**	**DESCRIPTION:**	**On-site Drainage Areas (D.A.)**
JOB #:	**11A1190**	**STATION:**	**116+00 to 140+00**
BY:	**M.BRUNING** **DATE:** **01.05.10**	**WATERSHED:**	**G0**
CHK:	**G.DALZIEL** **DATE:**	**SYSTEM:**	**No 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
G0.1.PV	0.99	34300	0.8	5	4.0	3.12	6.6	5.13	~	G0.1	Basin G0-North	127+00	Rt
G0.2.PV	0.99	39000	0.9	5	4.0	3.55	6.6	5.84	~	G0.2	Basin G0-North	121+00	Center
G0.3.PV	0.99	47000	1.1	5	4.0	4.27	6.6	7.04	~	G0.3	Basin G0-North	127+00	Center
G0.4.PV	0.99	29100	0.7	5	4.0	2.65	6.6	4.36	~	G0.4	Basin G0-North	131+50	Center
G0.5.PV	0.99	60500	1.4	5	4.0	5.50	6.6	9.06	~	G0.5	Basin G0-South	139+00	Lt
G0.6.PV	0.99	26900	0.6	5	4.0	2.45	6.6	4.03	~	G0.6	Basin G0-South	139+00	Rt
G0.7.PV	0.99	11400	0.3	5	4.0	1.04	6.6	1.71	~	G0.7	Basin G0-South	135+00	Rt
G0.8.PV	0.99	80300	1.8	10	2.8	5.16	4.2	7.69	G0.8	G0.8	bypass*	130+20	SDR3
G0.9.PV	0.99	40500	0.9	10	2.8	2.60	4.2	3.88	G0.9	G0.9	Basin G0-South	135+00	SV2
G0.10.PV	0.99	29200	0.7	5	4.0	2.65	6.6	4.37	~	G0.10	Basin G0-North	131+50	Rt
G0.11.PV	0.99	6200	0.1	5	4.0	0.56	6.6	0.93	~	G0.11	Basin G0-North	131+50	SV2
G0.12.PV	0.99	22800	0.5	5	4.0	2.07	6.6	3.41	~	G0.12	Basin G0-North	105+00	SV1
G0.13.PV	0.99	22800	0.5	5	4.0	2.07	6.6	3.41	~	G0.13	Basin G0-North	105+00	SV1
G0.14.PV	0.99	15700	0.4	5	4.0	1.43	6.6	2.35	~	G0.14	Basin G0-North	102+00	SV1
G0.15.PV	0.99	15700	0.4	5	4.0	1.43	6.6	2.35	~	G0.15	Basin G0-North	102+00	SV1
G0.16.PV	0.99	41700	1.0	5	4.0	3.79	6.6	6.24	~	G0.16	Basin G0-South	139+00	SDR3
G0.17.PV	0.99	62300	1.4	5	4.0	5.66	6.6	9.33	~	G0.17	Basin G0-South	139+00	SV2
G0.18.PV	0.99	67700	1.6	5	4.0	6.16	6.6	10.13	~	G0.18	Basin G0-South	Toll 1	~
G0.19.PV	0.99	67200	1.5	5	4.0	6.11	6.6	10.06	~	G0.19	Basin G0-South	Toll 2	~
G0.20.PV	0.99	10200	0.2	5	4.0	0.93	6.6	1.53	~	G0.20	Basin G0-South	100+00	SV1
G0.21.PV	0.99	10200	0.2	5	4.0	0.93	6.6	1.53	~	G0.21	Basin G0-South	100+00	SV1
G0.22.PV	0.99	34200	0.8	5	4.0	3.11	6.6	5.12	~	~	bypass*	96+50	SV2

Σ 774900 *PAVED*

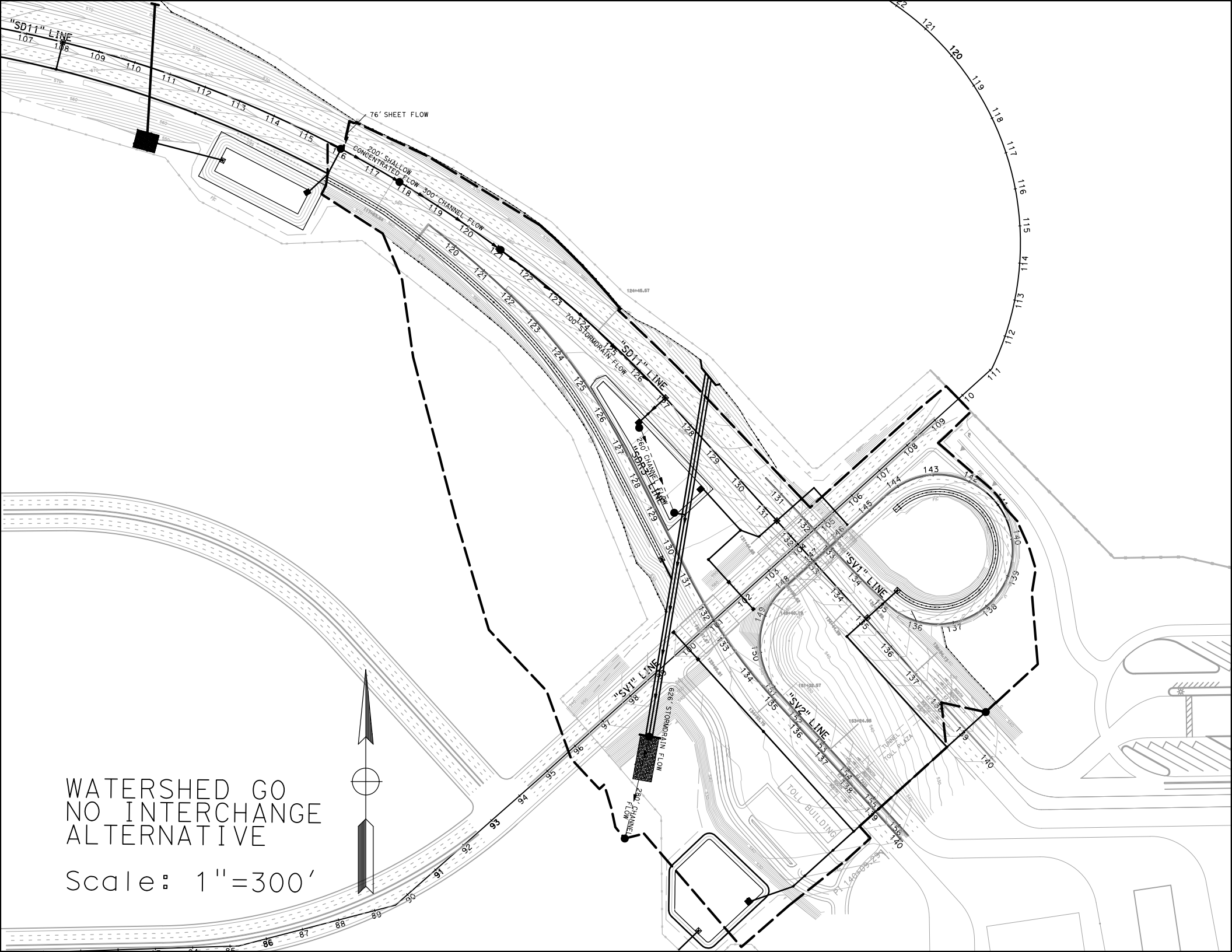
SLOPE

		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
G0.5.SL	0.61	13600	0.3	10	2.8	0.54	4.2	0.80	~	G0.5	Basin G0-South	139+00	Lt
G0.6.SL	0.61	70500	1.6	10	2.8	2.79	4.2	4.16	~	G0.6	Basin G0-South	139+00	Rt
G0.7.SL	0.61	30900	0.7	10	2.8	1.22	4.2	1.82	~	G0.7	Basin G0-South	135+00	Rt
G0.8.SL	0.61	59300	1.4	10	2.8	2.35	4.2	3.50	G0.8	G0.8	bypass*	130+20	SDR3
G0.9.SL	0.61	95600	2.2	10	2.8	3.79	4.2	5.64	G0.9	G0.9	Basin G0-South	135+00	SV1
G0.22.SL	0.61	40900	0.9	10	2.8	1.62	4.2	2.41	~	~	bypass*	96+50	SV2
G0.23.SL	0.61	101200	2.3	10	2.8	4.01	4.2	5.97	~	G0.23	Basin G0-South	135+00	Rt
G0.24.SL	0.61	40800	0.9	10	2.8	1.62	4.2	2.41	~	Culvert	bypass*	127+00	Lt
G0.25.SL	0.61	19700	0.5	10	2.8	0.78	4.2	1.16	~	~	bypass*	132+00	Rt
G0.26.SL	0.61	57400	1.3	10	2.8	2.27	4.2	3.39	~	G0.26	Basin G0-South	139+00	Lt
G0.27.SL	0.61	100900	2.3	10	2.8	4.00	4.2	5.95	~	G0.27	Basin G0-North	139+01	Lt

Σ 630800 *SLOPE*

* flow that does not reach the basin

Total :	1405700 *SF*	32.3 *ac*


"SD11" LINE
76' SHEET FLOW
200' SHALLOW CONCENTRATED FLOW
300' CHANNEL FLOW
700' STORMDRAIN FLOW
"SD11" LINE
260' CHANNEL FLOW
"SPR" LINE
"SV1" LINE
"SV1" LINE
628' STORMDRAIN FLOW
"SV2" LINE
280' CHANNEL FLOW
TOLL BUILDING
TUNNEL TOLL PLAZA
WATERSHED GO
NO INTERCHANGE
ALTERNATIVE
Scale: 1"=300'

G0 Post-Developed TcQ

PROJECT:	**SR-11**			**DESCRIPTION:**	**SR-11 Post-Developed**
JOB #:	**11A1190**			**STATION:**	**139+00**
BY:	**M.BRUNING**	**DATE:**	**01.05.10**	**WATERSHED:**	**G0**
CHK:	**G.DALZIEL**	**DATE:**		**SYSTEM:**	**No Interchange Option**

BASIN AREA:

A = **1846084** **ft^2** **SOURCE:** **MICROSTATION/USGS**
42.38 **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	24%	AT	0.39	0.093
PAVED SURFACE	42%	AT	0.90	0.378
COMMERCIAL AREA	0%	AT	0.85	0.000
CUT SLOPE (2:1 and 4:1)	34%	AT	0.55	0.188
TOTAL	100%			
	(100%)			

$C_{2,10}$ =	0.66
C_{25} =	0.72
C_{50} =	0.79
C_{100} =	0.82

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	567.0	ft	From asphalt, superelevation
LOW POINT ELEVATION	563.0	ft	
ELEVATION DIFF (H)	4.0	ft	
LENGTH (L)	76	ft	
SLOPE (S) = (H/L)	5.3%		
MANNING'S n	0.016		< = FROM TABLE 816.6A Asphalt Paving
T_t (SFF)=	1.19	minutes	

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

NOTES:

HIGH PT ELEVATION	563.0	ft	assumed SCF and not channelized or flowing full yet
LOW POINT ELEVATION	560.0	ft	
ELEVATION DIFF (H)	3.0	ft	
LENGTH (L)	200	ft	
SLOPE (S) = (H/L)	1.5%		
VELOCITY (SCF)	1.3	fps	<=V FROM FIG 816.5 nearly bare ground
T_C (SH)=	2.67	minutes	

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

NOTES:

HIGH PT ELEVATION	560.0	ft	median ditch
LOW POINT ELEVATION	557.0	ft	CHANNEL DATA TYPE = TRAP'Z
ELEVATION DIFF (H)	3.0	ft	Z= 4 ANG-RAD 0.245
LENGTH (L)	300	ft	b = 0 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	0.5	ft	R=(bdsinA+d^2cosA)/(bsinA+2d)
VELOCITY (CHANNEL)	1.84	fps	From Manning's Equation assuming flowing full: $V=1.49/n(R^{2/3}S^{1/2})$
T_C (CH)=	2.72	minutes	

G0 Post-Developed TcQ

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

HIGH PT ELEVATION	552.0	ft	Proposed storm drain through median (elev at pipe invert)
LOW POINT ELEVATION	545.0	ft	Sta 127+00 - basin G0-1
ELEVATION DIFF (H)	7.0	ft	
LENGTH (L)	700	ft	
SLOPE (S) = (H/L)	1.0%		
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)	7.2	fps	$V = \frac{K_u}{n} R^{2/3} S^{1/2}$
T_C (SD)=	1.62	minutes	

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

HIGH PT ELEVATION	545.0	ft	Detention basin (low flow channel)
LOW POINT ELEVATION	542.0	ft	CHANNEL DATA: Z= 4, ANG-RAD, 0.245; b = 2, ANG-DEG, 14.036; d = 1, FLOWING FULL ASS'M; TYPE = TRAP'Z
ELEVATION DIFF (H)	3.0	ft	
LENGTH (L)	260	ft	
SLOPE (S) = (H/L)	1.2%		
MANNING'S n	0.050		HDM Table 864.3A, Depressed Median - Earth (with growth)
HYDRAULIC RADIUS R	0.6	ft	R=(bdsinA+d^2cosA)/(bsinA+2d)
VELOCITY (CHANNEL)	2.24	fps	From Manning's Equation assuming flowing full: $V=1.49/n(R^{2/3}S^{1/2})$
T_C (CH)=	1.93	minutes	

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

HIGH PT ELEVATION	532.0	ft	Proposed RCB
LOW POINT ELEVATION	523.0	ft	Outlet
ELEVATION DIFF (H)	9.0	ft	
LENGTH (L)	626	ft	
SLOPE (S) = (H/L)	1.4%		
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)	13.7	fps	$V = \frac{K_u}{n} R^{2/3} S^{1/2}$
T_C (SD)=	0.76	minutes	

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

HIGH PT ELEVATION	523.0	ft	RCP to confluence point
LOW POINT ELEVATION	515.0	ft	CHANNEL DATA: Z= 4, ANG-RAD, 0.245; b = 2, ANG-DEG, 14.036; d = 1, FLOWING FULL ASS'M; TYPE = TRAP'Z
ELEVATION DIFF (H)	8.0	ft	
LENGTH (L)	280	ft	
SLOPE (S) = (H/L)	2.9%		
MANNING'S n	0.055		HDM Table 864.3A, Depressed Median - Earth (with growth) and RCP
HYDRAULIC RADIUS R	0.6	ft	R=(bdsinA+d^2cosA)/(bsinA+2d)
VELOCITY (CHANNEL)	3.21	fps	From Manning's Equation assuming flowing full: $V=1.49/n(R^{2/3}S^{1/2})$
T_C (CH)=	1.46	minutes	

Tc (TOTAL) =	12.34	minutes
Minimum Tc =	10	minutes
USE Tc =	**12.34**	minutes

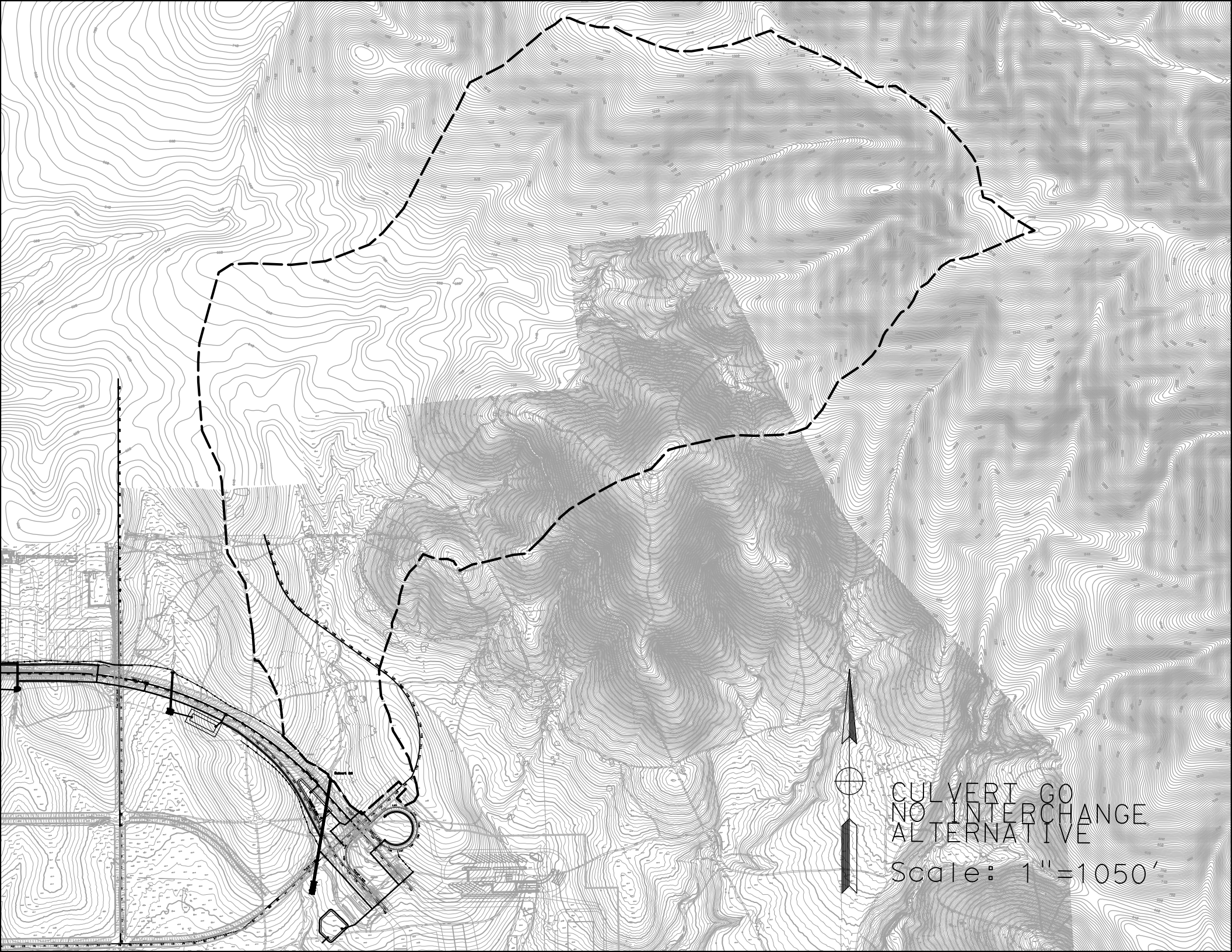
INTENSITY CHART: $I = 7.44\,P_6\,D^{-0.645}$

i_2 =	1.6	in/hr	X CA =	**Q_2 =**	45.2
i_{10} =	2.4	in/hr	X CA =	**Q_{10} =**	65.7
i_{25} =	2.9	in/hr	X CA =	**Q_{25} =**	90.4
i_{50} =	3.5	in/hr	X CA =	**Q_{50} =**	118.3
i_{100} =	3.7	in/hr	X CA =	**Q_{100} =**	**128.4**

FLOW RESULTS: (cfs)

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 GO
NO INTERCHANGE
ALTERNATIVE
Scale: 1"=1050'

Culvert Calculator Report
G0 100-yr

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	548.00	ft	Headwater Depth/Height	1.85	
Computed Headwater Elevation	547.39	ft	Discharge	658.00	cfs
Inlet Control HW Elev.	547.39	ft	Tailwater Elevation	518.04	ft
Outlet Control HW Elev.	546.56	ft	Control Type	Inlet Control	

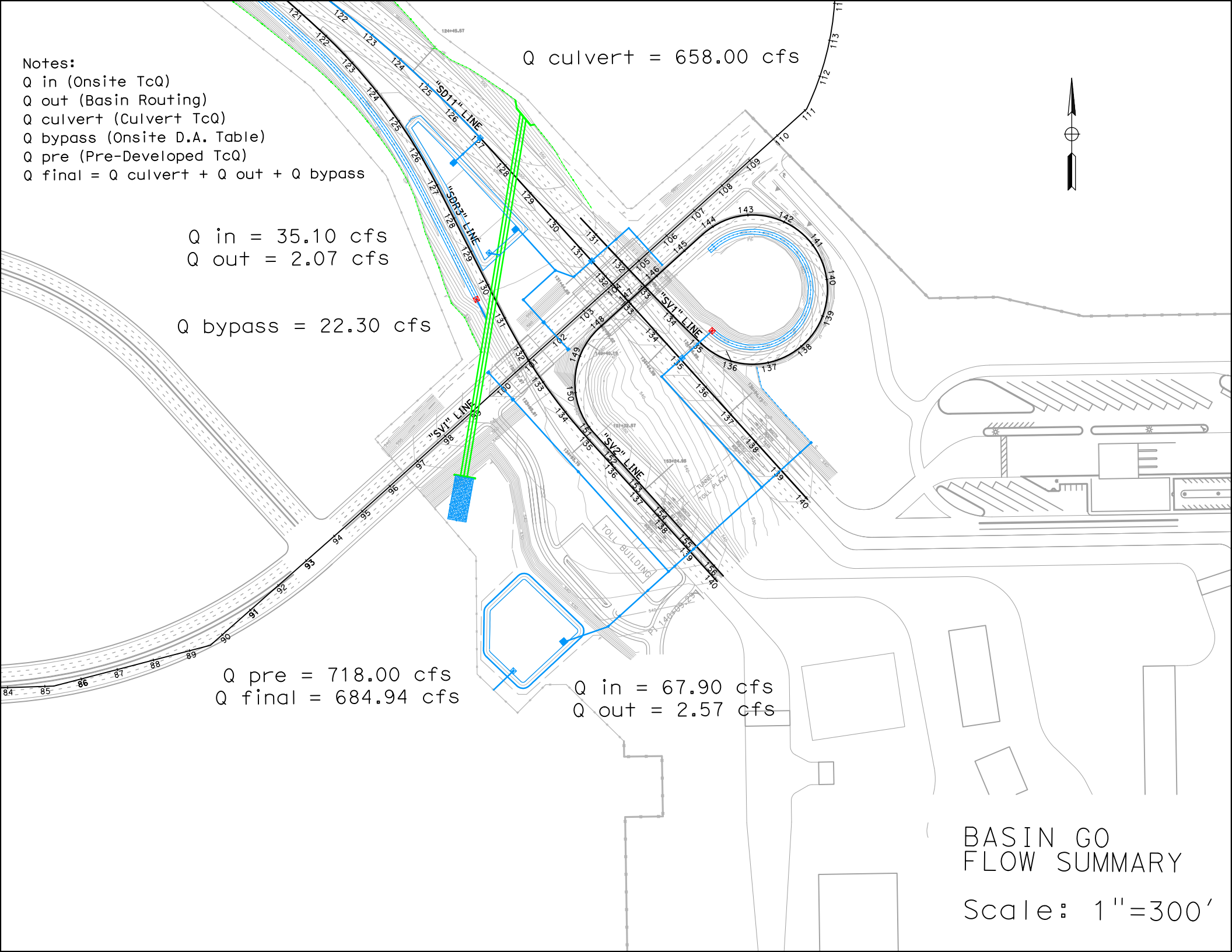
Grades					
Upstream Invert	540.00	ft	Downstream Invert	516.00	ft
Length	1,150.00	ft	Constructed Slope	2.1	%

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	20.17	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.	546.56	ft	Upstream Velocity Head	1.87	ft
Ke	0.50		Entrance Loss	0.94	ft

Inlet Control Properties					
Inlet Control HW Elev.	547.39	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				


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
Q culvert = 658.00 cfs
Q in = 35.10 cfs
Q out = 2.07 cfs
Q bypass = 22.30 cfs
"SD11" LINE
"SDR3" LINE
"SV1" LINE
"SV1" LINE
"SV2" LINE
Q pre = 718.00 cfs
Q final = 684.94 cfs
Q in = 67.90 cfs
Q out = 2.57 cfs
TOLL BUILDING
TUNNEL TOLL PLAZA
BASIN GO
FLOW SUMMARY
Scale: 1"=300'

Basin G0 Retention

PROJECT:	**SR-11**			**DESCRIPTION:**	**SR-11 Basin**
JOB #:	**11A1190**			**STATION:**	**139+00**
BY:	**M.BRUNING**	**DATE:**	**01.05.10**	**WATERSHED:**	**G0**
CHK:	**G.DALZIEL**	**DATE:**		**SYSTEM:**	**No Interchange Option**

Notes:

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

RETENTION VOLUME

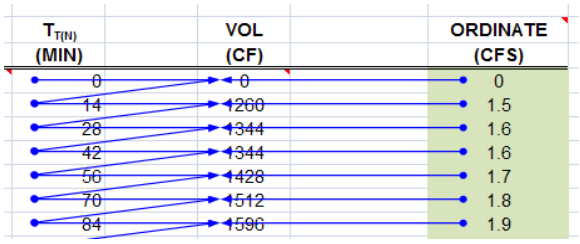
100-year, 6 hour duration storm event, use the Rational Method Hydrograph Procedure (SDCHM 6-1) ~ RatHydro

Pre-Developed volume calculations

Q_{100}= 60.0 cfs
Tc= 17.0 min
$P_{100,6}$= 2.5 in
C= 0.49
A= 41.08 acres

$T_{T(N)}$ (MIN)	VOL (CF)	ORDINATE (CFS)
0	0	0
17	3060	3
34	3162	3.1
51	3468	3.4
68	3570	3.5
85	3876	3.8
102	4080	4
119	4488	4.4
136	4794	4.7
153	5508	5.4
170	5916	5.8
187	7242	7.1
204	8262	8.1
221	12138	11.9
238	17340	17
255	61200	60
272	9792	9.6
289	6528	6.4
306	5100	5
323	4284	4.2
340	3672	3.6
357	3366	3.3
374	0	0

Example of Steps:



SUM= 180846 ft^3
4.15 acre-feet

Check: V = C*A*P_6
V= 4.17 acre-feet
OK

Basin G0 Retention

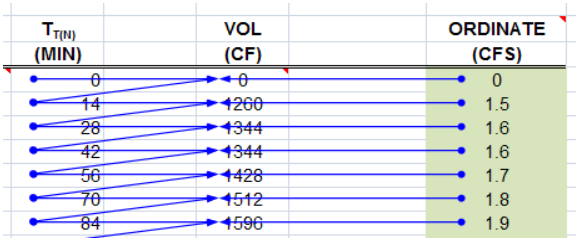
Post-Developed volume calculations

Q_{100}= 128.4 cfs
Tc= 12.3 min
$P_{100,6}$= 2.5 in

C= 0.82
A= 42.38 acres

$T_{T(N)}$ (MIN)	VOL (CF)	ORDINATE (CFS)
0	0	0
12	3744	5.2
24	3816	5.3
36	4032	5.6
48	4104	5.7
60	4320	6
72	4464	6.2
84	4752	6.6
96	4896	6.8
108	5256	7.3
120	5472	7.6
132	5904	8.2
144	6192	8.6
156	6912	9.6
168	7272	10.1
180	8352	11.6
192	9072	12.6
204	11088	15.4
216	12600	17.5
228	18576	25.8
240	27360	38
252	92448	128.4
264	14904	20.7
276	9936	13.8
288	7776	10.8
300	6552	9.1
312	5688	7.9
324	5040	7
336	4608	6.4
348	4248	5.9
360	3888	5.4
372	0	0

Example of Steps:



SUM= 313272 ft^3
7.19 acre-feet

Check: V = C*A*P_6
V= 7.27 acre-feet
OK

Retention volume = 7.19
- 4.15
= 3.04 acre-feet = 132426 ft^3 Basin Required

Basin G0 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 — Max C from North/South Onsite
A= 25.95 acres — Sum of North/South Onsite Area

WQ_{72}: 0.73 in/area

Water Quality Volume (WQV) = **68772** **ft³**

WQV to be added to retention volume = **0** **ft³** **WQV is within Retention**

If the WQV 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: 511000 ft²
A: 11.73 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 = 182.44 tons

Universal Soil Loss Equation (SDCHM 5.2.3)

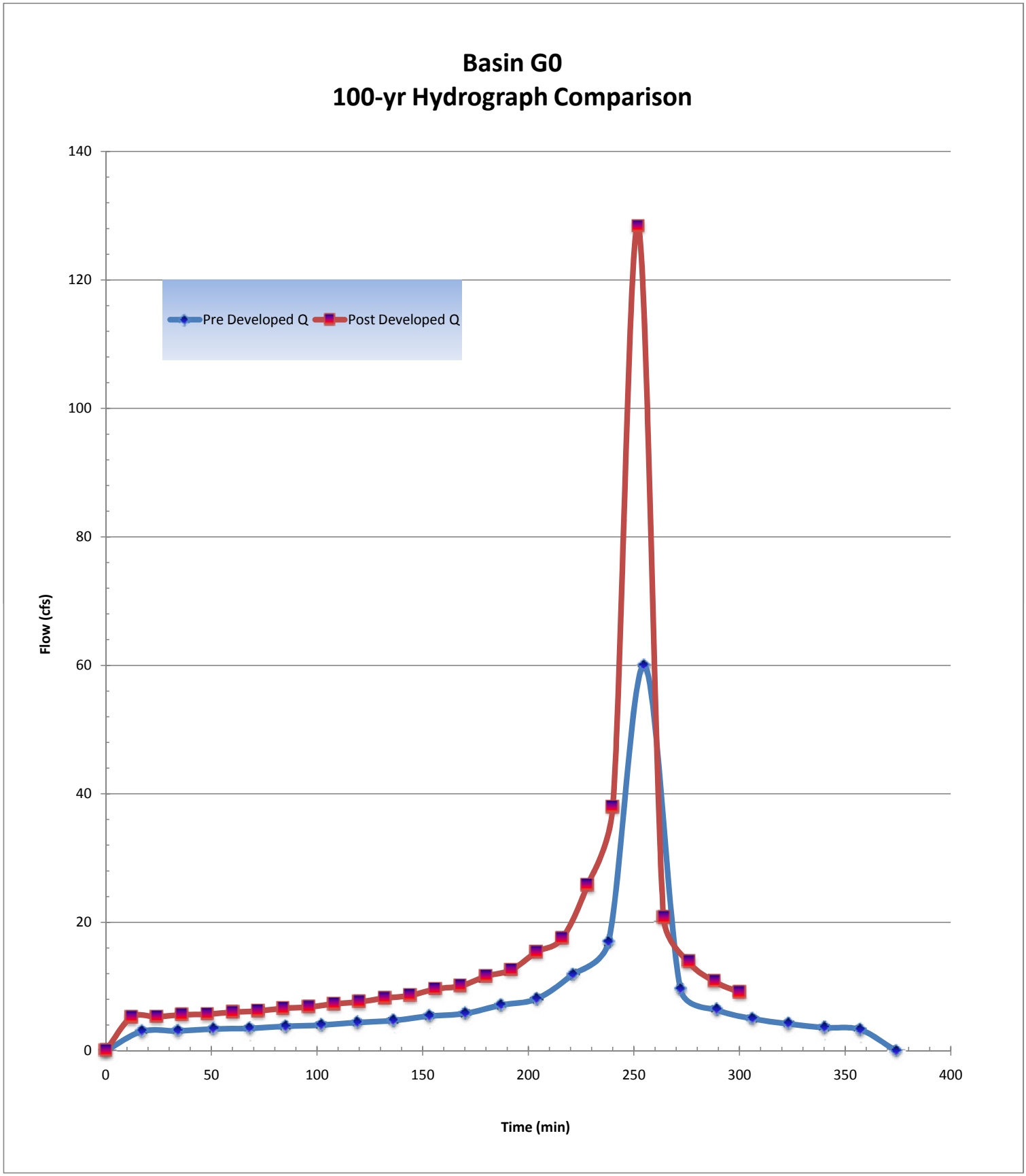
$A_s = RKLsCP$

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 = **4054** **ft³** **Add this volume to Basin**

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


Basin G0
100-yr Hydrograph Comparison
Pre Developed Q
Post Developed Q
Flow (cfs)
Time (min)
0
20
40
60
80
100
120
140
0
50
100
150
200
250
300
350
400

Basin G0-North Inflow TcQ

PROJECT:	**SR-11**			**DESCRIPTION:**	**SR-11 Basin**
JOB #:	**11A1190**			**STATION:**	**125+50**
BY:	**M.BRUNING**	**DATE:**	**01.05.10**	**WATERSHED:**	**G0**
CHK:	**G.DALZIEL**	**DATE:**		**SYSTEM:**	**Basin G0-North**

BASIN AREA:

A = **362700** **ft^2** **SOURCE:** **MICROSTATION/USGS**
8.33 **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	72%	AT	0.90	0.650
COMMERCIAL AREA	0%	AT	0.85	0.000
CUT SLOPE (2:1 and 4:1)	28%	AT	0.55	0.153
TOTAL	100%			
	(100%)			

$C_{2,10}$ =	0.80
C_{25} =	0.88
C_{50} =	0.96
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	565.0	ft	From asphalt, superelevation
LOW POINT ELEVATION	563.0	ft	
ELEVATION DIFF (H)	2.0	ft	
LENGTH (L)	76	ft	
SLOPE (S) = (H/L)	2.6%		
MANNING'S n	0.016		< = FROM TABLE 816.6A Asphalt Paving
T_t (SFF)=	1.57	minutes	

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

NOTES:

HIGH PT ELEVATION	563.0	ft	assumed SCF and not channelized or flowing full yet
LOW POINT ELEVATION	561.0	ft	
ELEVATION DIFF (H)	2.0	ft	
LENGTH (L)	200	ft	
SLOPE (S) = (H/L)	1.0%		
VELOCITY (SCF)	1.3	fps	<=V FROM FIG 816.5 nearly bare ground
T_c (SH)=	2.67	minutes	

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

NOTES:

HIGH PT ELEVATION	561.0	ft	median ditch
LOW POINT ELEVATION	557.0	ft	CHANNEL DATA TYPE = TRAP'Z
ELEVATION DIFF (H)	4.0	ft	Z= 4 ANG-RAD 0.245
LENGTH (L)	300	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)	2.12	fps	From Manning's Equation assuming flowing full: $V=1.49/n(R^{2/3}S^{1/2})$
T_c (CH)=	2.35	minutes	

Basin G0-North Inflow TcQ

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

HIGH PT ELEVATION	552.0	ft
LOW POINT ELEVATION	546.0	ft
ELEVATION DIFF (H)	6.0	ft
LENGTH (L)	700	ft
SLOPE (S) = (H/L)	0.9%	
MANNING'S n	0.013	
PIPE DIAMETER d	2.0	ft
HYDRAULIC RADIUS R	0.5	ft
VELOCITY (STORMDRAIN)	6.7	fps
T_C (SD)=	1.75	minutes

NOTES:

Proposed storm drain through median (elev at pipe invert)
Sta 127+00 - basin G0-1
RCP
R=D/4, Assume: flowing full
$V = \frac{K_u}{n} R^{2/3} S^{1/2}$

Tc (TOTAL) =	8.33	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 =	**Q_2 =**	12.4
i_{10} =	2.7	in/hr	X CA =	**Q_{10} =**	18.0
i_{25} =	3.4	in/hr	X CA =	**Q_{25} =**	24.8
i_{50} =	4.0	in/hr	X CA =	**Q_{50} =**	32.4
i_{100} =	4.2	in/hr	X CA =	**Q_{100} =**	**35.1**

FLOW RESULTS:

	cfs
Q_2 =	12.4
Q_{10} =	18.0
Q_{25} =	24.8
Q_{50} =	32.4
Q_{100} =	**35.1**

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 G0North Inflow Hydrograph

PROJECT:	**SR-11**			**DESCRIPTION:**	**SR-11 Basin**
JOB #:	**11A1190**			**STATION:**	**125+50 - 129+50**
BY:	**M.BRUNING**	**DATE:**	**01.06.10**	**WATERSHED:**	**G0**
CHK:	**G.DALZIEL**	**DATE:**		**SYSTEM:**	**No Interchange Option**

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

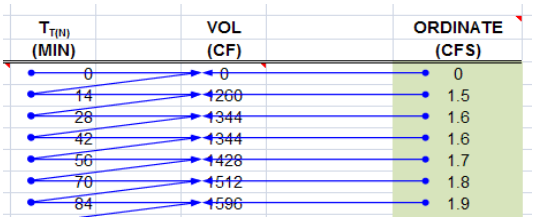
Basin Inflow Hydrograph

Basin Inflow Q

Q_{100}=	35.1	cfs	C_{100}=	1.00	
Tc=	10.0	min	A=	8.33	acres
$P_{100,6}$=	2.5	in			

$T_{T(N)}$ (MIN)	VOL (CF)	ORDINATE (CFS)
0	0	0
10	720	1.2
20	780	1.3
30	780	1.3
40	780	1.3
50	840	1.4
60	840	1.4
70	900	1.5
80	900	1.5
90	960	1.6
100	1020	1.7
110	1080	1.8
120	1080	1.8
130	1200	2
140	1200	2
150	1320	2.2
160	1380	2.3
170	1560	2.6
180	1620	2.7
190	1860	3.1
200	2040	3.4
210	2520	4.2
220	2820	4.7
230	4140	6.9
240	5880	9.8
250	21060	35.1
260	3360	5.6
270	2220	3.7
280	1740	2.9
290	1440	2.4
300	1260	2.1
310	1140	1.9
320	1020	1.7
330	960	1.6
340	900	1.5
350	840	1.4
360	780	1.3
370	0	0

Example of Steps:



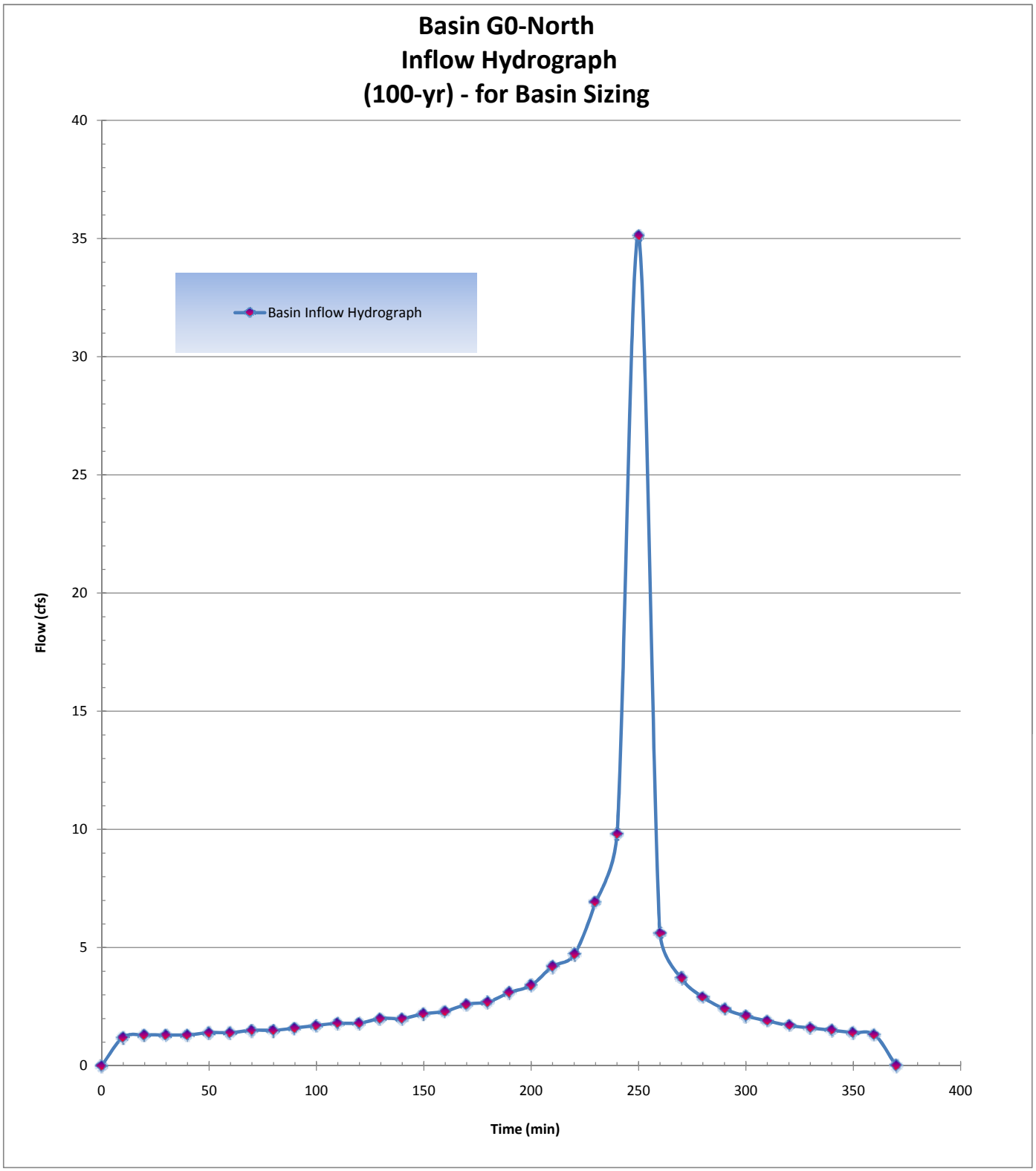
SUM= 74940 ft³
1.72 acre-feet

Onsite Runoff Volume

Check: $V = C*A*P_6$

V= 1.73 acre-feet

OK


Basin G0-North
Inflow Hydrograph
(100-yr) - for Basin Sizing
Basin Inflow Hydrograph
Flow (cfs)
Time (min)
0
5
10
15
20
25
30
35
40
0
50
100
150
200
250
300
350
400

Basin G0-North Outlet

PROJECT:	**SR-11**			**DESCRIPTION:**	**SR-11 Basin**
JOB #:	**11A1190**			**STATION:**	**129+50**
BY:	**M.BRUNING**	**DATE:**	**02.19.10**	**WATERSHED:**	**G0**
CHK:	**G.DALZIEL**	**DATE:**		**SYSTEM:**	**Basin G0-North**

Notes:

Volumes:

Required Retention Basin Volume =	136480	ft^3	from G0-ALL
Retention volume from this basin =	46802		at 2.6' depth, see G0-South for remainder of storage
Actual Basin Inflow =	74940	ft^4	*OK*

Flow Balance - determine maximum flow from basin

Predeveloped Peak 100-year Flow:	60.0	cfs	from G0-ALL
Post-Developed Peak Flow through Cross Culvert:	0.0	cfs	Independent of Culvert G0
Flow that does not reach detention basin (bypass per DA table):	22.3	cfs	Q_{100} from: G0.8.PVG0.22.PVG0.8.SLG0.22.SLG0.24.SLG0.25.SL
Maximum flow allowed to be released by this detention basin:	12.9	cfs	*34%* of G0-ALL (per retention ratios)

Outlet Pipe

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

Basin - Top of basin berm elevation =			546.40	ft
Basin flowline elevation =			542.00	ft
Maximum Basin Depth =			4.40	ft
Assume Culvert Design: free outfall, square-edge w/headwall				
Outlet pipe invert from basin floor =	2.60	ft	544.60	ft
Outlet pipe diameter =	2	ft		

Basin Characteristics

Base Length (L)	200	ft	L/2 due to sloped floor
Base Width (W)	75	ft	average width
W/L Ratio ®	0.38		
Side Slopes (Z)	1: 4		
Total Volume (V):	89047	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	542.00	0.00	0	0		542.00	0.00		0.00
1	542.20	0.20	3044	3044		542.20	0.00		0.00
2	542.40	0.40	3133	6178		542.40	0.00		0.00
3	542.60	0.60	3223	9401		542.60	0.00		0.00
4	542.80	0.80	3314	12715		542.80	0.00		0.00
5	543.00	1.00	3406	16122		543.00	0.00		0.00
6	543.20	1.20	3499	19621		543.20	0.00		0.00
7	543.40	1.40	3593	23215		543.40	0.00		0.00
8	543.60	1.60	3688	26903		543.60	0.00		0.00
9	543.80	1.80	3784	30687		543.80	0.00		0.00
10	544.00	2.00	3881	34568		544.00	0.00		0.00
11	544.20	2.20	3979	38547		544.20	0.00		0.00
12	544.40	2.40	4078	42625		544.40	0.00		0.00
13	544.60	2.60	4177	46802	*	544.60	0.00		0.00
14	544.80	2.80	4278	51080		544.80	0.15		0.15
15	545.00	3.00	4380	55460		545.00	0.59		0.59
16	545.20	3.20	4482	59943		545.20	1.30		1.30
17	545.40	3.40	4586	64529		545.40	2.25		2.25
18	545.60	3.60	4691	69219		545.60	3.42		3.42
19	545.80	3.80	4796	74016		545.80	4.79		4.79
20	546.00	4.00	4903	78918		546.00	6.32		6.32
21	546.20	4.20	5010	83929		546.20	7.99		7.99
22	546.40	4.40	5119	89047		546.40	9.77		9.77
								0.00	

Basin G0-North Routing

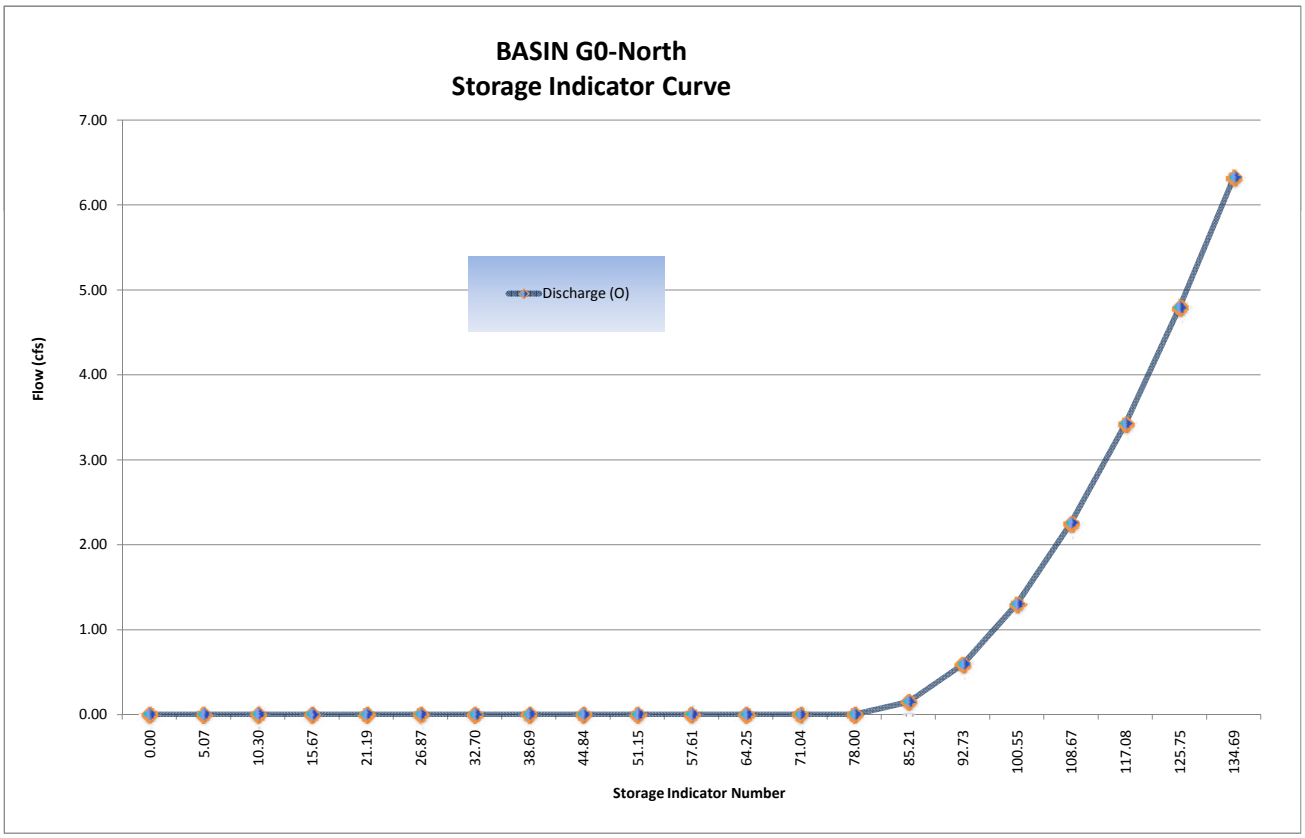
PROJECT:	**SR-11**			**DESCRIPTION:**	**SR-11 Basin**
JOB #:	**11A1190**			**STATION:**	**129+50**
BY:	**M.BRUNING**	**DATE:**	**02.19.10**	**WATERSHED:**	**G0**
CHK:	**G.DALZIEL**	**DATE:**		**SYSTEM:**	**Basin G0-North**

user input
linked input

STORAGE INDICATOR NUMBERS TABLE

					Storage Indicator #
(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)
542.00	0.00	0	0.00	0.00	0.00
542.20	0.00	3044	0.00	5.07	5.07
542.40	0.00	6178	0.00	10.30	10.30
542.60	0.00	9401	0.00	15.67	15.67
542.80	0.00	12715	0.00	21.19	21.19
543.00	0.00	16122	0.00	26.87	26.87
543.20	0.00	19621	0.00	32.70	32.70
543.40	0.00	23215	0.00	38.69	38.69
543.60	0.00	26903	0.00	44.84	44.84
543.80	0.00	30687	0.00	51.15	51.15
544.00	0.00	34568	0.00	57.61	57.61
544.20	0.00	38547	0.00	64.25	64.25
544.40	0.00	42625	0.00	71.04	71.04
544.60	0.00	46802	0.00	78.00	78.00
544.80	0.15	51080	0.08	85.13	85.21
545.00	0.59	55460	0.30	92.43	92.73
545.20	1.30	59943	0.65	99.90	100.55
545.40	2.25	64529	1.13	107.55	108.67
545.60	3.42	69219	1.71	115.37	117.08
545.80	4.79	74016	2.40	123.36	125.75
546.00	6.32	78918	3.16	131.53	134.69
546.20	7.99	83929	4.00	139.88	143.88
546.40	9.77	89047	4.89	148.41	153.30

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



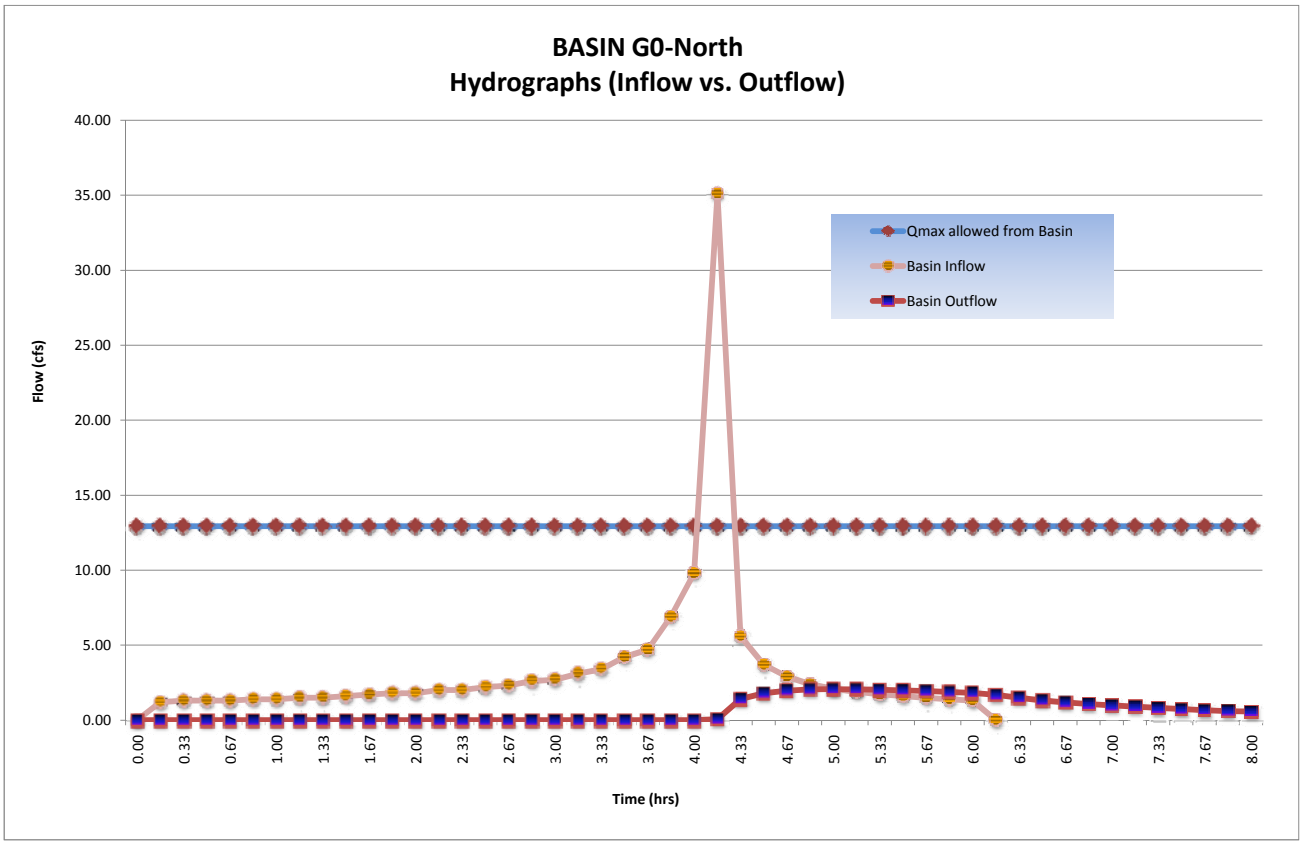
Basin G0-North Routing

FINAL ROUTING TABLE

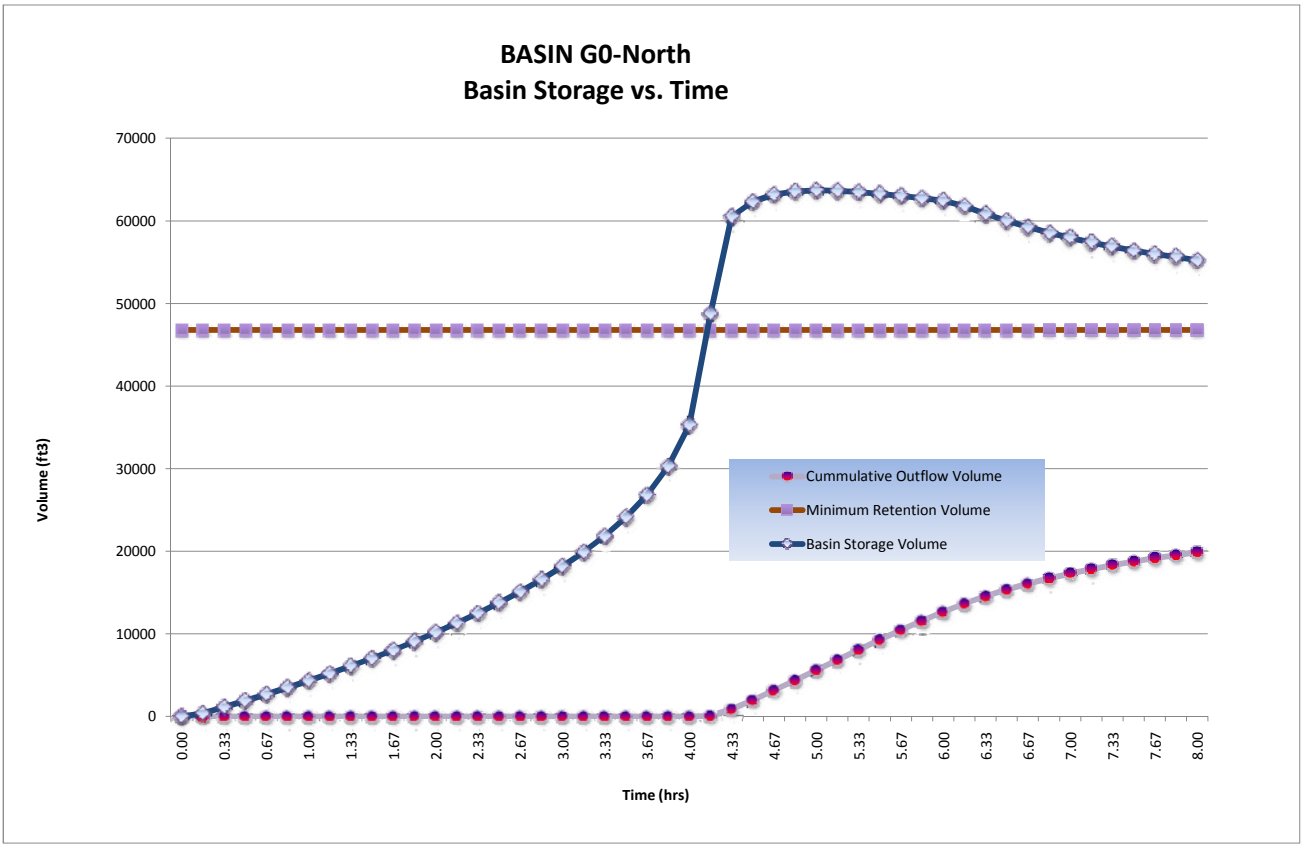
$$\frac{I_1 + I_2}{2} + \left(\frac{S_1}{\Delta t} - \frac{O_1}{2}\right) - O_1 = \left(\frac{S_2}{\Delta t} + \frac{O_2}{2}\right)$$

					Storage Indicator #			Volumes (ft3)		
(1) Time (hrs)	(2) Inflow (cfs) (Q_{post})	(3) $(I_1+I_2)/2$ (cfs)	(4) $(S_1/\Delta t + O_1/2)$ (cfs)	(5) O_1 (cfs)	(6) $S_2/\Delta t + O_2/2$ (cfs)	(7) O_2 (cfs)		Basin Storage *Volume*	Incremental Outflow *Volume*	Cummulative Outflow *Volume*
			col (6) from prev row	*col (7) from prev row*	*col (3)+(4)-(5)*	*(Hard input)*				
0.00	0.00	0.00	0.00	0.00	0.00	0.00		0	0	0
0.17	1.20	0.60	0.00	0.00	0.60	0.00		360	0	0
0.33	1.30	1.25	0.60	0.00	1.85	0.00		1110	0	0
0.50	1.30	1.30	1.85	0.00	3.15	0.00		1890	0	0
0.67	1.30	1.30	3.15	0.00	4.45	0.00		2670	0	0
0.83	1.40	1.35	4.45	0.00	5.80	0.00		3480	0	0
1.00	1.40	1.40	5.80	0.00	7.20	0.00		4320	0	0
1.17	1.50	1.45	7.20	0.00	8.65	0.00		5190	0	0
1.33	1.50	1.50	8.65	0.00	10.15	0.00		6090	0	0
1.50	1.60	1.55	10.15	0.00	11.70	0.00		7020	0	0
1.67	1.70	1.65	11.70	0.00	13.35	0.00		8010	0	0
1.83	1.80	1.75	13.35	0.00	15.10	0.00		9060	0	0
2.00	1.80	1.80	15.10	0.00	16.90	0.00		10140	0	0
2.17	2.00	1.90	16.90	0.00	18.80	0.00		11280	0	0
2.33	2.00	2.00	18.80	0.00	20.80	0.00		12480	0	0
2.50	2.20	2.10	20.80	0.00	22.90	0.00		13740	0	0
2.67	2.30	2.25	22.90	0.00	25.15	0.00		15090	0	0
2.83	2.60	2.45	25.15	0.00	27.60	0.00		16560	0	0
3.00	2.70	2.65	27.60	0.00	30.25	0.00		18150	0	0
3.17	3.10	2.90	30.25	0.00	33.15	0.00		19890	0	0
3.33	3.40	3.25	33.15	0.00	36.40	0.00		21840	0	0
3.50	4.20	3.80	36.40	0.00	40.20	0.00		24120	0	0
3.67	4.70	4.45	40.20	0.00	44.65	0.00		26790	0	0
3.83	6.90	5.80	44.65	0.00	50.45	0.00		30270	0	0
4.00	9.80	8.35	50.45	0.00	58.80	0.00		35280	0	0
4.17	35.10	22.45	58.80	0.00	81.25	0.07		48729	42	42
4.33	5.60	20.35	81.25	0.07	101.53	1.41		60495	846	888
4.50	3.70	4.65	101.53	1.41	104.77	1.79		62325	1074	1962
4.67	2.90	3.30	104.77	1.79	106.28	1.97		63177	1182	3144
4.83	2.40	2.65	106.28	1.97	106.96	2.05		63561	1230	4374
5.00	2.10	2.25	106.96	2.05	107.16	2.07		63675	1242	5616
5.17	1.90	2.00	107.16	2.07	107.09	2.06		63636	1236	6852
5.33	1.70	1.80	107.09	2.06	106.83	2.03		63489	1218	8070
5.50	1.60	1.65	106.83	2.03	106.45	1.99		63273	1194	9264
5.67	1.50	1.55	106.45	1.99	106.01	1.94		63024	1164	10428
5.83	1.40	1.45	106.01	1.94	105.52	1.88		62748	1128	11556
6.00	1.30	1.35	105.52	1.88	104.99	1.82		62448	1092	12648
6.17	0.00	0.65	104.99	1.82	103.82	1.68		61788	1008	13656
6.33		0.00	103.82	1.68	102.14	1.49		60837	894	14550
6.50		0.00	102.14	1.49	100.65	1.31		59997	786	15336
6.67		0.00	100.65	1.31	99.34	1.19		59247	714	16050
6.83		0.00	99.34	1.19	98.15	1.08		58566	648	16698
7.00		0.00	98.15	1.08	97.07	0.98		57948	588	17286
7.17		0.00	97.07	0.98	96.09	0.89		57387	534	17820
7.33		0.00	96.09	0.89	95.20	0.81		56877	486	18306
7.50		0.00	95.20	0.81	94.39	0.74		56412	444	18750
7.67		0.00	94.39	0.74	93.65	0.67		55989	402	19152
7.83		0.00	93.65	0.67	92.98	0.61		55605	366	19518
8.00		0.00	92.98	0.61	92.37	0.57		55251	342	19860

Basin G0-North Routing



Basin G0-North Routing



Detention / Retention Basin Volume Required:	**63,675**	ft^3	
@ Stage:	**545.40**	ft	
Freeboard:	**1.0**	ft	> 1' Freeboard
Final Total Basin Volume Provided:	**89,047**	ft^3	Basin **G0-North**
Maximum flow rate released from this basin:	**2.07**	cfs	

Basin G0-South Inflow TcQ

PROJECT:	**SR-11**			**DESCRIPTION:**	**SR-11 Basin**
JOB #:	**11A1190**			**STATION:**	**139+00**
BY:	**M.BRUNING**	**DATE:**	**01.05.10**	**WATERSHED:**	**G0**
CHK:	**G.DALZIEL**	**DATE:**		**SYSTEM:**	**Basin G0-South**

BASIN AREA:

A = **767800** **ft^2** **SOURCE:** **MICROSTATION/USGS**
17.63 **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	52%	AT	0.90	0.467
COMMERCIAL AREA	0%	AT	0.85	0.000
CUT SLOPE (2:1 and 4:1)	48%	AT	0.55	0.264
TOTAL	100%			
	(100%)			

$C_{2,10}$ =	0.73
C_{25} =	0.80
C_{50} =	0.88
C_{100} =	0.91

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	544.0	ft	From median, north of SV Line
LOW POINT ELEVATION	542.0	ft	
ELEVATION DIFF (H)	2.0	ft	
LENGTH (L)	60	ft	
SLOPE (S) = (H/L)	3.3%		
MANNING'S n	0.050		< = FROM TABLE 816.6A Fallow
T_t (SFF)=	2.94	minutes	

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

NOTES:

HIGH PT ELEVATION	542.0	ft	assumed SCF and not channelized or flowing full yet
LOW POINT ELEVATION	539.0	ft	
ELEVATION DIFF (H)	3.0	ft	
LENGTH (L)	183	ft	
SLOPE (S) = (H/L)	1.6%		
VELOCITY (SCF)	0.8	fps	<=V FROM FIG 816.5 short grass
T_c (SH)=	3.81	minutes	

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

NOTES:

HIGH PT ELEVATION	539.0	ft	median ditch
LOW POINT ELEVATION	537.0	ft	
ELEVATION DIFF (H)	2.0	ft	
LENGTH (L)	112	ft	
SLOPE (S) = (H/L)	1.8%		
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)	2.46	fps	From Manning's Equation assuming flowing full: $V=1.49/n(R^{2/3}S^{1/2})$
T_c (CH)=	0.76	minutes	

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

Basin G0-South Inflow TcQ

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

NOTES:

HIGH PT ELEVATION	532.0	ft	
LOW POINT ELEVATION	525.0	ft	
ELEVATION DIFF (H)	7.0	ft	
LENGTH (L)	472	ft	
SLOPE (S) = (H/L)	1.5%		
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)	11.5	fps	$V = \frac{K_u}{n} R^{2/3} S^{1/2}$
T_C (SD)=	0.68	minutes	

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

NOTES:

HIGH PT ELEVATION	525.0	ft	Proposed storm to basin
LOW POINT ELEVATION	512.0	ft	
ELEVATION DIFF (H)	13.0	ft	
LENGTH (L)	680	ft	
SLOPE (S) = (H/L)	1.9%		
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)	13.1	fps	$V = \frac{K_u}{n} R^{2/3} S^{1/2}$
T_C (SD)=	0.87	minutes	

Tc (TOTAL) =	9.06	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 =	**Q_2 =**	23.9
i_{10} =	2.7	in/hr	X CA =	**Q_{10} =**	34.8
i_{25} =	3.4	in/hr	X CA =	**Q_{25} =**	47.8
i_{50} =	4.0	in/hr	X CA =	**Q_{50} =**	62.6
i_{100} =	4.2	in/hr	X CA =	**Q_{100} =**	**67.9**

FLOW RESULTS:

cfs

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 G0South Inflow Hydrograph

PROJECT:	**SR-11**			**DESCRIPTION:**	**SR-11 Basin**
JOB #:	**11A1190**			**STATION:**	**137+00 - 139+00**
BY:	**M.BRUNING**	**DATE:**	**01.05.10**	**WATERSHED:**	**G0**
CHK:	**G.DALZIEL**	**DATE:**		**SYSTEM:**	**Basin G0-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

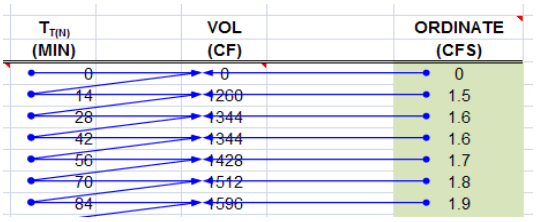
Basin Inflow Hydrograph

Basin Inflow Q

Q_{100}=	67.9	cfs	C_{100}=	0.91	
Tc=	10.0	min	A=	17.63	acres
$P_{100,6}$=	2.5	in			

$T_{T(N)}$ (MIN)	VOL (CF)	ORDINATE (CFS)
0	0	0
10	1440	2.4
20	1440	2.4
30	1500	2.5
40	1560	2.6
50	1620	2.7
60	1680	2.8
70	1740	2.9
80	1800	3
90	1860	3.1
100	1920	3.2
110	2040	3.4
120	2100	3.5
130	2280	3.8
140	2340	3.9
150	2580	4.3
160	2700	4.5
170	3000	5
180	3180	5.3
190	3600	6
200	3900	6.5
210	4800	8
220	5460	9.1
230	8040	13.4
240	11100	18.5
250	40740	67.9
260	6420	10.7
270	4320	7.2
280	3360	5.6
290	2820	4.7
300	2460	4.1
310	2220	3.7
320	1980	3.3
330	1800	3
340	1680	2.8
350	1560	2.6
360	1500	2.5
370	0	0

Example of Steps:



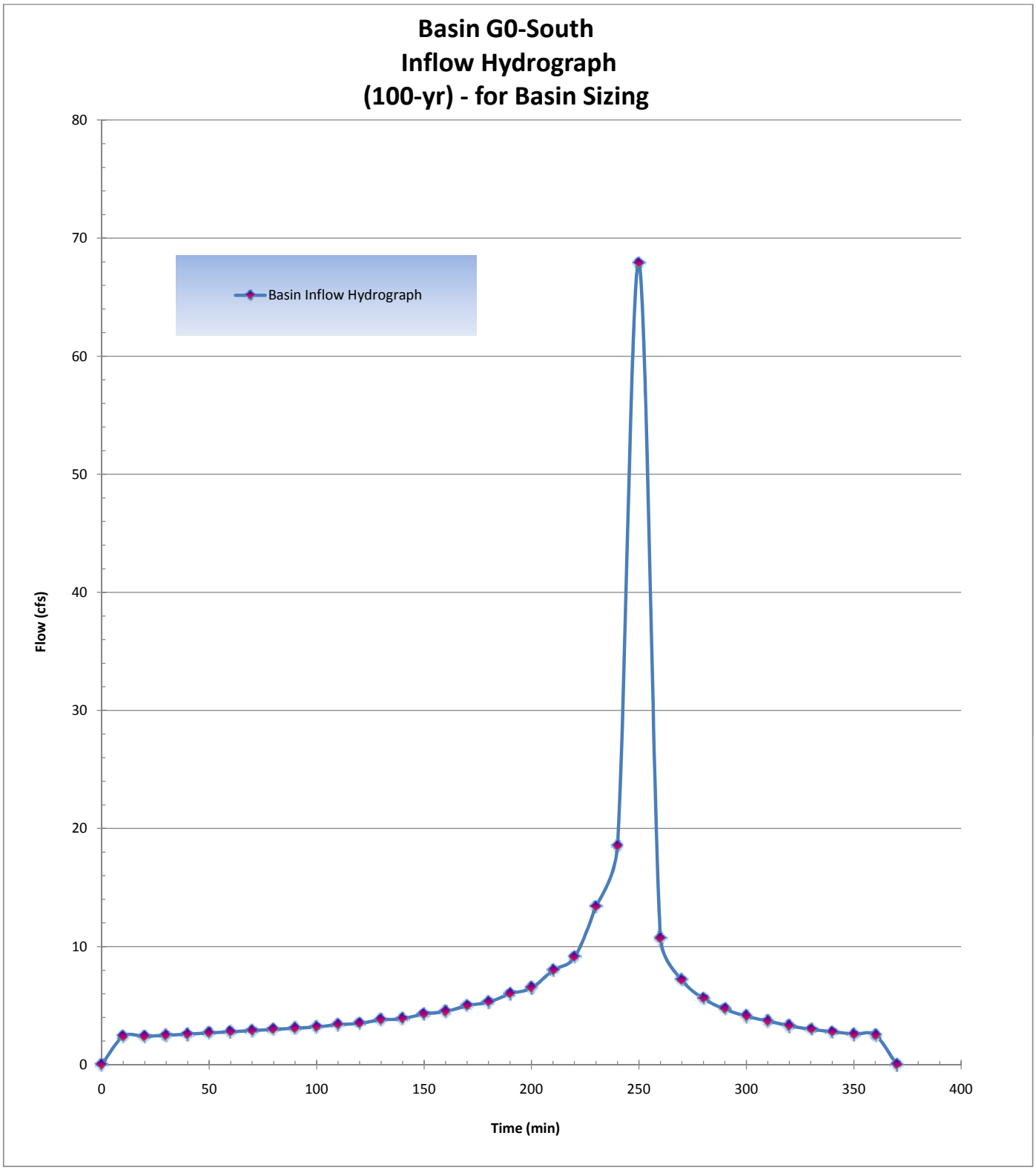
SUM= 144540 ft^3
3.32 acre-feet

Onsite Runoff Volume

Check: $V = C*A*P_6$

V= 3.36 acre-feet

OK


Basin G0-South
Inflow Hydrograph
(100-yr) - for Basin Sizing
Basin Inflow Hydrograph
Flow (cfs)
Time (min)
0
10
20
30
40
50
60
70
80
0
50
100
150
200
250
300
350
400

Basin G0-South Outlet

PROJECT:	**SR-11**			**DESCRIPTION:**	**SR-11 Basin**
JOB #:	**11A1190**			**STATION:**	**137+00**
BY:	**M.BRUNING**	**DATE:**	**02.19.10**	**WATERSHED:**	**G0-South**
CHK:	**G.DALZIEL**	**DATE:**		**SYSTEM:**	**Basin G0-South**

Notes:

Volumes:

Required Retention Basin Volume =	136480	ft^3	from G0-ALL
Retention volume from G0-North Basin =	46802	ft^4	
Minimum Retention volume from this basin =	89678		balance of required retention for G0-ALL
Actual Basin Inflow =	144540	ft^4	*OK*

Flow Balance - determine maximum flow from basin

Predeveloped Peak 100-year Flow:	60.0	cfs	from G0-ALL
Post-Developed Peak Flow through Cross Culvert:	0.0	cfs	Independent of Culvert G0
Flow that does not reach detention basin (bypass per DA table):	22.3	cfs	Q_{100} from: G0.8.PVG0.22.PVG0.8.SLG0.22.SLG0.24.SLG0.25.SL
Maximum flow to be released by G0-1 basin:	12.9	cfs	*34%* of G0-ALL (per retention ratios)
Maximum flow allowed to be released by this detention basin:	16.3	cfs	*66%* of G0-ALL (per retention ratios)

Outlet Pipe

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

Basin - Top of basin berm elevation =		516.60	ft
Basin flowline elevation =		512.00	ft
Maximum Basin Depth =		4.60	ft

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

Outlet pipe invert from basin floor =	2.60	ft	514.60	ft
Outlet pipe diameter =	2	ft		

Basin Characteristics

Base Length (L)	180	ft	L/2 due to sloped floor
Base Width (W)	180	ft	average
W/L Ratio ®	1.00		
Side Slopes (Z)	1: 4		
Total Volume (V):	181518	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
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	0.00
13	514.60	2.60	8001	94399	*	514.60	0.00		0.00
14	514.80	2.80	8128	102528		514.80	0.15		0.15
15	515.00	3.00	8256	110784		515.00	0.59		0.59
16	515.20	3.20	8384	119168		515.20	1.30		1.30
17	515.40	3.40	8513	127681		515.40	2.25		2.25
18	515.60	3.60	8643	136325		515.60	3.42		3.42
19	515.80	3.80	8774	145099		515.80	4.79		4.79
20	516.00	4.00	8906	154004		516.00	6.32		6.32
21	516.20	4.20	9038	163042		516.20	7.99		7.99
22	516.40	4.40	9171	172213		516.40	9.77		9.77
23	516.60	4.60	9305	181518		516.60	11.63		11.63

Basin G0-South Routing

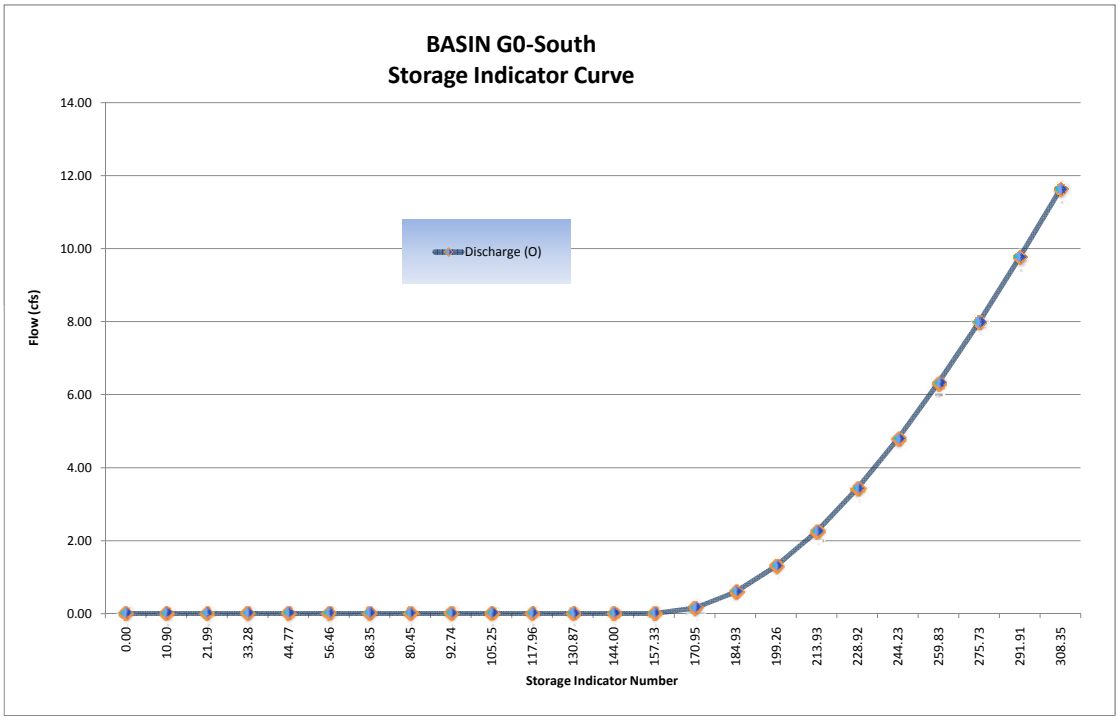
PROJECT:	SR-11			DESCRIPTION:	SR-11 Basin
JOB #:	11A1190			STATION:	137+00
BY:	M.BRUNING	DATE:	02.19.10	WATERSHED:	G0-South
CHK:	G.DALZIEL	DATE:		SYSTEM:	Basin G0-South

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)	*Storage Indicator #* (6) $S_2/delta\ t + O_2/2$ (cfs)
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	0.15	102528	0.08	170.88	170.95
515.00	0.59	110784	0.30	184.64	184.93
515.20	1.30	119168	0.65	198.61	199.26
515.40	2.25	127681	1.13	212.80	213.93
515.60	3.42	136325	1.71	227.21	228.92
515.80	4.79	145099	2.40	241.83	244.23
516.00	6.32	154004	3.16	256.67	259.83
516.20	7.99	163042	4.00	271.74	275.73
516.40	9.77	172213	4.89	287.02	291.91
516.60	11.63	181518	5.82	302.53	308.35

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

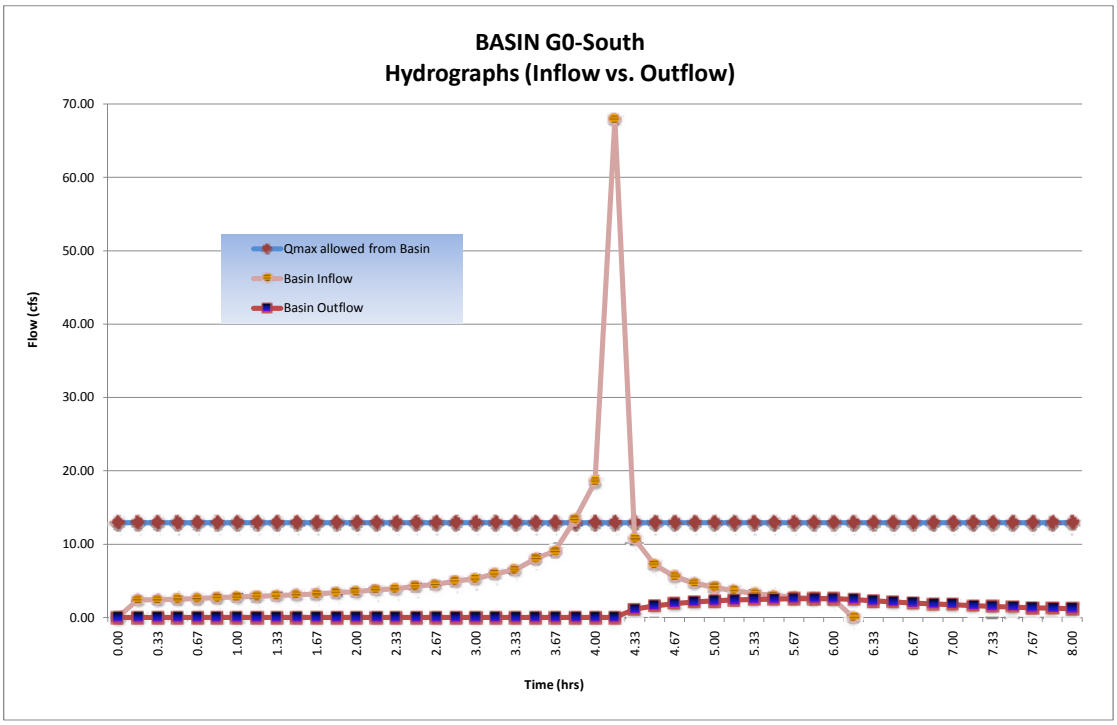


Basin G0-South Routing

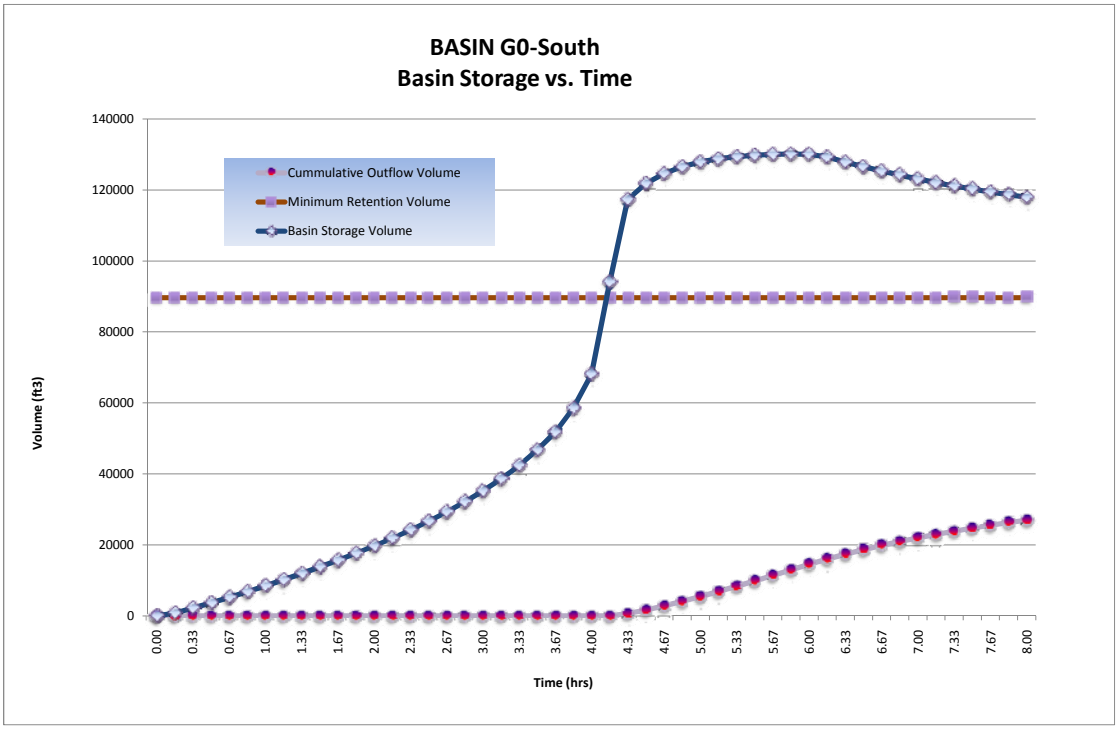
FINAL ROUTING TABLE

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

(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
0.17	2.40	1.20	0.00	0.00	1.20	0.00	720	0	0
0.33	2.40	2.40	1.20	0.00	3.60	0.00	2160	0	0
0.50	2.50	2.45	3.60	0.00	6.05	0.00	3630	0	0
0.67	2.60	2.55	6.05	0.00	8.60	0.00	5160	0	0
0.83	2.70	2.65	8.60	0.00	11.25	0.00	6750	0	0
1.00	2.80	2.75	11.25	0.00	14.00	0.00	8400	0	0
1.17	2.90	2.85	14.00	0.00	16.85	0.00	10110	0	0
1.33	3.00	2.95	16.85	0.00	19.80	0.00	11880	0	0
1.50	3.10	3.05	19.80	0.00	22.85	0.00	13710	0	0
1.67	3.20	3.15	22.85	0.00	26.00	0.00	15600	0	0
1.83	3.40	3.30	26.00	0.00	29.30	0.00	17580	0	0
2.00	3.50	3.45	29.30	0.00	32.75	0.00	19650	0	0
2.17	3.80	3.65	32.75	0.00	36.40	0.00	21840	0	0
2.33	3.90	3.85	36.40	0.00	40.25	0.00	24150	0	0
2.50	4.30	4.10	40.25	0.00	44.35	0.00	26610	0	0
2.67	4.50	4.40	44.35	0.00	48.75	0.00	29250	0	0
2.83	5.00	4.75	48.75	0.00	53.50	0.00	32100	0	0
3.00	5.30	5.15	53.50	0.00	58.65	0.00	35190	0	0
3.17	6.00	5.65	58.65	0.00	64.30	0.00	38580	0	0
3.33	6.50	6.25	64.30	0.00	70.55	0.00	42330	0	0
3.50	8.00	7.25	70.55	0.00	77.80	0.00	46680	0	0
3.67	9.10	8.55	77.80	0.00	86.35	0.00	51810	0	0
3.83	13.40	11.25	86.35	0.00	97.60	0.00	58560	0	0
4.00	18.50	15.95	97.60	0.00	113.55	0.00	68130	0	0
4.17	67.90	43.20	113.55	0.00	156.75	0.00	94050	0	0
4.33	10.70	39.30	156.75	0.00	196.05	1.14	117288	684	684
4.50	7.20	8.95	196.05	1.14	203.86	1.60	121836	960	1644
4.67	5.60	6.40	203.86	1.60	208.66	1.91	124623	1146	2790
4.83	4.70	5.15	208.66	1.91	211.90	2.12	126504	1272	4062
5.00	4.10	4.40	211.90	2.12	214.18	2.27	127827	1362	5424
5.17	3.70	3.90	214.18	2.27	215.81	2.40	128766	1440	6864
5.33	3.30	3.50	215.81	2.40	216.91	2.48	129402	1488	8352
5.50	3.00	3.15	216.91	2.48	217.58	2.54	129786	1524	9876
5.67	2.80	2.90	217.58	2.54	217.94	2.56	129996	1536	11412
5.83	2.60	2.70	217.94	2.56	218.08	2.57	130077	1542	12954
6.00	2.50	2.55	218.08	2.57	218.06	2.57	130065	1542	14496
6.17	0.00	1.25	218.06	2.57	216.74	2.47	129303	1482	15978
6.33		0.00	216.74	2.47	214.27	2.28	127878	1368	17346
6.50		0.00	214.27	2.28	211.99	2.12	126558	1272	18618
6.67		0.00	211.99	2.12	209.87	1.99	125325	1194	19812
6.83		0.00	209.87	1.99	207.88	1.86	124170	1116	20928
7.00		0.00	207.88	1.86	206.02	1.74	123090	1044	21972
7.17		0.00	206.02	1.74	204.28	1.63	122079	978	22950
7.33		0.00	204.28	1.63	202.65	1.52	121134	912	23862
7.50		0.00	202.65	1.52	201.13	1.42	120252	852	24714
7.67		0.00	201.13	1.42	199.71	1.33	119427	798	25512
7.83		0.00	199.71	1.33	198.38	1.26	118650	756	26268
8.00		0.00	198.38	1.26	197.12	1.19	117915	714	26982



Basin G0-South Routing



Detention / Retention Basin Volume Required:	**130,077**	**ft^3**	
@ Stage:	**515.60**	**ft**	
Freeboard:	**1.0**	**ft**	> 1' Freeboard
Final Total Basin Volume Provided:	**181,518**	**ft^3**	Basin **G0-South**
Maximum flow rate released from this basin:	**2.57**	**cfs**	

X0 Onsite D.A. Table

PROJECT:	**SR-11**	**DESCRIPTION:**	**On-site Drainage Areas (D.A.)**
JOB #:	**11A1190**	**STATION:**	**40+00**
BY:	**M.BRUNING** **DATE:** **01.25.10**	**WATERSHED:**	**X**
CHK:	**G.DALZIEL** **DATE:**	**SYSTEM:**	

			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
PAVED	X0.1.PV	0.99	2100	0.0	5	4.0	0.19	6.6	0.31	~	X0.1	bypass*	40+00	Rt
	X0.2.PV	0.99	64500	1.5	5	4.0	5.84	6.6	9.66	~	X0.2	bypass*	40+50	Rt
	X0.3.PV	0.99	2300	0.1	5	4.0	0.21	6.6	0.34	~	X0.3	bypass*	40+00	Lt
	X0.4.PV	0.99	66500	1.5	5	4.0	6.02	6.6	9.96	~	X0.4	bypass*	40+50	Lt

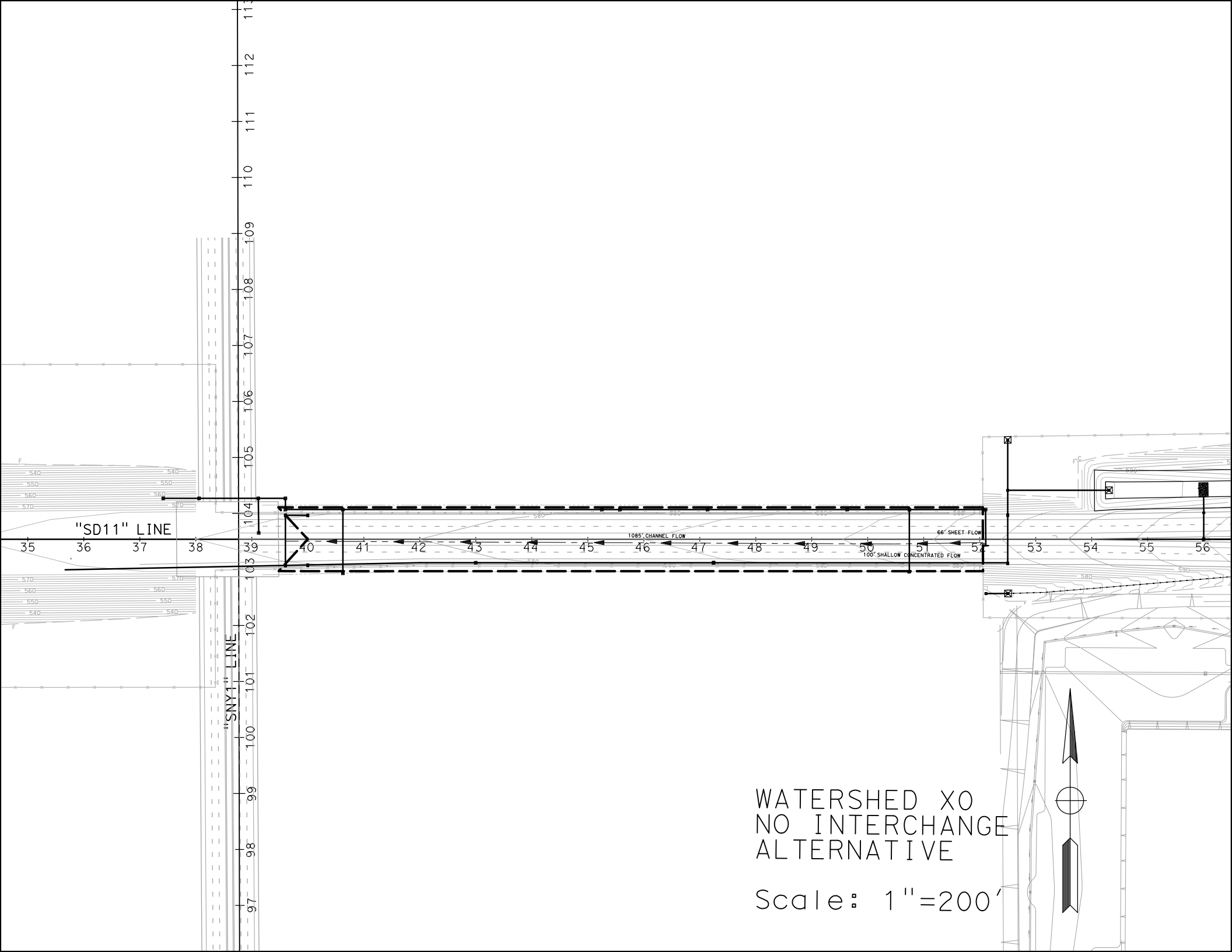
Σ	135400	*PAVED*

			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
SLOPE	X0.5.SL	0.61	5033	0.1	10	2.8	0.20	4.2	0.30	~	X0.5	bypass*	40+00	~

Σ	5033	*SLOPE*

*flow that does not reach the basin

Total :	140433	3.2
	SF	*ac*



WATERSHED X0
NO INTERCHANGE
ALTERNATIVE

Scale: 1"=200'

X0 Post-Developed TcQ

PROJECT:	**SR-11**			**DESCRIPTION:**	**SR-11 Post-Developed**
JOB #:	**11A1190**			**STATION:**	**40+00**
BY:	**M.BRUNING**	**DATE:**	**01.25.10**	**WATERSHED:**	**X0**
CHK:	**G.DALZIEL**	**DATE:**		**SYSTEM:**	**X0**

BASIN AREA:

A = **140433** **ft^2** | **3.22** **acres**

SOURCE: **MICROSTATION/USGS** **(SCALE = 1:1)**

COEFFICIENT OF RUNOFF:

KEY: User Input | Designer Tool

UNDEVELOPED AREA C (FROM HDM FIG. 819.2A)

RELIEF (.08-.35)	0.22	Hilly Slopes ~ 15%
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 =	0.49	

UNDEVELOPED AREA	17%	AT	0.49	0.084
PAVED SURFACE	83%	AT	0.90	0.746
COMMERCIAL AREA	0%	AT	0.85	0.000
CUT SLOPE (2:1 and 4:1)	0%	AT	0.55	0.000
TOTAL	100%			
	(100%)			

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

TIME OF CONCENTRATION:

SHEET FLOW: $T_t = \frac{0.42L^{.8}n^{.8}}{P_2^{.5}s^{.4}}$

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

HIGH PT ELEVATION	587.0	ft	SR-11 at Sta 52 CL
LOW POINT ELEVATION	586.0	ft	
ELEVATION DIFF (H)	1.0	ft	
LENGTH (L)	66	ft	
SLOPE (S) = (H/L)	1.5%		
MANNING'S n	0.016		< = from Table 816.6A HMA
T_t (SFF)=	1.75	minutes	

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

NOTES:

HIGH PT ELEVATION	586.0	ft	assumed not channelized yet
LOW POINT ELEVATION	584.0	ft	
ELEVATION DIFF (H)	2.0	ft	
LENGTH (L)	100	ft	
SLOPE (S) = (H/L)	2.0%		
VELOCITY (SCF)	4.0	fps	<=V FROM FIG 816.6 HMA
T_C (SH)=	0.42	minutes	

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

NOTES:

HIGH PT ELEVATION	584.0	ft	channelizes in shoulder of structure
LOW POINT ELEVATION	578.0	ft	CHANNEL DATA TYPE = TRAP'Z
ELEVATION DIFF (H)	6.0	ft	Z= 20 ANG-RAD 0.050
LENGTH (L)	1085	ft	b = 10 ANG-DEG 2.862
SLOPE (S) = (H/L)	0.6%		d = 0.5 FLOWING FULL ASS'M
MANNING'S n	0.016		HMA
HYDRAULIC RADIUS R	0.3	ft	R=(bdsinA+d^2cosA)/(bsinA+2d)
VELOCITY (CHANNEL)	3.33	fps	From Manning's Equation assuming flowing full: $V=1.49/n(R^{2/3}S^{1/2})$
T_C (CH)=	5.43	minutes	

Tc (TOTAL) =	7.60	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 =	**Q_2 =**	5.0
i_{10} =	2.7	in/hr	X CA =	**Q_{10} =**	7.2
i_{25} =	3.4	in/hr	X CA =	**Q_{25} =**	9.9
i_{50} =	4.0	in/hr	X CA =	**Q_{50} =**	13.0
i_{100} =	4.2	in/hr	X CA =	**Q_{100} =**	**13.6**

FLOW RESULTS:

cfs

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 X0 Retention

PROJECT:	SR-11			**DESCRIPTION:**	SR-11 Basin
JOB #:	11A1190			**STATION:**	40+00
BY:	M.BRUNING	**DATE:**	11.18.09	**WATERSHED:**	X0
CHK:	G.DALZIEL	**DATE:**		**SYSTEM:**	X

Notes:

* The difference between pre-developed and post-developed values gives the approximate volume to detain. Stage-Storage calculations will determine accurate volume

RETENTION BASIN VOLUME

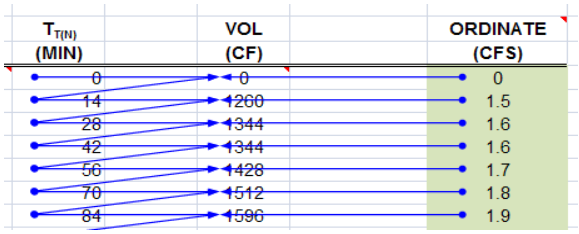
100-year, 6 hour duration storm event, use the Rational Method Hydrograph Procedure (SDCHM 6-1) ~ RatHydro

Pre-Developed volume calculations

Q_{100}=	10.4	cfs			
Tc=	10.0	min	C=	0.76	
$P_{100,6}$=	2.5	in	A=	3.22	acres

$T_{T(N)}$ (MIN)	VOL (CF)	ORDINATE (CFS)
0	0	0
10	240	0.4
20	240	0.4
30	240	0.4
40	240	0.4
50	240	0.4
60	240	0.4
70	240	0.4
80	300	0.5
90	300	0.5
100	300	0.5
110	300	0.5
120	300	0.5
130	360	0.6
140	360	0.6
150	420	0.7
160	420	0.7
170	480	0.8
180	480	0.8
190	540	0.9
200	600	1
210	720	1.2
220	840	1.4
230	1200	2
240	1680	2.8
250	6240	10.4
260	960	1.6
270	660	1.1
280	540	0.9
290	420	0.7
300	360	0.6
310	360	0.6
320	300	0.5
330	300	0.5
340	240	0.4
350	240	0.4
360	240	0.4
370	0	0

Example of Steps:



SUM= 22140 ft^3
0.51 acre-feet

Check: $V = C*A*P_6$
V= 0.51 acre-feet
OK

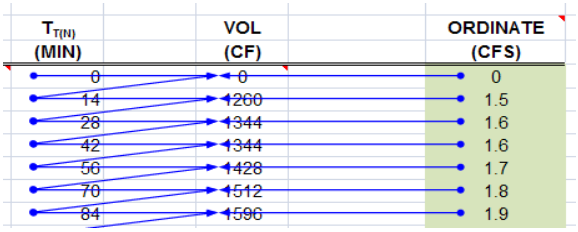
Basin X0 Retention

Post-Developed volume calculations

Q_{100}=	13.6	cfs			
Tc=	10.0	min	C=	1.00	
$P_{100,6}$=	2.5	in	A=	3.22	acres

$T_{T(N)}$ (MIN)	VOL (CF)	ORDINATE (CFS)
0	0	0
10	300	0.5
20	300	0.5
30	300	0.5
40	300	0.5
50	300	0.5
60	360	0.6
70	360	0.6
80	360	0.6
90	360	0.6
100	360	0.6
110	420	0.7
120	420	0.7
130	480	0.8
140	480	0.8
150	540	0.9
160	540	0.9
170	600	1
180	660	1.1
190	720	1.2
200	780	1.3
210	960	1.6
220	1080	1.8
230	1620	2.7
240	2220	3.7
250	8160	13.6
260	1320	2.2
270	840	1.4
280	660	1.1
290	540	0.9
300	480	0.8
310	420	0.7
320	420	0.7
330	360	0.6
340	360	0.6
350	300	0.5
360	300	0.5
370	0	0

Example of Steps:



SUM= 28980 ft^3
0.67 acre-feet

Check: $V = C*A*P_6$
V= 0.67 acre-feet
OK

		0.67			
	-	**0.51**			
Attenuation volume =		**0.16**	**acre-feet**	**=**	**6840 ft^3**

Basin Required
REFER TO BASIN Y

Basin X0 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= 3.22 acres

WQ_{72}: 0.73 in/area

Water Quality Volume (WQV) = **8543** ft^3

WQV to be added to retention volume = **1703** ft^3 **Add this Volume to Basin**

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

Onsite Highway *Sloped* runoff area, A: 5033 ft^2

	A:	0.12	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 = 1.80 tons

Universal Soil Loss Equation (SDCHM 5.2.3)

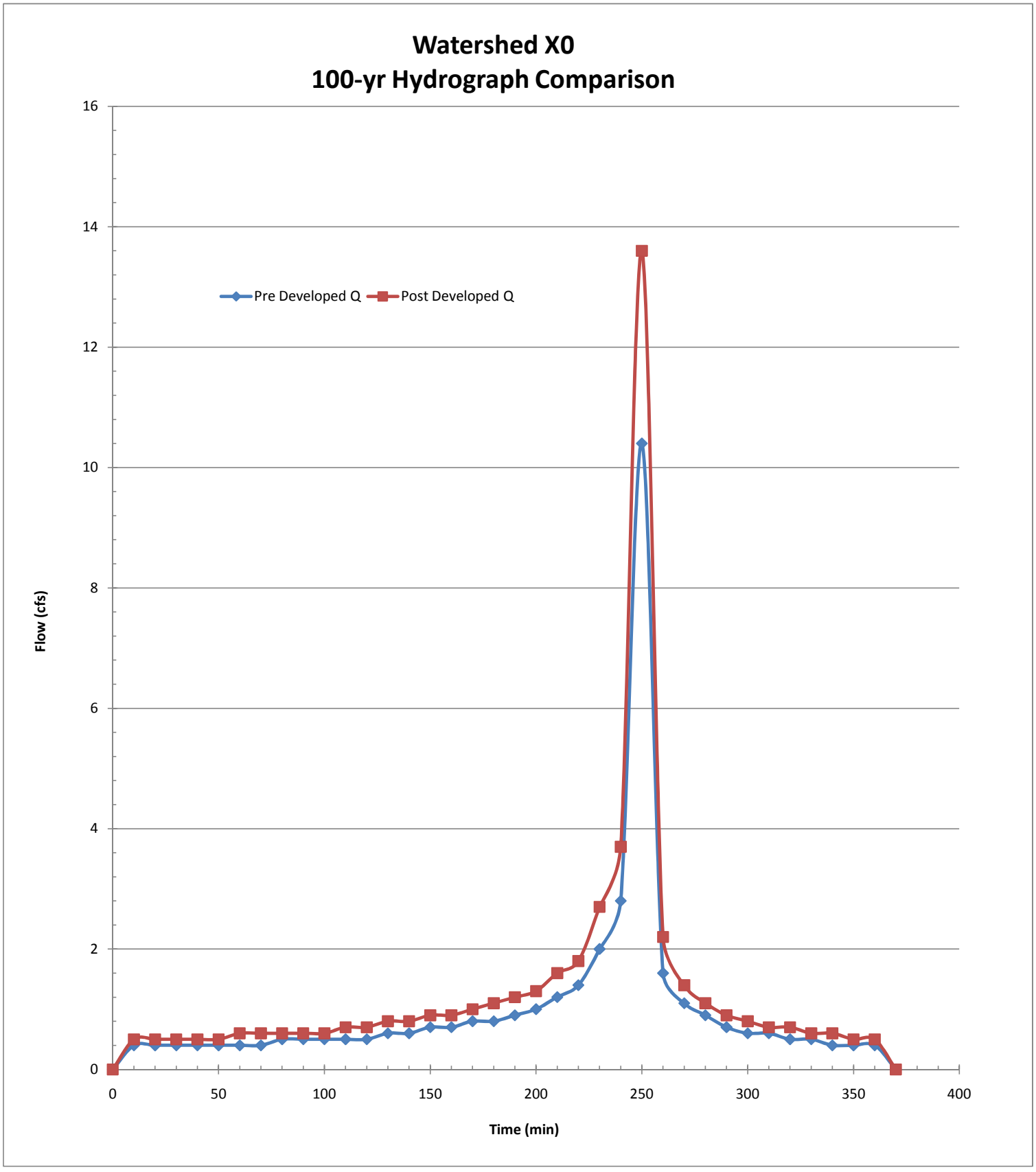
$A_s = RKLsCP$

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 = **40** ft^3

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


Watershed X0
100-yr Hydrograph Comparison
Pre Developed Q
Post Developed Q
Flow (cfs)
Time (min)
0
2
4
6
8
10
12
14
16
0
50
100
150
200
250
300
350
400

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Detention/Retention Basin Flows and Sizes – Zero Interchange Alternative

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)	
X	40+00	10.38	13.58	3.20	22,140	28,980	6,840	~	~	~	Routed to Basin Y-EAST	~	~	~	~	~
A	53+00	23.50	40.19	16.69	50,220	101,712	51,492	55,300	14,456	33,367	103,123	350	30	5.2	1.0	A0
B	69+00	30.80	27.75	(3.06)	124,488	104,250	(20,238)	~	~	~	No Basin Required	~	~	~	~	~
C	78+00	16.38	9.05	(7.33)	35,100	19,380	(15,720)	~	~	~	No Basin Required	~	~	~	~	~
D	80+00	18.54	10.28	(8.25)	42,636	22,260	(20,376)	~	~	~	No Basin Required	~	~	~	~	~
E	96+00	61.90	84.35	22.45	232,050	315,072	83,022	91,237	9,795	63,082	164,115	250	75	6.0	1.8	E0
F	110+00	154.03	168.09	14.06	667,620	704,178	36,558	39,712	40,989	109,528	190,229	265	85	6.0	3.0	F0
G	127+00	59.99	128.37	68.38	180,846	313,272	132,426	46,802	16,873	25,372	89,047	200	75	4.4	1.0	G0-North
	139+00							94,399	35,678	51,441	181,518	180	180	4.6	1.0	G0-South

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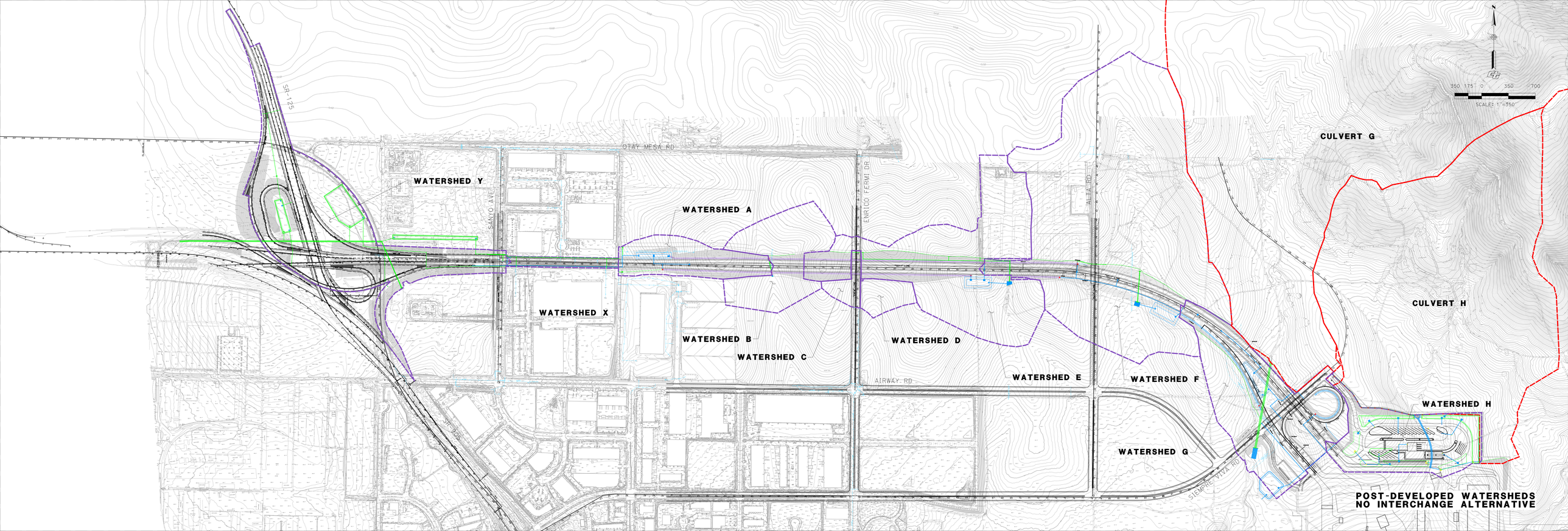
SR-125
OTAY MESA RD
SANYO AVE
ENRICO FERMI DR
ALTA RD
AIRWAY RD
SIEMPRE VIVA RD
SR-905
WATERSHED Y
WATERSHED A
WATERSHED X
WATERSHED B
WATERSHED C
WATERSHED D
WATERSHED E
WATERSHED F
WATERSHED G
WATERSHED H
CULVERT G
CULVERT H
350 175 0 350 700
SCALE: 1" = 350'
POST-DEVELOPED WATERSHEDS
NO INTERCHANGE ALTERNATIVE

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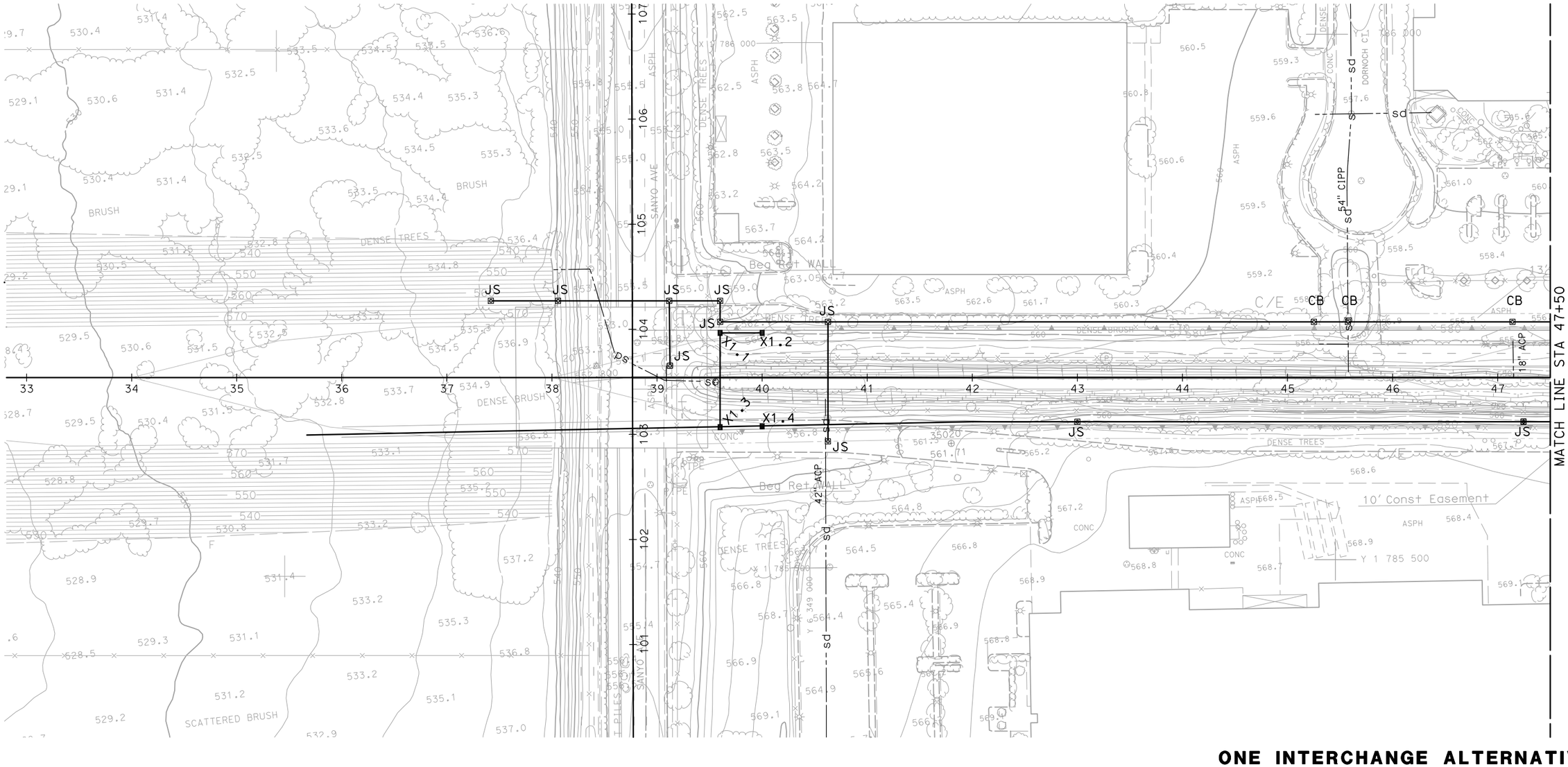
LEGEND:

- JS
- PIPE
- INLET W/APRON
- RSP
- HEADWALL
- ---sd— EXISTING STORMDRAIN



ONE INTERCHANGE ALTERNATIVE
DRAINAGE PLAN

SCALE 1"=50'

D-1

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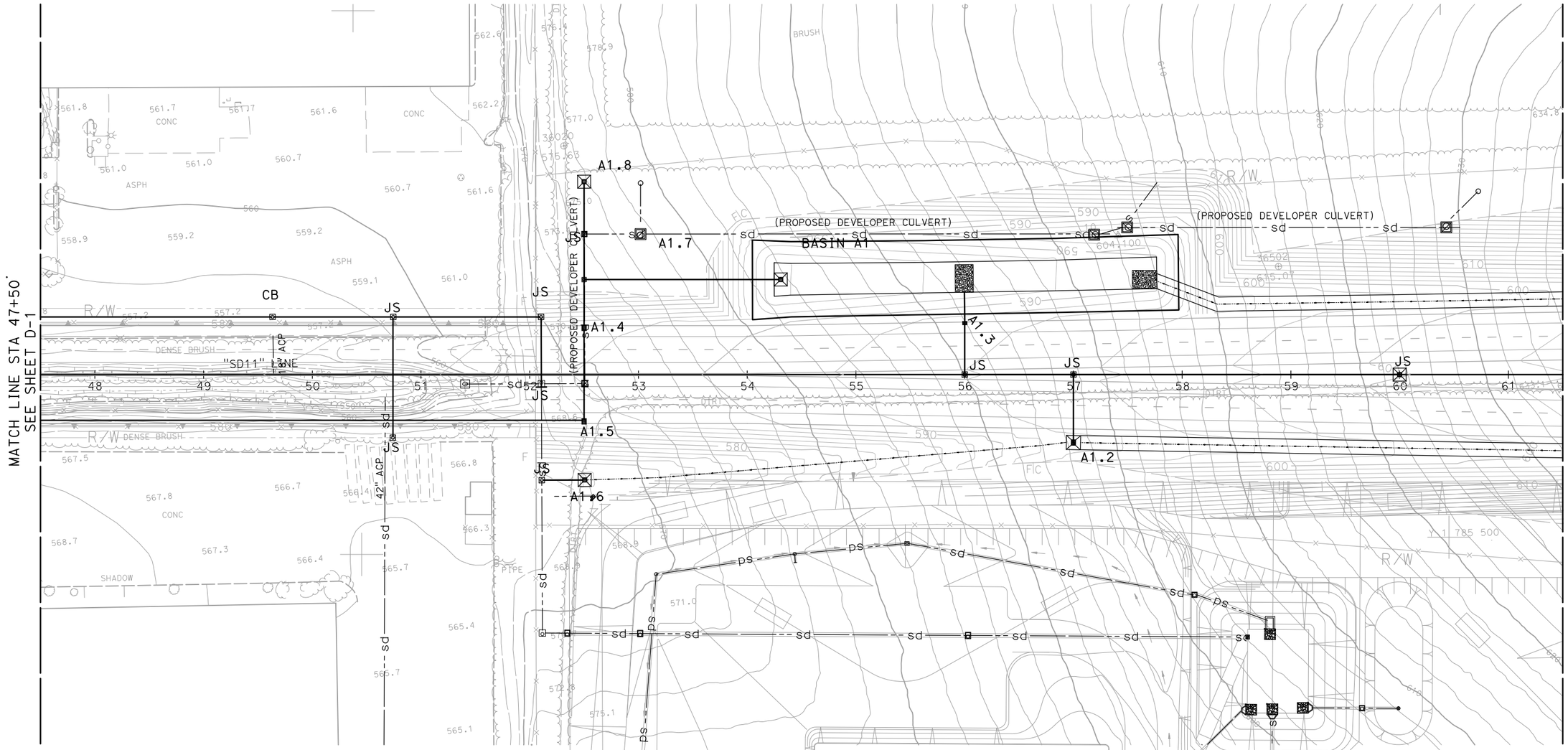

ONE INTERCHANGE ALTERNATIVE
DRAINAGE PLAN
D-2

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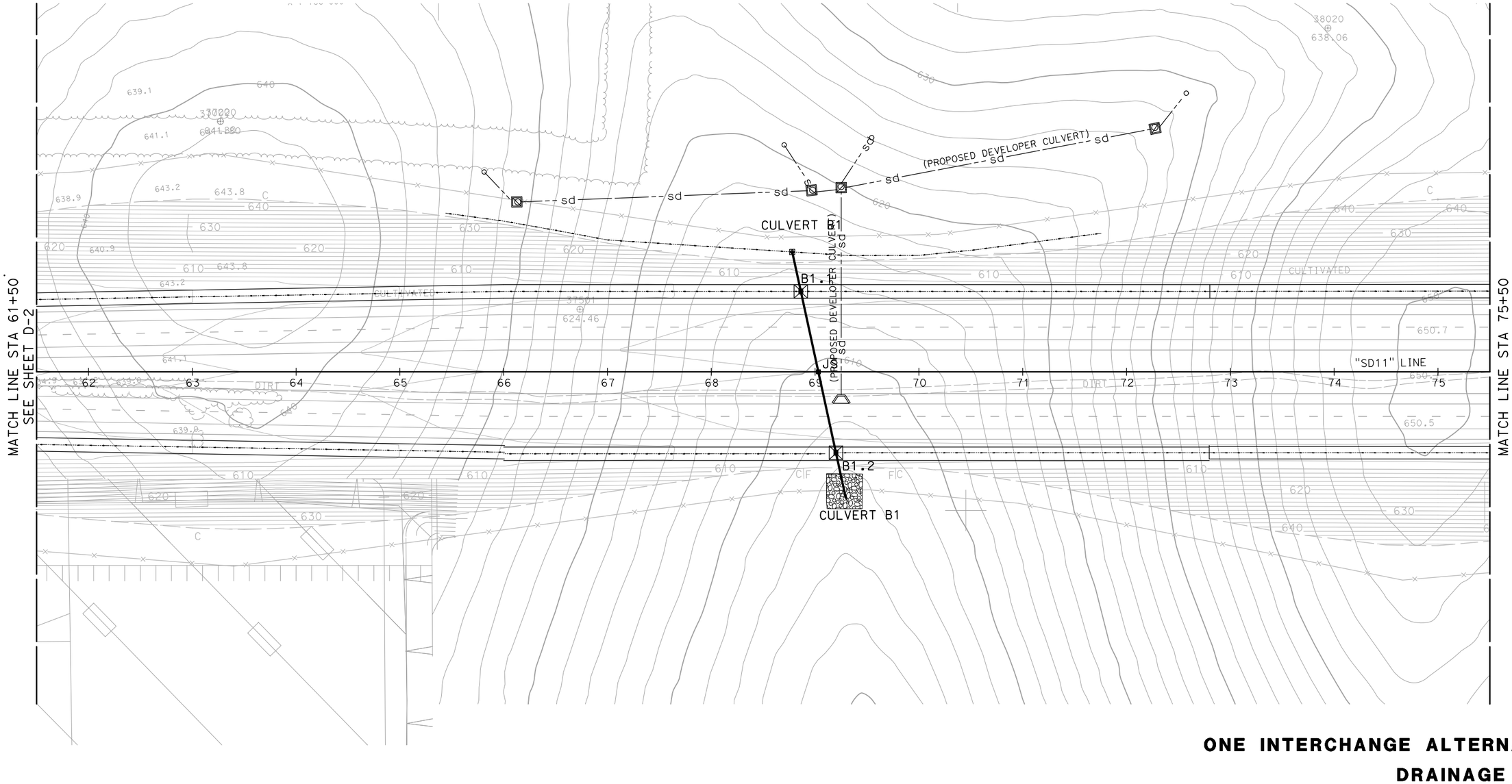

ONE INTERCHANGE ALTERNATIVE

DRAINAGE PLAN

SCALE 1"=50'

D-3

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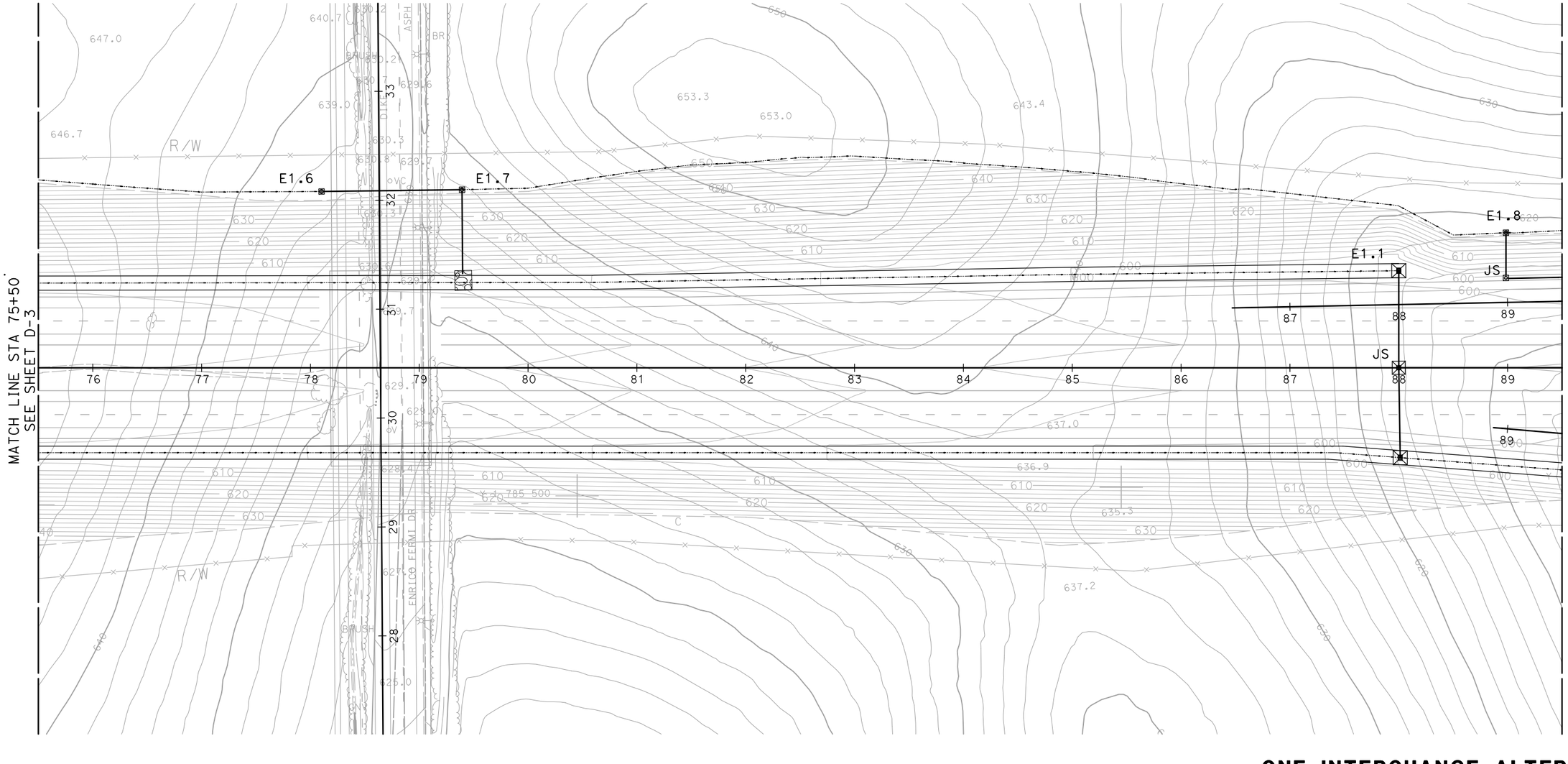

ONE INTERCHANGE ALTERNATIVE
DRAINAGE PLAN
D-4

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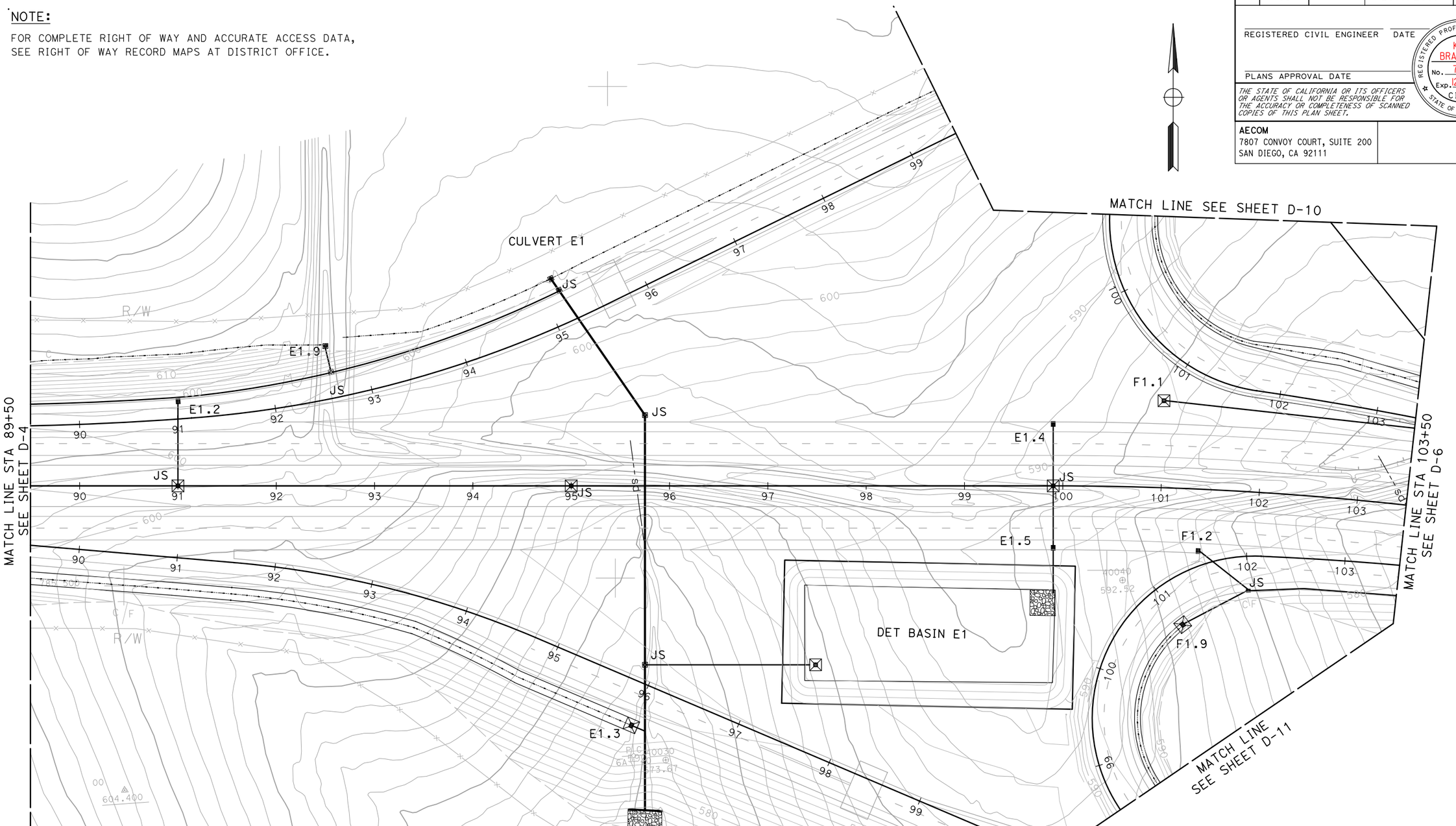

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DRAINAGE PLAN

SCALE 1"=50'

D-5

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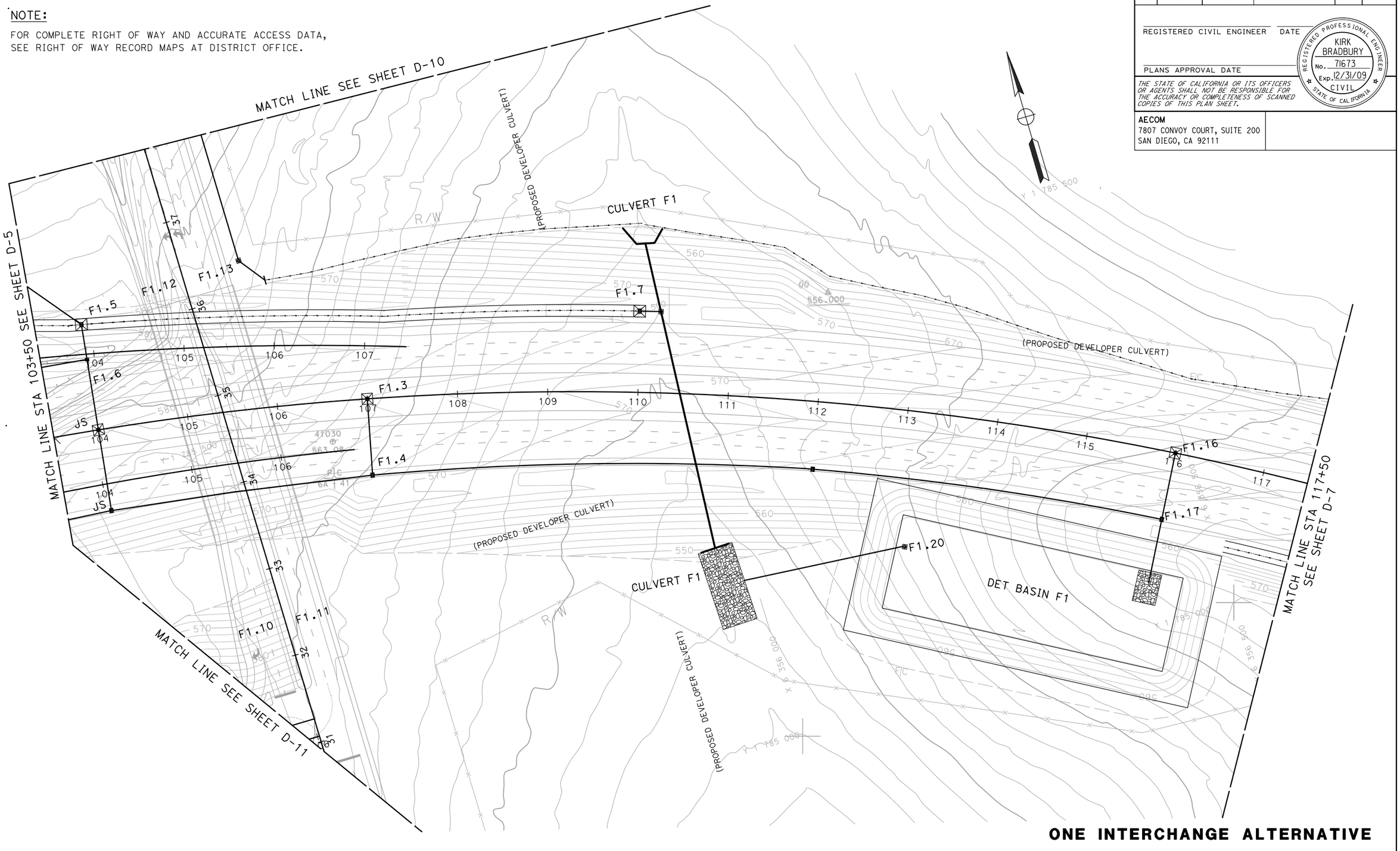

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DRAINAGE PLAN

SCALE 1"=50'

D-6

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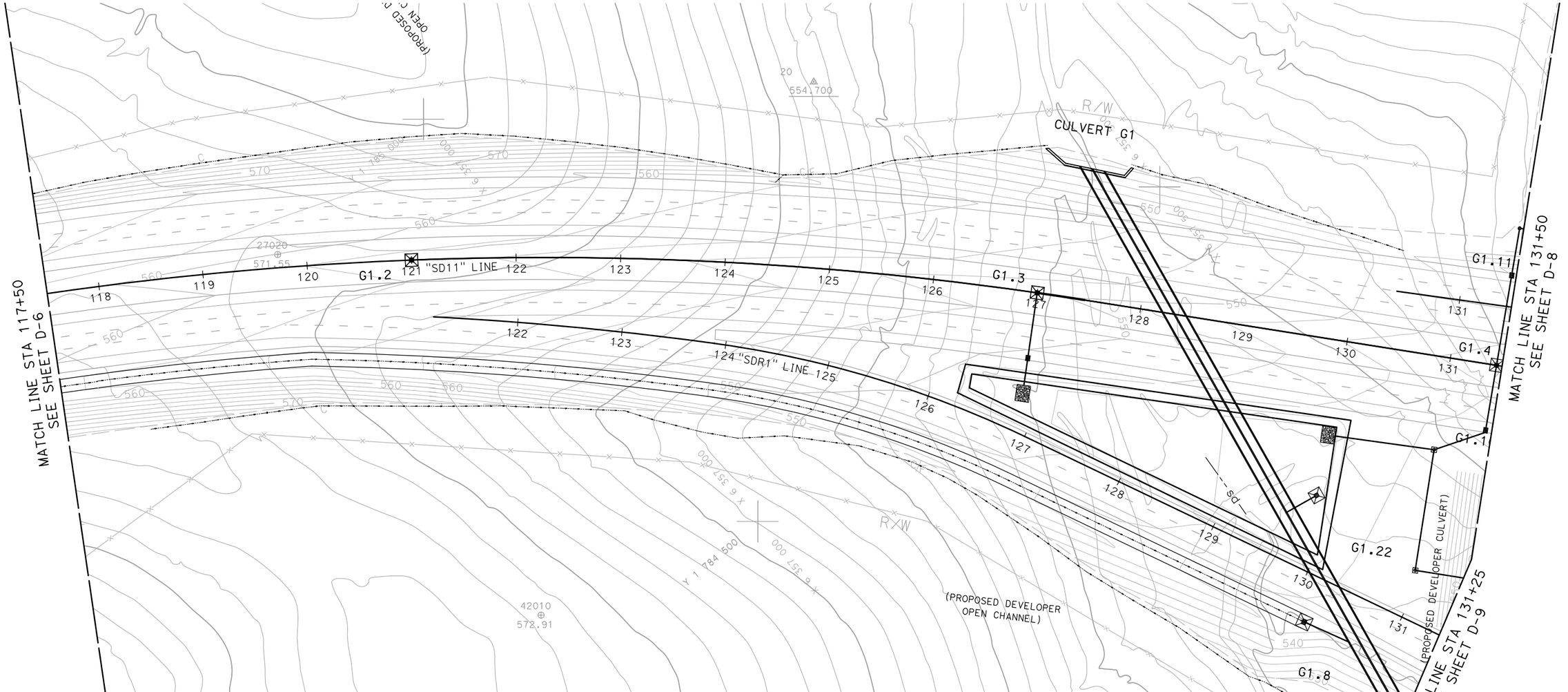

ONE INTERCHANGE ALTERNATIVE

DRAINAGE PLAN

D-7

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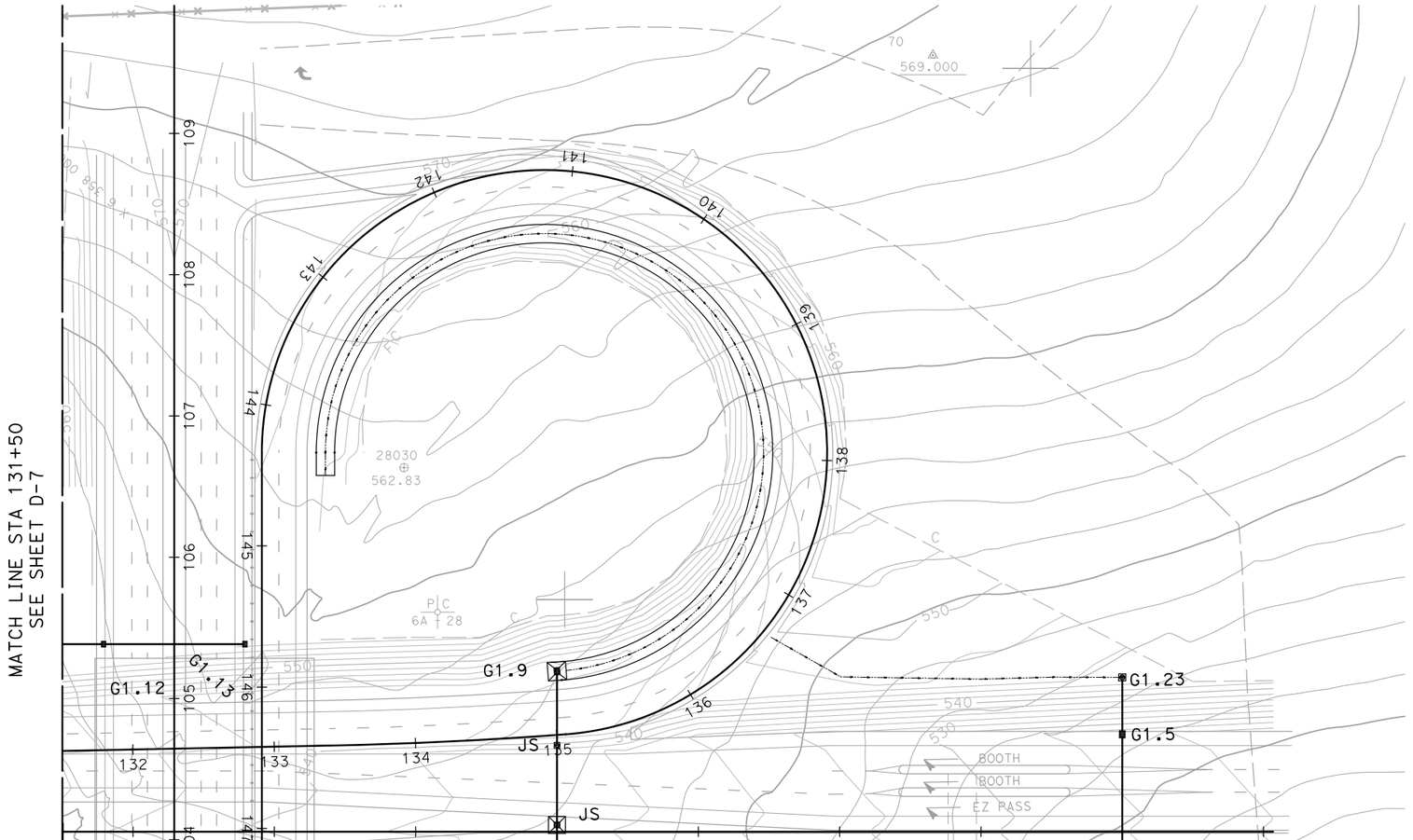

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DRAINAGE PLAN

SCALE 1"=50'

D-8

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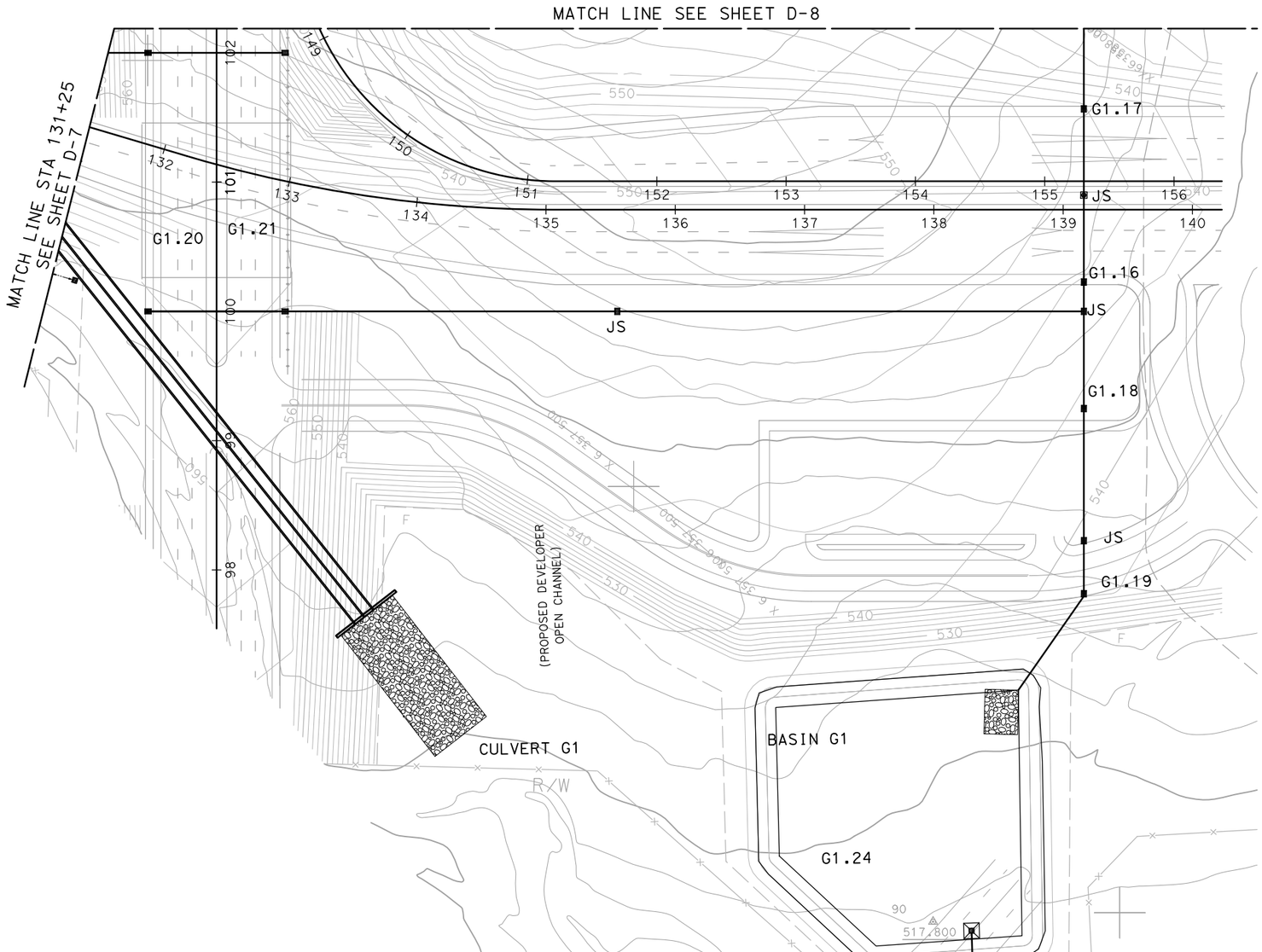

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DRAINAGE PLAN

SCALE 1"=50'

D-9

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ONE INTERCHANGE ALTERNATIVE
DRAINAGE PLAN
D-10

SCALE 1"=50'

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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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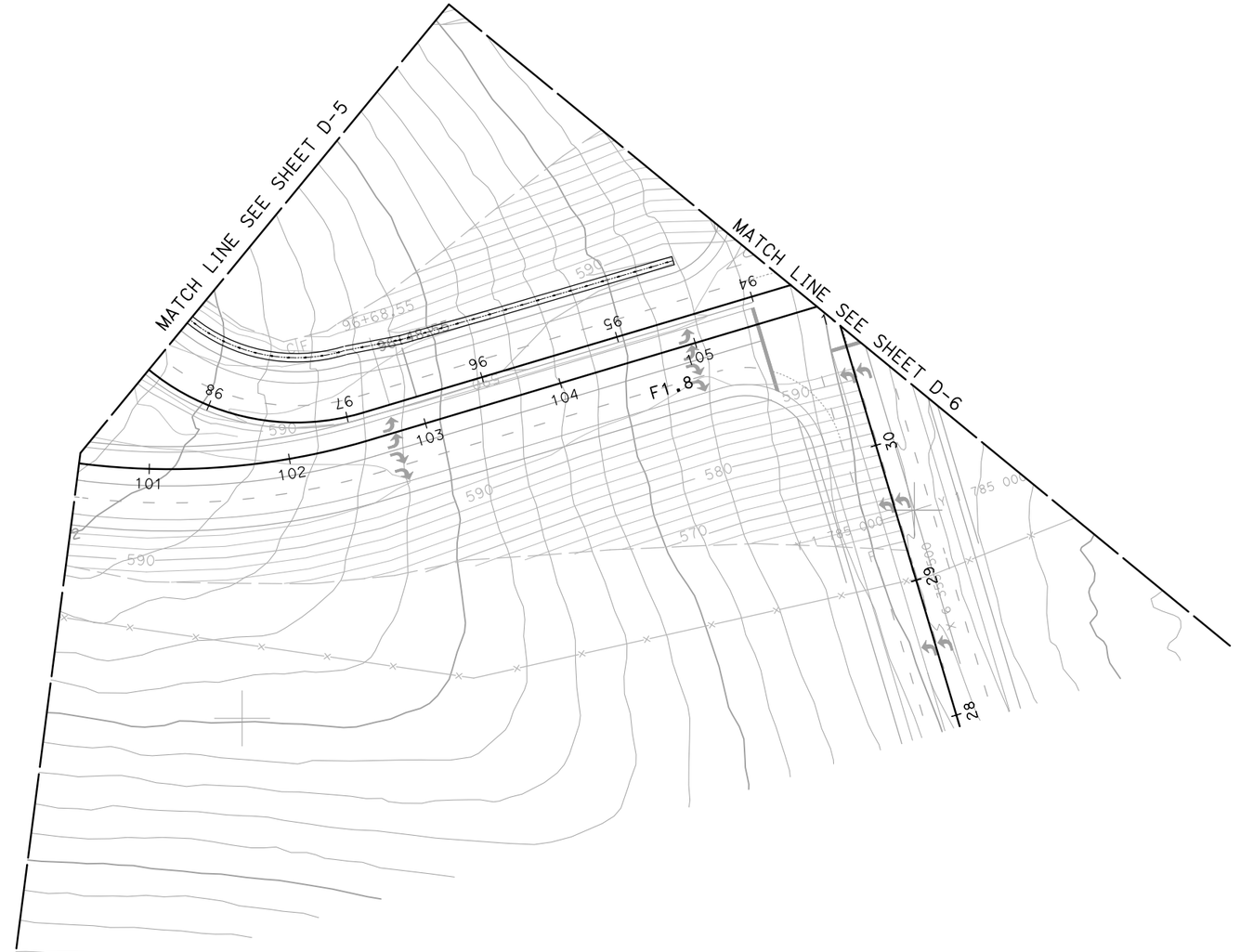

ONE INTERCHANGE ALTERNATIVE
DRAINAGE PLAN
D-11

SCALE 1"=50'

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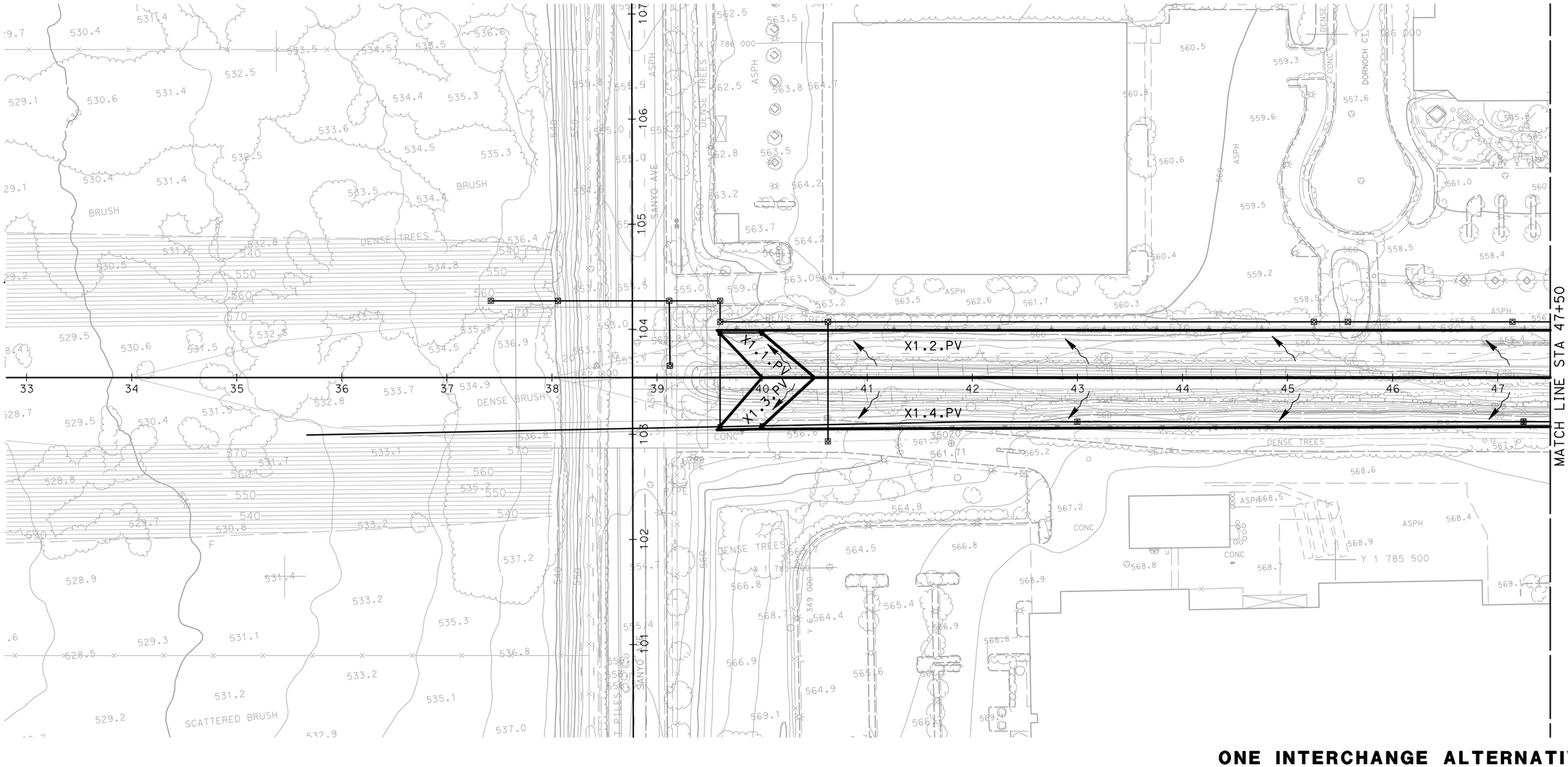
LEGEND:

- JS
- PIPE
- INLET W/APRON
- RSP
- HEADWALL
- ---sd--- EXISTING STORMDRAIN



ONE INTERCHANGE ALTERNATIVE
DRAINAGE AREA PLAN
DA-1

SCALE 1"=50'

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Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
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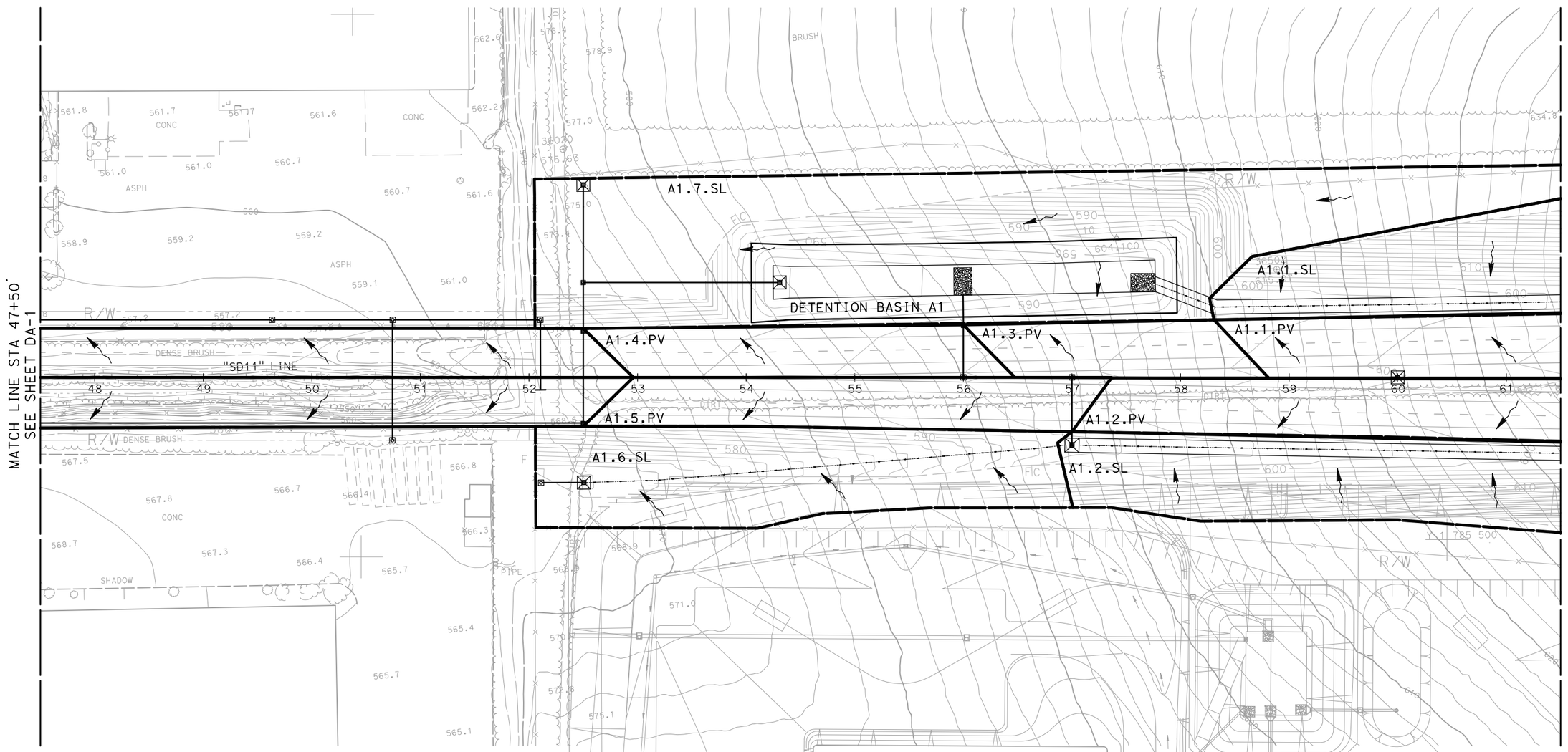

ONE INTERCHANGE ALTERNATIVE
DRAINAGE AREA PLAN
DA-2

SCALE 1"=50'

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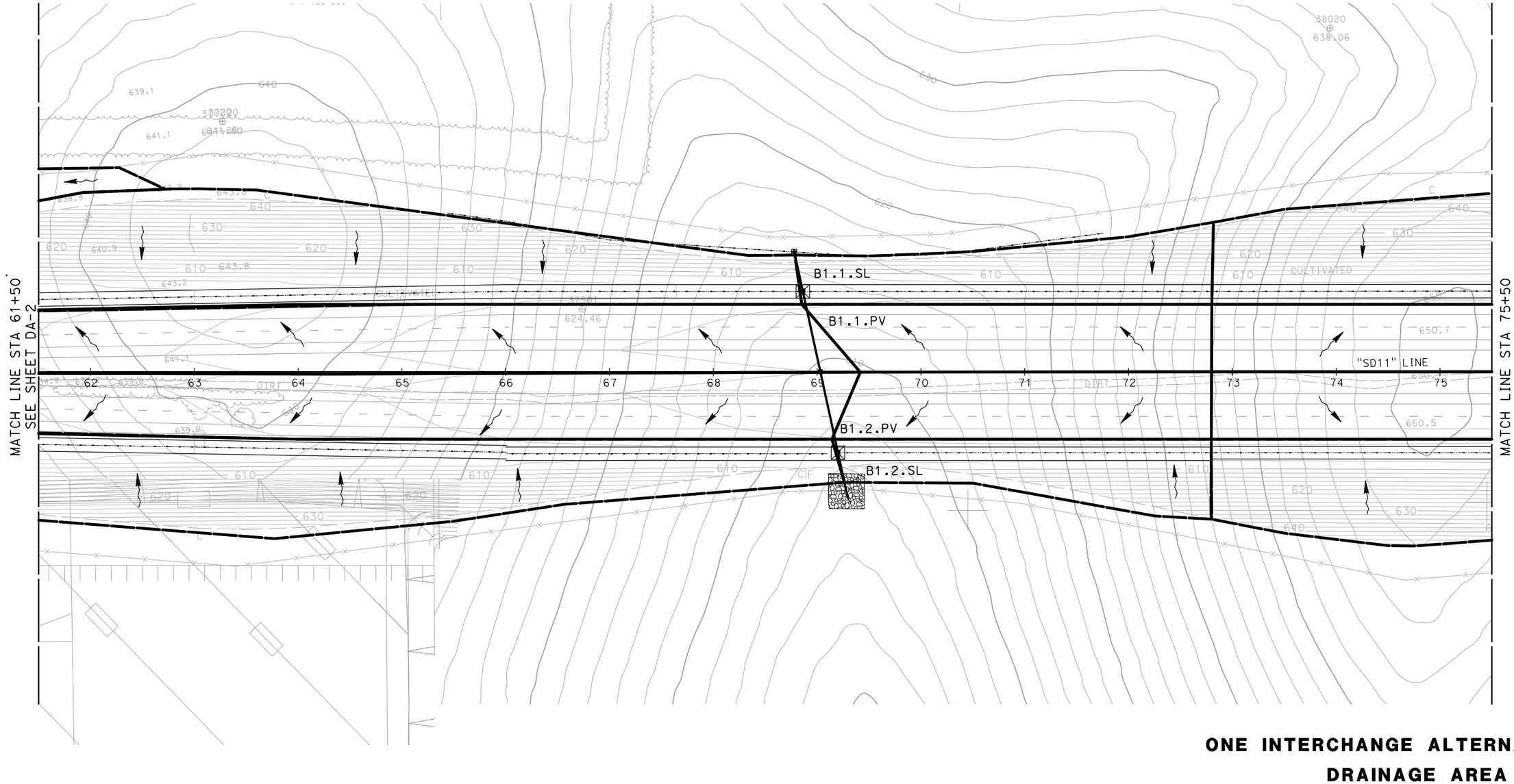

ONE INTERCHANGE ALTERNATIVE
DRAINAGE AREA PLAN
DA-3

SCALE 1"=50'

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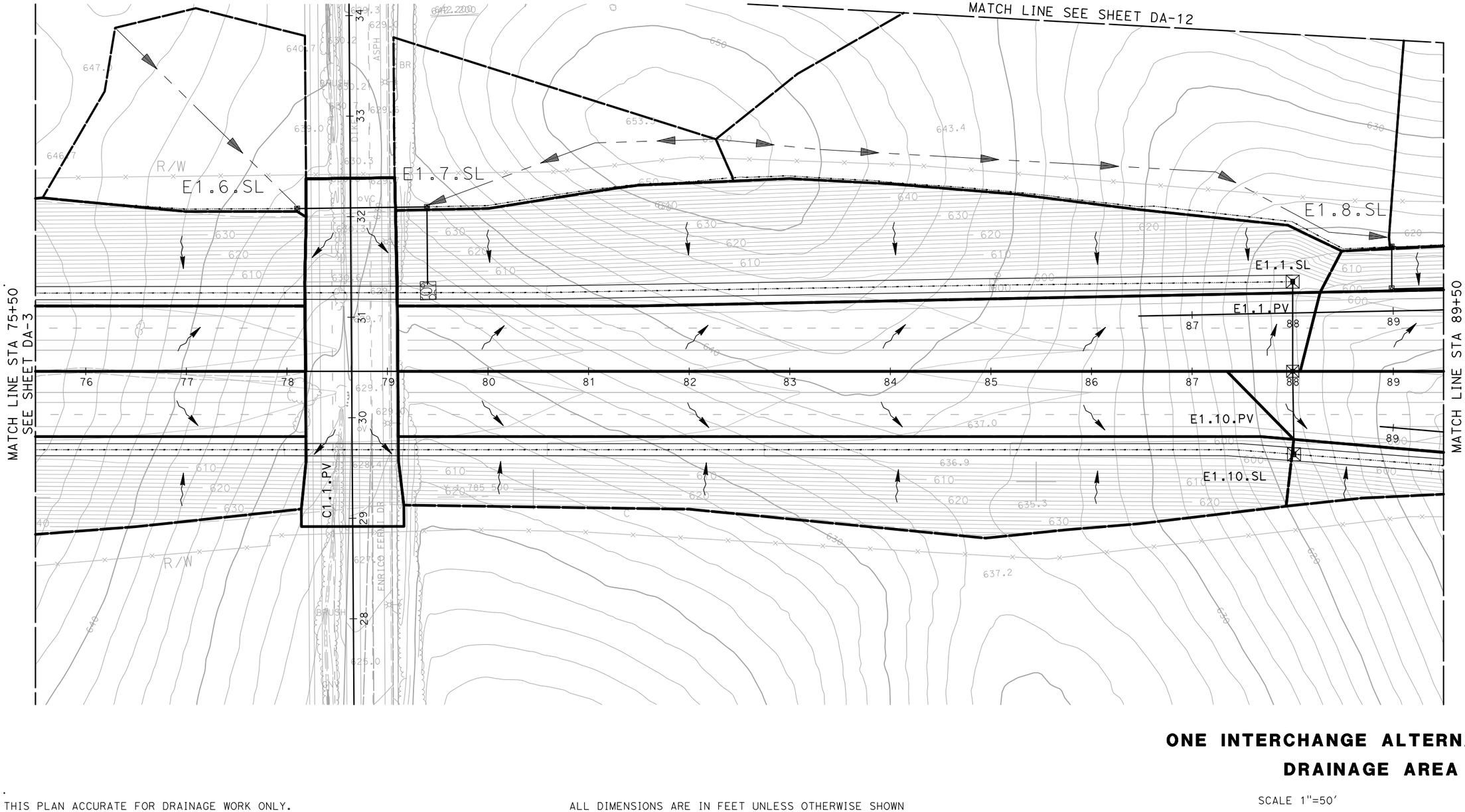

ONE INTERCHANGE ALTERNATIVE

DRAINAGE AREA PLAN

SCALE 1"=50'

DA-4

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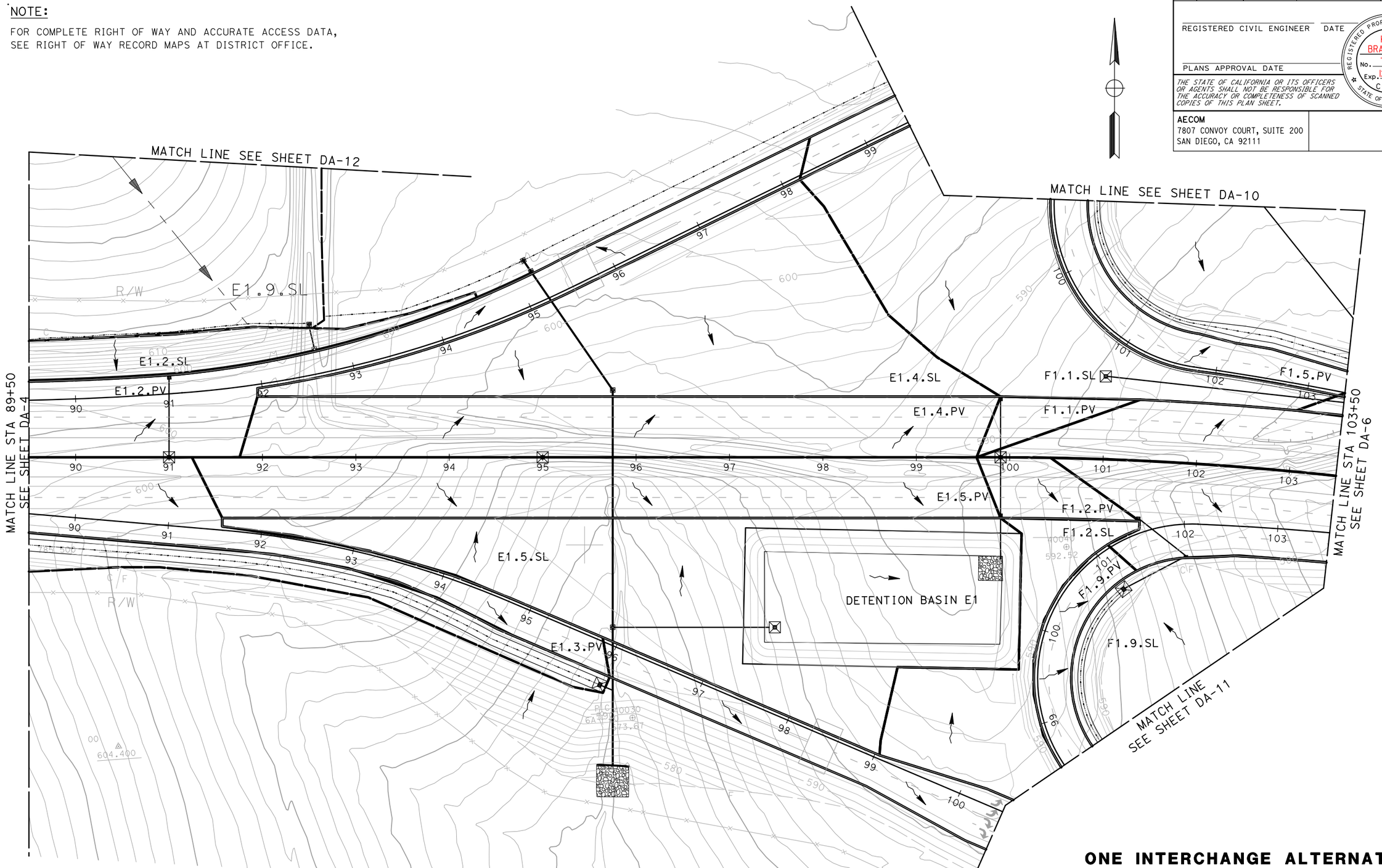

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ONE INTERCHANGE ALTERNATIVE
DRAINAGE AREA PLAN

SCALE 1"=50'

DA-5

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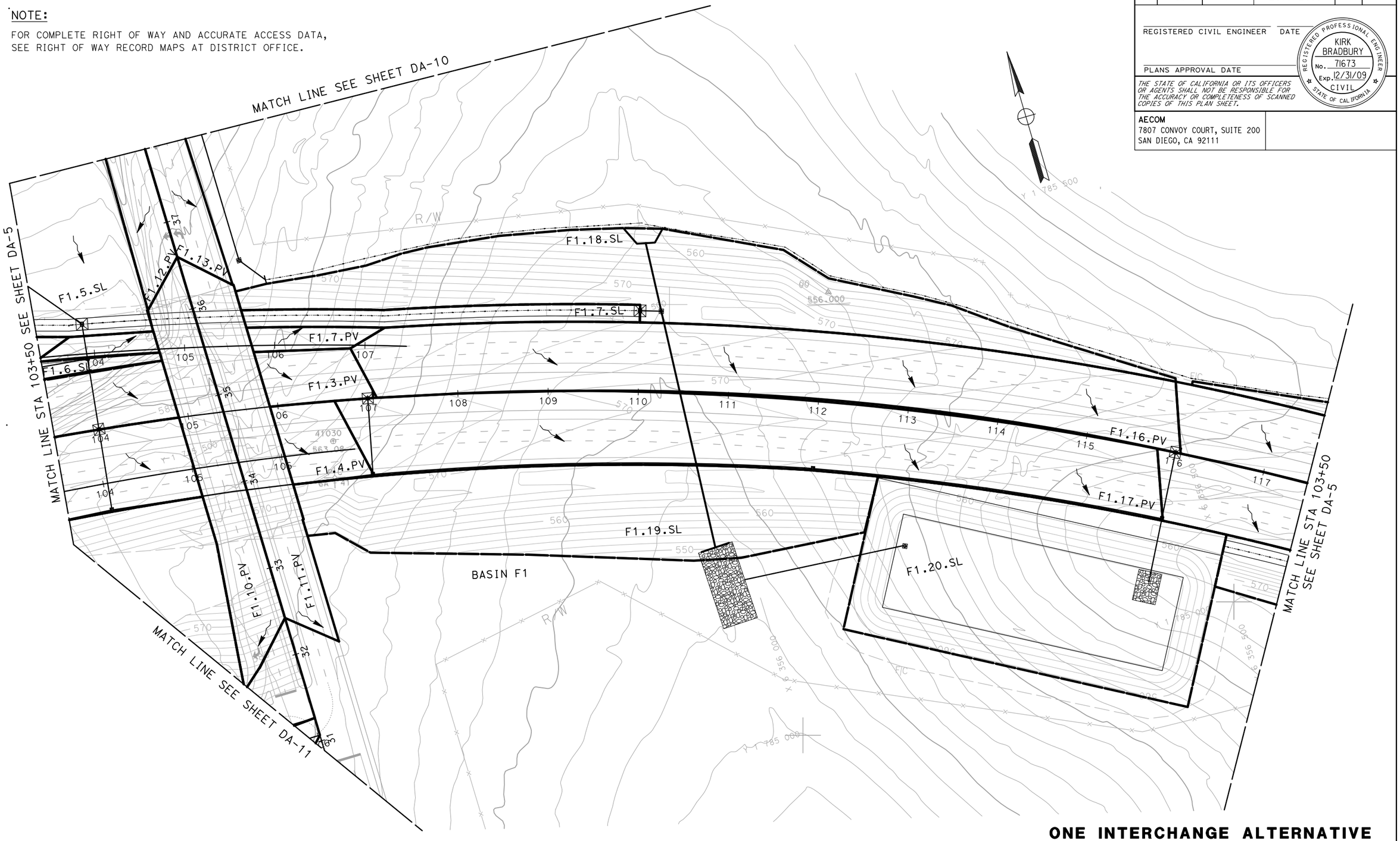

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DRAINAGE AREA PLAN

SCALE 1"=50'

DA-6

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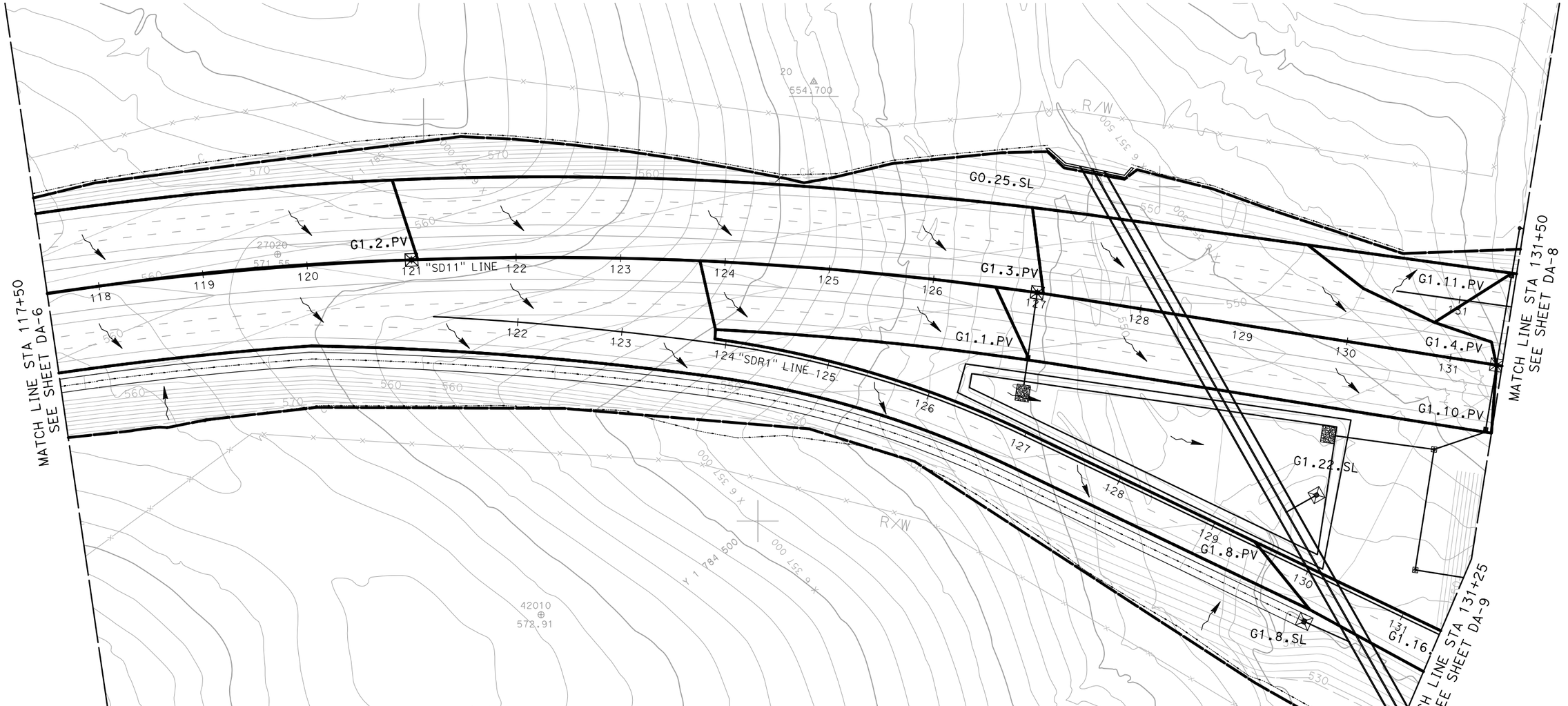

ONE INTERCHANGE ALTERNATIVE
DRAINAGE AREA PLAN
DA-7

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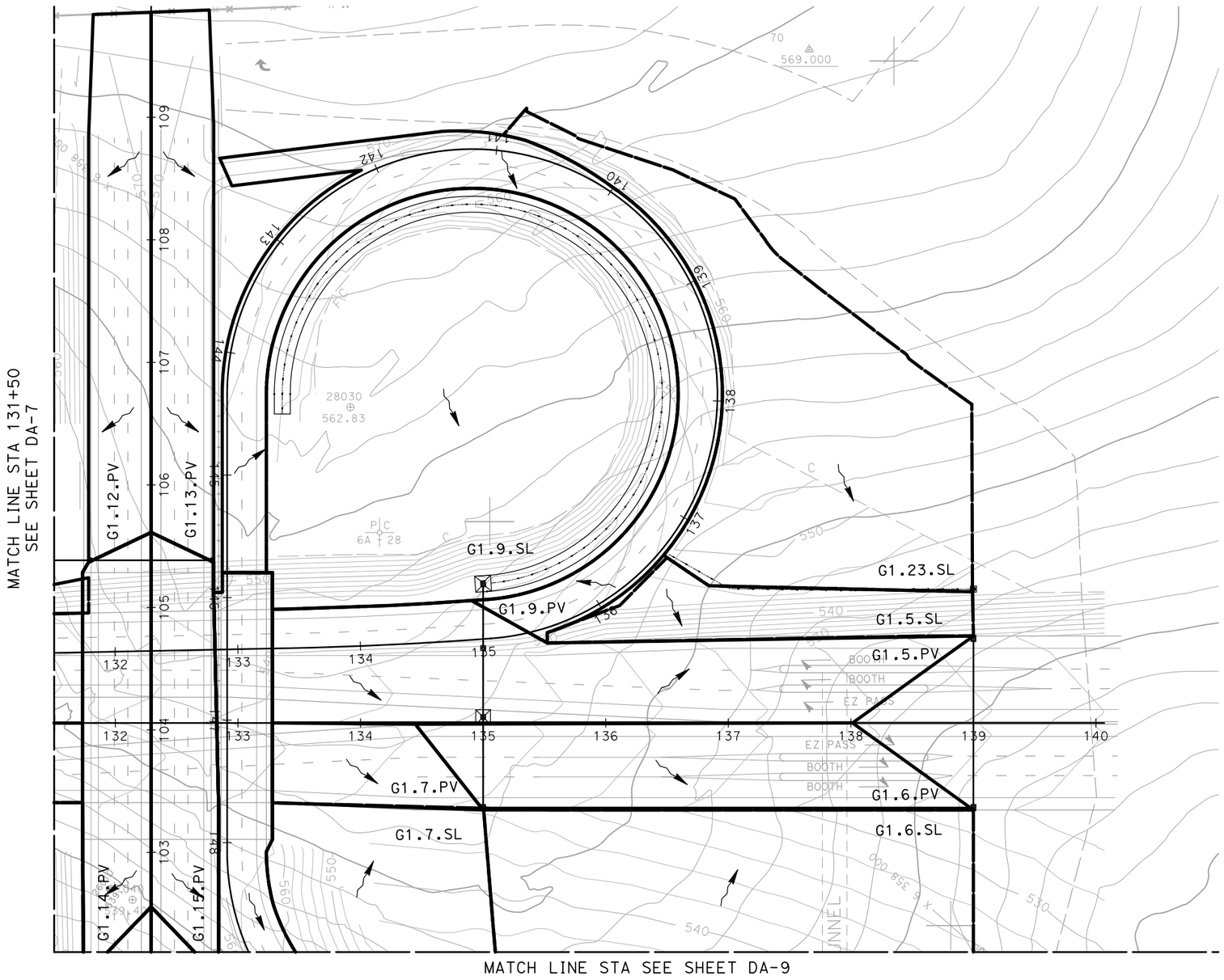

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ONE INTERCHANGE ALTERNATIVE
DRAINAGE AREA PLAN

SCALE 1"=50'

DA-8

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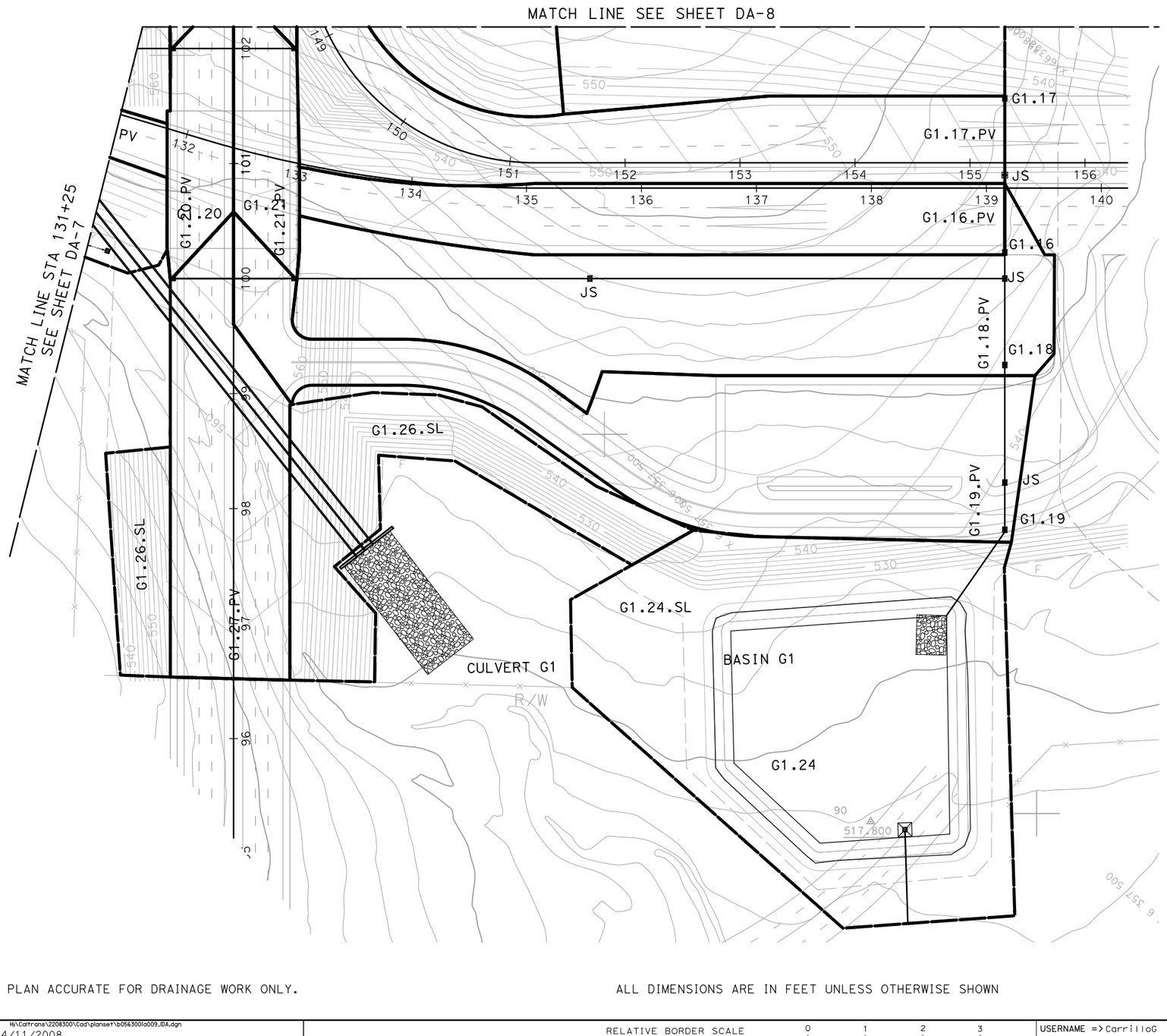

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ONE INTERCHANGE ALTERNATIVE
DRAINAGE AREA PLAN

SCALE 1"=50'

DA-9

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ONE INTERCHANGE ALTERNATIVE
DRAINAGE AREA PLAN

SCALE 1"=50'

DA-10

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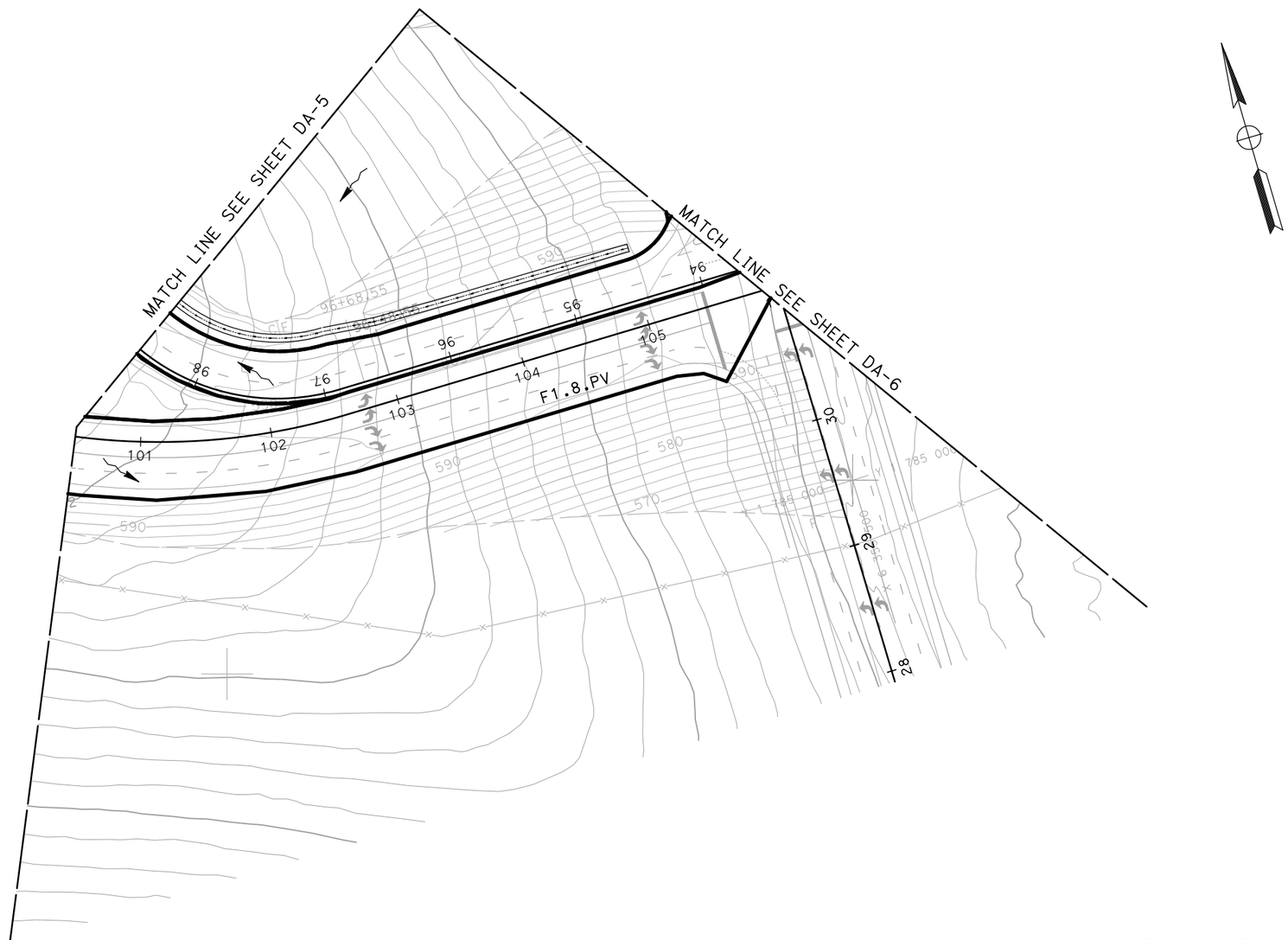

ONE INTERCHANGE ALTERNATIVE
DRAINAGE AREA PLAN

SCALE 1"=50'

DA-11

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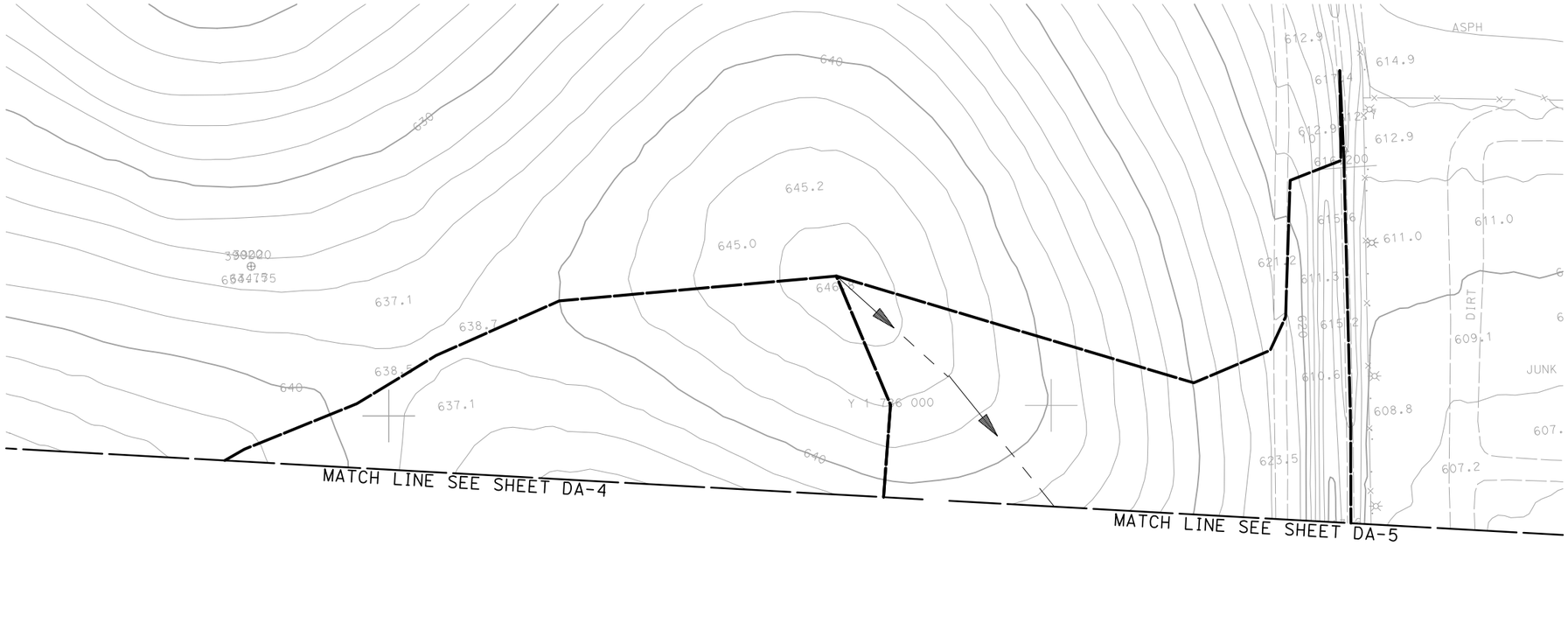
NOTE:

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



ONE INTERCHANGE ALTERNATIVE
DRAINAGE AREA PLAN

SCALE 1"=50'

DA-12

THIS PLAN ACCURATE FOR DRAINAGE WORK ONLY.

ALL DIMENSIONS ARE IN FEET UNLESS OTHERWISE SHOWN

REVISED BY	DATE REVISED

CALCULATED-DESIGNED BY MIKE BRUNING
CHECKED BY GERARD DALZIEL

CONSULTANT FUNCTIONAL SUPERVISOR KIRK BRADBURY

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION
Caltrans

LAST REVISION 11-13-09
DATE PLOTTED => 2/3/2010
TIME PLOTTED => 5:53:21 PM

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2/3/2010 5:53:20 PM YamanakaG h:\caltrans\2208300\cad\planset\b056300ia012_1da.dgn

BORDER LAST REVISED 4/11/2008

RELATIVE BORDER SCALE IS IN INCHES 0 1 2 3

USERNAME => YamanakaG
DGN FILE => ...\b056300ia012_1da.dgn

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EA 06002

A1 Onsite D.A. Table

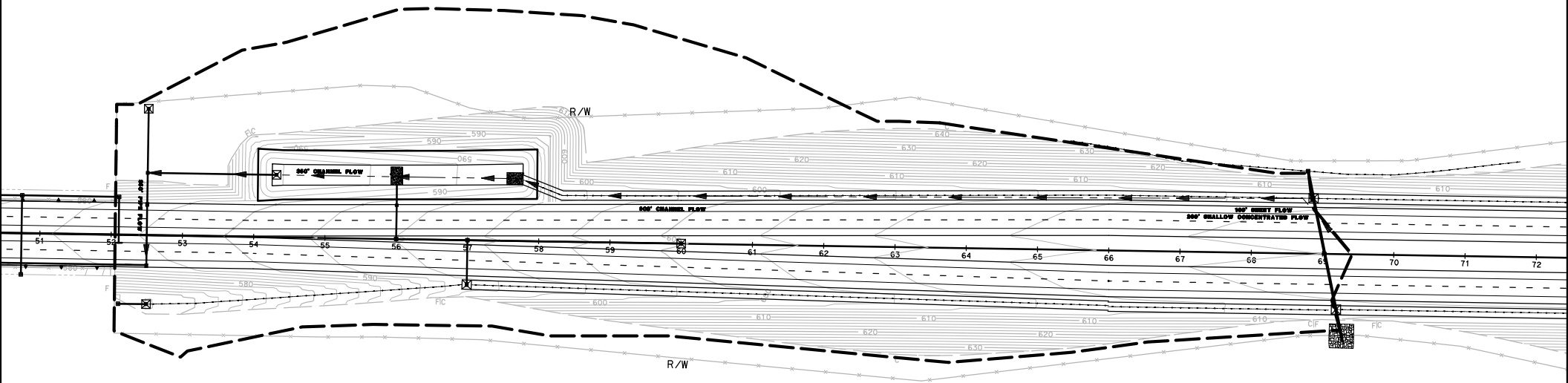
PROJECT:	**SR-11**	**DESCRIPTION:**	**Onsite Drainage Areas (D.A.)**
JOB #:	**11A1190**	**STATION:**	**~**
BY:	**M.BRUNING** **DATE:** **01.04.10**	**WATERSHED:**	**A1**
CHK:	**G.DALZIEL** **DATE:**	**SYSTEM:**	**One Interchange Option**

			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
PAVED	A1.1.PV	0.99	67100	1.5	10	2.8	4.31	4.2	6.42	A1.1	~	Basin A1	57+75	Lt
	A1.2.PV	0.99	72100	1.7	10	2.8	4.64	4.2	6.90	A1.2	A1.2	Basin A1	57+00	Rt
	A1.3.PV	0.99	12000	0.3	5	4.0	1.09	6.6	1.80	~	A1.3	Basin A1	56+00	Lt
	A1.4.PV	0.99	16500	0.4	5	4.0	1.50	6.6	2.47	~	A1.4	*bypass**	52+50	Lt
	A1.5.PV	0.99	20900	0.5	5	4.0	1.90	6.6	3.13	~	A1.5	*bypass**	52+50	Rt
		Σ	188600	*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
SLOPE	A1.1.SL	0.61	88300	2.0	10	2.8	3.50	4.2	5.21	A1.1	~	Basin A1	57+75	Lt
	A1.2.SL	0.61	92400	2.1	10	2.8	3.66	4.2	5.45	A1.2	A1.2	Basin A1	57+00	Rt
	A1.6.SL	0.61	40800	0.9	10	2.8	1.62	4.2	2.41	~	A1.6	*bypass**	52+50	Rt
	A1.7.SL	0.61	108200	2.5	10	2.8	4.29	4.2	6.38	~	A1.7	Basin A1	54+25	Lt
		Σ	329700	*SLOPE*										

** flow that does not reach the basin*

Total :	518300	11.9
	SF	*ac*



WATERSHED A1
ONE INTERCHANGE ALTERNATIVE

Scale: 1"=200'

A1 Post-Developed TcQ

PROJECT:	**SR-11**			**DESCRIPTION:**	**SR-11 Post-Developed**
JOB #:	**11A1190**			**STATION:**	**52+00**
BY:	**M.BRUNING**	**DATE:**	**01.04.10**	**WATERSHED:**	**A1**
CHK:	**G.DALZIEL**	**DATE:**		**SYSTEM:**	**One Interchange Option**

BASIN AREA:

A =	**615812**	**ft^2**	**SOURCE:**	**MICROSTATION/USGS**
	14.14	**acres**		**(SCALE = 1:1)**

COEFFICIENT OF RUNOFF:

KEY: User Input | Designer Tool

UNDEVELOPED AREA C (FROM HDM FIG. 819.2A)

		NOTES:
RELIEF (.08-.35)	0.14	Rolling slopes ~ 5%
INFILTRATION (.04-.16)	0.12	Negligible infiltration capacity - see Geotechnical Report
VEGETATION (.04-.16)	0.08	Fair natural cover
STORAGE (.04-.12)	0.08	Low
TOTAL C =	0.42	

UNDEVELOPED AREA	16%	AT	0.42	0.067
PAVED SURFACE	31%	AT	0.90	0.276
COMMERCIAL AREA	0%	AT	0.85	0.000
CUT SLOPE (2:1 and 4:1)	54%	AT	0.55	0.294
TOTAL	100%			
	(100%)			

$C_{2,10}$ =	0.64
C_{25} =	0.70
C_{50} =	0.76
C_{100} =	0.80

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	608.5	ft	SR-11 CL
LOW POINT ELEVATION	607.8	ft	SR-11 ES
ELEVATION DIFF (H)	0.7	ft	
LENGTH (L)	100	ft	to Bioswale
SLOPE (S) = (H/L)	0.7%		
MANNING'S n	0.016		<=n from Table 816.6A AC
T_t (SFF)=	3.32	minutes	

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

NOTES:

HIGH PT ELEVATION	607.8	ft	origin of Bioswale
LOW POINT ELEVATION	606.0	ft	
ELEVATION DIFF (H)	1.8	ft	
LENGTH (L)	200	ft	assumed bioswale does not have enough flow to be channelized
SLOPE (S) = (H/L)	0.9%		
VELOCITY (SCF)	1.8	fps	<=V from Figure 816.6 grassed waterway
T_C (SH)=	1.90	minutes	

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

NOTES:

HIGH PT ELEVATION	606.0	ft	Begin channel flow in bioswale
LOW POINT ELEVATION	590.0	ft	CHANNEL DATA TYPE = TRAP'Z
ELEVATION DIFF (H)	16.0	ft	Z= 4 ANG-RAD 0.245
LENGTH (L)	900	ft	b = 13 ANG-DEG 14.036
SLOPE (S) = (H/L)	1.8%		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)	3.42	fps	From Manning's Equation assuming flowing full: $V=1.49/n(R^{2/3}S^{1/2})$
T_C (CH)=	4.38	minutes	

A1 Post-Developed TcQ

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

HIGH PT ELEVATION	590.0	ft
LOW POINT ELEVATION	584.0	ft
ELEVATION DIFF (H)	6.0	ft
LENGTH (L)	350	ft
SLOPE (S) = (H/L)	1.7%	
MANNING'S n	0.050	
HYDRAULIC RADIUS R	0.80	ft
VELOCITY (CHANNEL)	3.36	fps
T_C (CH)=	1.73	minutes

NOTES:

assume basin floor has same dimensions of bioswale

CHANNEL DATA — TYPE = TRAP'Z

Z=	4	ANG-RAD	0.245
b =	13	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	584.0	ft
LOW POINT ELEVATION	583.0	ft
ELEVATION DIFF (H)	1.0	ft
LENGTH (L)	350	ft
SLOPE (S) = (H/L)	0.3%	
MANNING'S n	0.013	
PIPE DIAMETER d	2.0	ft
HYDRAULIC RADIUS R	0.5	ft
VELOCITY (STORMDRAIN)	3.9	fps
T_C (SD)=	1.51	minutes

NOTES:

proposed basin outlet pipe

discharge at watershed end (Sta 52+00)

RCP

R=D/4, Assume: flowing full

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

Tc (TOTAL) =	12.85	minutes
Minimum Tc =	10	minutes
USE Tc =	**12.85**	minutes

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

i_2 =	1.6	in/hr	X CA =
i_{10} =	2.3	in/hr	X CA =
i_{25} =	2.9	in/hr	X CA =
i_{50} =	3.4	in/hr	X CA =
i_{100} =	3.6	in/hr	X CA =

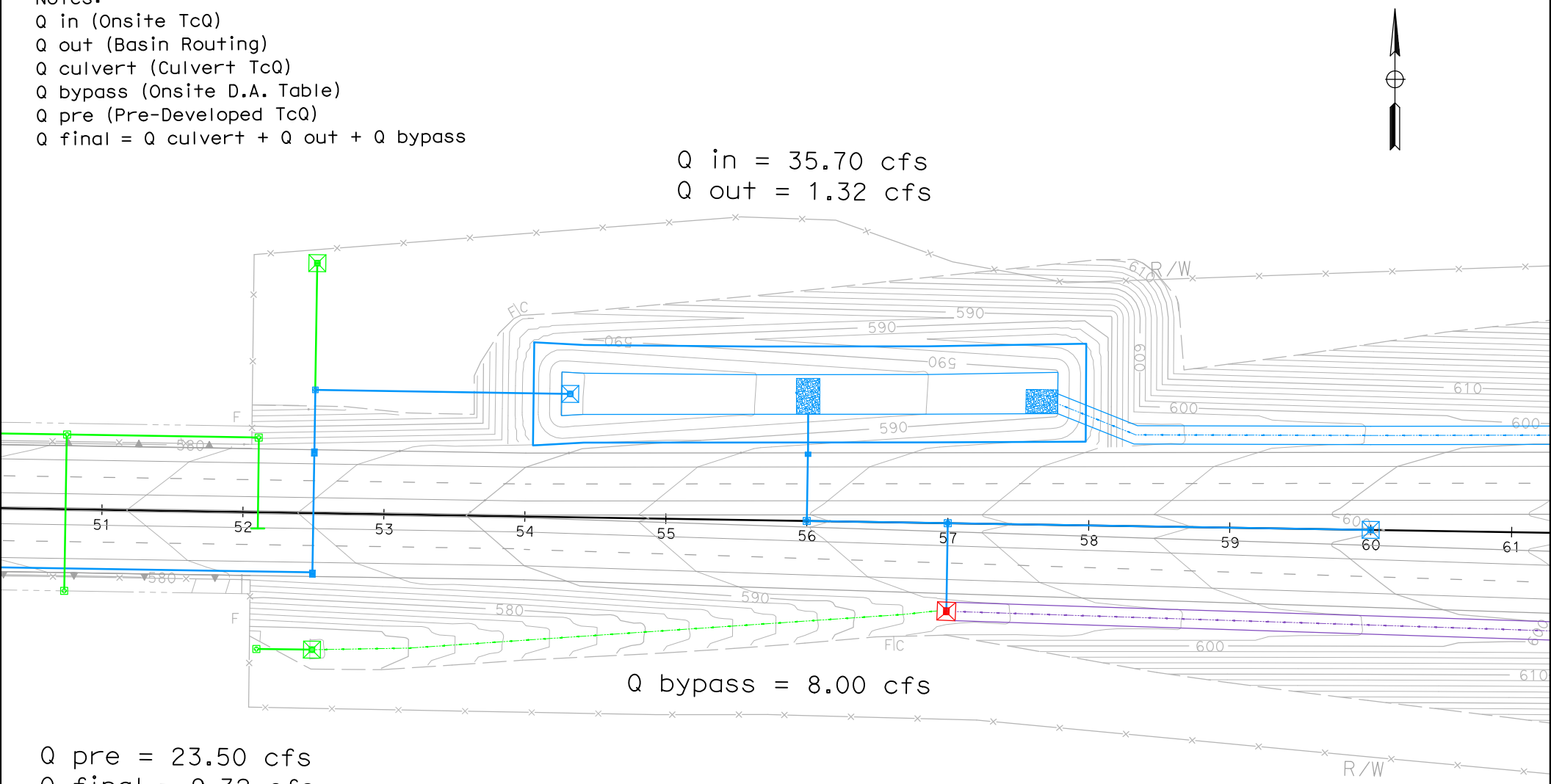
FLOW RESULTS:

	cfs
Q_2 =	14.2
Q_{10} =	20.6
Q_{25} =	28.4
Q_{50} =	37.2
Q_{100} =	**40.3**

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



Q pre = 23.50 cfs
Q final = 9.32 cfs

BASIN A1
FLOW SUMMARY

Scale: 1"=100'

Basin A1 Retention

PROJECT:	SR-11			**DESCRIPTION:**	SR-11 Basin
JOB #:	11A1190			**STATION:**	54+25 - 57+75
BY:	M.BRUNING	**DATE:**	01.04.10	**WATERSHED:**	A1
CHK:	G.DALZIEL	**DATE:**		**SYSTEM:**	One Interchange Option

Notes:

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

RETENTION VOLUME

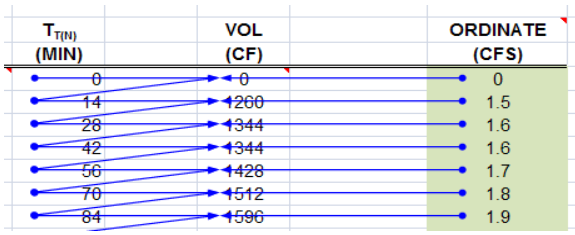
100-year, 6 hour duration storm event, use the Rational Method Hydrograph Procedure (SDCHM 6-1) ~ RatHydro

Pre-Developed volume calculations

Q_{100}=	23.5	cfs			
Tc=	10.0	min	C=	0.53	
$P_{100,6}$=	2.5	in	A=	10.51	acres

$T_{T(N)}$ (MIN)	VOL (CF)	ORDINATE (CFS)
0	0	0
10	480	0.8
20	480	0.8
30	540	0.9
40	540	0.9
50	540	0.9
60	600	1
70	600	1
80	600	1
90	660	1.1
100	660	1.1
110	720	1.2
120	720	1.2
130	780	1.3
140	840	1.4
150	900	1.5
160	960	1.6
170	1020	1.7
180	1080	1.8
190	1260	2.1
200	1380	2.3
210	1680	2.8
220	1920	3.2
230	2760	4.6
240	3900	6.5
250	14100	23.5
260	2220	3.7
270	1500	2.5
280	1140	1.9
290	960	1.6
300	840	1.4
310	780	1.3
320	720	1.2
330	660	1.1
340	600	1
350	540	0.9
360	540	0.9
370	0	0

Example of Steps:



SUM= 50220 ft^3
1.15 acre-feet

Check: $V = C*A*P_6$
V= 1.16 acre-feet
OK

Basin A1 Retention

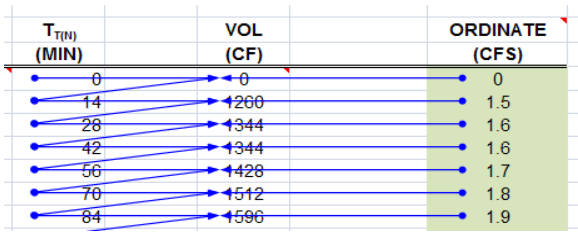
Post-Developed volume calculations

Q_{100}= 40.3 cfs
Tc= 12.8 min
$P_{100,6}$= 2.5 in

C= 0.80
A= 14.14 acres

$T_{T(N)}$ (MIN)	VOL (CF)	ORDINATE (CFS)
0	0	0
13	1092	1.4
26	1326	1.7
39	1404	1.8
52	1482	1.9
65	1482	1.9
78	1560	2
91	1638	2.1
104	1794	2.3
117	1794	2.3
130	1950	2.5
143	2106	2.7
156	2340	3
169	2418	3.1
182	2808	3.6
195	3042	3.9
208	3744	4.8
221	4212	5.4
234	6240	8
247	8736	11.2
260	31434	40.3
273	4992	6.4
286	3354	4.3
299	2574	3.3
312	2184	2.8
325	1872	2.4
338	1716	2.2
351	1560	2
364	1404	1.8
377	0	0

Example of Steps:



SUM= 102258 ft^3
2.35 acre-feet

Check: $V = C*A*P_6$
V= 2.34 acre-feet
OK

		2.35	*(Post)*		
	-	**1.15**	*(Pre)*		
Retention volume =		**1.19**	**acre-feet**	**=**	**52038 ft^3**

Basin Required

Basin A1 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}= 0.84
A= 10.10 acres

WQ_{72}: 0.66 in/area

Water Quality Volume (WQV) = **24206** 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:		288900	ft^2
	A:	6.63	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 = 103.14 tons

Silt Accumulation Basin volume = **2292** ft^3

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

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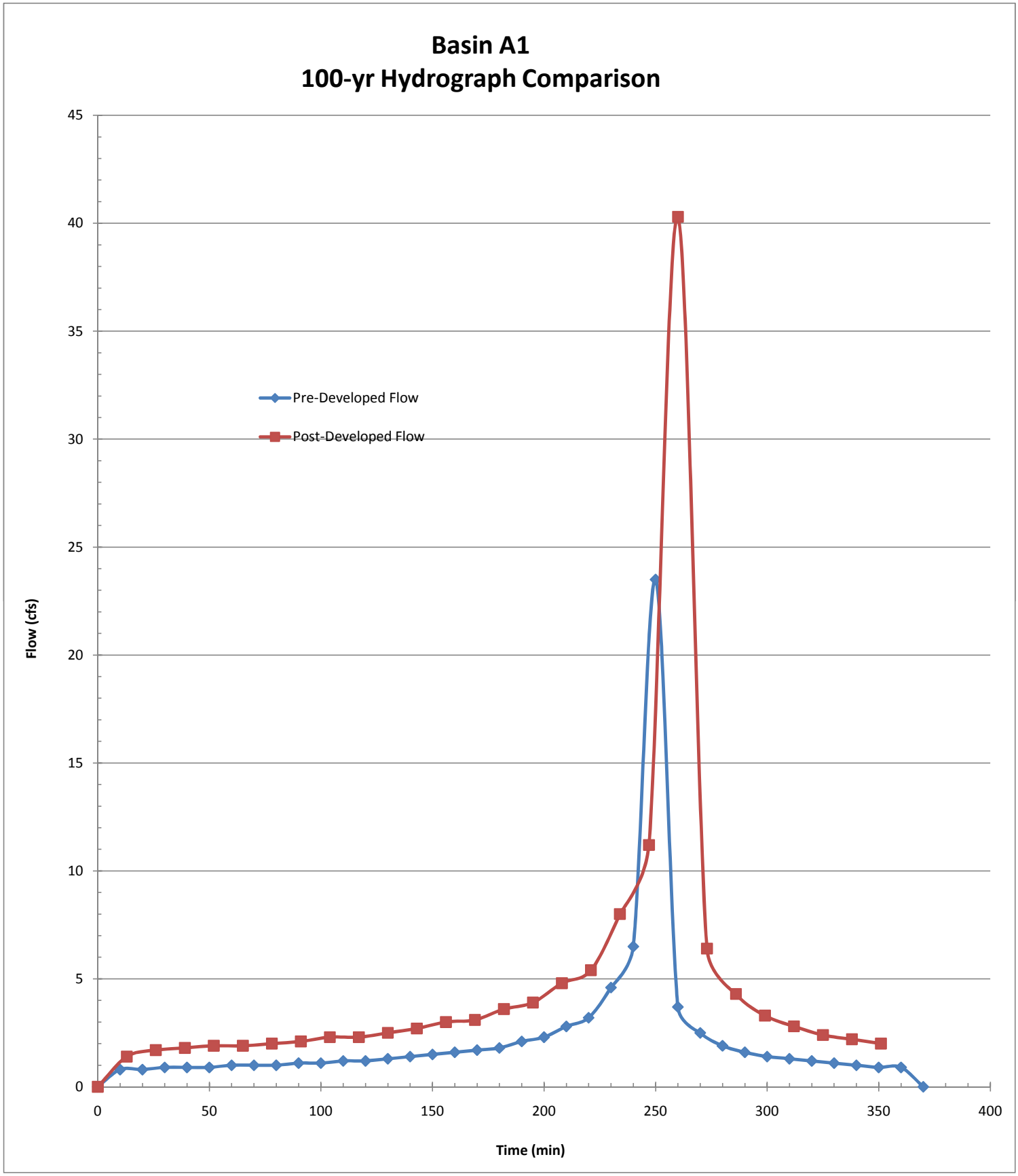

Basin A1
100-yr Hydrograph Comparison
Pre-Developed Flow
Post-Developed Flow
Flow (cfs)
Time (min)
0
5
10
15
20
25
30
35
40
45
0
50
100
150
200
250
300
350
400

Basin A1 Inflow TcQ

PROJECT:	**SR-11**			**DESCRIPTION:**	**SR-11 Basin**
JOB #:	**11A1190**			**STATION:**	**57+75**
BY:	**M.BRUNING**	**DATE:**	**01.04.10**	**WATERSHED:**	**A1**
CHK:	**G.DALZIEL**	**DATE:**		**SYSTEM:**	**One Interchange Option**

BASIN AREA:

A = 440100 ft^2 / 10.10 acres

SOURCE: MICROSTATION/USGS (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	34%	AT	0.90	0.309
COMMERCIAL AREA	0%	AT	0.85	0.000
CUT SLOPE (2:1 and 4:1)	66%	AT	0.55	0.361
TOTAL	100%			
	(100%)			

$C_{2,10}$ =	0.67
C_{25} =	0.74
C_{50} =	0.80
C_{100} =	0.84

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	608.5	ft	SR-11 CL
LOW POINT ELEVATION	607.8	ft	SR-11 ES
ELEVATION DIFF (H)	0.7	ft	
LENGTH (L)	100	ft	to Bioswale
SLOPE (S) = (H/L)	0.7%		
MANNING'S n	0.016		<=n from Table 816.6A AC
T_t (SFF)=	3.32	minutes	

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

NOTES:

HIGH PT ELEVATION	607.8	ft	origin of Bioswale
LOW POINT ELEVATION	606.0	ft	
ELEVATION DIFF (H)	1.8	ft	
LENGTH (L)	200	ft	assumed bioswale does not have enough flow to be channelized
SLOPE (S) = (H/L)	0.9%		
VELOCITY (SCF)	1.8	fps	<=V from Figure 816.6 grassed waterway
T_C (SH)=	1.90	minutes	

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

NOTES:

HIGH PT ELEVATION	606.0	ft	Begin channel flow in bioswale
LOW POINT ELEVATION	590.0	ft	CHANNEL DATA TYPE = TRAP'Z
ELEVATION DIFF (H)	16.0	ft	Z= 4 ANG-RAD 0.245
LENGTH (L)	900	ft	b = 13 ANG-DEG 14.036
SLOPE (S) = (H/L)	1.8%		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)	3.42	fps	From Manning's Equation assuming flowing full: $V=1.49/n(R^{2/3}S^{1/2})$
T_C (CH)=	4.38	minutes	

Basin A1 Inflow TcQ

Tc (TOTAL) =	9.60	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 =	**Q_2 =**	12.6
i_{10} =	2.7	in/hr	X CA =	**Q_{10} =**	18.3
i_{25} =	3.4	in/hr	X CA =	**Q_{25} =**	25.1
i_{50} =	4.0	in/hr	X CA =	**Q_{50} =**	32.9
i_{100} =	4.2	in/hr	X CA =	**Q_{100} =**	**35.7**

FLOW RESULTS:

	cfs
Q_2 =	12.6
Q_{10} =	18.3
Q_{25} =	25.1
Q_{50} =	32.9
Q_{100} =	**35.7**

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 A1 Inflow Hydrograph

PROJECT:	**SR-11**			**DESCRIPTION:**	**SR-11 Basin**
JOB #:	**11A1190**			**STATION:**	**54+25 - 57+75**
BY:	**M.BRUNING**	**DATE:**	**01.04.10**	**WATERSHED:**	**A1**
CHK:	**G.DALZIEL**	**DATE:**		**SYSTEM:**	**One Interchange Option**

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

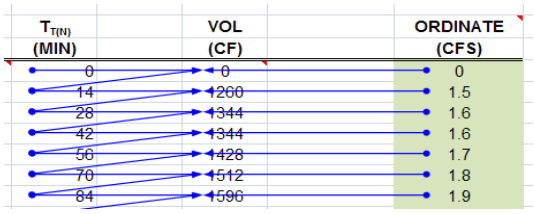
Basin Inflow Hydrograph

Basin Inflow Q

Q_{100}=	35.7	cfs	C_{100}=	0.84	
Tc=	10.0	min	A=	10.10	acres
$P_{100,6}$=	2.5	in			

$T_{T(N)}$ (MIN)	VOL (CF)	ORDINATE (CFS)
0	0	0
10	780	1.3
20	780	1.3
30	780	1.3
40	840	1.4
50	840	1.4
60	900	1.5
70	900	1.5
80	960	1.6
90	1020	1.7
100	1020	1.7
110	1080	1.8
120	1140	1.9
130	1200	2
140	1260	2.1
150	1380	2.3
160	1440	2.4
170	1560	2.6
180	1680	2.8
190	1920	3.2
200	2100	3.5
210	2520	4.2
220	2880	4.8
230	4260	7.1
240	6060	10.1
250	21420	35.7
260	3420	5.7
270	2280	3.8
280	1800	3
290	1500	2.5
300	1320	2.2
310	1140	1.9
320	1080	1.8
330	960	1.6
340	900	1.5
350	840	1.4
360	780	1.3
370	0	0

Example of Steps:



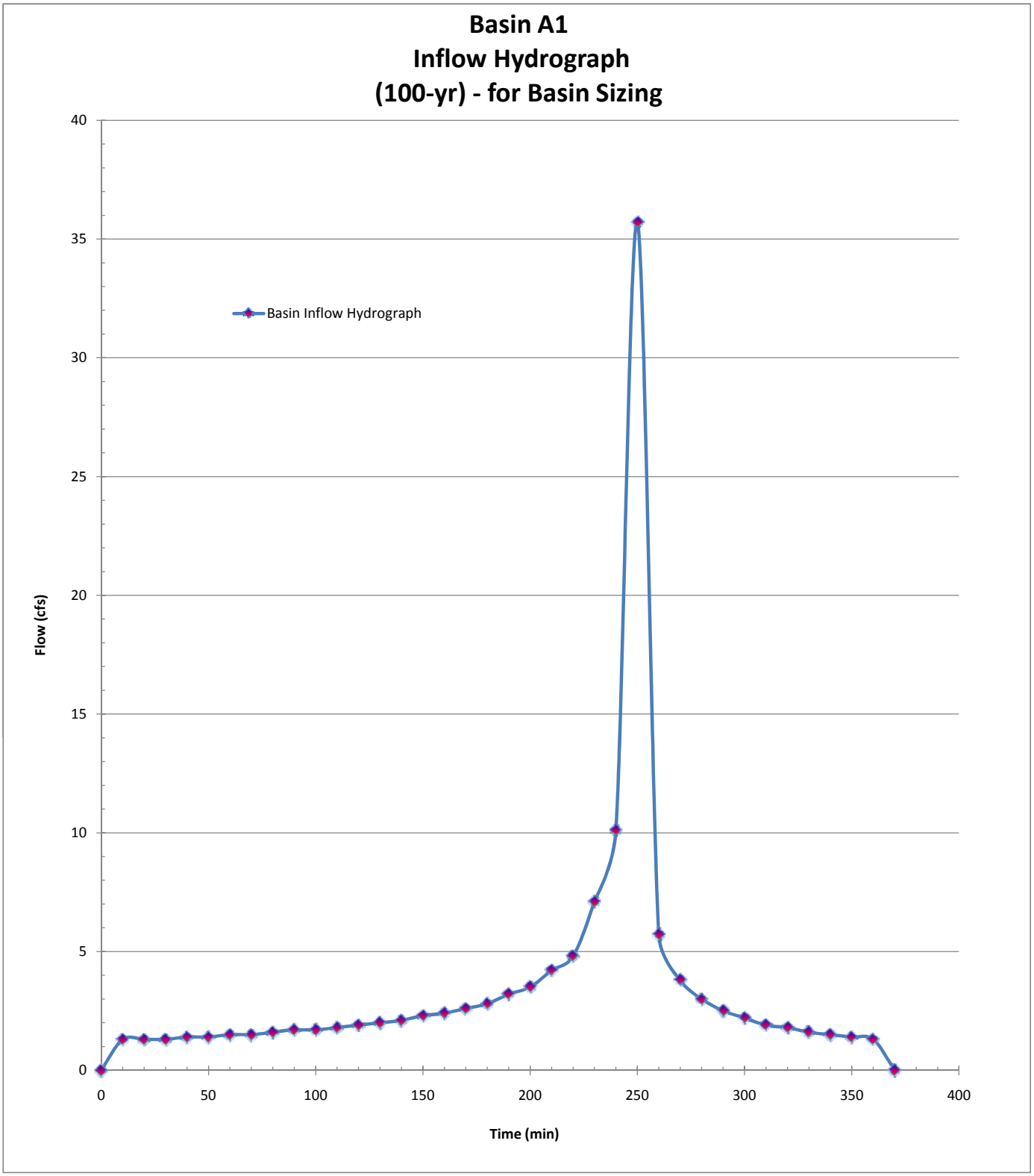
SUM= 76740 ft^3
1.76 acre-feet

Onsite Runoff Volume

Check: $V = C*A*P_6$

V= 1.76 acre-feet

OK


Basin A1
Inflow Hydrograph
(100-yr) - for Basin Sizing
Basin Inflow Hydrograph
Flow (cfs)
Time (min)
0
5
10
15
20
25
30
35
40
0
50
100
150
200
250
300
350
400

Basin A1 Outlet

PROJECT:	**SR-11**			**DESCRIPTION:**	**SR-11 Basin**
JOB #:	**11A1190**			**STATION:**	**54+25**
BY:	**M.BRUNING**	**DATE:**	**02.19.10**	**WATERSHED:**	**A1**
CHK:	**G.DALZIEL**	**DATE:**		**SYSTEM:**	**One Interchange Option**

Notes:

Required Retention Basin Volume = 54330 ft^3
Actual Basin Inflow = 76740 ft^4 *OK*

Flow Balance - determine maximum flow from basin

Predeveloped Peak 100-year Flow: 23.5 cfs
Post-Developed Peak Flow through Cross Culvert: 0.0 cfs
Flow that does not reach detention basin (bypass per DA table): 8.0 cfs ~ Q_{100} of: A1.4.PVA1.5.PVA1.6.SL
Maximum flow allowed to be released by this detention basin: 15.5 cfs

Outlet Pipe

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

Basin - Top of basin berm elevation = 589.20 ft
Basin flowline elevation = 584.00 ft
Maximum Basin Depth = 5.20 ft

Outlet Pipe

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

Outlet pipe invert from basin floor = 3.40 ft 587.40 ft
Outlet pipe diameter = 2 ft

Basin Characteristics

Base Length (L) 350 ft
Base Width (W) 30 ft
W/L Ratio ® 0.09
Side Slopes (Z) 1: 4
Total Volume (V): 103123 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)	Q_{out} (cfs)	Q_{inf} (cfs)	Q_{total} (cfs)
0	584.00	0.00	0	0		584.00	0.00		0.00
1	584.20	0.20	2161	2161		584.20	0.00		0.00
2	584.40	0.40	2284	4445		584.40	0.00		0.00
3	584.60	0.60	2410	6855		584.60	0.00		0.00
4	584.80	0.80	2539	9394		584.80	0.00		0.00
5	585.00	1.00	2670	12063		585.00	0.00		0.00
6	585.20	1.20	2804	14867		585.20	0.00		0.00
7	585.40	1.40	2940	17808		585.40	0.00		0.00
8	585.60	1.60	3079	20887		585.60	0.00		0.00
9	585.80	1.80	3221	24108		585.80	0.00		0.00
10	586.00	2.00	3366	27474		586.00	0.00		0.00
11	586.20	2.20	3513	30987		586.20	0.00		0.00
12	586.40	2.40	3662	34649		586.40	0.00		0.00
13	586.60	2.60	3815	38464		586.60	0.00	0.00	0.00
14	586.80	2.80	3970	42434		586.80	0.00		0.00
15	587.00	3.00	4127	46561		587.00	0.00		0.00
16	587.20	3.20	4288	50849		587.20	0.00		0.00
17	587.40	3.40	4451	55300	*	587.40	0.00		0.00
18	587.60	3.60	4616	59916		587.60	0.15		0.15
19	587.80	3.80	4784	64700		587.80	0.59		0.59
20	588.00	4.00	4955	69656		588.00	1.30		1.30
21	588.20	4.20	5129	74785		588.20	2.25		2.25
22	588.40	4.40	5305	80090		588.40	3.42		3.42
23	588.60	4.60	5484	85573		588.60	4.79		4.79
24	588.80	4.80	5665	91238		588.80	6.32		6.32
25	589.00	5.00	5849	97087		589.00	7.99		7.99
26	589.20	5.20	6036	103123		589.20	9.77		9.77

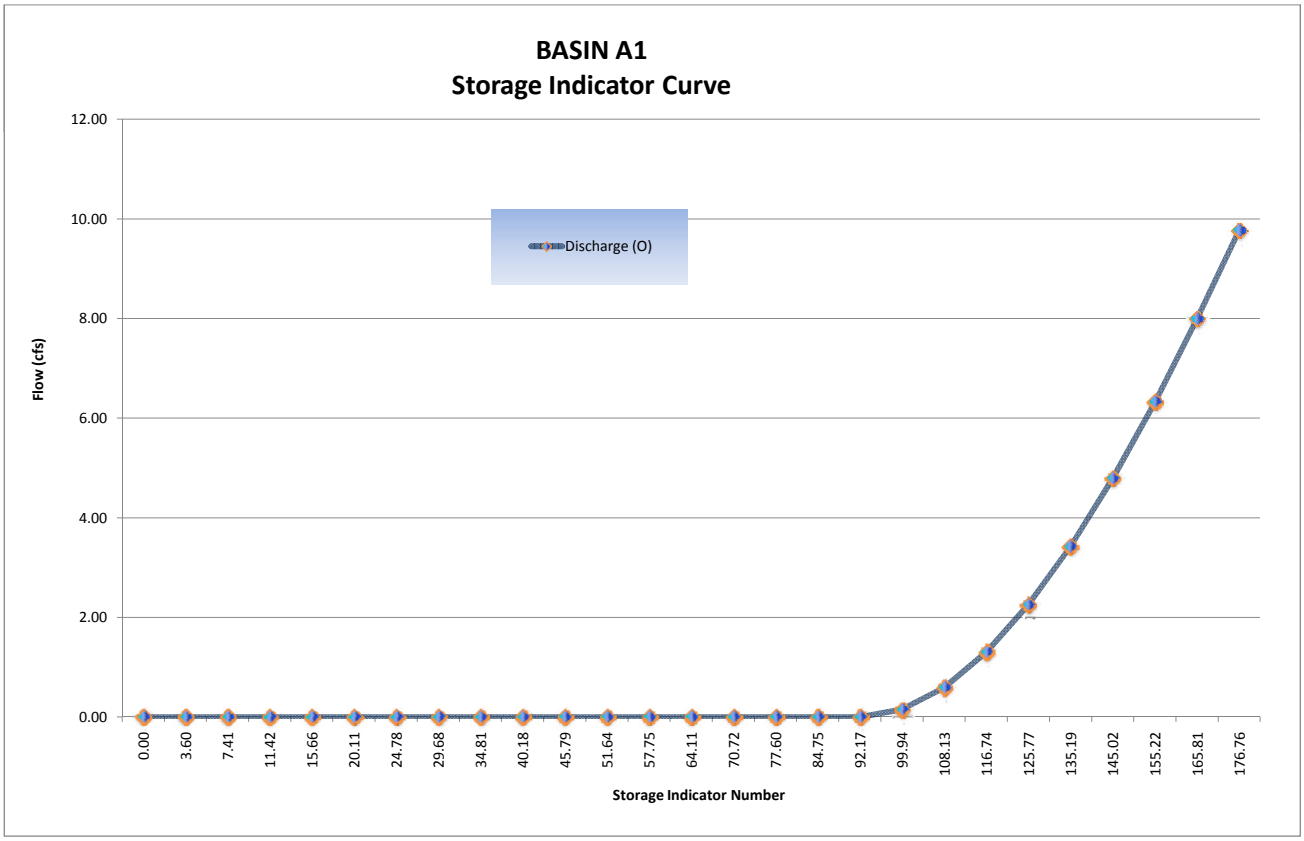
PROJECT:	**SR-11**			**DESCRIPTION:**	**SR-11 Basin**
JOB #:	**11A1190**			**STATION:**	**53+00**
BY:	**M.BRUNING**	**DATE:**	**02.19.10**	**WATERSHED:**	**A**
CHK:	**G.DALZIEL**	**DATE:**		**SYSTEM:**	**Basin A1**

user input
linked input

STORAGE INDICATOR NUMBERS TABLE

					Storage Indicator #
(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)
584.00	0.00	0	0.00	0.00	0.00
584.20	0.00	2161	0.00	3.60	3.60
584.40	0.00	4445	0.00	7.41	7.41
584.60	0.00	6855	0.00	11.42	11.42
584.80	0.00	9394	0.00	15.66	15.66
585.00	0.00	12063	0.00	20.11	20.11
585.20	0.00	14867	0.00	24.78	24.78
585.40	0.00	17808	0.00	29.68	29.68
585.60	0.00	20887	0.00	34.81	34.81
585.80	0.00	24108	0.00	40.18	40.18
586.00	0.00	27474	0.00	45.79	45.79
586.20	0.00	30987	0.00	51.64	51.64
586.40	0.00	34649	0.00	57.75	57.75
586.60	0.00	38464	0.00	64.11	64.11
586.80	0.00	42434	0.00	70.72	70.72
587.00	0.00	46561	0.00	77.60	77.60
587.20	0.00	50849	0.00	84.75	84.75
587.40	0.00	55300	0.00	92.17	92.17
587.60	0.15	59916	0.08	99.86	99.94
587.80	0.59	64700	0.30	107.83	108.13
588.00	1.30	69656	0.65	116.09	116.74
588.20	2.25	74785	1.13	124.64	125.77
588.40	3.42	80090	1.71	133.48	135.19
588.60	4.79	85573	2.40	142.62	145.02
588.80	6.32	91238	3.16	152.06	155.22
589.00	7.99	97087	4.00	161.81	165.81
589.20	9.77	103123	4.89	171.87	176.76

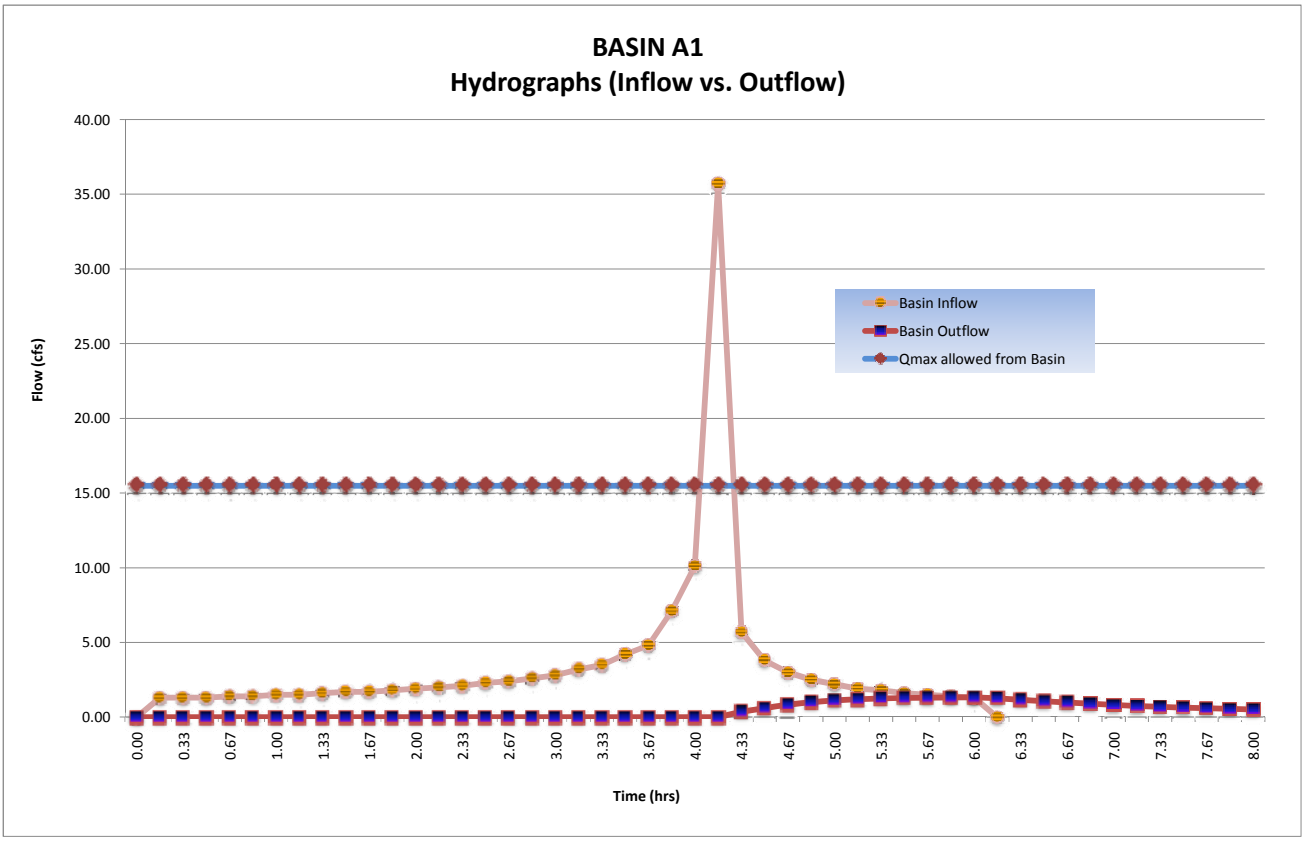
delta t = 0.17 hrs
delta t = 10 min
delta t = 600 sec

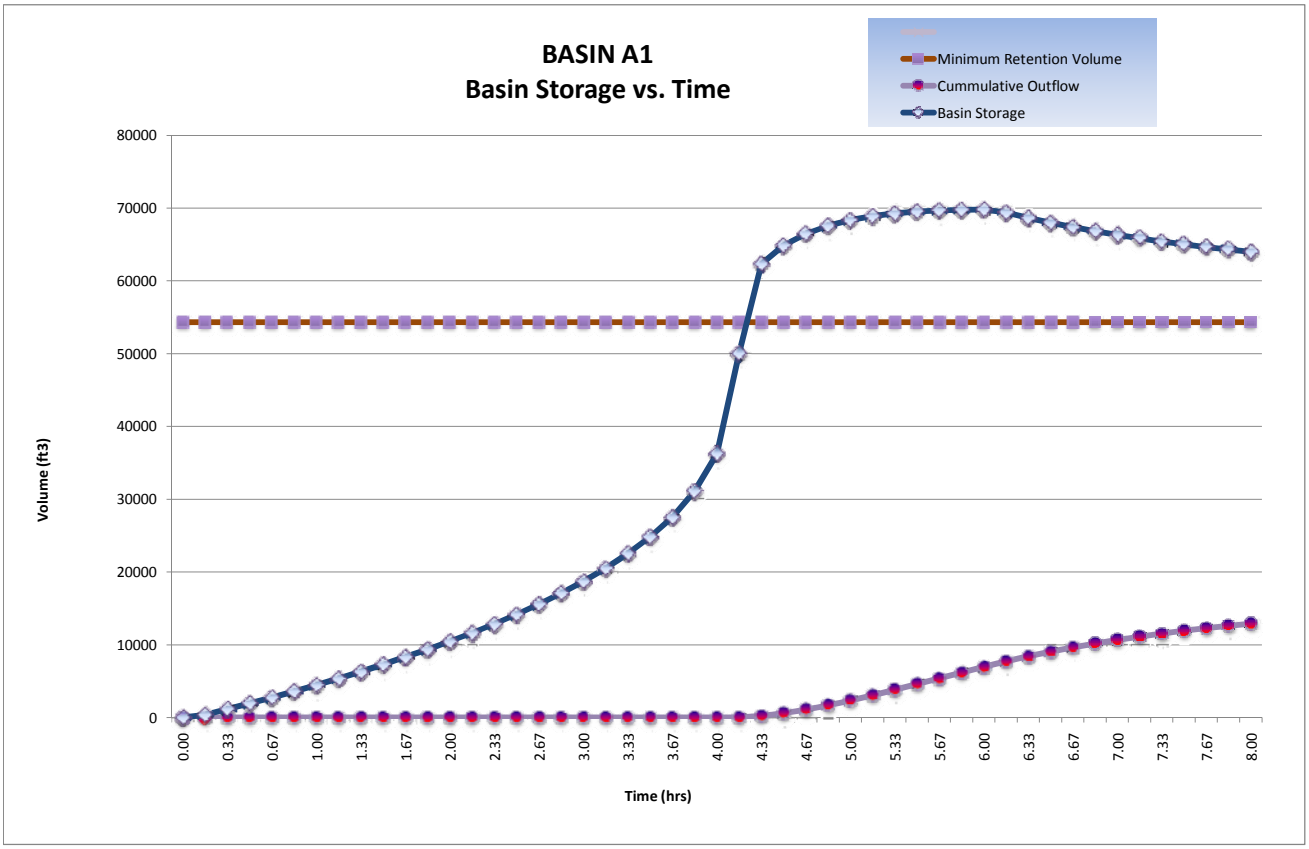


FINAL ROUTING TABLE

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

					Storage Indicator #		Volumes (ft3)		
(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*	(6) $S_2/\Delta t + O_2/2$ (cfs) *col (3)+(4)-(5)*	(7) O_2 (cfs) *(Hard input)*	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	1.30	0.65	0.00	0.00	0.65	0.00	390	0	0
0.33	1.30	1.30	0.65	0.00	1.95	0.00	1170	0	0
0.50	1.30	1.30	1.95	0.00	3.25	0.00	1950	0	0
0.67	1.40	1.35	3.25	0.00	4.60	0.00	2760	0	0
0.83	1.40	1.40	4.60	0.00	6.00	0.00	3600	0	0
1.00	1.50	1.45	6.00	0.00	7.45	0.00	4470	0	0
1.17	1.50	1.50	7.45	0.00	8.95	0.00	5370	0	0
1.33	1.60	1.55	8.95	0.00	10.50	0.00	6300	0	0
1.50	1.70	1.65	10.50	0.00	12.15	0.00	7290	0	0
1.67	1.70	1.70	12.15	0.00	13.85	0.00	8310	0	0
1.83	1.80	1.75	13.85	0.00	15.60	0.00	9360	0	0
2.00	1.90	1.85	15.60	0.00	17.45	0.00	10470	0	0
2.17	2.00	1.95	17.45	0.00	19.40	0.00	11640	0	0
2.33	2.10	2.05	19.40	0.00	21.45	0.00	12870	0	0
2.50	2.30	2.20	21.45	0.00	23.65	0.00	14190	0	0
2.67	2.40	2.35	23.65	0.00	26.00	0.00	15600	0	0
2.83	2.60	2.50	26.00	0.00	28.50	0.00	17100	0	0
3.00	2.80	2.70	28.50	0.00	31.20	0.00	18720	0	0
3.17	3.20	3.00	31.20	0.00	34.20	0.00	20520	0	0
3.33	3.50	3.35	34.20	0.00	37.55	0.00	22530	0	0
3.50	4.20	3.85	37.55	0.00	41.40	0.00	24840	0	0
3.67	4.80	4.50	41.40	0.00	45.90	0.00	27540	0	0
3.83	7.10	5.95	45.90	0.00	51.85	0.00	31110	0	0
4.00	10.10	8.60	51.85	0.00	60.45	0.00	36270	0	0
4.17	35.70	22.90	60.45	0.00	83.35	0.00	50010	0	0
4.33	5.70	20.70	83.35	0.00	104.05	0.37	62319	222	222
4.50	3.80	4.75	104.05	0.37	108.43	0.61	64875	366	588
4.67	3.00	3.40	108.43	0.61	111.22	0.84	66480	504	1092
4.83	2.50	2.75	111.22	0.84	113.13	1.00	67578	600	1692
5.00	2.20	2.35	113.13	1.00	114.48	1.11	68355	666	2358
5.17	1.90	2.05	114.48	1.11	115.42	1.19	68895	714	3072
5.33	1.80	1.85	115.42	1.19	116.08	1.25	69273	750	3822
5.50	1.60	1.70	116.08	1.25	116.53	1.28	69534	768	4590
5.67	1.50	1.55	116.53	1.28	116.80	1.31	69687	786	5376
5.83	1.40	1.45	116.80	1.31	116.94	1.32	69768	792	6168
6.00	1.30	1.35	116.94	1.32	116.97	1.32	69786	792	6960
6.17	0.00	0.65	116.97	1.32	116.30	1.26	69402	756	7716
6.33		0.00	116.30	1.26	115.04	1.16	68676	696	8412
6.50		0.00	115.04	1.16	113.88	1.06	68010	636	9048
6.67		0.00	113.88	1.06	112.82	0.98	67398	588	9636
6.83		0.00	112.82	0.98	111.84	0.90	66834	540	10176
7.00		0.00	111.84	0.90	110.94	0.82	66318	492	10668
7.17		0.00	110.94	0.82	110.12	0.75	65847	450	11118
7.33		0.00	110.12	0.75	109.37	0.69	65415	414	11532
7.50		0.00	109.37	0.69	108.68	0.64	65016	384	11916
7.67		0.00	108.68	0.64	108.04	0.59	64647	354	12270
7.83		0.00	108.04	0.59	107.45	0.55	64305	330	12600
8.00		0.00	107.45	0.55	106.90	0.52	63984	312	12912


BASIN A1
Hydrographs (Inflow vs. Outflow)
Flow (cfs)
40.00
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
Basin Inflow
Basin Outflow
Qmax allowed from Basin
0.00
0.33
0.67
1.00
1.33
1.67
2.00
2.33
2.67
3.00
3.33
3.67
4.00
4.33
4.67
5.00
5.33
5.67
6.00
6.33
6.67
7.00
7.33
7.67
8.00
Time (hrs)



Detention / Retention Basin Volume Required:	**69,786**	**ft^3**	
@ Stage:	**588.20**	**ft**	
Freeboard:	**1.0**	**ft**	Incl. >1' Freeboard
Final Total Basin Volume Provided:	**103,123**	**ft^3**	Basin **A1**
Maximum flow rate released from this basin:	**1.32**	**cfs**	

B1 Onsite D.A. Table

PROJECT:	**SR-11**	**DESCRIPTION:**	**On-site Drainage Areas (D.A.)**
JOB #:	**11A1190**	**STATION:**	**~**
BY:	**M.BRUNING** **DATE:** **01.04.10**	**WATERSHED:**	**B1**
CHK:	**G.DALZIEL** **DATE:**	**SYSTEM:**	**One Interchange Option**

						Caltrans	Caltrans	County	County					
			Area		Tc	i_{25}	Q_{25}	i_{100}	Q_{100}	Drains to:				
	Name	C	*SF*	*Acres*	*min*	*in/hr*	*cfs*	*in/hr*	*cfs*	Bioswale	Inlet	Destination	@ Station	Offset
PAVED	B1.1.PV	0.99	23900	0.5	10	2.8	1.54	4.2	2.29	B1.1	B1.1	*bypass**	69+00	Lt
	B1.2.PV	0.99	22900	0.5	10	2.8	1.47	4.2	2.19	B1.2	B1.2	*bypass**	69+00	Rt
		Σ	46800	*PAVED*										

						Caltrans	Caltrans	County	County					
			Area		Tc	i_{25}	Q_{25}	i_{100}	Q_{100}	Drains to:				
	Name	C	*SF*	*Acres*	*min*	*in/hr*	*cfs*	*in/hr*	*cfs*	Bioswale	Inlet	Destination	@ Station	Offset
SLOPE	B1.1.SL	0.61	22700	0.5	10	2.8	0.90	4.2	1.34	B1.1	B1.1	*bypass**	69+00	Lt
	B1.2.SL	0.61	19800	0.5	10	2.8	0.78	4.2	1.17	B1.2	B1.2	*bypass**	69+00	Rt
		Σ	42500	*SLOPE*										

**flow that does not reach the basin*

Total :	89300	2.1
	SF	*ac*

WATERSHED B1
ONE INTERCHANGE
ALTERNATIVE
Scale: 1"=200'
R/W
R/W
R/W
CULTIVATED
CULTIVATED
GROUND COVER
GROUND COVER
BRUSH
DIRT
DIRT

B1 Post-Developed TcQ

PROJECT:	SR-11			**DESCRIPTION:**	SR-11 Post-Developed
JOB #:	11A1190			**STATION:**	69+00
BY:	M.BRUNING	**DATE:**	01.04.10	**WATERSHED:**	B1
CHK:	G.DALZIEL	**DATE:**		**SYSTEM:**	One Interchange Option

BASIN AREA:

A =	910258	ft^2	**SOURCE:**	MICROSTATION/USGS
	20.90	acres		(SCALE = 1:1)

COEFFICIENT OF RUNOFF:

KEY: User Input | Designer Tool

UNDEVELOPED AREA C (FROM HDM FIG. 819.2A)

NOTES:

RELIEF (.08-.35)	0.14	Rolling Slopes ~ 5%
INFILTRATION (.04-.16)	0.12	Negligible infiltration capacity - see Geotechnical Report
VEGETATION (.04-.16)	0.08	Fair natural cover
STORAGE (.04-.12)	0.08	Low
TOTAL C =	0.42	

UNDEVELOPED AREA	90%	AT	0.42	0.379
PAVED SURFACE	5%	AT	0.90	0.046
COMMERCIAL AREA	0%	AT	0.85	0.000
CUT SLOPE (2:1 and 4:1)	5%	AT	0.55	0.026
TOTAL	100%			
	(100%)			

$C_{2,10}$ =	0.45
C_{25} =	0.50
C_{50} =	0.54
C_{100} =	0.56

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	657.1	ft	northern peak
LOW POINT ELEVATION	654.0	ft	
ELEVATION DIFF (H)	3.1	ft	
LENGTH (L)	100	ft	
SLOPE (S) = (H/L)	3.1%		
MANNING'S n	0.150		< = FROM TABLE 816.6A — short grass - prairie
T_t (SFF)=	10.96	minutes	

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

NOTES:

HIGH PT ELEVATION	654.0	ft	northern peak
LOW POINT ELEVATION	615.0	ft	
ELEVATION DIFF (H)	39.0	ft	
LENGTH (L)	828	ft	
SLOPE (S) = (H/L)	4.7%		
VELOCITY (SCF)	1.5	fps	V FROM FIG 816.6 — short grass
T_C (SH)=	9.20	minutes	

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

NOTES:

HIGH PT ELEVATION	615.0	ft	Slope Ditch
LOW POINT ELEVATION	614.5	ft	CHANNEL DATA — TYPE = TRAP'Z
ELEVATION DIFF (H)	0.5	ft	Z= 2 — ANG-RAD 0.464
LENGTH (L)	37	ft	b = 2 — ANG-DEG 26.565
SLOPE (S) = (H/L)	1.4%		d = 0.5 — FLOWING FULL ASS'M
MANNING'S n	0.015		Concrete-rough
HYDRAULIC RADIUS R	0.35	ft	R=(bdsinA+d^2cosA)/(bsinA+2d)
VELOCITY (CHANNEL)	5.78	fps	From Manning's Equation assuming flowing full: $V=1.49/n(R^{2/3}S^{1/2})$
T_C (CH)=	0.11	minutes	

B1 Post-Developed TcQ

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

HIGH PT ELEVATION	614.5	ft	Cross Culvert
LOW POINT ELEVATION	606.0	ft	
ELEVATION DIFF (H)	8.5	ft	
LENGTH (L)	226	ft	
SLOPE (S) = (H/L)	3.8%		
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)	18.3	fps	$V = \frac{K_u}{n} R^{2/3} S^{1/2}$
T_C (SD)=	0.21	minutes	

NOTES:

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

HIGH PT ELEVATION	606.0	ft	Begins to form natural channel
LOW POINT ELEVATION	594.0	ft	CHANNEL DATA TYPE = TRAP'Z
ELEVATION DIFF (H)	12.0	ft	Z= 5 ANG-RAD 0.197
LENGTH (L)	430	ft	b = 10 ANG-DEG 11.310
SLOPE (S) = (H/L)	2.8%		d = 0.5 FLOWING FULL ASS'M
MANNING'S n	0.080		grass
HYDRAULIC RADIUS R	0.4	ft	R=(bdsinA+d^2cosA)/(bsinA+2d)
VELOCITY (CHANNEL)	1.73	fps	From Manning's Equation assuming flowing full: $V=1.49/n(R^{2/3}S^{1/2})$
T_C (CH)=	4.15	minutes	

NOTES:

Tc (TOTAL) =	24.62	minutes
Minimum Tc =	10	minutes
USE Tc =	**24.62**	minutes

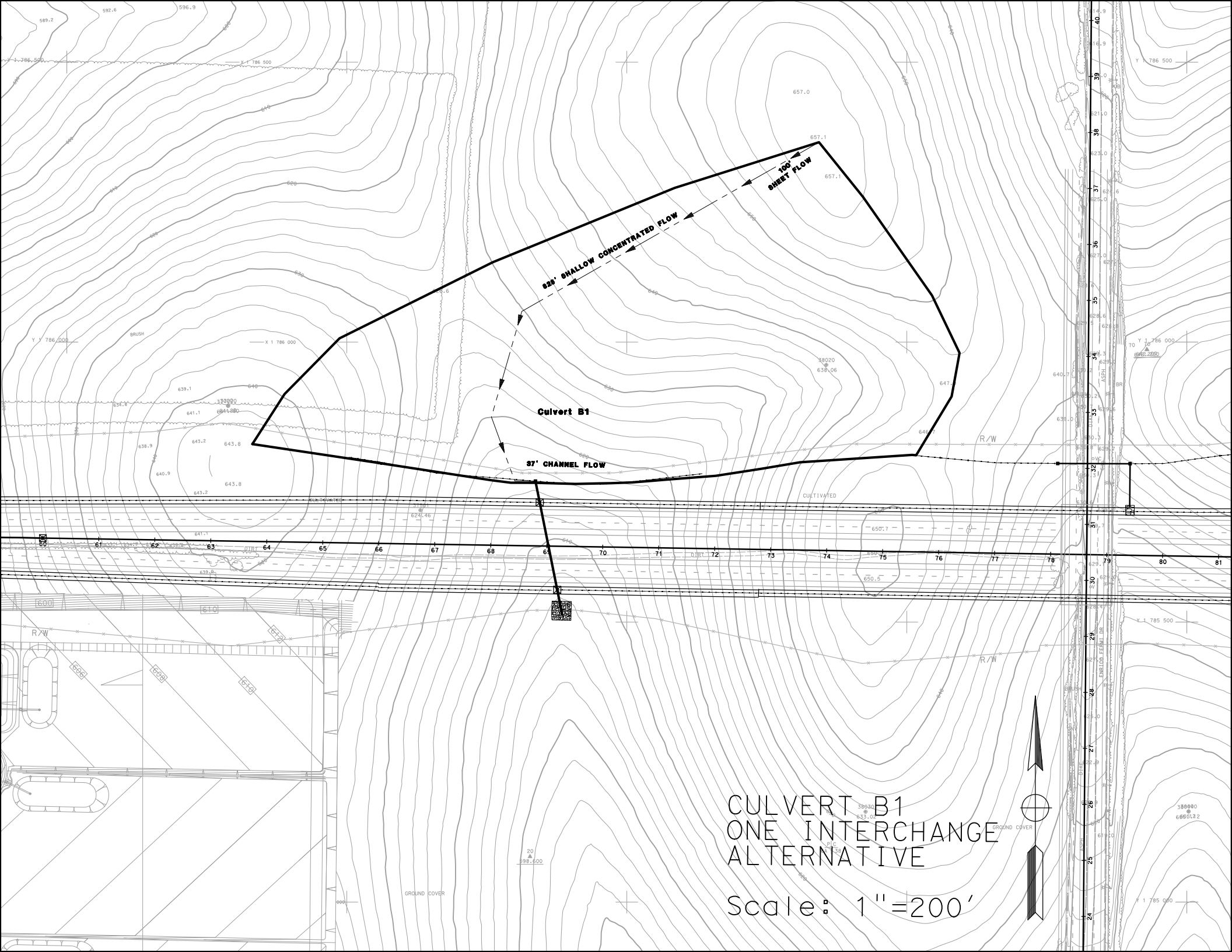
INTENSITY CHART: $I = 7.44\,P_6\,D^{-0.645}$

i_2 =	1.0	in/hr	X CA =	**Q_2 =**	9.8
i_{10} =	1.5	in/hr	X CA =	**Q_{10} =**	14.2
i_{25} =	1.9	in/hr	X CA =	**Q_{25} =**	19.5
i_{50} =	2.3	in/hr	X CA =	**Q_{50} =**	25.6
i_{100} =	2.4	in/hr	X CA =	**Q_{100} =**	**27.7**

FLOW RESULTS: cfs

COUNTY P_6 inches

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


100' SHEET FLOW
525' SHALLOW CONCENTRATED FLOW
Culvert B1
37' CHANNEL FLOW
CULVERT B1
ONE INTERCHANGE
ALTERNATIVE
Scale: 1"=200'

Culvert Calculator Report
B1 10-yr

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	616.50	ft	Headwater Depth/Height	0.77	
Computed Headwater Elevation	616.03	ft	Discharge	7.40	cfs
Inlet Control HW Elev.	615.86	ft	Tailwater Elevation	606.56	ft
Outlet Control HW Elev.	616.03	ft	Control Type	Entrance Control	

Grades					
Upstream Invert	614.50	ft	Downstream Invert	606.00	ft
Length	226.00	ft	Constructed Slope	3.8	%

Hydraulic Profile					
Profile	S2		Depth, Downstream	0.56	ft
Slope Type	Steep		Normal Depth	0.56	ft
Flow Regime	Supercritical		Critical Depth	0.97	ft
Velocity Downstream	10.39	ft/s	Critical Slope	0.5	%

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	2.00	ft
Section Size	24 inch		Rise	2.00	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	616.03	ft	Upstream Velocity Head	0.38	ft
Ke	0.50		Entrance Loss	0.19	ft

Inlet Control Properties					
Inlet Control HW Elev.	615.86	ft	Flow Control	Unsubmerged	
Inlet Type	Square edge w/headwall		Area Full	3.1	ft²
K	0.00980		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	1	
C	0.03980		Equation Form	1	
Y	0.67000				

Culvert Calculator Report
B1 100-yr

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	617.00	ft	Headwater Depth/Height	1.18	
Computed Headwater Elevation	616.85	ft	Discharge	15.00	cfs
Inlet Control HW Elev.	616.72	ft	Tailwater Elevation	606.81	ft
Outlet Control HW Elev.	616.85	ft	Control Type	Entrance Control	

Grades					
Upstream Invert	614.50	ft	Downstream Invert	606.00	ft
Length	226.00	ft	Constructed Slope	3.8	%

Hydraulic Profile					
Profile	S2		Depth, Downstream	0.81	ft
Slope Type	Steep		Normal Depth	0.81	ft
Flow Regime	Supercritical		Critical Depth	1.40	ft
Velocity Downstream	12.65	ft/s	Critical Slope	0.6	%

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	2.00	ft
Section Size	24 inch		Rise	2.00	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	616.85	ft	Upstream Velocity Head	0.64	ft
Ke	0.50		Entrance Loss	0.32	ft

Inlet Control Properties					
Inlet Control HW Elev.	616.72	ft	Flow Control	Unsubmerged	
Inlet Type	Square edge w/headwall		Area Full	3.1	ft²
K	0.00980		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	1	
C	0.03980		Equation Form	1	
Y	0.67000				

B1 Culvert TcQ

PROJECT:	**SR-11**			**DESCRIPTION:**	**SR-11 Post-Developed**
JOB #:	**11A1190**			**STATION:**	**69+00**
BY:	**M.BRUNING**	**DATE:**	**01.04.10**	**WATERSHED:**	**B1 Culvert**
CHK:	**G.DALZIEL**	**DATE:**		**SYSTEM:**	**B1 Culvert**

BASIN AREA:

A = 483334 **ft^2**
11.10 **acres**

SOURCE: **MICROSTATION/USGS**
(SCALE = 1:1)

COEFFICIENT OF RUNOFF:

KEY: User Input | Designer Tool

UNDEVELOPED AREA C (FROM HDM FIG. 819.2A)

NOTES:

RELIEF (.08-.35)	0.14	Rolling Slopes ~ 5%
INFILTRATION (.04-.16)	0.12	Negligible infiltration capacity - see Geotechnical Report
VEGETATION (.04-.16)	0.08	Fair natural cover
STORAGE (.04-.12)	0.08	Low
TOTAL C =	0.42	

UNDEVELOPED AREA	100%	AT	0.42	0.420
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%)			

$C_{2,10}$ =	0.42
C_{25} =	0.46
C_{50} =	0.50
C_{100} =	0.53

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	657.1	ft	northern peak
LOW POINT ELEVATION	654.0	ft	
ELEVATION DIFF (H)	3.1	ft	
LENGTH (L)	100	ft	
SLOPE (S) = (H/L)	3.1%		
MANNING'S n	0.150		< = FROM TABLE 816.6A — short grass prarie
T_t (SFF)=	10.96	minutes	

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

NOTES:

HIGH PT ELEVATION	657.1	ft	northern peak
LOW POINT ELEVATION	615.0	ft	
ELEVATION DIFF (H)	42.1	ft	
LENGTH (L)	828	ft	
SLOPE (S) = (H/L)	5.1%		
VELOCITY (SCF)	1.5	fps	V FROM FIG 816.6 — short grass
T_C (SH)=	9.20	minutes	

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

NOTES:

HIGH PT ELEVATION	615.0	ft	Slope Ditch
LOW POINT ELEVATION	614.5	ft	CHANNEL DATA — TYPE = TRAP'Z
ELEVATION DIFF (H)	0.5	ft	Z= 2 — ANG-RAD 0.464
LENGTH (L)	37	ft	b = 2 — ANG-DEG 26.565
SLOPE (S) = (H/L)	1.4%		d = 0.5 — FLOWING FULL ASS'M
MANNING'S n	0.015		Concrete-rough
HYDRAULIC RADIUS R	0.35	ft	R=(bdsinA+d^2cosA)/(bsinA+2d)
VELOCITY (CHANNEL)	5.78	fps	From Manning's Equation assuming flowing full: $V=1.49/n(R^{2/3}S^{1/2})$
T_C (CH)=	0.11	minutes	

B1 Culvert TcQ

Tc (TOTAL) =	20.27	minutes
Minimum Tc =	10	minutes
USE T_C =	**20.27**	minutes

INTENSITY CHART: Caltrans IDF2000

i_2 =	0.8	in/hr	X CA =	**Q_2 =**	3.9
i_{10} =	1.6	in/hr	X CA =	**Q_{10} =**	7.4
i_{25} =	2.0	in/hr	X CA =	**Q_{25} =**	10.2
i_{50} =	2.3	in/hr	X CA =	**Q_{50} =**	12.8
i_{100} =	2.6	in/hr	X CA =	**Q_{100} =**	**15.0**

FLOW RESULTS

cfs

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 B1 Retention

PROJECT:	SR-11			**DESCRIPTION:**	SR-11 Basin
JOB #:	11A1190			**STATION:**	69+00
BY:	M.BRUNING	**DATE:**	01.04.10	**WATERSHED:**	B1
CHK:	G.DALZIEL	**DATE:**		**SYSTEM:**	One Interchange Option

Notes:

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

RETENTION VOLUME

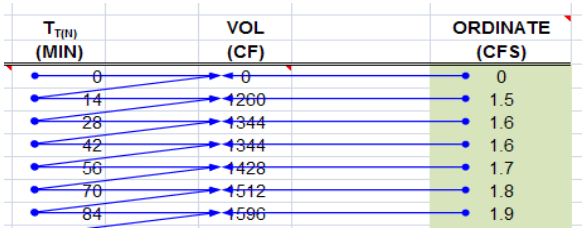
100-year, 6 hour duration storm event, use the Rational Method Hydrograph Procedure (SDCHM 6-1) ~ RatHydro

Pre-Developed volume calculations

Q_{100}=	30.8	cfs			
Tc=	26.2	min	C=	0.53	
$P_{100,6}$=	2.5	in	A=	25.94	acres

$T_{T(N)}$ (MIN)	VOL (CF)	ORDINATE (CFS)
0	0	0
26	3276	2.1
52	3588	2.3
78	3744	2.4
104	4368	2.8
130	4680	3
156	5772	3.7
182	6552	4.2
208	9672	6.2
234	14352	9.2
260	48048	30.8
286	7800	5
312	5148	3.3
338	4056	2.6
364	3432	2.2
390	0	0

Example of Steps:



SUM= 124488 ft^3
2.86 acre-feet

Check: $V = C*A*P_6$
V= 2.84 acre-feet
OK

Basin B1 Retention

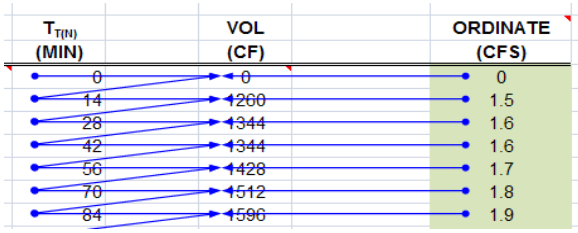
Post-Developed volume calculations

Q_{100}=	27.7	cfs			
Tc=	24.6	min	C=	0.56	
$P_{100,6}$=	2.5	in	A=	20.90	acres

$T_{T(N)}$ (MIN)	VOL (CF)	ORDINATE (CFS)
0	0	0
25	2700	1.8
50	3000	2
75	3150	2.1
100	3600	2.4
125	3900	2.6
150	4800	3.2
175	5550	3.7
200	8100	5.4
225	10800	7.2
250	41550	27.7
275	6450	4.3
300	4350	2.9
325	3450	2.3
350	2850	1.9
375	0	0

*

Example of Steps:



SUM= 104250 ft^3
2.39 acre-feet

Check: $V = C*A*P_6$
V= 2.45 acre-feet
OK

		2.39	*(Post)*		
	-	**2.86**	*(Pre)*		
Retention volume =		**-0.46**	**acre-feet**	=	**-20238 ft^3**

No Basin Required

Basin B1 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}= 0.99
A= 1.07 acres

WQ_{72}: 0.73 in/area

Water Quality Volume (WQV) = **2847** **ft^3**

Treatment within biofiltration swales

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

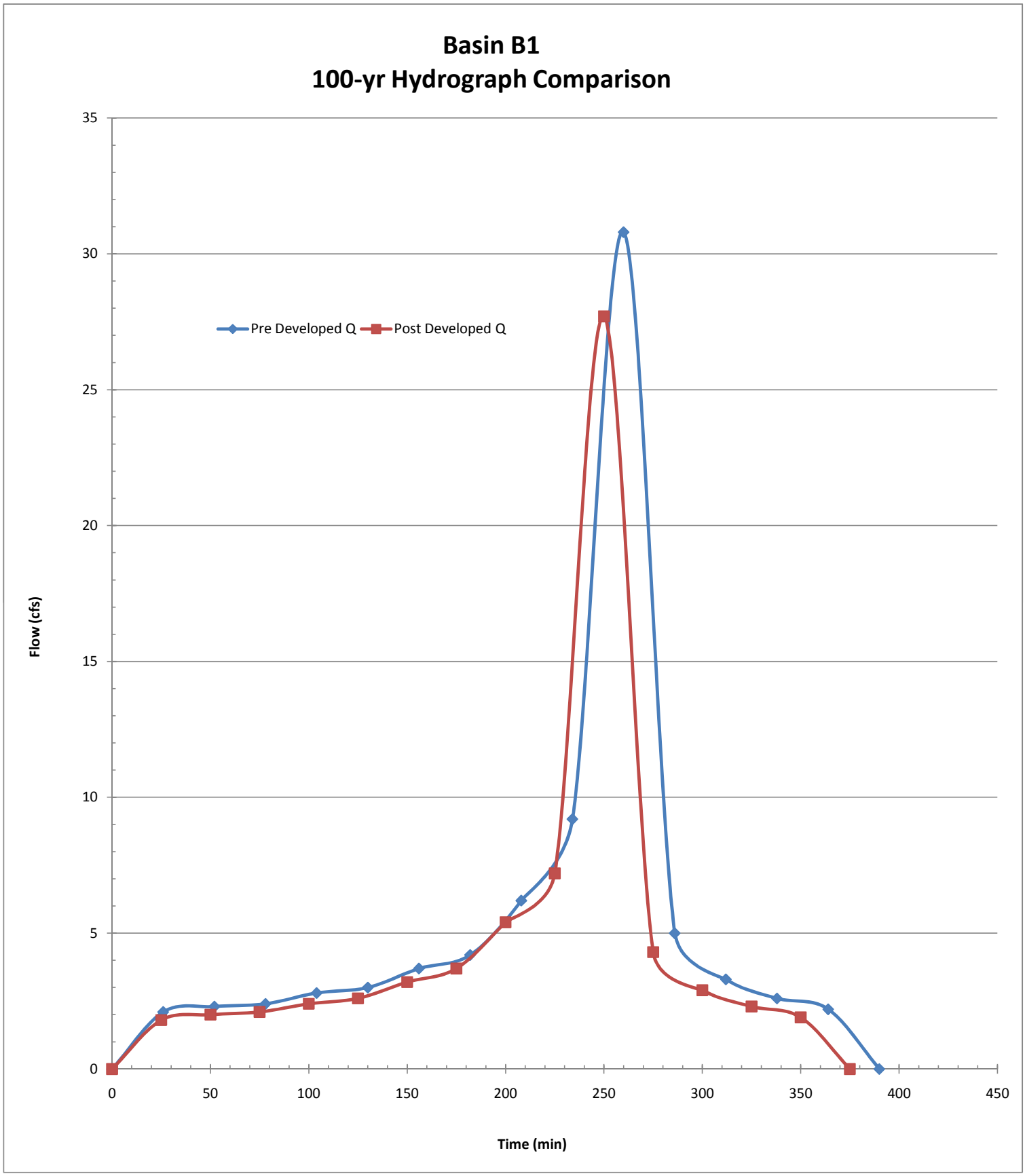
Onsite Highway *Sloped* runoff area, A:		42500	ft^2
	A:	0.98	acres
		10.00	years
where:	R=	30.00	
	K=	0.24	
	Ls=	18.00	
	C=	0.012	
	P=	1.00	
	As	1.56	tons/yr*Ac

Volume for 10-year Silt Accumulation = 15.17 tons

Silt Accumulation Basin volume = **337** **ft^3**

Silt extracted within biofiltration swale

.


Basin B1
100-yr Hydrograph Comparison
Pre Developed Q
Post Developed Q
Flow (cfs)
Time (min)
0
5
10
15
20
25
30
35
0
50
100
150
200
250
300
350
400
450

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C1 Onsite D.A. Table

PROJECT:	**SR-11**	**DESCRIPTION:**	**On-site Drainage Areas (D.A.)**
JOB #:	**11A1190**	**STATION:**	**~**
BY:	**M.BRUNING** **DATE:** **01.04.10**	**WATERSHED:**	**C1**
CHK:	**G.DALZIEL** **DATE:**	**SYSTEM:**	**One 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	Drains to: Inlet	Drains to: Destination	@ Station	Offset
C1.1.PV	0.99	32100	0.7	10	2.8	2.06	4.2	3.07	~	C1.1	*bypass**	29+00	ENF

Σ 32100 *PAVED*

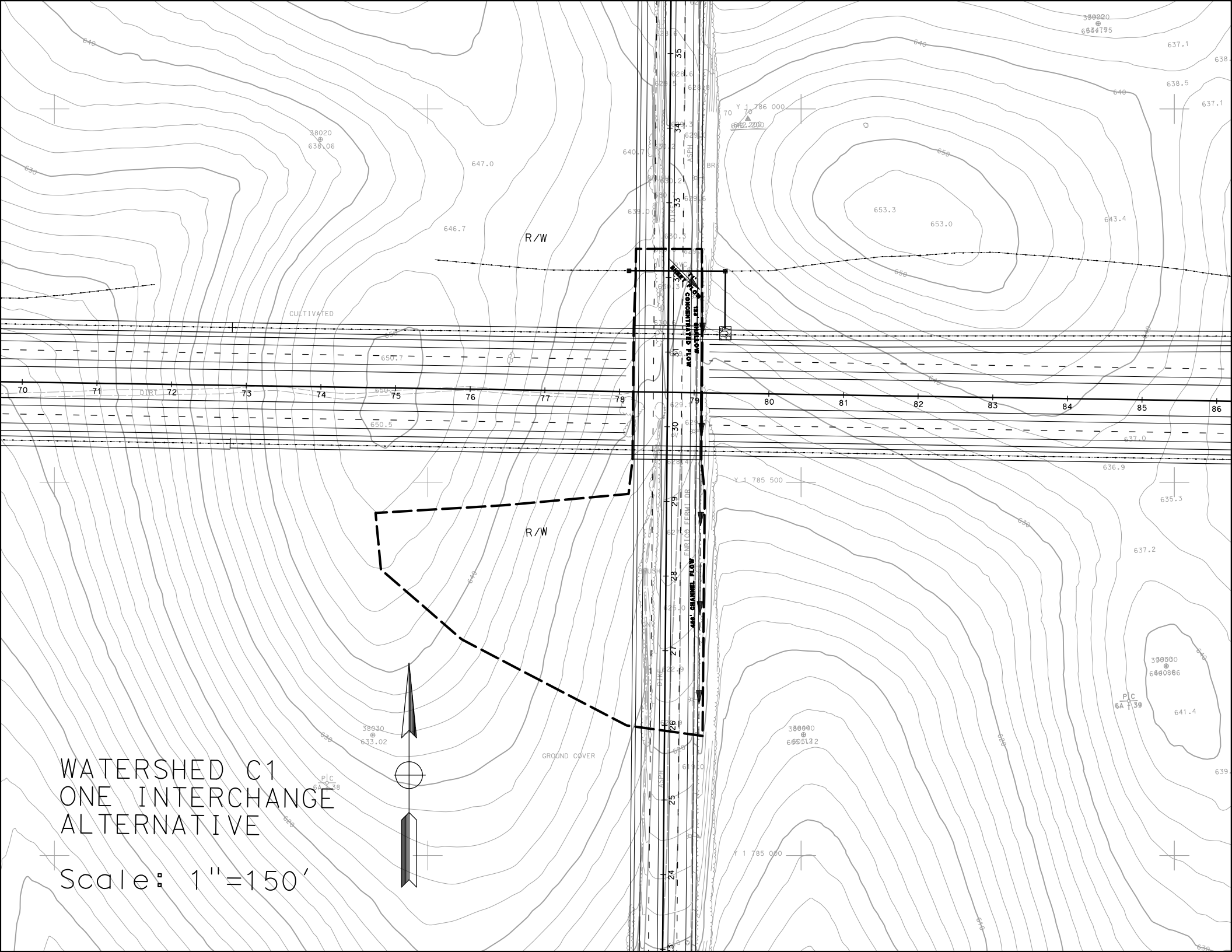
SLOPE

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	Drains to: Inlet	Drains to: Destination	@ Station	Offset
C1.1.SL	0.61	98400	2.3	10	2.8	3.90	4.2	5.80	~	C1.1	*bypass**	26+00	ENF

Σ 98400 *SLOPE*

**flow that does not reach the basin*

Total :	130500 *SF*	3.00 *ac*


R/W
R/W
CULTIVATED
GROUND COVER
ENRICO FERMI DR
Y 1 786 000
Y 1 785 500
Y 1 785 000
70
71
72
73
74
75
76
77
78
79
80
81
82
83
84
85
86
35
34
33
32
31
30
29
28
27
26
25
24
23
WATERSHED C1
ONE INTERCHANGE
ALTERNATIVE
Scale: 1"=150'

C1 Post-Developed TcQ

PROJECT:	**SR-11**			**DESCRIPTION:**	**SR-11 Post-Developed**
JOB #:	**11A1190**			**STATION:**	**78+00**
BY:	**M.BRUNING**	**DATE:**	**01.04.10**	**WATERSHED:**	**C1**
CHK:	**G.DALZIEL**	**DATE:**		**SYSTEM:**	**One Interchange Option**

BASIN AREA:

A =	**130500**	**ft^2**	**SOURCE:**	**MICROSTATION/USGS**
	3.00	**acres**		**(SCALE = 1:1)**

COEFFICIENT OF RUNOFF:

KEY: User Input | Designer Tool

UNDEVELOPED AREA C (FROM HDM FIG. 819.2A)

NOTES:

RELIEF (.08-.35)	0.14	Rolling Slopes ~ 5%
INFILTRATION (.04-.16)	0.12	Negligible infiltration capacity - see Geotechnical Report
VEGETATION (.04-.16)	0.08	Fair natural cover
STORAGE (.04-.12)	0.08	Low
TOTAL C =	0.42	

UNDEVELOPED AREA	75%	AT	0.42	0.317
PAVED SURFACE	25%	AT	0.90	0.221
COMMERCIAL AREA	0%	AT	0.85	0.000
CUT SLOPE (2:1 and 4:1)	0%	AT	0.55	0.000
TOTAL	100%			
	(100%)			

$C_{2,10}$ =	0.54
C_{25} =	0.59
C_{50} =	0.65
C_{100} =	0.67

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	630.8	ft	High Point on Enrico Fermi, north of SR-11
LOW POINT ELEVATION	630.0	ft	
ELEVATION DIFF (H)	0.8	ft	
LENGTH (L)	71	ft	
SLOPE (S) = (H/L)	1.2%		
MANNING'S n	0.016		< = From Table 816.6A Asphalt
T_t (SFF)=	2.05	minutes	

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

NOTES:

HIGH PT ELEVATION	630.0	ft	Eastern Gutter of Enrico Fermi, north of SR-11
LOW POINT ELEVATION	629.0	ft	Caltrans ROW
ELEVATION DIFF (H)	1.0	ft	
LENGTH (L)	123	ft	
SLOPE (S) = (H/L)	0.8%		
VELOCITY (SCF)	1.5	fps	V FROM FIG 816.6 nearly bare ground
T_C (SH)=	1.37	minutes	

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

NOTES:

HIGH PT ELEVATION	629.0	ft	Enrico Fermi Gutter - east
LOW POINT ELEVATION	620.0	ft	
ELEVATION DIFF (H)	9.0	ft	
LENGTH (L)	456	ft	
SLOPE (S) = (H/L)	2.0%		
MANNING'S n	0.015		
HYDRAULIC RADIUS R	0.16	ft	
VELOCITY (CHANNEL)	4.04	fps	
T_C (CH)=	1.88	minutes	

CHANNEL DATA		TYPE =	TRAP'Z
Z=	12	ANG-RAD	0.083
b =	2	ANG-DEG	4.764
d =	0.25	FLOWING FULL ASS'M	

Gutter

R=(bdsinA+d^2cosA)/(bsinA+2d)

From Manning's Equation assuming flowing full: $V=1.49/n(R^{2/3}S^{1/2})$

C1 Post-Developed TcQ

Tc (TOTAL) =	5.29	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 =	**Q_2 =** 3.0
i_{10} =	2.7	in/hr	X CA =	**Q_{10} =** 4.3
i_{25} =	3.4	in/hr	X CA =	**Q_{25} =** 6.0
i_{50} =	4.0	in/hr	X CA =	**Q_{50} =** 7.8
i_{100} =	4.2	in/hr	X CA =	**Q_{100} =** **8.5**

FLOW RESULTS:

cfs

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 C1 Retention

PROJECT:	SR-11			**DESCRIPTION:**	SR-11 Basin
JOB #:	11A1190			**STATION:**	78+00
BY:	M.BRUNING	**DATE:**	01.04.10	**WATERSHED:**	C1
CHK:	G.DALZIEL	**DATE:**		**SYSTEM:**	One Interchange Option

Notes:

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

RETENTION VOLUME

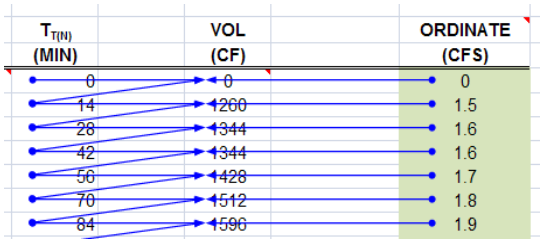
100-year, 6 hour duration storm event, use the Rational Method Hydrograph Procedure (SDCHM 6-1) ~ RatHydro

Pre-Developed volume calculations

Q_{100}=	16.4	cfs			
Tc=	10.0	min	C=	0.60	
$P_{100,6}$=	2.5	in	A=	6.49	acres

$T_{T(N)}$ (MIN)	VOL (CF)	ORDINATE (CFS)
0	0	0
10	360	0.6
20	360	0.6
30	360	0.6
40	360	0.6
50	420	0.7
60	420	0.7
70	420	0.7
80	420	0.7
90	480	0.8
100	480	0.8
110	480	0.8
120	540	0.9
130	540	0.9
140	600	1
150	600	1
160	660	1.1
170	720	1.2
180	780	1.3
190	900	1.5
200	960	1.6
210	1140	1.9
220	1320	2.2
230	1920	3.2
240	2760	4.6
250	9840	16.4
260	1560	2.6
270	1020	1.7
280	840	1.4
290	660	1.1
300	600	1
310	540	0.9
320	480	0.8
330	420	0.7
340	420	0.7
350	360	0.6
360	360	0.6
370	0	0

Example of Steps:



SUM= 35100 ft^3
0.81 acre-feet

Check: $V = C*A*P_6$
V= 0.81 acre-feet
OK

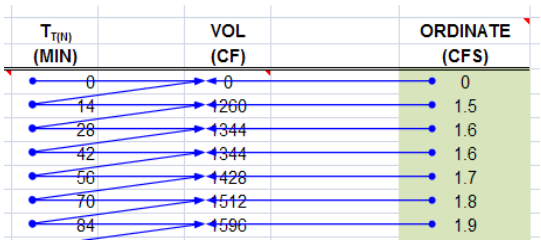
Basin C1 Retention

Post-Developed volume calculations

Q_{100}=	8.5	cfs			
Tc=	10.0	min	C=	0.67	
$P_{100,6}$=	2.5	in	A=	3.00	acres

$T_{T(N)}$ (MIN)	VOL (CF)	ORDINATE (CFS)
0	0	0
10	180	0.3
20	180	0.3
30	180	0.3
40	180	0.3
50	180	0.3
60	180	0.3
70	240	0.4
80	240	0.4
90	240	0.4
100	240	0.4
110	240	0.4
120	240	0.4
130	300	0.5
140	300	0.5
150	300	0.5
160	360	0.6
170	360	0.6
180	420	0.7
190	480	0.8
200	480	0.8
210	600	1
220	660	1.1
230	1020	1.7
240	1380	2.3
250	5100	8.5
260	780	1.3
270	540	0.9
280	420	0.7
290	360	0.6
300	300	0.5
310	300	0.5
320	240	0.4
330	240	0.4
340	240	0.4
350	180	0.3
360	180	0.3
370	0	0

Example of Steps:



SUM= 18060 ft^3
0.41 acre-feet

Check: $V = C*A*P_6$
V= 0.42 acre-feet
OK

	0.41	*(Post)*			
-	**0.81**	*(Pre)*			
Retention volume =	**-0.39**	**acre-feet**	**=**	**-17040 ft^3**	**No Basin Required**

Basin C1 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}= 0.99
A= 0.74 acres

WQ_{72}: 0.73 in/area

Water Quality Volume (WQV) = **1953** **ft^3**

Treatment within biofiltration swales

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:

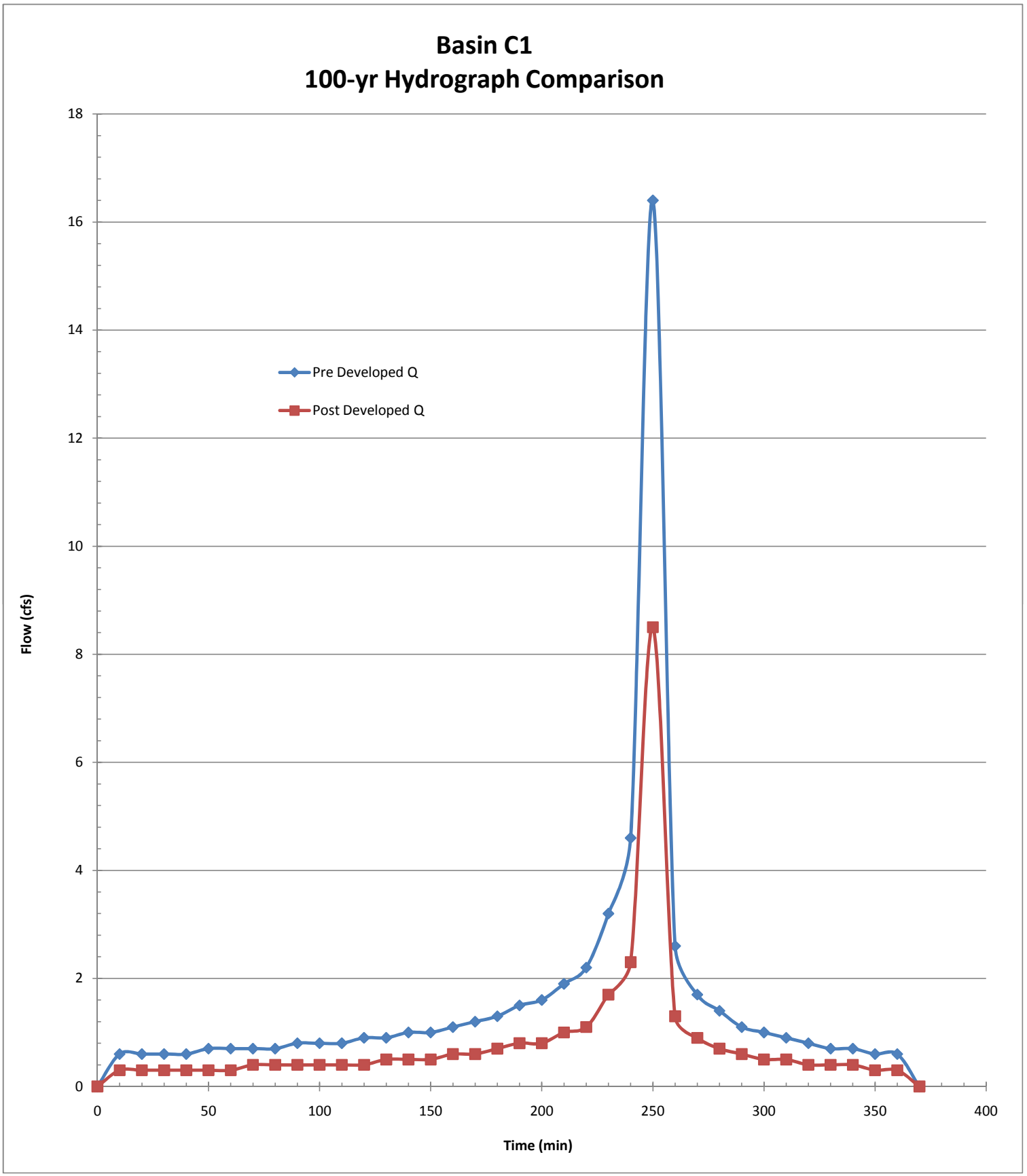
A_s = the computed soil loss in tons (dry weight)
R = the rainfall erosion index for the given storm period
K = the soil erodibility factor
L = the slope length factor
s = the slope gradient factor
C = cropping management (vegetation) factor
P = erosion control practice factor

Onsite Highway *Sloped* runoff area, A:		98400	ft^2
	A:	2.26	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 = 35.13 tons

Silt Accumulation Basin volume = **781** **ft^3**

Silt extracted within biofiltration swale


Basin C1
100-yr Hydrograph Comparison
Pre Developed Q
Post Developed Q
Flow (cfs)
Time (min)
0
2
4
6
8
10
12
14
16
18
0
50
100
150
200
250
300
350
400

D1 Onsite D.A. Table

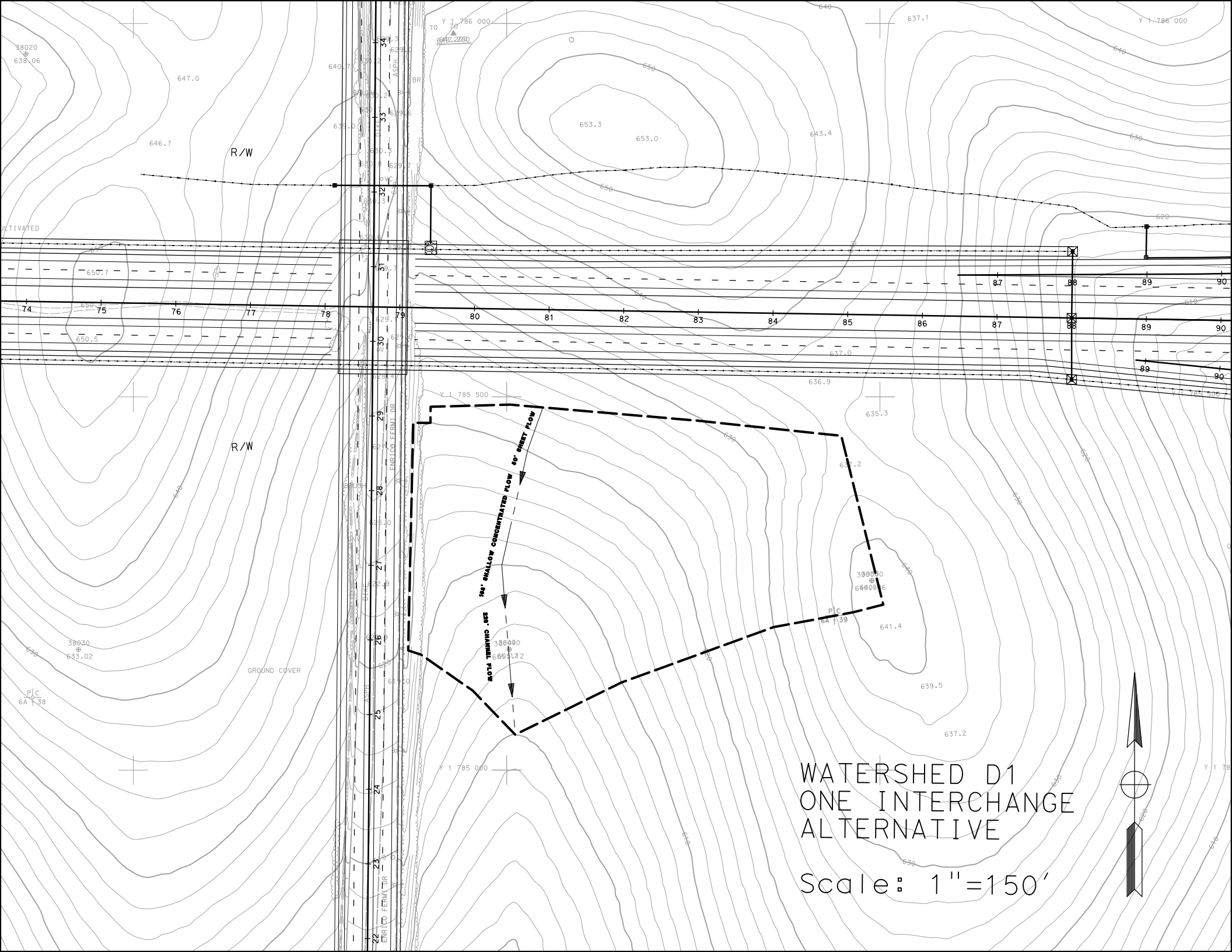
PROJECT:	**SR-11**	**DESCRIPTION:**	**On-site Drainage Areas (D.A.)**
JOB #:	**11A1190**	**STATION:**	**~**
BY:	**M.BRUNING** **DATE:** **01.04.10**	**WATERSHED:**	**D1**
CHK:	**G.DALZIEL** **DATE:**	**SYSTEM:**	**One Interchange Option**

						Caltrans	Caltrans	County	County					
PAVED			Area		Tc	i_{25}	Q_{25}	i_{100}	Q_{100}	Drains to:				
	Name	C	*SF*	*Acres*	*min*	*in/hr*	*cfs*	*in/hr*	*cfs*	Bioswale	Inlet	Destination	@ Station	Offset
	~	0.99	0	0.0	~	~	~	~	~	~	~	~	~	~
	Σ		0	*PAVED*										

						Caltrans	Caltrans	County	County					
SLOPE			Area		Tc	i_{25}	Q_{25}	i_{100}	Q_{100}	Drains to:				
	Name	C	*SF*	*Acres*	*min*	*in/hr*	*cfs*	*in/hr*	*cfs*	Bioswale	Inlet	Destination	@ Station	Offset
	D1.1.SL	0.61	202600	4.7	10	2.8	7.99	4.2	11.95	~	D1.1	**bypass*	26+00	ENF
	Σ		202600	*SLOPE*										

**flow that does not reach the basin*

Total :	202600	4.7
	SF	*ac*


R/W
R/W
100' SHALLOW CONCENTRATED FLOW
50' SHEET FLOW
225' CHANNEL FLOW
GROUND COVER
WATERSHED D1
ONE INTERCHANGE
ALTERNATIVE
Scale: 1"=150'

D1 Post-Developed TcQ

PROJECT:	**SR-11**			**DESCRIPTION:**	**SR-11 Post-Developed**
JOB #:	**11A1190**			**STATION:**	**81+00**
BY:	**M.BRUNING**	**DATE:**	**01.04.10**	**WATERSHED:**	**D1**
CHK:	**G.DALZIEL**	**DATE:**		**SYSTEM:**	**One Interchange Option**

BASIN AREA:

A = **202600** **ft^2** **SOURCE:** **MICROSTATION/USGS**
4.65 **acres** **(SCALE = 1:1)**

COEFFICIENT OF RUNOFF:

KEY: User Input | Designer Tool

UNDEVELOPED AREA C (FROM HDM FIG. 819.2A)

		NOTES:
RELIEF (.08-.35)	0.14	Rolling Slopes ~ 5%
INFILTRATION (.04-.16)	0.12	Negligible infiltration capacity - see Geotechnical Report
VEGETATION (.04-.16)	0.08	Fair natural cover
STORAGE (.04-.12)	0.08	Low
TOTAL C =	0.42	

UNDEVELOPED AREA	100%	AT	0.42	0.420
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%)			

$C_{2,10}$ =	0.42
C_{25} =	0.46
C_{50} =	0.50
C_{100} =	0.53

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	624.0	ft	High Point in Watershed, south of SR-11
LOW POINT ELEVATION	621.0	ft	
ELEVATION DIFF (H)	3.0	ft	
LENGTH (L)	50	ft	
SLOPE (S) = (H/L)	6.0%		
MANNING'S n	0.100		< = From Table 816.6A nearly bare ground
T_t (SFF)=	3.50	minutes	

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

NOTES:

HIGH PT ELEVATION	621.0	ft	
LOW POINT ELEVATION	612.0	ft	
ELEVATION DIFF (H)	9.0	ft	
LENGTH (L)	168	ft	
SLOPE (S) = (H/L)	5.4%		
VELOCITY (SCF)	2.4	fps	V FROM FIG 816.6 nearly bare ground
T_C (SH)=	1.17	minutes	

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

NOTES:

HIGH PT ELEVATION	612.0	ft	begins to channelize
LOW POINT ELEVATION	600.0	ft	CHANNEL DATA TYPE = TRAP'Z
ELEVATION DIFF (H)	12.0	ft	Z= 5 ANG-RAD 0.197
LENGTH (L)	228	ft	b = 2 ANG-DEG 11.310
SLOPE (S) = (H/L)	5.3%		d = 0.5 FLOWING FULL ASS'M
MANNING'S n	0.150		short prairie grass
HYDRAULIC RADIUS R	0.3	ft	R=(bdsinA+d^2cosA)/(bsinA+2d)
VELOCITY (CHANNEL)	1.06	fps	From Manning's Equation assuming flowing full: $V=1.49/n(R^{2/3}S^{1/2})$
T_C (CH)=	3.59	minutes	

D1 Post-Developed TcQ

Tc (TOTAL) =	8.25	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 =	3.6
Q_{10} =	5.3
Q_{25} =	7.2
Q_{50} =	9.5
Q_{100} =	**10.3**

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 D1 Retention

PROJECT:	**SR-11**			**DESCRIPTION:**	**SR-11 Basin**
JOB #:	**11A1190**			**STATION:**	**81+00**
BY:	**M.BRUNING**	**DATE:**	**01.04.10**	**WATERSHED:**	**D1**
CHK:	**G.DALZIEL**	**DATE:**		**SYSTEM:**	**One Interchange Option**

Notes:

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

RETENTION VOLUME

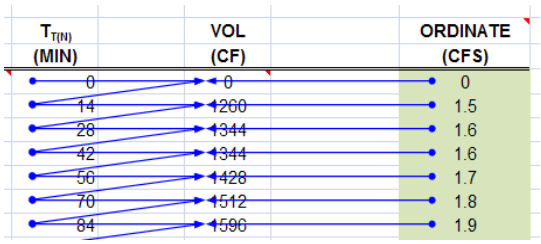
100-year, 6 hour duration storm event, use the Rational Method Hydrograph Procedure (SDCHM 6-1) ~ RatHydro

Pre-Developed volume calculations

Q_{100}=	18.5	cfs			
Tc=	11.0	min	C=	0.53	
$P_{100,6}$=	2.5	in	A=	8.89	acres

$T_{T(N)}$ (MIN)	VOL (CF)	ORDINATE (CFS)
0	0	0
11	462	0.7
22	462	0.7
33	462	0.7
44	528	0.8
55	528	0.8
66	528	0.8
77	594	0.9
88	594	0.9
99	594	0.9
110	660	1
121	660	1
132	726	1.1
143	792	1.2
154	792	1.2
165	924	1.4
176	990	1.5
187	1122	1.7
198	1188	1.8
209	1452	2.2
220	1650	2.5
231	2442	3.7
242	3564	5.4
253	12210	18.5
264	1980	3
275	1320	2
286	1056	1.6
297	858	1.3
308	726	1.1
319	660	1
330	594	0.9
341	528	0.8
352	528	0.8
363	462	0.7
374	0	0

Example of Steps:



SUM= 42636 ft^3
0.98 acre-feet

Check: $V = C*A*P_6$
V= 0.97 acre-feet
OK

Basin D1 Retention

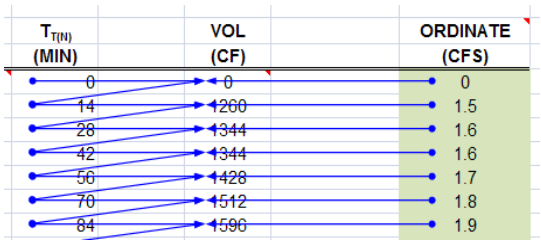
Post-Developed volume calculations

Q_{100}= 10.3 cfs
Tc= 10.0 min
$P_{100,6}$= 2.5 in

C= 0.53
A= 4.65 acres

$T_{T(N)}$ (MIN)	VOL (CF)	ORDINATE (CFS)
0	0	0
10	240	0.4
20	240	0.4
30	240	0.4
40	240	0.4
50	240	0.4
60	240	0.4
70	240	0.4
80	300	0.5
90	300	0.5
100	300	0.5
110	300	0.5
120	300	0.5
130	360	0.6
140	360	0.6
150	420	0.7
160	420	0.7
170	480	0.8
180	480	0.8
190	540	0.9
200	600	1
210	720	1.2
220	840	1.4
230	1260	2.1
240	1800	3
250	6180	10.3
260	960	1.6
270	660	1.1
280	540	0.9
290	420	0.7
300	360	0.6
310	360	0.6
320	300	0.5
330	300	0.5
340	240	0.4
350	240	0.4
360	240	0.4
370	0	0

Example of Steps:



SUM= 22260 ft^3
0.51 acre-feet

Check: $V = C*A*P_6$
V= 0.51 acre-feet
OK

	0.51	*(Post)*	
-	**0.98**	*(Pre)*	
Retention volume =	**-0.47**	**acre-feet**	**= -20376 ft^3**

No Basin Required

Basin D1 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}= 0.99
A= 0.00 acres

WQ_{72}: 0.73 in/area

Water Quality Volume (WQV) = **0** **ft^3**

No pavement areas proposed in this watershed

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

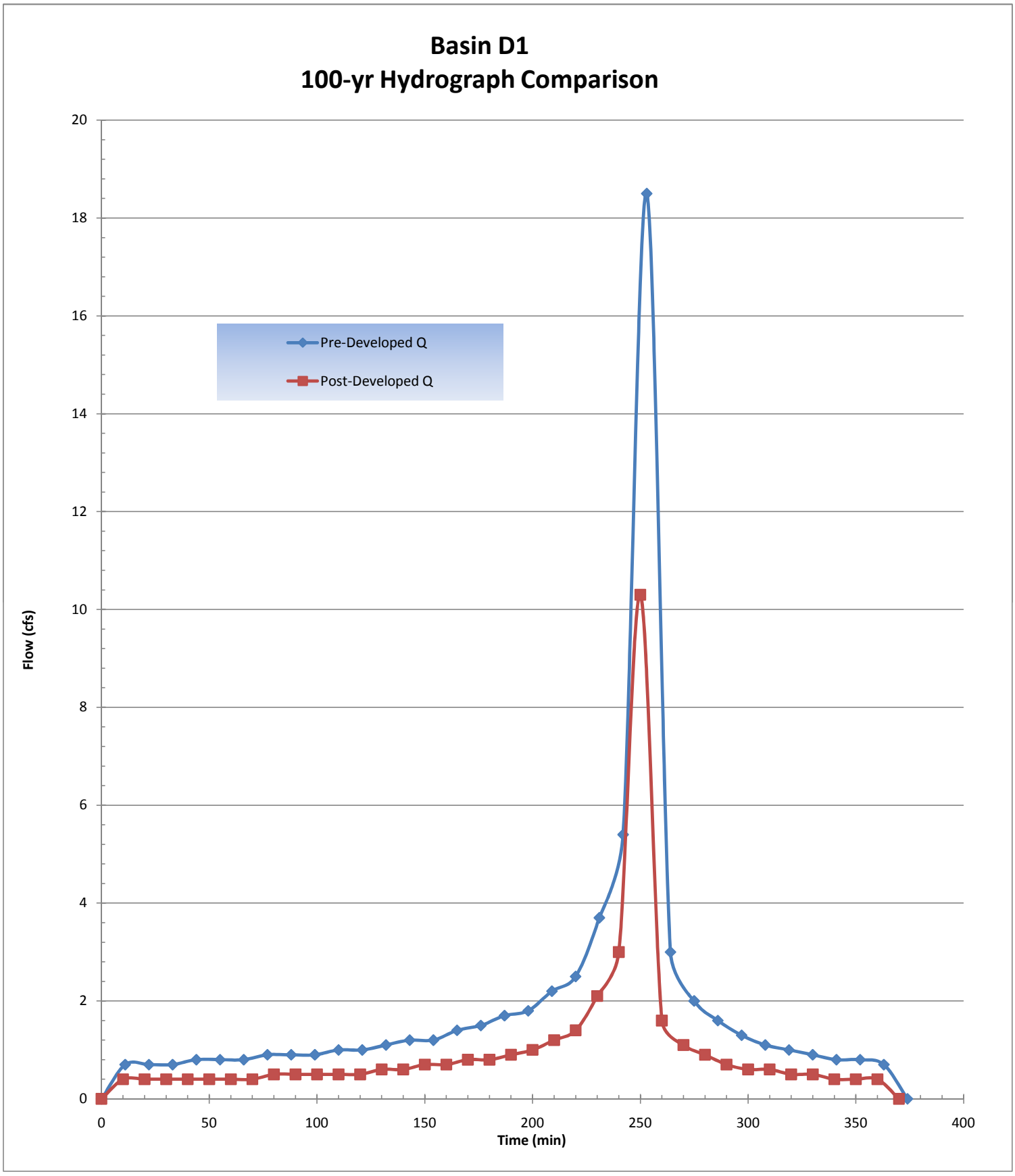
Onsite Highway *Sloped* runoff area, A:		202600	ft^2
	A:	4.65	acres
		10.00	years
where:	R=	30.00	
	K=	0.24	
	Ls=	18.00	
	C=	0.012	
	P=	1.00	
	As	1.56	tons/yr*Ac

Volume for 10-year Silt Accumulation = 72.33 tons

Silt Accumulation Basin volume = **1607** **ft^3**

These are existing Sloped Areas to remain

.


Basin D1
100-yr Hydrograph Comparison
Pre-Developed Q
Post-Developed Q
Flow (cfs)
Time (min)
0
2
4
6
8
10
12
14
16
18
20
0
50
100
150
200
250
300
350
400

E1 Onsite D.A. Table

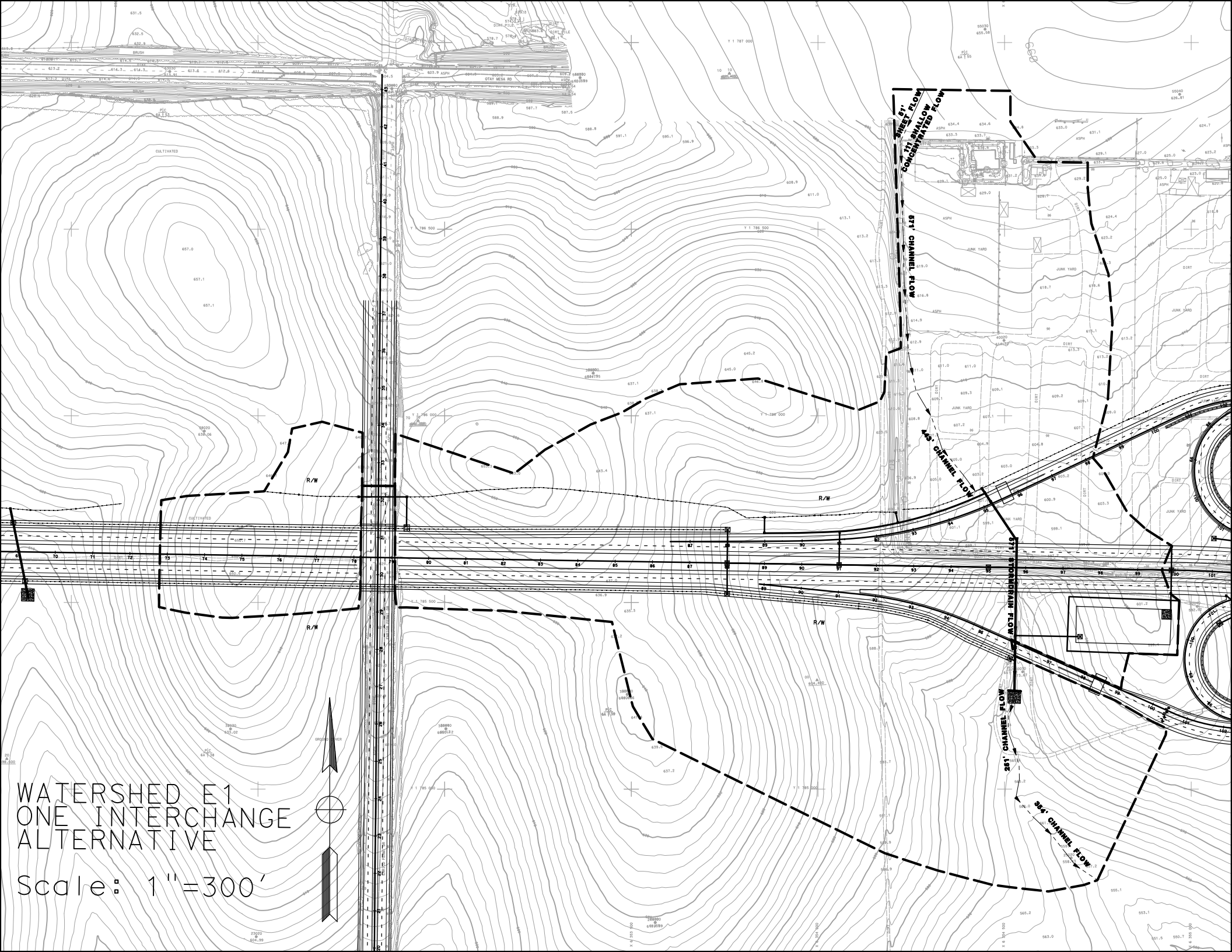
PROJECT:	**SR-11**	**DESCRIPTION:**	**Onsite Drainage Areas (D.A.)**
JOB #:	**11A1190**	**STATION:**	**~**
BY:	**M.BRUNING** **DATE:** **01.06.10**	**WATERSHED:**	**E1**
CHK:	**G.DALZIEL** **DATE:**	**SYSTEM:**	**One Interchange Option**

			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
PAVED	E1.1.PV	0.99	98500	2.3	10	2.8	6.33	4.2	9.43	E1.1	E1.1	Basin E1	88+00	Lt
	E1.2.PV	0.99	52500	1.2	5	4.0	4.77	6.6	7.86	~	E1.2	Basin E1	91+00	Lt
	E1.3.PV	0.99	43300	1.0	10	2.8	2.78	4.2	4.15	E1.3	E1.3	bypass*	96+00	Rt
	E1.4.PV	0.99	51500	1.2	5	4.0	4.68	6.6	7.71	~	E1.4	Basin E1	100+00	Lt
	E1.5.PV	0.99	54400	1.2	5	4.0	4.95	6.6	8.14	~	E1.5	Basin E1	100+00	Rt
	E1.10.PV	0.99	90700	2.1	6	3.7	7.53	5.9	12.07	E1.10	E1.10	Basin E1	88+00	Rt
		Σ	390900	*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
SLOPE	E1.1.SL	0.61	146500	3.4	10	2.8	5.80	4.2	8.64	E1.1	E1.1	Basin E1	88+00	Lt
	E1.2.SL	0.61	19600	0.4	5	4.0	1.10	6.6	1.81	~	E1.2	Basin E1	91+00	Lt
	E1.3.SL	0.61	25700	0.6	10	2.8	1.02	4.2	1.52	E1.3	E1.3	bypass*	96+00	Rt
	E1.4.SL	0.61	79900	1.8	5	4.0	4.48	6.6	7.37	~	E1.4	Basin E1	100+00	Lt
	E1.5.SL	0.61	104100	2.4	5	4.0	5.83	6.6	9.60	~	E1.5	Basin E1	100+00	Rt
	E1.6.SL	0.60	40800	0.9	10	3.3	1.82	4.2	2.35	E1.1	E1.6	Basin E1	78+00	Lt
	E1.7.SL	0.60	35000	0.8	10	3.3	1.56	4.2	2.02	E1.1	E1.7	Basin E1	79+50	Lt
	E1.8.SL	0.60	163800	3.8	10	3.3	7.30	4.2	9.45	~	E1.8	Culvert	88+00	Lt
	E1.9.SL	0.60	119300	2.7	10	3.3	5.31	4.2	6.88	~	E1.9	Culvert	92+50	Lt
	E1.10.SL	0.65	71500	1.6	11	3.1	3.31	4.0	4.23	E1.10	E1.10	Basin E1	88+00	Rt
		Σ	806200	*SLOPE*										

** flow that does not reach the basin*

Total :	1197100	27.5
	SF	*ac*



WATERSHED E1
ONE INTERCHANGE ALTERNATIVE

Scale: 1"=300'

E1 Post-Developed TcQ

PROJECT:	SR-11			**DESCRIPTION:**	SR-11 Post-Developed
JOB #:	11A1190			**STATION:**	96+00
BY:	M.BRUNING	**DATE:**	01.06.10	**WATERSHED:**	E1
CHK:	G.DALZIEL	**DATE:**		**SYSTEM:**	One Interchange Option

BASIN AREA:

A =	2495864	ft^2	**SOURCE:**	MICROSTATION/USGS
	57.30	acres		(SCALE = 1:1)

COEFFICIENT OF RUNOFF:

KEY: User Input | Designer Tool

UNDEVELOPED AREA C (FROM HDM FIG. 819.2A)

		NOTES:
RELIEF (.08-.35)	0.15	Rolling Slopes ~ 7.5%
INFILTRATION (.04-.16)	0.12	Negligible infiltration capacity - see Geotechnical Report
VEGETATION (.04-.16)	0.08	Fair natural cover
STORAGE (.04-.12)	0.08	Low
TOTAL C =	0.43	

UNDEVELOPED AREA	52%	AT	0.43	0.224
PAVED SURFACE	16%	AT	0.90	0.141
COMMERCIAL AREA	0%	AT	0.85	0.000
CUT SLOPE (2:1 and 4:1)	32%	AT	0.55	0.178
TOTAL	100%			
	(100%)			

$C_{2,10}$ =	0.54
C_{25} =	0.60
C_{50} =	0.65
C_{100} =	0.68

TIME OF CONCENTRATION:

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

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

HIGH PT ELEVATION	635.0	ft	South of Otay Mesa Road - Driveway Area
LOW POINT ELEVATION	634.0	ft	
ELEVATION DIFF (H)	1.0	ft	
LENGTH (L)	51	ft	
SLOPE (S) = (H/L)	2.0%		
MANNING'S n	0.016		< = From Table 816.6A Asphalt
T_t (SFF)=	1.28	minutes	

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

NOTES:

HIGH PT ELEVATION	634.0	ft	Mid-driveway
LOW POINT ELEVATION	633.0	ft	North end of Junk Yard
ELEVATION DIFF (H)	1.0	ft	
LENGTH (L)	111	ft	
SLOPE (S) = (H/L)	0.9%		
VELOCITY (SCF)	1.5	fps	<=V FROM FIG 816.6 Asphalt
T_C (SH)=	1.23	minutes	

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

NOTES:

HIGH PT ELEVATION	633.0	ft	channel along western side of junk yard
LOW POINT ELEVATION	612.0	ft	
ELEVATION DIFF (H)	21.0	ft	
LENGTH (L)	571	ft	
SLOPE (S) = (H/L)	3.7%		
MANNING'S n	0.050		earthen/dirt
HYDRAULIC RADIUS R	0.3	ft	R=(bdsinA+d^2cosA)/(bsinA+2d)
VELOCITY (CHANNEL)	2.61	fps	From Manning's Equation assuming flowing full: V=1.49/n($R^{2/3}S^{1/2}$)
T_C (CH)=	3.64	minutes	

CHANNEL DATA — TYPE = TRAP'Z

Z=	2	ANG-RAD	0.464
b =	1	ANG-DEG	26.565
d =	0.5	FLOWING FULL ASS'M	

E1 Post-Developed TcQ

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

HIGH PT ELEVATION	612.0	ft
LOW POINT ELEVATION	602.0	ft
ELEVATION DIFF (H)	10.0	ft
LENGTH (L)	443	ft
SLOPE (S) = (H/L)	2.3%	
MANNING'S n	0.100	
HYDRAULIC RADIUS R	0.3	ft
VELOCITY (CHANNEL)	0.97	fps
T_C (CH)=	7.58	minutes

NOTES:

Begins to broaden across junk yard

CHANNEL DATA		TYPE =	TRAP'Z
Z=	5	ANG-RAD	0.197
b =	1	ANG-DEG	11.310
d =	0.5	FLOWING FULL ASS'M	

dirt with junk yard obstructions

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	596.0	ft
LOW POINT ELEVATION	570.0	ft
ELEVATION DIFF (H)	26.0	ft
LENGTH (L)	571	ft
SLOPE (S) = (H/L)	4.6%	
MANNING'S n	0.013	
PIPE DIAMETER d	3.5	ft
HYDRAULIC RADIUS R	0.9	ft
VELOCITY (STORMDRAIN)	22.4	fps
T_C (SD)=	0.43	minutes

NOTES:

Proposed Cross Culvert (assumed 6' drop to invert)

Proposed Rip Rap Pad

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	570.0	ft
LOW POINT ELEVATION	565.2	ft
ELEVATION DIFF (H)	4.8	ft
LENGTH (L)	251	ft
SLOPE (S) = (H/L)	1.9%	
MANNING'S n	0.100	
HYDRAULIC RADIUS R	0.6	ft
VELOCITY (CHANNEL)	1.50	fps
T_C (CH)=	2.80	minutes

NOTES:

Natural Channel

CHANNEL DATA		TYPE =	TRAP'Z
Z=	2	ANG-RAD	0.464
b =	2	ANG-DEG	26.565
d =	1	FLOWING FULL ASS'M	

grass

R=(bdsinA+d^2cosA)/(bsinA+2d)

From Manning's Equation assuming flowing full: $V=1.49/n(R^{2/3}S^{1/2})$

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

HIGH PT ELEVATION	565.2	ft
LOW POINT ELEVATION	556.0	ft
ELEVATION DIFF (H)	9.2	ft
LENGTH (L)	354	ft
SLOPE (S) = (H/L)	2.6%	
MANNING'S n	0.100	
HYDRAULIC RADIUS R	0.7	ft
VELOCITY (CHANNEL)	1.81	fps
T_C (CH)=	3.26	minutes

NOTES:

Begins to broaden

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

grass

R=(bdsinA+d^2cosA)/(bsinA+2d)

From Manning's Equation assuming flowing full: $V=1.49/n(R^{2/3}S^{1/2})$

Tc (TOTAL) =	20.23	minutes
Minimum Tc =	10	minutes
USE Tc =	**20.23**	minutes

Total Length of Run (ft) = 2352

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

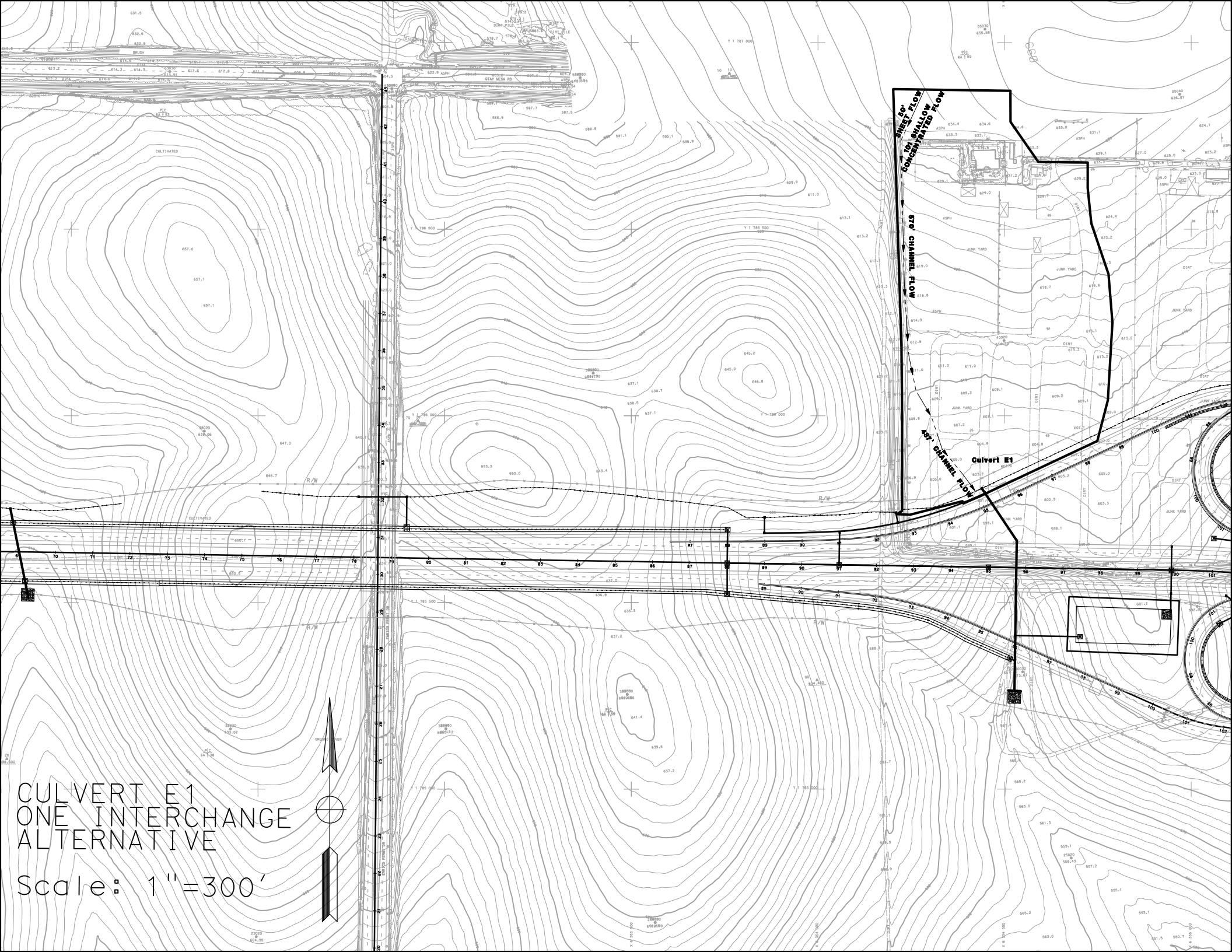
i_2 =	1.2	in/hr	X CA =
i_{10} =	1.7	in/hr	X CA =
i_{25} =	2.1	in/hr	X CA =
i_{50} =	2.6	in/hr	X CA =
i_{100} =	2.7	in/hr	X CA =

FLOW RESULTS:

	cfs
Q_2 =	36.6
Q_{10} =	53.2
Q_{25} =	73.1
Q_{50} =	95.7
Q_{100} =	**103.9**

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 E1
ONE INTERCHANGE ALTERNATIVE

Scale: 1"=300'

Culvert Calculator Report
E1 10-yr

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	599.00	ft	Headwater Depth/Height	0.65	
Computed Headwater Elevation	597.96	ft	Discharge	15.40	cfs
Inlet Control HW Elev.	597.70	ft	Tailwater Elevation	570.67	ft
Outlet Control HW Elev.	597.96	ft	Control Type	Entrance Control	

Grades					
Upstream Invert	596.00	ft	Downstream Invert	570.00	ft
Length	571.00	ft	Constructed Slope	4.6	%

Hydraulic Profile					
Profile	S2		Depth, Downstream	0.67	ft
Slope Type	Steep		Normal Depth	0.67	ft
Flow Regime	Supercritical		Critical Depth	1.25	ft
Velocity Downstream	13.17	ft/s	Critical Slope	0.4	%

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	3.00	ft
Section Size	36 inch		Rise	3.00	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	597.96	ft	Upstream Velocity Head	0.47	ft
Ke	0.50		Entrance Loss	0.24	ft

Inlet Control Properties					
Inlet Control HW Elev.	597.70	ft	Flow Control	Unsubmerged	
Inlet Type	Square edge w/headwall		Area Full	7.1	ft²
K	0.00980		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	1	
C	0.03980		Equation Form	1	
Y	0.67000				

Culvert Calculator Report
E1 100-yr

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	600.00	ft	Headwater Depth/Height	0.99	
Computed Headwater Elevation	598.96	ft	Discharge	31.30	cfs
Inlet Control HW Elev.	598.70	ft	Tailwater Elevation	570.96	ft
Outlet Control HW Elev.	598.96	ft	Control Type	Entrance Control	

Grades					
Upstream Invert	596.00	ft	Downstream Invert	570.00	ft
Length	571.00	ft	Constructed Slope	4.6	%

Hydraulic Profile					
Profile	S2		Depth, Downstream	0.96	ft
Slope Type	Steep		Normal Depth	0.96	ft
Flow Regime	Supercritical		Critical Depth	1.81	ft
Velocity Downstream	16.15	ft/s	Critical Slope	0.5	%

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	3.00	ft
Section Size	36 inch		Rise	3.00	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	598.96	ft	Upstream Velocity Head	0.76	ft
Ke	0.50		Entrance Loss	0.38	ft

Inlet Control Properties					
Inlet Control HW Elev.	598.70	ft	Flow Control	Unsubmerged	
Inlet Type	Square edge w/headwall		Area Full	7.1	ft²
K	0.00980		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	1	
C	0.03980		Equation Form	1	
Y	0.67000				

E1 Culvert TcQ

PROJECT:	**SR-11**			**DESCRIPTION:**	**SR-11 Culvert**
JOB #:	**11A1190**			**STATION:**	**95+50**
BY:	**M.BRUNING**	**DATE:**	**01.06.10**	**WATERSHED:**	**E1.Culvert**
CHK:	**G.DALZIEL**	**DATE:**		**SYSTEM:**	**Culvert E1**

BASIN AREA:

A = **813298** **ft^2** | **18.67** **acres**

SOURCE: **MICROSTATION/USGS** **(SCALE = 1:1)**

COEFFICIENT OF RUNOFF:

KEY: User Input | Designer Tool

UNDEVELOPED AREA C (FROM HDM FIG. 819.2A)

		NOTES:
RELIEF (.08-.35)	0.15	Rolling Slopes ~ 7.5%
INFILTRATION (.04-.16)	0.12	Negligible infiltration capacity - see Geotechnical Report
VEGETATION (.04-.16)	0.08	Fair natural cover
STORAGE (.04-.12)	0.08	Low
TOTAL C =	0.43	

UNDEVELOPED AREA	99%	AT	0.43	0.426
PAVED SURFACE	1%	AT	0.90	0.009
COMMERCIAL AREA	0%	AT	0.85	0.000
DENSE RESIDENTIAL	0%	AT	0.55	0.000
TOTAL	100%			
	(100%)			

$C_{2,10}$ =	0.43
C_{25} =	0.48
C_{50} =	0.52
C_{100} =	0.54

TIME OF CONCENTRATION:

SHEET FLOW: $T_t = \frac{0.42L^{.8}n^{.8}}{P_2^{.5}s^{.2}}$

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

HIGH PT ELEVATION	635.0	ft	South of Otay Mesa Road - Driveway Area
LOW POINT ELEVATION	634.7	ft	
ELEVATION DIFF (H)	0.3	ft	
LENGTH (L)	50	ft	
SLOPE (S) = (H/L)	0.6%		
MANNING'S n	0.016		< = From Table 816.6A Asphalt
T_t (SFF)=	2.03	minutes	

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

NOTES:

HIGH PT ELEVATION	634.7	ft	Mid-driveway
LOW POINT ELEVATION	633.0	ft	North end of Junk Yard
ELEVATION DIFF (H)	1.7	ft	
LENGTH (L)	101	ft	
SLOPE (S) = (H/L)	1.7%		
VELOCITY (SCF)	1.5	fps	<=V FROM FIG 816.6 Asphalt
T_C (SH)=	1.12	minutes	

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

NOTES:

HIGH PT ELEVATION	633.0	ft	channel along western side of junk yard
LOW POINT ELEVATION	612.0	ft	CHANNEL DATA TYPE = TRAP'Z
ELEVATION DIFF (H)	21.0	ft	Z= 2 ANG-RAD 0.464
LENGTH (L)	570	ft	b = 1 ANG-DEG 26.565
SLOPE (S) = (H/L)	3.7%		d = 0.5 FLOWING FULL ASS'M
MANNING'S n	0.050		earthen/dirt
HYDRAULIC RADIUS R	0.3	ft	R=(bdsinA+d^2cosA)/(bsinA+2d)
VELOCITY (CHANNEL)	2.61	fps	From Manning's Equation assuming flowing full: $V=1.49/n(R^{2/3}S^{1/2})$
T_C (CH)=	3.63	minutes	

E1 Culvert TcQ

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

HIGH PT ELEVATION	612.0	ft
LOW POINT ELEVATION	602.0	ft
ELEVATION DIFF (H)	10.0	ft
LENGTH (L)	437	ft
SLOPE (S) = (H/L)	2.3%	
MANNING'S n	0.100	
HYDRAULIC RADIUS R	0.3	ft
VELOCITY (CHANNEL)	0.98	fps
T_C (CH)=	7.43	minutes

NOTES:

Begins to broaden across junk yard

CHANNEL DATA		TYPE =	TRAP'Z
Z=	5	ANG-RAD	0.197
b =	1	ANG-DEG	11.310
d =	0.5	FLOWING FULL ASS'M	

dirt with junk yard obstructions

R=(bdsinA+d^2cosA)/(bsinA+2d)

From Manning's Equation assuming flowing full: $V=1.49/n(R^{2/3}S^{1/2})$

Tc (TOTAL) =	14.21	minutes
Minimum Tc =	10	minutes
USE T_C =	**14.21**	minutes

INTENSITY CHART: Caltrans IDF2000

FLOW RESULTS

					cfs
i_2 =	1.0	in/hr	X CA =	**Q_2 =**	8.2
i_{10} =	1.9	in/hr	X CA =	**Q_{10} =**	15.4
i_{25} =	2.4	in/hr	X CA =	**Q_{25} =**	21.2
i_{50} =	2.7	in/hr	X CA =	**Q_{50} =**	26.6
i_{100} =	3.1	in/hr	X CA =	**Q_{100} =**	**31.3**

~Use Caltrans 'i' for culvert sizing

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

FLOW RESULTS

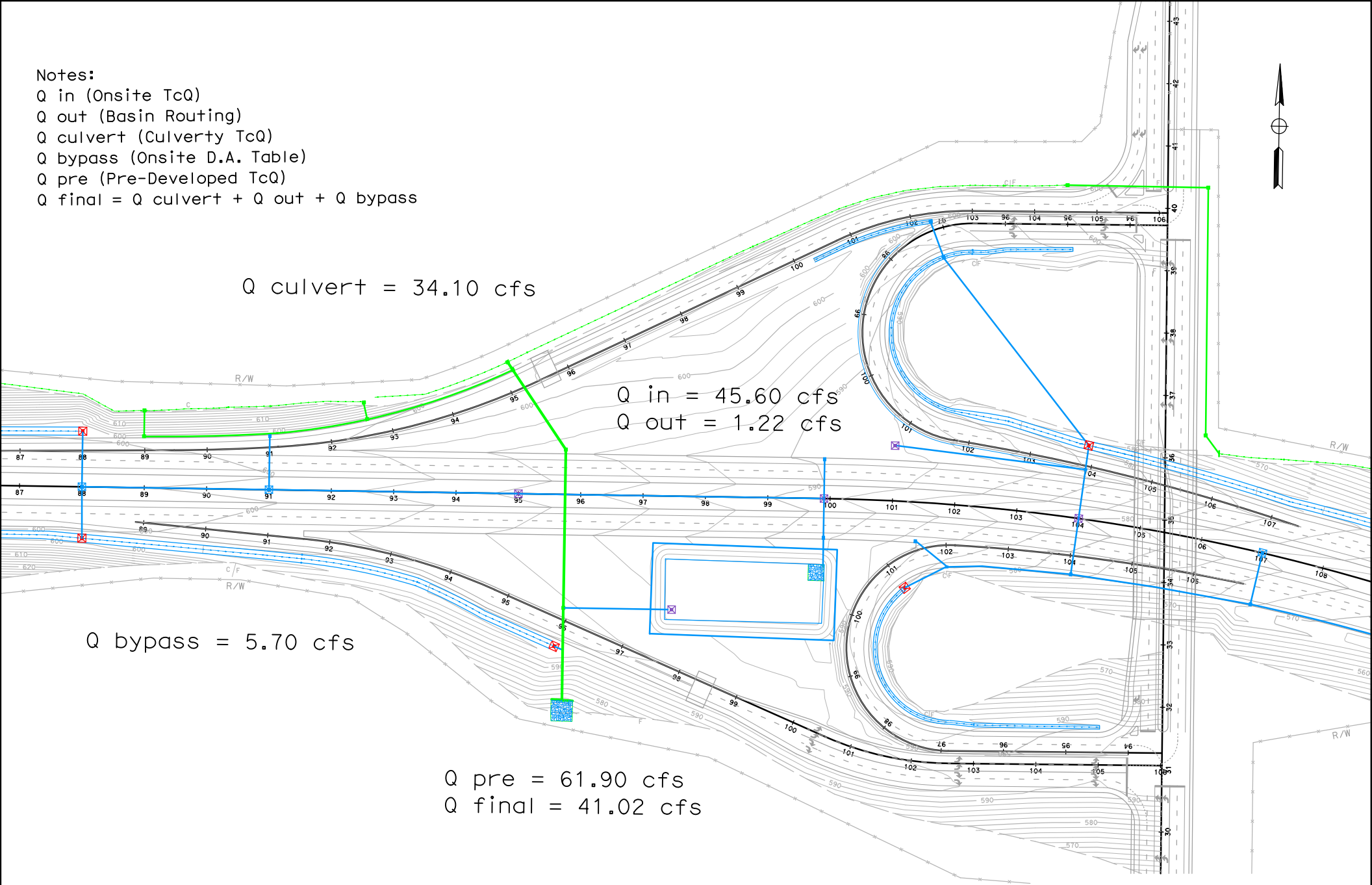
					cfs
i_2 =	1.5	in/hr	X CA =	**Q_2 =**	12.0
i_{10} =	2.1	in/hr	X CA =	**Q_{10} =**	17.4
i_{25} =	2.7	in/hr	X CA =	**Q_{25} =**	24.0
i_{50} =	3.2	in/hr	X CA =	**Q_{50} =**	31.4
i_{100} =	3.4	in/hr	X CA =	**Q_{100} =**	**34.1**

~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 (Culverty TcQ)
Q bypass (Onsite D.A. Table)
Q pre (Pre-Developed TcQ)
Q final = Q culvert + Q out + Q bypass



BASIN E1
FLOW SUMMARY

Scale: 1"=200'

Basin E1 Retention

PROJECT:	**SR-11**			**DESCRIPTION:**	**SR-11 Basin**
JOB #:	**11A1190**			**STATION:**	**96+00**
BY:	**M.BRUNING**	**DATE:**	**01.06.10**	**WATERSHED:**	**E1**
CHK:	**G.DALZIEL**	**DATE:**		**SYSTEM:**	**Basin E1**

Notes:

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

RETENTION BASIN VOLUME

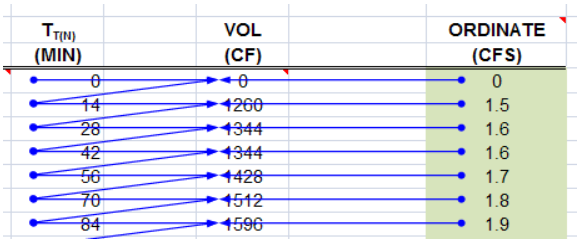
100-year, 6 hour duration storm event, use the Rational Method Hydrograph Procedure (SDCHM 6-1) ~ RatHydro

Pre-Developed volume calculations

Q_{100}=	61.9	cfs			
Tc=	24.5	min	C=	0.54	
$P_{100,6}$=	2.5	in	A=	48.15	acres

$T_{T(N)}$ (MIN)	VOL (CF)	ORDINATE (CFS)
0	0	0
25	6000	4
50	6750	4.5
75	7050	4.7
100	8100	5.4
125	8850	5.9
150	10800	7.2
175	12300	8.2
200	18000	12
225	23550	15.7
250	92850	61.9
275	14400	9.6
300	9600	6.4
325	7500	5
350	6300	4.2
375	0	0

Example of Steps:



SUM= 232050 ft^3

5.33 acre-feet

Check: $V = C*A*P_6$

V= 5.45 acre-feet

OK

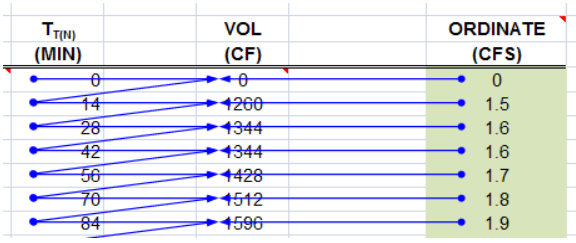
Basin E1 Retention

Post-Developed volume calculations

Q_{100}=	103.9	cfs			
Tc=	20.2	min	C=	0.68	
$P_{100,6}$=	2.5	in	A=	57.30	acres

$T_{T(N)}$ (MIN)	VOL (CF)	ORDINATE (CFS)
0	0	0
20	7080	5.9
40	7320	6.1
60	7920	6.6
80	8400	7
100	9240	7.7
120	9840	8.2
140	11280	9.4
160	12240	10.2
180	14880	12.4
200	17040	14.2
220	24960	20.8
240	36360	30.3
260	124680	103.9
280	20040	16.7
300	13440	11.2
320	10440	8.7
340	8760	7.3
360	7680	6.4
380	0	0

Example of Steps:



SUM= 351600 ft^3
8.07 acre-feet

Check: $V = C*A*P_6$
V= 8.09 acre-feet
OK

		8.07	*(Post)*		
	-	**5.33**	*(Pre)*		
Retention volume =		**2.74**	**acre-feet**	**=**	**119550 ft^3**

Basin Required

Basin E1 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}= 0.87
A= 19.40 acres

WQ_{72}: 0.66 in/area

Water Quality Volume (WQV) = **46475** 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:

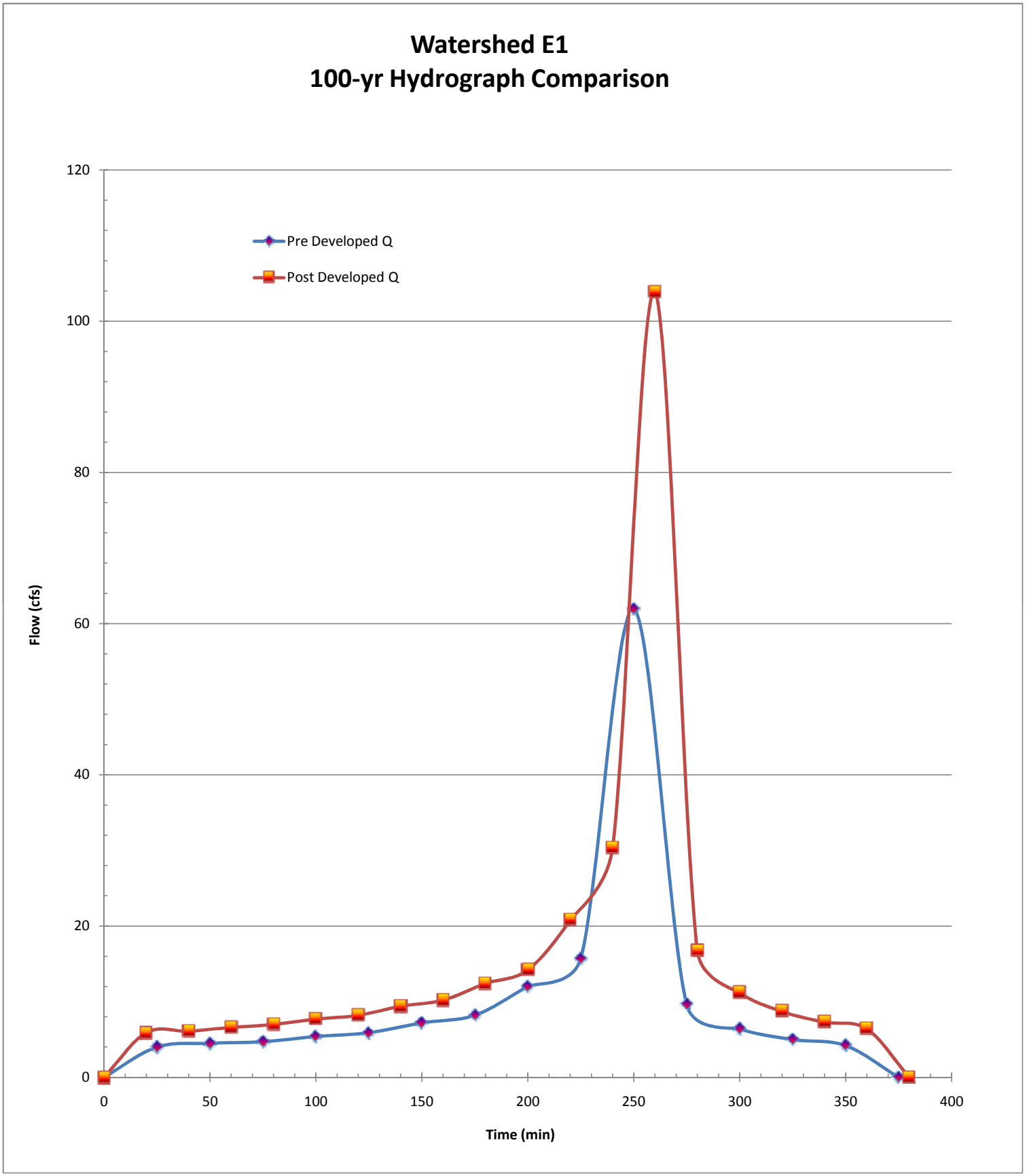
A_s = the computed soil loss in tons (dry weight)
R = the rainfall erosion index for the given storm period
K = the soil erodibility factor
L = the slope length factor
s = the slope gradient factor
C = cropping management (vegetation) factor
P = erosion control practice factor

Onsite Highway *Sloped* runoff area, A:		497400	ft^2
	A:	11.42	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 = 177.58 tons

Silt Accumulation Basin volume = **3946** ft^3

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


Watershed E1
100-yr Hydrograph Comparison
Pre Developed Q
Post Developed Q
Flow (cfs)
Time (min)
0
20
40
60
80
100
120
0
50
100
150
200
250
300
350
400

Basin E1 Inflow TcQ

PROJECT:	**SR-11**			**DESCRIPTION:**	**SR-11 Basin**
JOB #:	**11A1190**			**STATION:**	**96+00**
BY:	**M.BRUNING**	**DATE:**	**01.06.10**	**WATERSHED:**	**E1**
CHK:	**G.DALZIEL**	**DATE:**		**SYSTEM:**	**One Interchange Option**

BASIN AREA:

A = **845000** **ft^2** **SOURCE:** **MICROSTATION/USGS**
19.40 **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	41%	AT	0.90	0.370
COMMERCIAL AREA	0%	AT	0.85	0.000
CUT SLOPE (2:1 and 4:1)	59%	AT	0.55	0.324
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: $T_t = \frac{0.42 L^{4/5} n^{4/5}}{P_2^{1/2} s^{2/5}}$

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

HIGH PT ELEVATION	608.5	ft	SR-11 HP
LOW POINT ELEVATION	607.8	ft	
ELEVATION DIFF (H)	0.7	ft	
LENGTH (L)	117	ft	to Bioswale
SLOPE (S) = (H/L)	0.6%		
MANNING'S n	0.016		AC < = From Table 816.6A
T_t (SFF)=	4.01	minutes	

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

NOTES:

HIGH PT ELEVATION	607.8	ft	origin of Bioswale
LOW POINT ELEVATION	606.0	ft	
ELEVATION DIFF (H)	1.8	ft	
LENGTH (L)	200	ft	assumed SCF and not channelized or flowing full yet
SLOPE (S) = (H/L)	0.9%		
VELOCITY (SCF)	1.8	fps	0.9% , V FROM FIG 816.6 grassed waterway
T_C (SH)=	1.90	minutes	

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

NOTES:

HIGH PT ELEVATION	606.0	ft	Begin channel flow in bioswale
LOW POINT ELEVATION	600.0	ft	CHANNEL DATA TYPE = TRAP'Z
ELEVATION DIFF (H)	6.0	ft	Z= 4 ANG-RAD 0.245
LENGTH (L)	1212	ft	b = 13 ANG-DEG 14.036
SLOPE (S) = (H/L)	0.5%		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)	1.81	fps	From Manning's Equation assuming flowing full: $V=1.49/n(R^{2/3}S^{1/2})$
T_C (CH)=	11.18	minutes	

Basin E1 Inflow TcQ

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

NOTES:

HIGH PT ELEVATION	596.0	ft	Proposed onsite pipe (assumed 4' drop to invert)
LOW POINT ELEVATION	595.5	ft	
ELEVATION DIFF (H)	0.5	ft	
LENGTH (L)	87	ft	
SLOPE (S) = (H/L)	0.6%		
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)	5.5	fps	$V = \frac{K_u}{n} R^{2/3} S^{1/2}$
T_C (SD)=	0.26	minutes	

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

NOTES:

HIGH PT ELEVATION	595.5	ft	
LOW POINT ELEVATION	584.0	ft	Proposed Rip Rap Pad in Basin floor
ELEVATION DIFF (H)	11.5	ft	
LENGTH (L)	1300	ft	
SLOPE (S) = (H/L)	0.9%		
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)	8.9	fps	$V = \frac{K_u}{n} R^{2/3} S^{1/2}$
T_C (SD)=	2.43	minutes	

Tc (TOTAL) =	19.79	minutes
Minimum Tc =	5	minutes
USE T_C =	**19.79**	minutes

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

i_2 =	1.2	in/hr	X CA =	**Q_2 =**	16.1
i_{10} =	1.7	in/hr	X CA =	**Q_{10} =**	23.4
i_{25} =	2.2	in/hr	X CA =	**Q_{25} =**	32.1
i_{50} =	2.6	in/hr	X CA =	**Q_{50} =**	42.1
i_{100} =	2.7	in/hr	X CA =	**Q_{100} =**	**45.6**

FLOW RESULTS

cfs

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 E1 Inflow Hydrograph

PROJECT:	**SR-11**			**DESCRIPTION:**	**SR-11 Basin**
JOB #:	**11A1190**			**STATION:**	**96+00**
BY:	**M.BRUNING**	**DATE:**	**01.06.10**	**WATERSHED:**	**E1**
CHK:	**G.DALZIEL**	**DATE:**		**SYSTEM:**	**Basin E1**

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

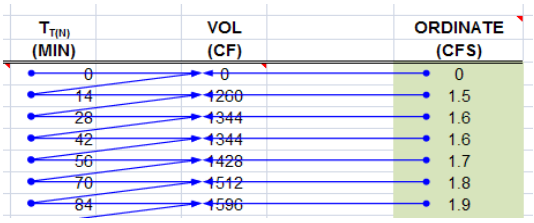
Basin Inflow Hydrograph

Basin Inflow Q

Q_{100}=	45.6	cfs	C_{100}=	0.87	
Tc=	19.8	min	A=	19.40	acres
$P_{100,6}$=	2.5	in			

$T_{T(N)}$ (MIN)	VOL (CF)	ORDINATE (CFS)
0	0	0
20	3000	2.5
40	3120	2.6
60	3480	2.9
80	3600	3
100	3960	3.3
120	4200	3.5
140	4920	4.1
160	5280	4.4
180	6480	5.4
200	7320	6.1
220	10800	9
240	15000	12.5
260	54720	45.6
280	8640	7.2
300	5760	4.8
320	4560	3.8
340	3840	3.2
360	3360	2.8
380	0	0

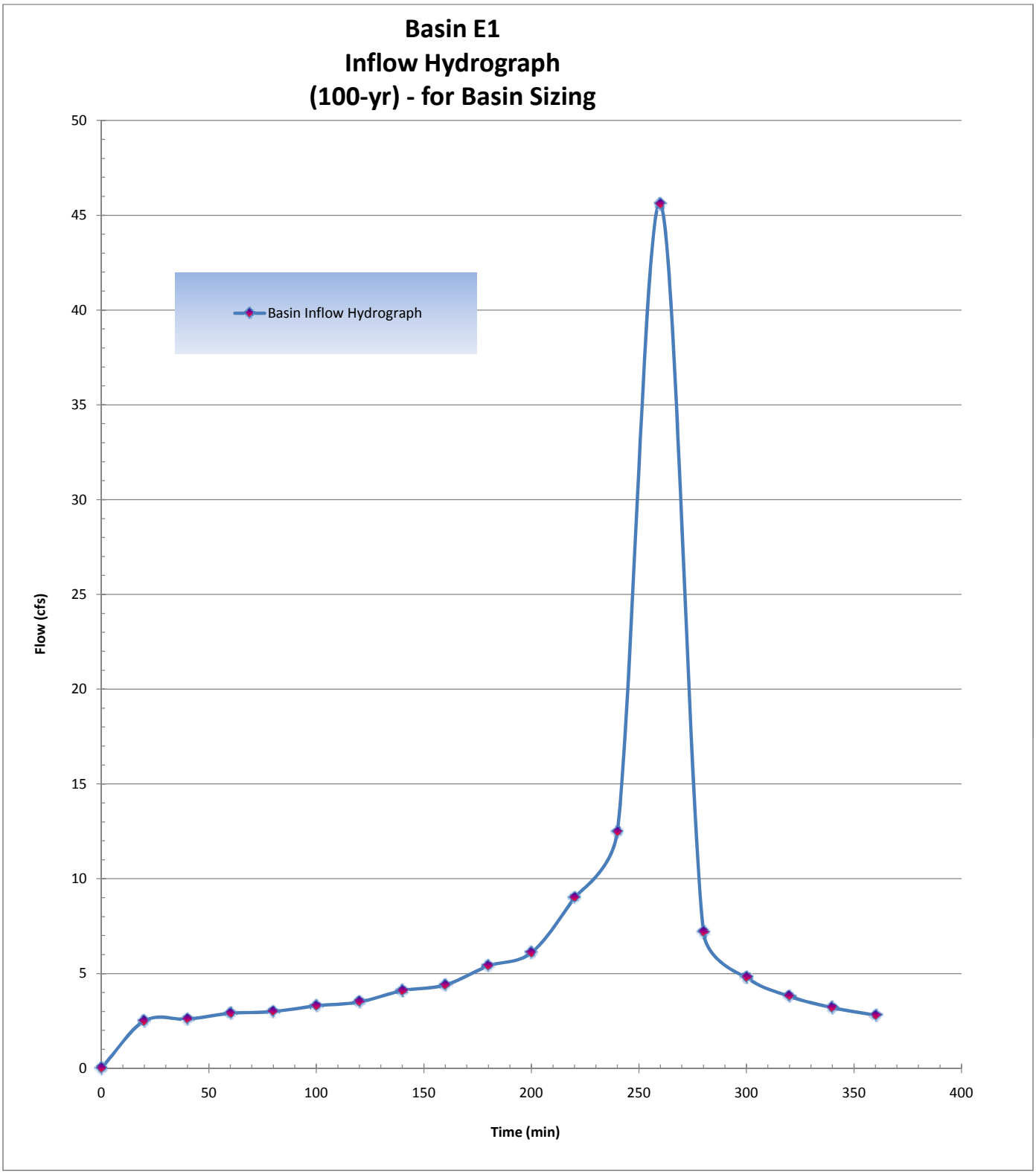
Example of Steps:



SUM= 152040 ft^3
3.49 acre-feet

Onsite Runoff Volume

Check: $V = C*A*P_6$
V= 3.51 acre-feet
OK


Basin E1
Inflow Hydrograph
(100-yr) - for Basin Sizing
Basin Inflow Hydrograph
Flow (cfs)
Time (min)
0
5
10
15
20
25
30
35
40
45
50
0
50
100
150
200
250
300
350
400

Basin E1 Outlet

PROJECT:	**SR-11**			**DESCRIPTION:**	**SR-11 Basin**
JOB #:	**11A1190**			**STATION:**	**96+00**
BY:	**M.BRUNING**	**DATE:**	**02.19.10**	**WATERSHED:**	**E1**
CHK:	**G.DALZIEL**	**DATE:**		**SYSTEM:**	**Basin E1**

Notes:

Required Retention Basin Volume = 123496 ft^3
Actual Basin Inflow = 152040 ft^4 *OK*

Flow Balance - determine maximum flow from basin

Predeveloped Peak 100-year Flow:	61.9	cfs		
Post-Developed Peak Flow through Cross Culvert:	34.1	cfs		Includes: E1.8.SL E1.9.SL
Flow that does not reach detention basin (bypass per DA table):	5.7	cfs	~	Q_{100} of: E1.3.PV E1.3.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 =	590.00	ft
Basin flowline elevation =	584.00	ft
Maximum Basin Depth =	6.00	ft

Outlet Pipe

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

Outlet pipe invert from basin floor =	4.00 ft	588.00	ft
Outlet pipe diameter =	2 ft		

Basin Characteristics

Base Length (L)	250	ft
Base Width (W)	100	ft
W/L Ratio ®	0.40	
Side Slopes (Z)	1: 4	
Total Volume (V):	204733	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)	Q_{out} (cfs)	Q_{inf} (cfs)	Q_{total} (cfs)
0	584.00	0.00	0	0		584.00	0.00		0.00
1	584.20	0.20	5056	5056		584.20	0.00		0.00
2	584.40	0.40	5169	10226		584.40	0.00		0.00
3	584.60	0.60	5284	15509		584.60	0.00		0.00
4	584.80	0.80	5399	20908		584.80	0.00		0.00
5	585.00	1.00	5515	26422		585.00	0.00		0.00
6	585.20	1.20	5631	32054		585.20	0.00		0.00
7	585.40	1.40	5749	37803		585.40	0.00		0.00
8	585.60	1.60	5868	43671		585.60	0.00		0.00
9	585.80	1.80	5988	49659		585.80	0.00		0.00
10	586.00	2.00	6109	55768		586.00	0.00		0.00
11	586.20	2.20	6230	61998		586.20	0.00		0.00
12	586.40	2.40	6353	68351		586.40	0.00		0.00
13	586.60	2.60	6476	74827		586.60	0.00		0.00
14	586.80	2.80	6601	81428		586.80	0.00		0.00
15	587.00	3.00	6726	88154		587.00	0.00	0.00	0.00
16	587.20	3.20	6852	95006		587.20	0.00		0.00
17	587.40	3.40	6980	101986		587.40	0.00		0.00
18	587.60	3.60	7108	109094		587.60	0.00		0.00
19	587.80	3.80	7237	116331		587.80	0.00		0.00
20	588.00	4.00	7367	123698	*	588.00	0.00		0.00
21	588.20	4.20	7498	131197		588.20	0.15		0.15
22	588.40	4.40	7630	138827		588.40	0.59		0.59
23	588.60	4.60	7763	146590		588.60	1.30		1.30
24	588.80	4.80	7897	154487		588.80	2.25		2.25
25	589.00	5.00	8032	162519		589.00	3.42		3.42
26	589.20	5.20	8168	170686		589.20	4.79		4.79
27	589.40	5.40	8304	178991		589.40	6.32		6.32
28	589.60	5.60	8442	187432		589.60	7.99		7.99
29	589.80	5.80	8580	196013		589.80	9.77		9.77
30	590.00	6.00	8720	204733		590.00	11.63		11.63

Basin E1 Routing

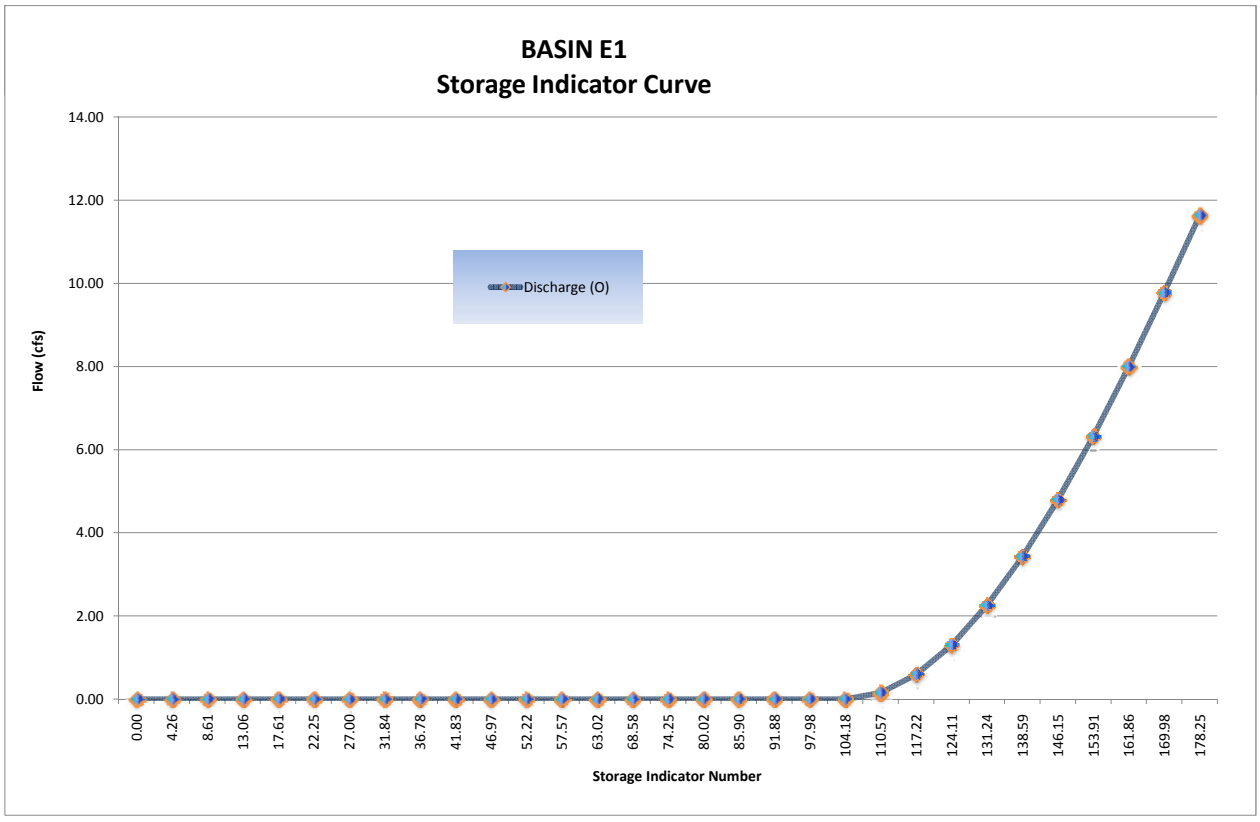
PROJECT:	SR-11			DESCRIPTION:	SR-11 Basin
JOB #:	11A1190			STATION:	96+00
BY:	M.BRUNING	DATE:	02.19.10	WATERSHED:	E
CHK:	G.DALZIEL	DATE:		SYSTEM:	Basin E1

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)	*Storage Indicator #* (6) $S_2/delta\ t + O_2/2$ (cfs)
584.00	0.00	0	0.00	0.00	0.00
584.20	0.00	5056	0.00	4.26	4.26
584.40	0.00	10226	0.00	8.61	8.61
584.60	0.00	15509	0.00	13.06	13.06
584.80	0.00	20908	0.00	17.61	17.61
585.00	0.00	26422	0.00	22.25	22.25
585.20	0.00	32054	0.00	27.00	27.00
585.40	0.00	37803	0.00	31.84	31.84
585.60	0.00	43671	0.00	36.78	36.78
585.80	0.00	49659	0.00	41.83	41.83
586.00	0.00	55768	0.00	46.97	46.97
586.20	0.00	61998	0.00	52.22	52.22
586.40	0.00	68351	0.00	57.57	57.57
586.60	0.00	74827	0.00	63.02	63.02
586.80	0.00	81428	0.00	68.58	68.58
587.00	0.00	88154	0.00	74.25	74.25
587.20	0.00	95006	0.00	80.02	80.02
587.40	0.00	101986	0.00	85.90	85.90
587.60	0.00	109094	0.00	91.88	91.88
587.80	0.00	116331	0.00	97.98	97.98
588.00	0.00	123698	0.00	104.18	104.18
588.20	0.15	131197	0.08	110.50	110.57
588.40	0.59	138827	0.30	116.93	117.22
588.60	1.30	146590	0.65	123.46	124.11
588.80	2.25	154487	1.13	130.12	131.24
589.00	3.42	162519	1.71	136.88	138.59
589.20	4.79	170686	2.40	143.76	146.15
589.40	6.32	178991	3.16	150.75	153.91
589.60	7.99	187432	4.00	157.86	161.86
589.80	9.77	196013	4.89	165.09	169.98
590.00	11.63	204733	5.82	172.44	178.25

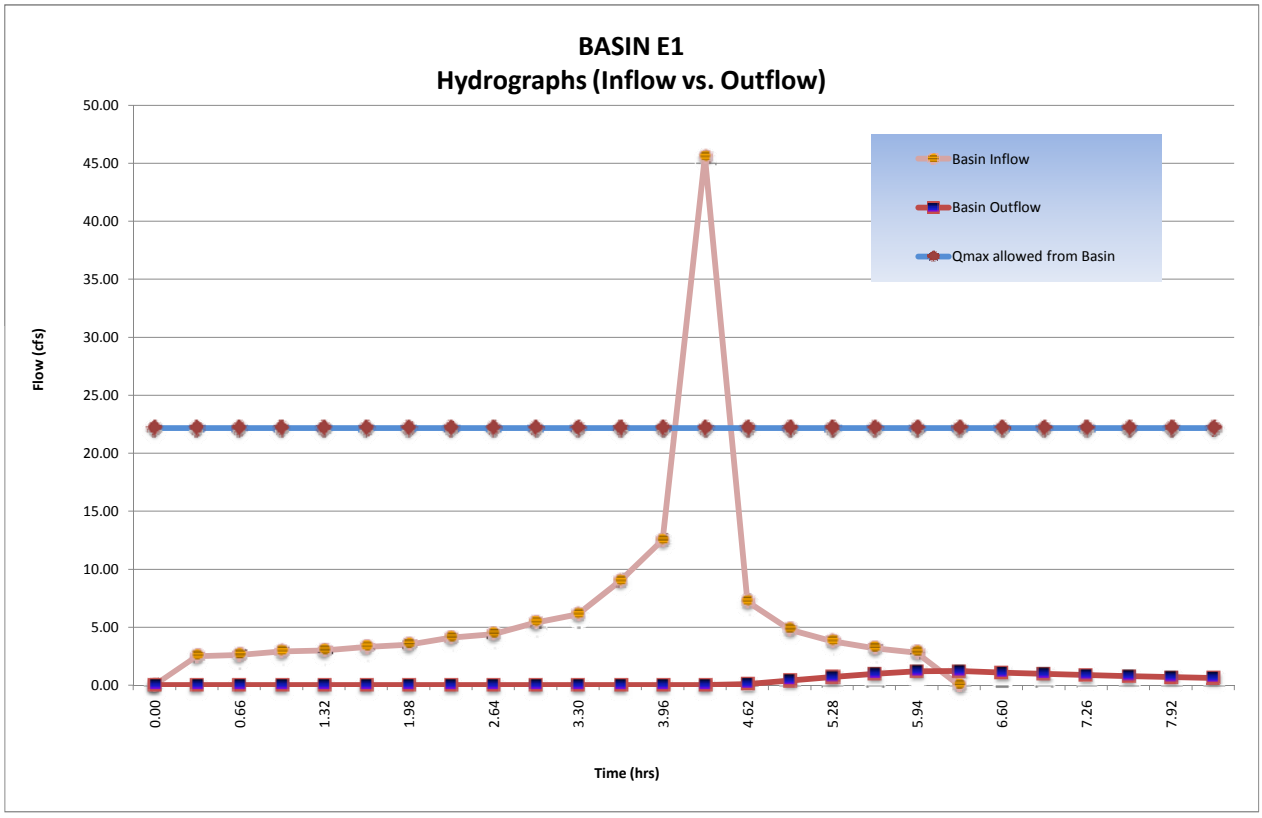
delta t = 0.33 hrs
delta t = 20 min
delta t = 1187.302 sec



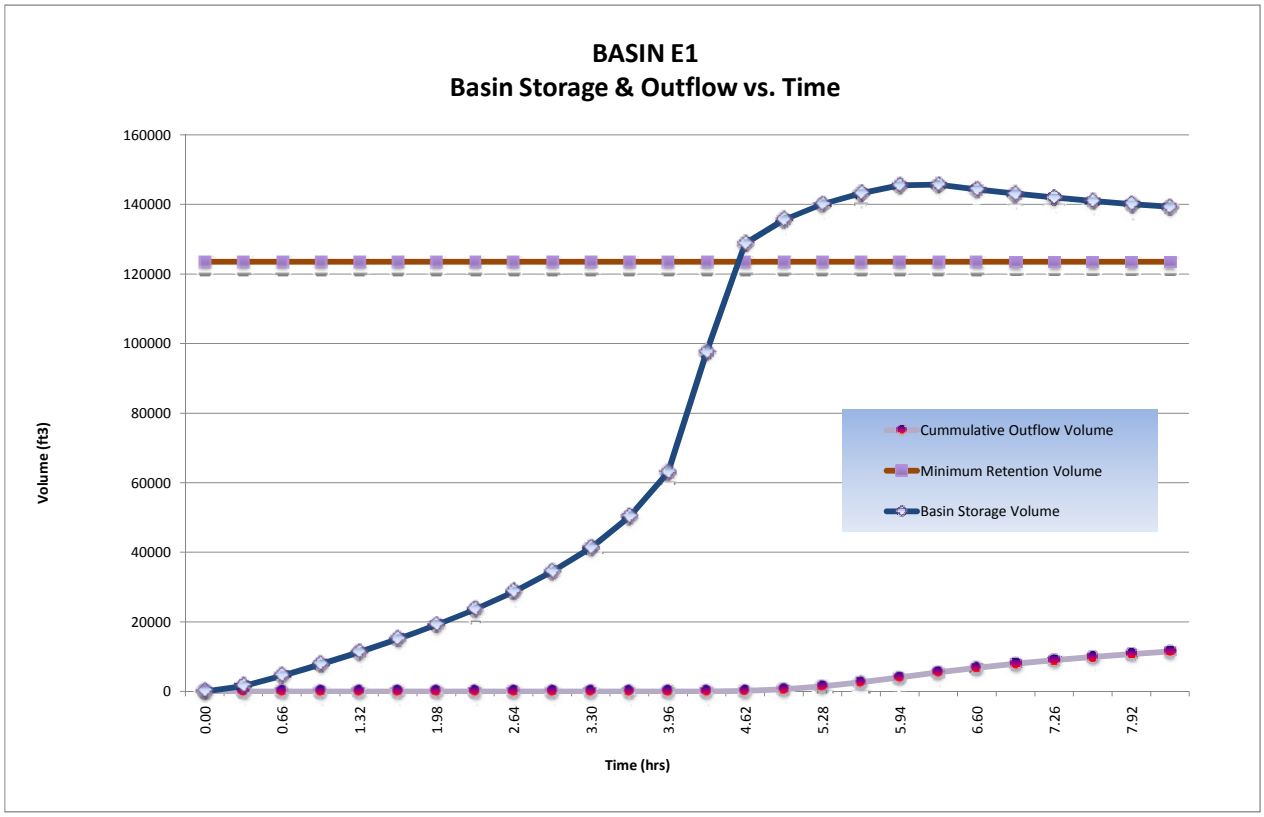
Basin E1 Routing

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)	(5) O_1 (cfs)	*Storage Indicator #* (6) $S_2/\Delta t + O_2/2$ (cfs)	(7) O_2 (cfs)	Volumes (ft3) Basin Storage	Incremental Outflow	Cummulative Outflow
			col (6) from prev row	*col (7) from prev row*	*col (3)+(4)-(5)*	*(Hard input)*	*Volume*	*Volume*	*Volume*
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
0.33	2.50	1.25	0.00	0.00	1.25	0.00	1484	0	0
0.66	2.60	2.55	1.25	0.00	3.80	0.00	4512	0	0
0.99	2.90	2.75	3.80	0.00	6.55	0.00	7777	0	0
1.32	3.00	2.95	6.55	0.00	9.50	0.00	11279	0	0
1.65	3.30	3.15	9.50	0.00	12.65	0.00	15019	0	0
1.98	3.50	3.40	12.65	0.00	16.05	0.00	19056	0	0
2.31	4.10	3.80	16.05	0.00	19.85	0.00	23568	0	0
2.64	4.40	4.25	19.85	0.00	24.10	0.00	28614	0	0
2.97	5.40	4.90	24.10	0.00	29.00	0.00	34432	0	0
3.30	6.10	5.75	29.00	0.00	34.75	0.00	41259	0	0
3.63	9.00	7.55	34.75	0.00	42.30	0.00	50223	0	0
3.96	12.50	10.75	42.30	0.00	53.05	0.00	62986	0	0
4.29	45.60	29.05	53.05	0.00	82.10	0.00	97477	0	0
4.62	7.20	26.40	82.10	0.00	108.50	0.10	128763	119	119
4.95	4.80	6.00	108.50	0.10	114.40	0.40	135590	475	594
5.28	3.80	4.30	114.40	0.40	118.30	0.70	140042	831	1425
5.61	3.20	3.50	118.30	0.70	121.10	0.99	143195	1175	2600
5.94	2.80	3.00	121.10	0.99	123.11	1.20	145456	1425	4025
6.27	0.00	1.40	123.11	1.20	123.31	1.22	145682	1449	5473
6.60		0.00	123.31	1.22	122.09	1.09	144311	1294	6768
6.93		0.00	122.09	1.09	121.00	0.98	143082	1164	7931
7.26		0.00	121.00	0.98	120.02	0.88	141978	1045	8976
7.59		0.00	120.02	0.88	119.14	0.79	140986	938	9914
7.92		0.00	119.14	0.79	118.35	0.71	140096	843	10757
8.25		0.00	118.35	0.71	117.64	0.63	139300	748	11505



Basin E1 Routing



Detention/Retention Basin Volume Required:	**145,682**	ft^3	
@ Stage:	**588.60**	ft	
Freeboard	**1.4**	ft	>1' Freeboard
Final Total Basin Volume Provided:	**204,733**	ft^3	Basin **E1**
Maximum flow rate released from this basin:	**1.22**	cfs	

F1 Onsite D.A. Table

PROJECT:	**SR-11**	**DESCRIPTION:**	**On-site Drainage Areas (D.A.)**
JOB #:	**11A1190**	**STATION:**	**~**
BY:	**M.BRUNING** **DATE:** **01.03.10**	**WATERSHED:**	**F1**
CHK:	**G.DALZIEL** **DATE:**	**SYSTEM:**	**One Interchange Option**

						Caltrans	Caltrans	County	County					
			Area		Tc	i_{25}	Q_{25}	i_{100}	Q_{100}	Drains to:				
	Name	C	SF	Acres	min	in/hr	cfs	in/hr	cfs	Bioswale	Inlet	Destination	@ Station	Offset
PAVED	F1.1.PV	0.99	5000	0.1	5	4.0	0.45	6.6	0.75	~	F1.1	Basin F1	101+00	Lt
	F1.2.PV	0.99	7400	0.2	5	4.0	0.67	6.6	1.11	~	F1.2	Basin F1	101+50	Rt
	F1.3.PV	0.99	35100	0.8	5	4.0	3.18	6.6	5.25	~	F1.3	Basin F1	107+00	Center
	F1.4.PV	0.99	44700	1.0	5	4.0	4.05	6.6	6.69	~	F1.4	Basin F1	107+00	Rt
	F1.5.PV	0.99	37600	0.9	10	2.8	2.41	4.2	3.60	F1.5	F1.5	Basin F1	104+00	Lt
	F1.7.PV	0.99	6100	0.1	10	2.8	0.39	4.2	0.58	F1.7	F1.7	bypass*	107+00	Lt
	F1.8.PV	0.99	51300	1.2	5	4.0	4.64	6.6	7.68	~	F1.8	Basin F1	105+00	AL3A1
	F1.9.PV	0.99	31500	0.7	10	2.8	2.02	4.2	3.02	F1.9	F1.9	Basin F1	101+00	AL3B1
	F1.10.PV	0.99	21800	0.5	10	2.8	1.40	4.2	2.09	~	F1.10	bypass*	32+00	ALTA
	F1.11.PV	0.99	21100	0.5	10	2.8	1.35	4.2	2.02	~	F1.11	bypass*	32+00	ALTA
	F1.12.PV	0.99	19200	0.4	10	2.8	1.23	4.2	1.84	~	F1.12	bypass*	36+00	ALTA
	F1.13.PV	0.99	21300	0.5	10	2.8	1.36	4.2	2.04	~	F1.13	bypass*	36+00	ALTA
	F1.14.PV	0.99	32500	0.7	5	4.0	2.94	6.6	4.87	~	F1.14	Basin F1	103+50	AL4A1
	F1.15.PV	0.99	19000	0.4	10	2.8	1.22	4.2	1.82	~	F1.15	Basin F1	102+25	AL4A1
	F1.16.PV	0.99	68700	1.6	5	4.0	6.22	6.6	10.28	~	F1.16	Basin F1	116+00	Lt
	F1.17.PV	0.99	71700	1.6	5	4.0	6.49	6.6	10.73	~	F1.17	Basin F1	116+00	Rt

Σ	494000	*PAVED*

						Caltrans	Caltrans	County	County					
			Area		Tc	i_{25}	Q_{25}	i_{100}	Q_{100}	Drains to:				
	Name	C	SF	Acres	min	in/hr	cfs	in/hr	cfs	Bioswale	Inlet	Destination	@ Station	Offset
SLOPE	F1.1.SL	0.61	80900	1.9	10	2.8	3.19	4.2	4.77	~	F1.1	Basin F1	101+00	Lt
	F1.2.SL	0.61	32000	0.7	10	2.8	1.26	4.2	1.89	~	F1.2	Basin F1	101+50	Rt
	F1.5.SL	0.61	115100	2.6	10	2.8	4.54	4.2	6.79	F1.5	F1.5	Basin F1	104+00	Lt
	F1.6.SL	0.61	2600	0.1	10	2.8	0.10	4.2	0.15	~	F1.6	Basin F1	104+00	Lt
	F1.7.SL	0.61	8600	0.2	10	2.8	0.34	4.2	0.51	F1.7	F1.7	bypass*	107+00	Lt
	F1.9.SL	0.61	98900	2.3	10	2.8	3.90	4.2	5.83	F1.9	F1.9	Basin F1	101+00	AL3B1
	F1.18.SL	0.61	58800	1.3	10	2.8	2.32	4.2	3.47	~	Culvert	Culvert	110+00	Lt
	F1.19.SL	0.61	57200	1.3	10	2.8	2.26	4.2	3.37	~	~	bypass*	110+00	Rt
	F1.20.SL	0.61	74800	1.7	10	2.8	2.95	4.2	4.41	~	F1.20	Basin F1	113+00	Rt

Σ	528900	*SLOPE*

** flow that does not reach the basin*

Total :	1022900	23.5
	SF	*ac*

WATERSHED F1
ONE INTERCHANGE
ALTERNATIVE
Scale: 1"=450'

F1 Post-Developed TcQ

PROJECT:	**SR-11**			**DESCRIPTION:**	**SR-11 Post-Developed**
JOB #:	**11A1190**			**STATION:**	**110+00**
BY:	**M.BRUNING**	**DATE:**	**01.03.10**	**WATERSHED:**	**F1**
CHK:	**G.DALZIEL**	**DATE:**		**SYSTEM:**	**One Interchange Option**

BASIN AREA:

A =	**5443181**	**ft^2**	**SOURCE:**	**MICROSTATION/USGS**
	124.96	**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	81%	AT	0.47	0.382
PAVED SURFACE	9%	AT	0.90	0.082
COMMERCIAL AREA	0%	AT	0.85	0.000
CUT SLOPE (2:1 and 4:1)	10%	AT	0.55	0.053
TOTAL	100%			
	(100%)			

$C_{2,10}$ =	0.52
C_{25} =	0.57
C_{50} =	0.62
C_{100} =	0.65

TIME OF CONCENTRATION:

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

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		

F1 Post-Developed TcQ

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

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	
T_C (SD)=	0.12	minutes	

CHANNEL FLOW: $T_t = \frac{L}{60\,V}$ $V = \frac{K_u}{n} R^{2/3} S^{1/2}$

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

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

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

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 =	60.0
Q_{10} =	87.2
Q_{25} =	120.0
Q_{50} =	157.0
Q_{100} =	**170.4**

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 F1
ONE INTERCHANGE ALTERNATIVE

Scale: 1" =450'

Culvert Calculator Report
F1 10-yr

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	559.00	ft	Headwater Depth/Height	0.92	
Computed Headwater Elevation	558.67	ft	Discharge	57.20	cfs
Inlet Control HW Elev.	558.36	ft	Tailwater Elevation	547.33	ft
Outlet Control HW Elev.	558.67	ft	Control Type	Entrance Control	

Grades					
Upstream Invert	555.00	ft	Downstream Invert	546.00	ft
Length	326.00	ft	Constructed Slope	2.8	%

Hydraulic Profile					
Profile	S2		Depth, Downstream	1.33	ft
Slope Type	Steep		Normal Depth	1.33	ft
Flow Regime	Supercritical		Critical Depth	2.28	ft
Velocity Downstream	15.60	ft/s	Critical Slope	0.4	%

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	4.00	ft
Section Size	48 inch		Rise	4.00	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	558.67	ft	Upstream Velocity Head	0.93	ft
Ke	0.50		Entrance Loss	0.47	ft

Inlet Control Properties					
Inlet Control HW Elev.	558.36	ft	Flow Control	Unsubmerged	
Inlet Type	Square edge w/headwall		Area Full	12.6	ft²
K	0.00980		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	1	
C	0.03980		Equation Form	1	
Y	0.67000				

Culvert Calculator Report
F1 100-yr

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	562.00	ft	Headwater Depth/Height	1.51	
Computed Headwater Elevation	561.02	ft	Discharge	116.10	cfs
Inlet Control HW Elev.	561.02	ft	Tailwater Elevation	547.98	ft
Outlet Control HW Elev.	560.88	ft	Control Type	Inlet Control	

Grades					
Upstream Invert	555.00	ft	Downstream Invert	546.00	ft
Length	326.00	ft	Constructed Slope	2.8	%

Hydraulic Profile					
Profile	S2		Depth, Downstream	1.98	ft
Slope Type	Steep		Normal Depth	1.97	ft
Flow Regime	Supercritical		Critical Depth	3.25	ft
Velocity Downstream	18.72	ft/s	Critical Slope	0.7	%

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	4.00	ft
Section Size	48 inch		Rise	4.00	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	560.88	ft	Upstream Velocity Head	1.75	ft
Ke	0.50		Entrance Loss	0.88	ft

Inlet Control Properties					
Inlet Control HW Elev.	561.02	ft	Flow Control	Submerged	
Inlet Type	Square edge w/headwall		Area Full	12.6	ft²
K	0.00980		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	1	
C	0.03980		Equation Form	1	
Y	0.67000				

F1 Culvert TcQ

PROJECT:	**SR-11**			**DESCRIPTION:**	**SR-11 Culvert**
JOB #:	**11A1190**			**STATION:**	**110+00**
BY:	**M.BRUNING**	**DATE:**	**11.17.09**	**WATERSHED:**	**F1.Culvert**
CHK:	**G.DALZIEL**	**DATE:**		**SYSTEM:**	**Culvert F1**

BASIN AREA:

A = **3796682** **ft^2**
87.16 **acres**

SOURCE: **MICROSTATION/USGS**
(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)	0.06	Normal
TOTAL C =	0.46	

UNDEVELOPED AREA	99%	AT	0.46	0.455
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%)			

$C_{2,10}$ =	0.46
C_{25} =	0.51
C_{50} =	0.56
C_{100} =	0.58

TIME OF CONCENTRATION:

SHEET FLOW: $T_t = \frac{0.42L^{.8}n^{.8}}{P_2^{.5}s^{.4}}$

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	

F1 Culvert TcQ

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

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	
T_C (SD)=	0.12	minutes	

NOTES:

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

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	

NOTES:

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

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	

NOTES:

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

INTENSITY CHART: Caltrans IDF2000

FLOW RESULTS:

					cfs
i_2 =	0.8	in/hr	X CA =	**Q_2 =**	30.4
i_{10} =	1.4	in/hr	X CA =	**Q_{10} =**	57.2
i_{25} =	1.8	in/hr	X CA =	**Q_{25} =**	78.7
i_{50} =	2.0	in/hr	X CA =	**Q_{50} =**	98.7
i_{100} =	2.3	in/hr	X CA =	**Q_{100} =**	**116.1**

~Use Caltrans 'i' for culvert sizing

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

FLOW RESULTS

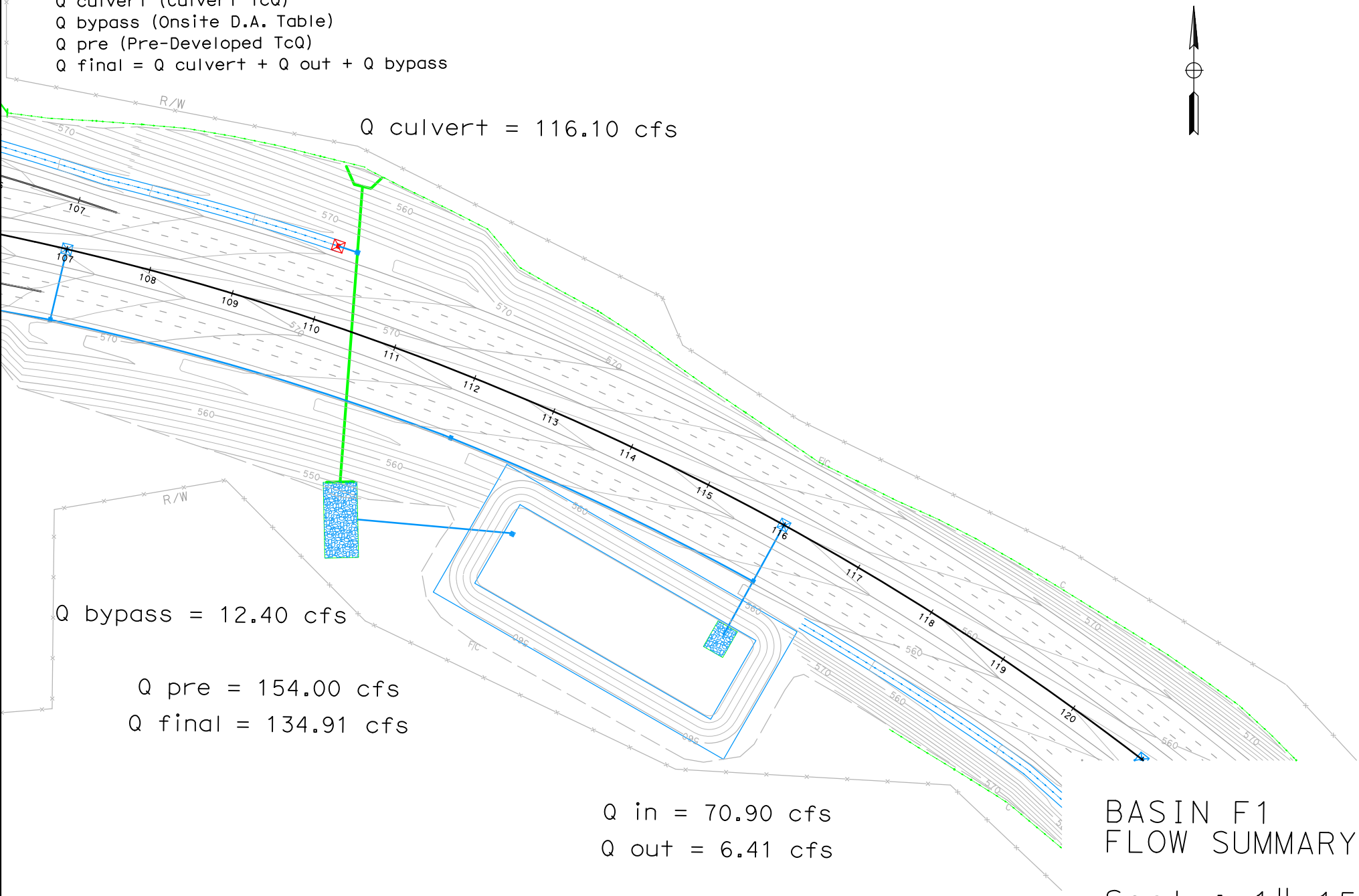
					cfs
i_2 =	1.0	in/hr	X CA =	**Q_2 =**	40.9
i_{10} =	1.5	in/hr	X CA =	**Q_{10} =**	59.5
i_{25} =	1.8	in/hr	X CA =	**Q_{25} =**	81.7
i_{50} =	2.2	in/hr	X CA =	**Q_{50} =**	107.0
i_{100} =	2.3	in/hr	X CA =	**Q_{100} =**	**116.1**

~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 F1
FLOW SUMMARY

Scale: 1"=150'

Basin F1 Retention

PROJECT:	**SR-11**			**DESCRIPTION:**	**SR-11 Basin**
JOB #:	**11A1190**			**STATION:**	**110+00**
BY:	**M.BRUNING**	**DATE:**	**10.13.09**	**WATERSHED:**	**F1**
CHK:	**G.DALZIEL**	**DATE:**		**SYSTEM:**	**Basin**

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

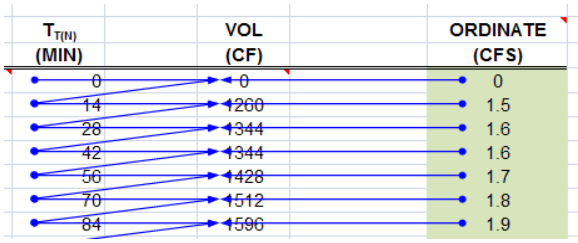
15.33 acre-feet

Check: V = C*A*P_6

V= 15.47 acre-feet

OK

Example of Steps:



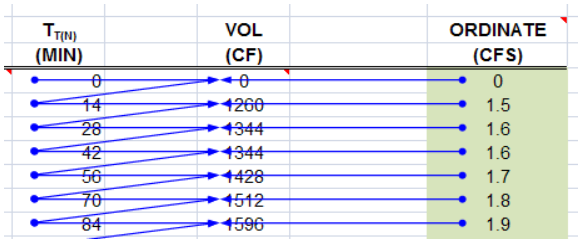
Basin F1 Retention

Post-Developed volume calculations

Q_{100}=	170.4	cfs			
Tc=	29.2	min	C=	0.65	
$P_{100,6}$=	2.5	in	A=	124.96	acres

$T_{T(N)}$ (MIN)	VOL (CF)	ORDINATE (CFS)
0	0	0
29	22098	12.7
58	23316	13.4
87	26796	15.4
116	29058	16.7
145	35496	20.4
174	40368	23.2
203	59334	34.1
232	86652	49.8
261	296496	170.4
290	47502	27.3
319	31842	18.3
348	24882	14.3
377	0	0

Example of Steps:



SUM= 723840 ft^3
16.62 acre-feet

Check: $V = C*A*P_6$
V= 16.82 acre-feet
OK

	16.62	*(Post)*			
-	**15.33**	*(Pre)*			
Retention volume =	**1.29**	**acre-feet**	**=**	**56220 ft^3**	**Basin Required**

Basin F1 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}= 0.91
A= 18.57 acres

WQ_{72}: 0.73 in/area

Water Quality Volume (WQV) = **49202** 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)

Onsite Highway *Sloped* runoff area, A:		404300	ft^2
	A:	9.28	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

$A_s = RKLsCP$

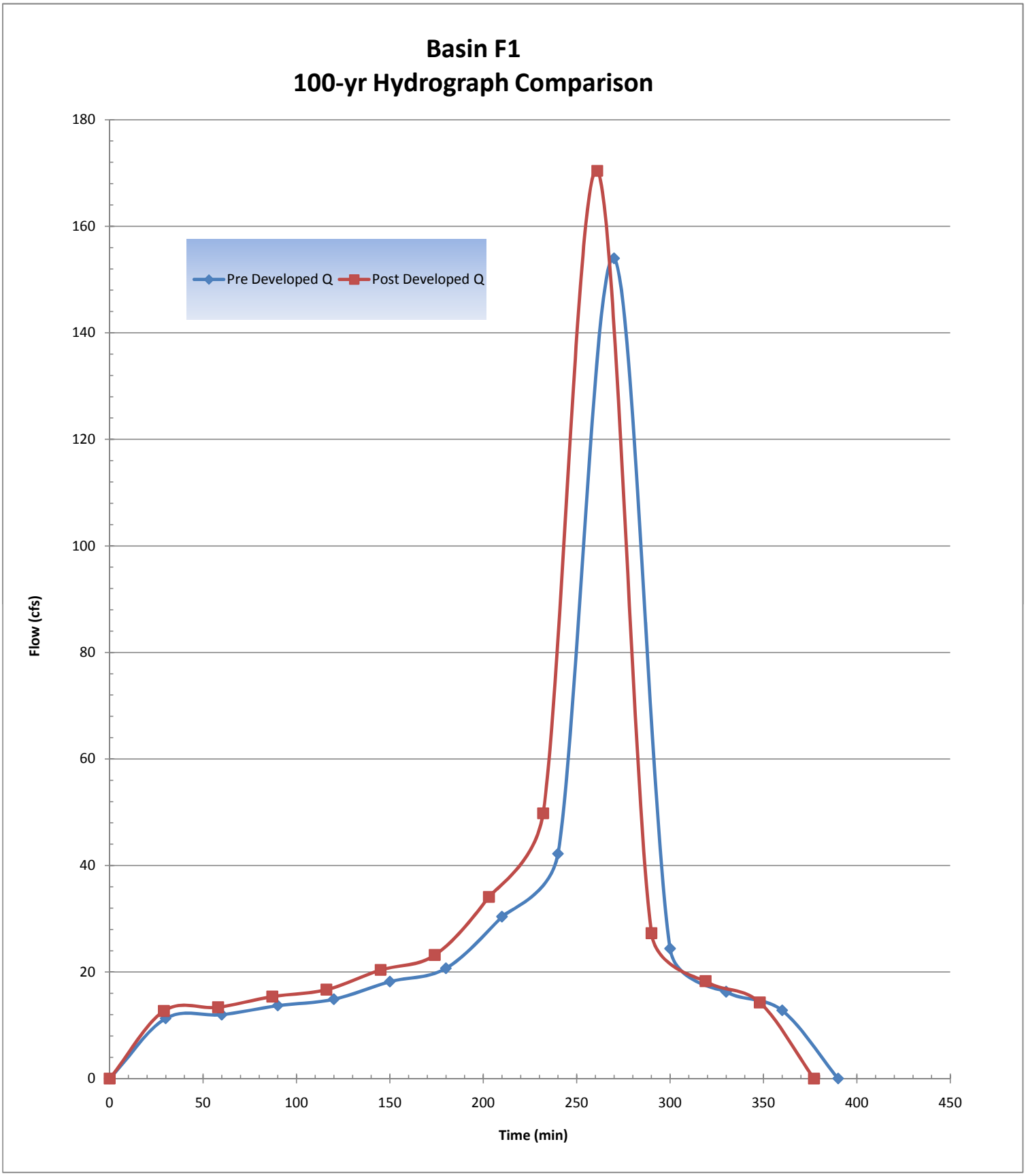
where:

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

Volume for 10-year Silt Accumulation = 144.35 tons

Silt Accumulation Basin volume = **3208** ft^3

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


Basin F1
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 F1 Inflow TcQ

PROJECT:	**SR-11**			**DESCRIPTION:**	**SR-11 Basin**
JOB #:	**11A1190**			**STATION:**	**110+00**
BY:	**M.BRUNING**	**DATE:**	**01.03.10**	**WATERSHED:**	**F1**
CHK:	**G.DALZIEL**	**DATE:**		**SYSTEM:**	**Basin**

BASIN AREA:

A = **808800** **ft^2** **SOURCE:** **MICROSTATION/USGS**
18.57 **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	50%	AT	0.90	0.450
COMMERCIAL AREA	0%	AT	0.85	0.000
CUT SLOPE (2:1 and 4:1)	50%	AT	0.55	0.275
TOTAL	100%			
	(100%)			

$C_{2,10}$ =	0.73
C_{25} =	0.80
C_{50} =	0.87
C_{100} =	0.91

TIME OF CONCENTRATION:

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

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

HIGH PT ELEVATION	604.0	ft	Alta Ramp AL4A1, Sta 98+50
LOW POINT ELEVATION	603.0	ft	
ELEVATION DIFF (H)	1.0	ft	
LENGTH (L)	100	ft	to ES
SLOPE (S) = (H/L)	1.0%		
MANNING'S n	0.016		AC < = From Table 816.6A
T_t (SFF)=	2.88	minutes	

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

NOTES:

HIGH PT ELEVATION	603.0	ft	flow in side road ditch - per grading
LOW POINT ELEVATION	602.0	ft	
ELEVATION DIFF (H)	1.0	ft	
LENGTH (L)	86	ft	assumed SCF and not channelized or flowing full yet
SLOPE (S) = (H/L)	1.2%		
VELOCITY (SCF)	1.1	fps	1.2% , V FROM FIG 816.6 Nearly Bare Ground
T_C (SH)=	1.30	minutes	

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

NOTES:

HIGH PT ELEVATION	602.0	ft	flow in side road ditch - per grading
LOW POINT ELEVATION	600.0	ft	CHANNEL DATA TYPE = TRAP'Z
ELEVATION DIFF (H)	2.0	ft	Z= 4 ANG-RAD 0.245
LENGTH (L)	196	ft	b = 6 ANG-DEG 14.036
SLOPE (S) = (H/L)	1.0%		d = 0.5 FLOWING FULL ASS'M
MANNING'S n	0.050		HDM Table 864.3A, Depressed Median - Earth (with growth)
HYDRAULIC RADIUS R	0.40	ft	R=(bdsinA+d^2cosA)/(bsinA+2d)
VELOCITY (CHANNEL)	1.62	fps	From Manning's Equation assuming flowing full: $V=1.49/n(R^{2/3}S^{1/2})$
T_C (CH)=	2.02	minutes	

Basin F1 Inflow TcQ

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

HIGH PT ELEVATION	595.0	ft
LOW POINT ELEVATION	550.0	ft
ELEVATION DIFF (H)	45.0	ft
LENGTH (L)	1891	ft
SLOPE (S) = (H/L)	2.4%	
MANNING'S n	0.013	
PIPE DIAMETER d	3.0	ft
HYDRAULIC RADIUS R	0.8	ft
VELOCITY (STORMDRAIN)	14.6	fps
T_C (SD)=	2.16	minutes

NOTES:

Proposed onsite pipe (assumed 5' drop to invert)
Proposed Rip Rap Pad in Basin floor
RCP
R=D/4, Assume: flowing full
$V = \frac{K_u}{n} R^{2/3} S^{1/2}$

Tc (TOTAL) =	8.35	minutes
Minimum Tc =	10	minutes
USE T_C =	**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 =	25.0
Q_{10} =	36.3
Q_{25} =	49.9
Q_{50} =	65.3
Q_{100} =	**70.9**

COUNTY P_6

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

Basin F1 Inflow Hydrograph

PROJECT:	**SR-11**			**DESCRIPTION:**	**SR-11 Basin**
JOB #:	**11A1190**			**STATION:**	**110+00**
BY:	**M.BRUNING**	**DATE:**	**11.17.09**	**WATERSHED:**	**F1**
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

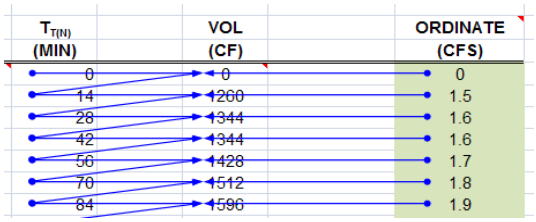
Basin Inflow Hydrograph

Basin Inflow Q

Q_{100}=	70.9	cfs	C_{100}=	0.91	
Tc=	10.0	min	A=	18.57	acres
$P_{100,6}$=	2.5	in			

$T_{T(N)}$ (MIN)	VOL (CF)	ORDINATE (CFS)
0	0	0
10	1500	2.5
20	1560	2.6
30	1620	2.7
40	1620	2.7
50	1680	2.8
60	1740	2.9
70	1860	3.1
80	1860	3.1
90	1980	3.3
100	2040	3.4
110	2160	3.6
120	2220	3.7
130	2400	4
140	2460	4.1
150	2700	4.5
160	2820	4.7
170	3120	5.2
180	3300	5.5
190	3840	6.4
200	4140	6.9
210	5040	8.4
220	5760	9.6
230	8460	14.1
240	12060	20.1
250	42540	70.9
260	6780	11.3
270	4560	7.6
280	3540	5.9
290	3000	5
300	2580	4.3
310	2280	3.8
320	2100	3.5
330	1920	3.2
340	1800	3
350	1680	2.8
360	1560	2.6
370	0	0

Example of Steps:



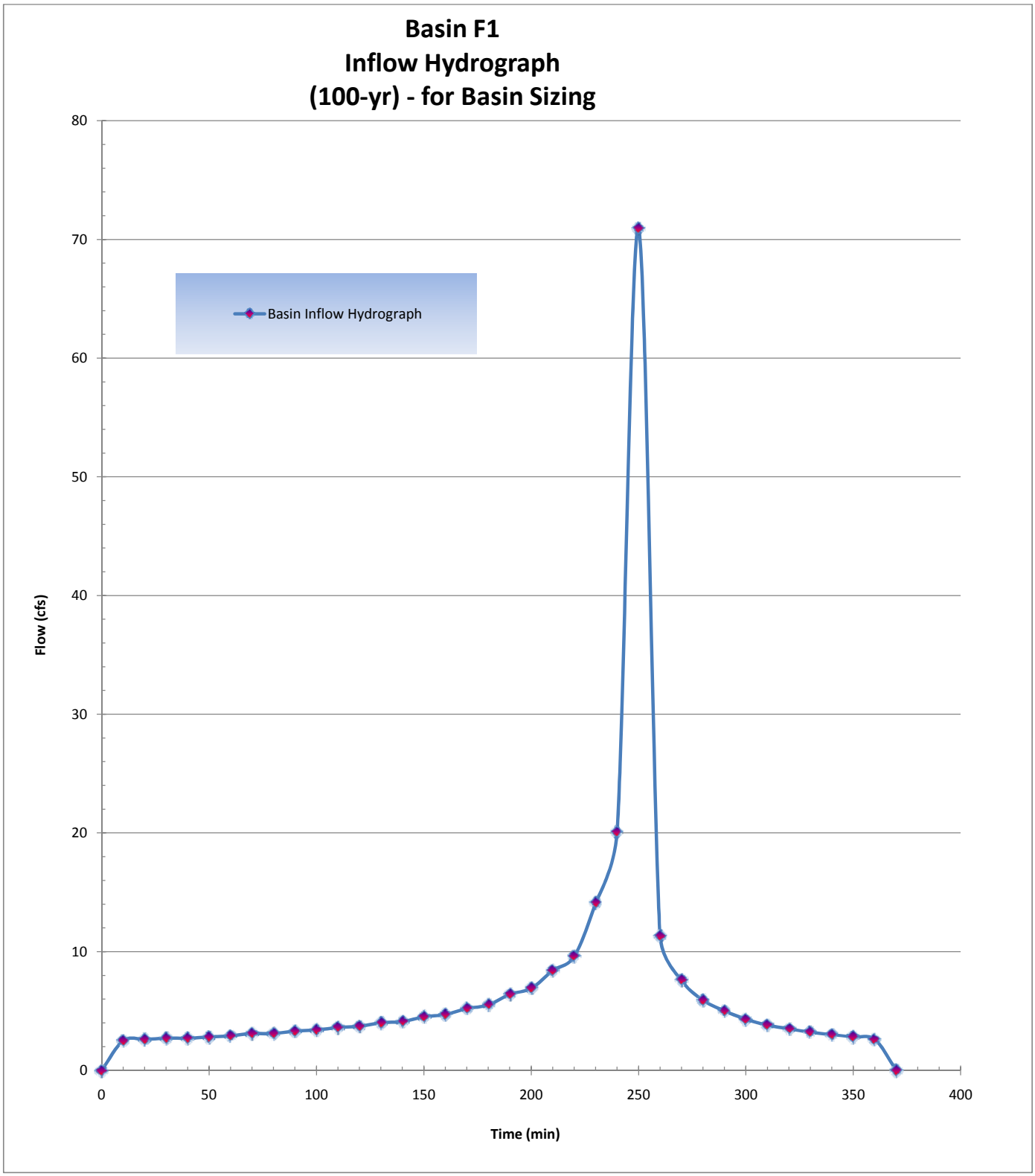
SUM= 152280 ft^3
3.50 acre-feet

Onsite Runoff Volume

Check: $V = C*A*P_6$

V= 3.51 acre-feet

OK


Basin F1
Inflow Hydrograph
(100-yr) - for Basin Sizing
Basin Inflow Hydrograph
Flow (cfs)
Time (min)
0
10
20
30
40
50
60
70
80
0
50
100
150
200
250
300
350
400

Basin F1 Outlet

PROJECT:	**SR-11**			**DESCRIPTION:**	**SR-11 Basin**
JOB #:	**11A1190**			**STATION:**	**110+00**
BY:	**M.BRUNING**	**DATE:**	**02.19.10**	**WATERSHED:**	**F1**
CHK:	**G.DALZIEL**	**DATE:**		**SYSTEM:**	**Basin Outlet**

Notes:

Required Retention Basin Volume = 59428 ft^3
Actual Basin Inflow = 152280 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:	116.1	cfs		Includes: F1.18.SL
Flow that does not reach detention basin (bypass per DA table):	12.4	cfs	~	Q_{100} from: Alta Road (County)
Maximum flow allowed to be released by this detention basin:	25.4	cfs		

Outlet Pipe

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

Basin - Top of basin berm elevation =			558.00	ft
Basin flowline elevation =			552.00	ft
Maximum Basin Depth =			6.00	ft

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

Outlet pipe invert from basin floor =	1.80	ft	553.80	ft
Outlet pipe diameter =	2	ft		

Basin Characteristics

Base Length (L)	325	ft	
Base Width (W)	100	ft	
W/L Ratio ®	0.31		
Side Slopes (Z)	1: 4		
Total Volume (V):	260961	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	552.00	0.00	0	0		552.00	0.00		0.00
1	552.20	0.20	6568	6568		552.20	0.00		0.00
2	552.40	0.40	6705	13273		552.40	0.00		0.00
3	552.60	0.60	6843	20116		552.60	0.00		0.00
4	552.80	0.80	6982	27099		552.80	0.00		0.00
5	553.00	1.00	7122	34221		553.00	0.00		0.00
6	553.20	1.20	7264	41485		553.20	0.00		0.00
7	553.40	1.40	7406	48891		553.40	0.00		0.00
8	553.60	1.60	7549	56440		553.60	0.00		0.00
9	553.80	1.80	7694	64134	*	553.80	0.00		0.00
10	554.00	2.00	7839	71973		554.00	0.15	0.00	0.15
11	554.20	2.20	7986	79959		554.20	0.59		0.59
12	554.40	2.40	8134	88093		554.40	1.30		1.30
13	554.60	2.60	8282	96375		554.60	2.25		2.25
14	554.80	2.80	8432	104807		554.80	3.42		3.42
15	555.00	3.00	8583	113390		555.00	4.79		4.79
16	555.20	3.20	8735	122125		555.20	6.32		6.32
17	555.40	3.40	8888	131013		555.40	7.99		7.99
18	555.60	3.60	9042	140055		555.60	9.77		9.77
19	555.80	3.80	9197	149252		555.80	11.63		11.63
20	556.00	4.00	9353	158605		556.00	13.53		13.53

Basin F1 Routing

PROJECT:	SR-11		DESCRIPTION:	SR-11 Basin	
JOB #:	11A1190		STATION:	110+00	
BY:	M.BRUNING	DATE: 02.19.10	WATERSHED:	F	
CHK:	G.DALZIEL	DATE:	SYSTEM:	Basin	F1

user input
linked input

STORAGE INDICATOR NUMBERS TABLE

					Storage Indicator #
(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)
552.00	0.00	0	0.00	0.00	0.00
552.20	0.00	6568	0.00	10.95	10.95
552.40	0.00	13273	0.00	22.12	22.12
552.60	0.00	20116	0.00	33.53	33.53
552.80	0.00	27099	0.00	45.16	45.16
553.00	0.00	34221	0.00	57.04	57.04
553.20	0.00	41485	0.00	69.14	69.14
553.40	0.00	48891	0.00	81.48	81.48
553.60	0.00	56440	0.00	94.07	94.07
553.80	0.00	64134	0.00	106.89	106.89
554.00	0.15	71973	0.08	119.96	120.03
554.20	0.59	79959	0.30	133.27	133.56
554.40	1.30	88093	0.65	146.82	147.47
554.60	2.25	96375	1.13	160.63	161.75
554.80	3.42	104807	1.71	174.68	176.39
555.00	4.79	113390	2.40	188.98	191.38
555.20	6.32	122125	3.16	203.54	206.70
555.40	7.99	131013	4.00	218.35	222.35
555.60	9.77	140055	4.89	233.42	238.31
555.80	11.63	149252	5.82	248.75	254.57
556.00	13.53	158605	6.77	264.34	271.11

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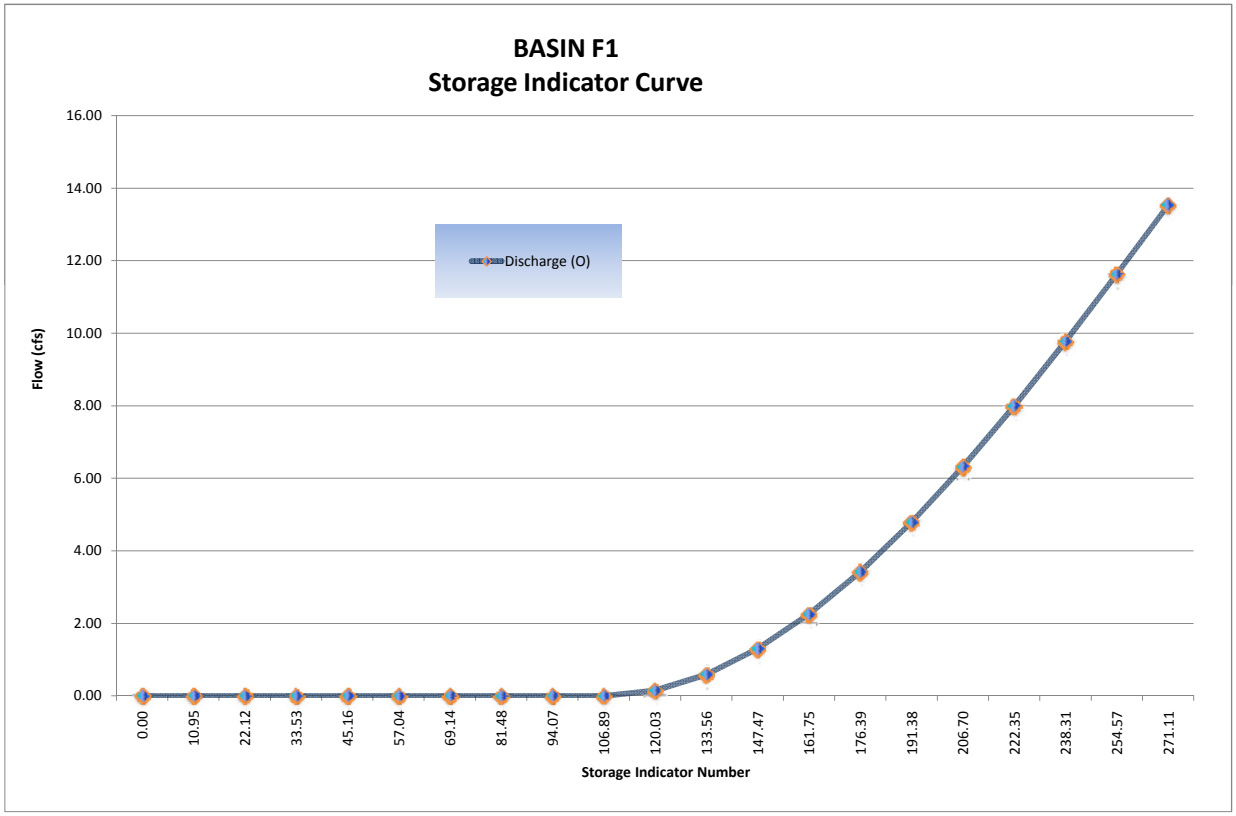
delta t =	0.17	hrs
delta t =	10	min
delta t =	600	sec



Basin F1 Routing

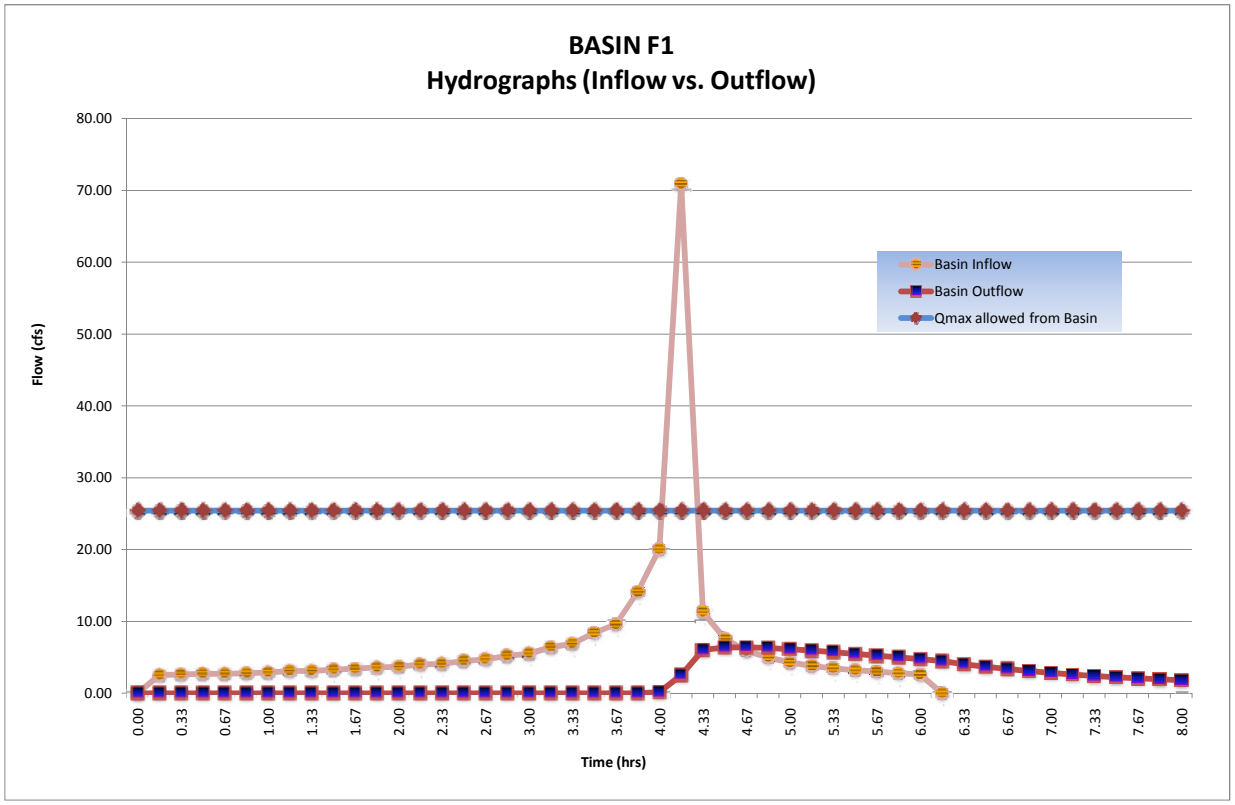
FINAL ROUTING TABLE

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

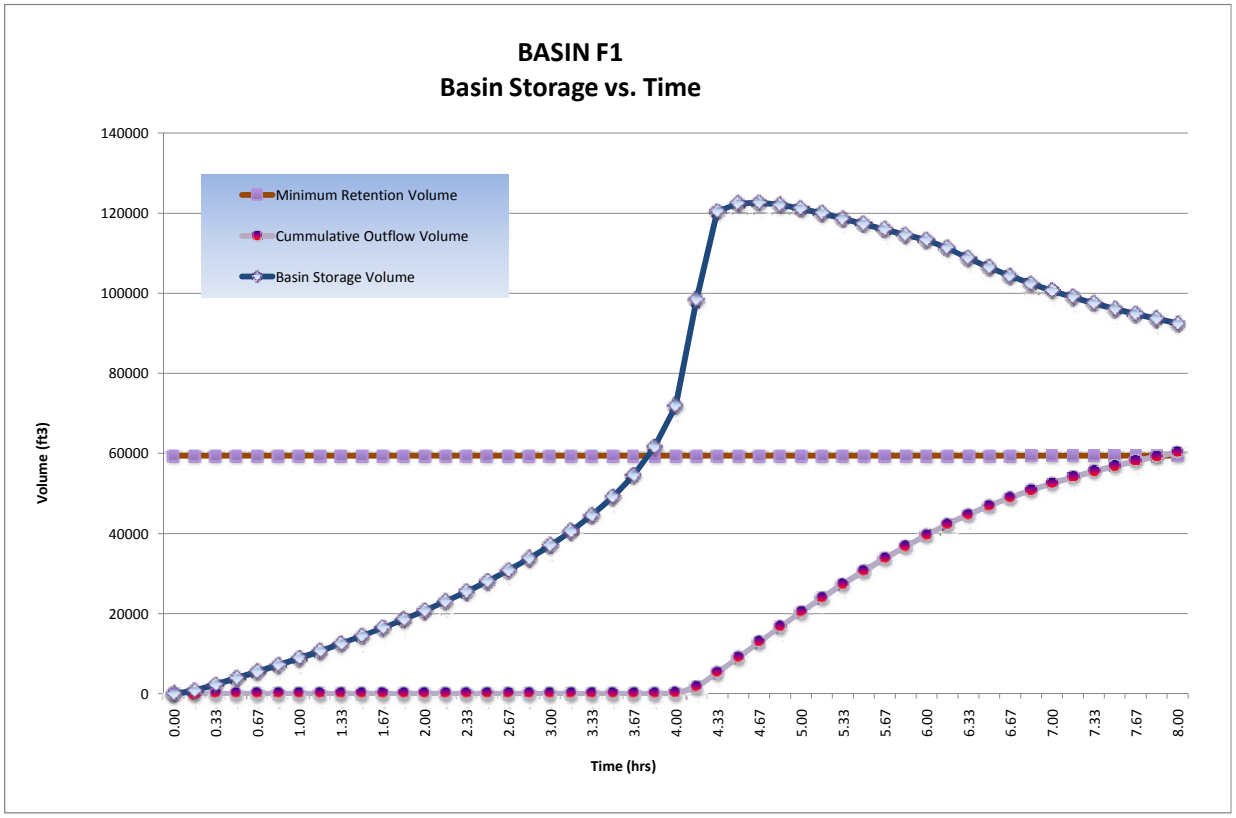
Storage Indicator #

(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*	(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
0.17	2.50	1.25	0.00	0.00	1.25	0.00	750	0	0
0.33	2.60	2.55	1.25	0.00	3.80	0.00	2280	0	0
0.50	2.70	2.65	3.80	0.00	6.45	0.00	3870	0	0
0.67	2.70	2.70	6.45	0.00	9.15	0.00	5490	0	0
0.83	2.80	2.75	9.15	0.00	11.90	0.00	7140	0	0
1.00	2.90	2.85	11.90	0.00	14.75	0.00	8850	0	0
1.17	3.10	3.00	14.75	0.00	17.75	0.00	10650	0	0
1.33	3.10	3.10	17.75	0.00	20.85	0.00	12510	0	0
1.50	3.30	3.20	20.85	0.00	24.05	0.00	14430	0	0
1.67	3.40	3.35	24.05	0.00	27.40	0.00	16440	0	0
1.83	3.60	3.50	27.40	0.00	30.90	0.00	18540	0	0
2.00	3.70	3.65	30.90	0.00	34.55	0.00	20730	0	0
2.17	4.00	3.85	34.55	0.00	38.40	0.00	23040	0	0
2.33	4.10	4.05	38.40	0.00	42.45	0.00	25470	0	0
2.50	4.50	4.30	42.45	0.00	46.75	0.00	28050	0	0
2.67	4.70	4.60	46.75	0.00	51.35	0.00	30810	0	0
2.83	5.20	4.95	51.35	0.00	56.30	0.00	33780	0	0
3.00	5.50	5.35	56.30	0.00	61.65	0.00	36990	0	0
3.17	6.40	5.95	61.65	0.00	67.60	0.00	40560	0	0
3.33	6.90	6.65	67.60	0.00	74.25	0.00	44550	0	0
3.50	8.40	7.65	74.25	0.00	81.90	0.00	49139	2	2
3.67	9.60	9.00	81.90	0.00	90.90	0.00	54537	2	4
3.83	14.10	11.85	90.90	0.00	102.74	0.00	61646	2	5
4.00	20.10	17.10	102.74	0.00	119.84	0.15	71860	90	95
4.17	70.90	45.50	119.84	0.15	165.19	2.53	98356	1518	1613
4.33	11.30	41.10	165.19	2.53	203.76	6.03	120448	3618	5231
4.50	7.60	9.45	203.76	6.03	207.18	6.37	122398	3822	9053
4.67	5.90	6.75	207.18	6.37	207.56	6.41	122614	3846	12899
4.83	5.00	5.45	207.56	6.41	206.60	6.31	122068	3786	16685
5.00	4.30	4.65	206.60	6.31	204.94	6.14	121123	3684	20369
5.17	3.80	4.05	204.94	6.14	202.85	5.94	119929	3564	23933
5.33	3.50	3.65	202.85	5.94	200.56	5.71	118624	3426	27359
5.50	3.20	3.35	200.56	5.71	198.20	5.47	117280	3282	30641
5.67	3.00	3.10	198.20	5.47	195.83	5.23	115930	3138	33779
5.83	2.80	2.90	195.83	5.23	193.50	5.00	114601	3000	36779
6.00	2.60	2.70	193.50	5.00	191.20	4.77	113290	2862	39641
6.17	0.00	1.30	191.20	4.77	187.73	4.46	111301	2676	42317
6.33		0.00	187.73	4.46	183.27	4.05	108748	2430	44747
6.50		0.00	183.27	4.05	179.22	3.68	106429	2208	46955
6.67		0.00	179.22	3.68	175.54	3.35	104320	2010	48965
6.83		0.00	175.54	3.35	172.19	3.08	102391	1848	50813
7.00		0.00	172.19	3.08	169.11	2.84	100615	1704	52517
7.17		0.00	169.11	2.84	166.27	2.61	98980	1566	54083
7.33		0.00	166.27	2.61	163.66	2.40	97477	1440	55523
7.50		0.00	163.66	2.40	161.26	2.22	96091	1332	56855
7.67		0.00	161.26	2.22	159.04	2.07	94804	1242	58097
7.83		0.00	159.04	2.07	156.97	1.93	93604	1158	59255
8.00		0.00	156.97	1.93	155.04	1.80	92485	1080	60335

Basin F1 Routing



Basin F1 Routing



Detention/Retention Basin Volume Required:	**122,614**	ft^3	
@ Stage:	**555.40**	ft	
Freeboard:	**2.6**	ft	> 1' Freeboard
Final Total Basin Volume Provided:	**260,961**	ft^3	Basin **F1**
Maximum flow rate released from this basin:	**6.41**	cfs	

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G1 Onsite D.A. Table

PROJECT:	**SR-11**	**DESCRIPTION:**	**On-site Drainage Areas (D.A.)**
JOB #:	**11A1190**	**STATION:**	**~**
BY:	**M.BRUNING** **DATE:** **01.06.10**	**WATERSHED:**	**G1**
CHK:	**G.DALZIEL** **DATE:**	**SYSTEM:**	**One Interchange Option**

						Caltrans	Caltrans	County	County					
			Area		Tc	i_{25}	Q_{25}	i_{100}	Q_{100}	Drains to:				
	Name	C	*SF*	*Acres*	*min*	*in/hr*	*cfs*	*in/hr*	*cfs*	Bioswale	Inlet	Destination	@ Station	Offset
PAVED	G1.1.PV	0.99	19000	0.4	5	4.0	1.73	6.6	2.84	~	G1.1	Basin G1-North	127+00	Rt
	G1.2.PV	0.99	39000	0.9	5	4.0	3.55	6.6	5.84	~	G1.2	Basin G1-North	121+00	Center
	G1.3.PV	0.99	47000	1.1	5	4.0	4.27	6.6	7.04	~	G1.3	Basin G1-North	127+00	Center
	G1.4.PV	0.99	29700	0.7	5	4.0	2.70	6.6	4.45	~	G1.4	Basin G1-North	131+50	Center
	G1.5.PV	0.99	45800	1.1	5	4.0	4.16	6.6	6.86	~	G1.5	Basin G1-South	139+00	Lt
	G1.6.PV	0.99	26800	0.6	5	4.0	2.44	6.6	4.01	~	G1.6	Basin G1-South	139+00	Rt
	G1.7.PV	0.99	11400	0.3	5	4.0	1.04	6.6	1.71	~	G1.7	Basin G1-South	135+00	Rt
	G1.8.PV	0.99	88200	2.0	10	2.8	5.67	4.2	8.44	G1.8	G1.8	bypass*	130+20	SDR1
	G1.9.PV	0.99	40500	0.9	10	2.8	2.60	4.2	3.88	G1.9	G1.9	Basin G1-South	135+00	SV1
	G1.10.PV	0.99	30300	0.7	5	4.0	2.76	6.6	4.54	~	G1.10	Basin G1-North	131+50	Rt
	G1.11.PV	0.99	6200	0.1	5	4.0	0.56	6.6	0.93	~	G1.11	Basin G1-North	131+50	Lt
	G1.12.PV	0.99	22100	0.5	5	4.0	2.01	6.6	3.31	~	G1.12	Basin G1-North	105+50	SVI1
	G1.13.PV	0.99	22200	0.5	5	4.0	2.02	6.6	3.32	~	G1.13	Basin G1-North	105+50	SVI1
	G1.14.PV	0.99	18000	0.4	5	4.0	1.64	6.6	2.69	~	G1.14	Basin G1-North	102+00	SVI1
	G1.15.PV	0.99	17300	0.4	5	4.0	1.57	6.6	2.59	~	G1.15	Basin G1-North	102+00	SVI1
	G1.16.PV	0.99	43800	1.0	5	4.0	3.98	6.6	6.56	~	G1.16	Basin G1-South	155+00	SDR1
	G1.17.PV	0.99	62900	1.4	5	4.0	5.72	6.6	9.42	~	G1.17	Basin G1-South	155+00	SV1
	G1.18.PV	0.99	68700	1.6	5	4.0	6.25	6.6	10.28	~	G1.18	Basin G1-South	Toll 1	~
	G1.19.PV	0.99	67300	1.5	5	4.0	6.12	6.6	10.07	~	G1.19	Basin G1-South	Toll 2	~
	G1.20.PV	0.99	11400	0.3	5	4.0	1.04	6.6	1.71	~	G1.20	Basin G1-South	100+00	SVI1
	G1.21.PV	0.99	11300	0.3	5	4.0	1.03	6.6	1.69	~	G1.21	Basin G1-South	100+00	SVI1
	G1.27.PV	0.99	34200	0.8	5	4.0	3.11	6.6	5.12	~	~	bypass*	96+50	SVI

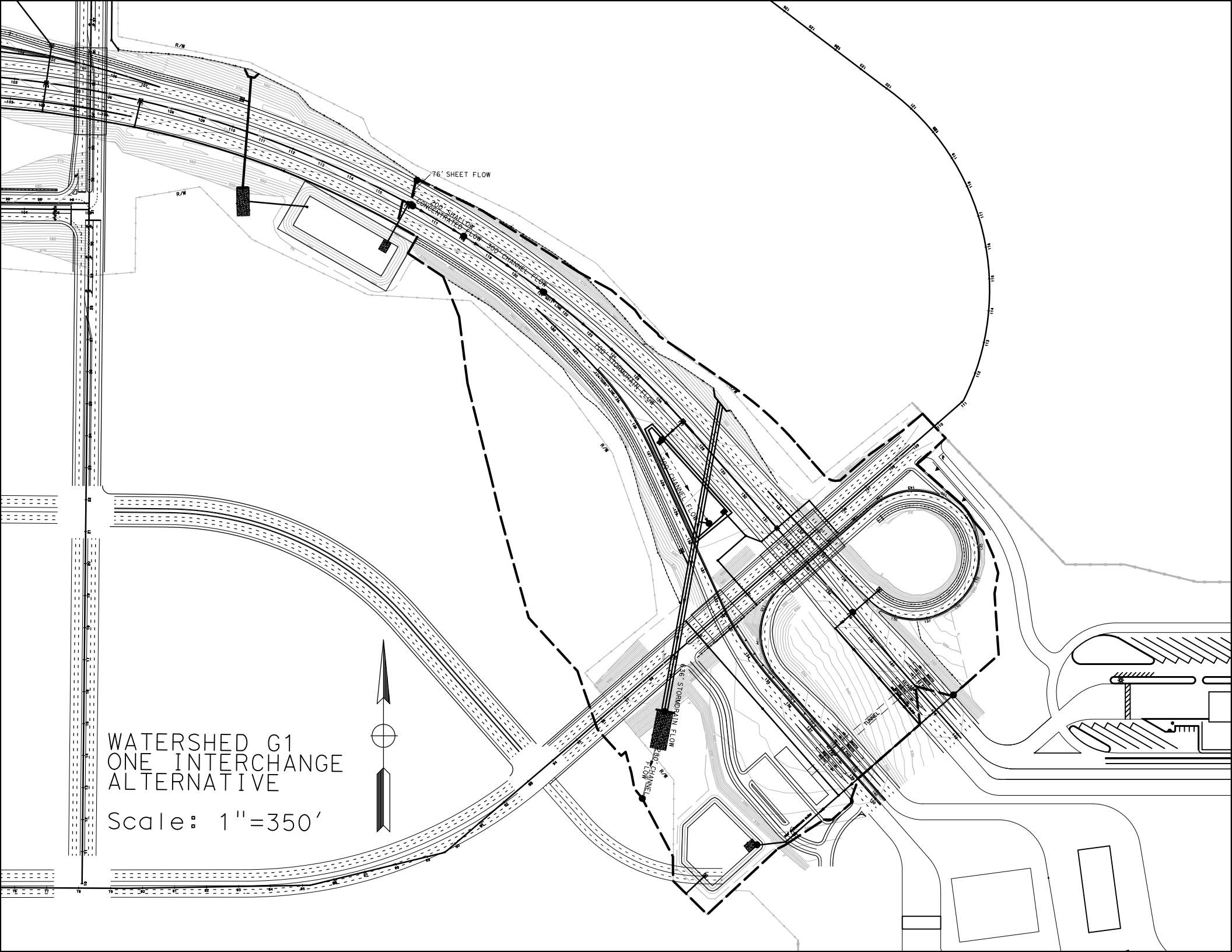
Σ 763100 *PAVED*

						Caltrans	Caltrans	County	County					
			Area		Tc	i_{25}	Q_{25}	i_{100}	Q_{100}	Drains to:				
	Name	C	*SF*	*Acres*	*min*	*in/hr*	*cfs*	*in/hr*	*cfs*	Bioswale	Inlet	Destination	@ Station	Offset
SLOPE	G1.5.SL	0.61	13600	0.3	10	2.8	0.54	4.2	0.80	~	G1.5	Basin G1-South	139+00	Lt
	G1.6.SL	0.61	70500	1.6	10	2.8	2.79	4.2	4.16	~	G1.6	Basin G1-South	139+00	Rt
	G1.7.SL	0.61	30700	0.7	10	2.8	1.22	4.2	1.81	~	G1.7	Basin G1-South	135+00	Rt
	G1.8.SL	0.61	87000	2.0	10	2.8	3.45	4.2	5.13	G1.8	G1.8	bypass*	130+20	SDR1
	G1.9.SL	0.61	95400	2.2	10	2.8	3.78	4.2	5.63	G1.9	G1.8	Basin G1-South	135+00	SV1
	G1.22.SL	0.61	74000	1.7	10	2.8	2.93	4.2	4.37	~	G1.22	Basin G1-North	130+00	SDR1
	G1.23.SL	0.61	57400	1.3	10	2.8	2.27	4.2	3.39	~	G1.23	Basin G1-South	139+00	Lt
	G1.24.SL	0.61	101200	2.3	10	2.8	4.01	4.2	5.97	~	G1.24	Basin G1-South	135+00	Rt
	G1.25.SL	0.61	40800	0.9	10	2.8	1.62	4.2	2.41	~	Culvert	bypass*	127+00	Lt
	G1.27.SL	0.61	40900	0.9	10	2.8	1.62	4.2	2.41	~	~	bypass*	135+02	Rt

Σ 611500 *SLOPE*

* flow that does not reach the basin

Total :	1374600	31.6
	SF	*ac*


76' SHEET FLOW
220' SHALLOW CONCENTRATED FLOW
365' CHANNEL FLOW
706' STORMDRAIN FLOW
365' CHANNEL FLOW
636' STORMDRAIN FLOW
380' CHANNEL FLOW
TUNNEL
R/W
WATERSHED G1
ONE INTERCHANGE
ALTERNATIVE
Scale: 1"=350'

G1 Post-Developed TcQ

PROJECT:	**SR-11**			**DESCRIPTION:**	**SR-11 Post-Developed**
JOB #:	**11A1190**			**STATION:**	**139+00**
BY:	**M.BRUNING**	**DATE:**	**01.06.10**	**WATERSHED:**	**G1-ALL**
CHK:	**G.DALZIEL**	**DATE:**		**SYSTEM:**	**One Interchange Option**

BASIN AREA:

A =	**1969019**	**ft^2**	**SOURCE:**	**MICROSTATION/USGS**
	45.20	**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	30%	AT	0.39	0.118
PAVED SURFACE	39%	AT	0.90	0.349
COMMERCIAL AREA	0%	AT	0.85	0.000
CUT SLOPE (2:1 and 4:1)	31%	AT	0.55	0.171
TOTAL	100%			
	(100%)			

$C_{2,10}$ =	0.64
C_{25} =	0.70
C_{50} =	0.76
C_{100} =	0.80

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	567.0	ft	From asphalt, superelevation
LOW POINT ELEVATION	563.0	ft	
ELEVATION DIFF (H)	4.0	ft	
LENGTH (L)	76	ft	
SLOPE (S) = (H/L)	5.3%		
MANNING'S n	0.016		< = FROM TABLE 816.6A Asphalt Paving
T_t (SFF)=	1.19	minutes	

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

NOTES:

HIGH PT ELEVATION	563.0	ft	assumed SCF and not channelized or flowing full yet
LOW POINT ELEVATION	560.0	ft	
ELEVATION DIFF (H)	3.0	ft	
LENGTH (L)	200	ft	
SLOPE (S) = (H/L)	1.5%		
VELOCITY (SCF)	1.3	fps	<=V FROM FIG 816.5 nearly bare ground
T_C (SH)=	2.67	minutes	

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

NOTES:

HIGH PT ELEVATION	560.0	ft	median ditch
LOW POINT ELEVATION	557.0	ft	
ELEVATION DIFF (H)	3.0	ft	
LENGTH (L)	300	ft	
SLOPE (S) = (H/L)	1.0%		
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)	1.84	fps	From Manning's Equation assuming flowing full: $V=1.49/n(R^{2/3}S^{1/2})$
T_C (CH)=	2.72	minutes	

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

G1 Post-Developed TcQ

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

HIGH PT ELEVATION	552.0	ft	Proposed storm drain through median (elev at pipe invert)
LOW POINT ELEVATION	545.0	ft	Sta 127+00 - basin G0-1
ELEVATION DIFF (H)	7.0	ft	
LENGTH (L)	700	ft	
SLOPE (S) = (H/L)	1.0%		
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)	7.2	fps	$V = \frac{K_u}{n} R^{2/3} S^{1/2}$
T_C (SD)=	1.62	minutes	

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

HIGH PT ELEVATION	545.0	ft	Detention basin (low flow channel)
LOW POINT ELEVATION	542.0	ft	CHANNEL DATA: Z= 4, TYPE = ANG-RAD, TRAP'Z 0.245; b = 2, ANG-DEG, 14.036; d = 1, FLOWING FULL ASS'M
ELEVATION DIFF (H)	3.0	ft	HDM Table 864.3A, Depressed Median - Earth (with growth)
LENGTH (L)	300	ft	R=(bdsinA+d^2cosA)/(bsinA+2d)
SLOPE (S) = (H/L)	1.0%		From Manning's Equation assuming flowing full: $V=1.49/n(R^{2/3}S^{1/2})$
MANNING'S n	0.050		
HYDRAULIC RADIUS R	0.6	ft	
VELOCITY (CHANNEL)	2.09	fps	
T_C (CH)=	2.40	minutes	

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

HIGH PT ELEVATION	532.0	ft	Proposed RCB
LOW POINT ELEVATION	523.0	ft	Outlet
ELEVATION DIFF (H)	9.0	ft	
LENGTH (L)	636	ft	
SLOPE (S) = (H/L)	1.4%		
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)	13.6	fps	$V = \frac{K_u}{n} R^{2/3} S^{1/2}$
T_C (SD)=	0.78	minutes	

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

HIGH PT ELEVATION	523.0	ft	RCP to confluence point
LOW POINT ELEVATION	515.0	ft	CHANNEL DATA: Z= 4, TYPE = ANG-RAD, TRAP'Z 0.245; b = 2, ANG-DEG, 14.036; d = 1, FLOWING FULL ASS'M
ELEVATION DIFF (H)	8.0	ft	HDM Table 864.3A, Depressed Median - Earth (with growth) and RCP
LENGTH (L)	280	ft	R=(bdsinA+d^2cosA)/(bsinA+2d)
SLOPE (S) = (H/L)	2.9%		From Manning's Equation assuming flowing full: $V=1.49/n(R^{2/3}S^{1/2})$
MANNING'S n	0.055		
HYDRAULIC RADIUS R	0.6	ft	
VELOCITY (CHANNEL)	3.21	fps	
T_C (CH)=	1.46	minutes	

Tc (TOTAL) =	12.82	minutes
Minimum Tc =	10	minutes
USE Tc =	**12.82**	minutes

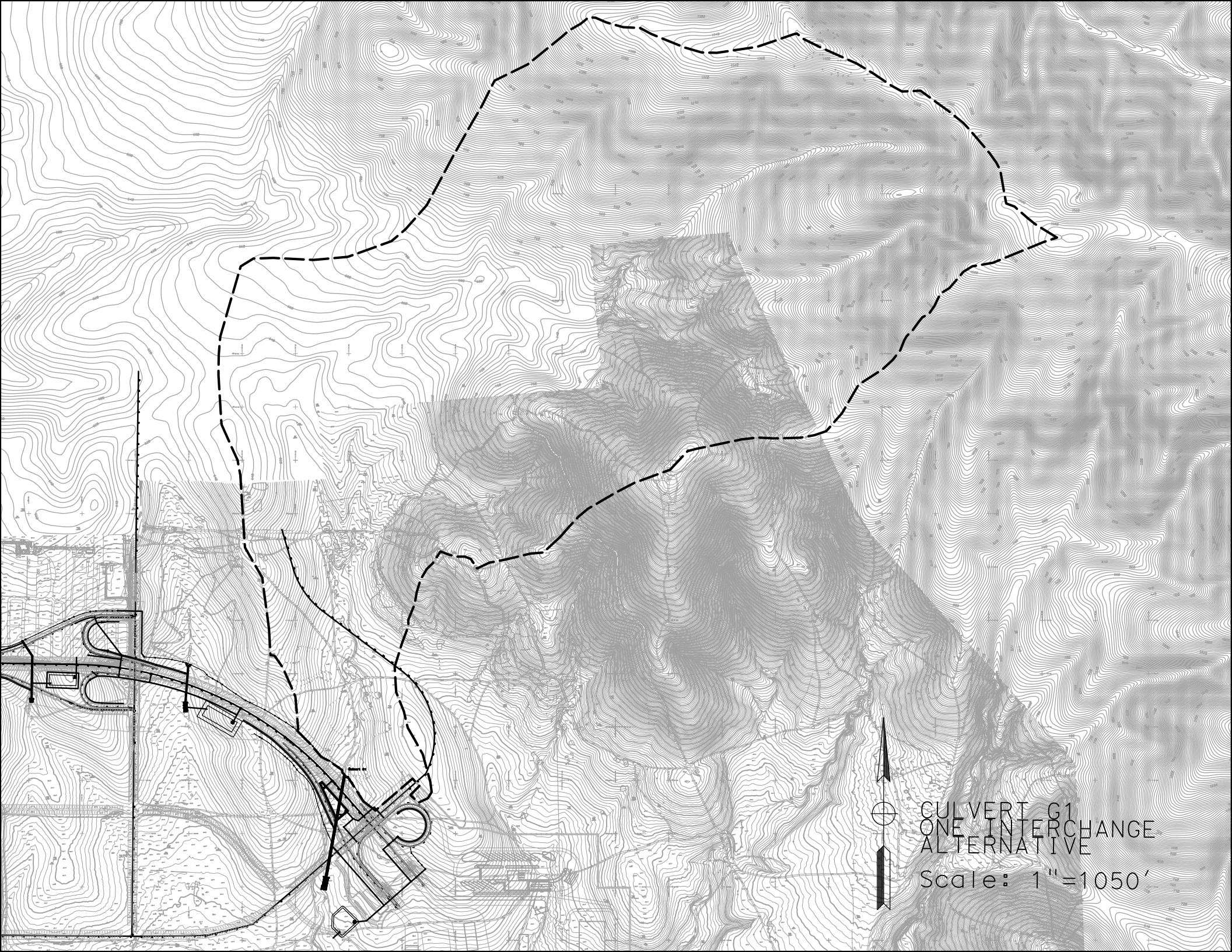
INTENSITY CHART: $I = 7.44\,P_6\,D^{-0.645}$

i_2 =	1.6	in/hr	X CA =	**Q_2 =**	45.5
i_{10} =	2.3	in/hr	X CA =	**Q_{10} =**	66.2
i_{25} =	2.9	in/hr	X CA =	**Q_{25} =**	91.0
i_{50} =	3.4	in/hr	X CA =	**Q_{50} =**	119.1
i_{100} =	3.6	in/hr	X CA =	**Q_{100} =**	**129.2**

FLOW RESULTS: cfs

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 G1
ONE INTERCHANGE
ALTERNATIVE
Scale: 1"=1050'

Culvert Calculator Report
G1 100-yr

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	548.00	ft	Headwater Depth/Height	1.85	
Computed Headwater Elevation	547.39	ft	Discharge	658.00	cfs
Inlet Control HW Elev.	547.39	ft	Tailwater Elevation	518.04	ft
Outlet Control HW Elev.	546.56	ft	Control Type	Inlet Control	

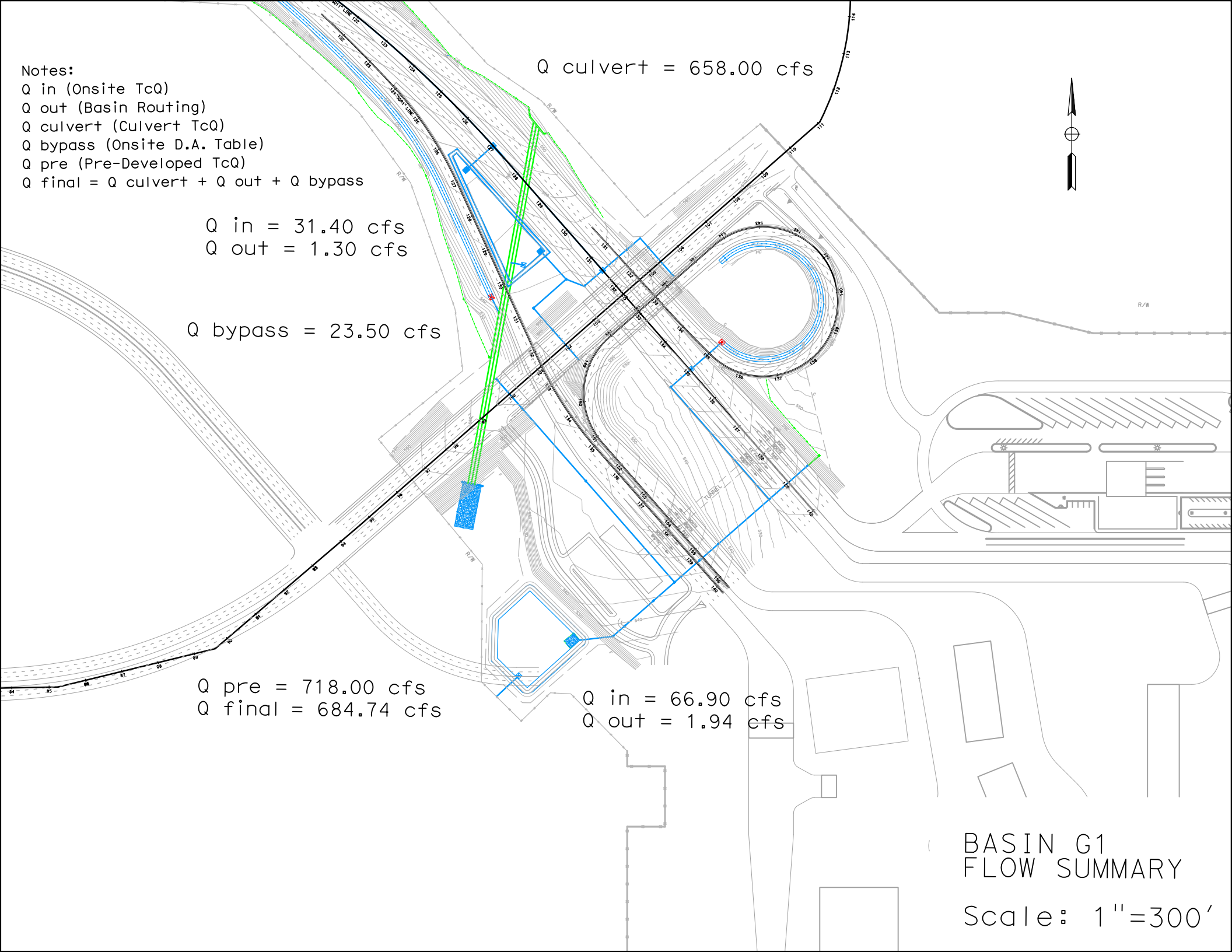
Grades					
Upstream Invert	540.00	ft	Downstream Invert	516.00	ft
Length	1,150.00	ft	Constructed Slope	2.1	%

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	20.17	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.	546.56	ft	Upstream Velocity Head	1.87	ft
Ke	0.50		Entrance Loss	0.94	ft

Inlet Control Properties					
Inlet Control HW Elev.	547.39	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				


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
Q culvert = 658.00 cfs
Q in = 31.40 cfs
Q out = 1.30 cfs
Q bypass = 23.50 cfs
Q pre = 718.00 cfs
Q final = 684.74 cfs
Q in = 66.90 cfs
Q out = 1.94 cfs
BASIN G1
FLOW SUMMARY
Scale: 1"=300'

Basin G1 Retention

PROJECT:	**SR-11**			**DESCRIPTION:**	**SR-11 Basin**
JOB #:	**11A1190**			**STATION:**	**139+00**
BY:	**M.BRUNING**	**DATE:**	**01.06.10**	**WATERSHED:**	**G1-ALL**
CHK:	**G.DALZIEL**	**DATE:**		**SYSTEM:**	**One Interchange Option**

Notes:

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

RETENTION VOLUME

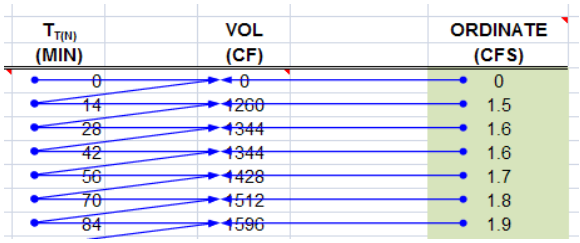
100-year, 6 hour duration storm event, use the Rational Method Hydrograph Procedure (SDCHM 6-1) ~ RatHydro

Pre-Developed volume calculations

Q_{100}= 60.0 cfs
Tc= 17.0 min
$P_{100,6}$= 2.5 in
C= 0.49
A= 41.08 acres

$T_{T(N)}$ (MIN)	VOL (CF)	ORDINATE (CFS)
0	0	0
17	3060	3
34	3162	3.1
51	3468	3.4
68	3570	3.5
85	3876	3.8
102	4080	4
119	4488	4.4
136	4794	4.7
153	5508	5.4
170	5916	5.8
187	7242	7.1
204	8262	8.1
221	12138	11.9
238	17340	17
255	61200	60
272	9792	9.6
289	6528	6.4
306	5100	5
323	4284	4.2
340	3672	3.6
357	3366	3.3
374	0	0

Example of Steps:



SUM= 180846 ft^3
4.15 acre-feet

Check: V = C*A*P_6
V= 4.17 acre-feet
OK

Basin G1 Retention

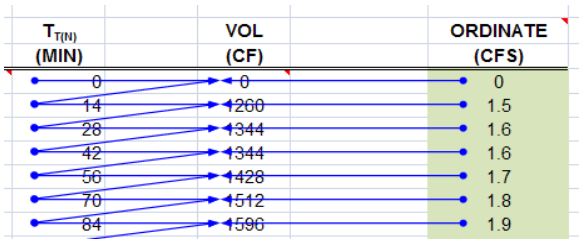
Post-Developed volume calculations

Q_{100}= 129.2 cfs
Tc= 12.8 min
$P_{100,6}$= 2.5 in

C= 0.80
A= 45.20 acres

$T_{T(N)}$ (MIN)	VOL (CF)	ORDINATE (CFS)
0	0	0
13	1872	2.4
26	4290	5.5
39	4446	5.7
52	4680	6
65	4758	6.1
78	5070	6.5
91	5226	6.7
104	5616	7.2
117	5850	7.5
130	6318	8.1
143	6630	8.5
156	7410	9.5
169	7800	10
182	8970	11.5
195	9750	12.5
208	11856	15.2
221	13494	17.3
234	19890	25.5
247	27534	35.3
260	100776	129.2
273	15912	20.4
286	10686	13.7
299	8346	10.7
312	7020	9
325	6084	7.8
338	5460	7
351	4914	6.3
364	4524	5.8
377	0	0

Example of Steps:



SUM= 325182 ft^3
7.47 acre-feet

Check: $V = C*A*P_6$
V= 7.50 acre-feet
OK

Retention volume = 7.47
- 4.15
= 3.31 acre-feet = 144336 ft^3 Basin Required

Basin G1 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 Max C from North/South Onsite
A= 24.87 acres Sum of North/South Onsite Area

WQ_{72}: 0.73 in/area

Water Quality Volume (WQV) = **65913** ft^3

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

If the WQV 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

Universal Soil Loss Equation (SDCHM 5.2.3)

$A_s = RKLsCP$

where:

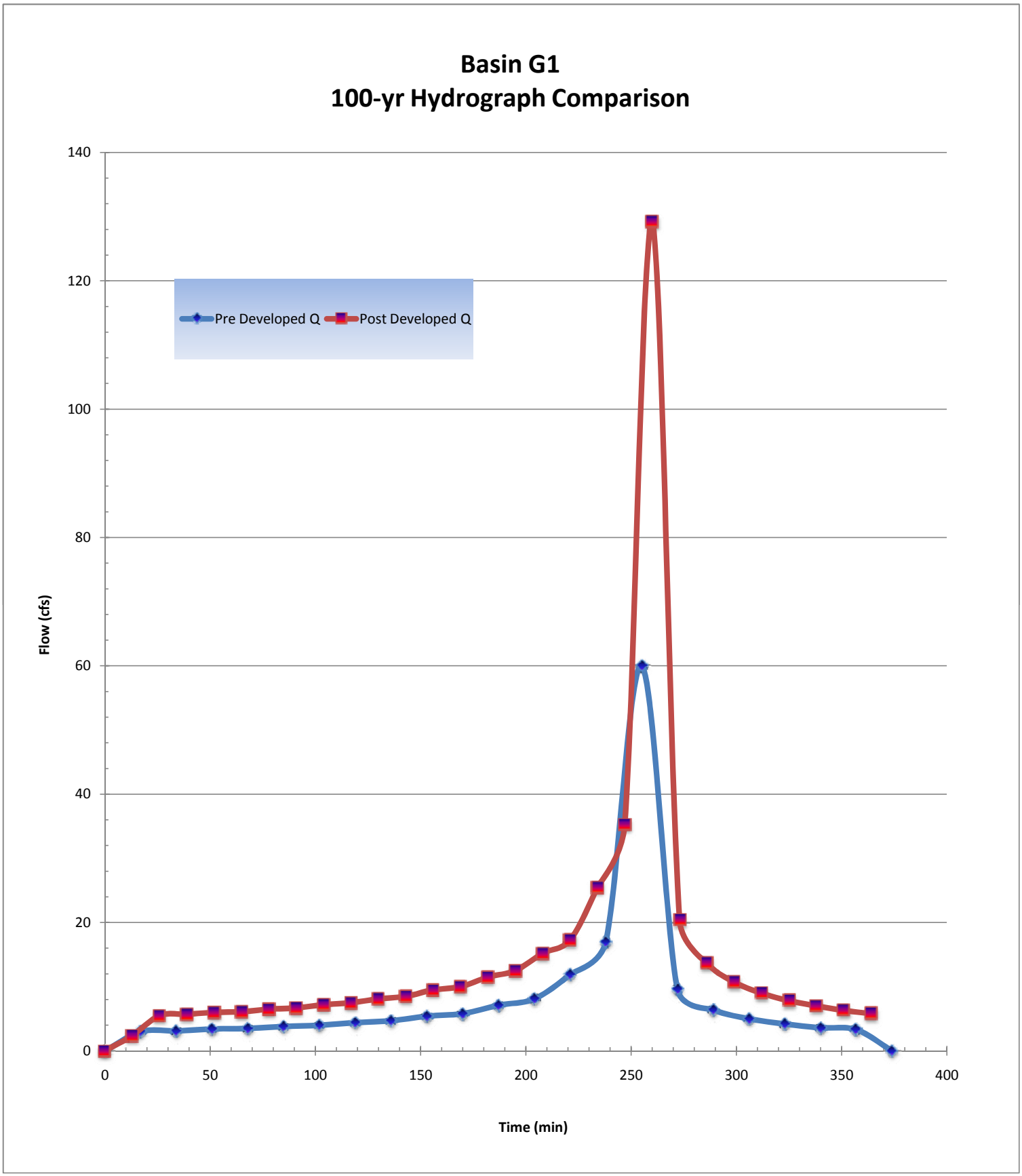
A_s = the computed soil loss in tons (dry weight)
R = the rainfall erosion index for the given storm period
K = the soil erodibility factor
L = the slope length factor
s = the slope gradient factor
C = cropping management (vegetation) factor
P = erosion control practice factor

Onsite Highway *Sloped* runoff area, A:		442800	ft^2
	A:	10.17	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 = 158.09 tons

Silt Accumulation Basin volume = **3513** ft^3

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


Basin G1
100-yr Hydrograph Comparison
Pre Developed Q
Post Developed Q
Flow (cfs)
Time (min)
0
20
40
60
80
100
120
140
0
50
100
150
200
250
300
350
400

Basin G1-North Inflow TcQ

PROJECT:	**SR-11**			**DESCRIPTION:**	**SR-11 Basin**
JOB #:	**11A1190**			**STATION:**	**127+00**
BY:	**M.BRUNING**	**DATE:**	**01.06.10**	**WATERSHED:**	**G1**
CHK:	**G.DALZIEL**	**DATE:**		**SYSTEM:**	**Basin G1-North**

BASIN AREA:

A = **324800** **ft^2** **SOURCE:** **MICROSTATION/USGS**
7.46 **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	77%	AT	0.90	0.695
COMMERCIAL AREA	0%	AT	0.85	0.000
CUT SLOPE (2:1 and 4:1)	23%	AT	0.55	0.125
TOTAL	100%			
	(100%)			

$C_{2,10}$ =	0.82
C_{25} =	0.90
C_{50} =	0.98
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	567.0	ft
LOW POINT ELEVATION	563.0	ft
ELEVATION DIFF (H)	4.0	ft
LENGTH (L)	76	ft
SLOPE (S) = (H/L)	5.3%	
MANNING'S n	0.016	
T_t (SFF)=	1.19	minutes

From asphalt, superelevation

< = FROM TABLE 816.6A Asphalt Paving

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

NOTES:

HIGH PT ELEVATION	563.0	ft
LOW POINT ELEVATION	560.0	ft
ELEVATION DIFF (H)	3.0	ft
LENGTH (L)	200	ft
SLOPE (S) = (H/L)	1.5%	
VELOCITY (SCF)	1.3	fps
T_C (SH)=	2.67	minutes

assumed SCF and not channelized or flowing full yet

<=V FROM FIG 816.5 nearly bare ground

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

NOTES:

HIGH PT ELEVATION	560.0	ft
LOW POINT ELEVATION	557.0	ft
ELEVATION DIFF (H)	3.0	ft
LENGTH (L)	300	ft
SLOPE (S) = (H/L)	1.0%	
MANNING'S n	0.050	
HYDRAULIC RADIUS R	0.5	ft
VELOCITY (CHANNEL)	1.84	fps
T_C (CH)=	2.72	minutes

median ditch

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: $V=1.49/n(R^{2/3}S^{1/2})$

Basin G1-North Inflow TcQ

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

HIGH PT ELEVATION	552.0	ft
LOW POINT ELEVATION	546.0	ft
ELEVATION DIFF (H)	6.0	ft
LENGTH (L)	700	ft
SLOPE (S) = (H/L)	0.9%	
MANNING'S n	0.013	
PIPE DIAMETER d	2.0	ft
HYDRAULIC RADIUS R	0.5	ft
VELOCITY (STORMDRAIN)	6.7	fps
T_C (SD)=	1.75	minutes

NOTES:

Proposed storm drain through median (elev at pipe invert)
Sta 127+00 - basin G1-North
RCP
R=D/4, Assume: flowing full
$V = \frac{K_u}{n} R^{2/3} S^{1/2}$

Tc (TOTAL) =	8.32	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 =	11.3
Q_{10} =	16.5
Q_{25} =	22.7
Q_{50} =	29.7
Q_{100} =	**31.4**

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 G1North Inflow Hydrograph

PROJECT:	**SR-11**			**DESCRIPTION:**	**SR-11 Basin**
JOB #:	**11A1190**			**STATION:**	**126+50 - 130+00**
BY:	**M.BRUNING**	**DATE:**	**01.06.10**	**WATERSHED:**	**G1**
CHK:	**G.DALZIEL**	**DATE:**		**SYSTEM:**	**No Interchange Option**

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

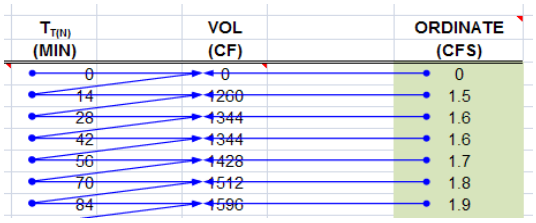
Basin Inflow Hydrograph

Q_{100}=	31.4	cfs		C_{100}=	1.00
Tc=	10.0	min		A=	7.46	acres
$P_{100,6}$=	2.5	in			

Basin Inflow Q

$T_{T(N)}$ (MIN)	VOL (CF)	ORDINATE (CFS)
0	0	0
10	660	1.1
20	660	1.1
30	720	1.2
40	720	1.2
50	780	1.3
60	780	1.3
70	780	1.3
80	840	1.4
90	900	1.5
100	900	1.5
110	960	1.6
120	960	1.6
130	1080	1.8
140	1080	1.8
150	1200	2
160	1260	2.1
170	1380	2.3
180	1440	2.4
190	1680	2.8
200	1800	3
210	2220	3.7
220	2520	4.2
230	3720	6.2
240	5280	8.8
250	18840	31.4
260	3000	5
270	1980	3.3
280	1560	2.6
290	1320	2.2
300	1140	1.9
310	1020	1.7
320	900	1.5
330	840	1.4
340	780	1.3
350	720	1.2
360	720	1.2
370	0	0

Example of Steps:



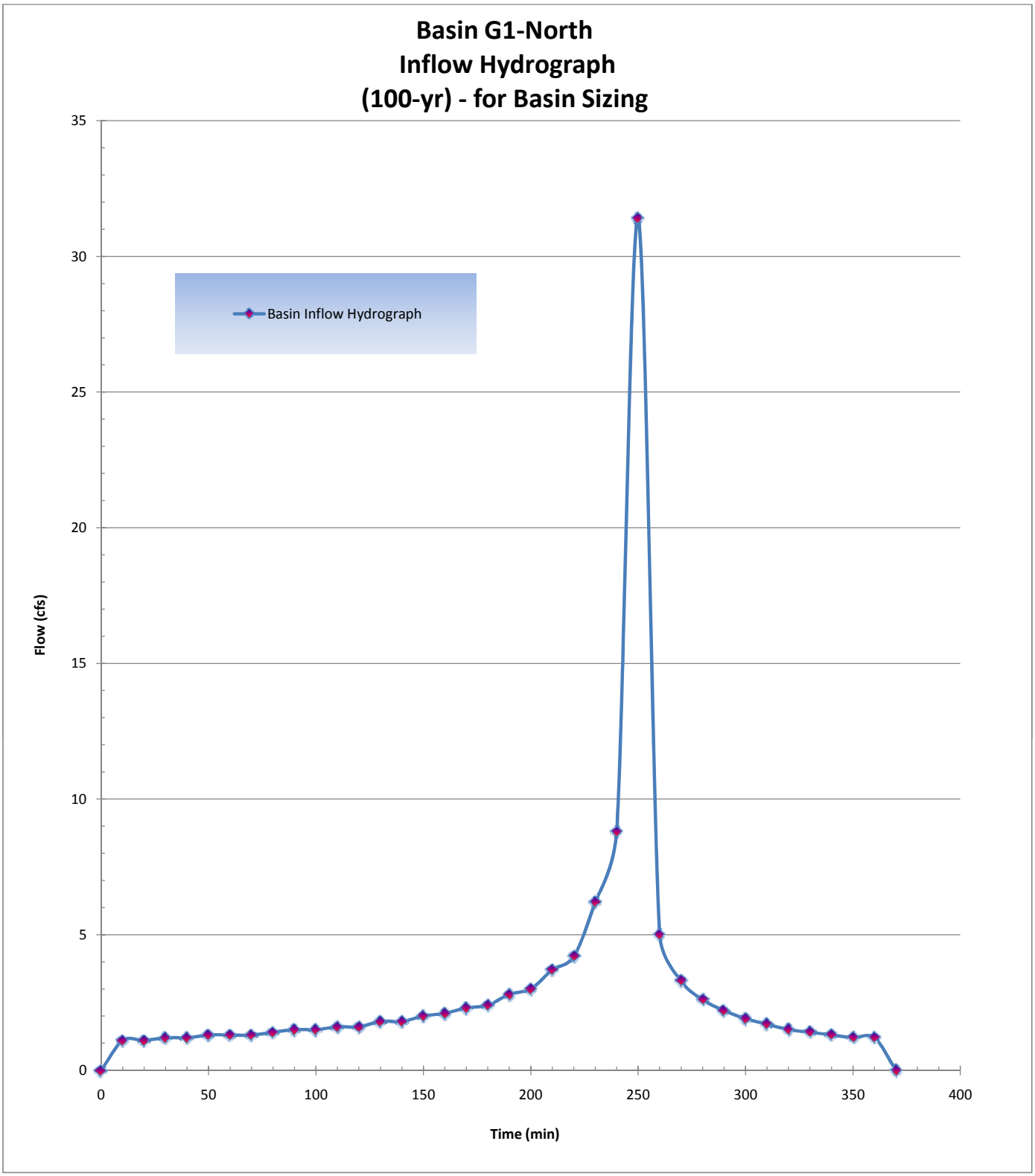
SUM= 67140 ft³
1.54 acre-feet

Onsite Runoff Volume

Check: $V = C*A*P_6$

V= 1.55 acre-feet

OK


Basin G1-North
Inflow Hydrograph
(100-yr) - for Basin Sizing
Basin Inflow Hydrograph
Flow (cfs)
Time (min)
0
5
10
15
20
25
30
35
0
50
100
150
200
250
300
350
400

Basin G1-North Outlet

PROJECT:	**SR-11**			**DESCRIPTION:**	**SR-11 Basin**
JOB #:	**11A1190**			**STATION:**	**130+00**
BY:	**M.BRUNING**	**DATE:**	**02.19.10**	**WATERSHED:**	**G1-North**
CHK:	**G.DALZIEL**	**DATE:**		**SYSTEM:**	**Basin G1-North**

Notes:

Volumes:

Required Retention Basin Volume =	147849	ft^3	from G1-ALL
Retention volume from this basin =	46802		at 2.6' depth, see G1-South for remainder of storage
Actual Basin Inflow =	67140	ft^3	*OK*

Flow Balance - determine maximum flow from basin

Predeveloped Peak 100-year Flow:	60.0	cfs	from G1-ALL
Post-Developed Peak Flow through Cross Culvert:	0.0	cfs	Independent of Culvert G1
Flow that does not reach detention basin (bypass per DA table):	23.5	cfs	Q_{100} from: G1.8.PVG1.27.PVG1.8.SLG1.25.SLG1.27.SL
Maximum flow allowed to be released by this detention basin:	11.5	cfs	*32%* of G1-ALL (per retention ratios)

Outlet Pipe

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

Basin - Top of basin berm elevation =			546.20 ft
Basin flowline elevation =			542.00 ft
Maximum Basin Depth =			4.20 ft
Assume Culvert Design: free outfall, square-edge w/headwall			
Outlet pipe invert from basin floor =	2.60	ft	544.60 ft
Outlet pipe diameter =	2	ft	

Basin Characteristics

Base Length (L)	200	ft	L/2 due to sloped floor
Base Width (W)	75	ft	average
W/L Ratio ®	0.38		
Side Slopes (Z)	1: 4		
Total Volume (V):	83929	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	542.00	0.00	0	0		542.00	0.00		0.00
1	542.20	0.20	3044	3044		542.20	0.00		0.00
2	542.40	0.40	3133	6178		542.40	0.00		0.00
3	542.60	0.60	3223	9401		542.60	0.00		0.00
4	542.80	0.80	3314	12715		542.80	0.00		0.00
5	543.00	1.00	3406	16122		543.00	0.00		0.00
6	543.20	1.20	3499	19621		543.20	0.00		0.00
7	543.40	1.40	3593	23215		543.40	0.00		0.00
8	543.60	1.60	3688	26903		543.60	0.00		0.00
9	543.80	1.80	3784	30687		543.80	0.00		0.00
10	544.00	2.00	3881	34568		544.00	0.00		0.00
11	544.20	2.20	3979	38547		544.20	0.00		0.00
12	544.40	2.40	4078	42625		544.40	0.00		0.00
13	544.60	2.60	4177	46802	*	544.60	0.00	0.00	0.00
14	544.80	2.80	4278	51080		544.80	0.15		0.15
15	545.00	3.00	4380	55460		545.00	0.59		0.59
16	545.20	3.20	4482	59943		545.20	1.30		1.30
17	545.40	3.40	4586	64529		545.40	2.25		2.25
18	545.60	3.60	4691	69219		545.60	3.42		3.42
19	545.80	3.80	4796	74016		545.80	4.79		4.79
20	546.00	4.00	4903	78918		546.00	6.32		6.32
21	546.20	4.20	5010	83929		546.20	7.99		7.99
22	546.40	4.40	5119	89047		546.40	9.77		9.77
23	546.60	4.60	5228	94276		546.60	11.63		11.63
24	546.80	4.80	5339	99614		546.80	13.53		13.53
25	547.00	5.00	5450	105064		547.00	15.46		15.46

Basin G1-North Routing

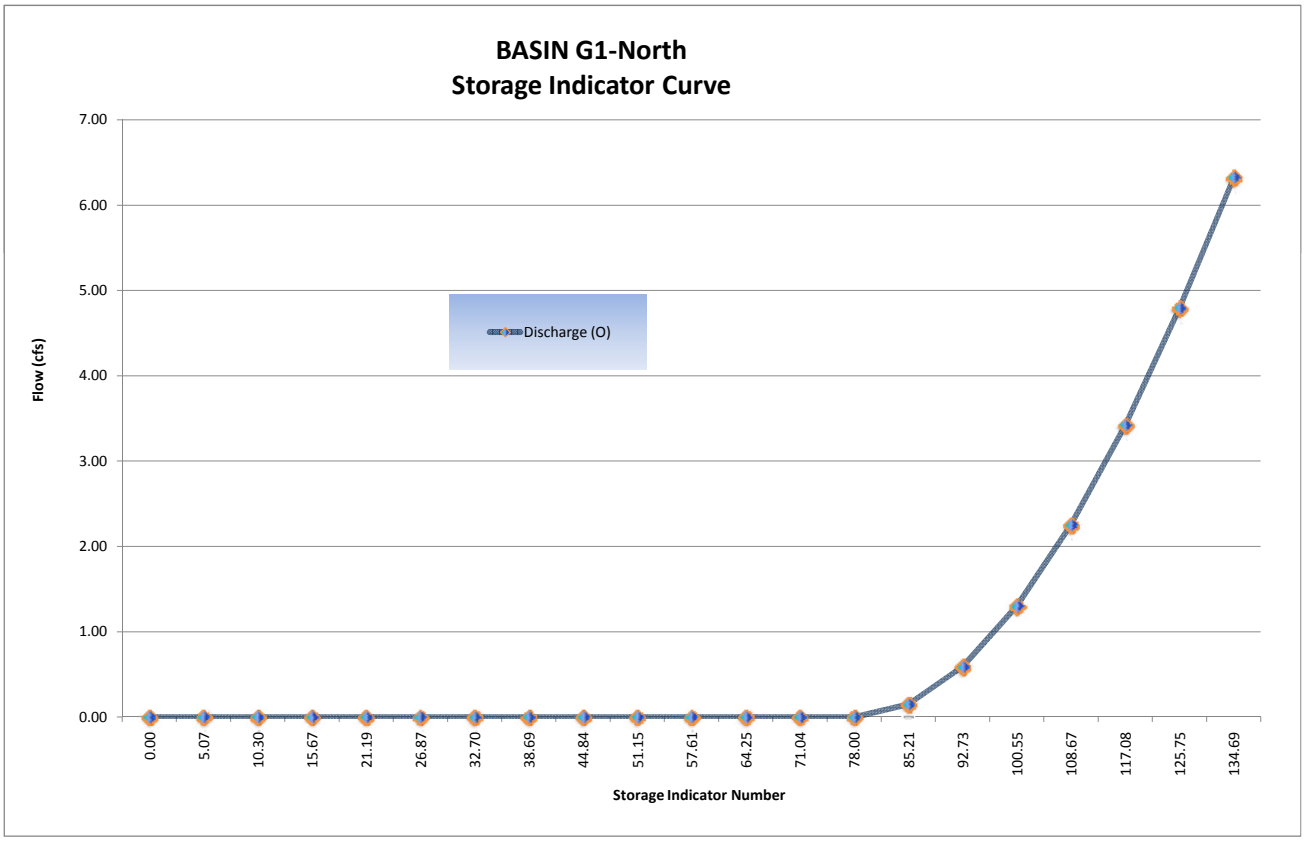
PROJECT:	**SR-11**			**DESCRIPTION:**	**SR-11 Basin**
JOB #:	**11A1190**			**STATION:**	**130+00**
BY:	**M.BRUNING**	**DATE:**	**02.19.10**	**WATERSHED:**	**G1-North**
CHK:	**G.DALZIEL**	**DATE:**		**SYSTEM:**	**Basin G1-North**

user input
linked input

STORAGE INDICATOR NUMBERS TABLE

					Storage Indicator #
(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)
542.00	0.00	0	0.00	0.00	0.00
542.20	0.00	3044	0.00	5.07	5.07
542.40	0.00	6178	0.00	10.30	10.30
542.60	0.00	9401	0.00	15.67	15.67
542.80	0.00	12715	0.00	21.19	21.19
543.00	0.00	16122	0.00	26.87	26.87
543.20	0.00	19621	0.00	32.70	32.70
543.40	0.00	23215	0.00	38.69	38.69
543.60	0.00	26903	0.00	44.84	44.84
543.80	0.00	30687	0.00	51.15	51.15
544.00	0.00	34568	0.00	57.61	57.61
544.20	0.00	38547	0.00	64.25	64.25
544.40	0.00	42625	0.00	71.04	71.04
544.60	0.00	46802	0.00	78.00	78.00
544.80	0.15	51080	0.08	85.13	85.21
545.00	0.59	55460	0.30	92.43	92.73
545.20	1.30	59943	0.65	99.90	100.55
545.40	2.25	64529	1.13	107.55	108.67
545.60	3.42	69219	1.71	115.37	117.08
545.80	4.79	74016	2.40	123.36	125.75
546.00	6.32	78918	3.16	131.53	134.69

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



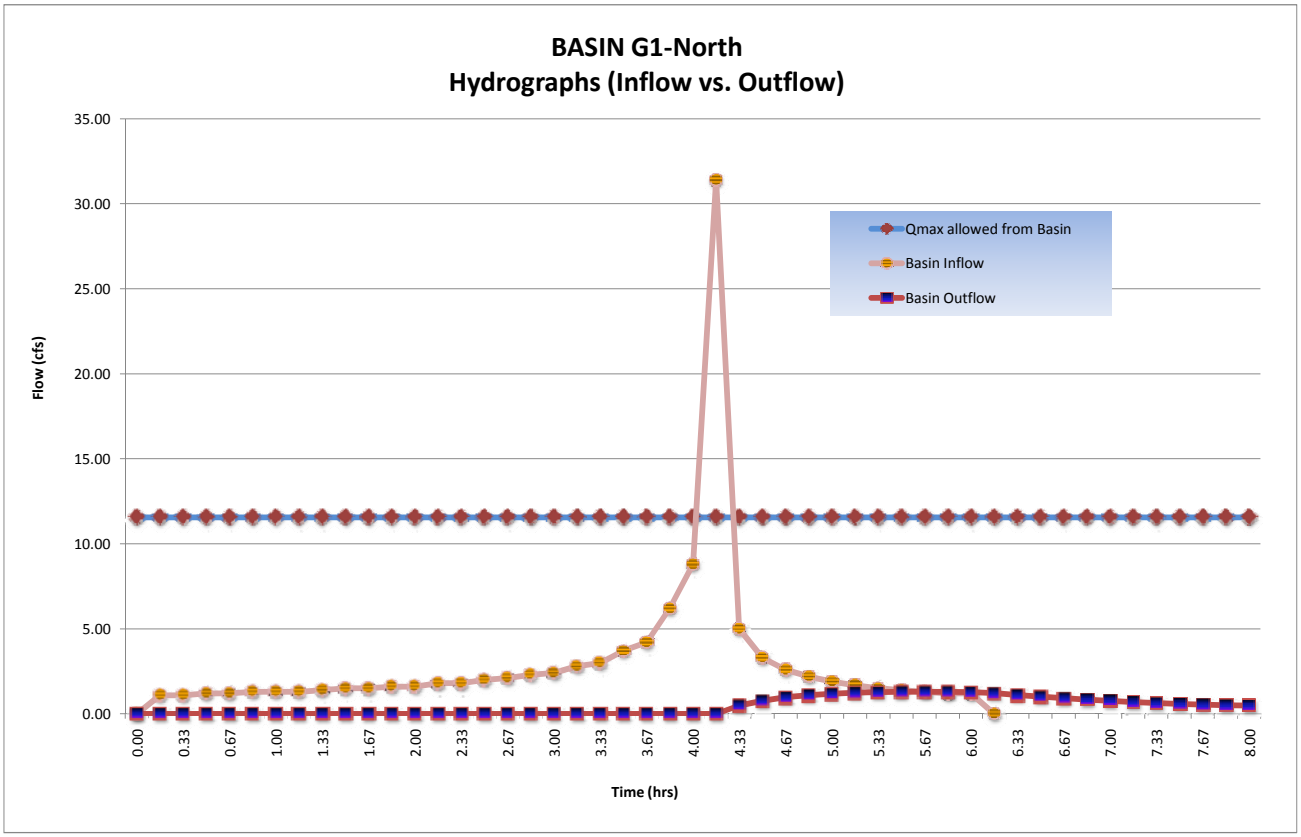
Basin G1-North Routing

FINAL ROUTING TABLE

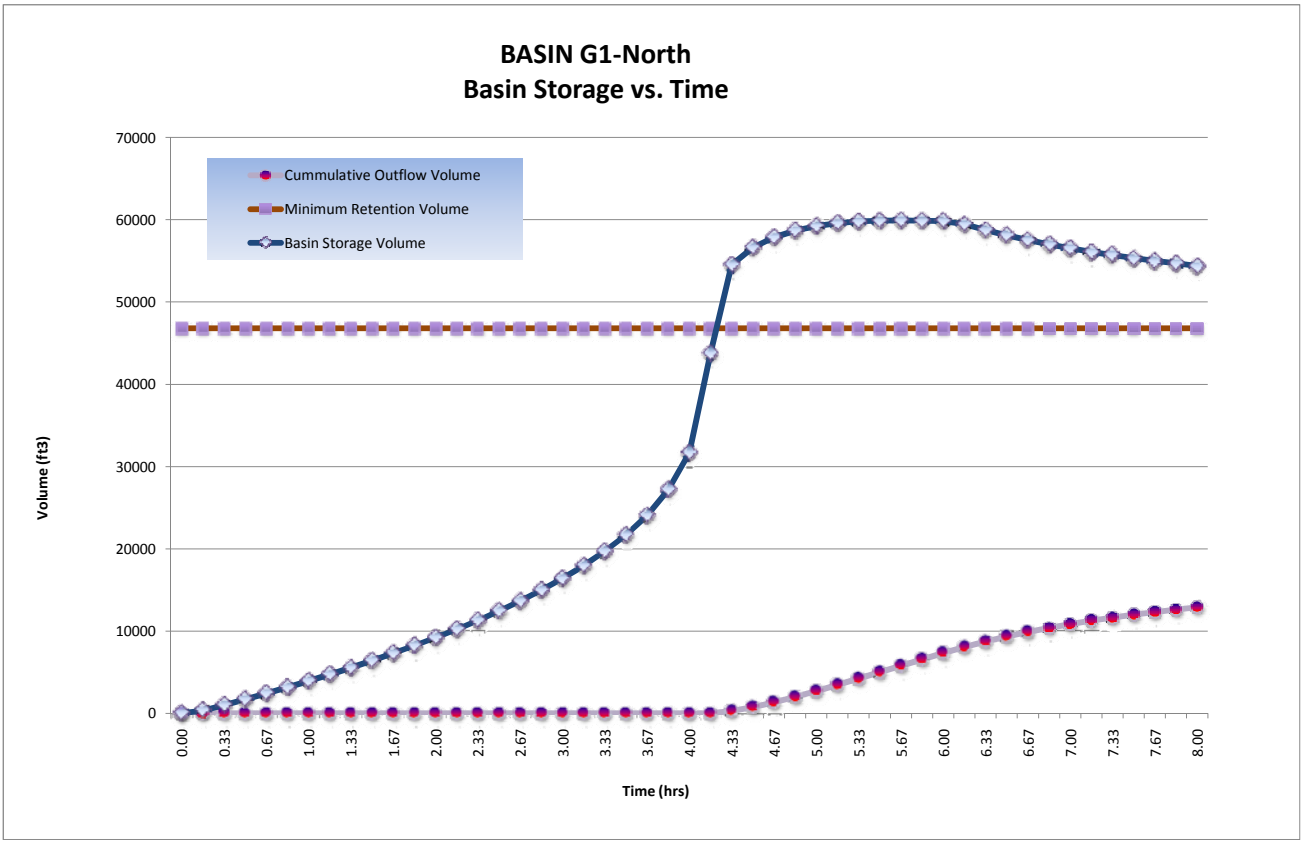
$$\frac{I_1 + I_2}{2} + \left(\frac{S_1}{\Delta t} - \frac{O_1}{2}\right) = O_1 + \left(\frac{S_2}{\Delta t} + \frac{O_2}{2}\right)$$

					Storage Indicator #			Volumes (ft3)		
(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*	(6) $S_2/\Delta t + O_2/2$ (cfs) *col (3)+(4)-(5)*	(7) O_2 (cfs) *(Hard input)*		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	1.10	0.55	0.00	0.00	0.55	0.00		330	0	0
0.33	1.10	1.10	0.55	0.00	1.65	0.00		990	0	0
0.50	1.20	1.15	1.65	0.00	2.80	0.00		1680	0	0
0.67	1.20	1.20	2.80	0.00	4.00	0.00		2400	0	0
0.83	1.30	1.25	4.00	0.00	5.25	0.00		3150	0	0
1.00	1.30	1.30	5.25	0.00	6.55	0.00		3930	0	0
1.17	1.30	1.30	6.55	0.00	7.85	0.00		4710	0	0
1.33	1.40	1.35	7.85	0.00	9.20	0.00		5520	0	0
1.50	1.50	1.45	9.20	0.00	10.65	0.00		6390	0	0
1.67	1.50	1.50	10.65	0.00	12.15	0.00		7290	0	0
1.83	1.60	1.55	12.15	0.00	13.70	0.00		8220	0	0
2.00	1.60	1.60	13.70	0.00	15.30	0.00		9180	0	0
2.17	1.80	1.70	15.30	0.00	17.00	0.00		10200	0	0
2.33	1.80	1.80	17.00	0.00	18.80	0.00		11280	0	0
2.50	2.00	1.90	18.80	0.00	20.70	0.00		12420	0	0
2.67	2.10	2.05	20.70	0.00	22.75	0.00		13650	0	0
2.83	2.30	2.20	22.75	0.00	24.95	0.00		14970	0	0
3.00	2.40	2.35	24.95	0.00	27.30	0.00		16380	0	0
3.17	2.80	2.60	27.30	0.00	29.90	0.00		17940	0	0
3.33	3.00	2.90	29.90	0.00	32.80	0.00		19680	0	0
3.50	3.70	3.35	32.80	0.00	36.15	0.00		21690	0	0
3.67	4.20	3.95	36.15	0.00	40.10	0.00		24060	0	0
3.83	6.20	5.20	40.10	0.00	45.30	0.00		27180	0	0
4.00	8.80	7.50	45.30	0.00	52.80	0.00		31680	0	0
4.17	31.40	20.10	52.80	0.00	72.90	0.00		43740	0	0
4.33	5.00	18.20	72.90	0.00	91.10	0.49		54513	294	294
4.50	3.30	4.15	91.10	0.49	94.76	0.77		56625	462	756
4.67	2.60	2.95	94.76	0.77	96.94	0.97		57873	582	1338
4.83	2.20	2.40	96.94	0.97	98.37	1.10		58692	660	1998
5.00	1.90	2.05	98.37	1.10	99.32	1.19		59235	714	2712
5.17	1.70	1.80	99.32	1.19	99.93	1.24		59586	744	3456
5.33	1.50	1.60	99.93	1.24	100.29	1.28		59790	768	4224
5.50	1.40	1.45	100.29	1.28	100.46	1.29		59889	774	4998
5.67	1.30	1.35	100.46	1.29	100.52	1.30		59922	780	5778
5.83	1.20	1.25	100.52	1.30	100.47	1.29		59895	774	6552
6.00	1.20	1.20	100.47	1.29	100.38	1.28		59844	768	7320
6.17	0.00	0.60	100.38	1.28	99.70	1.22		59454	732	8052
6.33		0.00	99.70	1.22	98.48	1.11		58755	666	8718
6.50		0.00	98.48	1.11	97.37	1.01		58119	606	9324
6.67		0.00	97.37	1.01	96.36	0.92		57540	552	9876
6.83		0.00	96.36	0.92	95.44	0.84		57012	504	10380
7.00		0.00	95.44	0.84	94.60	0.76		56532	456	10836
7.17		0.00	94.60	0.76	93.84	0.69		56097	414	11250
7.33		0.00	93.84	0.69	93.15	0.63		55701	378	11628
7.50		0.00	93.15	0.63	92.52	0.58		55338	348	11976
7.67		0.00	92.52	0.58	91.94	0.54		55002	324	12300
7.83		0.00	91.94	0.54	91.40	0.51		54687	306	12606
8.00		0.00	91.40	0.51	90.89	0.48		54390	288	12894

Basin G1-North Routing



Basin G1-North Routing



Detention / Retention Basin Volume Required:	**59,922**	**ft^3**	
@ Stage:	**545.20**	**ft**	
Freeboard:	**1.0**	**ft**	> 1' Freeboard
Final Total Basin Volume Provided:	**83,929**	**ft^3**	Basin **G1-North**
Maximum flow rate released from this basin:	**1.30**	**cfs**	

Basin G1-South Inflow TcQ

PROJECT:	**SR-11**			**DESCRIPTION:**	**SR-11 Basin**
JOB #:	**11A1190**			**STATION:**	**139+00**
BY:	**M.BRUNING**	**DATE:**	**01.06.10**	**WATERSHED:**	**G1**
CHK:	**G.DALZIEL**	**DATE:**		**SYSTEM:**	**Basin G1-South**

BASIN AREA:

A = **758700** **ft^2** **SOURCE:** **MICROSTATION/USGS**
17.42 **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	51%	AT	0.90	0.463
COMMERCIAL AREA	0%	AT	0.85	0.000
CUT SLOPE (2:1 and 4:1)	49%	AT	0.55	0.267
TOTAL	100%			
	(100%)			

$C_{2,10}$ =	0.73
C_{25} =	0.80
C_{50} =	0.88
C_{100} =	0.91

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	568.0	ft
LOW POINT ELEVATION	567.0	ft
ELEVATION DIFF (H)	1.0	ft
LENGTH (L)	60	ft
SLOPE (S) = (H/L)	1.7%	
MANNING'S n	0.016	
T_t (SFF)=	1.56	minutes

SVI Line to bioswale

< = FROM TABLE 816.6A AC

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

NOTES:

HIGH PT ELEVATION	567.0	ft
LOW POINT ELEVATION	565.0	ft
ELEVATION DIFF (H)	2.0	ft
LENGTH (L)	116	ft
SLOPE (S) = (H/L)	1.7%	
VELOCITY (SCF)	0.8	fps
T_C (SH)=	2.42	minutes

Flow in Bioswale

assumed SCF and not channelized or flowing full yet

<=V FROM FIG 816.5 short grass

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

NOTES:

HIGH PT ELEVATION	565.0	ft
LOW POINT ELEVATION	541.0	ft
ELEVATION DIFF (H)	24.0	ft
LENGTH (L)	611	ft
SLOPE (S) = (H/L)	3.9%	
MANNING'S n	0.050	
HYDRAULIC RADIUS R	0.5	ft
VELOCITY (CHANNEL)	3.65	fps
T_C (CH)=	2.79	minutes

biofiltration swale

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: $V=1.49/n(R^{2/3}S^{1/2})$

Basin G1-South Inflow TcQ

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

HIGH PT ELEVATION	536.0	ft
LOW POINT ELEVATION	525.0	ft
ELEVATION DIFF (H)	11.0	ft
LENGTH (L)	579	ft
SLOPE (S) = (H/L)	1.9%	
MANNING'S n	0.013	
PIPE DIAMETER d	2.0	ft
HYDRAULIC RADIUS R	0.5	ft
VELOCITY (STORMDRAIN)	10.0	fps
T_C (SD)=	0.97	minutes

NOTES:

Proposed stormdrain - upper segment

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	525.0	ft
LOW POINT ELEVATION	512.0	ft
ELEVATION DIFF (H)	13.0	ft
LENGTH (L)	645	ft
SLOPE (S) = (H/L)	2.0%	
MANNING'S n	0.013	
PIPE DIAMETER d	3.0	ft
HYDRAULIC RADIUS R	0.8	ft
VELOCITY (STORMDRAIN)	13.4	fps
T_C (SD)=	0.80	minutes

NOTES:

Proposed stormdrain -lower segment to basin

Basin G1-South

RCP

R=D/4, Assume: flowing full

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

Tc (TOTAL) =	8.54	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 =	23.6
Q_{10} =	34.3
Q_{25} =	47.1
Q_{50} =	61.7
Q_{100} =	**66.9**

COUNTY P_6

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

Basin G1South Inflow Hydrograph

PROJECT:	**SR-11**			**DESCRIPTION:**	**SR-11 Basin**
JOB #:	**11A1190**			**STATION:**	**137+00 - 139+00**
BY:	**M.BRUNING**	**DATE:**	**01.06.10**	**WATERSHED:**	**G1**
CHK:	**G.DALZIEL**	**DATE:**		**SYSTEM:**	**Basin G1-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

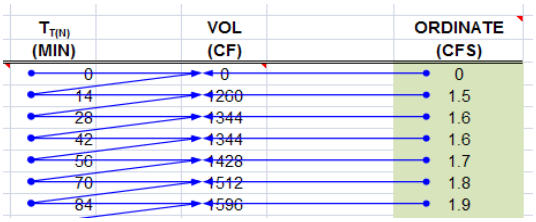
Basin Inflow Hydrograph

Basin Inflow Q

Q_{100}=	66.9	cfs	C_{100}=	0.91	
Tc=	10.0	min	A=	17.42	acres
$P_{100,6}$=	2.5	in			

$T_{T(N)}$ (MIN)	VOL (CF)	ORDINATE (CFS)
0	0	0
10	1440	2.4
20	1440	2.4
30	1500	2.5
40	1560	2.6
50	1620	2.7
60	1620	2.7
70	1740	2.9
80	1740	2.9
90	1860	3.1
100	1920	3.2
110	2040	3.4
120	2100	3.5
130	2220	3.7
140	2340	3.9
150	2520	4.2
160	2640	4.4
170	2940	4.9
180	3120	5.2
190	3600	6
200	3900	6.5
210	4740	7.9
220	5400	9
230	7920	13.2
240	11100	18.5
250	40140	66.9
260	6360	10.6
270	4260	7.1
280	3360	5.6
290	2760	4.6
300	2400	4
310	2160	3.6
320	1980	3.3
330	1800	3
340	1680	2.8
350	1560	2.6
360	1500	2.5
370	0	0

Example of Steps:



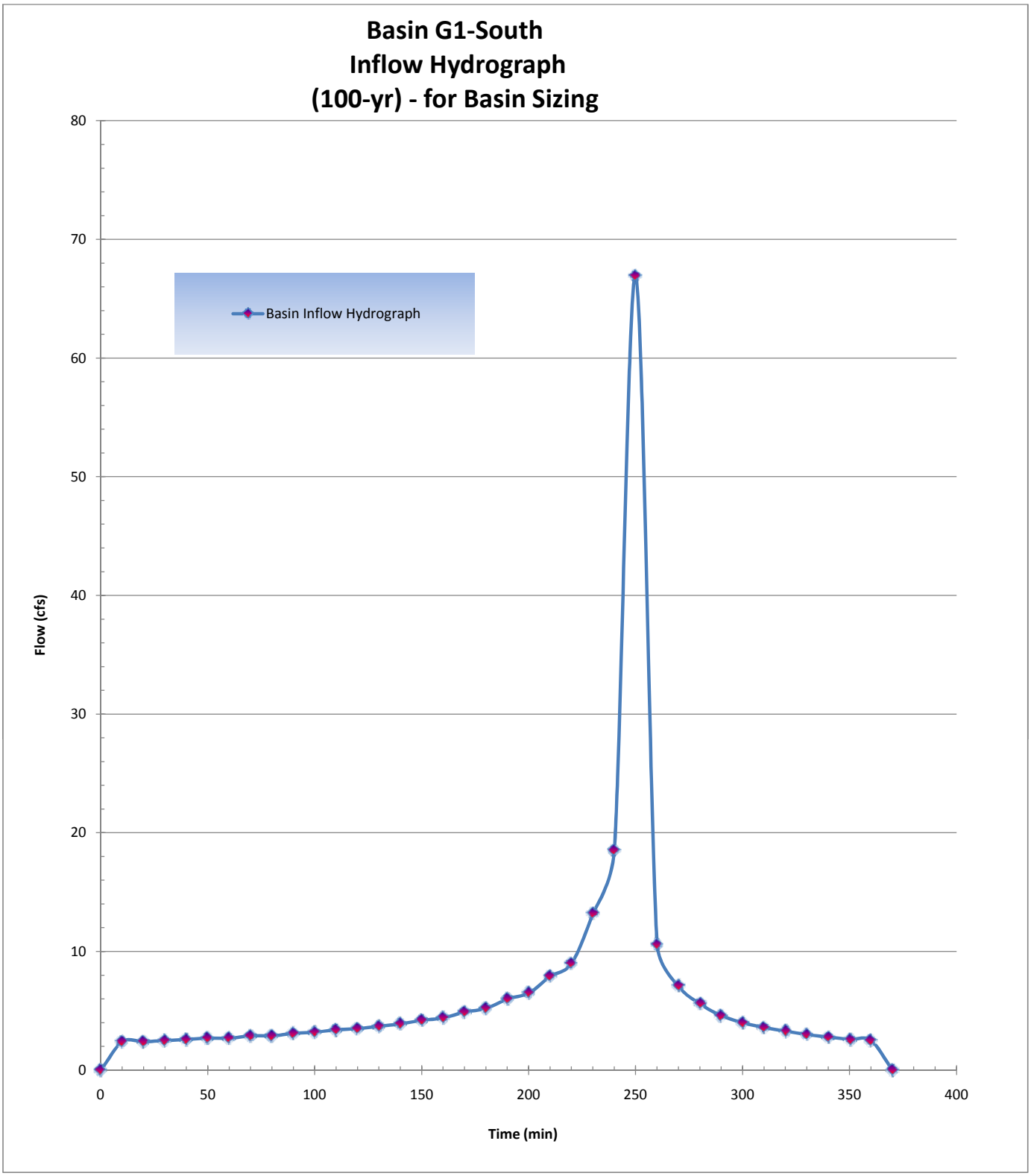
SUM= 142980 ft^3
3.28 acre-feet

Onsite Runoff Volume

Check: $V = C*A*P_6$

V= 3.31 acre-feet

OK


Basin G1-South
Inflow Hydrograph
(100-yr) - for Basin Sizing
Basin Inflow Hydrograph
Flow (cfs)
Time (min)
0
10
20
30
40
50
60
70
80
0
50
100
150
200
250
300
350
400

Basin G1-South Outlet

PROJECT:	**SR-11**			**DESCRIPTION:**	**SR-11 Basin**
JOB #:	**11A1190**			**STATION:**	**139+00**
BY:	**M.BRUNING**	**DATE:**	**02.19.10**	**WATERSHED:**	**G1-South**
CHK:	**G.DALZIEL**	**DATE:**		**SYSTEM:**	**Basin G1-South**

Notes:

Volumes:

Required Retention Basin Volume =	147849	ft^3	from G1-ALL
Retention volume from G1-North Basin =	46802	ft^4	
Minimum Retention volume from this basin =	101047		balance of required retention for G1-ALL
Actual Basin Inflow =	142980	ft^4	*OK*

Flow Balance - determine maximum flow from basin

Predeveloped Peak 100-year Flow:	60.0	cfs	from G1-ALL
Post-Developed Peak Flow through Cross Culvert:	0.0	cfs	Independent of Culvert G1
Flow that does not reach detention basin (bypass per DA table):	23.5	cfs	Q_{100} from: G1.8.PVG1.27.PVG1.8.SLG1.25.SLG1.27.SL
Maximum flow to be released by G1-North basin:	11.5	cfs	*32%* of G1-ALL (per retention ratios)
Maximum flow allowed to be released by this detention basin:	17.0	cfs	*68%* of G1-ALL (per retention ratios)

Outlet Pipe

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

Basin - Top of basin berm elevation =		516.60	ft
Basin flowline elevation =		512.00	ft
Maximum Basin Depth =		4.60	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):	181518	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
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	0.00
13	514.60	2.60	8001	94399		514.60	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

Basin G1-South Routing

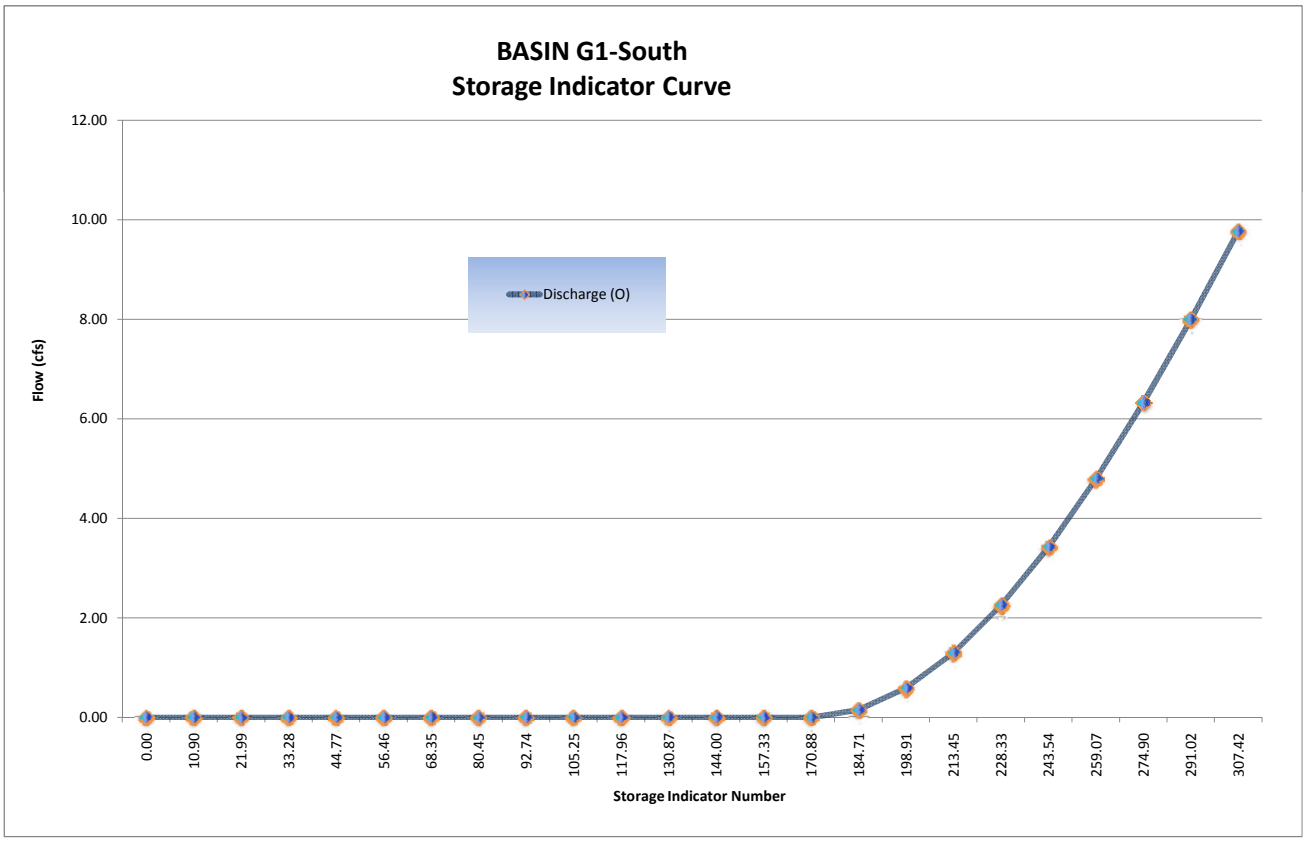
PROJECT:	**SR-11**			**DESCRIPTION:**	**SR-11 Basin**
JOB #:	**11A1190**			**STATION:**	**139+00**
BY:	**M.BRUNING**	**DATE:**	**02.19.10**	**WATERSHED:**	**G1-South**
CHK:	**G.DALZIEL**	**DATE:**		**SYSTEM:**	**Basin G1-South**

user input
linked input

STORAGE INDICATOR NUMBERS TABLE

					Storage Indicator #
(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)
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

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



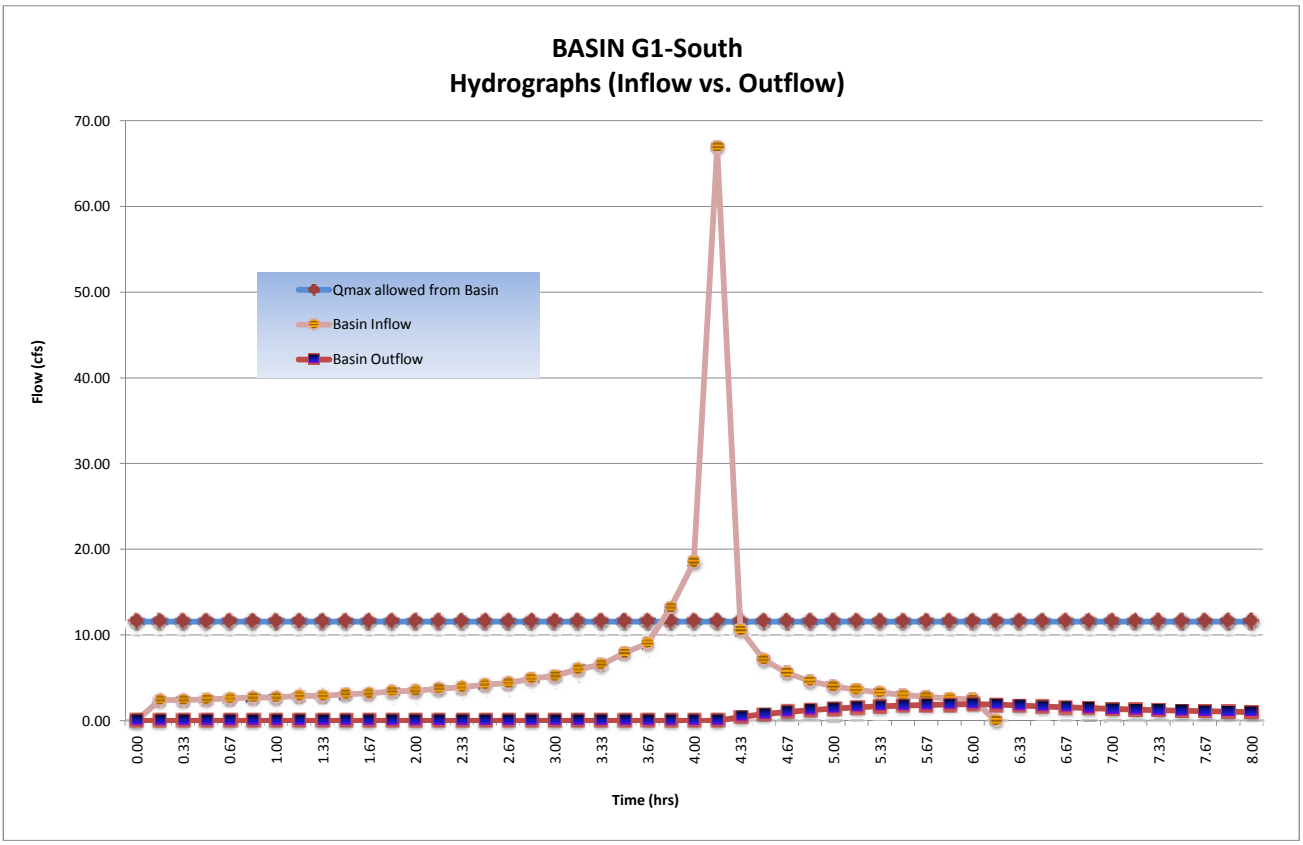
Basin G1-South Routing

FINAL ROUTING TABLE

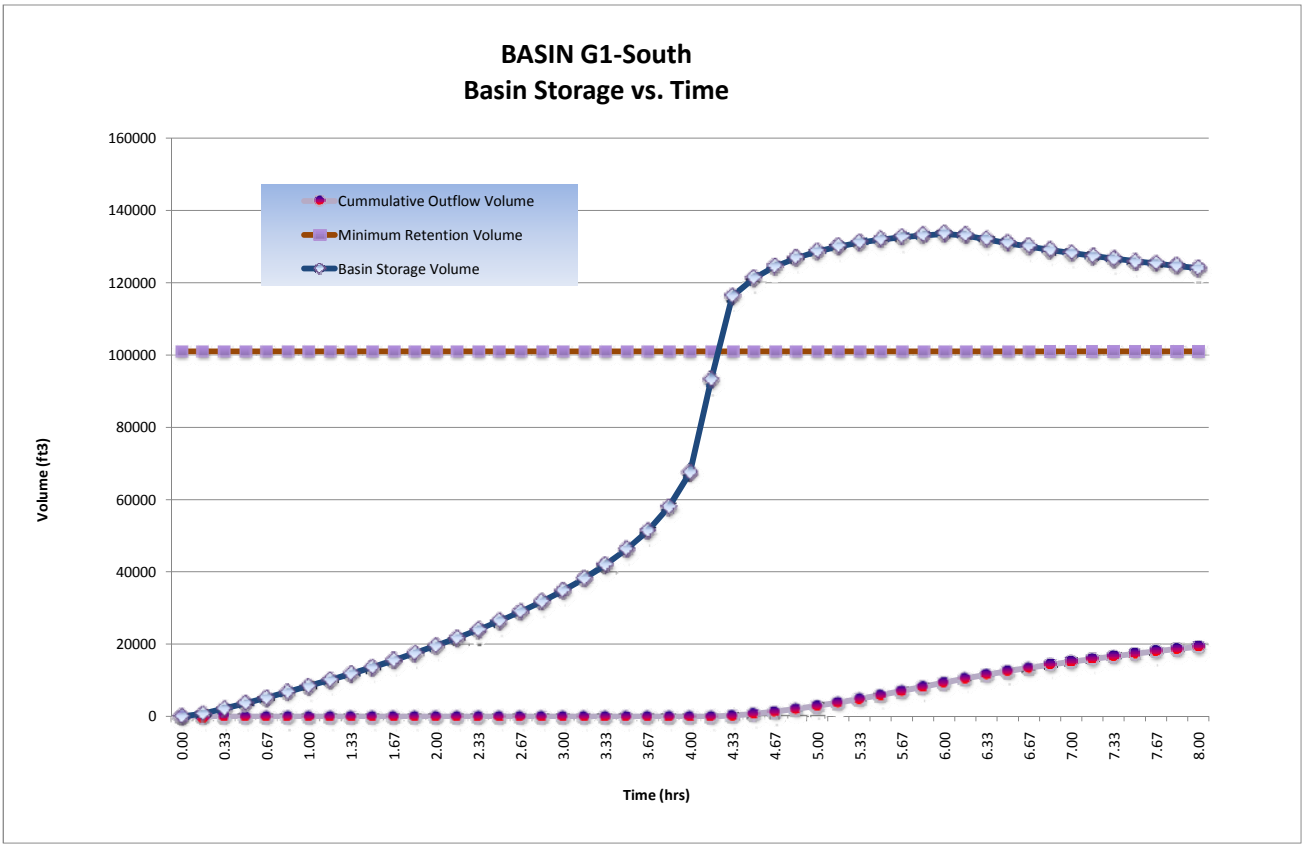
$$\frac{I_1 + I_2}{2} + \left(\frac{S_1}{\Delta t} - \frac{O_1}{2}\right) - O_1 = \left(\frac{S_2}{\Delta t} + \frac{O_2}{2}\right)$$

					Storage Indicator #			Volumes (ft3)	
(1) Time (hrs)	(2) Inflow (cfs) (Q_{post})	(3) $(I_1+I_2)/2$ (cfs)	(4) $(S_1/\Delta t + O_1/2)$ (cfs)	(5) O_1 (cfs)	(6) $S_2/\Delta t + O_2/2$ (cfs)	(7) O_2 (cfs)		Basin Storage *Volume*	Incremental Outflow *Volume*	Cummulative Outflow *Volume*
			col (6) from prev row	*col (7) from prev row*	*col (3)+(4)-(5)*	*(Hard input)*				
0.00	0.00	0.00	0.00	0.00	0.00	0.00		0	0	0
0.17	2.40	1.20	0.00	0.00	1.20	0.00		720	0	0
0.33	2.40	2.40	1.20	0.00	3.60	0.00		2160	0	0
0.50	2.50	2.45	3.60	0.00	6.05	0.00		3630	0	0
0.67	2.60	2.55	6.05	0.00	8.60	0.00		5160	0	0
0.83	2.70	2.65	8.60	0.00	11.25	0.00		6750	0	0
1.00	2.70	2.70	11.25	0.00	13.95	0.00		8370	0	0
1.17	2.90	2.80	13.95	0.00	16.75	0.00		10050	0	0
1.33	2.90	2.90	16.75	0.00	19.65	0.00		11790	0	0
1.50	3.10	3.00	19.65	0.00	22.65	0.00		13590	0	0
1.67	3.20	3.15	22.65	0.00	25.80	0.00		15480	0	0
1.83	3.40	3.30	25.80	0.00	29.10	0.00		17460	0	0
2.00	3.50	3.45	29.10	0.00	32.55	0.00		19530	0	0
2.17	3.70	3.60	32.55	0.00	36.15	0.00		21690	0	0
2.33	3.90	3.80	36.15	0.00	39.95	0.00		23970	0	0
2.50	4.20	4.05	39.95	0.00	44.00	0.00		26400	0	0
2.67	4.40	4.30	44.00	0.00	48.30	0.00		28980	0	0
2.83	4.90	4.65	48.30	0.00	52.95	0.00		31770	0	0
3.00	5.20	5.05	52.95	0.00	58.00	0.00		34800	0	0
3.17	6.00	5.60	58.00	0.00	63.60	0.00		38160	0	0
3.33	6.50	6.25	63.60	0.00	69.85	0.00		41910	0	0
3.50	7.90	7.20	69.85	0.00	77.05	0.00		46230	0	0
3.67	9.00	8.45	77.05	0.00	85.50	0.00		51300	0	0
3.83	13.20	11.10	85.50	0.00	96.60	0.00		57960	0	0
4.00	18.50	15.85	96.60	0.00	112.45	0.00		67470	0	0
4.17	66.90	42.70	112.45	0.00	155.15	0.00		93090	0	0
4.33	10.60	38.75	155.15	0.00	193.90	0.43		116211	258	258
4.50	7.10	8.85	193.90	0.43	202.32	0.76		121164	456	714
4.67	5.60	6.35	202.32	0.76	207.91	1.03		124437	618	1332
4.83	4.60	5.10	207.91	1.03	211.98	1.23		126819	738	2070
5.00	4.00	4.30	211.98	1.23	215.05	1.40		128610	840	2910
5.17	3.60	3.80	215.05	1.40	217.45	1.56		130002	936	3846
5.33	3.30	3.45	217.45	1.56	219.34	1.68		131100	1008	4854
5.50	3.00	3.15	219.34	1.68	220.81	1.77		131955	1062	5916
5.67	2.80	2.90	220.81	1.77	221.94	1.84		132612	1104	7020
5.83	2.60	2.70	221.94	1.84	222.80	1.90		133110	1140	8160
6.00	2.50	2.55	222.80	1.90	223.45	1.94		133488	1164	9324
6.17	0.00	1.25	223.45	1.94	222.76	1.89		133089	1134	10458
6.33		0.00	222.76	1.89	220.87	1.77		131991	1062	11520
6.50		0.00	220.87	1.77	219.10	1.66		130962	996	12516
6.67		0.00	219.10	1.66	217.44	1.55		129999	930	13446
6.83		0.00	217.44	1.55	215.89	1.46		129096	876	14322
7.00		0.00	215.89	1.46	214.43	1.36		128250	816	15138
7.17		0.00	214.43	1.36	213.07	1.28		127458	768	15906
7.33		0.00	213.07	1.28	211.79	1.22		126708	732	16638
7.50		0.00	211.79	1.22	210.57	1.16		125994	696	17334
7.67		0.00	210.57	1.16	209.41	1.10		125316	660	17994
7.83		0.00	209.41	1.10	208.31	1.05		124671	630	18624
8.00		0.00	208.31	1.05	207.26	1.00		124056	600	19224

Basin G1-South Routing



Basin G1-South Routing



Detention/Retention Basin Volume Required:	**133,488**	**ft^3**	
@ Stage:	**515.60**	**ft**	
Freeboard:	**1.0**	**ft**	> 1' Freeboard
Final Total Basin Volume Provided:	**181,518**	**ft^3**	Basin **G1-South**
Maximum flow rate released from this basin:	**1.94**	**cfs**	

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X1 Onsite D.A. Table

PROJECT:	**SR-11**	**DESCRIPTION:**	**On-site Drainage Areas (D.A.)**
JOB #:	**11A1190**	**STATION:**	**40+00**
BY:	**M.BRUNING** **DATE:** **01.27.10**	**WATERSHED:**	**X**
CHK:	**G.DALZIEL** **DATE:**	**SYSTEM:**	

			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
PAVED	X1.1.PV	0.99	2000	0.0	5	4.0	0.18	6.6	0.30	~	X1.1	bypass*	40+00	Rt
	X1.2.PV	0.99	64000	1.5	5	4.0	5.79	6.6	9.58	~	X1.2	bypass*	40+50	Rt
	X1.3.PV	0.99	2200	0.1	5	4.0	0.20	6.6	0.33	~	X1.3	bypass*	40+00	Lt
	X1.4.PV	0.99	66500	1.5	5	4.0	6.02	6.6	9.96	~	X1.4	bypass*	40+50	Lt

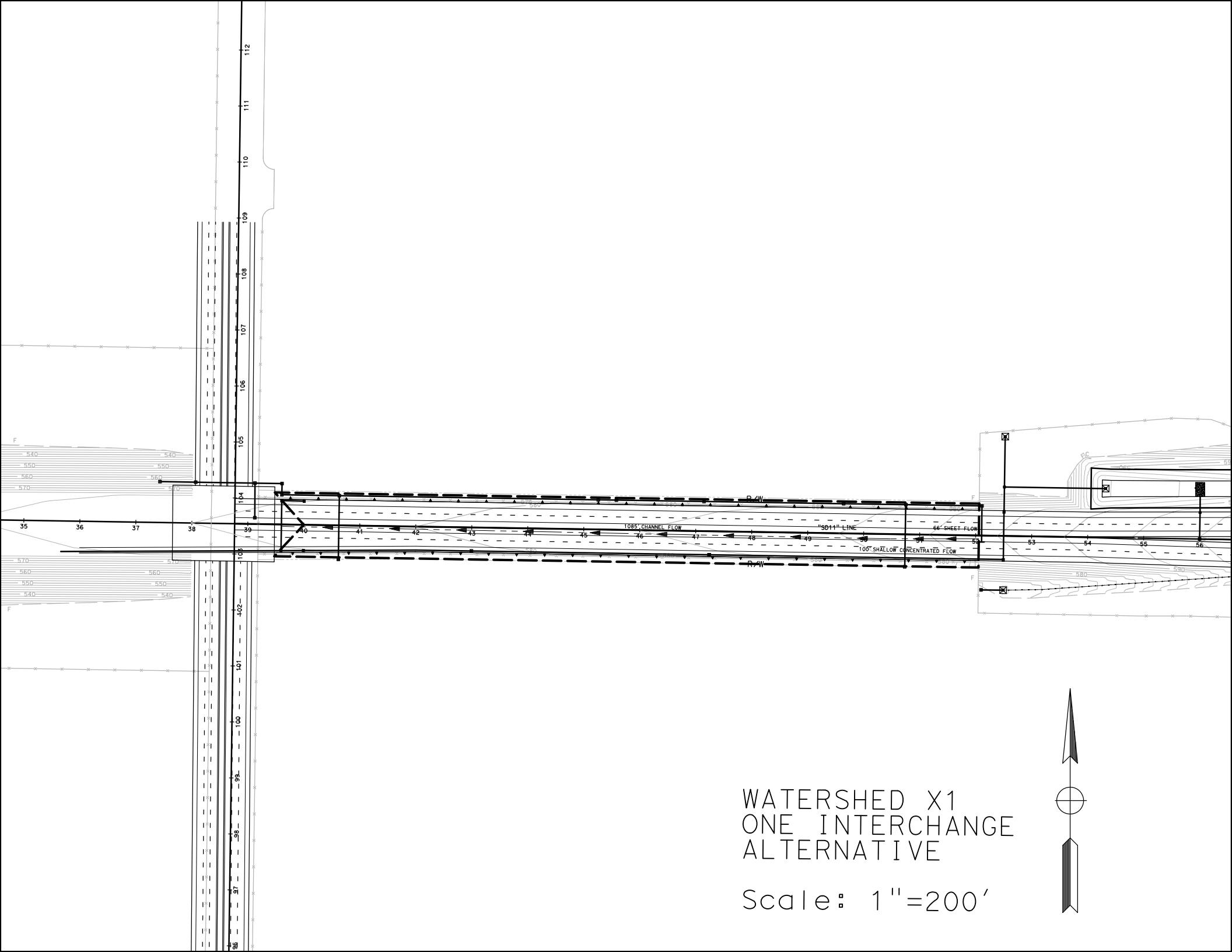
Σ 134700 *PAVED*

			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
SLOPE	X1.5.SL	0.61	5733	0.1	10	2.8	0.23	4.2	0.34	~	X1.5	bypass*	40+00	~

Σ 5733 *SLOPE*

*flow that does not reach the basin

Total :	140433 *SF*	3.2 *ac*



WATERSHED X1
ONE INTERCHANGE ALTERNATIVE

Scale: 1"=200'

X1 Post-Developed TcQ

PROJECT:	**SR-11**			**DESCRIPTION:**	**SR-11 Post-Developed**
JOB #:	**11A1190**			**STATION:**	**40+00**
BY:	**M.BRUNING**	**DATE:**	**01.27.10**	**WATERSHED:**	**X1**
CHK:	**G.DALZIEL**	**DATE:**		**SYSTEM:**	**X1**

BASIN AREA:

A = **140433** **ft^2** | **3.22** **acres**

SOURCE: **MICROSTATION/USGS** **(SCALE = 1:1)**

COEFFICIENT OF RUNOFF:

KEY: User Input | Designer Tool

UNDEVELOPED AREA C (FROM HDM FIG. 819.2A)

		NOTES:
RELIEF (.08-.35)	0.22	Hilly Slopes ~ 15%
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 =	0.49	

UNDEVELOPED AREA	15%	AT	0.49	0.071
PAVED SURFACE	85%	AT	0.90	0.769
COMMERCIAL AREA	0%	AT	0.85	0.000
CUT SLOPE (2:1 and 4:1)	0%	AT	0.55	0.000
TOTAL	100%			
	(100%)			

$C_{2,10}$ =	0.84
C_{25} =	0.92
C_{50} =	1.00
C_{100} =	1.00

TIME OF CONCENTRATION:

SHEET FLOW: $T_t = \frac{0.42L^{.8}n^{.8}}{P_2^{.5}s^{.4}}$

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

HIGH PT ELEVATION	587.0	ft	SR-11 at Sta 52 CL
LOW POINT ELEVATION	586.0	ft	
ELEVATION DIFF (H)	1.0	ft	
LENGTH (L)	66	ft	
SLOPE (S) = (H/L)	1.5%		
MANNING'S n	0.016		< = FROM TABLE 816.6A HMA
T_t (SFF)=	1.75	minutes	

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

NOTES:

HIGH PT ELEVATION	586.0	ft	assumed not channelized yet
LOW POINT ELEVATION	584.0	ft	
ELEVATION DIFF (H)	2.0	ft	
LENGTH (L)	100	ft	
SLOPE (S) = (H/L)	2.0%		
VELOCITY (SCF)	4.0	fps	<=V FROM FIG 816.6 HMA
T_C (SH)=	0.42	minutes	

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

NOTES:

HIGH PT ELEVATION	584.0	ft	channelizes in shoulder of structure
LOW POINT ELEVATION	578.0	ft	CHANNEL DATA TYPE = TRAP'Z
ELEVATION DIFF (H)	6.0	ft	Z= 20 ANG-RAD 0.050
LENGTH (L)	1085	ft	b = 10 ANG-DEG 2.862
SLOPE (S) = (H/L)	0.6%		d = 0.5 FLOWING FULL ASS'M
MANNING'S n	0.016		HMA
HYDRAULIC RADIUS R	0.3	ft	R=(bdsinA+d^2cosA)/(bsinA+2d)
VELOCITY (CHANNEL)	3.33	fps	From Manning's Equation assuming flowing full: $V=1.49/n(R^{2/3}S^{1/2})$
T_C (CH)=	5.43	minutes	

Tc (TOTAL) =	7.60	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 =	Q_2 =	5.0
i_{10} =	2.7	in/hr	X CA =	Q_{10} =	7.3
i_{25} =	3.4	in/hr	X CA =	Q_{25} =	10.0
i_{50} =	4.0	in/hr	X CA =	Q_{50} =	13.0
i_{100} =	4.2	in/hr	X CA =	Q_{100} =	**13.6**

FLOW RESULTS:

	cfs
Q_2 =	5.0
Q_{10} =	7.3
Q_{25} =	10.0
Q_{50} =	13.0
Q_{100} =	**13.6**

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 X1 Retention

PROJECT:	SR-11			**DESCRIPTION:**	SR-11 Basin
JOB #:	11A1190			**STATION:**	40+00
BY:	M.BRUNING	**DATE:**	01.27.10	**WATERSHED:**	X1
CHK:	G.DALZIEL	**DATE:**		**SYSTEM:**	X1

Notes:

* The difference between pre-developed and post-developed values gives the approximate volume to detain. Stage-Storage calculations will determine accurate volume

RETENTION BASIN VOLUME

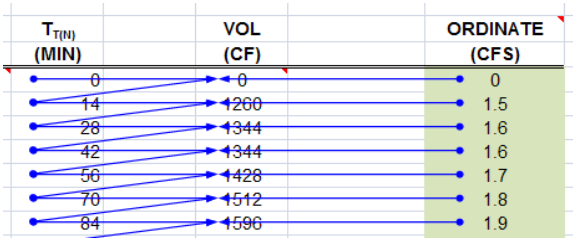
100-year, 6 hour duration storm event, use the Rational Method Hydrograph Procedure (SDCHM 6-1) ~ RatHydro

Pre-Developed volume calculations

Q_{100}=	10.4	cfs			
Tc=	10.0	min	C=	0.76	
$P_{100,6}$=	2.5	in	A=	3.22	acres

$T_{T(N)}$ (MIN)	VOL (CF)	ORDINATE (CFS)
0	0	0
10	240	0.4
20	240	0.4
30	240	0.4
40	240	0.4
50	240	0.4
60	240	0.4
70	240	0.4
80	300	0.5
90	300	0.5
100	300	0.5
110	300	0.5
120	300	0.5
130	360	0.6
140	360	0.6
150	420	0.7
160	420	0.7
170	480	0.8
180	480	0.8
190	540	0.9
200	600	1
210	720	1.2
220	840	1.4
230	1200	2
240	1680	2.8
250	6240	10.4
260	960	1.6
270	660	1.1
280	540	0.9
290	420	0.7
300	360	0.6
310	360	0.6
320	300	0.5
330	300	0.5
340	240	0.4
350	240	0.4
360	240	0.4
370	0	0

Example of Steps:



SUM= 22140 ft^3
0.51 acre-feet

Check: $V = C*A*P_6$
V= 0.51 acre-feet
OK

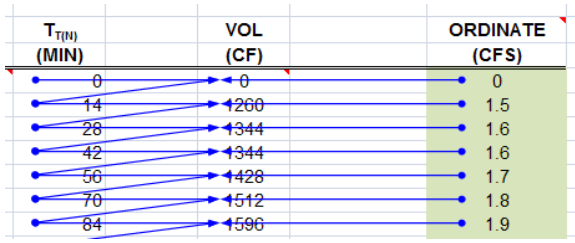
Basin X1 Retention

Post-Developed volume calculations

Q_{100}=	13.6	cfs			
Tc=	10.0	min	C=	1.00	
$P_{100,6}$=	2.5	in	A=	3.22	acres

$T_{T(N)}$ (MIN)	VOL (CF)	ORDINATE (CFS)
0	0	0
10	300	0.5
20	300	0.5
30	300	0.5
40	300	0.5
50	300	0.5
60	360	0.6
70	360	0.6
80	360	0.6
90	360	0.6
100	360	0.6
110	420	0.7
120	420	0.7
130	480	0.8
140	480	0.8
150	540	0.9
160	540	0.9
170	600	1
180	660	1.1
190	720	1.2
200	780	1.3
210	960	1.6
220	1080	1.8
230	1620	2.7
240	2220	3.7
250	8160	13.6
260	1320	2.2
270	840	1.4
280	660	1.1
290	540	0.9
300	480	0.8
310	420	0.7
320	420	0.7
330	360	0.6
340	360	0.6
350	300	0.5
360	300	0.5
370	0	0

Example of Steps:



SUM= 28980 ft^3
0.67 acre-feet

Check: $V = C*A*P_6$
V= 0.67 acre-feet
OK

		0.67			
	-	**0.51**			
Attenuation volume =		**0.16**	**acre-feet**	**=**	**6840 ft^3**

Basin Required
REFER TO BASIN Y

Basin X1 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= 3.22 acres

WQ_{72}: 0.73 in/area

Water Quality Volume (WQV) = **8543** ft^3

WQV to be added to retention volume = **1703** ft^3 **Add this Volume to Basin**

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:

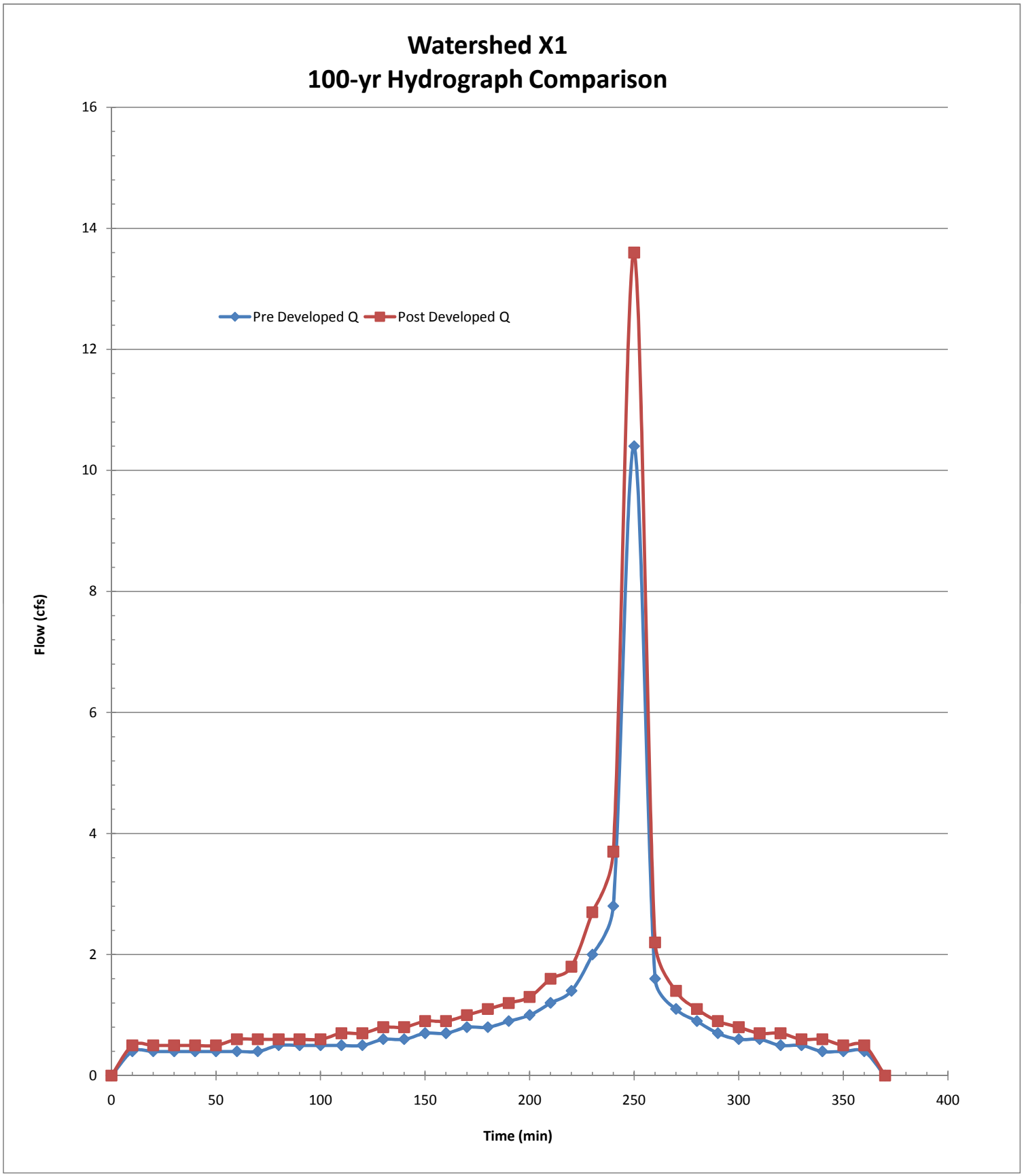
A_s = the computed soil loss in tons (dry weight)
R = the rainfall erosion index for the given storm period
K = the soil erodibility factor
L = the slope length factor
s = the slope gradient factor
C = cropping management (vegetation) factor
P = erosion control practice factor

Onsite Highway *Sloped* runoff area, A:		5733	ft^2
	A:	0.13	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 = 2.05 tons

Silt Accumulation Basin volume = **45** ft^3

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


Watershed X1
100-yr Hydrograph Comparison
Pre Developed Q
Post Developed Q
Flow (cfs)
Time (min)
0
2
4
6
8
10
12
14
16
0
50
100
150
200
250
300
350
400

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Detention/Retention Basin Flows and Sizes – One Interchange Alternative

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)	
X	40+00	10.38	13.58	3.20	22,140	28,980	6,840	~	~	~	Routed to Basin Y-EAST	~	~	~	~	~
A	53+00	23.50	40.31	16.81	50,220	102,258	52,038	55,300	14,486	33,337	103,123	350	30	5.2	1.0	A1
B	69+00	30.80	27.73	(3.07)	124,488	104,250	(20,238)	~	~	~	No Basin Required	~	~	~	~	~
C	78+00	16.38	8.49	(7.90)	35,100	18,060	(17,040)	~	~	~	No Basin Required	~	~	~	~	~
D	80+00	18.54	10.29	(8.25)	42,636	22,260	(20,376)	~	~	~	No Basin Required	~	~	~	~	~
E	101+00	61.90	103.88	41.98	232,050	351,600	119,550	123,698	21,983	59,051	204,733	250	100	6.0	1.4	E1
F	110+00	154.03	170.40	16.37	667,620	723,840	56,220	64,134	58,480	138,348	260,961	325	100	6.0	2.6	F1
G	127+00	59.99	129.24	69.25	180,846	325,182	144,336	46,802	13,120	24,007	83,929	200	75	4.2	1.0	G1-North
	139+00							102,528	30,960	48,030	181,518	180	180	4.6	1.0	G1-South

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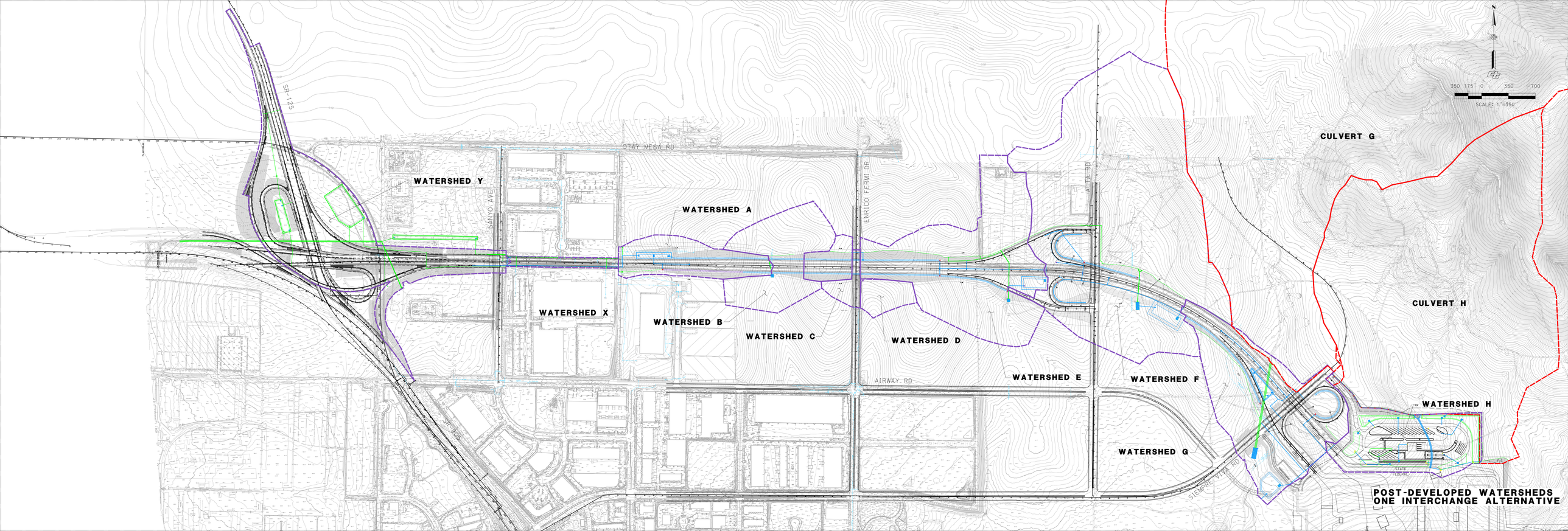
SR-125
OTAY MESA RD
SANYO AVE
ENRICO FERMI DR
ALTA RD
AIRWAY RD
SIEMPRE VIVA RD
SR-905
WATERSHED Y
WATERSHED A
WATERSHED X
WATERSHED B
WATERSHED C
WATERSHED D
WATERSHED E
WATERSHED F
WATERSHED G
WATERSHED H
CULVERT G
CULVERT H
350 175 0 350 700
SCALE: 1" = 350'
POST-DEVELOPED WATERSHEDS
ONE INTERCHANGE ALTERNATIVE

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Appendix D

TWO-Interchange Alternative

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11	SD	11	23.3/26.6		

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No. 71673
Exp. 12/31/09
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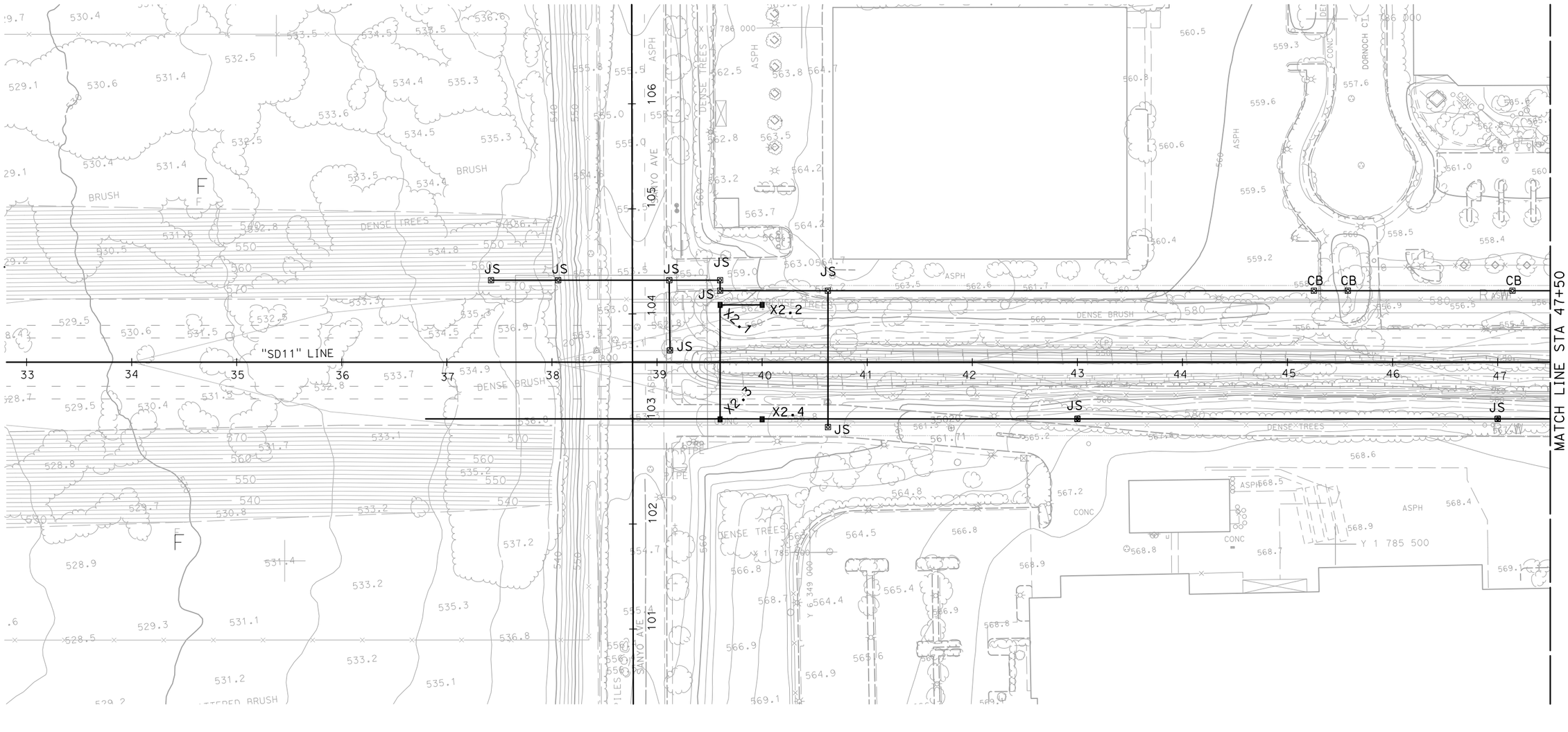
LEGEND:

- JS
- PIPE
- INLET W/APRON
- RSP
- HEADWALL
- --sd— EXISTING STORMDRAIN



TWO INTERCHANGE ALTERNATIVE DRAINAGE PLAN

SCALE 1"=50'

D-1

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CONSULTANT FUNCTIONAL SUPERVISOR: KIRK BRADBURY

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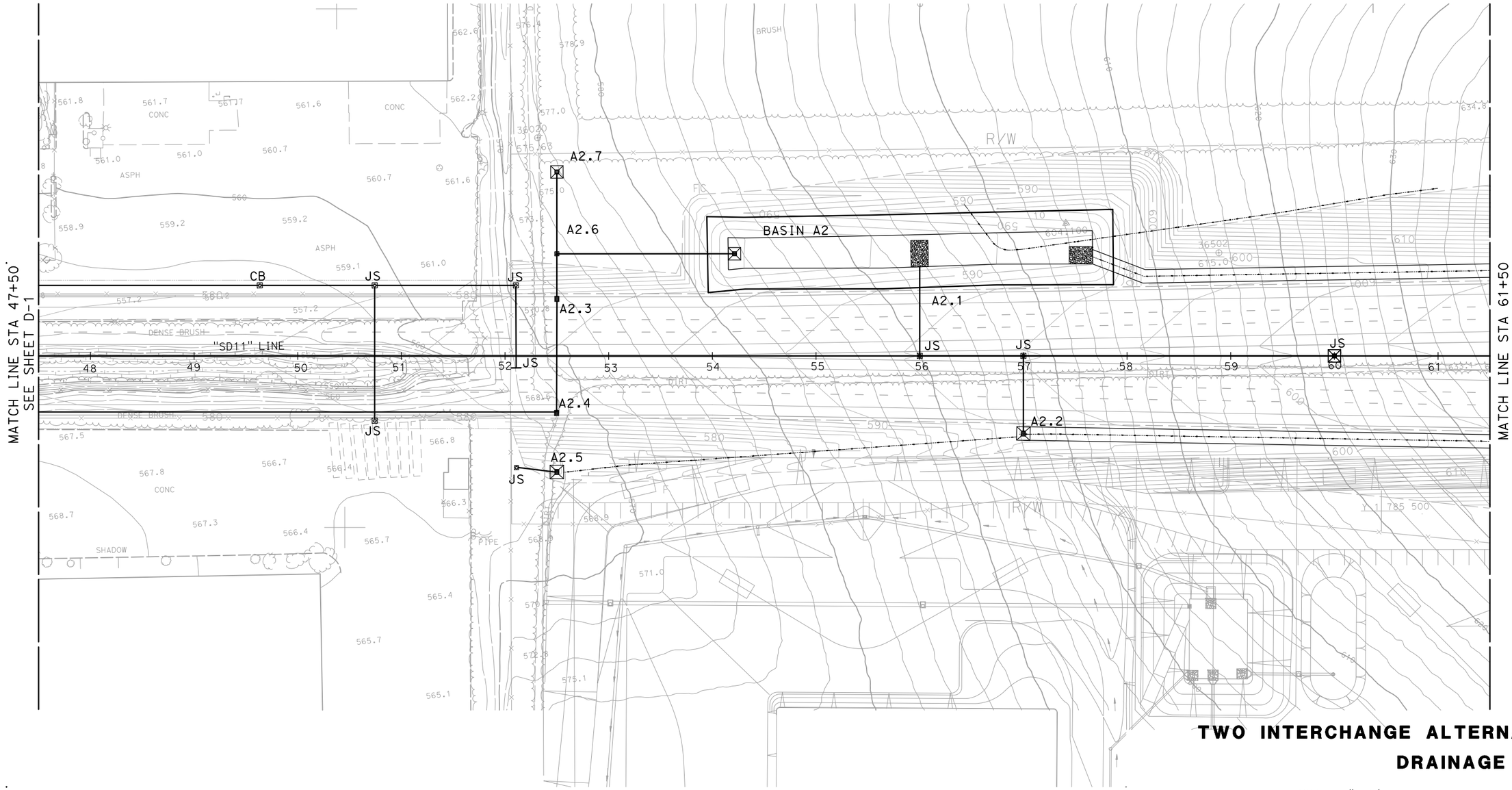

TWO INTERCHANGE ALTERNATIVE

DRAINAGE PLAN

D-2

SCALE 1"=50'

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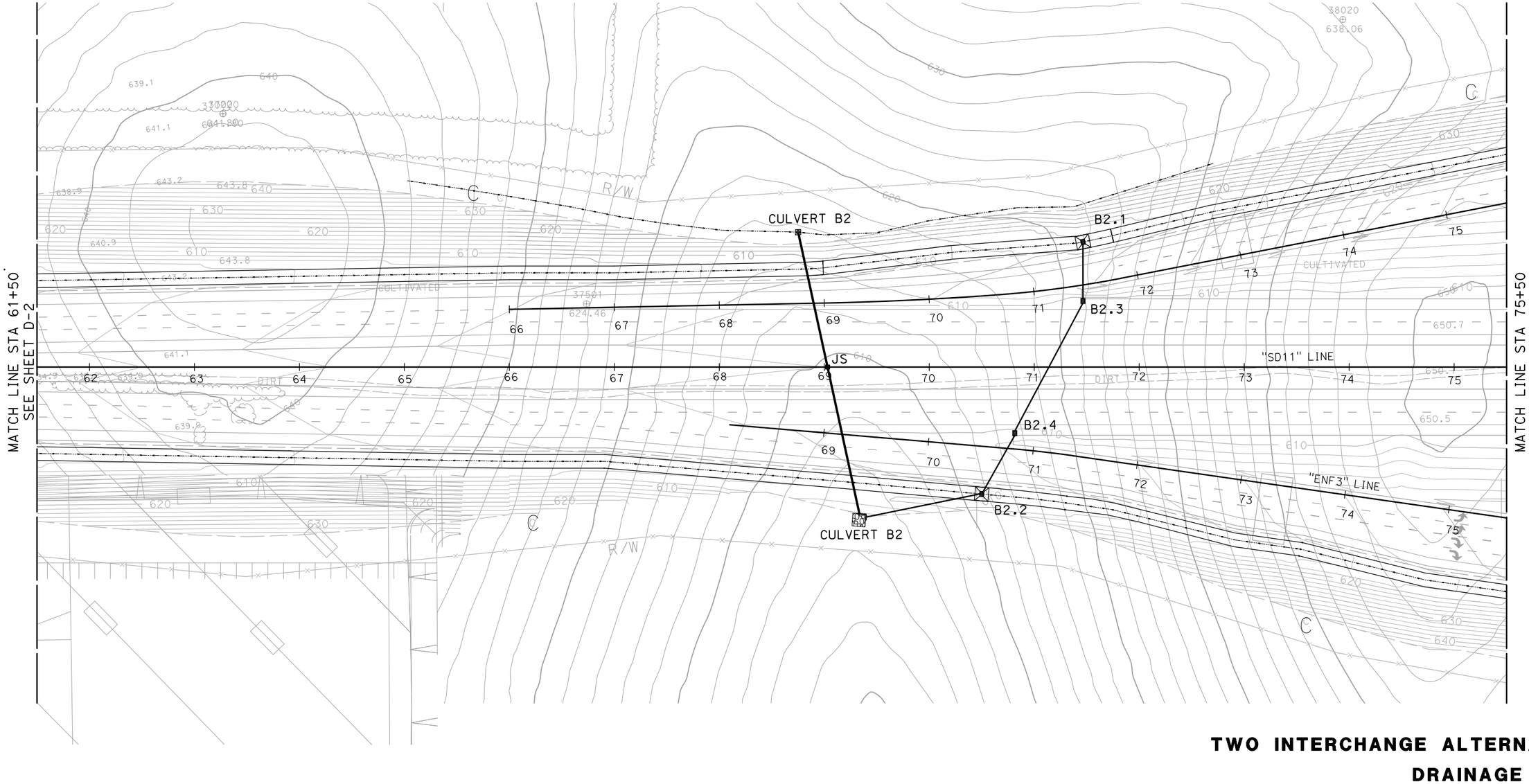

TWO INTERCHANGE ALTERNATIVE
DRAINAGE PLAN

SCALE 1"=50'

D-3

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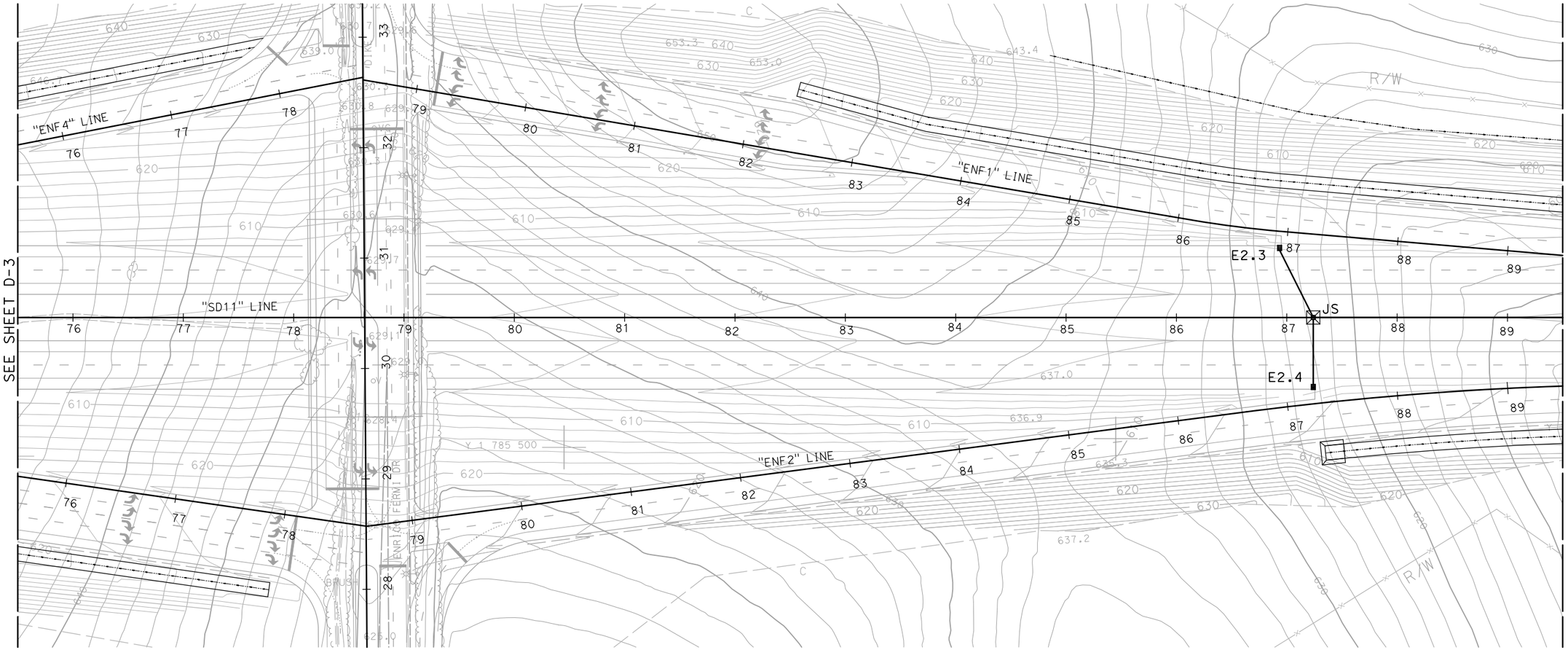

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TWO INTERCHANGE ALTERNATIVE
DRAINAGE PLAN

SCALE 1"=50'

D-4

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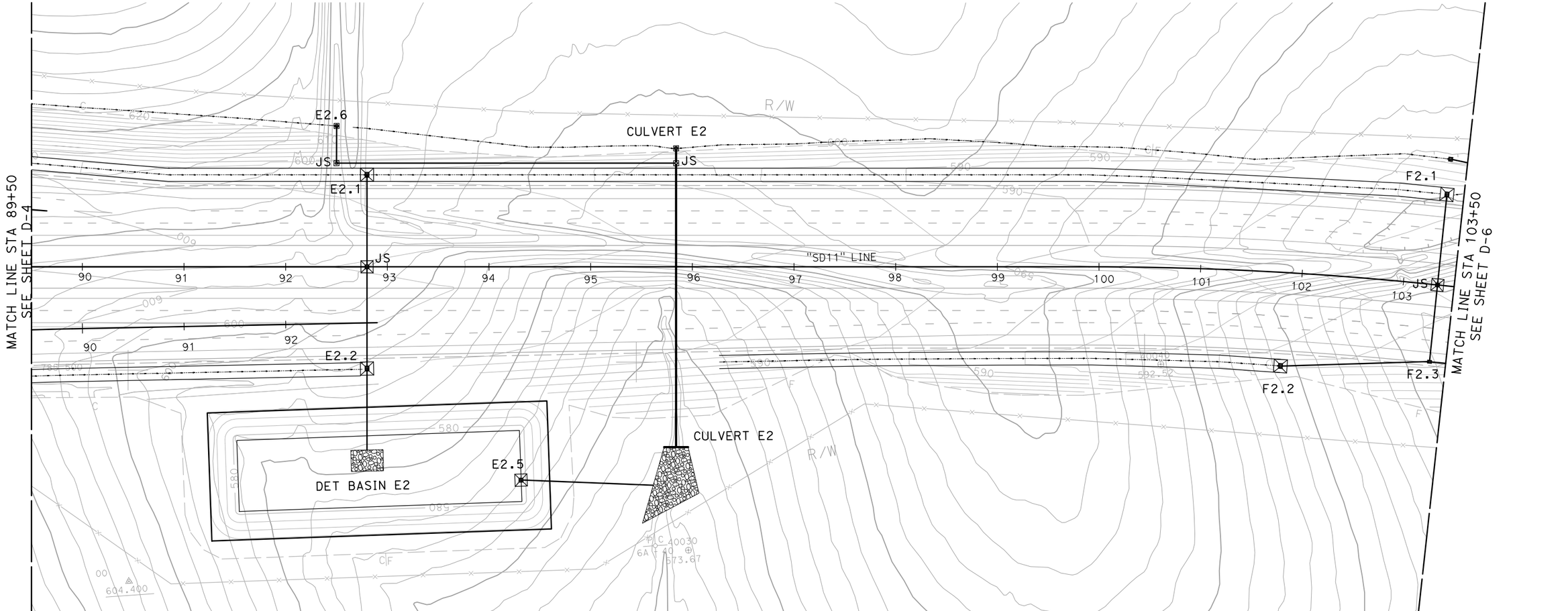

TWO INTERCHANGE ALTERNATIVE
DRAINAGE PLAN
D-5

SCALE 1"=50'

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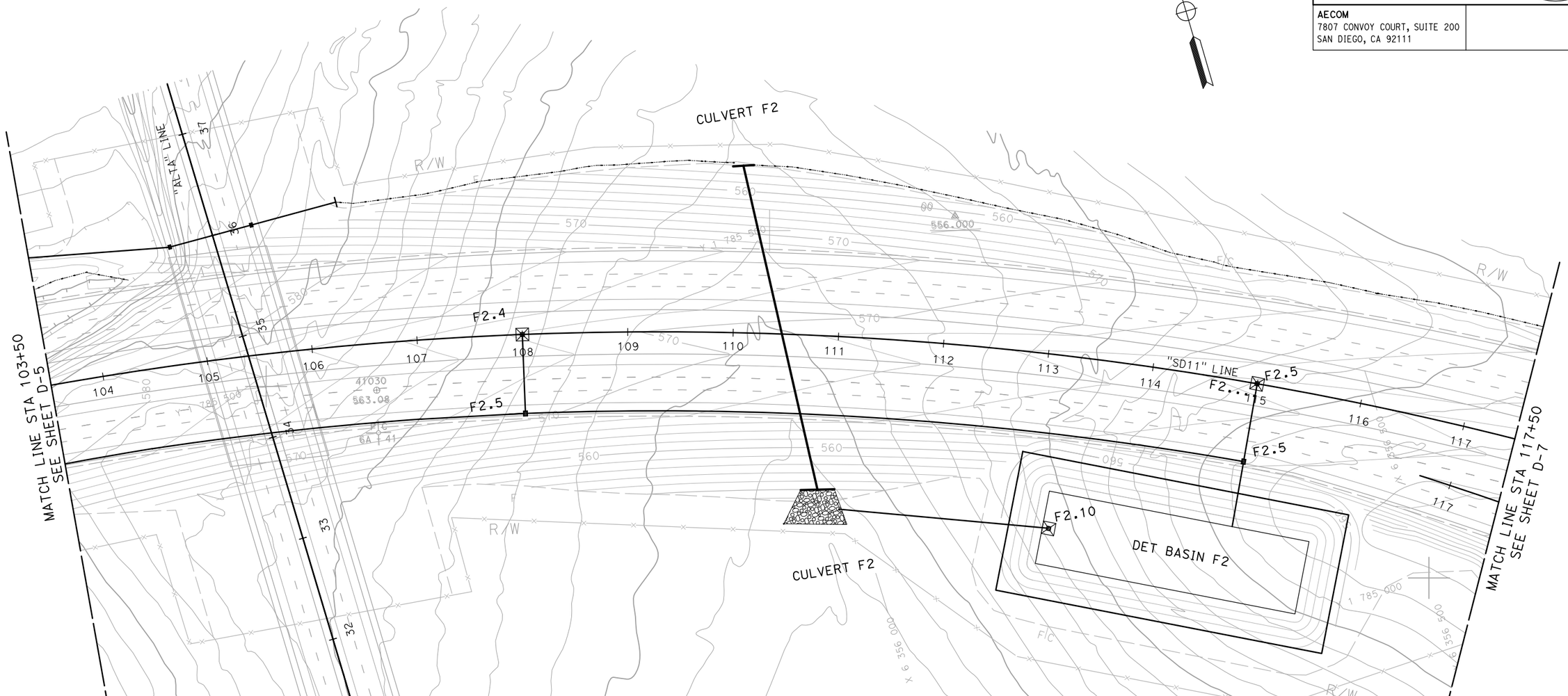

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TWO INTERCHANGE ALTERNATIVE
DRAINAGE PLAN

SCALE 1"=50'

D-6

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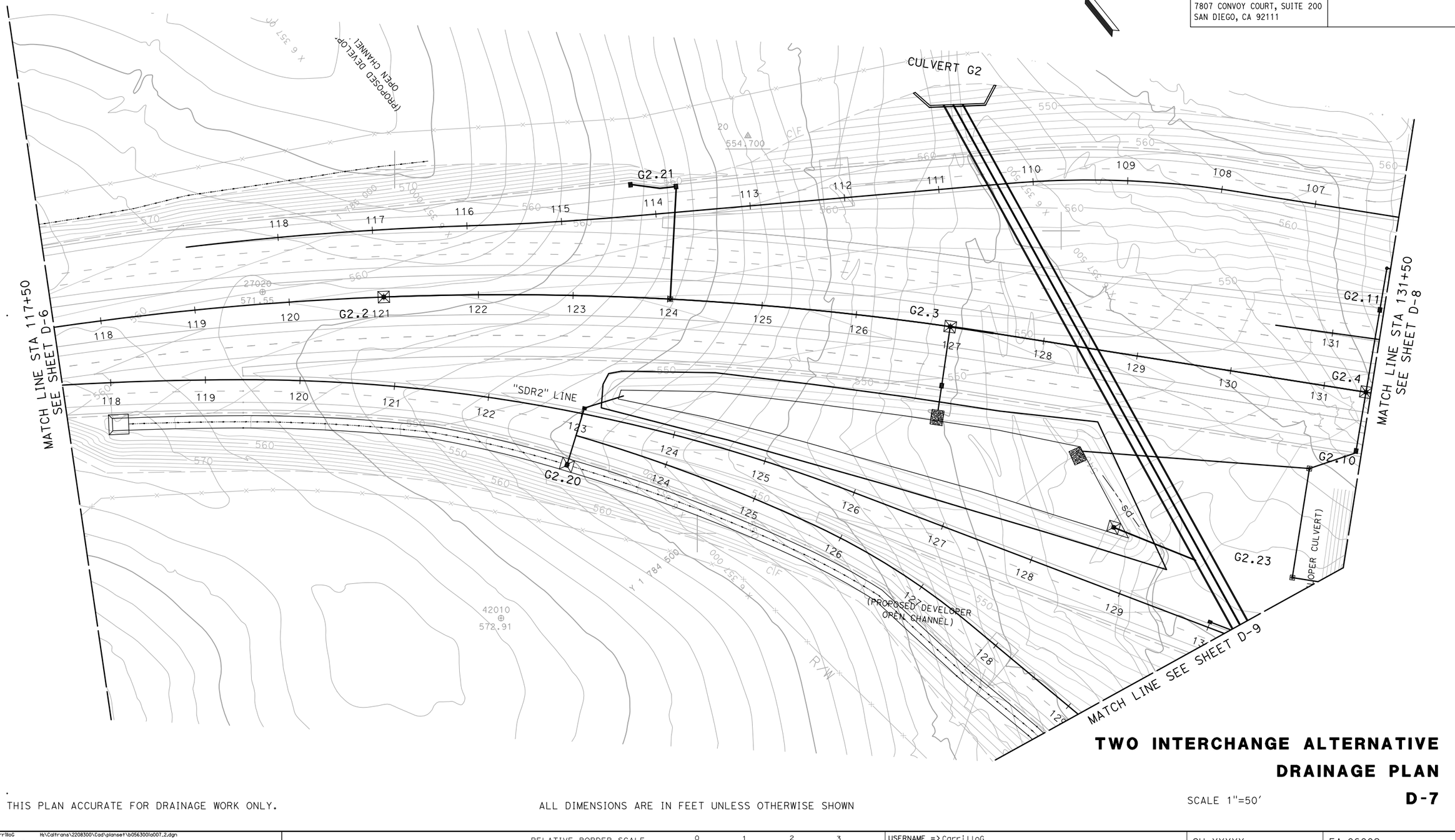

TWO INTERCHANGE ALTERNATIVE DRAINAGE PLAN

SCALE 1"=50'

D-7

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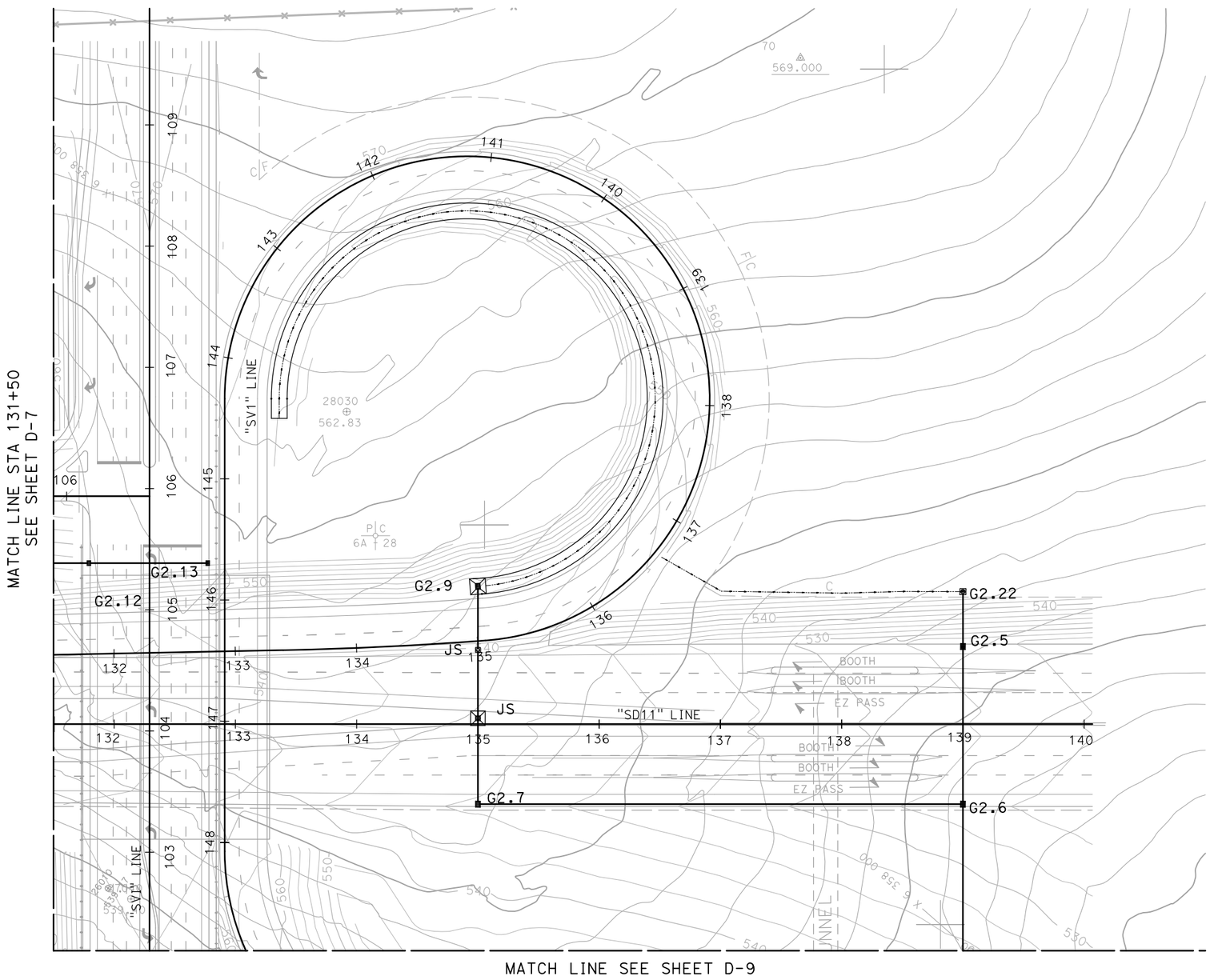

THIS PLAN ACCURATE FOR DRAINAGE WORK ONLY.

ALL DIMENSIONS ARE IN FEET UNLESS OTHERWISE SHOWN

TWO INTERCHANGE ALTERNATIVE
DRAINAGE PLAN

SCALE 1"=50'

D-8

LAST REVISION 11-13-09 | DATE PLOTTED => 2/3/2010 | TIME PLOTTED => 5:52:18 PM

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RELATIVE BORDER SCALE IS IN INCHES 0 1 2 3

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DGN FILE => ...\b056300la008_2.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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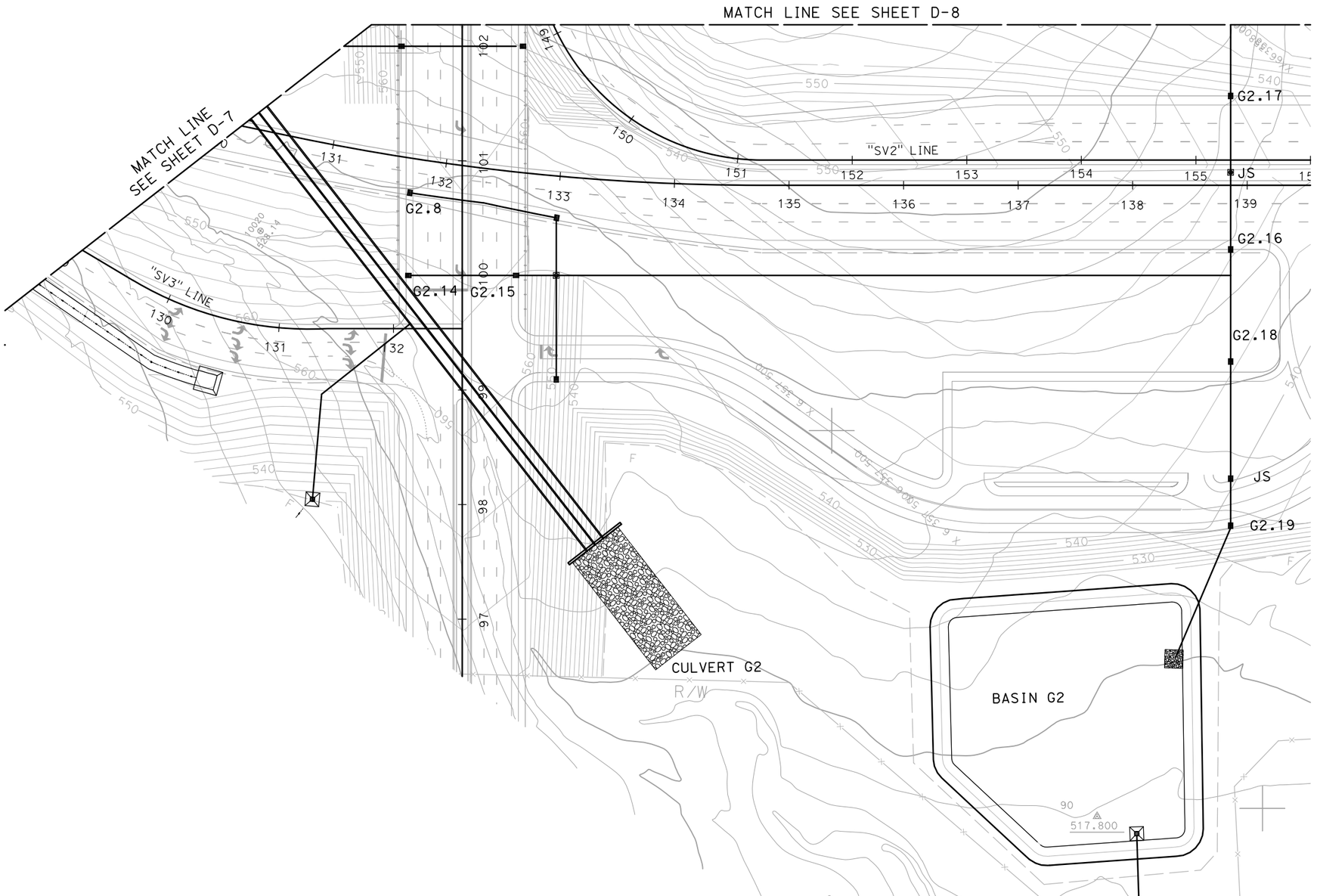

THIS PLAN ACCURATE FOR DRAINAGE WORK ONLY.

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TWO INTERCHANGE ALTERNATIVE DRAINAGE PLAN

SCALE 1"=50'

D-9

REVISED BY	DATE REVISED
MIKE BRUNING	GERARD DALZIEL
CALCULATED-DESIGNED BY	CHECKED BY
CONSULTANT FUNCTIONAL SUPERVISOR	KIRK BRADBURY

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION

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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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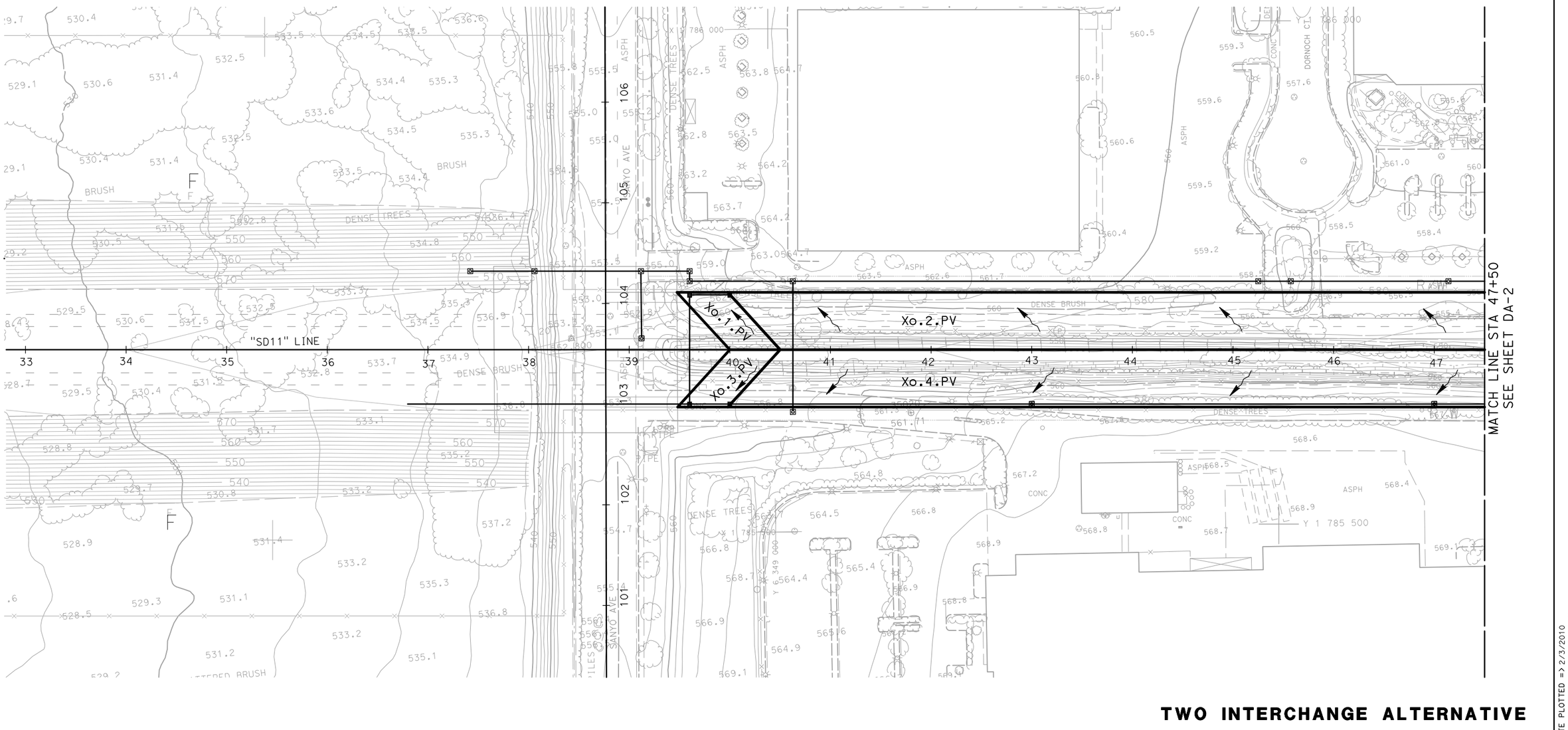
LEGEND:

- JS
- PIPE
- INLET W/APRON
- RSP
- HEADWALL
- --sd-- EXISTING STORMDRAIN



TWO INTERCHANGE ALTERNATIVE
DRAINAGE AREA PLAN

SCALE 1"=50'

DA-1

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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

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REGISTERED PROFESSIONAL ENGINEER
KIRK BRADBURY
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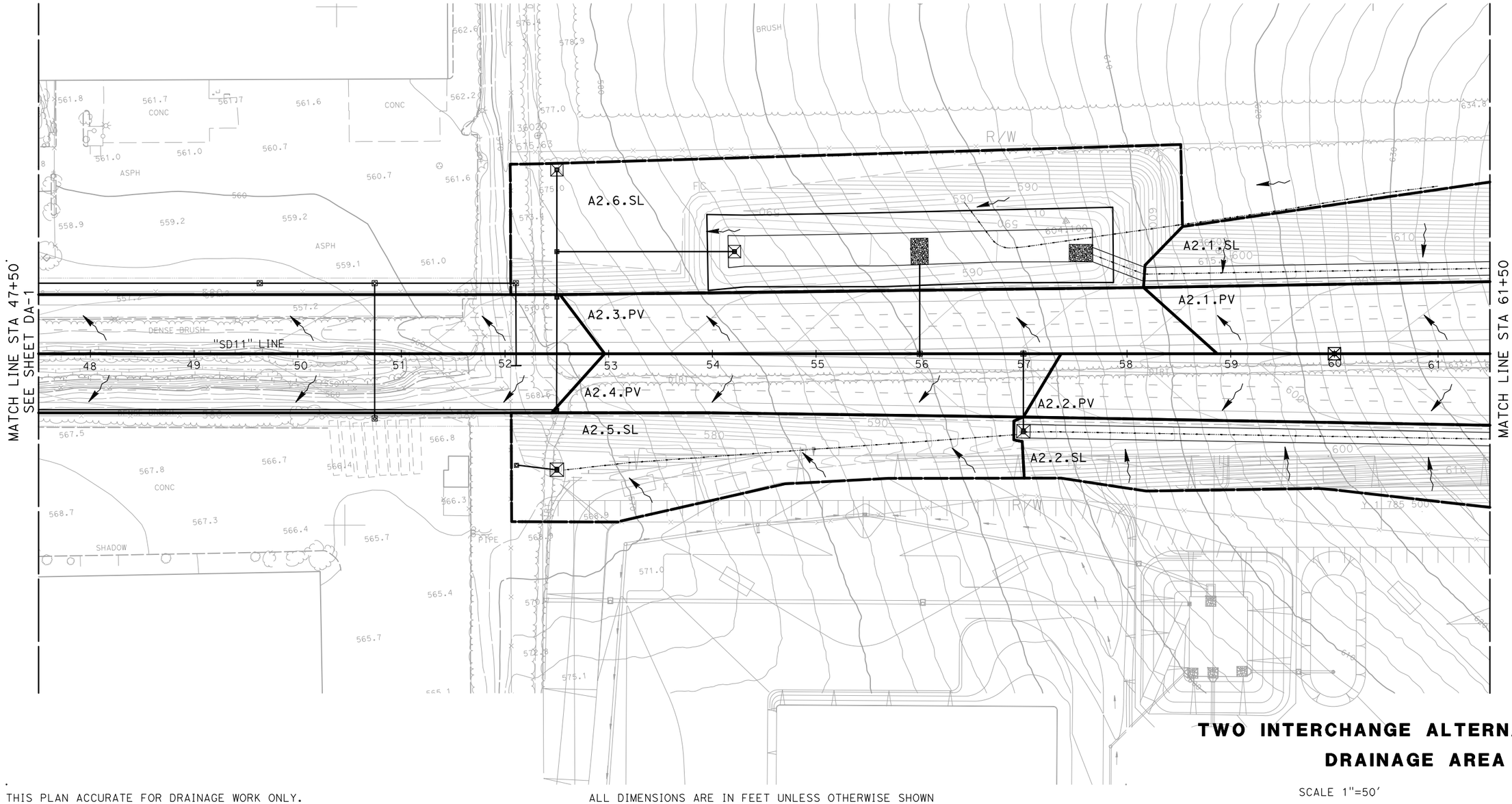

TWO INTERCHANGE ALTERNATIVE
DRAINAGE AREA PLAN

SCALE 1"=50'

DA-2

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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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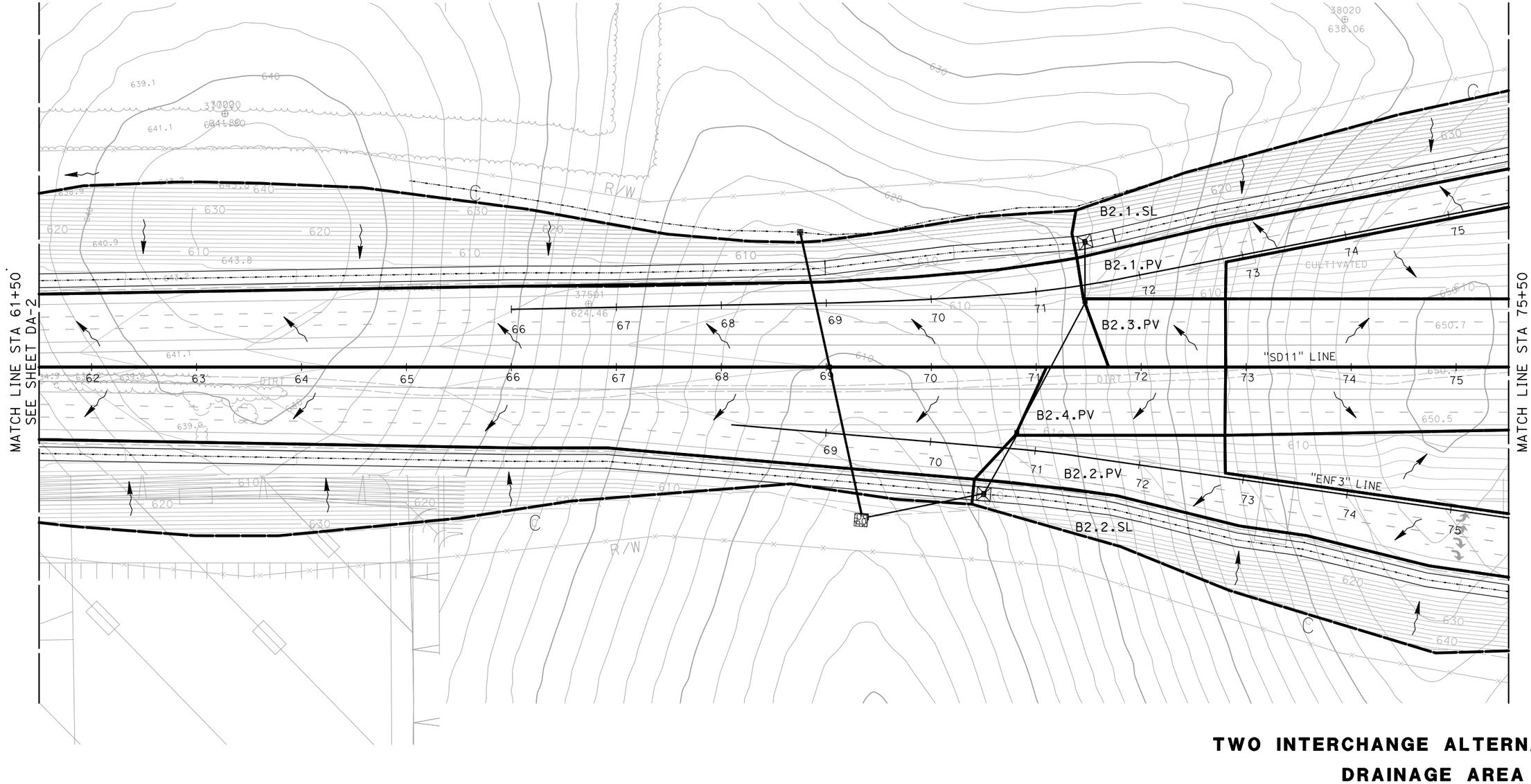

TWO INTERCHANGE ALTERNATIVE
DRAINAGE AREA PLAN

SCALE 1"=50'

DA-3

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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
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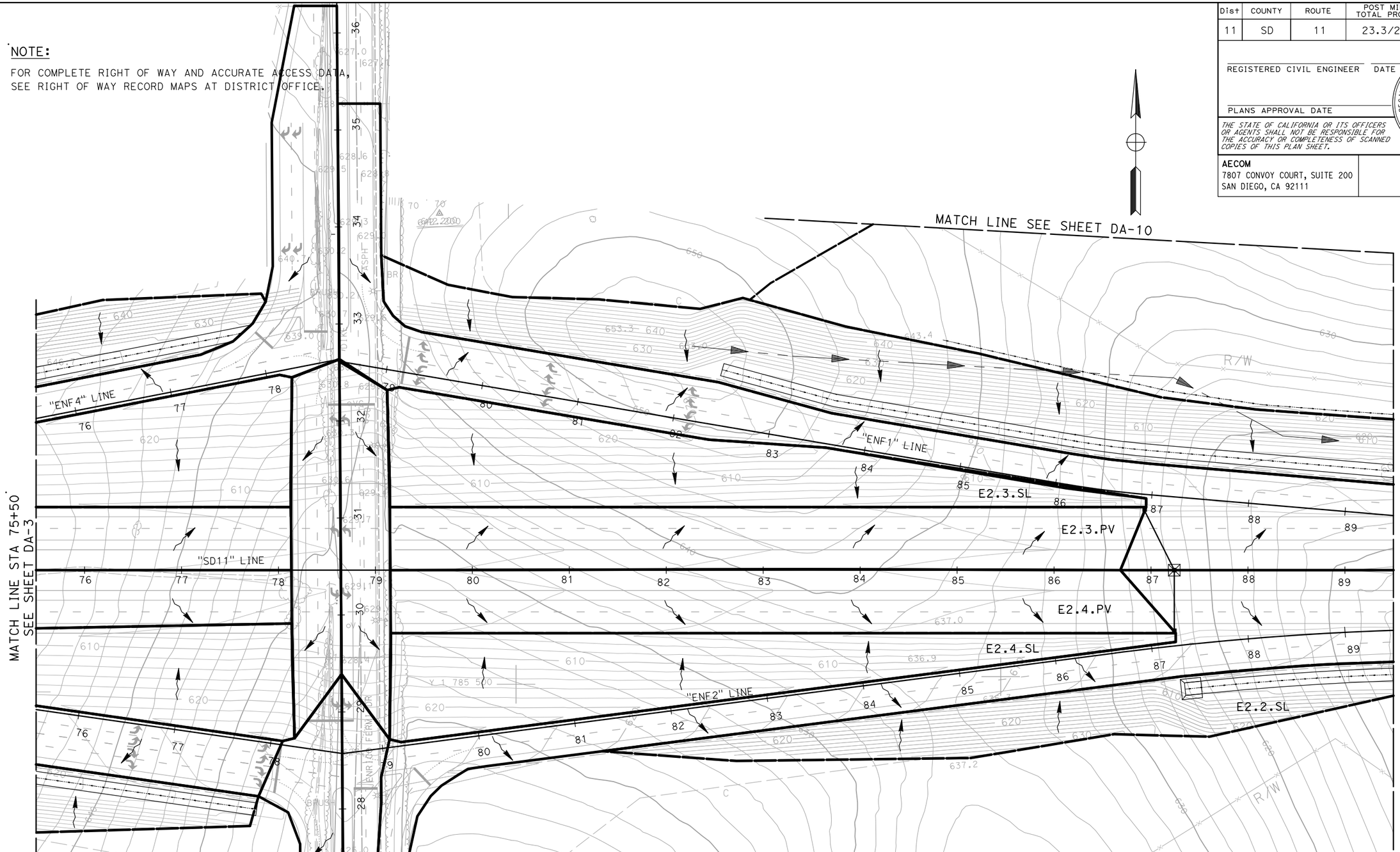

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TWO INTERCHANGE ALTERNATIVE
DRAINAGE AREA PLAN

SCALE 1"=50'

DA-4

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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
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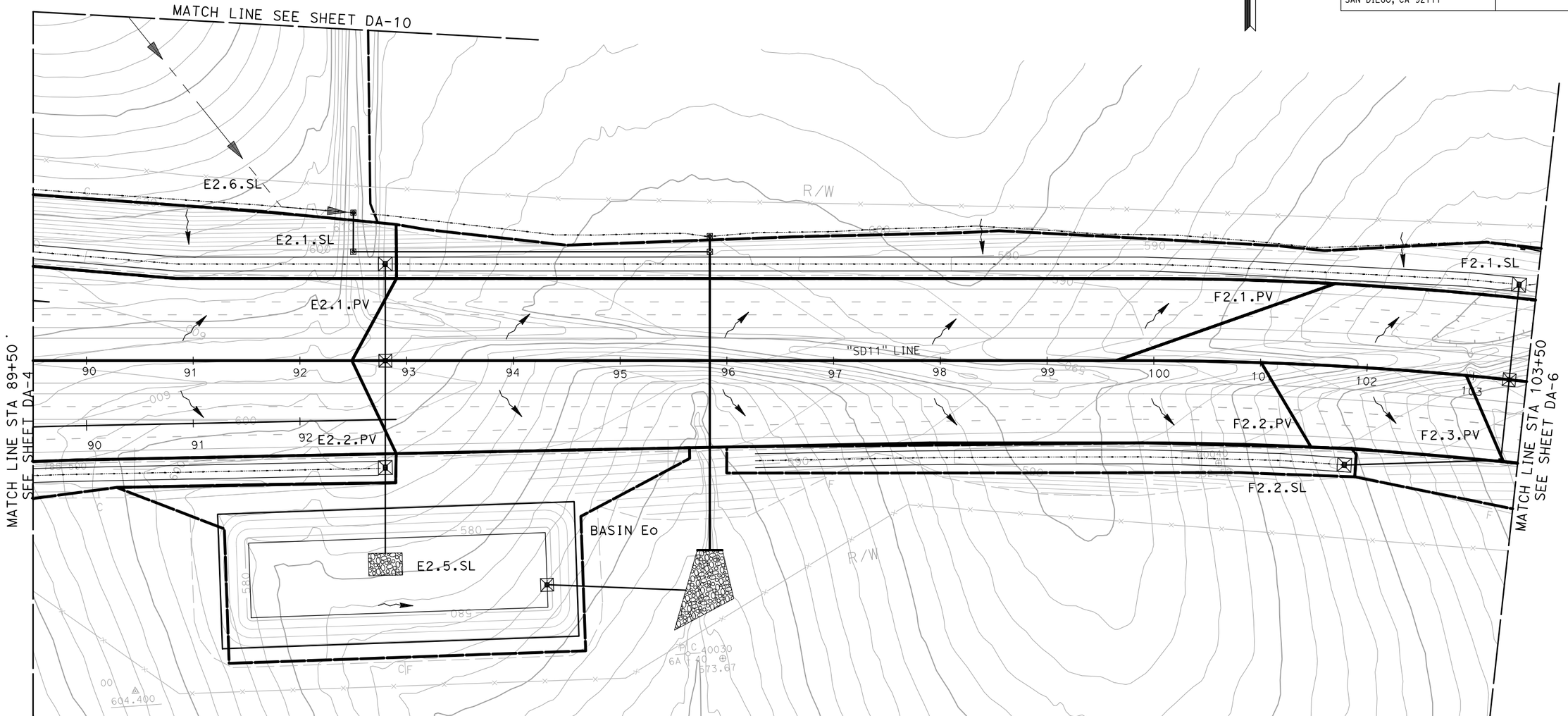

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TWO INTERCHANGE ALTERNATIVE
DRAINAGE AREA PLAN

SCALE 1"=50'

DA-5

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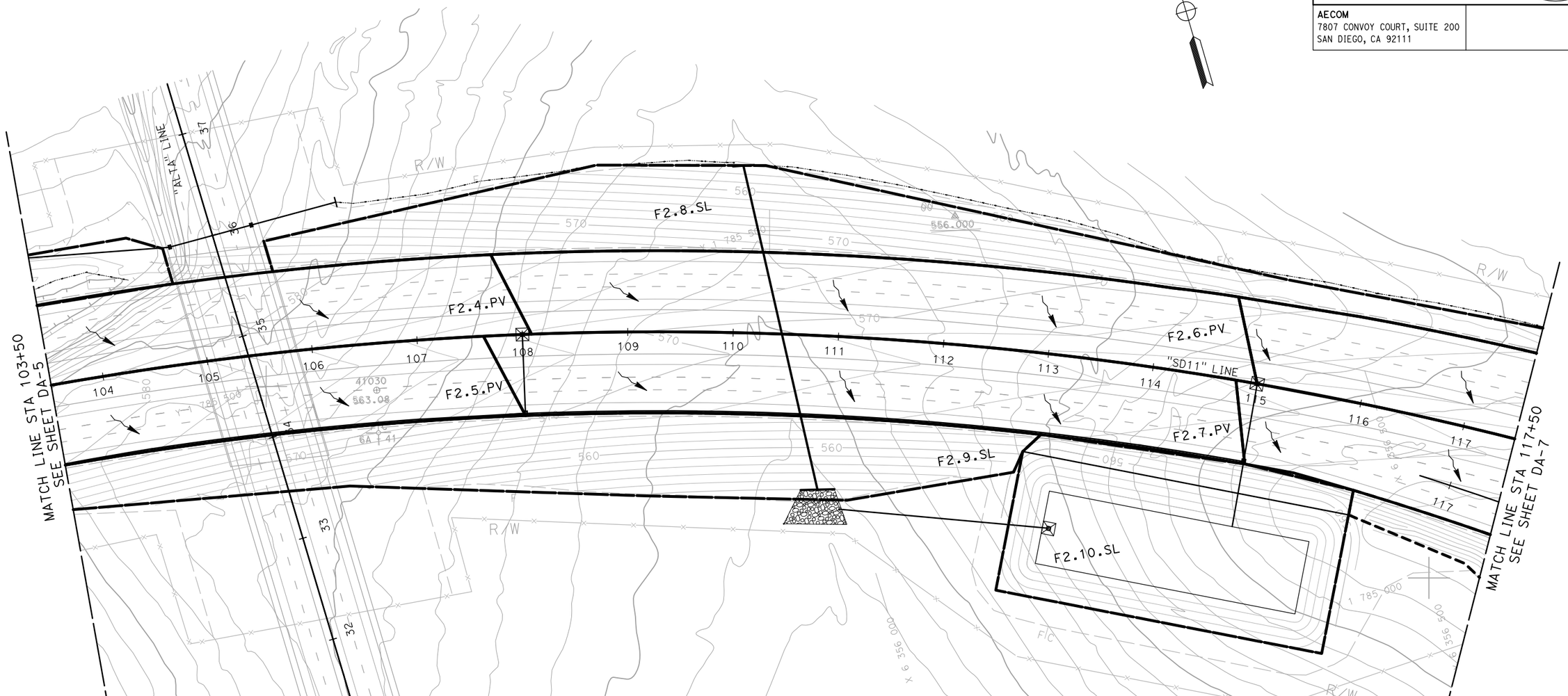

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TWO INTERCHANGE ALTERNATIVE
DRAINAGE AREA PLAN

SCALE 1"=50'

DA-6

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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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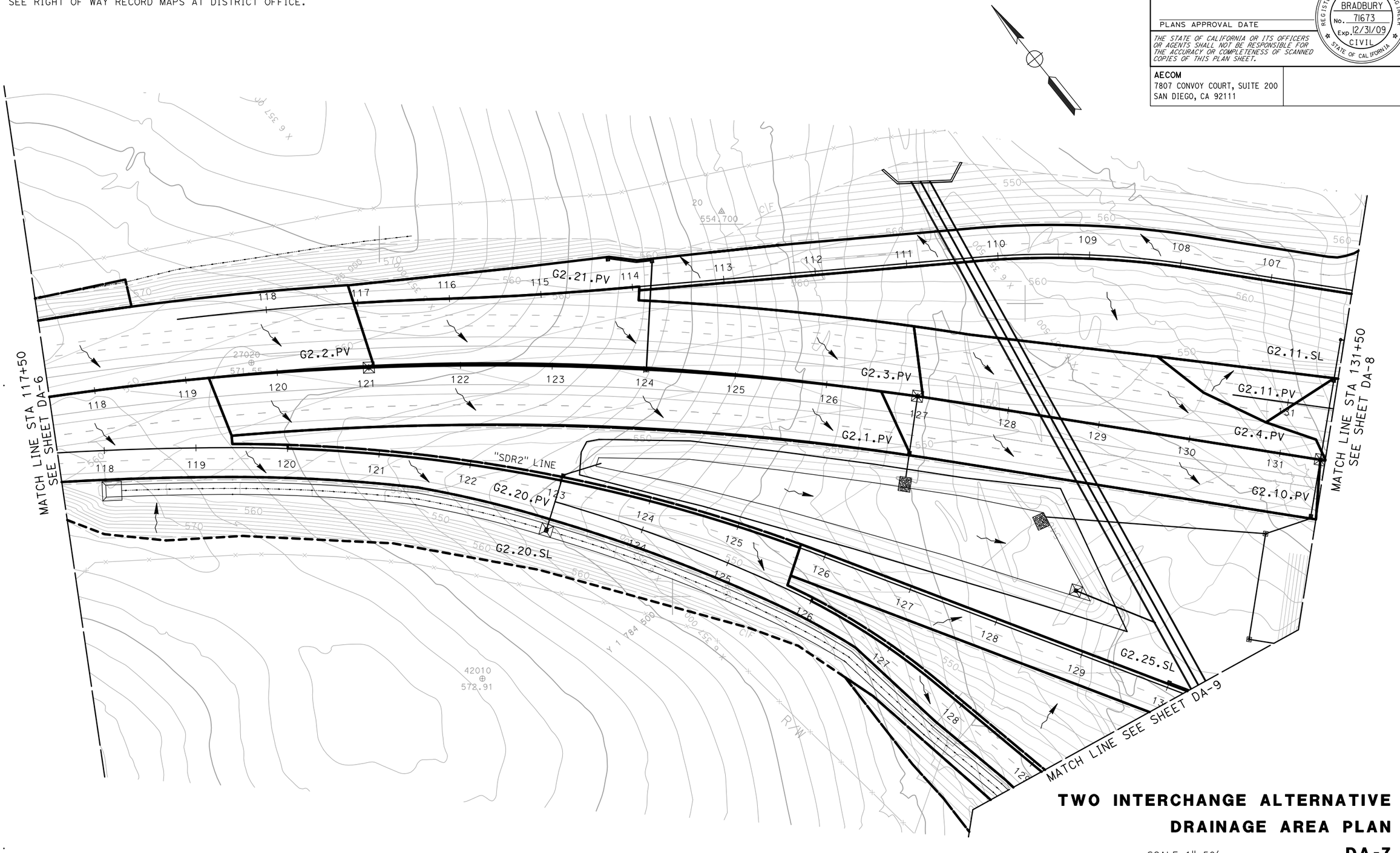

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TWO INTERCHANGE ALTERNATIVE
DRAINAGE AREA PLAN

SCALE 1"=50'

DA-7

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EA 06002

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11	SD	11	23.3/26.6		

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KIRK BRADBURY
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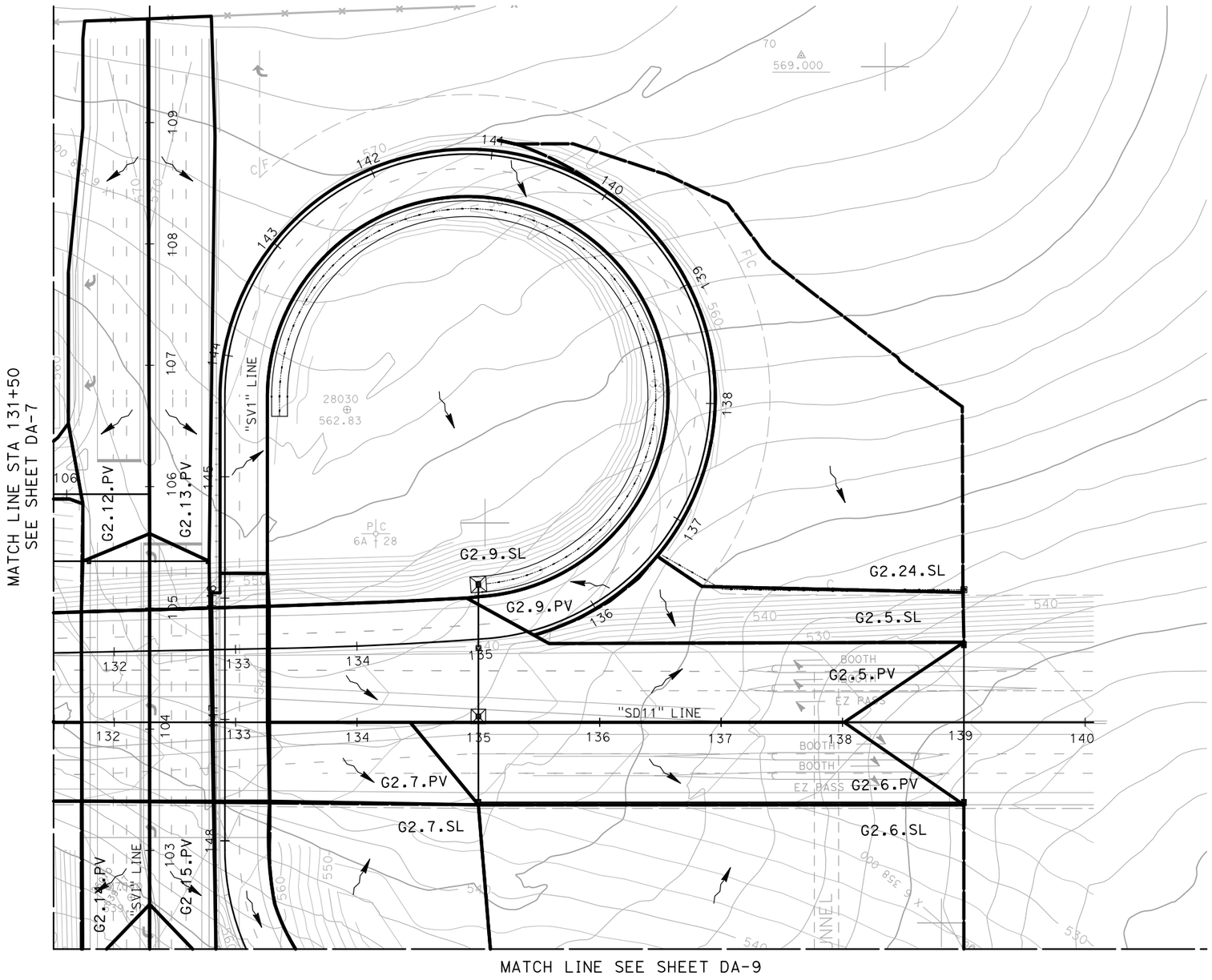

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TWO INTERCHANGE ALTERNATIVE
DRAINAGE AREA PLAN

SCALE 1"=50'

DA-8

REVISED BY	DATE REVISED
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GERARD DALZIEL	

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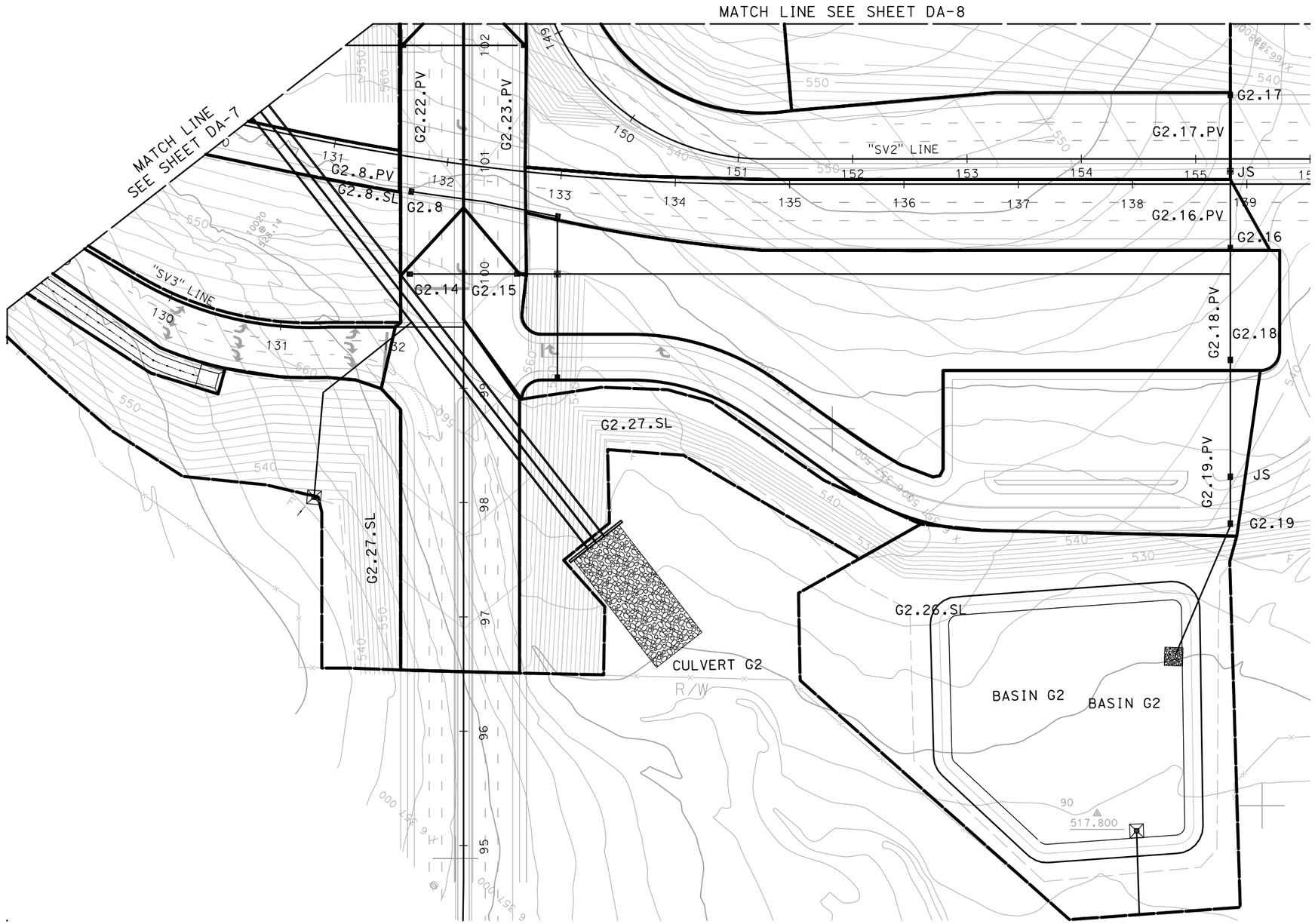

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DRAINAGE AREA PLAN

SCALE 1"=50'

DA-9

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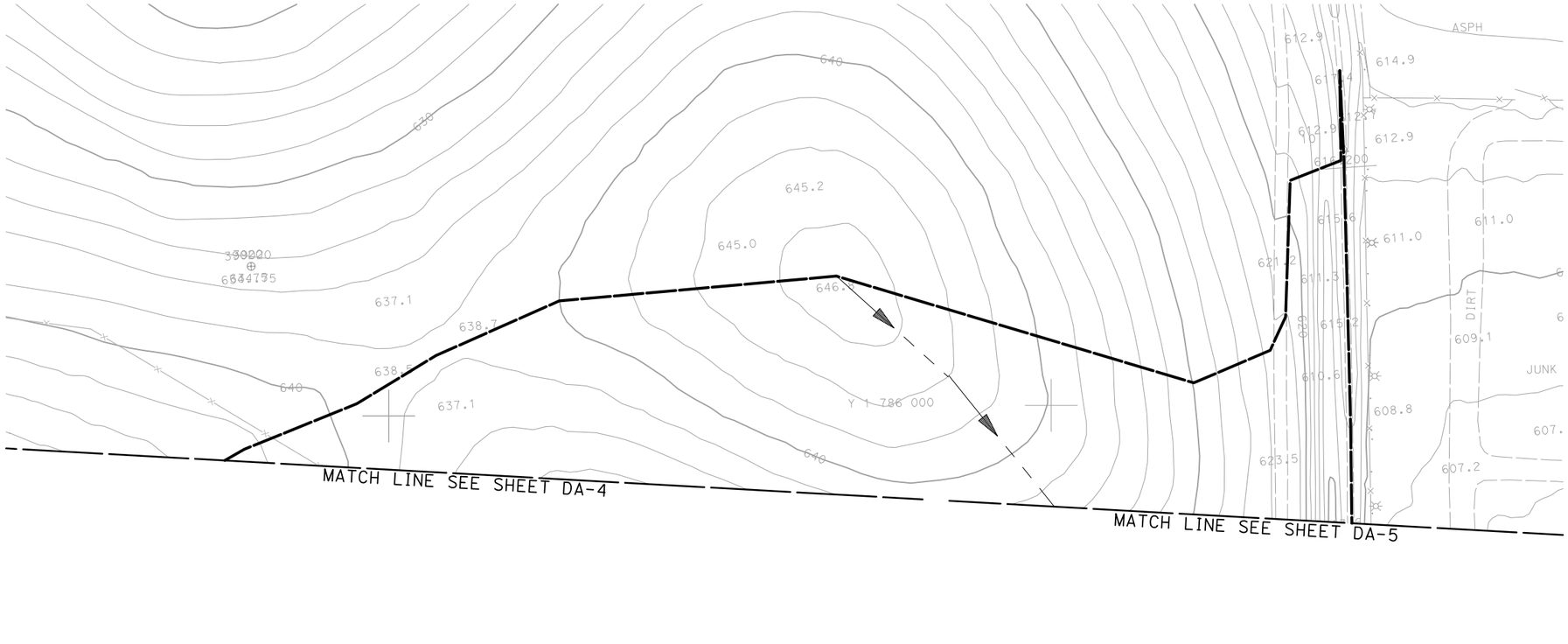

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TWO INTERCHANGE ALTERNATIVE
DRAINAGE AREA PLAN

SCALE 1"=50'

DA-10

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USERNAME => YamanakaG
DGN FILE => ...\b056300ia010_2da.dgn

CU XXXXX

EA 06002

A2 Onsite D.A. Table

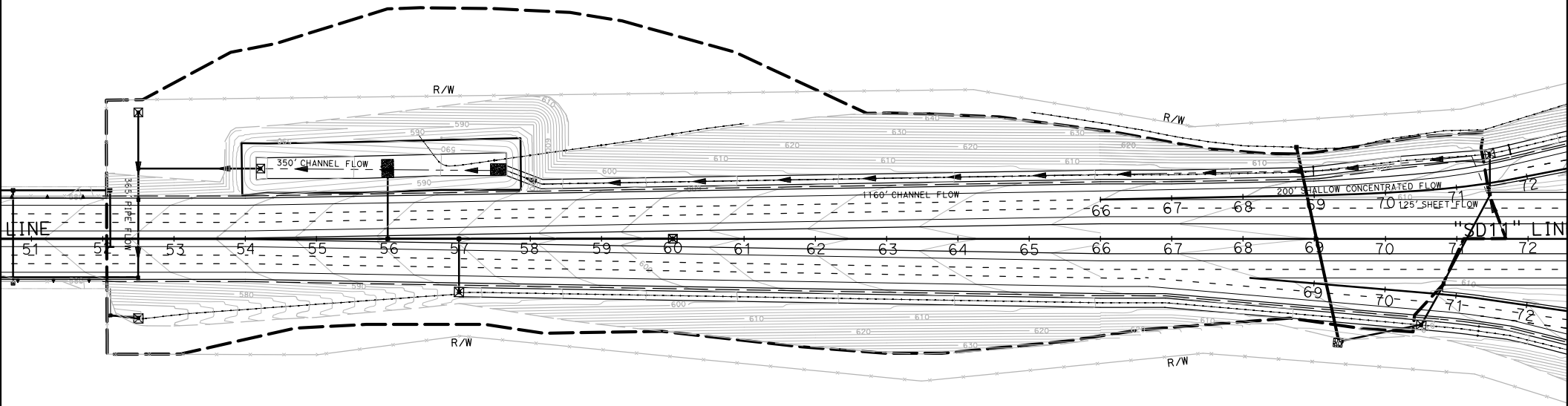
PROJECT:	**SR-11**	**DESCRIPTION:**	**Onsite Drainage Areas (D.A.)**
JOB #:	**11A1190**	**STATION:**	**~**
BY:	**M.BRUNING** **DATE:** **01.04.10**	**WATERSHED:**	**A2**
CHK:	**G.DALZIEL** **DATE:**	**SYSTEM:**	**Two Interchange Option**

						Caltrans	Caltrans	County	County					
			Area		Tc	i_{25}	Q_{25}	i_{100}	Q_{100}	Drains to:				
	Name	C	*SF*	*Acres*	*min*	*in/hr*	*cfs*	*in/hr*	*cfs*	Bioswale	Inlet	Destination	@ Station	Offset
PAVED	A2.1.PV	0.99	99500	2.3	10	2.8	6.40	4.2	9.53	A2.1	~	Basin A2	57+75	Lt
	A2.2.PV	0.99	104500	2.4	10	2.8	6.72	4.2	10.00	A2.2	A2.2	Basin A2	57+00	Rt
	A2.3.PV	0.99	35100	0.8	5	4.0	3.19	6.6	5.25	~	A2.3	*bypass**	52+50	Lt
	A2.4.PV	0.99	26200	0.6	5	4.0	2.38	6.6	3.92	~	A2.4	*bypass**	52+50	Rt
	Σ		265300	*PAVED*										

						Caltrans	Caltrans	County	County					
			Area		Tc	i_{25}	Q_{25}	i_{100}	Q_{100}	Drains to:				
	Name	C	*SF*	*Acres*	*min*	*in/hr*	*cfs*	*in/hr*	*cfs*	Bioswale	Inlet	Basin:	@ Station	Offset
SLOPE	A2.1.SL	0.61	94700	2.2	10	2.8	3.75	4.2	5.59	A2.1	~	Basin A2	56+00	Lt
	A2.2.SL	0.61	81400	1.9	10	2.8	3.22	4.2	4.80	A2.2	A2.5	Basin A2	57+00	Rt
	A2.5.SL	0.61	38800	0.9	10	2.8	1.54	4.2	2.29	~	A2.5	*bypass**	52+50	Rt
	A2.6.SL	0.61	83900	1.9	10	2.8	3.32	4.2	4.95	~	A2.6	Basin A2	53+00	Lt
	Σ		298800	*SLOPE*										

** flow that does not reach the basin*

Total :	564100	12.9
	SF	*ac*



WATERSHED A2
TWO INTERCHANGE ALTERNATIVE

Scale: 1"=200'

A2 Post-Developed TcQ

PROJECT:	**SR-11**			**DESCRIPTION:**	**SR-11 Post-Developed**
JOB #:	**11A1190**			**STATION:**	**52+00**
BY:	**M.BRUNING**	**DATE:**	**01.04.10**	**WATERSHED:**	**A2**
CHK:	**G.DALZIEL**	**DATE:**		**SYSTEM:**	**Two Interchange Option**

BASIN AREA:

A = 675608 ft^2 / 15.51 acres **SOURCE:** MICROSTATION/USGS (SCALE = 1:1)

COEFFICIENT OF RUNOFF:

KEY: User Input | Designer Tool

UNDEVELOPED AREA C (FROM HDM FIG. 819.2A)

		NOTES:
RELIEF (.08-.35)	0.14	Rolling slopes ~ 5%
INFILTRATION (.04-.16)	0.12	Negligible infiltration capacity - see Geotechnical Report
VEGETATION (.04-.16)	0.08	Fair natural cover
STORAGE (.04-.12)	0.08	Low
TOTAL C =	0.42	

UNDEVELOPED AREA	17%	AT	0.42	0.069
PAVED SURFACE	39%	AT	0.90	0.353
COMMERCIAL AREA	0%	AT	0.85	0.000
CUT SLOPE (2:1 and 4:1)	44%	AT	0.55	0.243
TOTAL	100%			
	(100%)			

$C_{2,10}$ =	0.67
C_{25} =	0.73
C_{50} =	0.80
C_{100} =	0.83

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	611.5	ft	SR-11 CL
LOW POINT ELEVATION	610.0	ft	SR-11 ES
ELEVATION DIFF (H)	1.5	ft	
LENGTH (L)	125	ft	To Bioswale
SLOPE (S) = (H/L)	1.2%		
MANNING'S n	0.016		<=n from Table 816.6A AC
T_t (SFF)=	3.20	minutes	

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

NOTES:

HIGH PT ELEVATION	610.0	ft	Origin of Bioswale
LOW POINT ELEVATION	609.0	ft	
ELEVATION DIFF (H)	1.0	ft	
LENGTH (L)	200	ft	Assumed bioswale does not have enough flow to be channelized
SLOPE (S) = (H/L)	0.5%		
VELOCITY (SCF)	1.8	fps	<=V from Figure 816.6 grassed waterway
T_C (SH)=	1.85	minutes	

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

NOTES:

HIGH PT ELEVATION	609.0	ft	Begin channel flow in bioswale
LOW POINT ELEVATION	590.0	ft	CHANNEL DATA TYPE = TRAP'Z
ELEVATION DIFF (H)	19.0	ft	Z= 4 ANG-RAD 0.245
LENGTH (L)	1160	ft	b = 13 ANG-DEG 14.036
SLOPE (S) = (H/L)	1.6%		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)	3.29	fps	From Manning's Equation assuming flowing full: $V=1.49/n(R^{2/3}S^{1/2})$
T_C (CH)=	5.88	minutes	

A2 Post-Developed TcQ

CHANNEL FLOW: $T_t = T_t = \frac{L}{60\,V}$ $V = \frac{K_u}{n} R^{2/3} S^{1/2}$

HIGH PT ELEVATION	590.0	ft
LOW POINT ELEVATION	584.0	ft
ELEVATION DIFF (H)	6.0	ft
LENGTH (L)	350	ft
SLOPE (S) = (H/L)	1.7%	
MANNING'S n	0.050	
HYDRAULIC RADIUS R	0.80	ft
VELOCITY (CHANNEL)	3.36	fps
T_C (CH)=	1.73	minutes

assume basin floor has same dimensions of bioswale

CHANNEL DATA		TYPE =	TRAP'Z
Z=	4	ANG-RAD	0.245
b =	13	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	584.0	ft
LOW POINT ELEVATION	581.0	ft
ELEVATION DIFF (H)	3.0	ft
LENGTH (L)	365	ft
SLOPE (S) = (H/L)	0.8%	
MANNING'S n	0.013	
PIPE DIAMETER d	2.0	ft
HYDRAULIC RADIUS R	0.5	ft
VELOCITY (STORMDRAIN)	6.5	fps
T_C (SD)=	0.93	minutes

NOTES:

proposed basin outlet pipe

discharge at watershed end (Sta 52+00)

RCP

R=D/4, Assume: flowing full

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

Tc (TOTAL) =	13.59	minutes
Minimum Tc =	10	minutes
USE Tc =	**13.59**	minutes

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

i_2 =	1.5	in/hr	X CA =	
i_{10} =	2.2	in/hr	X CA =	
i_{25} =	2.8	in/hr	X CA =	
i_{50} =	3.3	in/hr	X CA =	
i_{100} =	3.5	in/hr	X CA =	

FLOW RESULTS:

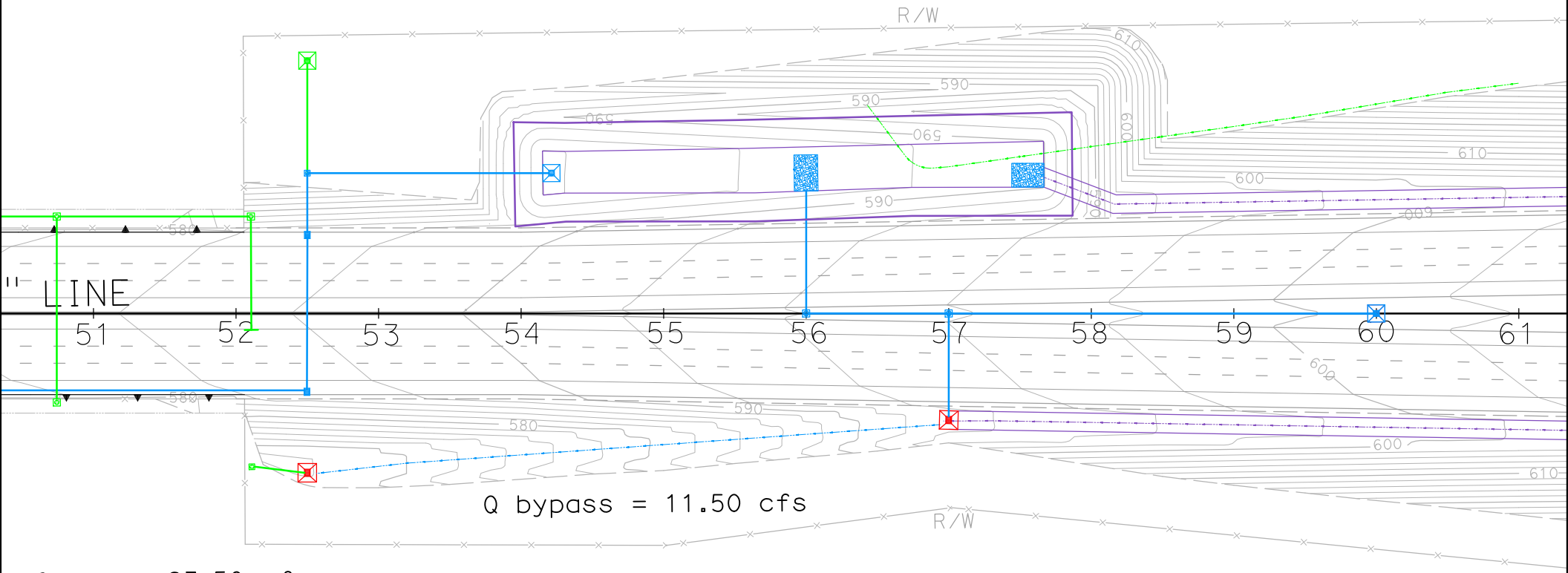
	cfs
Q_2 =	15.7
Q_{10} =	22.8
Q_{25} =	31.4
Q_{50} =	41.1
Q_{100} =	**44.6**

COUNTY P_6

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

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

Q in = 37.30 cfs
Q out = 0.77 cfs



Q pre = 23.50 cfs
Q final = 12.27 cfs

BASIN A2
FLOW SUMMARY

Scale: 1"=100'

Basin A2 Retention

PROJECT:	SR-11			**DESCRIPTION:**	SR-11 Basin
JOB #:	11A1190			**STATION:**	54+25 - 57+75
BY:	M.BRUNING	**DATE:**	01.04.10	**WATERSHED:**	A2
CHK:	G.DALZIEL	**DATE:**		**SYSTEM:**	Two Interchange Option

Notes:

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

RETENTION VOLUME

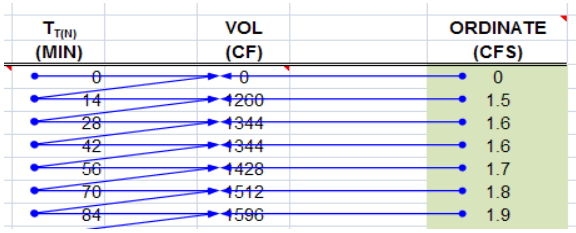
100-year, 6 hour duration storm event, use the Rational Method Hydrograph Procedure (SDCHM 6-1) ~ RatHydro

Pre-Developed volume calculations

Q_{100}=	23.5	cfs			
Tc=	10.0	min	C=	0.53	
$P_{100,6}$=	2.5	in	A=	10.51	acres

$T_{T(N)}$ (MIN)	VOL (CF)	ORDINATE (CFS)
0	0	0
10	480	0.8
20	480	0.8
30	540	0.9
40	540	0.9
50	540	0.9
60	600	1
70	600	1
80	600	1
90	660	1.1
100	660	1.1
110	720	1.2
120	720	1.2
130	780	1.3
140	840	1.4
150	900	1.5
160	960	1.6
170	1020	1.7
180	1080	1.8
190	1260	2.1
200	1380	2.3
210	1680	2.8
220	1920	3.2
230	2760	4.6
240	3900	6.5
250	14100	23.5
260	2220	3.7
270	1500	2.5
280	1140	1.9
290	960	1.6
300	840	1.4
310	780	1.3
320	720	1.2
330	660	1.1
340	600	1
350	540	0.9
360	540	0.9
370	0	0

Example of Steps:



SUM= 50220 ft^3
1.15 acre-feet

Check: $V = C*A*P_6$
V= 1.16 acre-feet
OK

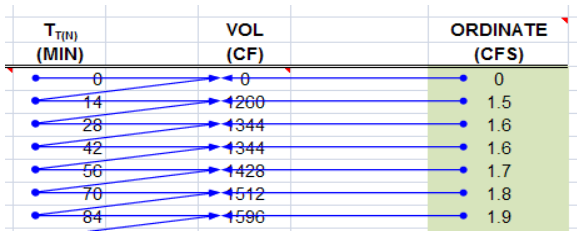
Basin A2 Retention

Post-Developed volume calculations

Q_{100}=	44.6	cfs			
Tc=	13.6	min	C=	0.83	
$P_{100,6}$=	2.5	in	A=	15.51	acres

$T_{T(N)}$ (MIN)	VOL (CF)	ORDINATE (CFS)
0	0	0
14	1596	1.9
28	1680	2
42	1764	2.1
56	1848	2.2
70	1932	2.3
84	2016	2.4
98	2100	2.5
112	2352	2.8
126	2436	2.9
140	2688	3.2
154	2856	3.4
168	3276	3.9
182	3528	4.2
196	4368	5.2
210	4956	5.9
224	7224	8.6
238	9408	11.2
252	37464	44.6
266	5796	6.9
280	3864	4.6
294	3024	3.6
308	2520	3
322	2184	2.6
336	2016	2.4
350	1764	2.1
364	1680	2
378	0	0

Example of Steps:



SUM= 116340 ft^3
2.67 acre-feet

Check: $V = C*A*P_6$
V= 2.69 acre-feet
OK

		2.67	*(Post)*		
	-	**1.15**	*(Pre)*		
Retention volume =		**1.52**	**acre-feet**	=	**66120 ft^3** **Basin Required**

Basin A2 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}= 0.88
A= 10.65 acres

WQ_{72}: 0.66 in/area

Water Quality Volume (WQV) = **25520** 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:

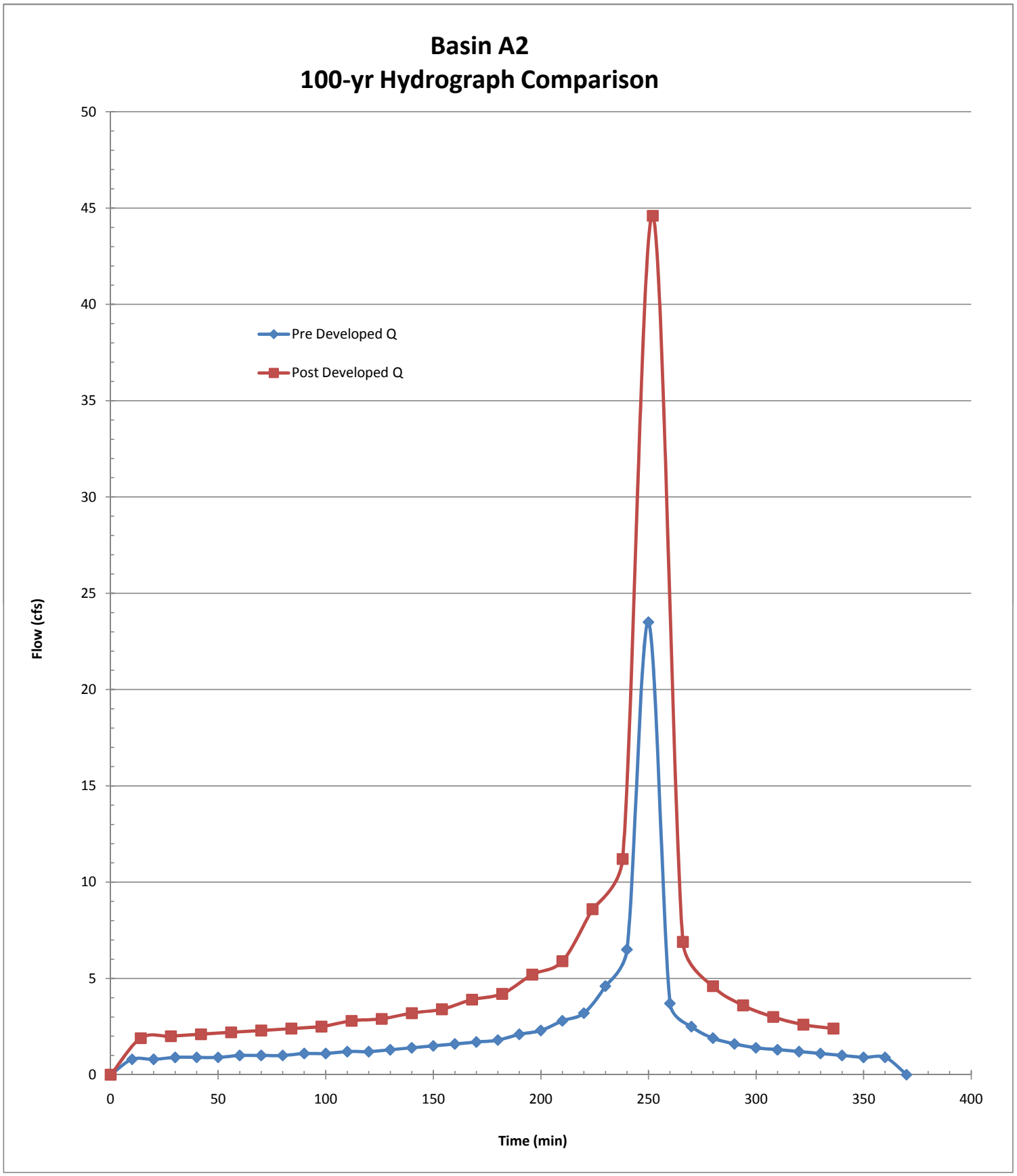
A_s = the computed soil loss in tons (dry weight)
R = the rainfall erosion index for the given storm period
K = the soil erodibility factor
L = the slope length factor
s = the slope gradient factor
C = cropping management (vegetation) factor
P = erosion control practice factor

Onsite Highway *Sloped* runoff area, A:		260000	ft^2
	A:	5.97	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 = 92.83 tons

Silt Accumulation Basin volume = **2063** ft^3

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


Basin A2
100-yr Hydrograph Comparison
Pre Developed Q
Post Developed Q
Flow (cfs)
Time (min)
0
5
10
15
20
25
30
35
40
45
50
0
50
100
150
200
250
300
350
400

Basin A2 Inflow TcQ

PROJECT:	**SR-11**			**DESCRIPTION:**	**SR-11 Basin**
JOB #:	**11A1190**			**STATION:**	**57+75**
BY:	**M.BRUNING**	**DATE:**	**01.04.10**	**WATERSHED:**	**A2**
CHK:	**G.DALZIEL**	**DATE:**		**SYSTEM:**	**Two Interchange Option**

BASIN AREA:

A = 464000 ft^2 | 10.65 acres

SOURCE: MICROSTATION/USGS (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	44%	AT	0.90	0.396
COMMERCIAL AREA	0%	AT	0.85	0.000
CUT SLOPE (2:1 and 4:1)	56%	AT	0.55	0.308
TOTAL	100%			
	(100%)			

$C_{2,10}$ =	0.70
C_{25} =	0.77
C_{50} =	0.84
C_{100} =	0.88

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	611.5	ft	SR-11 CL
LOW POINT ELEVATION	610.0	ft	SR-11 ES
ELEVATION DIFF (H)	1.5	ft	
LENGTH (L)	125	ft	to Bioswale
SLOPE (S) = (H/L)	1.2%		
MANNING'S n	0.016		<=n from Table 816.6A AC
T_t (SFF)=	3.20	minutes	

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

NOTES:

HIGH PT ELEVATION	610.0	ft	origin of Bioswale
LOW POINT ELEVATION	609.0	ft	
ELEVATION DIFF (H)	1.0	ft	
LENGTH (L)	200	ft	assumed bioswale does not have enough flow to be channelized
SLOPE (S) = (H/L)	0.5%		
VELOCITY (SCF)	1.8	fps	<=V from Figure 816.6 grassed waterway
T_C (SH)=	1.85	minutes	

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

NOTES:

HIGH PT ELEVATION	609.0	ft	Begin channel flow in bioswale
LOW POINT ELEVATION	590.0	ft	CHANNEL DATA TYPE = TRAP'Z
ELEVATION DIFF (H)	19.0	ft	Z= 4 ANG-RAD 0.245
LENGTH (L)	1160	ft	b = 13 ANG-DEG 14.036
SLOPE (S) = (H/L)	1.6%		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)	3.29	fps	From Manning's Equation assuming flowing full: $V=1.49/n(R^{2/3}S^{1/2})$
T_C (CH)=	5.88	minutes	

Basin A2 Inflow TcQ

Tc (TOTAL) =	10.93	minutes
Minimum Tc =	10	minutes
USE Tc =	**10.93**	minutes

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

i_2 =	1.8	in/hr	X CA =
i_{10} =	2.5	in/hr	X CA =
i_{25} =	3.2	in/hr	X CA =
i_{50} =	3.8	in/hr	X CA =
i_{100} =	4.0	in/hr	X CA =

FLOW RESULTS:

	cfs
Q_2 =	13.1
Q_{10} =	19.1
Q_{25} =	26.2
Q_{50} =	34.4
Q_{100} =	**37.3**

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 A2 Inflow Hydrograph

PROJECT:	**SR-11**			**DESCRIPTION:**	**SR-11 Basin**
JOB #:	**11A1190**			**STATION:**	**54+25 - 57+75**
BY:	**M.BRUNING**	**DATE:**	**01.04.10**	**WATERSHED:**	**A2**
CHK:	**G.DALZIEL**	**DATE:**		**SYSTEM:**	**Two Interchange Option**

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

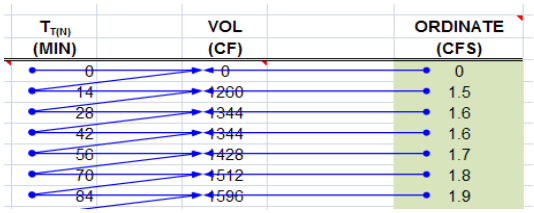
Basin Inflow Hydrograph

Basin Inflow Q

Q_{100}=	37.3	cfs	C_{100}=	0.88	
Tc=	10.9	min	A=	10.65	acres
$P_{100,6}$=	2.5	in			

$T_{T(N)}$ (MIN)	VOL (CF)	ORDINATE (CFS)
0	0	0
11	924	1.4
22	924	1.4
33	990	1.5
44	990	1.5
55	1056	1.6
66	1056	1.6
77	1122	1.7
88	1188	1.8
99	1254	1.9
110	1254	1.9
121	1386	2.1
132	1452	2.2
143	1518	2.3
154	1650	2.5
165	1782	2.7
176	1914	2.9
187	2178	3.3
198	2376	3.6
209	2904	4.4
220	3300	5
231	4884	7.4
242	6732	10.2
253	24618	37.3
264	3894	5.9
275	2574	3.9
286	2046	3.1
297	1716	2.6
308	1518	2.3
319	1320	2
330	1188	1.8
341	1122	1.7
352	1056	1.6
363	990	1.5
374	0	0

Example of Steps:



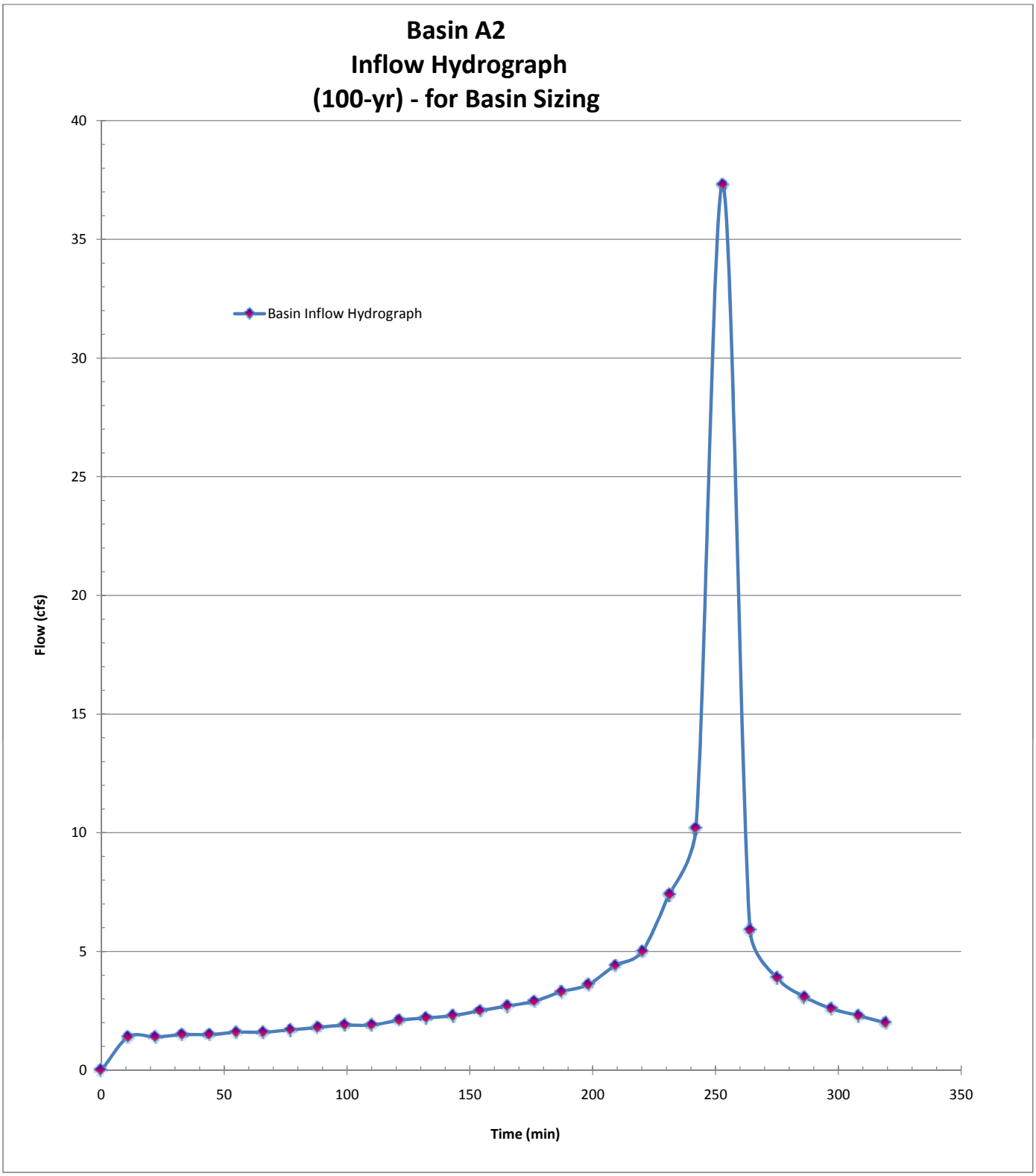
SUM= 84876 ft³
1.95 acre-feet

Onsite Runoff Volume

Check: $V = C*A*P_6$

V= 1.95 acre-feet

OK


Basin A2
Inflow Hydrograph
(100-yr) - for Basin Sizing
Basin Inflow Hydrograph
Flow (cfs)
Time (min)
0
5
10
15
20
25
30
35
40
0
50
100
150
200
250
300
350

Basin A2 Outlet

PROJECT:	**SR-11**			**DESCRIPTION:**	**SR-11 Basin**
JOB #:	**11A1190**			**STATION:**	**54+25**
BY:	**M.BRUNING**	**DATE:**	**02.19.10**	**WATERSHED:**	**A2**
CHK:	**G.DALZIEL**	**DATE:**		**SYSTEM:**	**Two Interchange Option**

Notes:

Required Retention Basin Volume = 68183 ft^3
Actual Basin Inflow = 84876 ft^4 *OK*

Flow Balance - determine maximum flow from basin

Predeveloped Peak 100-year Flow:	23.5	cfs	
Post-Developed Peak Flow through Cross Culvert:	0.0	cfs	
Flow that does not reach detention basin (bypass per DA table):	11.5	cfs	~ Q_{100} of: A2.3.PVA2.4.PVA2.5.SL
Maximum flow allowed to be released by this detention basin:	12.0	cfs	

Outlet Pipe

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

Basin - Top of basin berm elevation =	589.60	ft
Basin flowline elevation =	584.00	ft
Maximum Basin Depth =	5.60	ft

Outlet Pipe

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

Outlet pipe invert from basin floor =	4.00	ft	588.00	ft
Outlet pipe diameter =	2	ft		

Basin Characteristics

Base Length (L)	350	ft
Base Width (W)	30	ft
W/L Ratio ®	0.09	
Side Slopes (Z)	1: 4	
Total Volume (V):	115766	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)	Q_{out} (cfs)	Q_{inf} (cfs)	Q_{total} (cfs)
0	584.00	0.00	0	0		584.00	0.00		0.00
1	584.20	0.20	2161	2161		584.20	0.00		0.00
2	584.40	0.40	2284	4445		584.40	0.00		0.00
3	584.60	0.60	2410	6855		584.60	0.00		0.00
4	584.80	0.80	2539	9394		584.80	0.00		0.00
5	585.00	1.00	2670	12063		585.00	0.00		0.00
6	585.20	1.20	2804	14867		585.20	0.00		0.00
7	585.40	1.40	2940	17808		585.40	0.00		0.00
8	585.60	1.60	3079	20887		585.60	0.00		0.00
9	585.80	1.80	3221	24108		585.80	0.00		0.00
10	586.00	2.00	3366	27474		586.00	0.00		0.00
11	586.20	2.20	3513	30987		586.20	0.00		0.00
12	586.40	2.40	3662	34649		586.40	0.00		0.00
13	586.60	2.60	3815	38464		586.60	0.00		0.00
14	586.80	2.80	3970	42434		586.80	0.00	0.00	0.00
15	587.00	3.00	4127	46561		587.00	0.00		0.00
16	587.20	3.20	4288	50849		587.20	0.00		0.00
17	587.40	3.40	4451	55300		587.40	0.00		0.00
18	587.60	3.60	4616	59916		587.60	0.00		0.00
19	587.80	3.80	4784	64700		587.80	0.00		0.00
20	588.00	4.00	4955	69656	*	588.00	0.00		0.00
21	588.20	4.20	5129	74785		588.20	0.15		0.15
22	588.40	4.40	5305	80090		588.40	0.59		0.59
23	588.60	4.60	5484	85573		588.60	1.30		1.30
24	588.80	4.80	5665	91238		588.80	2.25		2.25
25	589.00	5.00	5849	97087		589.00	3.42		3.42
26	589.20	5.20	6036	103123		589.20	4.79		4.79
27	589.40	5.40	6225	109348		589.40	6.32		6.32
28	589.60	5.60	6417	115766		589.60	7.99		7.99

Basin A2 Routing

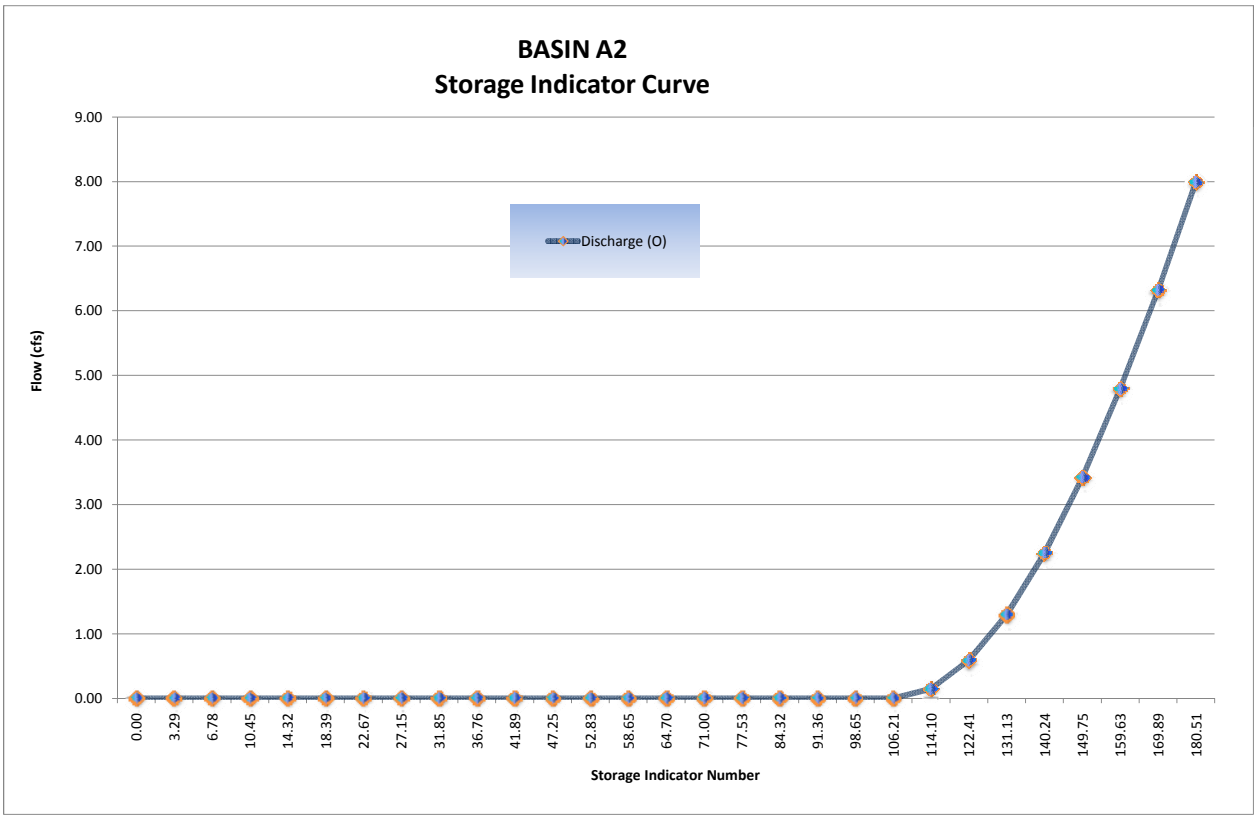
PROJECT:	SR-11			DESCRIPTION:	SR-11 Basin
JOB #:	11A1190			STATION:	54+75
BY:	M.BRUNING	DATE:	02.19.10	WATERSHED:	A
CHK:	G.DALZIEL	DATE:		SYSTEM:	Basin A2

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)	*Storage Indicator #* (6) S_2/delta t + $O_2/2$ (cfs)
584.00	0.00	0	0.00	0.00	0.00
584.20	0.00	2161	0.00	3.29	3.29
584.40	0.00	4445	0.00	6.78	6.78
584.60	0.00	6855	0.00	10.45	10.45
584.80	0.00	9394	0.00	14.32	14.32
585.00	0.00	12063	0.00	18.39	18.39
585.20	0.00	14867	0.00	22.67	22.67
585.40	0.00	17808	0.00	27.15	27.15
585.60	0.00	20887	0.00	31.85	31.85
585.80	0.00	24108	0.00	36.76	36.76
586.00	0.00	27474	0.00	41.89	41.89
586.20	0.00	30987	0.00	47.25	47.25
586.40	0.00	34649	0.00	52.83	52.83
586.60	0.00	38464	0.00	58.65	58.65
586.80	0.00	42434	0.00	64.70	64.70
587.00	0.00	46561	0.00	71.00	71.00
587.20	0.00	50849	0.00	77.53	77.53
587.40	0.00	55300	0.00	84.32	84.32
587.60	0.00	59916	0.00	91.36	91.36
587.80	0.00	64700	0.00	98.65	98.65
588.00	0.00	69656	0.00	106.21	106.21
588.20	0.15	74785	0.08	114.03	114.10
588.40	0.59	80090	0.30	122.12	122.41
588.60	1.30	85573	0.65	130.48	131.13
588.80	2.25	91238	1.13	139.12	140.24
589.00	3.42	97087	1.71	148.04	149.75
589.20	4.79	103123	2.40	157.24	159.63
589.40	6.32	109348	3.16	166.73	169.89
589.60	7.99	115766	4.00	176.52	180.51

delta t = 0.18 hrs
delta t = 11 min
delta t = 655.8389 sec



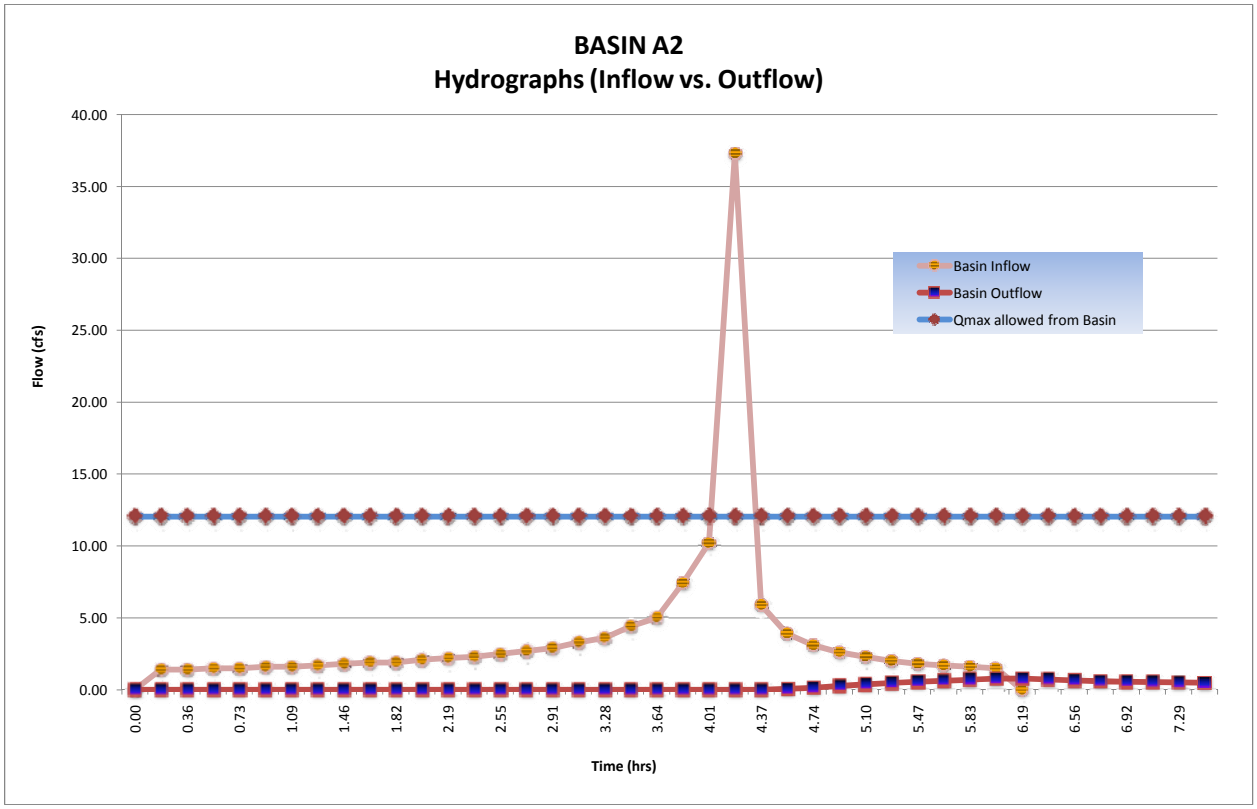
Basin A2 Routing

FINAL ROUTING TABLE

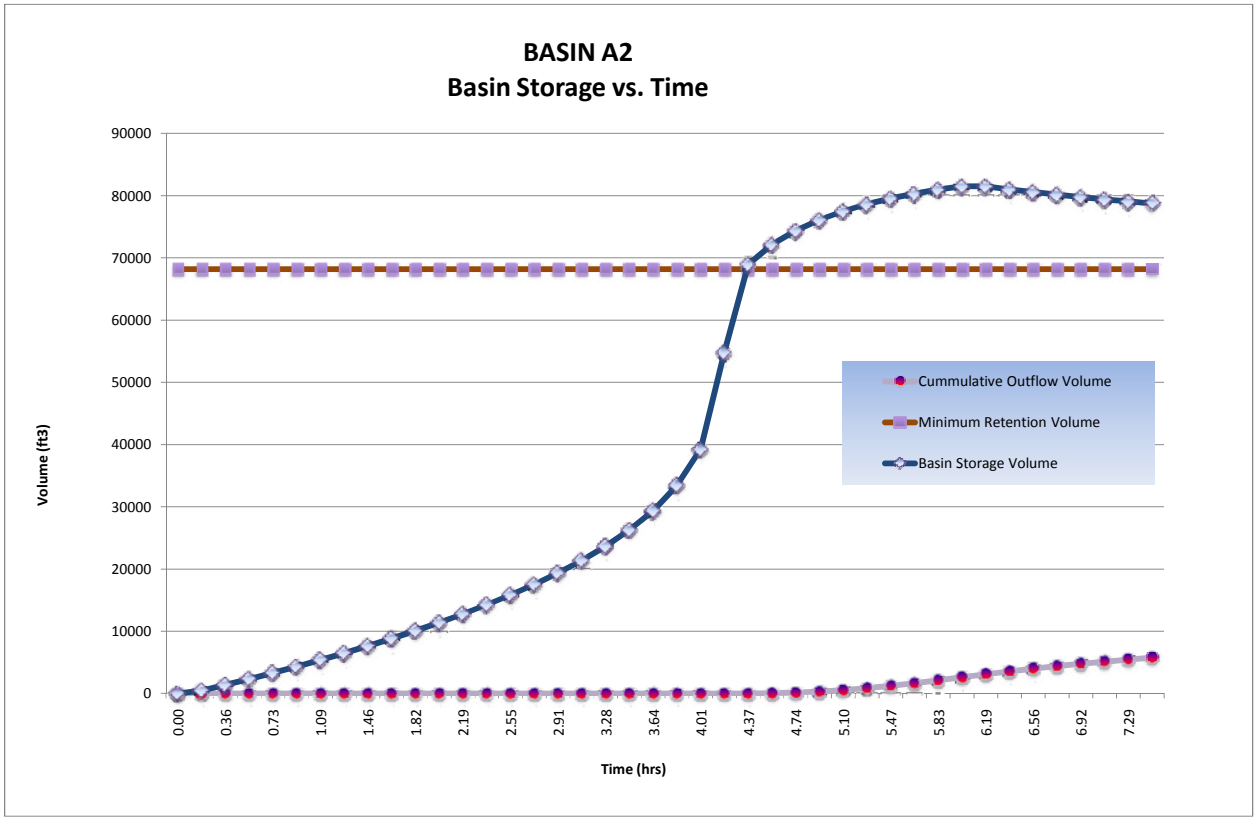
$$\frac{I_1 + I_2}{2} + \left(\frac{S_1}{\Delta t} - \frac{O_1}{2}\right) - O_1 - \left(\frac{S_2}{\Delta t} + \frac{O_2}{2}\right)$$

(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
0.18	1.40	0.70	0.00	0.00	0.70	0.00	459	0	0
0.36	1.40	1.40	0.70	0.00	2.10	0.00	1377	0	0
0.55	1.50	1.45	2.10	0.00	3.55	0.00	2328	0	0
0.73	1.50	1.50	3.55	0.00	5.05	0.00	3312	0	0
0.91	1.60	1.55	5.05	0.00	6.60	0.00	4329	0	0
1.09	1.60	1.60	6.60	0.00	8.20	0.00	5378	0	0
1.28	1.70	1.65	8.20	0.00	9.85	0.00	6460	0	0
1.46	1.80	1.75	9.85	0.00	11.60	0.00	7608	0	0
1.64	1.90	1.85	11.60	0.00	13.45	0.00	8821	0	0
1.82	1.90	1.90	13.45	0.00	15.35	0.00	10067	0	0
2.00	2.10	2.00	15.35	0.00	17.35	0.00	11379	0	0
2.19	2.20	2.15	17.35	0.00	19.50	0.00	12789	0	0
2.37	2.30	2.25	19.50	0.00	21.75	0.00	14264	0	0
2.55	2.50	2.40	21.75	0.00	24.15	0.00	15839	0	0
2.73	2.70	2.60	24.15	0.00	26.75	0.00	17544	0	0
2.91	2.90	2.80	26.75	0.00	29.55	0.00	19380	0	0
3.10	3.30	3.10	29.55	0.00	32.65	0.00	21413	0	0
3.28	3.60	3.45	32.65	0.00	36.10	0.00	23676	0	0
3.46	4.40	4.00	36.10	0.00	40.10	0.00	26299	0	0
3.64	5.00	4.70	40.10	0.00	44.80	0.00	29382	0	0
3.83	7.40	6.20	44.80	0.00	51.00	0.00	33448	0	0
4.01	10.20	8.80	51.00	0.00	59.80	0.00	39219	0	0
4.19	37.30	23.75	59.80	0.00	83.55	0.00	54795	0	0
4.37	5.90	21.60	83.55	0.00	105.15	0.00	68961	0	0
4.55	3.90	4.90	105.15	0.00	110.05	0.07	72152	46	46
4.74	3.10	3.50	110.05	0.07	113.48	0.14	74379	92	138
4.92	2.60	2.85	113.48	0.14	116.19	0.26	76117	171	308
5.10	2.30	2.45	116.19	0.26	118.38	0.38	77514	249	557
5.28	2.00	2.15	118.38	0.38	120.15	0.47	78645	308	866
5.47	1.80	1.90	120.15	0.47	121.58	0.55	79557	361	1226
5.65	1.70	1.75	121.58	0.55	122.78	0.62	80321	407	1633
5.83	1.60	1.65	122.78	0.62	123.81	0.70	80970	459	2092
6.01	1.50	1.55	123.81	0.70	124.66	0.77	81504	505	2597
6.19	0.00	0.75	124.66	0.77	124.64	0.77	81491	505	3102
6.38		0.00	124.64	0.77	123.87	0.71	81006	466	3568
6.56		0.00	123.87	0.71	123.16	0.65	80560	426	3994
6.74		0.00	123.16	0.65	122.51	0.60	80150	394	4388
6.92		0.00	122.51	0.60	121.91	0.56	79770	367	4755
7.10		0.00	121.91	0.56	121.35	0.53	79412	348	5102
7.29		0.00	121.35	0.53	120.82	0.51	79071	334	5437
7.47		0.00	120.82	0.51	120.31	0.48	78747	315	5752
7.65		0.00	120.31	0.48	119.83	0.45	78442	295	6047
7.83		0.00	119.83	0.45	119.38	0.43	78153	282	6329
8.02		0.00	119.38	0.43	118.95	0.41	77878	269	6598

Basin A2 Routing



Basin A2 Routing



Detention/Retention Basin Volume Required:	**81,504**	ft^3	
@ Stage:	**588.60**	ft	
Freeboard:	**1.0**	ft	Incl. >1' Freeboard
Final Total Basin Volume Provided:	**115,766**	ft^3	Basin **A2**
Maximum flow rate released from this basin:	**0.77**	cfs	

B2 Onsite D.A. Table

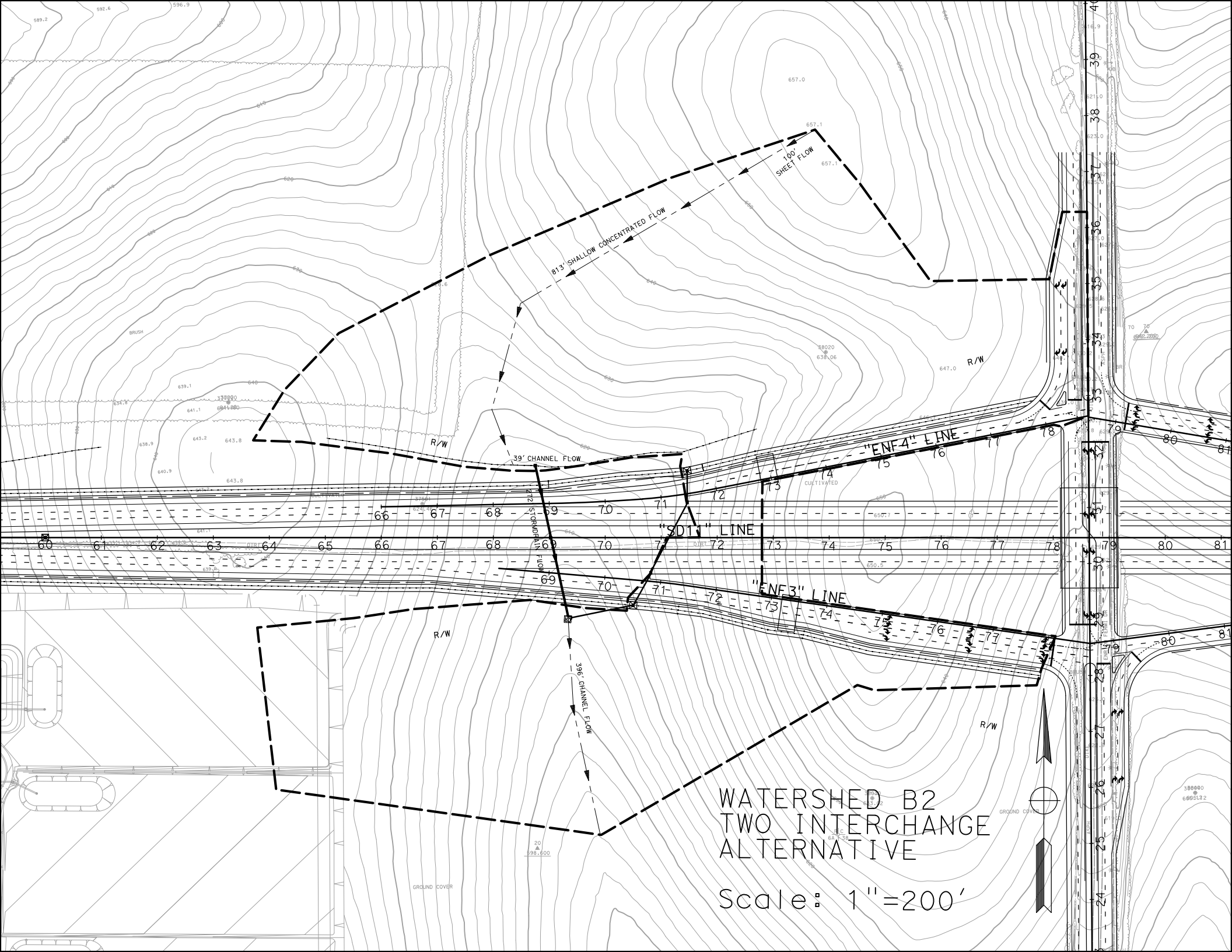
PROJECT:	**SR-11**			**DESCRIPTION:**	**On-site Drainage Areas (D.A.)**
JOB #:	**11A1190**			**STATION:**	**~**
BY:	**M.BRUNING**	**DATE:**	**01.04.10**	**WATERSHED:**	**B2**
CHK:	**G.DALZIEL**	**DATE:**		**SYSTEM:**	**Two Interchange Option**

						Caltrans	Caltrans	County	County					
			Area		Tc	i_{25}	Q_{25}	i_{100}	Q_{100}	Drains to:				
	Name	C	*SF*	*Acres*	*min*	*in/hr*	*cfs*	*in/hr*	*cfs*	Bioswale	Inlet	Destination	@ Station	Offset
PAVED	B2.1.PV	0.99	5200	0.1	10	2.8	0.33	4.2	0.50	B2.1	B2.1	*bypass**	71+50	ENF4
	B2.2.PV	0.99	42500	1.0	10	2.8	2.73	4.2	4.07	B2.2	B2.2	*bypass**	70+50	ENF3
	B2.3.PV	0.99	8100	0.2	5	4.0	0.74	6.6	1.21	~	B2.2	*bypass**	71+50	Lt
	B2.4.PV	0.99	12100	0.3	5	4.0	1.10	6.6	1.81	~	B2.2	*bypass**	71+00	Rt
		Σ	67900	*PAVED*										

						Caltrans	Caltrans	County	County					
			Area		Tc	i_{25}	Q_{25}	i_{100}	Q_{100}	Drains to:				
	Name	C	*SF*	*Acres*	*min*	*in/hr*	*cfs*	*in/hr*	*cfs*	Bioswale	Inlet	Destination	@ Station	Offset
SLOPE	B2.1.SL	0.61	41200	0.9	10	2.8	1.63	4.2	2.43	B2.1	B2.1	*bypass**	71+50	ENF4
	B2.2.SL	0.61	42300	1.0	10	2.8	1.68	4.2	2.50	B2.2	B2.2	*bypass**	70+50	ENF3
		Σ	83500	*SLOPE*										

**flow that does not reach the basin*

Total :	151400	3.5
	SF	*ac*


100' SHEET FLOW
813' SHALLOW CONCENTRATED FLOW
39' CHANNEL FLOW
812' STORMDRAIN FLOW
396' CHANNEL FLOW
"ENF4" LINE
"SD11" LINE
"ENF3" LINE
R/W
BRUSH
CULTIVATED
DIRT
GROUND COVER
WATERSHED B2
TWO INTERCHANGE
ALTERNATIVE
Scale: 1"=200'

B2 Post-Developed TcQ

PROJECT:	**SR-11**			**DESCRIPTION:**	**SR-11 Post-Developed**
JOB #:	**11A1190**			**STATION:**	**69+00**
BY:	**M.BRUNING**	**DATE:**	**01.04.10**	**WATERSHED:**	**B2**
CHK:	**G.DALZIEL**	**DATE:**		**SYSTEM:**	**Two Interchange Option**

BASIN AREA:

A = 984937 ft^2 / 22.61 acres **SOURCE:** MICROSTATION/USGS (SCALE = 1:1)

COEFFICIENT OF RUNOFF:

KEY: User Input | Designer Tool

UNDEVELOPED AREA C (FROM HDM FIG. 819.2A)

NOTES:

RELIEF (.08-.35)	0.14	Rolling Slopes ~ 5%
INFILTRATION (.04-.16)	0.12	Negligible infiltration capacity - see Geotechnical Report
VEGETATION (.04-.16)	0.08	Fair natural cover
STORAGE (.04-.12)	0.08	Low
TOTAL C =	0.42	

UNDEVELOPED AREA	85%	AT	0.42	0.355
PAVED SURFACE	7%	AT	0.90	0.062
COMMERCIAL AREA	0%	AT	0.85	0.000
CUT SLOPE (2:1 and 4:1)	8%	AT	0.55	0.047
TOTAL	100%			
	(100%)			

$C_{2,10}$ =	0.46
C_{25} =	0.51
C_{50} =	0.56
C_{100} =	0.58

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	657.1	ft	northern peak
LOW POINT ELEVATION	654.0	ft	
ELEVATION DIFF (H)	3.1	ft	
LENGTH (L)	100	ft	
SLOPE (S) = (H/L)	3.1%		
MANNING'S n	0.150		< = FROM TABLE 816.6A — short grass prarie
T_t (SFF)=	10.96	minutes	

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

NOTES:

HIGH PT ELEVATION	654.0	ft	northern peak
LOW POINT ELEVATION	615.0	ft	
ELEVATION DIFF (H)	39.0	ft	
LENGTH (L)	813	ft	to slope ditch
SLOPE (S) = (H/L)	4.8%		
VELOCITY (SCF)	1.5	fps	V FROM FIG 816.6 — short grass
T_C (SH)=	9.03	minutes	

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

NOTES:

HIGH PT ELEVATION	615.0	ft	Slope Ditch
LOW POINT ELEVATION	614.5	ft	CHANNEL DATA — TYPE = TRAP'Z
ELEVATION DIFF (H)	0.5	ft	Z= 2 — ANG-RAD 0.464
LENGTH (L)	39	ft	b = 2 — ANG-DEG 26.565
SLOPE (S) = (H/L)	1.3%		d = 0.5 — FLOWING FULL ASS'M
MANNING'S n	0.015		Concrete-rough
HYDRAULIC RADIUS R	0.35	ft	R=(bdsinA+d^2cosA)/(bsinA+2d)
VELOCITY (CHANNEL)	5.63	fps	From Manning's Equation assuming flowing full: $V=1.49/n(R^{2/3}S^{1/2})$
T_C (CH)=	0.12	minutes	

B2 Post-Developed TcQ

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

			NOTES:
HIGH PT ELEVATION	614.5	ft	Cross Culvert
LOW POINT ELEVATION	605.0	ft	
ELEVATION DIFF (H)	9.5	ft	
LENGTH (L)	272	ft	
SLOPE (S) = (H/L)	3.5%		
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)	17.7	fps	$V = \frac{K_u}{n} R^{2/3} S^{1/2}$
T_C (SD)=	0.26	minutes	

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

			NOTES:
HIGH PT ELEVATION	605.0	ft	Begins to form natural channel
LOW POINT ELEVATION	594.0	ft	
ELEVATION DIFF (H)	11.0	ft	
LENGTH (L)	396	ft	
SLOPE (S) = (H/L)	2.8%		
MANNING'S n	0.080		grass
HYDRAULIC RADIUS R	0.4	ft	R=(bdsinA+d^2cosA)/(bsinA+2d)
VELOCITY (CHANNEL)	1.72	fps	From Manning's Equation assuming flowing full: $V=1.49/n(R^{2/3}S^{1/2})$
T_C (CH)=	3.83	minutes	

CHANNEL DATA		TYPE =	TRAP'Z
Z=	5	ANG-RAD	0.197
b =	10	ANG-DEG	11.310
d =	0.5	FLOWING FULL ASS'M	

Tc (TOTAL) =	24.20	minutes
Minimum Tc =	10	minutes
USE Tc =	**24.20**	minutes

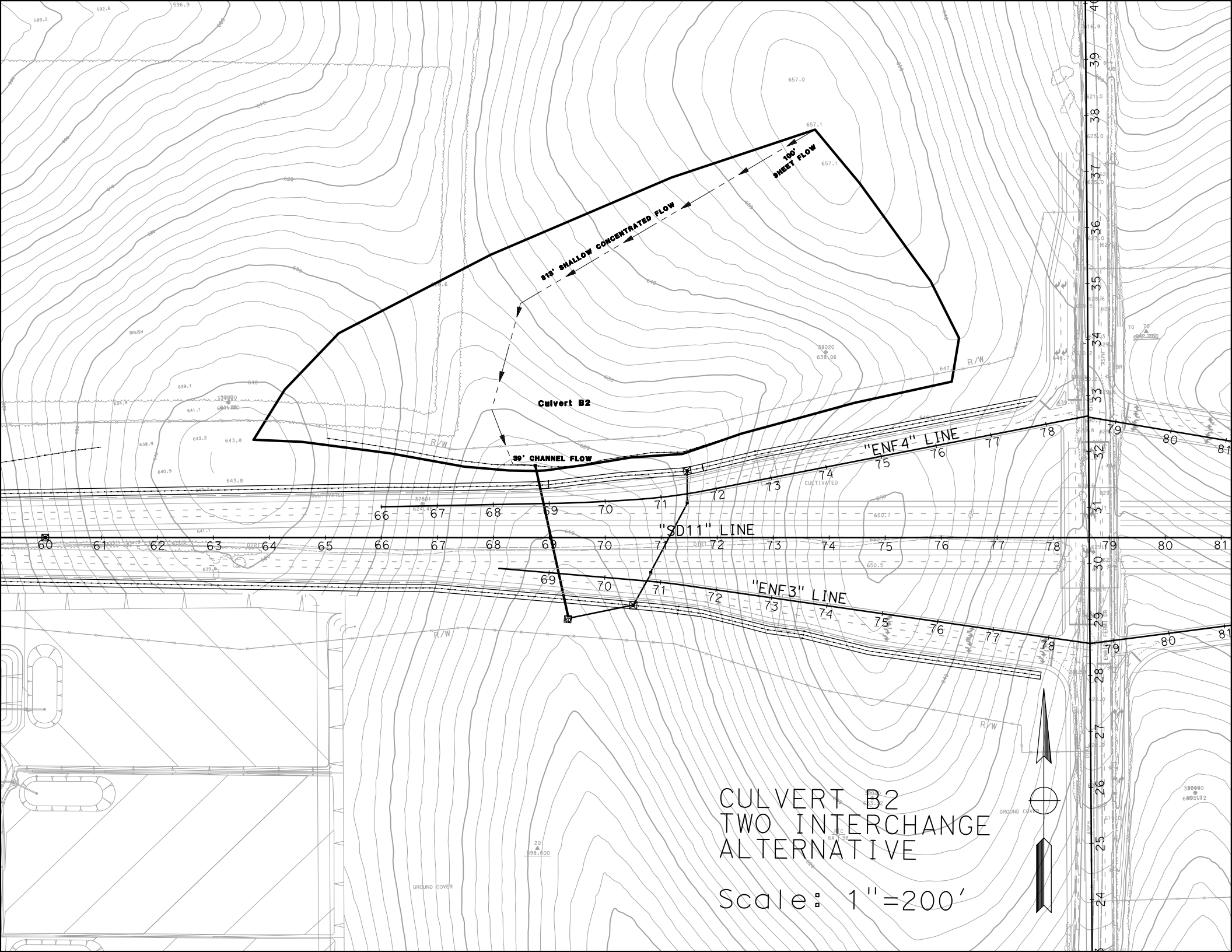
INTENSITY CHART: $I = 7.44\,P_6\,D^{-0.645}$

i_2 =	1.0	in/hr	X CA =	**Q_2 =**	11.0
i_{10} =	1.5	in/hr	X CA =	**Q_{10} =**	16.0
i_{25} =	1.9	in/hr	X CA =	**Q_{25} =**	22.0
i_{50} =	2.3	in/hr	X CA =	**Q_{50} =**	28.8
i_{100} =	2.4	in/hr	X CA =	**Q_{100} =**	**31.2**

FLOW RESULTS: (cfs)

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 B2
TWO INTERCHANGE ALTERNATIVE

Scale: 1"=200'

Culvert Calculator Report
B2 10-yr

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	616.50	ft	Headwater Depth/Height	0.74	
Computed Headwater Elevation	615.97	ft	Discharge	6.90	cfs
Inlet Control HW Elev.	615.80	ft	Tailwater Elevation	605.55	ft
Outlet Control HW Elev.	615.97	ft	Control Type	Entrance Control	

Grades					
Upstream Invert	614.50	ft	Downstream Invert	605.00	ft
Length	272.00	ft	Constructed Slope	3.5	%

Hydraulic Profile					
Profile	S2		Depth, Downstream	0.55	ft
Slope Type	Steep		Normal Depth	0.55	ft
Flow Regime	Supercritical		Critical Depth	0.93	ft
Velocity Downstream	9.92	ft/s	Critical Slope	0.5	%

Section			
Section Shape	Circular	Mannings Coefficient	0.013
Section Material	Concrete	Span	2.00 ft
Section Size	24 inch	Rise	2.00 ft
Number Sections	1		

Outlet Control Properties					
Outlet Control HW Elev.	615.97	ft	Upstream Velocity Head	0.36	ft
Ke	0.50		Entrance Loss	0.18	ft

Inlet Control Properties					
Inlet Control HW Elev.	615.80	ft	Flow Control	Unsubmerged	
Inlet Type	Square edge w/headwall		Area Full	3.1	ft²
K	0.00980		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	1	
C	0.03980		Equation Form	1	
Y	0.67000				

Culvert Calculator Report
B2 100-yr

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	617.00	ft	Headwater Depth/Height	1.12	
Computed Headwater Elevation	616.74	ft	Discharge	13.90	cfs
Inlet Control HW Elev.	616.60	ft	Tailwater Elevation	605.79	ft
Outlet Control HW Elev.	616.74	ft	Control Type	Entrance Control	

Grades					
Upstream Invert	614.50	ft	Downstream Invert	605.00	ft
Length	272.00	ft	Constructed Slope	3.5	%

Hydraulic Profile					
Profile	S2		Depth, Downstream	0.79	ft
Slope Type	Steep		Normal Depth	0.79	ft
Flow Regime	Supercritical		Critical Depth	1.34	ft
Velocity Downstream	12.06	ft/s	Critical Slope	0.6	%

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	2.00	ft
Section Size	24 inch		Rise	2.00	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	616.74	ft	Upstream Velocity Head	0.60	ft
Ke	0.50		Entrance Loss	0.30	ft

Inlet Control Properties					
Inlet Control HW Elev.	616.60	ft	Flow Control	Unsubmerged	
Inlet Type	Square edge w/headwall		Area Full	3.1	ft²
K	0.00980		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	1	
C	0.03980		Equation Form	1	
Y	0.67000				

B2 Culvert TcQ

PROJECT:	**SR-11**			**DESCRIPTION:**	**SR-11 Post-Developed**
JOB #:	**11A1190**			**STATION:**	**69+00**
BY:	**M.BRUNING**	**DATE:**	**01.04.10**	**WATERSHED:**	**B2 Culvert**
CHK:	**G.DALZIEL**	**DATE:**		**SYSTEM:**	**B2 Culvert**

BASIN AREA:

A =	**446229**	**ft^2**	**SOURCE:**	**MICROSTATION/USGS**
	10.24	**acres**		**(SCALE = 1:1)**

COEFFICIENT OF RUNOFF:

KEY: User Input | Designer Tool

UNDEVELOPED AREA C (FROM HDM FIG. 819.2A)

NOTES:

RELIEF (.08-.35)	0.14	Rolling Slopes ~ 5%
INFILTRATION (.04-.16)	0.12	Negligible infiltration capacity - see Geotechnical Report
VEGETATION (.04-.16)	0.08	Fair natural cover
STORAGE (.04-.12)	0.08	Low
TOTAL C =	0.42	

UNDEVELOPED AREA	100%	AT	0.42	0.420
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%)			

$C_{2,10}$ =	0.42
C_{25} =	0.46
C_{50} =	0.50
C_{100} =	0.53

TIME OF CONCENTRATION:

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

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

HIGH PT ELEVATION	657.1	ft	northern peak
LOW POINT ELEVATION	654.0	ft	
ELEVATION DIFF (H)	3.1	ft	
LENGTH (L)	100	ft	
SLOPE (S) = (H/L)	3.1%		
MANNING'S n	0.150		< = FROM TABLE 816.6A — short grass prarie
T_t (SFF)=	10.96	minutes	

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

NOTES:

HIGH PT ELEVATION	654.0	ft	northern peak
LOW POINT ELEVATION	615.0	ft	
ELEVATION DIFF (H)	39.0	ft	
LENGTH (L)	813	ft	
SLOPE (S) = (H/L)	4.8%		
VELOCITY (SCF)	1.5	fps	V FROM FIG 816.6 — short grass
T_C (SH)=	9.03	minutes	

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

NOTES:

HIGH PT ELEVATION	615.0	ft	Slope Ditch
LOW POINT ELEVATION	614.5	ft	CHANNEL DATA — TYPE = TRAP'Z
ELEVATION DIFF (H)	0.5	ft	Z= 2 — ANG-RAD 0.464
LENGTH (L)	39	ft	b = 2 — ANG-DEG 26.565
SLOPE (S) = (H/L)	1.3%		d = 0.5 — FLOWING FULL ASS'M
MANNING'S n	0.015		Concrete-rough
HYDRAULIC RADIUS R	0.35	ft	R=(bdsinA+d^2cosA)/(bsinA+2d)
VELOCITY (CHANNEL)	5.63	fps	From Manning's Equation assuming flowing full: $V=1.49/n(R^{2/3}S^{1/2})$
T_C (CH)=	0.12	minutes	

B2 Culvert TcQ

Tc (TOTAL) =	20.11	minutes
Minimum Tc =	10	minutes
USE T_C =	**20.11**	minutes

INTENSITY CHART: Caltrans IDF2000

i_2 =	0.8	in/hr	X CA =	**Q_2 =**	3.7
i_{10} =	1.6	in/hr	X CA =	**Q_{10} =**	6.9
i_{25} =	2.0	in/hr	X CA =	**Q_{25} =**	9.4
i_{50} =	2.3	in/hr	X CA =	**Q_{50} =**	11.8
i_{100} =	2.6	in/hr	X CA =	**Q_{100} =**	**13.9**

FLOW RESULTS

cfs

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 B2 Retention

PROJECT:	**SR-11**			**DESCRIPTION:**	**SR-11 Basin**
JOB #:	**11A1190**			**STATION:**	**69+00**
BY:	**M.BRUNING**	**DATE:**	**01.04.10**	**WATERSHED:**	**B2**
CHK:	**G.DALZIEL**	**DATE:**		**SYSTEM:**	**Two Interchange Option**

Notes:

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

RETENTION VOLUME

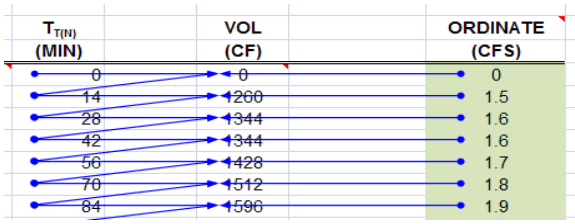
100-year, 6 hour duration storm event, use the Rational Method Hydrograph Procedure (SDCHM 6-1) ~ RatHydro

Pre-Developed volume calculations

Q_{100}=	30.8	cfs			
Tc=	26.2	min	C=	0.53	
$P_{100,6}$=	2.5	in	A=	25.94	acres

$T_{T(N)}$ (MIN)	VOL (CF)	ORDINATE (CFS)
0	0	0
26	3276	2.1
52	3588	2.3
78	3744	2.4
104	4368	2.8
130	4680	3
156	5772	3.7
182	6552	4.2
208	9672	6.2
234	14352	9.2
260	48048	30.8
286	7800	5
312	5148	3.3
338	4056	2.6
364	3432	2.2
390	0	0

Example of Steps:



SUM= 124488 ft^3
2.86 acre-feet

Check: $V = C*A*P_6$
V= 2.84 acre-feet
OK

Basin B2 Retention

Post-Developed volume calculations

Q_{100}=	31.2	cfs			
Tc=	24.2	min	C=	0.58	
$P_{100,6}$=	2.5	in	A=	22.61	acres

$T_{T(N)}$ (MIN)	VOL (CF)	ORDINATE (CFS)
0	0	0
24	2880	2
48	3024	2.1
72	3312	2.3
96	3456	2.4
120	4032	2.8
144	4320	3
168	5328	3.7
192	6048	4.2
216	8928	6.2
240	12960	9
264	44928	31.2
288	7200	5
312	4752	3.3
336	3744	2.6
360	3168	2.2
384	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= 118080 ft^3
2.71 acre-feet

Check: $V = C*A*P_6$
V= 2.73 acre-feet
OK

	2.71	*(Post)*			
-	**2.86**	*(Pre)*			
Retention volume =	**-0.15**	**acre-feet**	**=**	**-6408 ft^3**	**No Basin Required**

Basin B2 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}= 0.99
A= 1.56 acres

WQ_{72}: 0.73 in/area

Water Quality Volume (WQV) = **4131** **ft^3**

Treatment within biofiltration swales

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

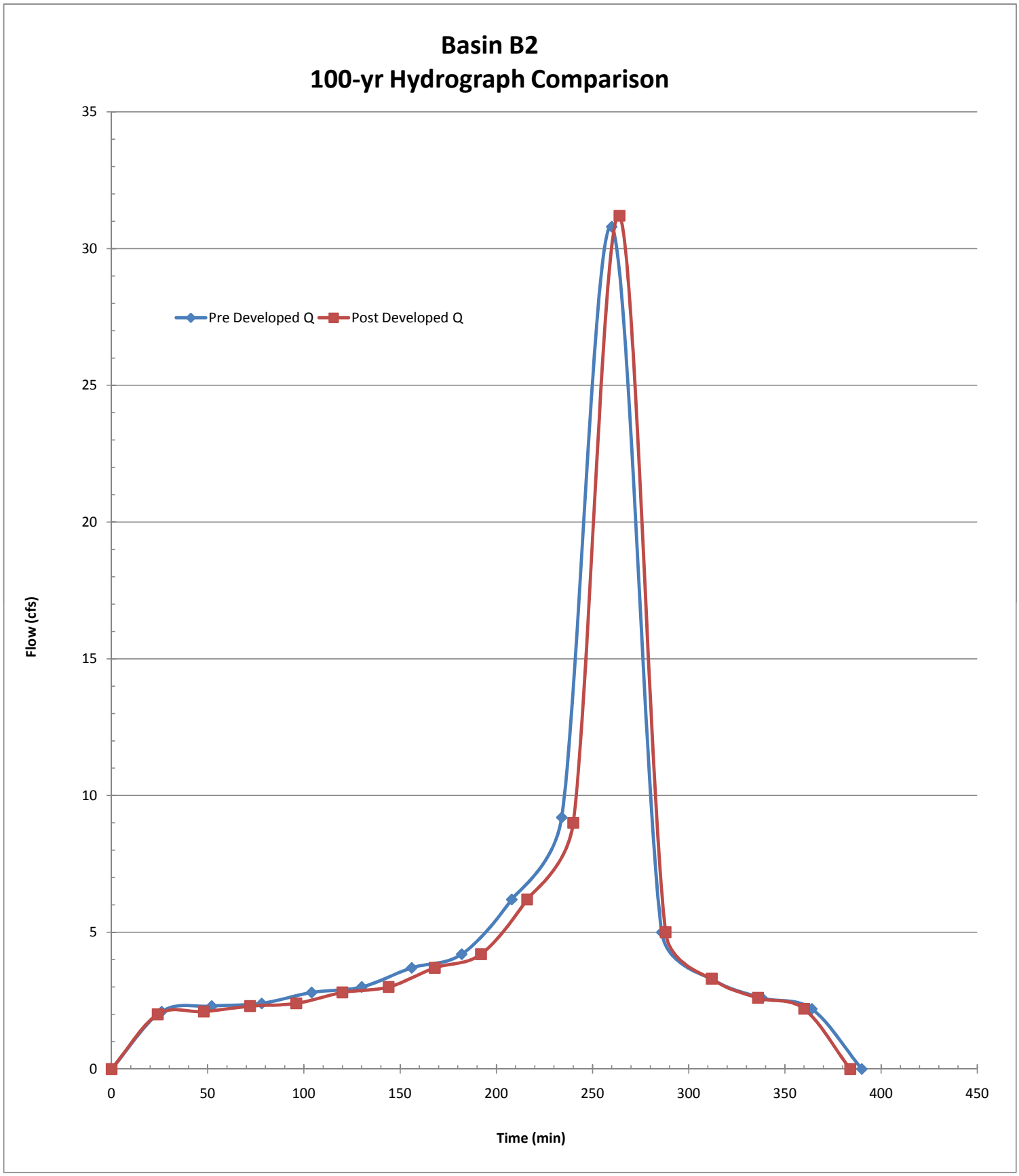
Onsite Highway *Sloped* runoff area, A:		83500	ft^2
	A:	1.92	acres
		10.00	years
where:	R=	30.00	
	K=	0.24	
	Ls=	18.00	
	C=	0.012	
	P=	1.00	
	As	1.56	tons/yr*Ac

Volume for 10-year Silt Accumulation = 29.81 tons

Silt Accumulation Basin volume = **662** **ft^3**

Silt extracted within biofiltration swale

.


Basin B2
100-yr Hydrograph Comparison
Pre Developed Q
Post Developed Q
Flow (cfs)
Time (min)
0
5
10
15
20
25
30
35
0
50
100
150
200
250
300
350
400
450

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C2 Onsite D.A. Table

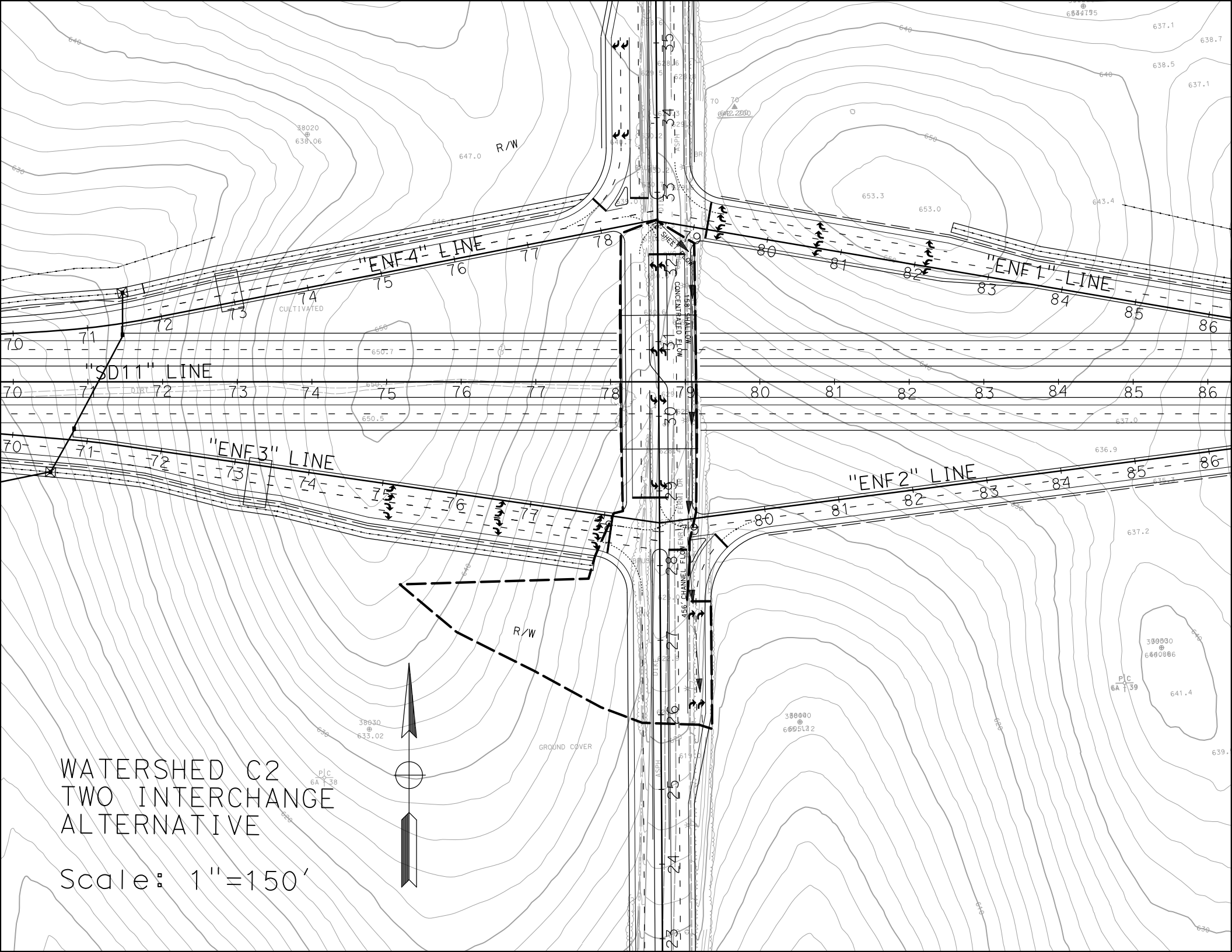
PROJECT:	**SR-11**	**DESCRIPTION:**	**On-site Drainage Areas (D.A.)**
JOB #:	**11A1190**	**STATION:**	**~**
BY:	**M.BRUNING** **DATE:** **01.04.10**	**WATERSHED:**	**C2**
CHK:	**G.DALZIEL** **DATE:**	**SYSTEM:**	**Two Interchange Option**

						Caltrans	Caltrans	County	County					
			Area		Tc	i_{25}	Q_{25}	i_{100}	Q_{100}	Drains to:				
	Name	C	*SF*	*Acres*	*min*	*in/hr*	*cfs*	*in/hr*	*cfs*	Bioswale	Inlet	Destination	@ Station	Offset
PAVED	C2.1.PV	0.99	34100	0.8	5	4.0	3.10	6.6	5.10	~	C2.1	*bypass**	26+00	ENF
	C2.2.PV	0.99	35100	0.8	5	4.0	3.19	6.6	5.25	~	C2.2	*bypass**	26+00	ENF
		Σ	69200	*PAVED*										

						Caltrans	Caltrans	County	County					
			Area		Tc	i_{25}	Q_{25}	i_{100}	Q_{100}	Drains to:				
	Name	C	*SF*	*Acres*	*min*	*in/hr*	*cfs*	*in/hr*	*cfs*	Bioswale	Inlet	Destination	@ Station	Offset
SLOPE	C2.1.SL	0.61	32600	0.7	5	4.0	1.83	6.6	3.01	~	C2.1	*bypass**	26+00	ENF
		Σ	32600	*SLOPE*										

**flow that does not reach the basin*

Total :	101800	2.3
	SF	*ac*


"ENF4" LINE
"ENF1" LINE
"SD11" LINE
"ENF3" LINE
"ENF2" LINE
R/W
R/W
CULTIVATED
DIRT
GROUND COVER
CONCENTRATED FLOW
SHEET FLOW
466' CHANNEL FLOW
FERMT DR
ASPH
WATERSHED C2
TWO INTERCHANGE
ALTERNATIVE
Scale: 1"=150'

C2 Post-Developed TcQ

PROJECT:	**SR-11**			**DESCRIPTION:**	**SR-11 Post-Developed**
JOB #:	**11A1190**			**STATION:**	**78+00**
BY:	**M.BRUNING**	**DATE:**	**01.04.10**	**WATERSHED:**	**C2**
CHK:	**G.DALZIEL**	**DATE:**		**SYSTEM:**	**Two Interchange Option**

BASIN AREA:

A = 101800 ft^2 | 2.34 acres

SOURCE: MICROSTATION/USGS (SCALE = 1:1)

COEFFICIENT OF RUNOFF:

KEY: User Input | Designer Tool

UNDEVELOPED AREA C (FROM HDM FIG. 819.2A)

NOTES:

RELIEF (.08-.35)	0.14	Rolling Slopes ~ 5%
INFILTRATION (.04-.16)	0.12	Negligible infiltration capacity - see Geotechnical Report
VEGETATION (.04-.16)	0.08	Fair natural cover
STORAGE (.04-.12)	0.08	Low
TOTAL C =	0.42	

UNDEVELOPED AREA	32%	AT	0.42	0.134
PAVED SURFACE	68%	AT	0.90	0.612
COMMERCIAL AREA	0%	AT	0.85	0.000
CUT SLOPE (2:1 and 4:1)	0%	AT	0.55	0.000
TOTAL	100%			
	(100%)			

$C_{2,10}$ =	0.75
C_{25} =	0.82
C_{50} =	0.90
C_{100} =	0.93

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	632.0	ft	High Point on Enrico Fermi, north of SR-11
LOW POINT ELEVATION	631.0	ft	
ELEVATION DIFF (H)	1.0	ft	
LENGTH (L)	70	ft	
SLOPE (S) = (H/L)	1.4%		
MANNING'S n	0.016		< = From Table 816.6A Asphalt
T_t (SFF)=	1.88	minutes	

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

NOTES:

HIGH PT ELEVATION	631.0	ft	Eastern Gutter of Enrico Fermi, north of SR-11
LOW POINT ELEVATION	629.0	ft	Caltrans ROW
ELEVATION DIFF (H)	2.0	ft	
LENGTH (L)	158	ft	
SLOPE (S) = (H/L)	1.3%		
VELOCITY (SCF)	1.5	fps	V FROM FIG 816.6 nearly bare ground
T_C (SH)=	1.76	minutes	

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

NOTES:

HIGH PT ELEVATION	629.0	ft	Enrico Fermi Gutter - east
LOW POINT ELEVATION	620.0	ft	CHANNEL DATA TYPE = TRAP'Z
ELEVATION DIFF (H)	9.0	ft	Z= 12 ANG-RAD 0.083
LENGTH (L)	456	ft	b = 2 ANG-DEG 4.764
SLOPE (S) = (H/L)	2.0%		d = 0.25 FLOWING FULL ASS'M
MANNING'S n	0.015		Gutter
HYDRAULIC RADIUS R	0.16	ft	R=(bdsinA+d^2cosA)/(bsinA+2d)
VELOCITY (CHANNEL)	4.04	fps	From Manning's Equation assuming flowing full: $V=1.49/n(R^{2/3}S^{1/2})$
T_C (CH)=	1.88	minutes	

C2 Post-Developed TcQ

Tc (TOTAL) =	5.51	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 =	**Q_2 =** 3.2
i_{10} =	2.7	in/hr	X CA =	**Q_{10} =** 4.7
i_{25} =	3.4	in/hr	X CA =	**Q_{25} =** 6.5
i_{50} =	4.0	in/hr	X CA =	**Q_{50} =** 8.5
i_{100} =	4.2	in/hr	X CA =	**Q_{100} =** **9.2**

FLOW RESULTS:

	cfs
Q_2 =	3.2
Q_{10} =	4.7
Q_{25} =	6.5
Q_{50} =	8.5
Q_{100} =	**9.2**

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 C2 Retention

PROJECT:	SR-11			**DESCRIPTION:**	SR-11 Basin
JOB #:	11A1190			**STATION:**	78+00
BY:	M.BRUNING	**DATE:**	01.04.10	**WATERSHED:**	C2
CHK:	G.DALZIEL	**DATE:**		**SYSTEM:**	Two Interchange Option

Notes:

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

RETENTION VOLUME

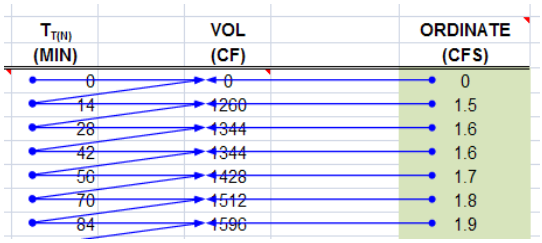
100-year, 6 hour duration storm event, use the Rational Method Hydrograph Procedure (SDCHM 6-1) ~ RatHydro

Pre-Developed volume calculations

Q_{100}=	16.4	cfs			
Tc=	10.0	min	C=	0.60	
$P_{100,6}$=	2.5	in	A=	6.49	acres

$T_{T(N)}$ (MIN)	VOL (CF)	ORDINATE (CFS)
0	0	0
10	360	0.6
20	360	0.6
30	360	0.6
40	360	0.6
50	420	0.7
60	420	0.7
70	420	0.7
80	420	0.7
90	480	0.8
100	480	0.8
110	480	0.8
120	540	0.9
130	540	0.9
140	600	1
150	600	1
160	660	1.1
170	720	1.2
180	780	1.3
190	900	1.5
200	960	1.6
210	1140	1.9
220	1320	2.2
230	1920	3.2
240	2760	4.6
250	9840	16.4
260	1560	2.6
270	1020	1.7
280	840	1.4
290	660	1.1
300	600	1
310	540	0.9
320	480	0.8
330	420	0.7
340	420	0.7
350	360	0.6
360	360	0.6
370	0	0

Example of Steps:



SUM= 35100 ft^3
0.81 acre-feet

Check: $V = C*A*P_6$
V= 0.81 acre-feet
OK

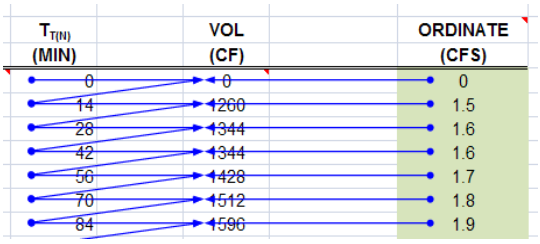
Basin C2 Retention

Post-Developed volume calculations

Q_{100}=	9.2	cfs			
Tc=	10.0	min	C=	0.93	
$P_{100,6}$=	2.5	in	A=	2.34	acres

$T_{T(N)}$ (MIN)	VOL (CF)	ORDINATE (CFS)
0	0	0
10	180	0.3
20	180	0.3
30	180	0.3
40	240	0.4
50	240	0.4
60	240	0.4
70	240	0.4
80	240	0.4
90	240	0.4
100	240	0.4
110	300	0.5
120	300	0.5
130	300	0.5
140	300	0.5
150	360	0.6
160	360	0.6
170	420	0.7
180	420	0.7
190	480	0.8
200	540	0.9
210	660	1.1
220	720	1.2
230	1080	1.8
240	1500	2.5
250	5520	9.2
260	900	1.5
270	600	1
280	480	0.8
290	360	0.6
300	360	0.6
310	300	0.5
320	240	0.4
330	240	0.4
340	240	0.4
350	240	0.4
360	180	0.3
370	0	0

Example of Steps:



SUM= 19620 ft^3
0.45 acre-feet

Check: $V = C*A*P_6$
V= 0.45 acre-feet
OK

		0.45	*(Post)*		
	-	**0.81**	*(Pre)*		
Retention volume =		**-0.36**	**acre-feet**	**=**	**-15480 ft^3**

No Basin Required

Basin C2 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}= 0.99
A= 1.59 acres

WQ_{72}: 0.73 in/area

Water Quality Volume (WQV) = **4210** **ft^3**

Treatment within biofiltration swales

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

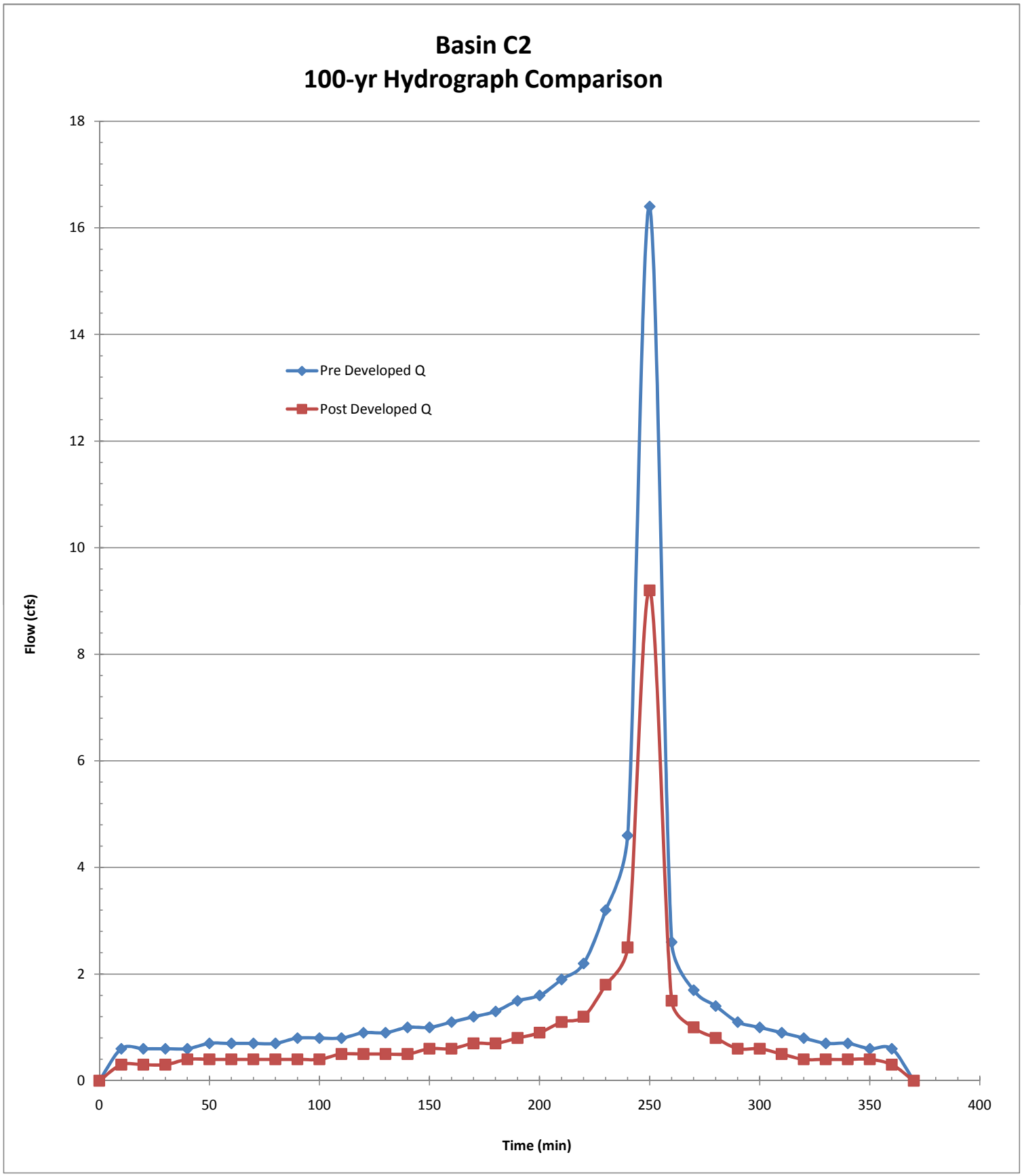
Onsite Highway *Sloped* runoff area, A:		32600	ft^2
	A:	0.75	acres
		10.00	years
where:	R=	30.00	
	K=	0.24	
	Ls=	18.00	
	C=	0.012	
	P=	1.00	
	As	1.56	tons/yr*Ac

Volume for 10-year Silt Accumulation = 11.64 tons

Silt Accumulation Basin volume = **259** **ft^3**

Silt extracted within biofiltration swale

.


Basin C2
100-yr Hydrograph Comparison
Pre Developed Q
Post Developed Q
Flow (cfs)
Time (min)
0
2
4
6
8
10
12
14
16
18
0
50
100
150
200
250
300
350
400

D2 Onsite D.A. Table

PROJECT:	**SR-11**			**DESCRIPTION:**	**On-site Drainage Areas (D.A.)**
JOB #:	**11A1190**			**STATION:**	**~**
BY:	**M.BRUNING**	**DATE:**	**01.04.10**	**WATERSHED:**	**D2**
CHK:	**G.DALZIEL**	**DATE:**		**SYSTEM:**	**Two Interchange Option**

PAVED

		Area			Caltrans	Caltrans	County	County	Drains to:				
Name	**C**	*SF*	*Acres*	*min*	i_{25} *in/hr*	Q_{25} *cfs*	i_{100} *in/hr*	Q_{100} *cfs*	Bioswale	Inlet	Destination	@ Station	Offset
~	0.99	0	0.0	0	~	~	~	~	~	~	~	~	~

Σ 0 *PAVED*

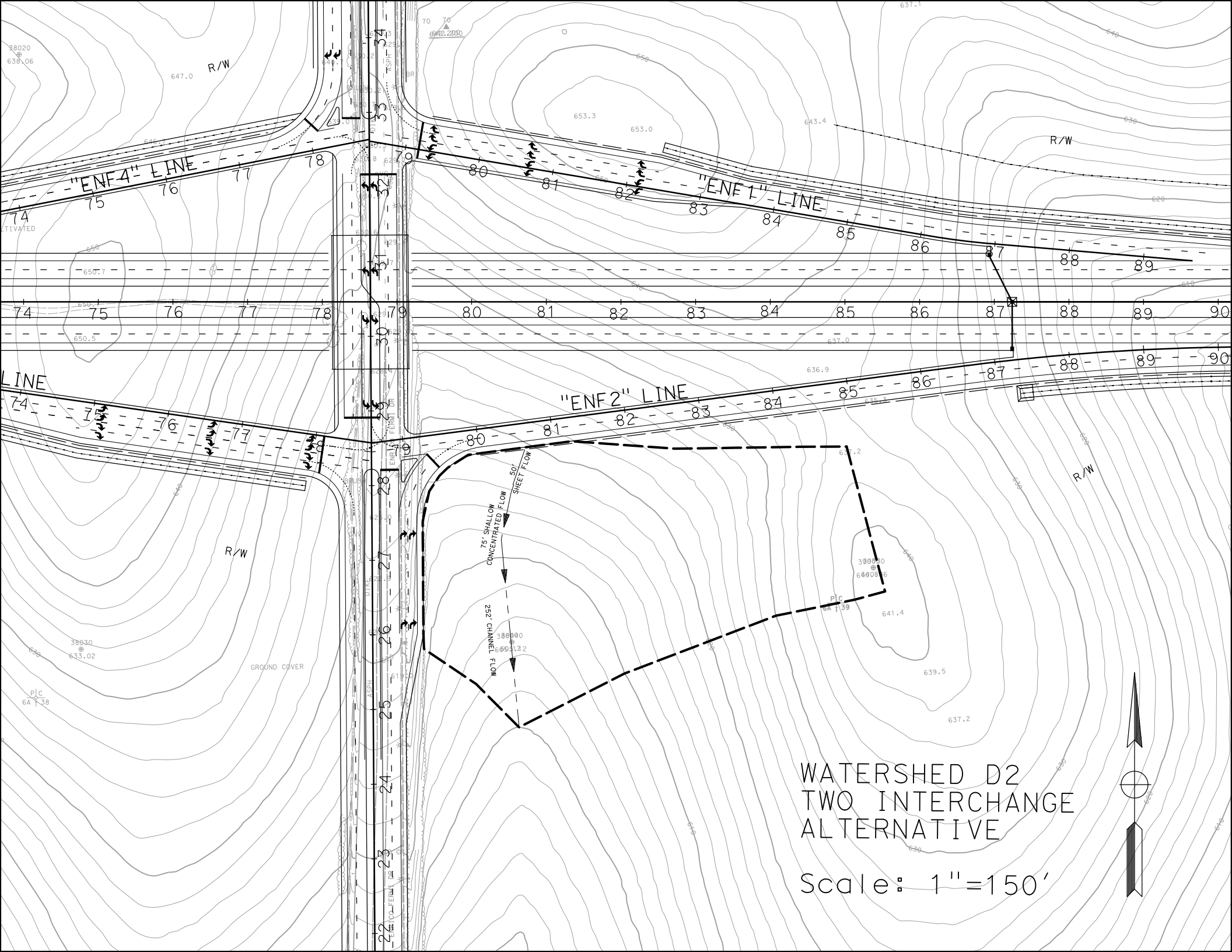
SLOPE

		Area			Caltrans	Caltrans	County	County	Drains to:				
Name	**C**	*SF*	*Acres*	*min*	i_{25} *in/hr*	Q_{25} *cfs*	i_{100} *in/hr*	Q_{100} *cfs*	Bioswale	Inlet	Destination	@ Station	Offset
D2.1.SL	0.61	166100	3.8	10	2.8	6.55	4.2	9.80	~	D2.1	**bypass*	26+00	ENF

Σ 166100 *SLOPE*

**flow that does not reach the basin*

Total :	166100	3.8
	SF	*ac*


"ENF4" LINE
"ENF1" LINE
"ENF2" LINE
R/W
GROUND COVER
75' SHALLOW CONCENTRATED FLOW
50' SHEET FLOW
252' CHANNEL FLOW
WATERSHED D2
TWO INTERCHANGE
ALTERNATIVE
Scale: 1"=150'

D2 Post-Developed TcQ

PROJECT:	**SR-11**			**DESCRIPTION:**	**SR-11 Post-Developed**
JOB #:	**11A1190**			**STATION:**	**81+00**
BY:	**M.BRUNING**	**DATE:**	**01.04.10**	**WATERSHED:**	**D2**
CHK:	**G.DALZIEL**	**DATE:**		**SYSTEM:**	**Two Interchange Option**

BASIN AREA:

A = **166100** **ft^2** | **3.81** **acres**

SOURCE: **MICROSTATION/USGS** **(SCALE = 1:1)**

COEFFICIENT OF RUNOFF:

KEY: User Input | Designer Tool

UNDEVELOPED AREA C (FROM HDM FIG. 819.2A)

		NOTES:
RELIEF (.08-.35)	0.14	Rolling Slopes ~ 5%
INFILTRATION (.04-.16)	0.12	Negligible infiltration capacity - see Geotechnical Report
VEGETATION (.04-.16)	0.08	Fair natural cover
STORAGE (.04-.12)	0.08	Low
TOTAL C =	0.42	

UNDEVELOPED AREA	100%	AT	0.42	0.420
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%)			

$C_{2,10}$ =	0.42
C_{25} =	0.46
C_{50} =	0.50
C_{100} =	0.53

TIME OF CONCENTRATION:

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

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

HIGH PT ELEVATION	620.0	ft	High Point in Watershed, south of SR-11
LOW POINT ELEVATION	618.0	ft	
ELEVATION DIFF (H)	2.0	ft	
LENGTH (L)	50	ft	
SLOPE (S) = (H/L)	4.0%		
MANNING'S n	0.100		< = From Table 816.6A — nearly bare ground
T_t (SFF)=	4.11	minutes	

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

NOTES:

HIGH PT ELEVATION	618.0	ft	
LOW POINT ELEVATION	612.0	ft	
ELEVATION DIFF (H)	6.0	ft	
LENGTH (L)	75	ft	
SLOPE (S) = (H/L)	8.0%		
VELOCITY (SCF)	2.8	fps	V FROM FIG 816.6 — nearly bare ground
T_C (SH)=	0.45	minutes	

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

NOTES:

HIGH PT ELEVATION	612.0	ft	begins to channelize
LOW POINT ELEVATION	600.0	ft	CHANNEL DATA — TYPE = TRAP'Z
ELEVATION DIFF (H)	12.0	ft	Z= 5 — ANG-RAD 0.197
LENGTH (L)	252	ft	b = 2 — ANG-DEG 11.310
SLOPE (S) = (H/L)	4.8%		d = 0.5 — FLOWING FULL ASS'M
MANNING'S n	0.150		short prairie grass
HYDRAULIC RADIUS R	0.3	ft	R=(bdsinA+d^2cosA)/(bsinA+2d)
VELOCITY (CHANNEL)	1.01	fps	From Manning's Equation assuming flowing full: $V=1.49/n(R^{2/3}S^{1/2})$
T_C (CH)=	4.17	minutes	

D2 Post-Developed TcQ

Tc (TOTAL) =	8.73	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 =	3.0
Q_{10} =	4.3
Q_{25} =	5.9
Q_{50} =	7.8
Q_{100} =	**8.4**

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 D2 Retention

PROJECT:	**SR-11**			**DESCRIPTION:**	**SR-11 Basin**
JOB #:	**11A1190**			**STATION:**	**81+00**
BY:	**M.BRUNING**	**DATE:**	**01.04.10**	**WATERSHED:**	**D2**
CHK:	**G.DALZIEL**	**DATE:**		**SYSTEM:**	**Two Interchange Option**

Notes:

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

RETENTION VOLUME

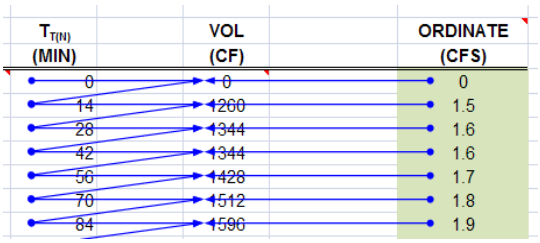
100-year, 6 hour duration storm event, use the Rational Method Hydrograph Procedure (SDCHM 6-1) ~ RatHydro

Pre-Developed volume calculations

Q_{100}=	18.5	cfs			
Tc=	11.0	min	C=	0.53	
$P_{100,6}$=	2.5	in	A=	8.89	acres

$T_{T(N)}$ (MIN)	VOL (CF)	ORDINATE (CFS)
0	0	0
11	462	0.7
22	462	0.7
33	462	0.7
44	528	0.8
55	528	0.8
66	528	0.8
77	594	0.9
88	594	0.9
99	594	0.9
110	660	1
121	660	1
132	726	1.1
143	792	1.2
154	792	1.2
165	924	1.4
176	990	1.5
187	1122	1.7
198	1188	1.8
209	1452	2.2
220	1650	2.5
231	2442	3.7
242	3564	5.4
253	12210	18.5
264	1980	3
275	1320	2
286	1056	1.6
297	858	1.3
308	726	1.1
319	660	1
330	594	0.9
341	528	0.8
352	528	0.8
363	462	0.7
374	0	0

Example of Steps:



SUM= 42636 ft^3
0.98 acre-feet

Check: $V = C*A*P_6$
V= 0.97 acre-feet
OK

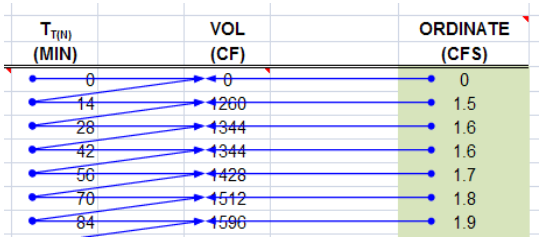
Basin D2 Retention

Post-Developed volume calculations

Q_{100}=	8.4	cfs			
Tc=	10.0	min	C=	0.53	
$P_{100,6}$=	2.5	in	A=	3.81	acres

$T_{T(N)}$ (MIN)	VOL (CF)	ORDINATE (CFS)
0	0	0
10	180	0.3
20	180	0.3
30	180	0.3
40	180	0.3
50	180	0.3
60	180	0.3
70	240	0.4
80	240	0.4
90	240	0.4
100	240	0.4
110	240	0.4
120	240	0.4
130	300	0.5
140	300	0.5
150	300	0.5
160	360	0.6
170	360	0.6
180	420	0.7
190	480	0.8
200	480	0.8
210	600	1
220	660	1.1
230	1020	1.7
240	1500	2.5
250	5040	8.4
260	780	1.3
270	540	0.9
280	420	0.7
290	360	0.6
300	300	0.5
310	300	0.5
320	240	0.4
330	240	0.4
340	240	0.4
350	180	0.3
360	180	0.3
370	0	0

Example of Steps:



SUM= 18120 ft^3
0.42 acre-feet

Check: $V = C*A*P_6$
V= 0.42 acre-feet
OK

	0.42	*(Post)*			
-	**0.98**	*(Pre)*			
Retention volume =	**-0.56**	**acre-feet**	**=**	**-24516 ft^3**	**No Basin Required**

Basin D2 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}= 0.99
A= 0.00 acres

WQ_{72}: 0.73 in/area

Water Quality Volume (WQV) = **0** **ft^3**

No pavement areas proposed in this watershed

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

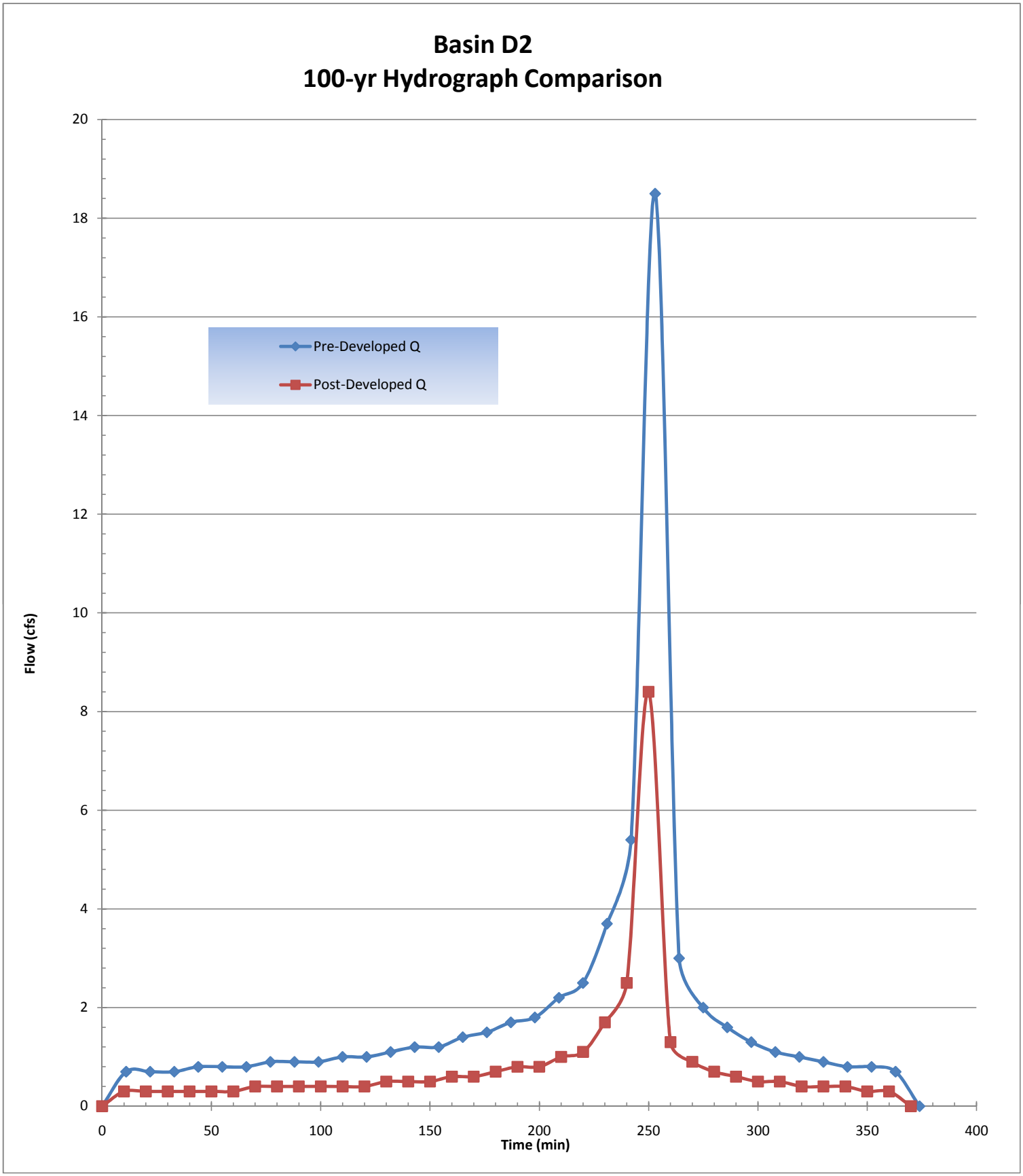
Onsite Highway *Sloped* runoff area, A:		166100	ft^2
	A:	3.81	acres
		10.00	years
where:	R=	30.00	
	K=	0.24	
	Ls=	18.00	
	C=	0.012	
	P=	1.00	
	As	1.56	tons/yr*Ac

Volume for 10-year Silt Accumulation = 59.30 tons

Silt Accumulation Basin volume = **1318** **ft^3**

These are existing Sloped Areas to remain

.


Basin D2
100-yr Hydrograph Comparison
Pre-Developed Q
Post-Developed Q
Flow (cfs)
Time (min)
0
2
4
6
8
10
12
14
16
18
20
0
50
100
150
200
250
300
350
400

E2 Onsite D.A. Table

PROJECT:	**SR-11**	**DESCRIPTION:**	**Onsite Drainage Areas (D.A.)**
JOB #:	**11A1190**	**STATION:**	**~**
BY:	**M.BRUNING** **DATE:** **01.06.10**	**WATERSHED:**	**E2**
CHK:	**G.DALZIEL** **DATE:**	**SYSTEM:**	**Two Interchange Option**

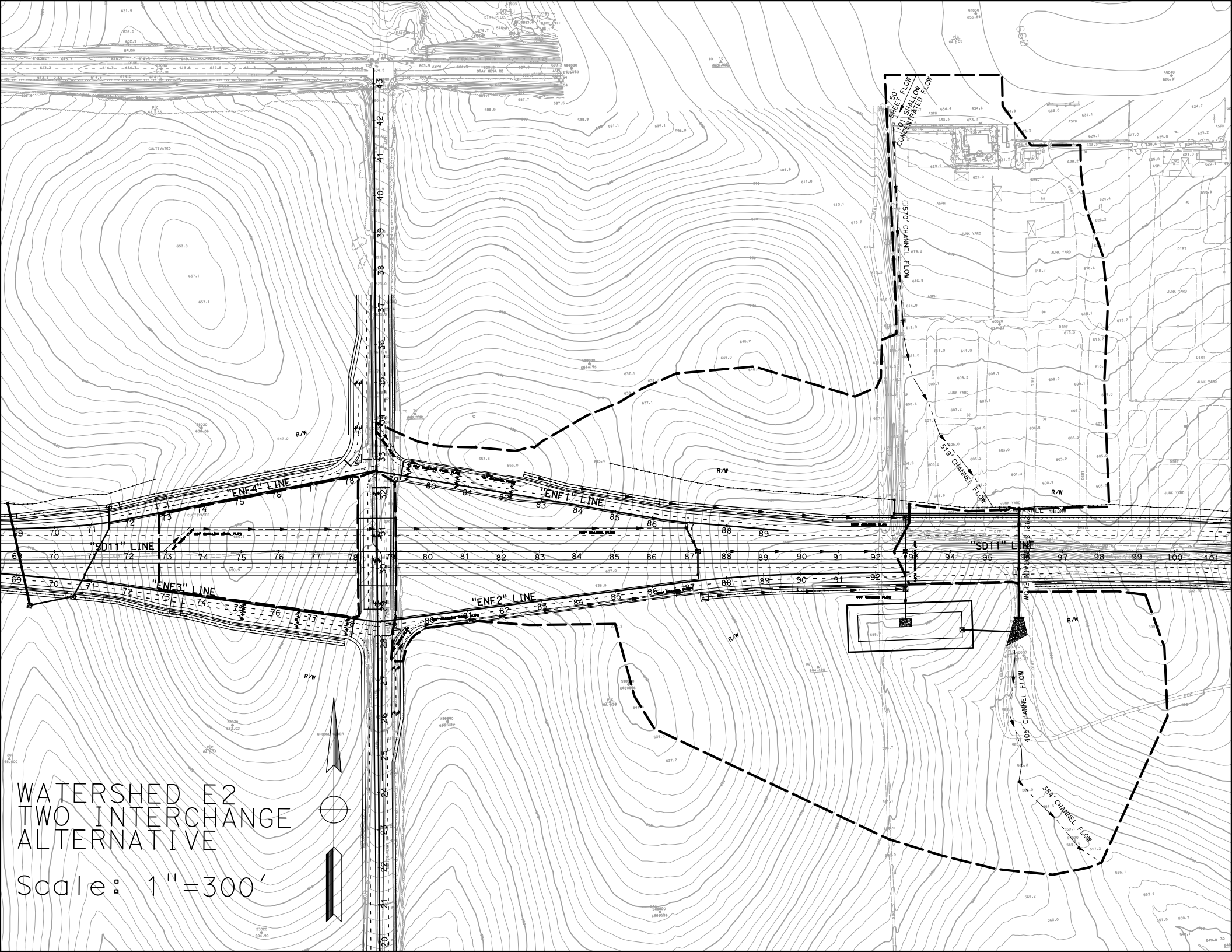
			Area		Tc	Caltrans i_{25}	Caltrans Q_{25}	County i_{100}	County Q_{100}	Drains to:				
	Name	C	SF	Acres	min	in/hr	cfs	in/hr	cfs	Bioswale	Inlet	Destination	@ Station	Offset
PAVED	E2.1.PV	0.99	102800	2.4	10	2.8	6.61	4.2	9.84	E2.1	E2.1	Basin E2	93+00	Lt
	E2.2.PV	0.99	86900	2.0	10	2.8	5.59	4.2	8.32	E2.2	E2.2	Basin E2	96+00	Rt
	E2.3.PV	0.99	84100	1.9	10	2.8	5.41	4.2	8.05	~	E2.3	Basin E2	87+00	Lt
	E2.4.PV	0.99	83200	1.9	10	2.8	5.35	4.2	7.96	~	E2.4	Basin E2	87+00	Rt

Σ 357000 *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
SLOPE	E2.1.SL	0.61	98100	2.3	10	2.8	3.89	4.2	5.79	E2.1	E2.1	Basin E2	93+00	Lt
	E2.2.SL	0.61	44800	1.0	10	2.8	1.77	4.2	2.64	E2.2	E2.2	Basin E2	93+00	Rt
	E2.3.SL	0.61	97800	2.2	10	2.8	3.87	4.2	5.77	~	E2.3	Basin E2	87+00	Lt
	E2.4.SL	0.61	92100	2.1	10	2.8	3.65	4.2	5.43	~	E2.4	Basin E2	87+00	Rt
	E2.5.SL	0.61	65200	1.5	5	4.0	3.65	6.6	6.01	~	E2.5	Basin E2	93+00	Rt
	E2.6.SL	0.61	247500	5.7	10	3.3	11.27	4.2	14.60	~	E2.6	Culvert	92+50	Lt

Watershed Σ 645500 *SLOPE*

Total :	1002500	23.0
	SF	*ac*



WATERSHED E2
TWO INTERCHANGE ALTERNATIVE

Scale: 1"=300'

E2 Post-Developed TcQ

PROJECT:	SR-11			**DESCRIPTION:**	SR-11 Post-Developed
JOB #:	11A1190			**STATION:**	96+00
BY:	M.BRUNING	**DATE:**	01.06.10	**WATERSHED:**	E2
CHK:	G.DALZIEL	**DATE:**		**SYSTEM:**	Two Interchange Option

BASIN AREA:

A = 2354540 ft^2 — 54.05 acres

SOURCE: MICROSTATION/USGS (SCALE = 1:1)

COEFFICIENT OF RUNOFF:

KEY: User Input | Designer Tool

UNDEVELOPED AREA C (FROM HDM FIG. 819.2A)

NOTES:

RELIEF (.08-.35)	0.15	Rolling Slopes ~ 7.5%
INFILTRATION (.04-.16)	0.12	Negligible infiltration capacity - see Geotechnical Report
VEGETATION (.04-.16)	0.08	Fair natural cover
STORAGE (.04-.12)	0.08	Low
TOTAL C =	0.43	

UNDEVELOPED AREA	57%	AT	0.43	0.247
PAVED SURFACE	15%	AT	0.90	0.136
COMMERCIAL AREA	0%	AT	0.85	0.000
CUT SLOPE (2:1 and 4:1)	27%	AT	0.55	0.151
TOTAL	100%			
	(100%)			

$C_{2,10}$ =	0.53
C_{25} =	0.59
C_{50} =	0.64
C_{100} =	0.67

TIME OF CONCENTRATION:

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

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

HIGH PT ELEVATION	635.0	ft	South of Otay Mesa Road - Driveway Area
LOW POINT ELEVATION	634.7	ft	
ELEVATION DIFF (H)	0.3	ft	
LENGTH (L)	50	ft	
SLOPE (S) = (H/L)	0.6%		
MANNING'S n	0.016		< = From Table 816.6A — Asphalt
T_t (SFF)=	2.03	minutes	

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

NOTES:

HIGH PT ELEVATION	634.7	ft	Mid-driveway
LOW POINT ELEVATION	633.0	ft	North end of Junk Yard
ELEVATION DIFF (H)	1.7	ft	
LENGTH (L)	101	ft	
SLOPE (S) = (H/L)	1.7%		
VELOCITY (SCF)	1.5	fps	<=V FROM FIG 816.6 — Asphalt
T_C (SH)=	1.12	minutes	

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

NOTES:

HIGH PT ELEVATION	633.0	ft	channel along western side of junk yard
LOW POINT ELEVATION	612.0	ft	CHANNEL DATA — TYPE = TRAP'Z
ELEVATION DIFF (H)	21.0	ft	Z= 2 — ANG-RAD 0.464
LENGTH (L)	570	ft	b = 1 — ANG-DEG 26.565
SLOPE (S) = (H/L)	3.7%		d = 0.5 — FLOWING FULL ASS'M
MANNING'S n	0.050		earthen/dirt
HYDRAULIC RADIUS R	0.3	ft	R=(bdsinA+d^2cosA)/(bsinA+2d)
VELOCITY (CHANNEL)	2.61	fps	From Manning's Equation assuming flowing full: $V=1.49/n(R^{2/3}S^{1/2})$
T_C (CH)=	3.63	minutes	

E2 Post-Developed TcQ

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

HIGH PT ELEVATION	612.0	ft
LOW POINT ELEVATION	599.0	ft
ELEVATION DIFF (H)	13.0	ft
LENGTH (L)	519	ft
SLOPE (S) = (H/L)	2.5%	
MANNING'S n	0.100	
HYDRAULIC RADIUS R	0.3	ft
VELOCITY (CHANNEL)	1.03	fps
T_C (CH)=	8.43	minutes

NOTES:

Begins to broaden across junk yard

CHANNEL DATA		TYPE =	TRAP'Z
Z=	5	ANG-RAD	0.197
b =	1	ANG-DEG	11.310
d =	0.5	FLOWING FULL ASS'M	

dirt with junk yard obstructions

R=(bdsinA+d^2cosA)/(bsinA+2d)

From Manning's Equation assuming flowing full: $V=1.49/n(R^{2/3}S^{1/2})$

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

HIGH PT ELEVATION	599.0	ft
LOW POINT ELEVATION	598.0	ft
ELEVATION DIFF (H)	1.0	ft
LENGTH (L)	68	ft
SLOPE (S) = (H/L)	1.5%	
MANNING'S n	0.015	
HYDRAULIC RADIUS R	0.3	ft
VELOCITY (CHANNEL)	5.51	fps
T_C (CH)=	0.21	minutes

NOTES:

Proposed Slope Ditch

CHANNEL DATA		TYPE =	TRAP'Z
Z=	2	ANG-RAD	0.464
b =	1	ANG-DEG	26.565
d =	0.5	FLOWING FULL ASS'M	

concrete - rough

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	592.0	ft
LOW POINT ELEVATION	573.0	ft
ELEVATION DIFF (H)	19.0	ft
LENGTH (L)	292	ft
SLOPE (S) = (H/L)	6.5%	
MANNING'S n	0.013	
PIPE DIAMETER d	3.5	ft
HYDRAULIC RADIUS R	0.9	ft
VELOCITY (STORMDRAIN)	26.7	fps
T_C (SD)=	0.18	minutes

NOTES:

Proposed Cross Culvert

Proposed Rip Rap Pad

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	573.0	ft
LOW POINT ELEVATION	565.2	ft
ELEVATION DIFF (H)	7.8	ft
LENGTH (L)	405	ft
SLOPE (S) = (H/L)	1.9%	
MANNING'S n	0.100	
HYDRAULIC RADIUS R	0.6	ft
VELOCITY (CHANNEL)	1.50	fps
T_C (CH)=	4.50	minutes

NOTES:

Natural Channel

CHANNEL DATA		TYPE =	TRAP'Z
Z=	2	ANG-RAD	0.464
b =	2	ANG-DEG	26.565
d =	1	FLOWING FULL ASS'M	

grass

R=(bdsinA+d^2cosA)/(bsinA+2d)

From Manning's Equation assuming flowing full: $V=1.49/n(R^{2/3}S^{1/2})$

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

HIGH PT ELEVATION	565.2	ft
LOW POINT ELEVATION	556.0	ft
ELEVATION DIFF (H)	9.2	ft
LENGTH (L)	354	ft
SLOPE (S) = (H/L)	2.6%	
MANNING'S n	0.100	
HYDRAULIC RADIUS R	0.7	ft
VELOCITY (CHANNEL)	1.81	fps
T_C (CH)=	3.26	minutes

NOTES:

Begins to broaden

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

grass

R=(bdsinA+d^2cosA)/(bsinA+2d)

From Manning's Equation assuming flowing full: $V=1.49/n(R^{2/3}S^{1/2})$

Tc (TOTAL) =	23.36	minutes
Minimum Tc =	10	minutes
USE Tc =	**23.36**	minutes

Total Length of Run (ft) = 2359

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

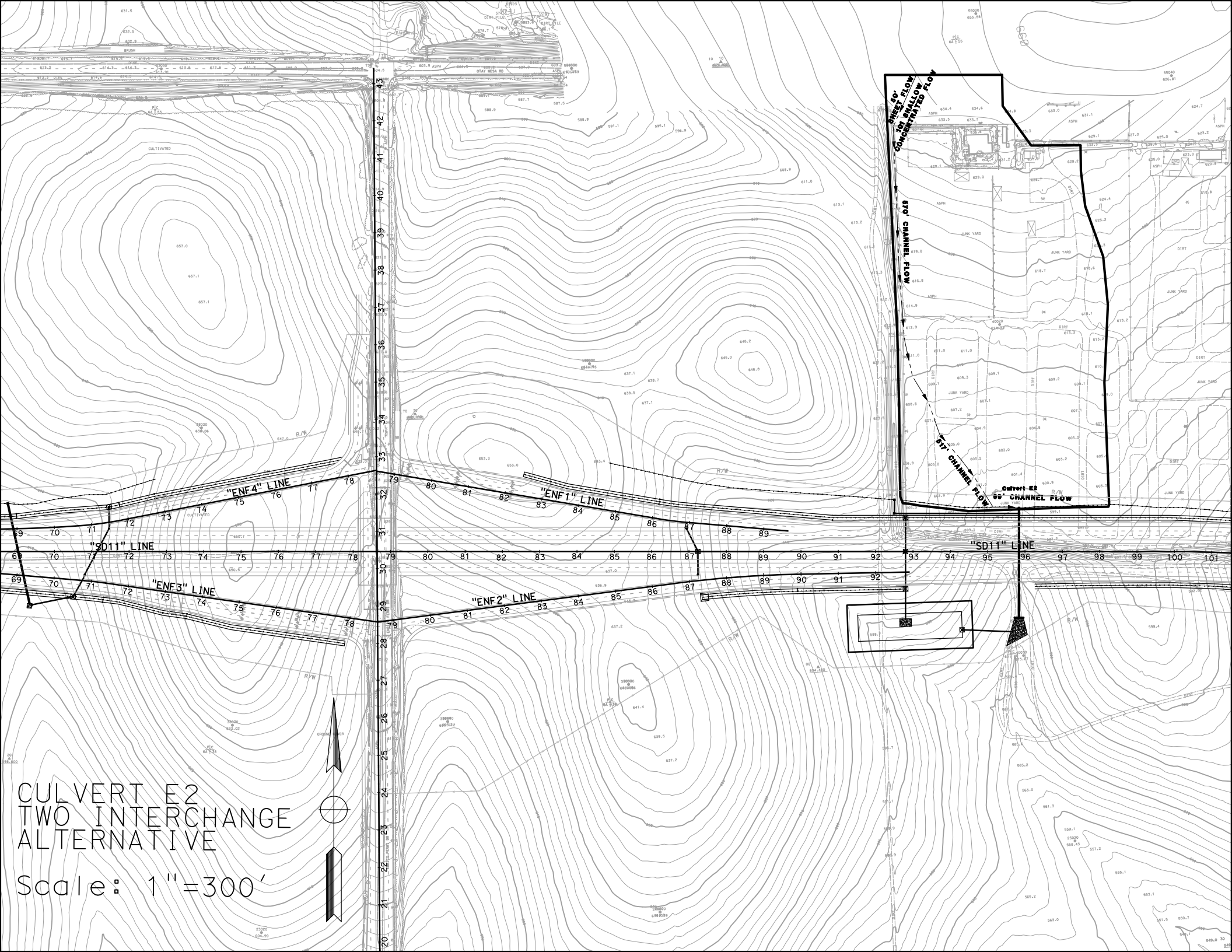
i_2 =	1.1	in/hr	X CA =	
i_{10} =	1.6	in/hr	X CA =	
i_{25} =	1.9	in/hr	X CA =	
i_{50} =	2.3	in/hr	X CA =	
i_{100} =	2.4	in/hr	X CA =	

FLOW RESULTS:

	cfs
Q_2 =	31.0
Q_{10} =	45.0
Q_{25} =	61.9
Q_{50} =	81.0
Q_{100} =	**87.9**

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 E2
TWO INTERCHANGE ALTERNATIVE

Scale: 1"=300'

Culvert Calculator Report
E2 10-yr

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	595.00	ft	Headwater Depth/Height	0.64	
Computed Headwater Elevation	593.92	ft	Discharge	14.80	cfs
Inlet Control HW Elev.	593.63	ft	Tailwater Elevation	573.60	ft
Outlet Control HW Elev.	593.92	ft	Control Type	Entrance Control	

Grades					
Upstream Invert	592.00	ft	Downstream Invert	573.00	ft
Length	292.00	ft	Constructed Slope	6.5	%

Hydraulic Profile					
Profile	S2		Depth, Downstream	0.60	ft
Slope Type	Steep		Normal Depth	0.60	ft
Flow Regime	Supercritical		Critical Depth	1.23	ft
Velocity Downstream	14.77	ft/s	Critical Slope	0.4	%

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	3.00	ft
Section Size	36 inch		Rise	3.00	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	593.92	ft	Upstream Velocity Head	0.46	ft
Ke	0.50		Entrance Loss	0.23	ft

Inlet Control Properties					
Inlet Control HW Elev.	593.63	ft	Flow Control	Unsubmerged	
Inlet Type	Square edge w/headwall		Area Full	7.1	ft²
K	0.00980		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	1	
C	0.03980		Equation Form	1	
Y	0.67000				

Culvert Calculator Report
E2 100-yr

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	596.00	ft	Headwater Depth/Height	0.96	
Computed Headwater Elevation	594.89	ft	Discharge	30.10	cfs
Inlet Control HW Elev.	594.60	ft	Tailwater Elevation	573.85	ft
Outlet Control HW Elev.	594.89	ft	Control Type	Entrance Control	

Grades					
Upstream Invert	592.00	ft	Downstream Invert	573.00	ft
Length	292.00	ft	Constructed Slope	6.5	%

Hydraulic Profile					
Profile	S2		Depth, Downstream	0.85	ft
Slope Type	Steep		Normal Depth	0.85	ft
Flow Regime	Supercritical		Critical Depth	1.78	ft
Velocity Downstream	18.15	ft/s	Critical Slope	0.5	%

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	3.00	ft
Section Size	36 inch		Rise	3.00	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	594.89	ft	Upstream Velocity Head	0.74	ft
Ke	0.50		Entrance Loss	0.37	ft

Inlet Control Properties					
Inlet Control HW Elev.	594.60	ft	Flow Control	Unsubmerged	
Inlet Type	Square edge w/headwall		Area Full	7.1	ft²
K	0.00980		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	1	
C	0.03980		Equation Form	1	
Y	0.67000				

E2 Culvert TcQ

PROJECT:	**SR-11**			**DESCRIPTION:**	**SR-11 Culvert**
JOB #:	**11A1190**			**STATION:**	**95+90**
BY:	**M.BRUNING**	**DATE:**	**01.06.10**	**WATERSHED:**	**E2.Culvert**
CHK:	**G.DALZIEL**	**DATE:**		**SYSTEM:**	**Culvert E2**

BASIN AREA:

A =	**843184**	**ft^2**	**SOURCE:**	**MICROSTATION/USGS**
	19.36	**acres**		**(SCALE = 1:1)**

COEFFICIENT OF RUNOFF:

KEY: User Input | Designer Tool

UNDEVELOPED AREA C (FROM HDM FIG. 819.2A)

NOTES:

RELIEF (.08-.35)	0.15	Rolling Slopes ~ 7.5%
INFILTRATION (.04-.16)	0.12	Negligible infiltration capacity - see Geotechnical Report
VEGETATION (.04-.16)	0.08	Fair natural cover
STORAGE (.04-.12)	0.08	Low
TOTAL C =	0.43	

UNDEVELOPED AREA	99%	AT	0.43	0.426
PAVED SURFACE	1%	AT	0.90	0.009
COMMERCIAL AREA	0%	AT	0.85	0.000
CUT SLOPE (2:1)	0%	AT	0.55	0.000
TOTAL	100%			
	(100%)			

$C_{2,10}$ =	0.43
C_{25} =	0.48
C_{50} =	0.52
C_{100} =	0.54

TIME OF CONCENTRATION:

SHEET FLOW: $T_t = \frac{0.42L^{.8}n^{.8}}{P_2^{.5}s^{.25}}$

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

HIGH PT ELEVATION	635.0	ft	South of Otay Mesa Road - Driveway Area
LOW POINT ELEVATION	634.7	ft	
ELEVATION DIFF (H)	0.3	ft	
LENGTH (L)	50	ft	
SLOPE (S) = (H/L)	0.6%		
MANNING'S n	0.016		< = FROM FIG 816.6A Asphalt
T_t (SFF)=	2.03	minutes	

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

NOTES:

HIGH PT ELEVATION	634.7	ft	Mid-driveway
LOW POINT ELEVATION	633.0	ft	North end of Junk Yard
ELEVATION DIFF (H)	1.7	ft	
LENGTH (L)	101	ft	
SLOPE (S) = (H/L)	1.7%		
VELOCITY (SCF)	1.5	fps	<=V FROM FIG 816.6 Asphalt
T_C (SH)=	1.12	minutes	

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

NOTES:

HIGH PT ELEVATION	633.0	ft	channel along western side of junk yard
LOW POINT ELEVATION	612.0	ft	CHANNEL DATA TYPE = TRAP'Z
ELEVATION DIFF (H)	21.0	ft	Z= 2 ANG-RAD 0.464
LENGTH (L)	570	ft	b = 1 ANG-DEG 26.565
SLOPE (S) = (H/L)	3.7%		d = 0.5 FLOWING FULL ASS'M
MANNING'S n	0.050		earthen/dirt
HYDRAULIC RADIUS R	0.3	ft	R=(bdsinA+d^2cosA)/(bsinA+2d)
VELOCITY (CHANNEL)	2.61	fps	From Manning's Equation assuming flowing full: $V=1.49/n(R^{2/3}S^{1/2})$
T_C (CH)=	3.63	minutes	

E2 Culvert TcQ

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

HIGH PT ELEVATION	612.0	ft
LOW POINT ELEVATION	602.0	ft
ELEVATION DIFF (H)	10.0	ft
LENGTH (L)	517	ft
SLOPE (S) = (H/L)	1.9%	
MANNING'S n	0.100	
HYDRAULIC RADIUS R	0.3	ft
VELOCITY (CHANNEL)	0.90	fps
T_C (CH)=	9.56	minutes

NOTES:

Begins to broaden across junk yard

CHANNEL DATA		TYPE =	TRAP'Z
Z=	5	ANG-RAD	0.197
b =	1	ANG-DEG	11.310
d =	0.5	FLOWING FULL ASS'M	

dirt with junk yard obstructions

R=(bdsinA+d^2cosA)/(bsinA+2d)

From Manning's Equation assuming flowing full: $V=1.49/n(R^{2/3}S^{1/2})$

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

HIGH PT ELEVATION	602.0	ft
LOW POINT ELEVATION	598.0	ft
ELEVATION DIFF (H)	4.0	ft
LENGTH (L)	69	ft
SLOPE (S) = (H/L)	5.8%	
MANNING'S n	0.015	
HYDRAULIC RADIUS R	0.3	ft
VELOCITY (CHANNEL)	10.93	fps
T_C (CH)=	0.11	minutes

NOTES:

Proposed Slope Ditch

CHANNEL DATA		TYPE =	TRAP'Z
Z=	2	ANG-RAD	0.464
b =	1	ANG-DEG	26.565
d =	0.5	FLOWING FULL ASS'M	

concrete - rough

R=(bdsinA+d^2cosA)/(bsinA+2d)

From Manning's Equation assuming flowing full: $V=1.49/n(R^{2/3}S^{1/2})$

Tc (TOTAL) =	16.45	minutes
Minimum Tc =	10	minutes
USE T_C =	**16.45**	minutes

INTENSITY CHART: Caltrans IDF2000

FLOW RESULTS

					cfs
i_2 =	0.9	in/hr	X CA =	**Q_2 =**	7.9
i_{10} =	1.8	in/hr	X CA =	**Q_{10} =**	14.8
i_{25} =	2.2	in/hr	X CA =	**Q_{25} =**	20.4
i_{50} =	2.5	in/hr	X CA =	**Q_{50} =**	25.6
i_{100} =	2.9	in/hr	X CA =	**Q_{100} =**	**30.1**

~Use Caltrans 'i' for culvert sizing

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

FLOW RESULTS

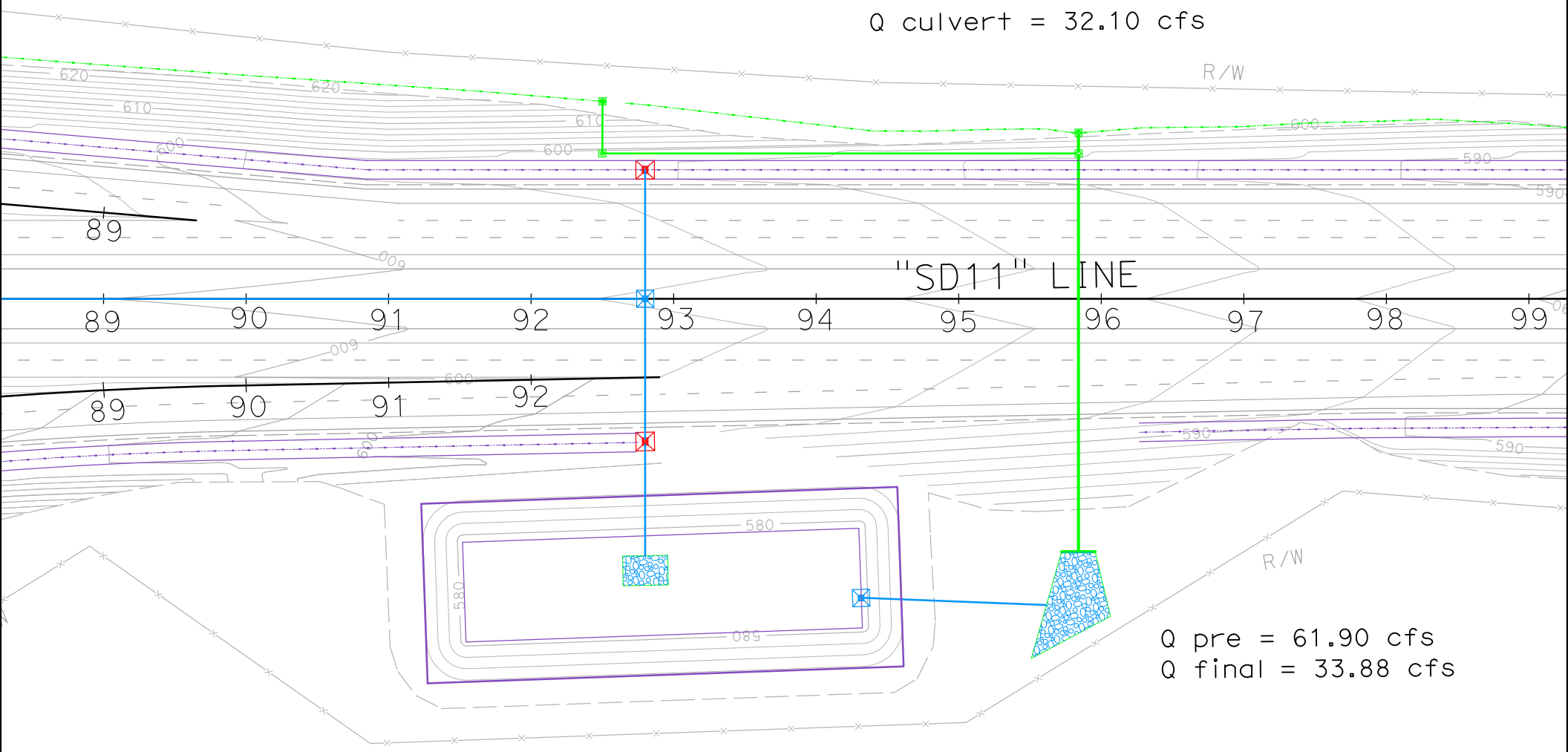
					cfs
i_2 =	1.3	in/hr	X CA =	**Q_2 =**	11.3
i_{10} =	2.0	in/hr	X CA =	**Q_{10} =**	16.5
i_{25} =	2.4	in/hr	X CA =	**Q_{25} =**	22.6
i_{50} =	2.9	in/hr	X CA =	**Q_{50} =**	29.6
i_{100} =	3.1	in/hr	X CA =	**Q_{100} =**	**32.1**

~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 E2
FLOW SUMMARY

Scale: 1"=100'

Basin E2 Retention

PROJECT:	**SR-11**			**DESCRIPTION:**	**SR-11 Basin**
JOB #:	**11A1190**			**STATION:**	**96+00**
BY:	**M.BRUNING**	**DATE:**	**01.06.10**	**WATERSHED:**	**E2**
CHK:	**G.DALZIEL**	**DATE:**		**SYSTEM:**	**Basin E2**

Notes:

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

RETENTION BASIN VOLUME

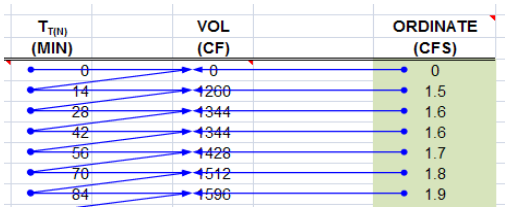
100-year, 6 hour duration storm event, use the Rational Method Hydrograph Procedure (SDCHM 6-1) ~ RatHydro

Pre-Developed volume calculations

Q_{100}=	61.9	cfs			
Tc=	24.5	min	C=	0.54	
$P_{100,6}$=	2.5	in	A=	48.15	acres

$T_{T(N)}$ (MIN)	VOL (CF)	ORDINATE (CFS)
0	0	0
25	6000	4
50	6750	4.5
75	7050	4.7
100	8100	5.4
125	8850	5.9
150	10800	7.2
175	12300	8.2
200	18000	12
225	23550	15.7
250	92850	61.9
275	14400	9.6
300	9600	6.4
325	7500	5
350	6300	4.2
375	0	0

Example of Steps:



SUM= 232050 ft^3
5.33 acre-feet

Check: V = C*A*P_6
V= 5.45 acre-feet
OK

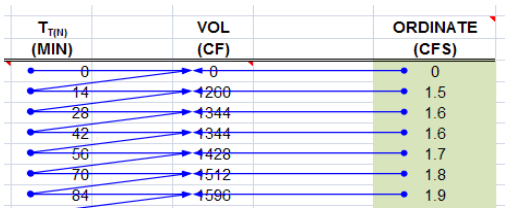
Basin E2 Retention

Post-Developed volume calculations

Q_{100}=	87.9	cfs			
Tc=	23.4	min	C=	0.67	
$P_{100,6}$=	2.5	in	A=	54.05	acres

$T_{T(N)}$ (MIN)	VOL (CF)	ORDINATE (CFS)
0	0	0
23	3450	2.5
46	7728	5.6
69	8142	5.9
92	9108	6.6
115	9522	6.9
138	11040	8
161	11868	8.6
184	14628	10.6
207	16560	12
230	24426	17.7
253	36018	26.1
276	121302	87.9
299	19596	14.2
322	13110	9.5
345	10212	7.4
368	8556	6.2
391	0	0

Example of Steps:



SUM= 325266 ft^3
7.47 acre-feet

Check: $V = C*A*P_6$
V= 7.52 acre-feet
OK

		7.47	*(Post)*			
	-	**5.33**	*(Pre)*			
Retention volume =		**2.14**	**acre-feet**	**=**	**93216 ft^3**	**Basin Required**

Basin E2 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}= 0.89
A= 17.33 acres

WQ_{72}: 0.66 in/area

Water Quality Volume (WQV) = **41525** **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

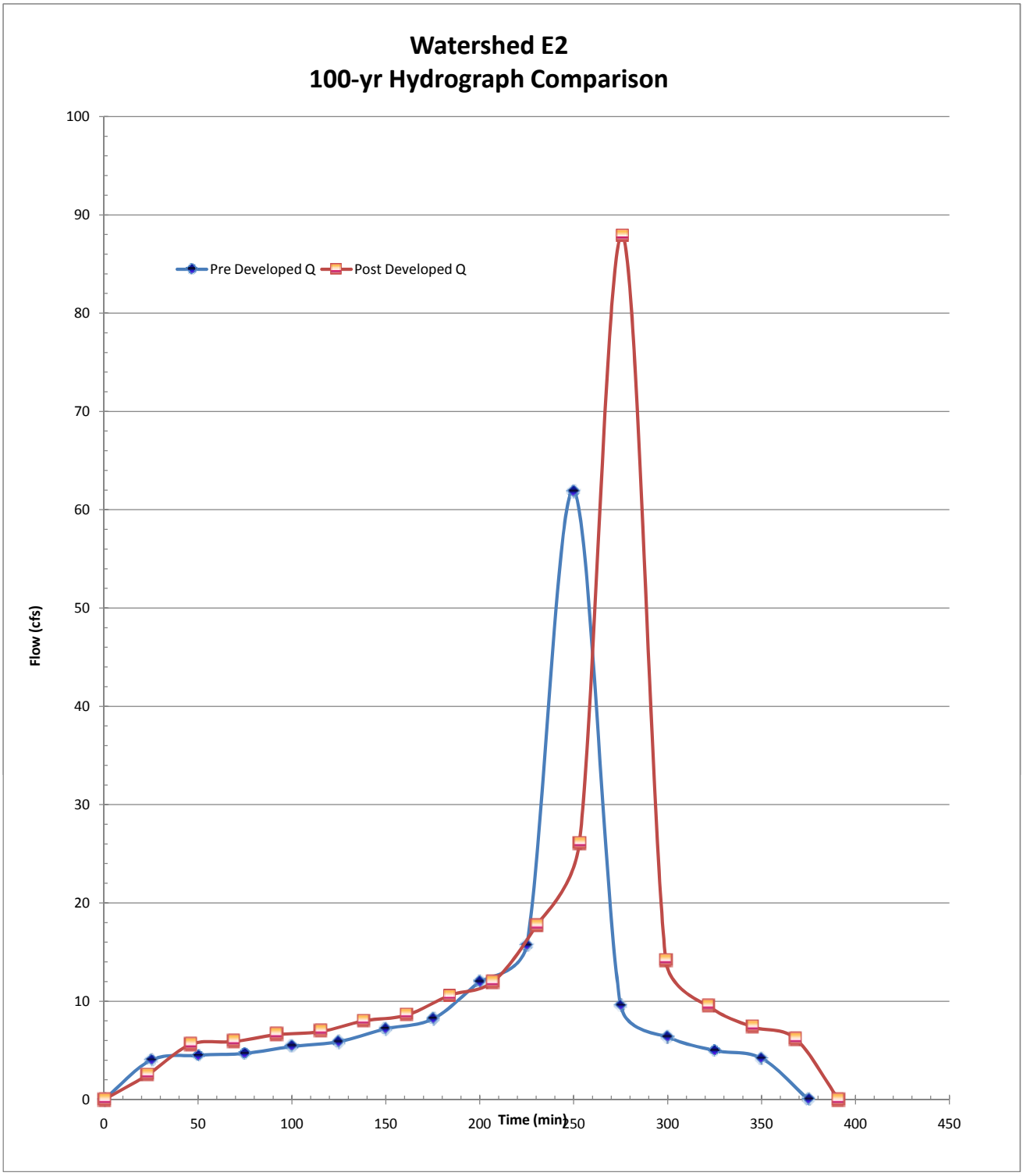
Onsite Highway *Sloped* runoff area, A:		398000	ft^2
	A:	9.14	acres
		10.00	years
where:	R=	30.00	
	K=	0.24	
	Ls=	18.00	
	C=	0.012	
	P=	1.00	
	As	1.56	tons/yr.Ac

Volume for 10-year Silt Accumulation = 142.10 tons

Silt Accumulation Basin volume = **3158** **ft^3**

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

Basin E2 Retention



Basin E2 Inflow TcQ

PROJECT:	**SR-11**			**DESCRIPTION:**	**SR-11 Basin**
JOB #:	**11A1190**			**STATION:**	**93+00**
BY:	**M.BRUNING**	**DATE:**	**01.06.10**	**WATERSHED:**	**E2**
CHK:	**G.DALZIEL**	**DATE:**		**SYSTEM:**	**Two Interchange Option**

BASIN AREA:

A =	**755000**	**ft^2**	**SOURCE:**	**MICROSTATION/USGS**
	17.33	**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	47%	AT	0.90	0.426
COMMERCIAL AREA	0%	AT	0.85	0.000
CUT SLOPE (2:1 and 4:1)	53%	AT	0.55	0.290
TOTAL	100%			
	(100%)			

$C_{2,10}$ =	0.72
C_{25} =	0.79
C_{50} =	0.86
C_{100} =	0.89

TIME OF CONCENTRATION:

SHEET FLOW: $T_t = \frac{0.42 L^{.8} n^{.8}}{P_2^{.5} s^{.4}}$

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

HIGH PT ELEVATION	610.5	ft	SR-11 HP
LOW POINT ELEVATION	610.0	ft	
ELEVATION DIFF (H)	0.5	ft	
LENGTH (L)	100	ft	to ES
SLOPE (S) = (H/L)	0.5%		
MANNING'S n	0.016		AC < = From Table 816.6A
T_t (SFF)=	3.80	minutes	

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

NOTES:

HIGH PT ELEVATION	610.0	ft	Flow in gutter (SCF)
LOW POINT ELEVATION	608.5	ft	
ELEVATION DIFF (H)	1.5	ft	
LENGTH (L)	200	ft	assumed SCF and not channelized or flowing full yet
SLOPE (S) = (H/L)	0.8%		
VELOCITY (SCF)	2.5	fps	0.8% , V FROM FIG 816.6 AC
T_C (SH)=	1.33	minutes	

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

NOTES:

HIGH PT ELEVATION	608.5	ft	along HMA dike
LOW POINT ELEVATION	603.0	ft	
ELEVATION DIFF (H)	5.5	ft	
LENGTH (L)	1127	ft	
SLOPE (S) = (H/L)	0.5%		
MANNING'S n	0.016		
HYDRAULIC RADIUS R	0.33	ft	
VELOCITY (CHANNEL)	3.13	fps	
T_C (CH)=	6.01	minutes	

CHANNEL DATA		TYPE =	TRAP'Z
Z=	20	ANG-RAD	0.050
b =	10	ANG-DEG	2.862
d =	0.5	FLOWING FULL ASS'M	

HMA

R=(bdsinA+d^2cosA)/(bsinA+2d)

From Manning's Equation assuming flowing full: $V=1.49/n(R^{2/3}S^{1/2})$

Basin E2 Inflow TcQ

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

HIGH PT ELEVATION	598.0	ft
LOW POINT ELEVATION	580.0	ft
ELEVATION DIFF (H)	18.0	ft
LENGTH (L)	808	ft
SLOPE (S) = (H/L)	2.2%	
MANNING'S n	0.013	
PIPE DIAMETER d	2.0	ft
HYDRAULIC RADIUS R	0.5	ft
VELOCITY (STORMDRAIN)	10.8	fps
T_C (SD)=	1.25	minutes

NOTES:

Proposed onsite pipe (assumed 5' drop to invert)
Proposed Rip Rap Pad in Basin floor
RCP
R=D/4, Assume: flowing full
$V = \frac{K_u}{n} R^{2/3} S^{1/2}$

Tc (TOTAL) =	12.39	minutes
Minimum Tc =	5	minutes
USE T_C =	**12.39**	minutes

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

i_2 =	1.6	in/hr	X CA =
i_{10} =	2.3	in/hr	X CA =
i_{25} =	2.9	in/hr	X CA =
i_{50} =	3.5	in/hr	X CA =
i_{100} =	3.7	in/hr	X CA =

FLOW RESULTS

	cfs
Q_2 =	20.0
Q_{10} =	29.1
Q_{25} =	40.0
Q_{50} =	52.4
Q_{100} =	**56.9**

COUNTY P_6

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

Basin E2 Inflow Hydrograph

PROJECT:	**SR-11**			**DESCRIPTION:**	**SR-11 Basin**
JOB #:	**11A1190**			**STATION:**	**93+00**
BY:	**M.BRUNING**	**DATE:**	**01.06.10**	**WATERSHED:**	**E2**
CHK:	**G.DALZIEL**	**DATE:**		**SYSTEM:**	**Basin E2**

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

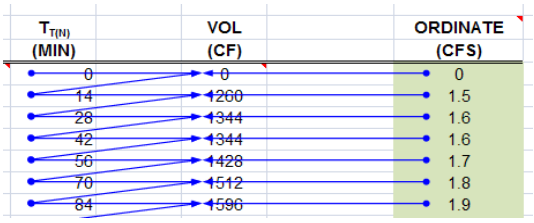
Basin Inflow Hydrograph

Basin Inflow Q

Q_{100}=	56.9	cfs	C_{100}=	0.89	
Tc=	12.4	min	A=	17.33	acres
$P_{100,6}$=	2.5	in			

$T_{T(N)}$ (MIN)	VOL (CF)	ORDINATE (CFS)
0	0	0
12	1656	2.3
24	1728	2.4
36	1800	2.5
48	1800	2.5
60	1944	2.7
72	2016	2.8
84	2088	2.9
96	2160	3
108	2304	3.2
120	2448	3.4
132	2664	3.7
144	2736	3.8
156	3024	4.2
168	3240	4.5
180	3744	5.2
192	4032	5.6
204	4896	6.8
216	5616	7.8
228	8208	11.4
240	12240	17
252	40968	56.9
264	6624	9.2
276	4392	6.1
288	3456	4.8
300	2880	4
312	2520	3.5
324	2232	3.1
336	2016	2.8
348	1872	2.6
360	1728	2.4
372	0	0

Example of Steps:

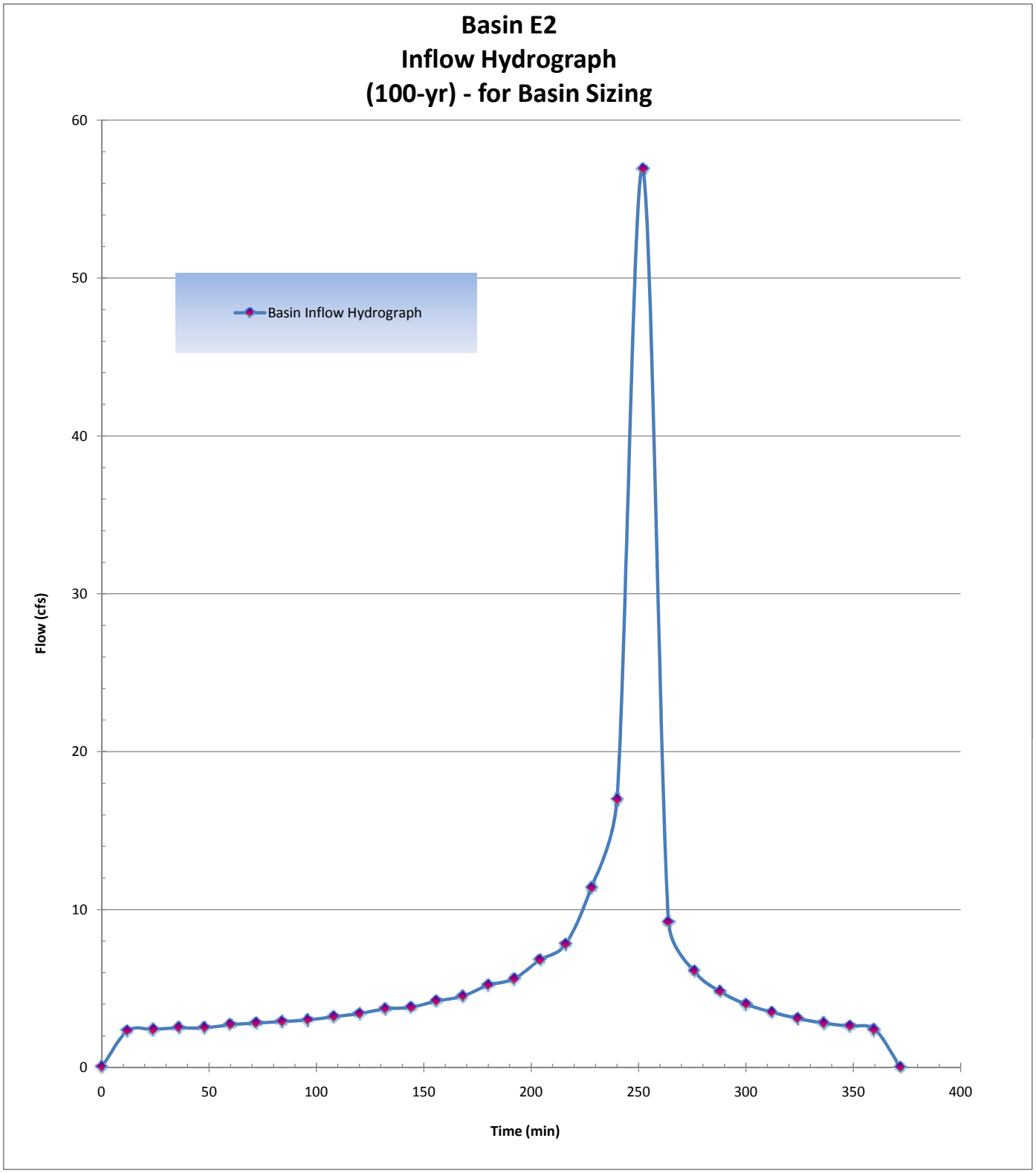


SUM= 139032 ft³
3.19 acre-feet

Onsite Runoff Volume

Check: $V = C*A*P_6$
V= 3.23 acre-feet
OK

Basin E2 Inflow Hydrograph



Basin E2 Outlet

PROJECT:	**SR-11**			**DESCRIPTION:**	**SR-11 Basin**
JOB #:	**11A1190**			**STATION:**	**93+00**
BY:	**M.BRUNING**	**DATE:**	**02.19.10**	**WATERSHED:**	**E2**
CHK:	**G.DALZIEL**	**DATE:**		**SYSTEM:**	**Basin E2**

Notes:

Required Retention Basin Volume = 96374 ft^3
Actual Basin Inflow = 139032 ft^4 *OK*

Flow Balance - determine maximum flow from basin

Predeveloped Peak 100-year Flow: 61.9 cfs
Post-Developed Peak Flow through Cross Culvert: 32.1 cfs — Includes: E2.6.SL
Flow that does not reach detention basin (bypass per DA table): 0.0 cfs ~ Q_{100} of: ~
Maximum flow allowed to be released by this detention basin: 29.8 cfs

Outlet Pipe

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

Basin - Top of basin berm elevation = 586.00 ft
Basin flowline elevation = 580.00 ft
Maximum Basin Depth = 6.00 ft

Outlet Pipe

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

Outlet pipe invert from basin floor = 4.00 ft — 584.00 ft
Outlet pipe diameter = 2 ft

Basin Characteristics

Base Length (L) = 285 ft
Base Width (W) = 75 ft
W/L Ratio ® = 0.26
Side Slopes (Z) = 1: 4
Total Volume (V): = 185217 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)	Q_{out} (cfs)	Q_{inf} (cfs)	Q_{total} (cfs)
0	580.00	0.00	0	0		580.00	0.00		0.00
1	580.20	0.20	4333	4333		580.20	0.00		0.00
2	580.40	0.40	4449	8781		580.40	0.00		0.00
3	580.60	0.60	4566	13348		580.60	0.00		0.00
4	580.80	0.80	4685	18032		580.80	0.00		0.00
5	581.00	1.00	4804	22836		581.00	0.00		0.00
6	581.20	1.20	4925	27761		581.20	0.00		0.00
7	581.40	1.40	5047	32808		581.40	0.00		0.00
8	581.60	1.60	5170	37978		581.60	0.00		0.00
9	581.80	1.80	5294	43272		581.80	0.00		0.00
10	582.00	2.00	5420	48692		582.00	0.00		0.00
11	582.20	2.20	5546	54238		582.20	0.00		0.00
12	582.40	2.40	5674	59912		582.40	0.00		0.00
13	582.60	2.60	5803	65715		582.60	0.00		0.00
14	582.80	2.80	5933	71648		582.80	0.00		0.00
15	583.00	3.00	6064	77712		583.00	0.00	0.00	0.00
16	583.20	3.20	6197	83909		583.20	0.00		0.00
17	583.40	3.40	6330	90239		583.40	0.00		0.00
18	583.60	3.60	6465	96704		583.60	0.00		0.00
19	583.80	3.80	6601	103305		583.80	0.00		0.00
20	584.00	4.00	6738	110043	*	584.00	0.00		0.00
21	584.20	4.20	6876	116919		584.20	0.15		0.15
22	584.40	4.40	7016	123935		584.40	0.59		0.59
23	584.60	4.60	7156	131091		584.60	1.30		1.30
24	584.80	4.80	7298	138389		584.80	2.25		2.25
25	585.00	5.00	7441	145829		585.00	3.42		3.42
26	585.20	5.20	7585	153414		585.20	4.79		4.79
27	585.40	5.40	7730	161144		585.40	6.32		6.32
28	585.60	5.60	7876	169021		585.60	7.99		7.99
29	585.80	5.80	8024	177045		585.80	9.77		9.77
30	586.00	6.00	8173	185217		586.00	11.63		11.63

Basin E2 Routing

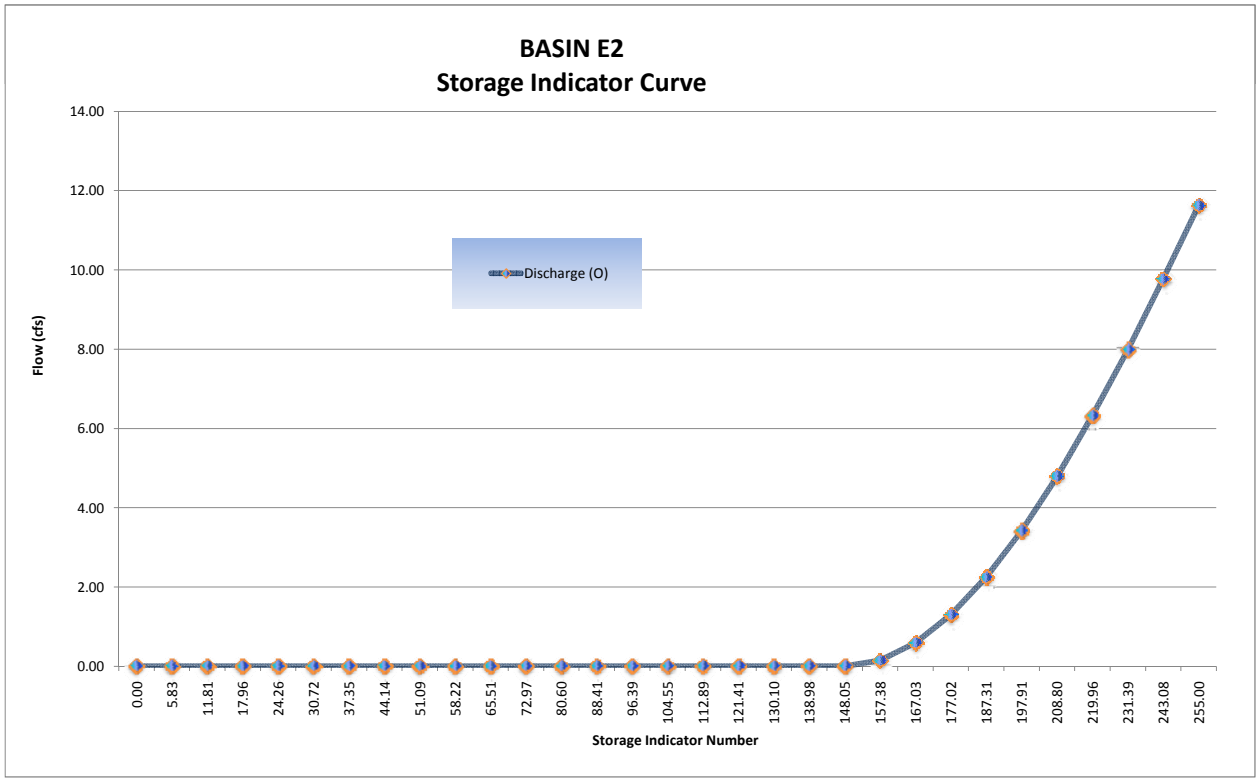
PROJECT:	SR-11			DESCRIPTION:	SR-11 Basin
JOB #:	11A1190			STATION:	96+00
BY:	M.BRUNING	DATE:	02.19.10	WATERSHED:	E
CHK:	G.DALZIEL	DATE:		SYSTEM:	Basin E2

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)	*Storage Indicator #* (6) S_2/delta t + $O_2/2$ (cfs)
580.00	0.00	0	0.00	0.00	0.00
580.20	0.00	4333	0.00	5.83	5.83
580.40	0.00	8781	0.00	11.81	11.81
580.60	0.00	13348	0.00	17.96	17.96
580.80	0.00	18032	0.00	24.26	24.26
581.00	0.00	22836	0.00	30.72	30.72
581.20	0.00	27761	0.00	37.35	37.35
581.40	0.00	32808	0.00	44.14	44.14
581.60	0.00	37978	0.00	51.09	51.09
581.80	0.00	43272	0.00	58.22	58.22
582.00	0.00	48692	0.00	65.51	65.51
582.20	0.00	54238	0.00	72.97	72.97
582.40	0.00	59912	0.00	80.60	80.60
582.60	0.00	65715	0.00	88.41	88.41
582.80	0.00	71648	0.00	96.39	96.39
583.00	0.00	77712	0.00	104.55	104.55
583.20	0.00	83909	0.00	112.89	112.89
583.40	0.00	90239	0.00	121.41	121.41
583.60	0.00	96704	0.00	130.10	130.10
583.80	0.00	103305	0.00	138.98	138.98
584.00	0.00	110043	0.00	148.05	148.05
584.20	0.15	116919	0.08	157.30	157.38
584.40	0.59	123935	0.30	166.74	167.03
584.60	1.30	131091	0.65	176.37	177.02
584.80	2.25	138389	1.13	186.19	187.31
585.00	3.42	145829	1.71	196.20	197.91
585.20	4.79	153414	2.40	206.40	208.80
585.40	6.32	161144	3.16	216.80	219.96
585.60	7.99	169021	4.00	227.40	231.39
585.80	9.77	177045	4.89	238.19	243.08
586.00	11.63	185217	5.82	249.19	255.00

delta t = 0.21 hrs
delta t = 12 min
delta t = 743.2807 sec

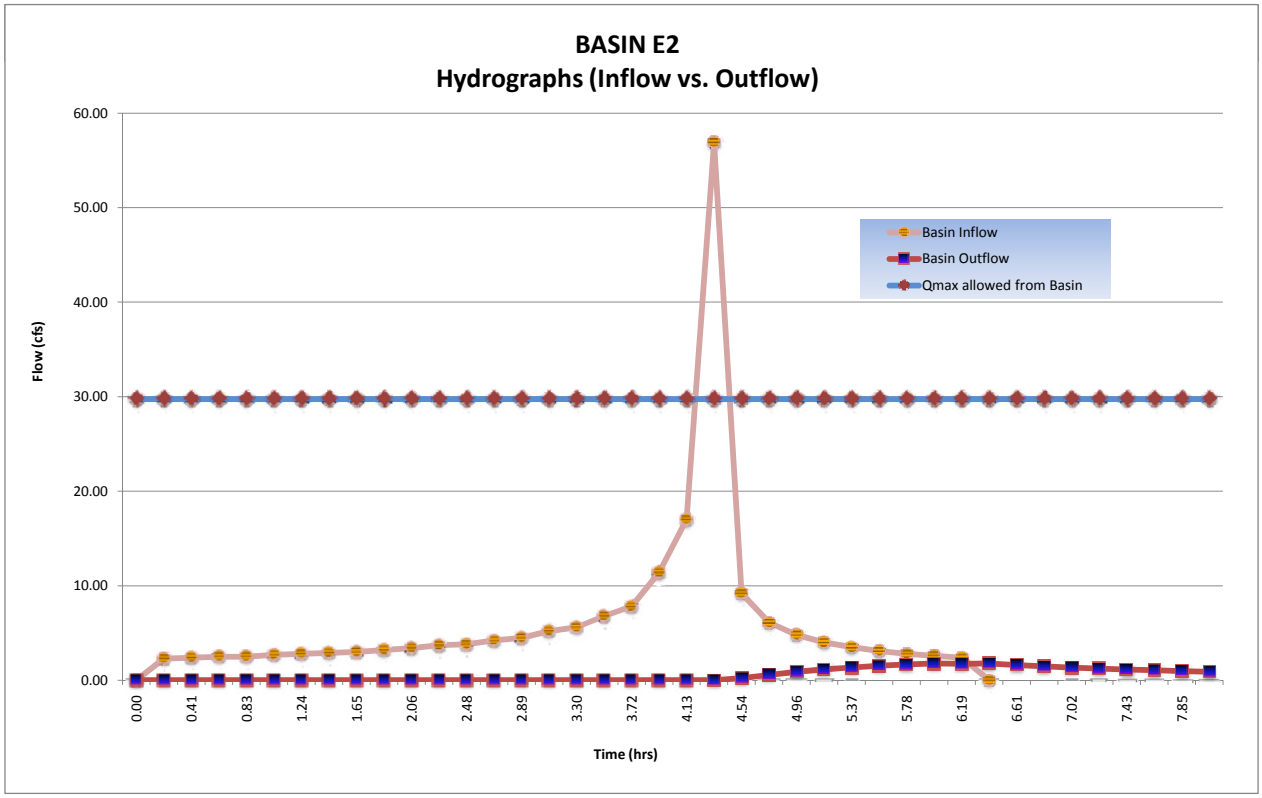


Basin E2 Routing

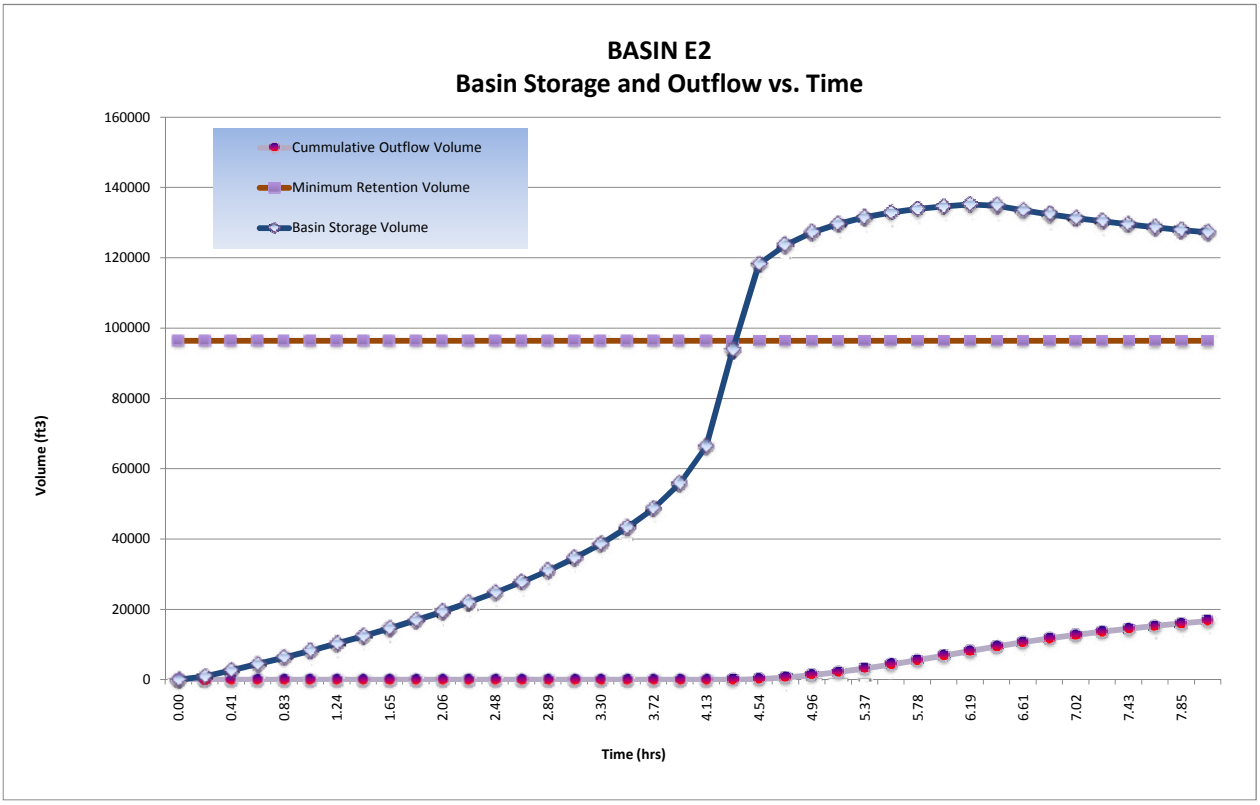
FINAL ROUTING TABLE

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

(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)	(5) O_1 (cfs)	Storage Indicator # (6) $S_2/\text{delta t} + O_2/2$ (cfs)	(7) O_2 (cfs)	Volumes (ft3) Basin Storage Volume	Incremental Outflow Volume	Cummulative Outflow Volume
			col (6) from prev row	*col (7) from prev row*	*col (3)+(4)-(5)*	*(Hard input)*			
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
0.21	2.30	1.15	0.00	0.00	1.15	0.00	855	0	0
0.41	2.40	2.35	1.15	0.00	3.50	0.00	2601	0	0
0.62	2.50	2.45	3.50	0.00	5.95	0.00	4423	0	0
0.83	2.50	2.50	5.95	0.00	8.45	0.00	6281	0	0
1.03	2.70	2.60	8.45	0.00	11.05	0.00	8213	0	0
1.24	2.80	2.75	11.05	0.00	13.80	0.00	10257	0	0
1.45	2.90	2.85	13.80	0.00	16.65	0.00	12376	0	0
1.65	3.00	2.95	16.65	0.00	19.60	0.00	14568	0	0
1.86	3.20	3.10	19.60	0.00	22.70	0.00	16872	0	0
2.06	3.40	3.30	22.70	0.00	26.00	0.00	19325	0	0
2.27	3.70	3.55	26.00	0.00	29.55	0.00	21964	0	0
2.48	3.80	3.75	29.55	0.00	33.30	0.00	24751	0	0
2.68	4.20	4.00	33.30	0.00	37.30	0.00	27724	0	0
2.89	4.50	4.35	37.30	0.00	41.65	0.00	30958	0	0
3.10	5.20	4.85	41.65	0.00	46.50	0.00	34563	0	0
3.30	5.60	5.40	46.50	0.00	51.90	0.00	38576	0	0
3.51	6.80	6.20	51.90	0.00	58.10	0.00	43185	0	0
3.72	7.80	7.30	58.10	0.00	65.40	0.00	48611	0	0
3.92	11.40	9.60	65.40	0.00	75.00	0.00	55746	0	0
4.13	17.00	14.20	75.00	0.00	89.20	0.00	66301	0	0
4.34	56.90	36.95	89.20	0.00	126.15	0.00	93765	0	0
4.54	9.20	33.05	126.15	0.00	159.20	0.23	118245	171	171
4.75	6.10	7.65	159.20	0.23	166.62	0.57	123634	424	595
4.96	4.80	5.45	166.62	0.57	171.50	0.91	127134	676	1271
5.16	4.00	4.40	171.50	0.91	174.99	1.16	129636	862	2133
5.37	3.50	3.75	174.99	1.16	177.58	1.35	131490	1003	3137
5.57	3.10	3.30	177.58	1.35	179.53	1.53	132873	1137	4274
5.78	2.80	2.95	179.53	1.53	180.95	1.66	133880	1234	5508
5.99	2.60	2.70	180.95	1.66	181.99	1.76	134616	1308	6816
6.19	2.40	2.50	181.99	1.76	182.73	1.73	135177	1286	8102
6.40	0.00	1.20	182.73	1.73	182.20	1.78	134764	1323	9425
6.61		0.00	182.20	1.78	180.42	1.61	133504	1197	10621
6.81		0.00	180.42	1.61	178.81	1.47	132360	1093	11714
7.02		0.00	178.81	1.47	177.34	1.33	131319	989	12703
7.23		0.00	177.34	1.33	176.01	1.23	130368	914	13617
7.43		0.00	176.01	1.23	174.78	1.14	129487	847	14464
7.64		0.00	174.78	1.14	173.64	1.06	128669	788	15252
7.85		0.00	173.64	1.06	172.58	0.98	127911	728	15981
8.05		0.00	172.58	0.98	171.60	0.91	127209	676	16657



Basin E2 Routing



Detention/Retention Basin Volume Required:	**135,177**	ft^3	
@ Stage:	**584.80**	ft	
Freeboard:	**1.2**	ft	>1' Freeboard
Final Total Basin Volume Provided:	**185,217**	ft^3	Basin **E2**
Maximum flow rate released from this basin:	**1.78**	cfs	

F2 Onsite D.A. Table

PROJECT:	**SR-11**	**DESCRIPTION:**	**On-site Drainage Areas (D.A.)**
JOB #:	**11A1190**	**STATION:**	**~**
BY:	**M.BRUNING** **DATE:** **01.04.10**	**WATERSHED:**	**F2**
CHK:	**G.DALZIEL** **DATE:**	**SYSTEM:**	**Two Interchange Option**

			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
PAVED	F2.1.PV	0.99	61700	1.4	10.28	2.8	3.90	4.1	5.80	F2.1	F2.1	Basin F2	101+00	Lt
	F2.2.PV	0.99	68500	1.6	10	2.8	4.39	4.2	6.56	F2.2	F2.2	Basin F2	101+50	Rt
	F2.3.PV	0.99	14400	0.3	5	4.0	1.30	6.6	2.16	~	F2.3	Basin F2	103+35	Rt
	F2.4.PV	0.99	56300	1.3	5	4.0	5.10	6.6	8.43	~	F2.4	Basin F2	108+00	Center
	F2.5.PV	0.99	35600	0.8	5	4.0	3.22	6.6	5.33	~	F2.5	Basin F2	108+00	Rt
	F2.6.PV	0.99	54100	1.2	5	4.0	4.90	6.6	8.10	~	F2.6	Basin F2	115+00	Lt
	F2.7.PV	0.99	54000	1.2	5	4.0	4.89	6.6	8.08	~	F2.7	Basin F2	115+00	Rt

Σ 344600 *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
SLOPE	F2.1.SL	0.61	47700	1.1	10.28	2.8	1.86	4.1	2.76	F2.1	F2.1	Basin F2	103+35	Lt
	F2.2.SL	0.61	15500	0.4	10	2.8	0.61	4.2	0.91	F2.2	F2.2	Basin F2	101+90	Rt
	F2.8.SL	0.61	61700	1.4	10	2.8	2.43	4.2	3.64	~	Culvert	Culvert	110+50	Lt
	F2.9.SL	0.61	63300	1.5	10	2.8	2.50	4.2	3.73	~	~	bypass*	110+50	Rt
	F2.10.SL	0.61	49800	1.1	10	2.8	1.96	4.2	2.94	~	F2.10	Basin F2	114+00	Rt

Σ 238000 *SLOPE*

** flow that does not reach the basin*

Total :	582600	13.4
	SF	*ac*

100' SHEET FLOW
667' SHALLOW CONCENTRATED FLOW
378' CHANNEL FLOW
100' STORM DRAIN FLOW
371' CHANNEL FLOW
957' CHANNEL FLOW
700' CHANNEL FLOW
"ENF1" LINE
"ENF2" LINE
"SD1" LINE
"SDR2" LINE
"ALTA" LINE
ALTA ROAD
WATERSHED F2
TWO INTERCHANGE
ALTERNATIVE
Scale: 1"=450'

F2 Post-Developed TcQ

PROJECT:	**SR-11**			**DESCRIPTION:**	**SR-11 Post-Developed**
JOB #:	**11A1190**			**STATION:**	**110+00**
BY:	**M.BRUNING**	**DATE:**	**01.04.10**	**WATERSHED:**	**F2**
CHK:	**G.DALZIEL**	**DATE:**		**SYSTEM:**	**Two Interchange Option**

BASIN AREA:

A =	**5547848**	**ft^2**	**SOURCE:**	**MICROSTATION/USGS**
	127.36	**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		

NOTES:

UNDEVELOPED AREA	89%	AT	0.47	0.421
PAVED SURFACE	6%	AT	0.90	0.056
COMMERCIAL AREA	0%	AT	0.85	0.000
CUT SLOPE (2:1 and 4:1)	4%	AT	0.55	0.024
TOTAL	100%			
	(100%)			

$C_{2,10}$ =	0.50
C_{25} =	0.55
C_{50} =	0.60
C_{100} =	0.63

TIME OF CONCENTRATION:

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

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	

F2 Post-Developed TcQ

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

HIGH PT ELEVATION	589.0	ft
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	
PIPE DIAMETER d	3.0	ft
HYDRAULIC RADIUS R	0.8	ft
VELOCITY (STORMDRAIN)	13.4	fps
T_C (SD)=	0.12	minutes

NOTES:

Exist Cross Culvert under berm

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	587.0	ft
LOW POINT ELEVATION	576.0	ft
ELEVATION DIFF (H)	11.0	ft
LENGTH (L)	311	ft
SLOPE (S) = (H/L)	3.5%	
MANNING'S n	0.080	
HYDRAULIC RADIUS R	0.9	ft
VELOCITY (CHANNEL)	3.30	fps
T_C (CH)=	1.57	minutes

NOTES:

defined broad channel south of berm (field verified new berm)

CHANNEL DATA		TYPE =	TRAP'Z
Z=	5	ANG-RAD	0.197
b =	50	ANG-DEG	11.310
d =	1	FLOWING FULL ASS'M	

Natural Channel

R=(bdsinA+d^2cosA)/(bsinA+2d)

From Manning's Equation assuming flowing full: $V=1.49/n(R^{2/3}S^{1/2})$

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

HIGH PT ELEVATION	576.0	ft
LOW POINT ELEVATION	555.0	ft
ELEVATION DIFF (H)	21.0	ft
LENGTH (L)	957	ft
SLOPE (S) = (H/L)	2.2%	
MANNING'S n	0.050	
HYDRAULIC RADIUS R	0.8	ft
VELOCITY (CHANNEL)	3.74	fps
T_C (CH)=	4.27	minutes

NOTES:

channel begins to narrow

CHANNEL DATA		TYPE =	TRAP'Z
Z=	2	ANG-RAD	0.464
b =	1	ANG-DEG	26.565
d =	1.5	FLOWING FULL ASS'M	

Natural Channel

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	555.0	ft
LOW POINT ELEVATION	546.0	ft
ELEVATION DIFF (H)	9.0	ft
LENGTH (L)	326	ft
SLOPE (S) = (H/L)	2.8%	
MANNING'S n	0.013	
PIPE DIAMETER d	4.0	ft
HYDRAULIC RADIUS R	1.0	ft
VELOCITY (STORMDRAIN)	19.0	fps
T_C (SD)=	0.29	minutes

NOTES:

Proposed Cross Culvert under SR-11

Outfall/Rip Rap Pad

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	546.0	ft
LOW POINT ELEVATION	536.0	ft
ELEVATION DIFF (H)	10.0	ft
LENGTH (L)	700	ft
SLOPE (S) = (H/L)	1.4%	
MANNING'S n	0.050	
HYDRAULIC RADIUS R	1.0	ft
VELOCITY (CHANNEL)	3.58	fps
T_C (CH)=	3.26	minutes

NOTES:

channellized - natural

CHANNEL DATA		TYPE =	TRAP'Z
Z=	2	ANG-RAD	0.464
b =	1	ANG-DEG	26.565
d =	2	FLOWING FULL ASS'M	

Natural Channel

R=(bdsinA+d^2cosA)/(bsinA+2d)

From Manning's Equation assuming flowing full: $V=1.49/n(R^{2/3}S^{1/2})$

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 =	59.2
Q_{10} =	86.1
Q_{25} =	118.3
Q_{50} =	154.9
Q_{100} =	**168.1**

COUNTY P_6

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

887' SHEET FLOW
887' SHALLOW CONCENTRATED FLOW
318' CHANNEL FLOW
100' STORM DRAIN FLOW
311' CHANNEL FLOW
887' CHANNEL FLOW
"ENF1" LINE
"ENF2" LINE
"SD11" LINE
"ALTA" LINE
ALTA ROAD
"SD11" LINE
"SDR2" LINE
CULVERT F2
TWO INTERCHANGE
ALTERNATIVE
Scale: 1"=450'

Culvert Calculator Report
F2 10-yr

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	559.00	ft	Headwater Depth/Height	0.98	
Computed Headwater Elevation	558.91	ft	Discharge	63.30	cfs
Inlet Control HW Elev.	558.60	ft	Tailwater Elevation	547.41	ft
Outlet Control HW Elev.	558.91	ft	Control Type	Entrance Control	

Grades					
Upstream Invert	555.00	ft	Downstream Invert	546.00	ft
Length	326.00	ft	Constructed Slope	2.8	%

Hydraulic Profile					
Profile	S2		Depth, Downstream	1.41	ft
Slope Type	Steep		Normal Depth	1.41	ft
Flow Regime	Supercritical		Critical Depth	2.40	ft
Velocity Downstream	16.05	ft/s	Critical Slope	0.4	%

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	4.00	ft
Section Size	48 inch		Rise	4.00	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	558.91	ft	Upstream Velocity Head	1.00	ft
Ke	0.50		Entrance Loss	0.50	ft

Inlet Control Properties					
Inlet Control HW Elev.	558.60	ft	Flow Control	Unsubmerged	
Inlet Type	Square edge w/headwall		Area Full	12.6	ft²
K	0.00980		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	1	
C	0.03980		Equation Form	1	
Y	0.67000				

Culvert Calculator Report
F2 100-yr

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	562.00	ft	Headwater Depth/Height	1.69	
Computed Headwater Elevation	561.78	ft	Discharge	128.40	cfs
Inlet Control HW Elev.	561.78	ft	Tailwater Elevation	548.11	ft
Outlet Control HW Elev.	561.37	ft	Control Type	Inlet Control	

Grades					
Upstream Invert	555.00	ft	Downstream Invert	546.00	ft
Length	326.00	ft	Constructed Slope	2.8	%

Hydraulic Profile					
Profile	S2		Depth, Downstream	2.11	ft
Slope Type	Steep		Normal Depth	2.09	ft
Flow Regime	Supercritical		Critical Depth	3.39	ft
Velocity Downstream	19.11	ft/s	Critical Slope	0.8	%

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	4.00	ft
Section Size	48 inch		Rise	4.00	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	561.37	ft	Upstream Velocity Head	1.98	ft
Ke	0.50		Entrance Loss	0.99	ft

Inlet Control Properties					
Inlet Control HW Elev.	561.78	ft	Flow Control	Submerged	
Inlet Type	Square edge w/headwall		Area Full	12.6	ft²
K	0.00980		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	1	
C	0.03980		Equation Form	1	
Y	0.67000				

F2 Culvert TcQ

PROJECT:	**SR-11**			**DESCRIPTION:**	**SR-11 Culvert**
JOB #:	**11A1190**			**STATION:**	**110+00**
BY:	**M.BRUNING**	**DATE:**	**11.17.09**	**WATERSHED:**	**F2**
CHK:	**G.DALZIEL**	**DATE:**		**SYSTEM:**	**Culvert**

BASIN AREA:

A =	**4110979**	**ft^2**	**SOURCE:**	**MICROSTATION/USGS**
	94.38	**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: $T_t = \frac{0.42 L^{4/5} n^{4/5}}{P_2^{1/2} s^{2/5}}$

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	

F2 Culvert TcQ

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

HIGH PT ELEVATION	589.0	ft
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	
PIPE DIAMETER d	3.0	ft
HYDRAULIC RADIUS R	0.8	ft
VELOCITY (STORMDRAIN)	13.4	fps
T_C (SD)=	0.12	minutes

NOTES:

Exist Cross Culvert under berm

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	587.0	ft
LOW POINT ELEVATION	576.0	ft
ELEVATION DIFF (H)	11.0	ft
LENGTH (L)	311	ft
SLOPE (S) = (H/L)	3.5%	
MANNING'S n	0.080	
HYDRAULIC RADIUS R	0.9	ft
VELOCITY (CHANNEL)	3.30	fps
T_C (CH)=	1.57	minutes

NOTES:

defined broad channel south of berm (field verified new berm)

CHANNEL DATA		TYPE =	TRAP'Z
Z=	5	ANG-RAD	0.197
b =	50	ANG-DEG	11.310
d =	1	FLOWING FULL ASS'M	

Natural Channel

R=(bdsinA+d^2cosA)/(bsinA+2d)

From Manning's Equation assuming flowing full: $V=1.49/n(R^{2/3}S^{1/2})$

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

HIGH PT ELEVATION	576.0	ft
LOW POINT ELEVATION	555.0	ft
ELEVATION DIFF (H)	21.0	ft
LENGTH (L)	957	ft
SLOPE (S) = (H/L)	2.2%	
MANNING'S n	0.050	
HYDRAULIC RADIUS R	0.8	ft
VELOCITY (CHANNEL)	3.74	fps
T_C (CH)=	4.27	minutes

NOTES:

channel begins to narrow

CHANNEL DATA		TYPE =	TRAP'Z
Z=	2	ANG-RAD	0.464
b =	1	ANG-DEG	26.565
d =	1.5	FLOWING FULL ASS'M	

Natural Channel

R=(bdsinA+d^2cosA)/(bsinA+2d)

From Manning's Equation assuming flowing full: $V=1.49/n(R^{2/3}S^{1/2})$

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 =**	33.7
i_{10} =	1.4	in/hr	X CA =	**Q_{10} =**	63.3
i_{25} =	1.8	in/hr	X CA =	**Q_{25} =**	87.0
i_{50} =	2.0	in/hr	X CA =	**Q_{50} =**	109.1
i_{100} =	2.3	in/hr	X CA =	**Q_{100} =**	**128.4**

~Use Caltrans 'i' for culvert sizing

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

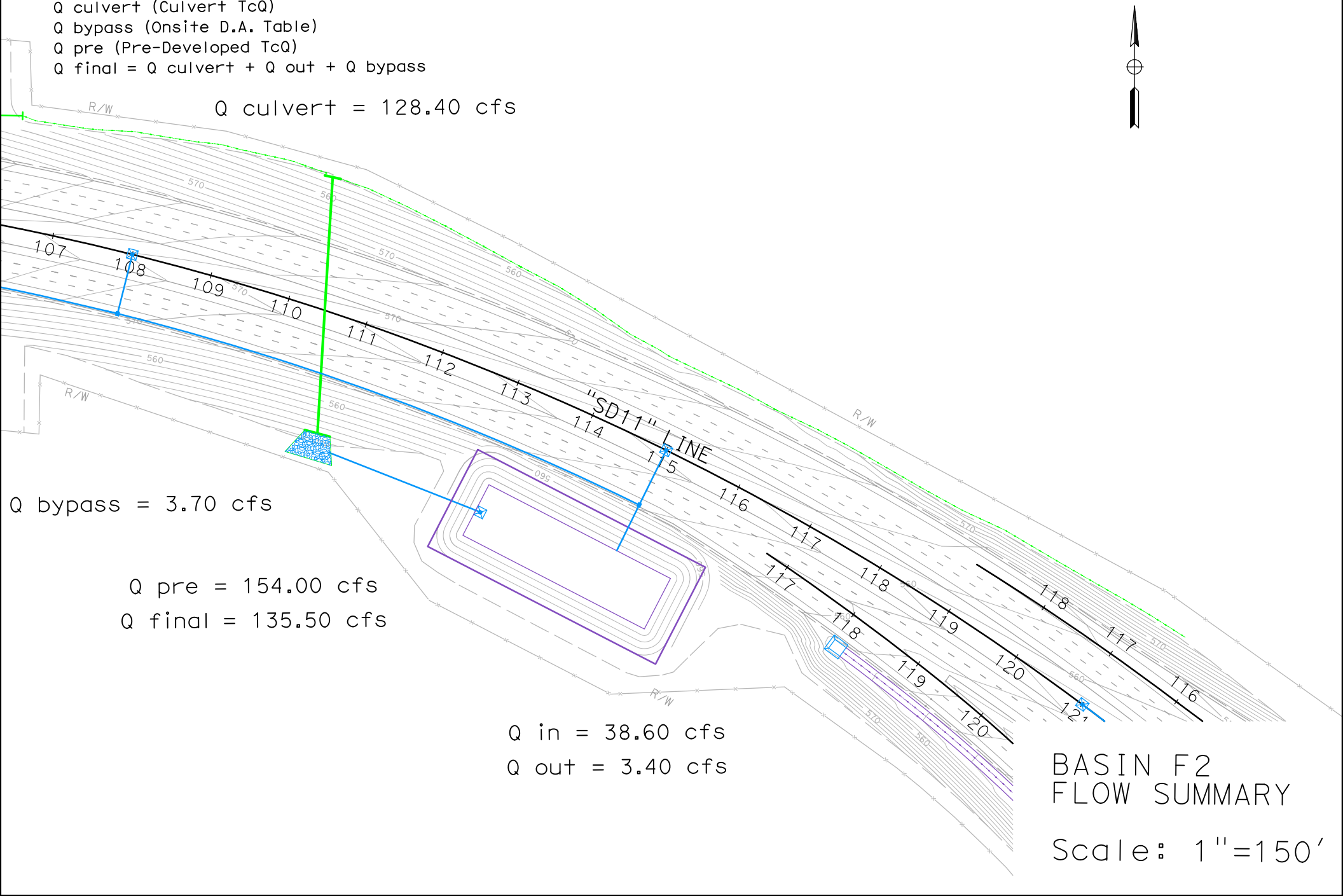
				FLOW RESULTS	**cfs**
i_2 =	1.0	in/hr	X CA =	**Q_2 =**	45.2
i_{10} =	1.5	in/hr	X CA =	**Q_{10} =**	65.7
i_{25} =	1.8	in/hr	X CA =	**Q_{25} =**	90.4
i_{50} =	2.2	in/hr	X CA =	**Q_{50} =**	118.3
i_{100} =	2.3	in/hr	X CA =	**Q_{100} =**	**128.4**

~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 F2
FLOW SUMMARY

Scale: 1"=150'

Basin F2 Retention

PROJECT:	**SR-11**			**DESCRIPTION:**	**SR-11 Basin**
JOB #:	**11A1190**			**STATION:**	**110+00**
BY:	**M.BRUNING**	**DATE:**	**01.04.10**	**WATERSHED:**	**F2**
CHK:	**G.DALZIEL**	**DATE:**		**SYSTEM:**	**Two 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

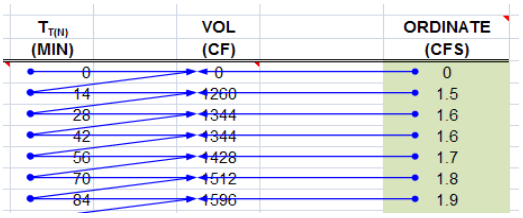
Q_{100}=	154.0	cfs			
Tc=	30.0	min	C=	0.59	
$P_{100,6}$=	2.5	in	A=	125.36	acres

$T_{T(N)}$ (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:



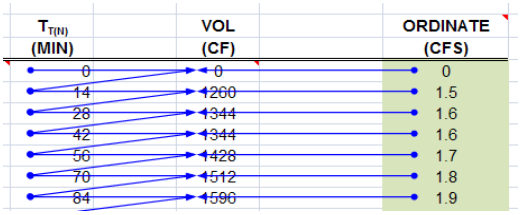
Basin F2 Retention

Post-Developed volume calculations

Q_{100}=	168.1	cfs			
Tc=	29.2	min	C=	0.63	
$P_{100,6}$=	2.5	in	A=	127.36	acres

$T_{T(N)}$ (MIN)	VOL (CF)	ORDINATE (CFS)
0	0	0
29	21750	12.5
58	23142	13.3
87	26448	15.2
116	28710	16.5
145	34974	20.1
174	39846	22.9
203	58638	33.7
232	85956	49.4
261	292494	168.1
290	46980	27
319	31494	18.1
348	24534	14.1
377	0	0

Example of Steps:



SUM= 714966 ft^3
16.41 acre-feet

Check: $V = C*A*P_6$
V= 16.59 acre-feet
OK

	16.41	*(Post)*			
-	**15.33**	*(Pre)*			
Retention volume =	**1.09**	**acre-feet**	**=**	**47346 ft^3**	**Basin Required**

Basin F2 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= 10.51 acres

WQ_{72}: 0.73 in/area

Water Quality Volume (WQV) = **27837** 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:

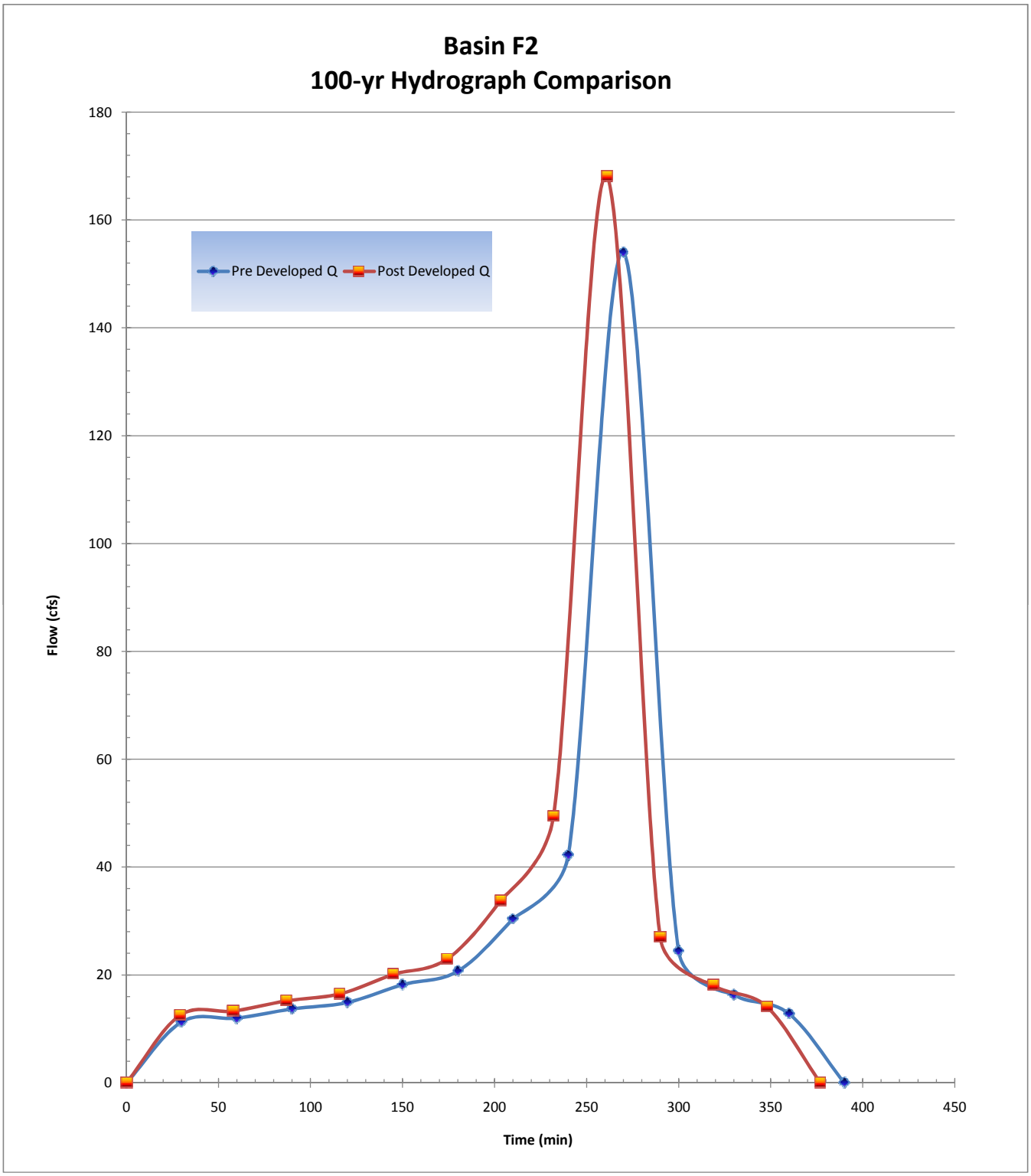
A_s = the computed soil loss in tons (dry weight)
R = the rainfall erosion index for the given storm period
K = the soil erodibility factor
L = the slope length factor
s = the slope gradient factor
C = cropping management (vegetation) factor
P = erosion control practice factor

Onsite Highway *Sloped* runoff area, A:		113000	ft^2
	A:	2.59	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 = 40.34 tons

Silt Accumulation Basin volume = **897** ft^3

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


Basin F2
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 F2 Inflow TcQ

PROJECT:	**SR-11**			**DESCRIPTION:**	**SR-11 Basin**
JOB #:	**11A1190**			**STATION:**	**110+00**
BY:	**M.BRUNING**	**DATE:**	**11.13.09**	**WATERSHED:**	**F2**
CHK:	**G.DALZIEL**	**DATE:**		**SYSTEM:**	**Two Interchange Option**

BASIN AREA:

A = **457600** **ft^2** **SOURCE:** **MICROSTATION/USGS**
10.51 **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	75%	AT	0.90	0.678
COMMERCIAL AREA	0%	AT	0.85	0.000
CUT SLOPE (2:1 and 4:1)	25%	AT	0.55	0.136
TOTAL	100%			
	(100%)			

$C_{2,10}$ =	0.81
C_{25} =	0.89
C_{50} =	1.00
C_{100} =	1.00

TIME OF CONCENTRATION:

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

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

HIGH PT ELEVATION	599.0	ft	Median to ES
LOW POINT ELEVATION	597.0	ft	
ELEVATION DIFF (H)	2.0	ft	
LENGTH (L)	113	ft	to ES
SLOPE (S) = (H/L)	1.8%		
MANNING'S n	0.016		AC < = FROM FIG 816.6A
T_t (SFF)=	2.52	minutes	

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

NOTES:

HIGH PT ELEVATION	597.0	ft	Flow in Bioswale
LOW POINT ELEVATION	596.0	ft	
ELEVATION DIFF (H)	1.0	ft	
LENGTH (L)	200	ft	assumed SCF and not channelized or flowing full yet
SLOPE (S) = (H/L)	0.5%		
VELOCITY (SCF)	1.0	fps	0.5% , V FROM FIG 816.6 grass lined
T_C (SH)=	3.33	minutes	

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

NOTES:

HIGH PT ELEVATION	596.0	ft	Flow in Bioswale
LOW POINT ELEVATION	585.0	ft	
ELEVATION DIFF (H)	11.0	ft	
LENGTH (L)	799	ft	
SLOPE (S) = (H/L)	1.4%		
MANNING'S n	0.050		
HYDRAULIC RADIUS R	0.80	ft	
VELOCITY (CHANNEL)	3.01	fps	
T_C (CH)=	4.42	minutes	

CHANNEL DATA TYPE = TRAP'Z

Z=	4	ANG-RAD	0.245
b =	13	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: $V=1.49/n(R^{2/3}S^{1/2})$

Basin F2 Inflow TcQ

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

HIGH PT ELEVATION	580.0	ft
LOW POINT ELEVATION	549.0	ft
ELEVATION DIFF (H)	31.0	ft
LENGTH (L)	1366	ft
SLOPE (S) = (H/L)	2.3%	
MANNING'S n	0.013	
PIPE DIAMETER d	2.0	ft
HYDRAULIC RADIUS R	0.5	ft
VELOCITY (STORMDRAIN)	10.9	fps
T_C (SD)=	2.09	minutes

NOTES:

Proposed onsite pipe (assumed 5' drop to invert)
Proposed Rip Rap Pad in Basin floor
RCP
R=D/4, Assume: flowing full
$V = \frac{K_u}{n} R^{2/3} S^{1/2}$

Tc (TOTAL) =	12.37	minutes
Minimum Tc =	10	minutes
USE T_C =	**12.37**	minutes

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

i_2 =	1.6	in/hr	X CA =
i_{10} =	2.4	in/hr	X CA =
i_{25} =	2.9	in/hr	X CA =
i_{50} =	3.5	in/hr	X CA =
i_{100} =	3.7	in/hr	X CA =

FLOW RESULTS

	cfs
Q_2 =	13.8
Q_{10} =	20.1
Q_{25} =	27.6
Q_{50} =	37.0
Q_{100} =	**38.6**

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 F2 Inflow Hydrograph

PROJECT:	**SR-11**			**DESCRIPTION:**	**SR-11 Basin**
JOB #:	**11A1190**			**STATION:**	**110+00**
BY:	**M.BRUNING**	**DATE:**	**11.17.09**	**WATERSHED:**	**F2**
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

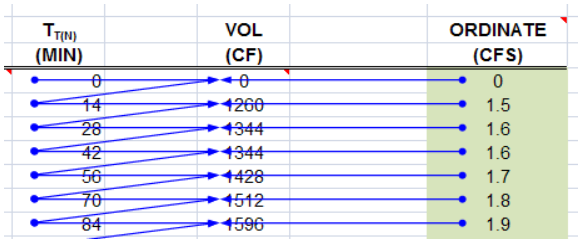
Basin Inflow Hydrograph

Basin Inflow Q

Q_{100}=	38.6	cfs	C_{100}=	1.00	
Tc=	12.4	min	A=	10.51	acres
$P_{100,6}$=	2.5	in			

$T_{T(N)}$ (MIN)	VOL (CF)	ORDINATE (CFS)
0	0	0
12	1152	1.6
24	1152	1.6
36	1224	1.7
48	1224	1.7
60	1296	1.8
72	1368	1.9
84	1440	2
96	1512	2.1
108	1584	2.2
120	1656	2.3
132	1800	2.5
144	1872	2.6
156	2088	2.9
168	2232	3.1
180	2520	3.5
192	2736	3.8
204	3384	4.7
216	3816	5.3
228	5616	7.8
240	8424	11.7
252	27792	38.6
264	4536	6.3
276	3024	4.2
288	2376	3.3
300	1944	2.7
312	1728	2.4
324	1512	2.1
336	1368	1.9
348	1296	1.8
360	1152	1.6
372	0	0

Example of Steps:



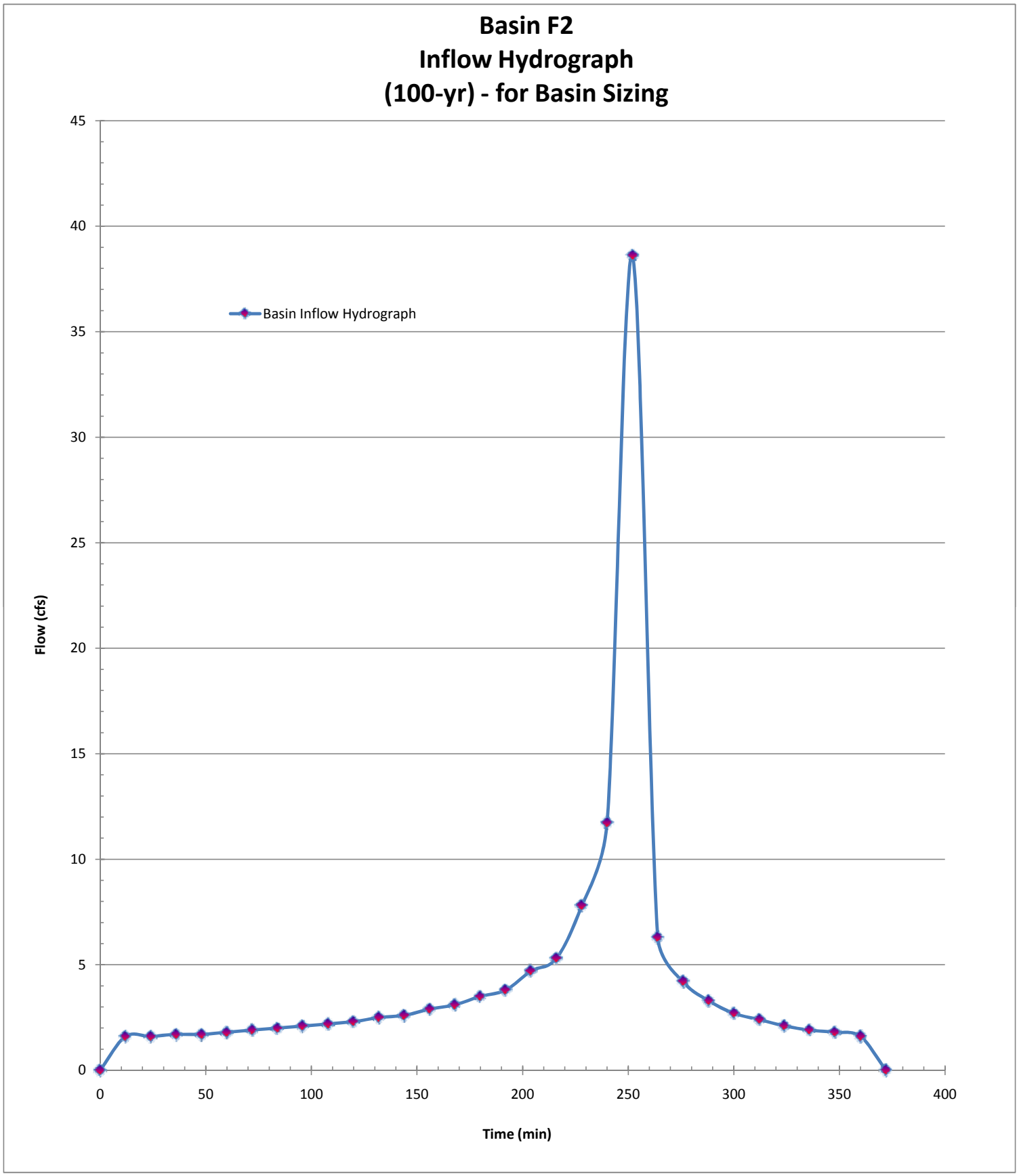
SUM= 94824 ft³
2.18 acre-feet

Onsite Runoff Volume

Check: $V = C*A*P_6$

V= 2.19 acre-feet

OK


Basin F2
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 F2 Outlet

PROJECT:	**SR-11**			**DESCRIPTION:**	**SR-11 Basin**
JOB #:	**11A1190**			**STATION:**	**113+00**
BY:	**M.BRUNING**	**DATE:**	**02.19.10**	**WATERSHED:**	**F2**
CHK:	**G.DALZIEL**	**DATE:**		**SYSTEM:**	**Basin Outlet**

Notes:

Required Retention Basin Volume = 48243 ft^3

Actual Basin Inflow = 94824 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:	128.4 cfs	~	Includes:	F2.8.SL
Flow that does not reach detention basin (bypass per DA table):	3.7 cfs	~	Q_{100} from:	F2.9.SL
Maximum flow allowed to be released by this detention basin:	21.9 cfs			

Outlet Pipe

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

Basin - Top of basin berm elevation =		558.00	ft
Basin flowline elevation =		552.00	ft
Maximum Basin Depth =		6.00	ft
Assume Culvert Design: free outfall, square-edge w/headwall			
Outlet pipe invert from basin floor =	2.00 ft	554.00	ft
Outlet pipe diameter =	2 ft		

Basin Characteristics

Base Length (L)	265	ft
Base Width (W)	85	ft
W/L Ratio ®	0.32	
Side Slopes (Z)	1: 4	
Total Volume (V):	190229	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	552.00	0.00	0	0		552.00	0.00		0.00
1	552.20	0.20	4561	4561		552.20	0.00		0.00
2	552.40	0.40	4674	9235		552.40	0.00		0.00
3	552.60	0.60	4788	14023		552.60	0.00		0.00
4	552.80	0.80	4903	18927		552.80	0.00		0.00
5	553.00	1.00	5019	23946		553.00	0.00		0.00
6	553.20	1.20	5137	29083		553.20	0.00		0.00
7	553.40	1.40	5255	34338		553.40	0.00		0.00
8	553.60	1.60	5374	39712		553.60	0.00		0.00
9	553.80	1.80	5494	45206		553.80	0.00		0.00
10	554.00	2.00	5616	50822	*	554.00	0.00	0.00	0.00
11	554.20	2.20	5738	56560		554.20	0.15		0.15
12	554.40	2.40	5862	62422		554.40	0.59		0.59
13	554.60	2.60	5986	68408		554.60	1.30		1.30
14	554.80	2.80	6112	74519		554.80	2.25		2.25
15	555.00	3.00	6238	80757		555.00	3.42		3.42
16	555.20	3.20	6366	87123		555.20	4.79		4.79
17	555.40	3.40	6494	93618		555.40	6.32		6.32
18	555.60	3.60	6624	100242		555.60	7.99		7.99
19	555.80	3.80	6755	106997		555.80	9.77		9.77
20	556.00	4.00	6887	113883		556.00	11.63		11.63

Basin F2 Routing

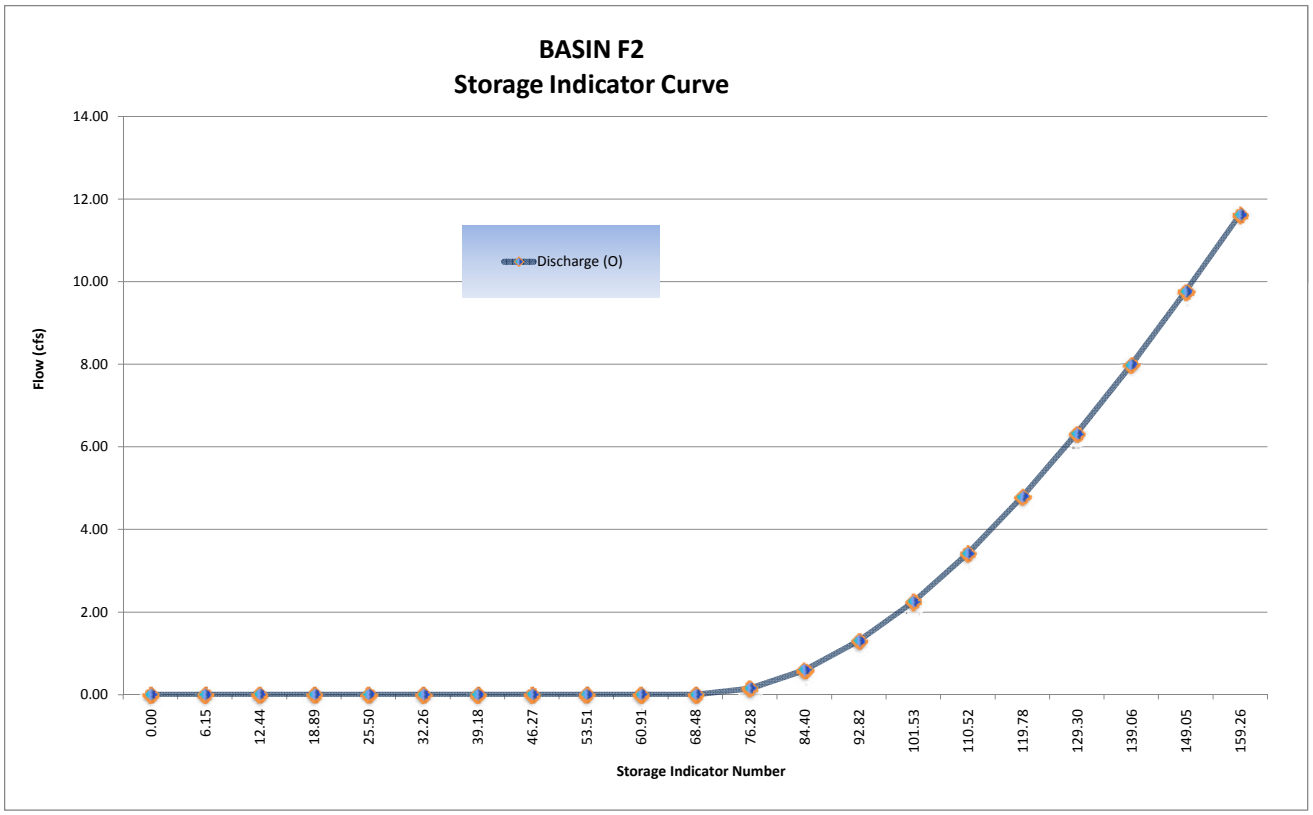
PROJECT:	**SR-11**		**DESCRIPTION:**	**SR-11 Basin**	
JOB #:	**11A1190**		**STATION:**	**110+00**	
BY:	**M.BRUNING**	**DATE:** **02.19.10**	**WATERSHED:**	**F**	
CHK:	**G.DALZIEL**	**DATE:**	**SYSTEM:**	**Basin**	**F2**

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)	*Storage Indicator #* (6) $S_2/delta\ t + O_2/2$ (cfs)
552.00	0.00	0	0.00	0.00	0.00
552.20	0.00	4561	0.00	6.15	6.15
552.40	0.00	9235	0.00	12.44	12.44
552.60	0.00	14023	0.00	18.89	18.89
552.80	0.00	18927	0.00	25.50	25.50
553.00	0.00	23946	0.00	32.26	32.26
553.20	0.00	29083	0.00	39.18	39.18
553.40	0.00	34338	0.00	46.27	46.27
553.60	0.00	39712	0.00	53.51	53.51
553.80	0.00	45206	0.00	60.91	60.91
554.00	0.00	50822	0.00	68.48	68.48
554.20	0.15	56560	0.08	76.21	76.28
554.40	0.59	62422	0.30	84.10	84.40
554.60	1.30	68408	0.65	92.17	92.82
554.80	2.25	74519	1.13	100.40	101.53
555.00	3.42	80757	1.71	108.81	110.52
555.20	4.79	87123	2.40	117.39	119.78
555.40	6.32	93618	3.16	126.14	129.30
555.60	7.99	100242	4.00	135.06	139.06
555.80	9.77	106997	4.89	144.16	149.05
556.00	11.63	113883	5.82	153.44	159.26

delta t = 0.21 hrs
delta t = 12 min
delta t = 742.1936 sec



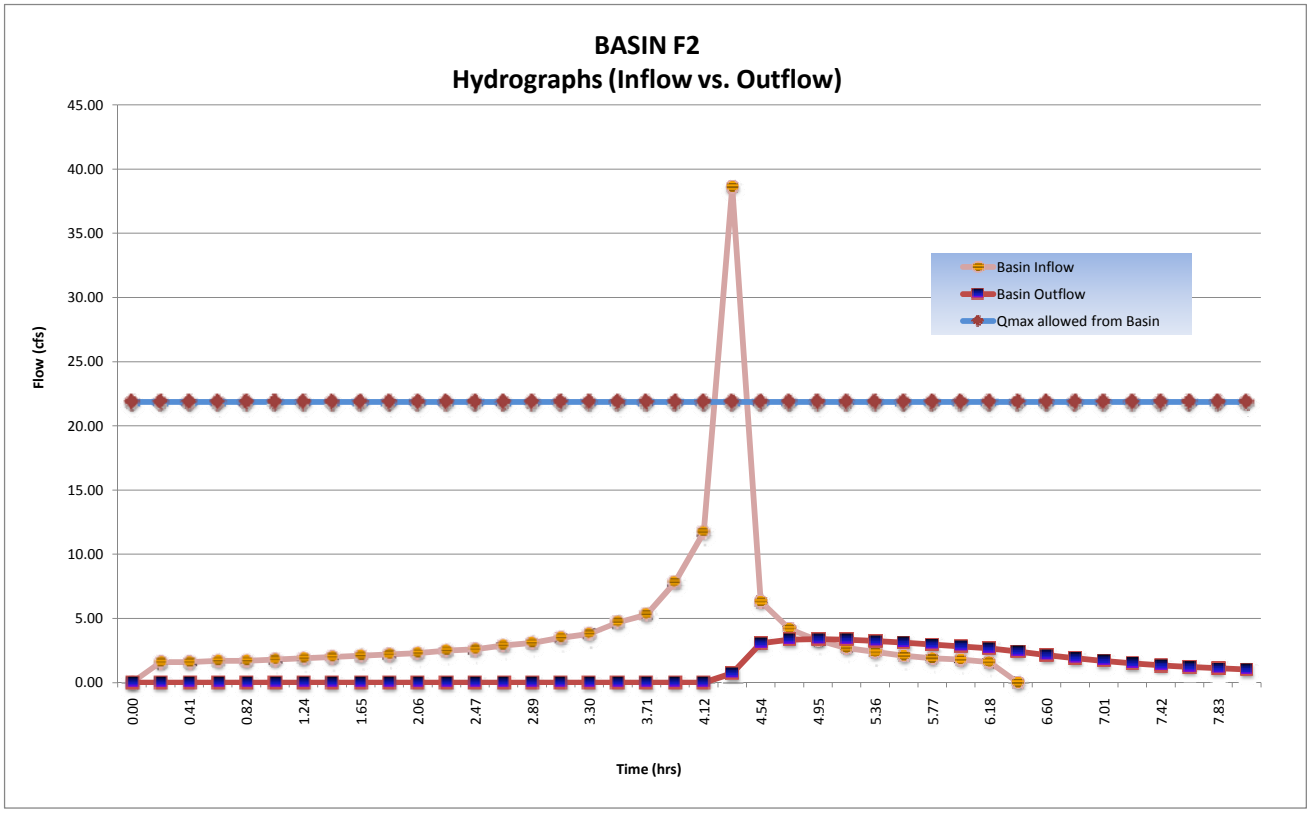
Basin F2 Routing

FINAL ROUTING TABLE

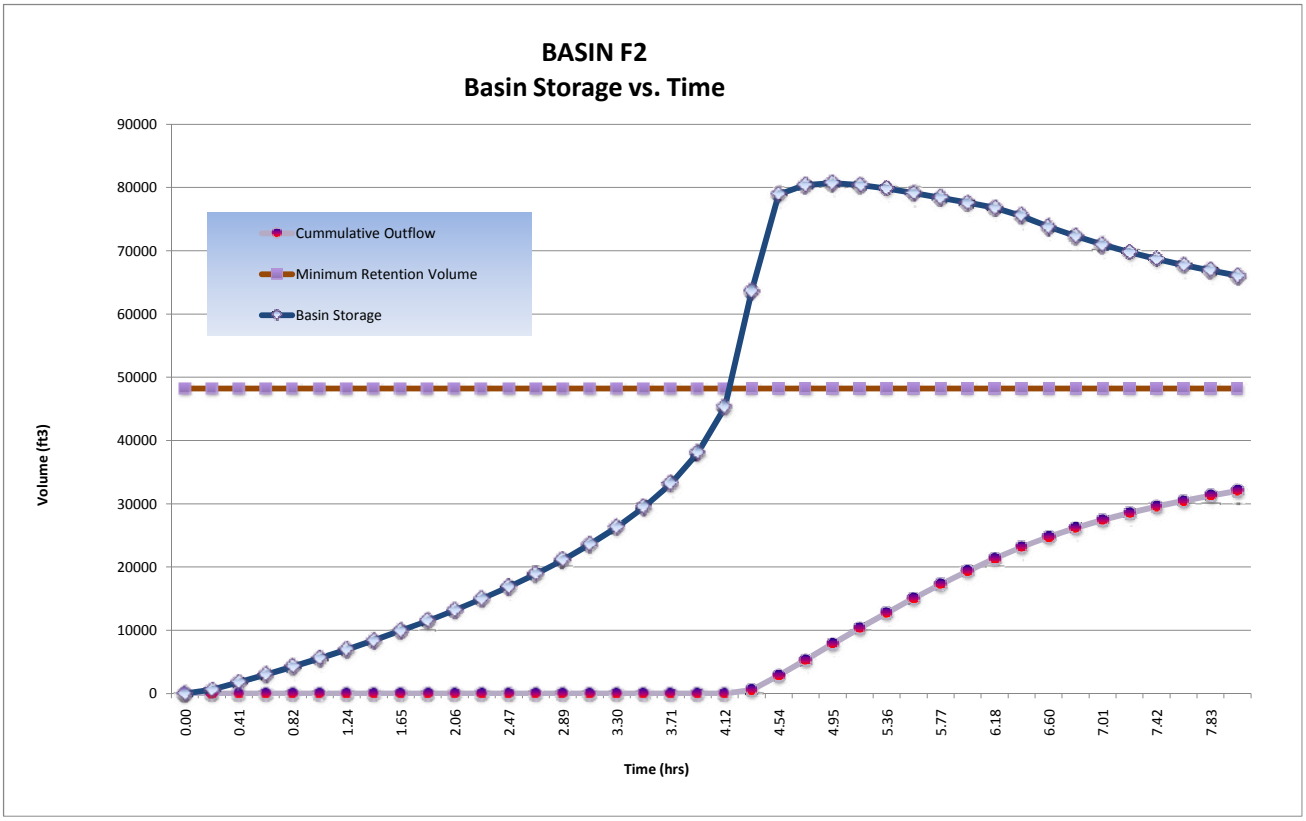
$$\frac{I_1 + I_2}{2} + \left(\frac{S_1}{\Delta t} - \frac{O_1}{2}\right) - O_1 - \left(\frac{S_2}{\Delta t} - \frac{O_2}{2}\right)$$

					Storage Indicator #				
(1)	(2)	(3)	(4)	(5)	(6)	(7)		Volumes (ft3)	
Time	Inflow	$(I_1+I_2)/2$	$(S_1/\text{delta t} + O_1/2)$	O_1	$S_2/\text{delta t} + O_2/2$	O_2	Basin	Incremental	Cummulative
(hrs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	Storage	Outflow	Outflow
	(Q_{post})		*col (6) from prev row*	*col (7) from prev row*	*col (3)+(4)-(5)*	*(Hard input)*	*Volume*	*Volume*	*Volume*
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
0.21	1.60	0.80	0.00	0.00	0.80	0.00	594	0	0
0.41	1.60	1.60	0.80	0.00	2.40	0.00	1781	0	0
0.62	1.70	1.65	2.40	0.00	4.05	0.00	3006	0	0
0.82	1.70	1.70	4.05	0.00	5.75	0.00	4268	0	0
1.03	1.80	1.75	5.75	0.00	7.50	0.00	5566	0	0
1.24	1.90	1.85	7.50	0.00	9.35	0.00	6940	0	0
1.44	2.00	1.95	9.35	0.00	11.30	0.00	8387	0	0
1.65	2.10	2.05	11.30	0.00	13.35	0.00	9908	0	0
1.86	2.20	2.15	13.35	0.00	15.50	0.00	11504	0	0
2.06	2.30	2.25	15.50	0.00	17.75	0.00	13174	0	0
2.27	2.50	2.40	17.75	0.00	20.15	0.00	14955	0	0
2.47	2.60	2.55	20.15	0.00	22.70	0.00	16848	0	0
2.68	2.90	2.75	22.70	0.00	25.45	0.00	18889	0	0
2.89	3.10	3.00	25.45	0.00	28.45	0.00	21115	0	0
3.09	3.50	3.30	28.45	0.00	31.75	0.00	23565	0	0
3.30	3.80	3.65	31.75	0.00	35.40	0.00	26274	0	0
3.50	4.70	4.25	35.40	0.00	39.65	0.00	29428	0	0
3.71	5.30	5.00	39.65	0.00	44.65	0.00	33139	0	0
3.92	7.80	6.55	44.65	0.00	51.20	0.00	38000	0	0
4.12	11.70	9.75	51.20	0.00	60.95	0.00	45237	0	0
4.33	38.60	25.15	60.95	0.00	86.10	0.73	63632	542	542
4.54	6.30	22.45	86.10	0.73	107.82	3.07	78884	2279	2820
4.74	4.20	5.25	107.82	3.07	110.00	3.35	80398	2486	5307
4.95	3.30	3.75	110.00	3.35	110.40	3.40	80676	2523	7830
5.15	2.70	3.00	110.40	3.40	110.00	3.35	80398	2486	10316
5.36	2.40	2.55	110.00	3.35	109.20	3.25	79841	2412	12729
5.57	2.10	2.25	109.20	3.25	108.20	3.12	79148	2316	15044
5.77	1.90	2.00	108.20	3.12	107.08	2.97	78372	2204	17249
5.98	1.80	1.85	107.08	2.97	105.96	2.83	77593	2100	19349
6.18	1.60	1.70	105.96	2.83	104.83	2.68	76810	1989	21338
6.39	0.00	0.80	104.83	2.68	102.95	2.43	75507	1804	23142
6.60		0.00	102.95	2.43	100.52	2.14	73811	1588	24730
6.80		0.00	100.52	2.14	98.38	1.91	72308	1418	26147
7.01		0.00	98.38	1.91	96.47	1.70	70969	1262	27409
7.22		0.00	96.47	1.70	94.77	1.51	69777	1121	28530
7.42		0.00	94.77	1.51	93.26	1.35	68716	1002	29532
7.63		0.00	93.26	1.35	91.91	1.22	67762	905	30437
7.83		0.00	91.91	1.22	90.69	1.12	66894	831	31269
8.04		0.00	90.69	1.12	89.57	1.03	66096	764	32033

Basin F2 Routing



Basin F2 Routing



Detention/Retention Basin Volume Required:	**80,676**	**ft^3**	
@ Stage:	**555.00**	**ft**	
Freeboard:	**3.0**	**ft**	> 1' Freeboard
Final Total Basin Volume Provided:	**190,229**	**ft^3**	Basin **F2**
Maximum flow rate released from this basin:	**3.40**	**cfs**	

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G2 Onsite D.A. Table

PROJECT: SR-11
JOB #: 11A1190
BY: M.BRUNING **DATE:** 1.11.10
CHK: G.DALZIEL **DATE:**

DESCRIPTION: Onsite Drainage Areas (D.A.)
STATION: ~
WATERSHED: G2
SYSTEM: Two Interchange Option

			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
PAVED	G2.1.PV	0.99	48800	1.1	5	4.0	4.44	6.6	7.31	~	G2.1	Basin G2 North	127+00	Rt
	G2.2.PV	0.99	52300	1.2	5	4.0	4.76	6.6	7.83	~	G2.2	Basin G2 North	121+00	Center
	G2.3.PV	0.99	46100	1.1	5	4.0	4.19	6.6	6.90	~	G2.3	Basin G2 North	127+00	Center
	G2.4.PV	0.99	28600	0.7	5	4.0	2.60	6.6	4.28	~	G2.4	Basin G2 North	131+50	Center
	G2.5.PV	0.99	45900	1.1	5	4.0	4.17	6.6	6.87	~	G2.5	Basin G2 South	139+00	Lt
	G2.6.PV	0.99	25800	0.6	5	4.0	2.35	6.6	3.86	~	G2.6	Basin G2 South	139+00	Rt
	G2.7.PV	0.99	11200	0.3	5	4.0	1.02	6.6	1.68	~	G2.7	Basin G2 South	135+00	Rt
	G2.8.PV	0.99	21200	0.5	5	4.0	1.93	6.6	3.17	~	G2.8	Basin G2 South	131+80	SDR2
	G2.9.PV	0.99	38500	0.9	10	2.8	2.48	4.2	3.69	G2.9	G2.9	Basin G2 South	135+00	SV2
	G2.10.PV	0.99	30300	0.7	5	4.0	2.76	6.6	4.54	~	G2.10	Basin G2 North	131+50	Rt
	G2.11.PV	0.99	6100	0.1	5	4.0	0.55	6.6	0.91	~	G2.11	Basin G2 North	131+50	SV2
	G2.12.PV	0.99	26200	0.6	5	4.0	2.38	6.6	3.92	~	G2.12	Basin G2 North	105+00	SV1
	G2.13.PV	0.99	23000	0.5	5	4.0	2.09	6.6	3.44	~	G2.13	Basin G2 North	105+00	SV1
	G2.14.PV	0.99	18000	0.4	5	4.0	1.64	6.6	2.69	~	G2.14	Basin G2 North	102+00	SV1
	G2.15.PV	0.99	16700	0.4	5	4.0	1.52	6.6	2.50	~	G2.15	Basin G2 North	102+00	SV1
	G2.16.PV	0.99	37300	0.9	5	4.0	3.39	6.6	5.58	~	G2.16	Basin G2 South	139+00	SDR2
	G2.17.PV	0.99	63400	1.5	5	4.0	5.76	6.6	9.49	~	G2.17	Basin G2 South	139+00	SV2
	G2.18.PV	0.99	75300	1.7	5	4.0	6.85	6.6	11.27	~	G2.18	Basin G2 South	Toll 1 Bldg	~
	G2.19.PV	0.99	59500	1.4	5	4.0	5.41	6.6	8.91	~	G2.19	Basin G2 South	Toll 2 Prkg	~
	G2.20.PV	0.99	89500	2.1	10	2.8	5.75	4.2	8.57	G2.20	G2.20	Basin G2 North	123+00	SDR2
	G2.21.PV	0.99	38100	0.9	5	4.0	3.46	6.6	5.70	~	G2.21	Basin G2 North	114+00	SV4
	G2.22.PV	0.99	11000	0.3	5	4.0	1.00	6.6	1.65	~	G2.22	Basin G2 South	100+00	SV1
	G2.23.PV	0.99	11000	0.3	5	4.0	1.00	6.6	1.65	~	G2.23	Basin G2 South	100+00	SV1
	G2.27.PV	0.99	34900	0.8	5	4.0	3.17	6.6	5.22	~	~	bypass*	96+50	SV1

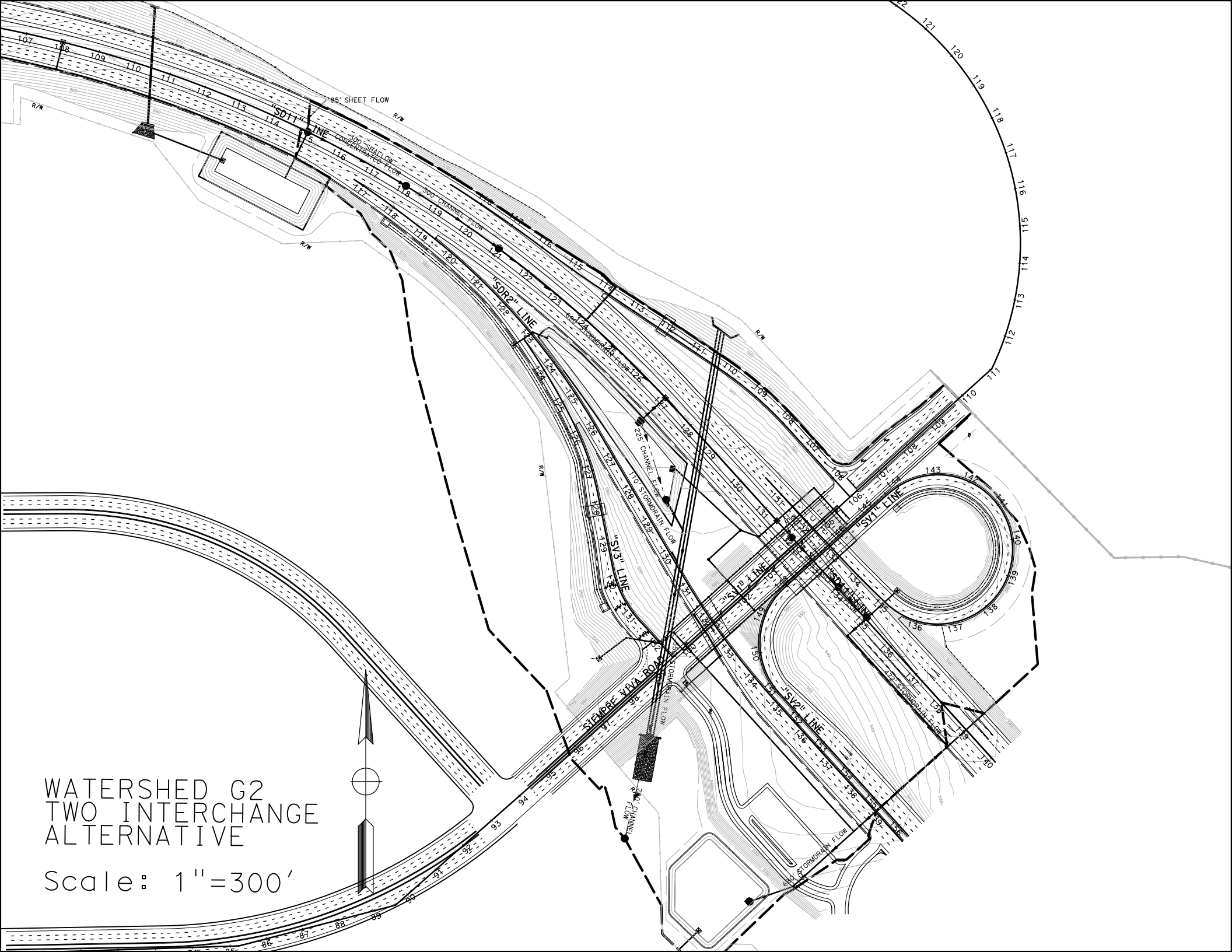
Σ 858700 *PAVED*

			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
SLOPE	G2.5.SL	0.61	14900	0.3	10	2.8	0.59	4.2	0.88	~	G2.5	Basin G2 South	139+00	Lt
	G2.6.SL	0.61	71700	1.6	10	2.8	2.84	4.2	4.23	~	G2.6	Basin G2 South	139+00	Rt
	G2.7.SL	0.61	30300	0.7	10	2.8	1.20	4.2	1.79	~	G2.7	Basin G2 South	135+00	Rt
	G2.8.SL	0.61	48800	1.1	10	2.8	1.93	4.2	2.88	~	G2.8	Basin G2 South	131+80	SDR2
	G2.9.SL	0.61	92200	2.1	10	2.8	3.65	4.2	5.44	G2.9	G2.9	Basin G2 South	135+00	SV2
	G2.11.SL	0.61	56700	1.3	10	2.8	2.25	4.2	3.34	~	G2.11	Basin G2 North	131+50	SV2
	G2.20.SL	0.61	63000	1.4	10	2.8	2.50	4.2	3.72	G2.20	G2.20	Basin G2 North	123+00	SDR2
	G2.24.SL	0.61	56700	1.3	10	2.8	2.25	4.2	3.34	~	G2.24	Basin G2 South	139+00	Lt
	G2.25.SL	0.61	132900	3.1	10	2.8	5.26	4.2	7.84	~	G2.25	Basin G2 North	130+50	SDR2
	G2.26.SL	0.61	101200	2.3	10	2.8	4.01	4.2	5.97	~	G2.26	Basin G2 South	135+00	Rt
	G2.27.SL	0.61	74200	1.7	10	2.8	2.94	4.2	4.38	~	~	bypass*	96+50	SV1

Σ 742600 *SLOPE*

* flow that does not reach the basin

Total :	1601300	36.8
	SF	*ac*


WATERSHED G2
TWO INTERCHANGE
ALTERNATIVE
Scale: 1"=300'
"SD11" LINE
"SDR2" LINE
"SV3" LINE
"SV1" LINE
"SV2" LINE
SIEMPRE VIVA ROAD
85' SHEET FLOW
300' SHALLOW CONCENTRATED FLOW
300' CHANNEL FLOW
690' STORMDRAIN FLOW
225' CHANNEL FLOW
110' STORMDRAIN FLOW
472' STORMDRAIN FLOW
R/W

G2 Post-Developed TcQ

PROJECT:	**SR-11**			**DESCRIPTION:**	**SR-11 Post-Developed**
JOB #:	**11A1190**			**STATION:**	**139+00**
BY:	**M.BRUNING**	**DATE:**	**1.11.10**	**WATERSHED:**	**G2**
CHK:	**G.DALZIEL**	**DATE:**		**SYSTEM:**	**Two Interchange Option**

BASIN AREA:

A =	**1974747**	**ft^2**	**SOURCE:**	**MICROSTATION/USGS**
	45.33	**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	19%	AT	0.39	0.074
PAVED SURFACE	43%	AT	0.90	0.391
COMMERCIAL AREA	0%	AT	0.85	0.000
CUT SLOPE (2:1 and 4:1)	38%	AT	0.55	0.207
TOTAL	100%			
	(100%)			

$C_{2,10}$ =	0.67
C_{25} =	0.74
C_{50} =	0.81
C_{100} =	0.84

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	569.0	ft	From asphalt, superelevation
LOW POINT ELEVATION	564.0	ft	
ELEVATION DIFF (H)	5.0	ft	
LENGTH (L)	85	ft	
SLOPE (S) = (H/L)	5.9%		
MANNING'S n	0.016		< = FROM TABLE 816.6A Asphalt Paving
T_t (SFF)=	1.24	minutes	

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

NOTES:

HIGH PT ELEVATION	564.0	ft	within median, low flows, not 'channel'
LOW POINT ELEVATION	561.0	ft	
ELEVATION DIFF (H)	3.0	ft	
LENGTH (L)	300	ft	
SLOPE (S) = (H/L)	1.0%		
VELOCITY (SCF)	1.3	fps	<=V FROM FIG 816.5 nearly bare ground
T_C (SH)=	4.00	minutes	

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

NOTES:

HIGH PT ELEVATION	561.0	ft	median ditch
LOW POINT ELEVATION	557.0	ft	
ELEVATION DIFF (H)	4.0	ft	
LENGTH (L)	300	ft	
SLOPE (S) = (H/L)	1.3%		
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)	2.12	fps	From Manning's Equation assuming flowing full: $V=1.49/n(R^{2/3}S^{1/2})$
T_C (CH)=	2.35	minutes	

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

G2 Post-Developed TcQ

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

HIGH PT ELEVATION	552.0	ft
LOW POINT ELEVATION	542.0	ft
ELEVATION DIFF (H)	10.0	ft
LENGTH (L)	690	ft
SLOPE (S) = (H/L)	1.4%	
MANNING'S n	0.013	
PIPE DIAMETER d	2.0	ft
HYDRAULIC RADIUS R	0.5	ft
VELOCITY (STORMDRAIN)	8.7	fps
T_C (SD)=	1.32	minutes

NOTES:

Proposed storm drain through median (elev at pipe invert)
Sta 127+00

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	542.0	ft
LOW POINT ELEVATION	540.0	ft
ELEVATION DIFF (H)	2.0	ft
LENGTH (L)	225	ft
SLOPE (S) = (H/L)	0.9%	
MANNING'S n	0.050	
HYDRAULIC RADIUS R	0.5	ft
VELOCITY (CHANNEL)	1.73	fps
T_C (CH)=	2.16	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	540.0	ft
LOW POINT ELEVATION	534.0	ft
ELEVATION DIFF (H)	6.0	ft
LENGTH (L)	110	ft
SLOPE (S) = (H/L)	5.5%	
MANNING'S n	0.013	
PIPE DIAMETER d	2.0	ft
HYDRAULIC RADIUS R	0.5	ft
VELOCITY (STORMDRAIN)	16.9	fps
T_C (SD)=	0.11	minutes

NOTES:

Proposed storm drain connecting to cross culvert
Sta 135+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	534.0	ft
LOW POINT ELEVATION	523.0	ft
ELEVATION DIFF (H)	11.0	ft
LENGTH (L)	550	ft
SLOPE (S) = (H/L)	2.0%	
MANNING'S n	0.013	
PIPE DIAMETER d	4.0	ft
HYDRAULIC RADIUS R	1.0	ft
VELOCITY (STORMDRAIN)	16.2	fps
T_C (SD)=	0.57	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	523.0	ft
LOW POINT ELEVATION	515.0	ft
ELEVATION DIFF (H)	8.0	ft
LENGTH (L)	280	ft
SLOPE (S) = (H/L)	2.9%	
MANNING'S n	0.055	
HYDRAULIC RADIUS R	0.6	ft
VELOCITY (CHANNEL)	3.21	fps
T_C (CH)=	1.46	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: $V=1.49/n(R^{2/3}S^{1/2})$

G2 Post-Developed TcQ

Tc (TOTAL) =	13.21	minutes
Minimum Tc =	10	minutes
USE Tc =	**13.21**	minutes

INTENSITY CHART:

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

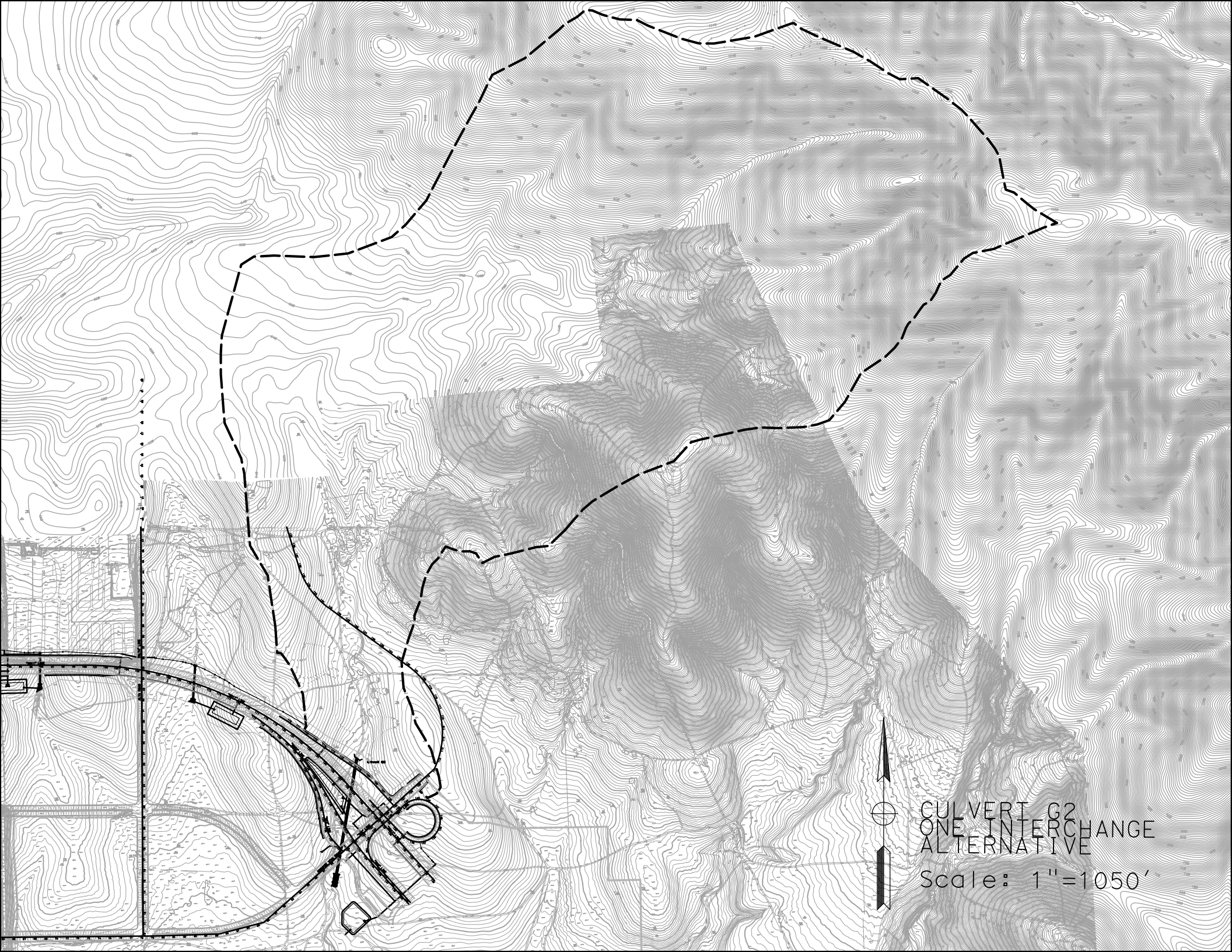
i_2 =	1.5	in/hr	X CA =	
i_{10} =	2.3	in/hr	X CA =	
i_{25} =	2.8	in/hr	X CA =	
i_{50} =	3.4	in/hr	X CA =	
i_{100} =	3.5	in/hr	X CA =	

FLOW RESULTS:

	cfs
Q_2 =	47.2
Q_{10} =	68.6
Q_{25} =	94.3
Q_{50} =	123.5
Q_{100} =	**134.0**

COUNTY P_6

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


CULVERT G2
ONE INTERCHANGE
ALTERNATIVE
Scale: 1"=1050'

Culvert Calculator Report
G2 100-yr

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	548.00	ft	Headwater Depth/Height	1.85	
Computed Headwater Elevation	547.39	ft	Discharge	658.00	cfs
Inlet Control HW Elev.	547.39	ft	Tailwater Elevation	518.04	ft
Outlet Control HW Elev.	546.56	ft	Control Type	Inlet Control	

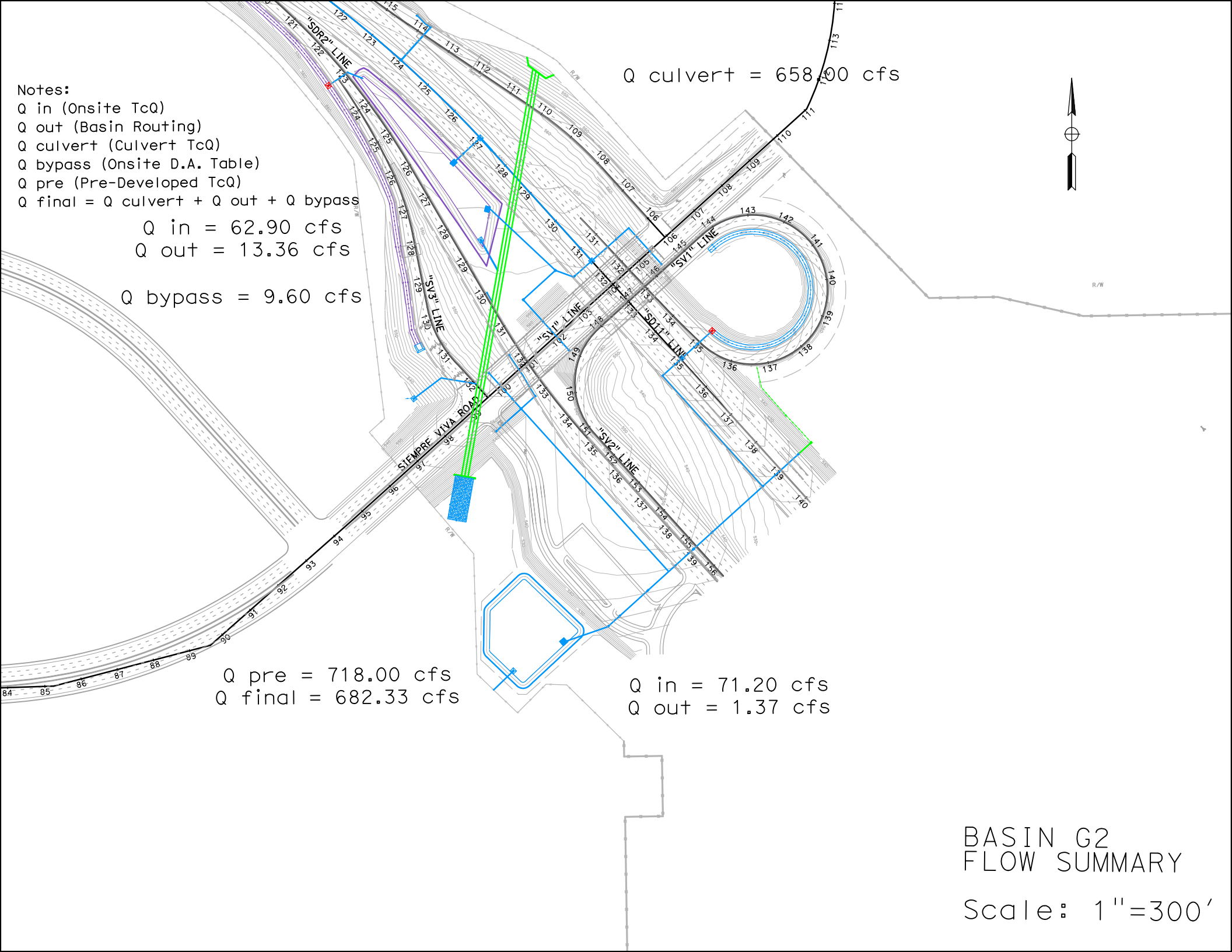
Grades					
Upstream Invert	540.00	ft	Downstream Invert	516.00	ft
Length	1,150.00	ft	Constructed Slope	2.1	%

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	20.17	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.	546.56	ft	Upstream Velocity Head	1.87	ft
Ke	0.50		Entrance Loss	0.94	ft

Inlet Control Properties					
Inlet Control HW Elev.	547.39	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				


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
Q in = 62.90 cfs
Q out = 13.36 cfs
Q bypass = 9.60 cfs
Q culvert = 658.00 cfs
Q pre = 718.00 cfs
Q final = 682.33 cfs
Q in = 71.20 cfs
Q out = 1.37 cfs
"SDR2" LINE
"SV3" LINE
"SV1" LINE
"SD1" LINE
"SV2" LINE
SIEMPRE VIVA ROAD
R/W
BASIN G2
FLOW SUMMARY
Scale: 1"=300'

Basin G2 Retention

PROJECT:	**SR-11**			**DESCRIPTION:**	**SR-11 Basin**
JOB #:	**11A1190**			**STATION:**	**139+00**
BY:	**M.BRUNING**	**DATE:**	**01.11.10**	**WATERSHED:**	**G2**
CHK:	**G.DALZIEL**	**DATE:**		**SYSTEM:**	**Two Interchange Option**

Notes:

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

RETENTION VOLUME

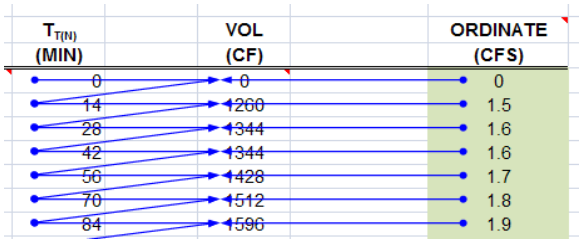
100-year, 6 hour duration storm event, use the Rational Method Hydrograph Procedure (SDCHM 6-1) ~ RatHydro

Pre-Developed volume calculations

Q_{100}=	60.0	cfs			
Tc=	17.0	min	C=	0.49	
$P_{100,6}$=	2.5	in	A=	41.08	acres

$T_{T(N)}$ (MIN)	VOL (CF)	ORDINATE (CFS)
0	0	0
17	3060	3
34	3162	3.1
51	3468	3.4
68	3570	3.5
85	3876	3.8
102	4080	4
119	4488	4.4
136	4794	4.7
153	5508	5.4
170	5916	5.8
187	7242	7.1
204	8262	8.1
221	12138	11.9
238	17340	17
255	61200	60
272	9792	9.6
289	6528	6.4
306	5100	5
323	4284	4.2
340	3672	3.6
357	3366	3.3
374	0	0

Example of Steps:



SUM= 180846 ft^3
4.15 acre-feet

Check: V = C*A*P_6
V= 4.17 acre-feet
OK

Basin G2 Retention

Post-Developed volume calculations

Q_{100}= 134.0 cfs
Tc= 13.2 min
$P_{100,6}$= 2.5 in

C= 0.84
A= 45.33 acres

$T_{T(N)}$ (MIN)	VOL (CF)	ORDINATE (CFS)
0	0	0
13	0	0
26	4524	5.8
39	4680	6
52	4914	6.3
65	5070	6.5
78	5382	6.9
91	5538	7.1
104	5928	7.6
117	6162	7.9
130	6708	8.6
143	7020	9
156	7800	10
169	8268	10.6
182	9438	12.1
195	10218	13.1
208	12480	16
221	14274	18.3
234	20904	26.8
247	30576	39.2
260	104520	134
273	16770	21.5
286	11232	14.4
299	8814	11.3
312	7332	9.4
325	6396	8.2
338	5694	7.3
351	5148	6.6
364	4758	6.1
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= 340548 ft^3
7.82 acre-feet

Check: $V = C*A*P_6$
V= 7.93 acre-feet
OK

Retention volume = **7.82** − **4.15** = **3.67** **acre-feet** = **159702 ft^3** **Basin Required**

Basin G2 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}= 0.96 — Max C from North/South Onsite
A= 34.26 acres — Sum of North/South Onsite Area

WQ_{72}: 0.73 in/area

Water Quality Volume (WQV) = **90776** 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

Universal Soil Loss Equation (SDCHM 5.2.3)

$A_s = RKLsCP$

where:

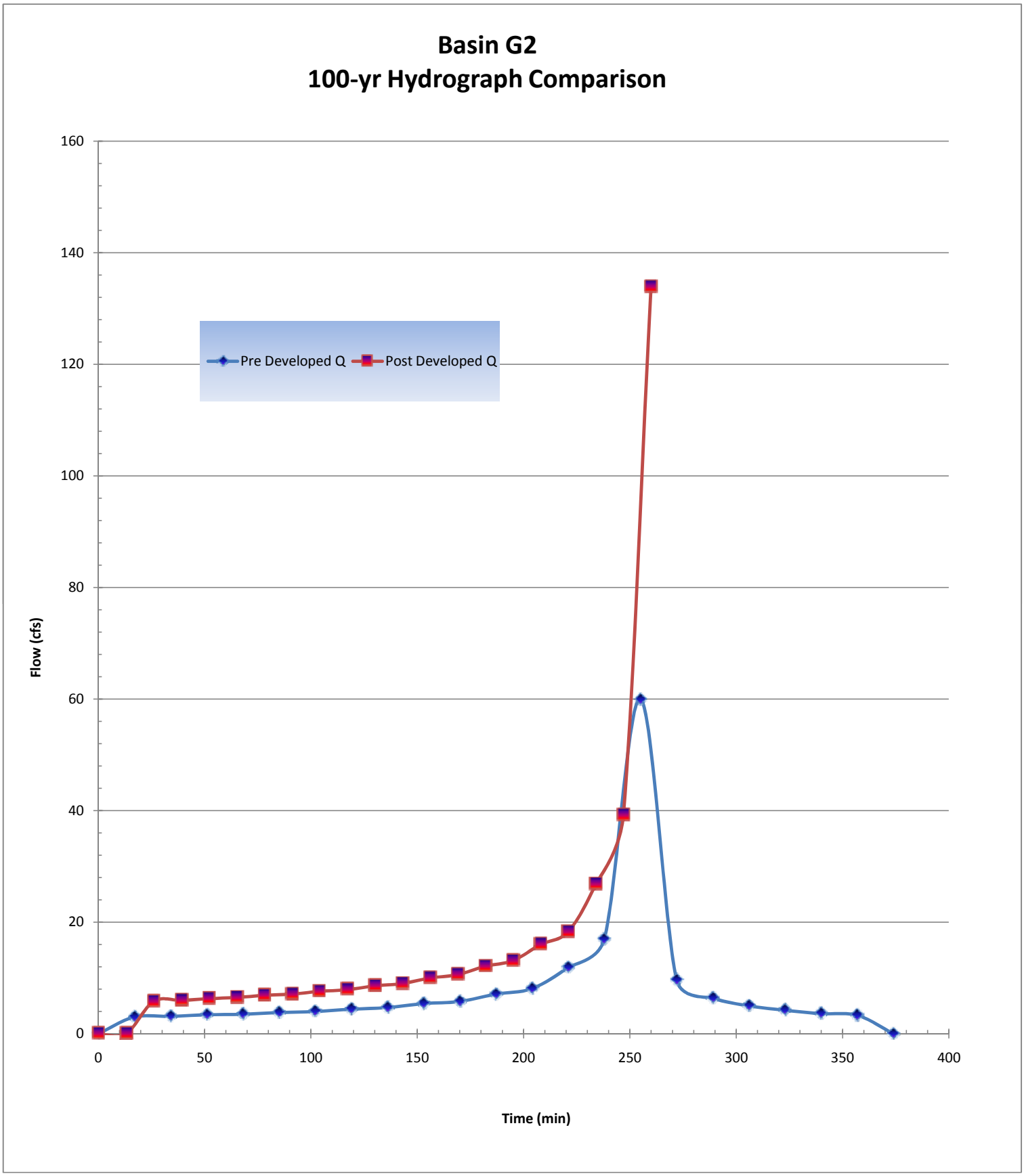
A_s = the computed soil loss in tons (dry weight)
R = the rainfall erosion index for the given storm period
K = the soil erodibility factor
L = the slope length factor
s = the slope gradient factor
C = cropping management (vegetation) factor
P = erosion control practice factor

Onsite Highway *Sloped* runoff area, A:		668400	ft^2
	A:	15.34	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 = 238.64 tons

Silt Accumulation Basin volume = **5303** ft^3

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


Basin G2
100-yr Hydrograph Comparison
Pre Developed Q
Post Developed Q
Flow (cfs)
Time (min)
0
20
40
60
80
100
120
140
160
0
50
100
150
200
250
300
350
400

Basin G2-North Inflow TcQ

PROJECT:	**SR-11**			**DESCRIPTION:**	**SR-11 Basin**
JOB #:	**11A1190**			**STATION:**	**127+00**
BY:	**M.BRUNING**	**DATE:**	**01.11.10**	**WATERSHED:**	**G2**
CHK:	**G.DALZIEL**	**DATE:**		**SYSTEM:**	**Basin G2-North**

BASIN AREA:

A = **676300** **ft^2** **SOURCE:** **MICROSTATION/USGS**
15.53 **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	63%	AT	0.90	0.564
COMMERCIAL AREA	0%	AT	0.85	0.000
CUT SLOPE (2:1 and 4:1)	37%	AT	0.55	0.205
TOTAL	100%			
	(100%)			

$C_{2,10}$ =	0.77
C_{25} =	0.85
C_{50} =	0.92
C_{100} =	0.96

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	569.0	ft	From asphalt, superelevation
LOW POINT ELEVATION	564.0	ft	
ELEVATION DIFF (H)	5.0	ft	
LENGTH (L)	85	ft	
SLOPE (S) = (H/L)	5.9%		
MANNING'S n	0.016		< = FROM TABLE 816.6A Asphalt Paving
T_t (SFF)=	1.24	minutes	

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

NOTES:

HIGH PT ELEVATION	564.0	ft	within median, low flows, not 'channel'
LOW POINT ELEVATION	561.0	ft	
ELEVATION DIFF (H)	3.0	ft	
LENGTH (L)	300	ft	
SLOPE (S) = (H/L)	1.0%		
VELOCITY (SCF)	1.3	fps	<=V FROM FIG 816.5 nearly bare ground
T_c (SH)=	4.00	minutes	

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

NOTES:

HIGH PT ELEVATION	561.0	ft	median ditch
LOW POINT ELEVATION	557.0	ft	CHANNEL DATA TYPE = TRAP'Z
ELEVATION DIFF (H)	4.0	ft	Z= 4 ANG-RAD 0.245
LENGTH (L)	300	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)	2.12	fps	From Manning's Equation assuming flowing full: $V=1.49/n(R^{2/3}S^{1/2})$
T_c (CH)=	2.35	minutes	

Basin G2-North Inflow TcQ

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

HIGH PT ELEVATION	552.0	ft
LOW POINT ELEVATION	542.0	ft
ELEVATION DIFF (H)	10.0	ft
LENGTH (L)	690	ft
SLOPE (S) = (H/L)	1.4%	
MANNING'S n	0.013	
PIPE DIAMETER d	2.0	ft
HYDRAULIC RADIUS R	0.5	ft
VELOCITY (STORMDRAIN)	8.7	fps
T_C (SD)=	1.32	minutes

NOTES:

Proposed storm drain through median (elev at pipe invert)
Sta 127+00
RCP
R=D/4, Assume: flowing full
$V = \frac{K_u}{n} R^{2/3} S^{1/2}$

Tc (TOTAL) =	8.92	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 =	**Q_2 =**	22.1
i_{10} =	2.7	in/hr	X CA =	**Q_{10} =**	32.2
i_{25} =	3.4	in/hr	X CA =	**Q_{25} =**	44.3
i_{50} =	4.0	in/hr	X CA =	**Q_{50} =**	58.0
i_{100} =	4.2	in/hr	X CA =	**Q_{100} =**	**62.9**

FLOW RESULTS: cfs

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 G2North Inflow Hydrograph

PROJECT:	**SR-11**			**DESCRIPTION:**	**SR-11 Basin**
JOB #:	**11A1190**			**STATION:**	**127+00**
BY:	**M.BRUNING**	**DATE:**	**01.11.10**	**WATERSHED:**	**G2**
CHK:	**G.DALZIEL**	**DATE:**		**SYSTEM:**	**Basin G2-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

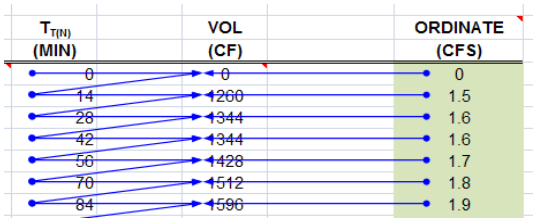
Basin Inflow Hydrograph

Basin Inflow Q

Q_{100}=	62.9	cfs	C_{100}=	0.96	
Tc=	10.0	min	A=	15.53	acres
$P_{100,6}$=	2.5	in			

$T_{T(N)}$ (MIN)	VOL (CF)	ORDINATE (CFS)
0	0	0
10	1320	2.2
20	1380	2.3
30	1440	2.4
40	1440	2.4
50	1500	2.5
60	1560	2.6
70	1620	2.7
80	1680	2.8
90	1740	2.9
100	1800	3
110	1920	3.2
120	1980	3.3
130	2100	3.5
140	2220	3.7
150	2400	4
160	2520	4.2
170	2760	4.6
180	2940	4.9
190	3360	5.6
200	3660	6.1
210	4440	7.4
220	5100	8.5
230	7440	12.4
240	10440	17.4
250	37740	62.9
260	6000	10
270	4020	6.7
280	3120	5.2
290	2640	4.4
300	2280	3.8
310	2040	3.4
320	1860	3.1
330	1680	2.8
340	1560	2.6
350	1500	2.5
360	1380	2.3
370	0	0

Example of Steps:



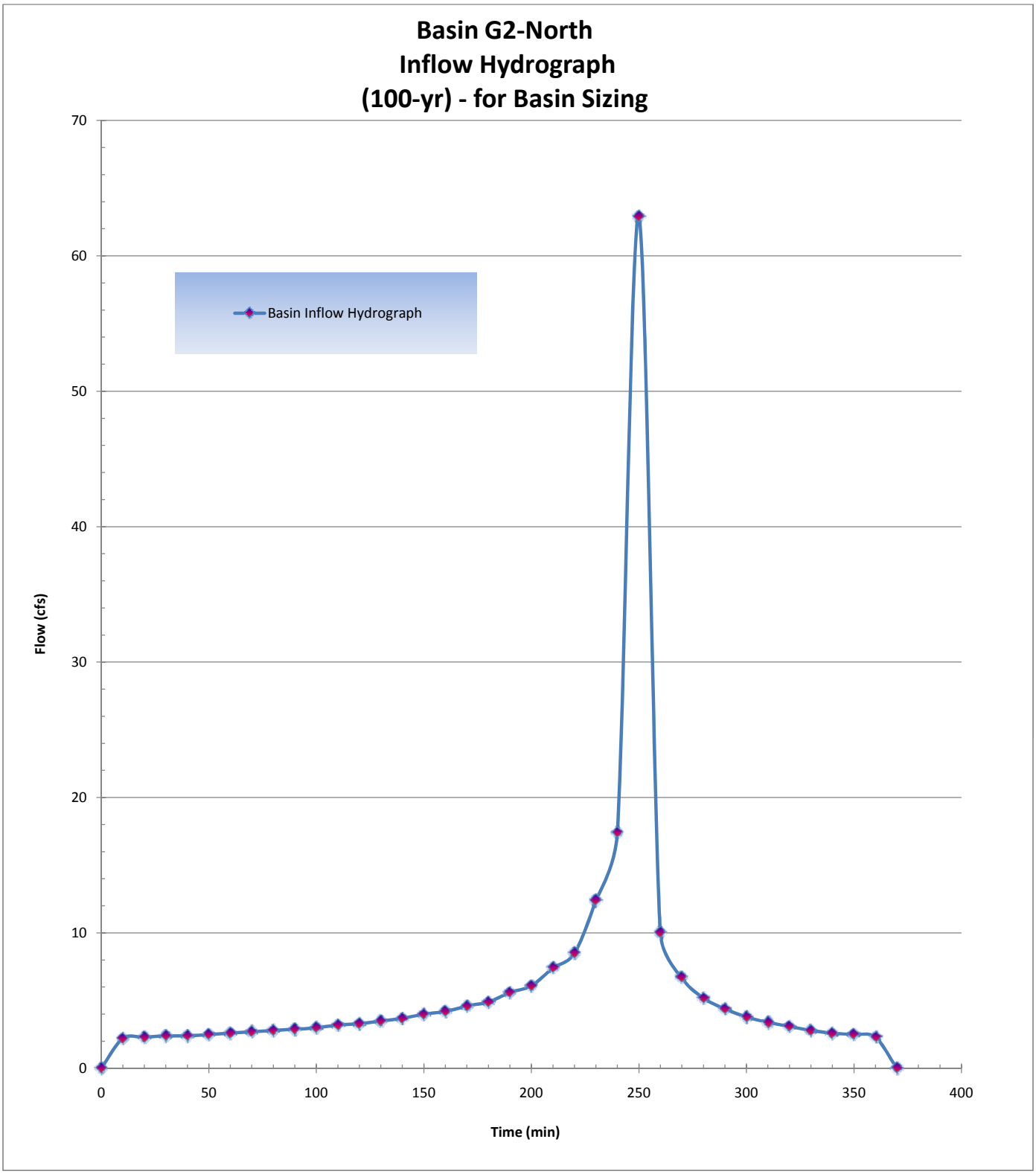
SUM= 134580 ft³
3.09 acre-feet

Onsite Runoff Volume

Check: $V = C*A*P_6$

V= 3.11 acre-feet

OK


Basin G2-North
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 G2-North Outlet

PROJECT:	**SR-11**			**DESCRIPTION:**	**SR-11 Basin**
JOB #:	**11A1190**			**STATION:**	**127+00**
BY:	**M.BRUNING**	**DATE:**	**02.19.10**	**WATERSHED:**	**G2**
CHK:	**G.DALZIEL**	**DATE:**		**SYSTEM:**	**Basin G2-North**

Notes:

Volumes:

Required Retention Basin Volume =	165005	ft^3	from G2-ALL
Retention volume from this basin =	51890		at 3.4' depth, see G2-South for remainder of storage
Actual Basin Inflow =	134580	ft^3	*OK*

Flow Balance - determine maximum flow from basin

Predeveloped Peak 100-year Flow:	60.0	cfs	from G2-ALL
Post-Developed Peak Flow through Cross Culvert:	0.0	cfs	Independent of Culvert G2
Flow that does not reach detention basin (bypass per DA table):	9.6	cfs	Q_{100} from: G2.27.PVG2.27.SL
Maximum flow allowed to be released by this detention basin:	15.8	cfs	*31%* of G2-ALL (per retention ratios)

Outlet Pipe

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

Basin - Top of basin berm elevation =			546.60	ft
Basin flowline elevation =			540.00	ft
Maximum Basin Depth =			6.60	ft
Assume Culvert Design: free outfall, square-edge w/headwall				
Outlet pipe invert from basin floor =	3.40	ft	543.40	ft
Outlet pipe diameter =	2	ft		

Basin Characteristics

Base Length (L)	200	ft	L/2 due to sloped floor
Base Width (W)	58	ft	average
W/L Ratio ®	0.29		
Side Slopes (Z)	1: 4		
Total Volume (V):	127310	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	540.00	0.00	0	0		540.00	0.00		0.00
1	540.20	0.20	2341	2341		540.20	0.00		0.00
2	540.40	0.40	2425	4766		540.40	0.00		0.00
3	540.60	0.60	2509	7275		540.60	0.00		0.00
4	540.80	0.80	2595	9870		540.80	0.00		0.00
5	541.00	1.00	2681	12551		541.00	0.00		0.00
6	541.20	1.20	2769	15320		541.20	0.00		0.00
7	541.40	1.40	2858	18178		541.40	0.00		0.00
8	541.60	1.60	2948	21126		541.60	0.00		0.00
9	541.80	1.80	3039	24165		541.80	0.00		0.00
10	542.00	2.00	3131	27296		542.00	0.00		0.00
11	542.20	2.20	3225	30521		542.20	0.00		0.00
12	542.40	2.40	3319	33840		542.40	0.00		0.00
13	542.60	2.60	3415	37255		542.60	0.00		0.00
14	542.80	2.80	3511	40766		542.80	0.00	0.00	0.00
15	543.00	3.00	3609	44375		543.00	0.00		0.00
16	543.20	3.20	3708	48082		543.20	0.00		0.00
17	543.40	3.40	3808	51890	*	543.40	0.00		0.00
18	543.60	3.60	3909	55799		543.60	0.15		0.15
19	543.80	3.80	4011	59810		543.80	0.59		0.59
20	544.00	4.00	4114	63924		544.00	1.30		1.30
21	544.20	4.20	4219	68143		544.20	2.25		2.25
22	544.40	4.40	4324	72467		544.40	3.42		3.42
23	544.60	4.60	4431	76897		544.60	4.79		4.79
24	544.80	4.80	4538	81436		544.80	6.32		6.32
25	545.00	5.00	4647	86083		545.00	7.99		7.99
26	545.20	5.20	4757	90840		545.20	9.77		9.77
27	545.40	5.40	4868	95708		545.40	11.63		11.63
28	545.60	5.60	4980	100688		545.60	13.53		13.53

Basin G2-North Routing

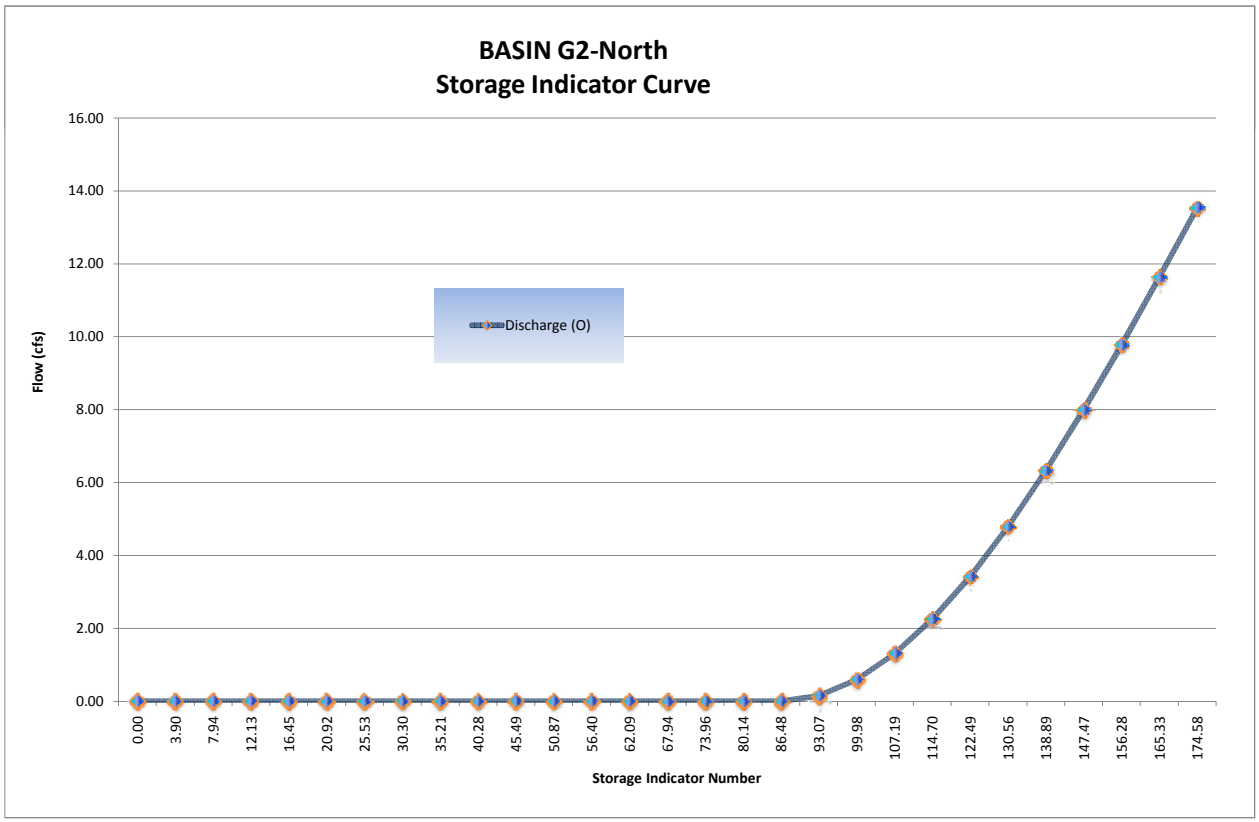
PROJECT:	SR-11			DESCRIPTION:	SR-11 Basin
JOB #:	11A1190			STATION:	127+00
BY:	M.BRUNING	DATE:	02.19.10	WATERSHED:	G2
CHK:	G.DALZIEL	DATE:		SYSTEM:	Basin G2-North

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)	*Storage Indicator #* (6) S_2/delta t + $O_2/2$ (cfs)
540.00	0.00	0	0.00	0.00	0.00
540.20	0.00	2341	0.00	3.90	3.90
540.40	0.00	4766	0.00	7.94	7.94
540.60	0.00	7275	0.00	12.13	12.13
540.80	0.00	9870	0.00	16.45	16.45
541.00	0.00	12551	0.00	20.92	20.92
541.20	0.00	15320	0.00	25.53	25.53
541.40	0.00	18178	0.00	30.30	30.30
541.60	0.00	21126	0.00	35.21	35.21
541.80	0.00	24165	0.00	40.28	40.28
542.00	0.00	27296	0.00	45.49	45.49
542.20	0.00	30521	0.00	50.87	50.87
542.40	0.00	33840	0.00	56.40	56.40
542.60	0.00	37255	0.00	62.09	62.09
542.80	0.00	40766	0.00	67.94	67.94
543.00	0.00	44375	0.00	73.96	73.96
543.20	0.00	48082	0.00	80.14	80.14
543.40	0.00	51890	0.00	86.48	86.48
543.60	0.15	55799	0.08	93.00	93.07
543.80	0.59	59810	0.30	99.68	99.98
544.00	1.30	63924	0.65	106.54	107.19
544.20	2.25	68143	1.13	113.57	114.70
544.40	3.42	72467	1.71	120.78	122.49
544.60	4.79	76897	2.40	128.16	130.56
544.80	6.32	81436	3.16	135.73	138.89
545.00	7.99	86083	4.00	143.47	147.47
545.20	9.77	90840	4.89	151.40	156.28
545.40	11.63	95708	5.82	159.51	165.33
545.60	13.53	100688	6.77	167.81	174.58

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



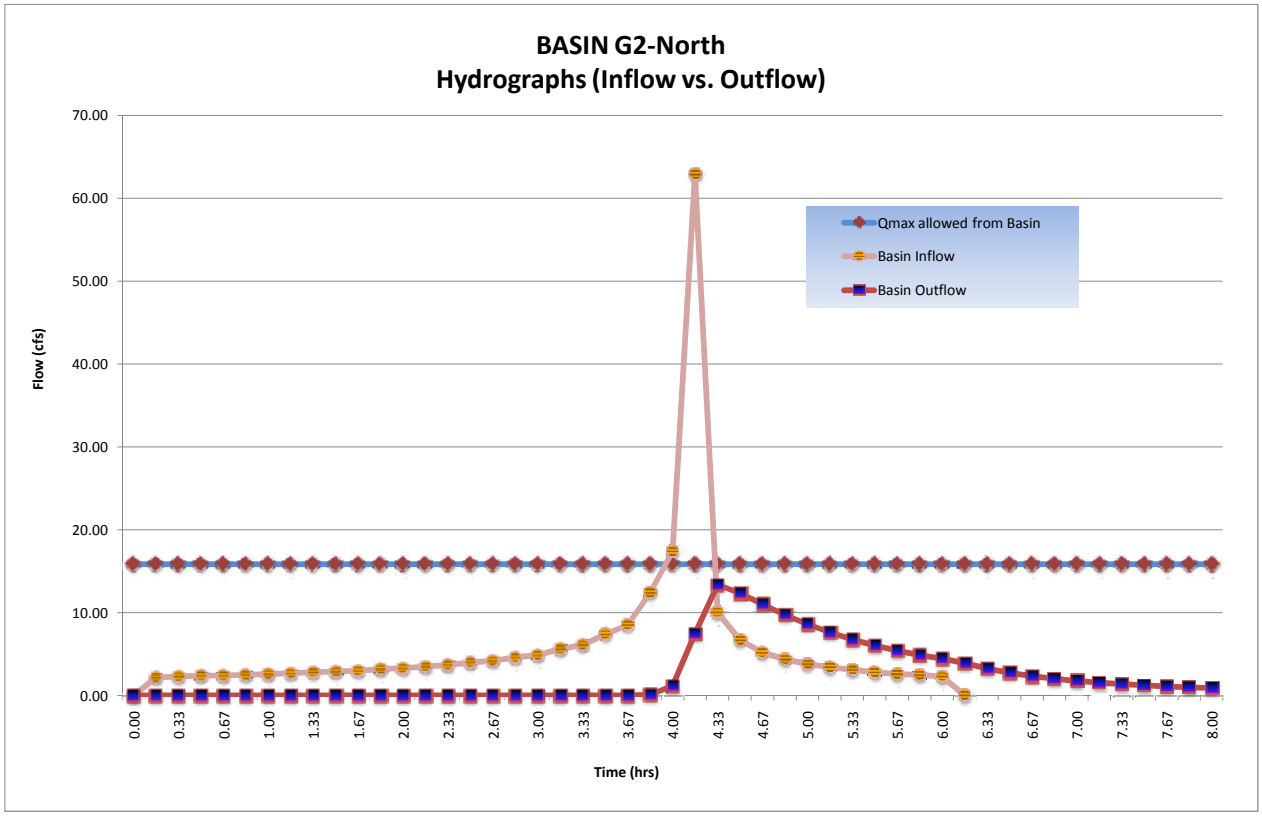
Basin G2-North Routing

FINAL ROUTING TABLE

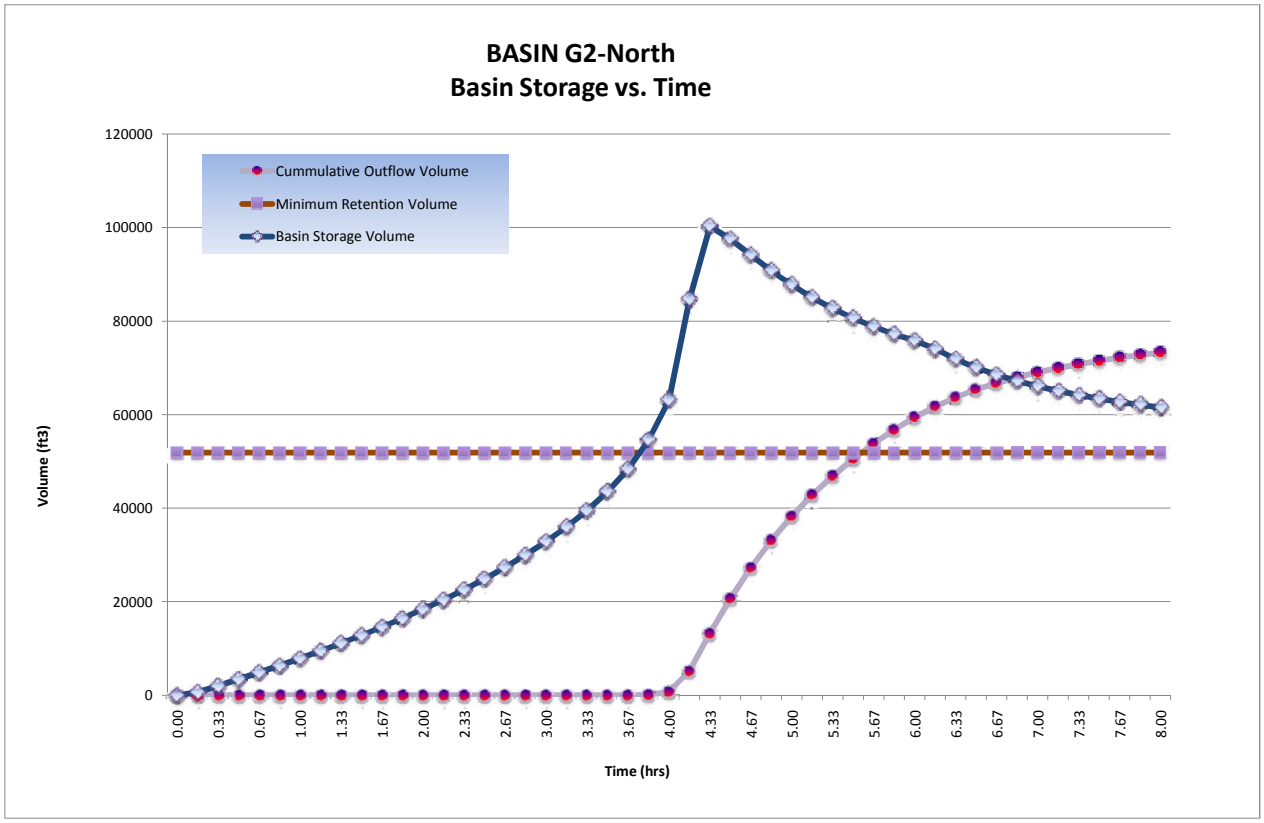
$$\frac{I_1 + I_2}{2} + \left(\frac{S_1}{\Delta t} - \frac{O_1}{2}\right) = O_1 + \left(\frac{S_2}{\Delta t} + \frac{O_2}{2}\right)$$

					Storage Indicator #				
(1)	(2)	(3)	(4)	(5)	(6)	(7)		Volumes (ft3)	
Time	Inflow	$(I_1+I_2)/2$	$(S_1/\text{delta t} + O_1/2)$	O_1	$S_2/\text{delta t} + O_2/2$	O_2	Basin	Incremental	Cummulative
(hrs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	Storage	Outflow	Outflow
	(Q_{post})		*col (6) from prev row*	*col (7) from prev row*	*col (3)+(4)-(5)*	*(Hard input)*	*Volume*	*Volume*	*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	2.30	2.25	1.10	0.00	3.35	0.00	2010	0	0
0.50	2.40	2.35	3.35	0.00	5.70	0.00	3420	0	0
0.67	2.40	2.40	5.70	0.00	8.10	0.00	4860	0	0
0.83	2.50	2.45	8.10	0.00	10.55	0.00	6330	0	0
1.00	2.60	2.55	10.55	0.00	13.10	0.00	7860	0	0
1.17	2.70	2.65	13.10	0.00	15.75	0.00	9450	0	0
1.33	2.80	2.75	15.75	0.00	18.50	0.00	11100	0	0
1.50	2.90	2.85	18.50	0.00	21.35	0.00	12810	0	0
1.67	3.00	2.95	21.35	0.00	24.30	0.00	14580	0	0
1.83	3.20	3.10	24.30	0.00	27.40	0.00	16440	0	0
2.00	3.30	3.25	27.40	0.00	30.65	0.00	18390	0	0
2.17	3.50	3.40	30.65	0.00	34.05	0.00	20430	0	0
2.33	3.70	3.60	34.05	0.00	37.65	0.00	22590	0	0
2.50	4.00	3.85	37.65	0.00	41.50	0.00	24900	0	0
2.67	4.20	4.10	41.50	0.00	45.60	0.00	27360	0	0
2.83	4.60	4.40	45.60	0.00	50.00	0.00	30000	0	0
3.00	4.90	4.75	50.00	0.00	54.75	0.00	32850	0	0
3.17	5.60	5.25	54.75	0.00	60.00	0.00	36000	0	0
3.33	6.10	5.85	60.00	0.00	65.85	0.00	39510	0	0
3.50	7.40	6.75	65.85	0.00	72.60	0.00	43560	0	0
3.67	8.50	7.95	72.60	0.00	80.55	0.00	48330	0	0
3.83	12.40	10.45	80.55	0.00	91.00	0.10	54570	60	60
4.00	17.40	14.90	91.00	0.10	105.80	1.16	63132	696	756
4.17	62.90	40.15	105.80	1.16	144.79	7.47	84633	4482	5238
4.33	10.00	36.45	144.79	7.47	173.77	13.36	100254	8016	13254
4.50	6.70	8.35	173.77	13.36	168.76	12.33	97557	7398	20652
4.67	5.20	5.95	168.76	12.33	162.38	11.02	94122	6612	27264
4.83	4.40	4.80	162.38	11.02	156.16	9.74	90774	5844	33108
5.00	3.80	4.10	156.16	9.74	150.52	8.61	87729	5166	38274
5.17	3.40	3.60	150.52	8.61	145.51	7.61	85023	4566	42840
5.33	3.10	3.25	145.51	7.61	141.15	6.76	82662	4056	46896
5.50	2.80	2.95	141.15	6.76	137.34	6.04	80592	3624	50520
5.67	2.60	2.70	137.34	6.04	134.00	5.42	78774	3252	53772
5.83	2.50	2.55	134.00	5.42	131.13	4.90	77208	2940	56712
6.00	2.30	2.40	131.13	4.90	128.63	4.46	75840	2676	59388
6.17	0.00	1.15	128.63	4.46	125.32	3.90	74022	2340	61728
6.33		0.00	125.32	3.90	121.42	3.26	71874	1956	63684
6.50		0.00	121.42	3.26	118.16	2.77	70065	1662	65346
6.67		0.00	118.16	2.77	115.39	2.35	68529	1410	66756
6.83		0.00	115.39	2.35	113.04	2.04	67212	1224	67980
7.00		0.00	113.04	2.04	111.00	1.78	66066	1068	69048
7.17		0.00	111.00	1.78	109.22	1.56	65064	936	69984
7.33		0.00	109.22	1.56	107.66	1.36	64188	816	70800
7.50		0.00	107.66	1.36	106.30	1.21	63417	726	71526
7.67		0.00	106.30	1.21	105.09	1.09	62727	654	72180
7.83		0.00	105.09	1.09	104.00	0.99	62103	594	72774
8.00		0.00	104.00	0.99	103.01	0.89	61539	534	73308

Basin G2-North Routing



Basin G2-North Routing



Detention/Retention Basin Volume Required:	**100,254**	ft^3	
@ Stage:	**545.60**	ft	
Freeboard:	**1.0**	ft	> 1' Freeboard
Final Total Basin Volume Provided:	**127,310**	ft^3	Basin **G2-North**
Maximum flow rate released from this basin:	**13.36**	cfs	

Basin G2-South Inflow TcQ

PROJECT:	**SR-11**			**DESCRIPTION:**	**SR-11 Basin**
JOB #:	**11A1190**			**STATION:**	**139+00**
BY:	**M.BRUNING**	**DATE:**	**01.11.10**	**WATERSHED:**	**G2**
CHK:	**G.DALZIEL**	**DATE:**		**SYSTEM:**	**Basin G2-South**

BASIN AREA:

A = **815900** **ft^2** **SOURCE:** **MICROSTATION/USGS**
18.73 **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	0.441
COMMERCIAL AREA	0%	AT	0.85	0.000
CUT SLOPE (2:1 and 4:1)	51%	AT	0.55	0.280
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	544.0	ft	From median, north of SV Line
LOW POINT ELEVATION	542.0	ft	
ELEVATION DIFF (H)	2.0	ft	
LENGTH (L)	60	ft	
SLOPE (S) = (H/L)	3.3%		
MANNING'S n	0.050		< = FROM TABLE 816.6A Fallow
T_t (SFF)=	2.94	minutes	

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

NOTES:

HIGH PT ELEVATION	542.0	ft	assumed SCF and not channelized or flowing full yet
LOW POINT ELEVATION	539.0	ft	
ELEVATION DIFF (H)	3.0	ft	
LENGTH (L)	183	ft	
SLOPE (S) = (H/L)	1.6%		
VELOCITY (SCF)	0.8	fps	<=V FROM FIG 816.5 short grass
T_C (SH)=	3.81	minutes	

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

NOTES:

HIGH PT ELEVATION	539.0	ft	median ditch
LOW POINT ELEVATION	537.0	ft	CHANNEL DATA TYPE = TRAP'Z
ELEVATION DIFF (H)	2.0	ft	Z= 4 ANG-RAD 0.245
LENGTH (L)	112	ft	b = 0 ANG-DEG 14.036
SLOPE (S) = (H/L)	1.8%		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)	2.46	fps	From Manning's Equation assuming flowing full: $V=1.49/n(R^{2/3}S^{1/2})$
T_C (CH)=	0.76	minutes	

Basin G2-South Inflow TcQ

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

NOTES:

HIGH PT ELEVATION	532.0	ft	
LOW POINT ELEVATION	525.0	ft	
ELEVATION DIFF (H)	7.0	ft	
LENGTH (L)	472	ft	
SLOPE (S) = (H/L)	1.5%		
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)	11.5	fps	$V = \frac{K_u}{n} R^{2/3} S^{1/2}$
T_C (SD)=	0.68	minutes	

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

NOTES:

HIGH PT ELEVATION	525.0	ft	Proposed storm to basin
LOW POINT ELEVATION	512.0	ft	
ELEVATION DIFF (H)	13.0	ft	
LENGTH (L)	680	ft	
SLOPE (S) = (H/L)	1.9%		
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)	13.1	fps	$V = \frac{K_u}{n} R^{2/3} S^{1/2}$
T_C (SD)=	0.87	minutes	

Tc (TOTAL) =	9.06	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 =	**Q_2 =**	25.1
i_{10} =	2.7	in/hr	X CA =	**Q_{10} =**	36.4
i_{25} =	3.4	in/hr	X CA =	**Q_{25} =**	50.1
i_{50} =	4.0	in/hr	X CA =	**Q_{50} =**	65.6
i_{100} =	4.2	in/hr	X CA =	**Q_{100} =**	**71.2**

FLOW RESULTS:

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 G2South Inflow Hydrograph

PROJECT:	**SR-11**			**DESCRIPTION:**	**SR-11 Basin**
JOB #:	**11A1190**			**STATION:**	**139+00**
BY:	**M.BRUNING**	**DATE:**	**01.11.10**	**WATERSHED:**	**G2**
CHK:	**G.DALZIEL**	**DATE:**		**SYSTEM:**	**Basin G2-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

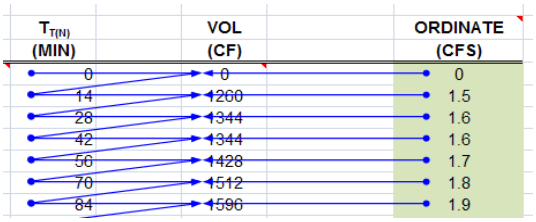
Basin Inflow Hydrograph

Basin Inflow Q

Q_{100}=	71.2	cfs	C_{100}=	0.90	
Tc=	10.0	min	A=	18.73	acres
$P_{100,6}$=	2.5	in			

$T_{T(N)}$ (MIN)	VOL (CF)	ORDINATE (CFS)
0	0	0
10	1500	2.5
20	1560	2.6
30	1620	2.7
40	1620	2.7
50	1680	2.8
60	1740	2.9
70	1800	3
80	1860	3.1
90	1980	3.3
100	2040	3.4
110	2160	3.6
120	2220	3.7
130	2400	4
140	2460	4.1
150	2700	4.5
160	2820	4.7
170	3120	5.2
180	3300	5.5
190	3780	6.3
200	4140	6.9
210	5040	8.4
220	5760	9.6
230	8460	14.1
240	11760	19.6
250	42720	71.2
260	6780	11.3
270	4500	7.5
280	3540	5.9
290	2940	4.9
300	2580	4.3
310	2280	3.8
320	2100	3.5
330	1920	3.2
340	1800	3
350	1680	2.8
360	1560	2.6
370	0	0

Example of Steps:



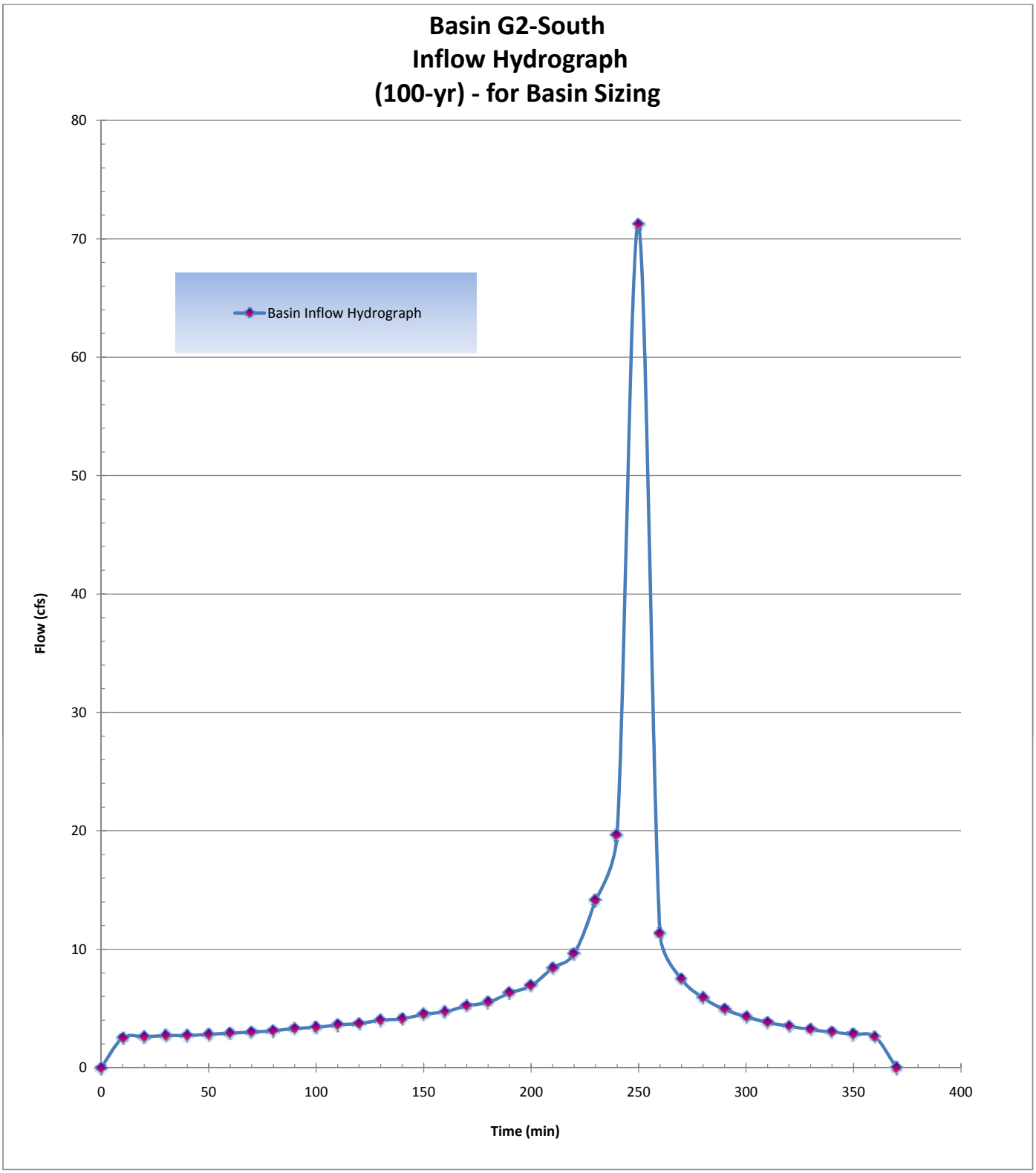
SUM= 151920 ft^3
3.49 acre-feet

Onsite Runoff Volume

Check: $V = C*A*P_6$

V= 3.52 acre-feet

OK


Basin G2-South
Inflow Hydrograph
(100-yr) - for Basin Sizing
Basin Inflow Hydrograph
Flow (cfs)
Time (min)
0
10
20
30
40
50
60
70
80
0
50
100
150
200
250
300
350
400

Basin G2-South Outlet

PROJECT:	**SR-11**			**DESCRIPTION:**	**SR-11 Basin**
JOB #:	**11A1190**			**STATION:**	**139+00**
BY:	**M.BRUNING**	**DATE:**	**02.19.10**	**WATERSHED:**	**G2**
CHK:	**G.DALZIEL**	**DATE:**		**SYSTEM:**	**Basin G2-South**

Notes:

Volumes:

Required Retention Basin Volume =	165005	ft^3	from G2-ALL
Retention volume from G2-North Basin =	51890	ft^4	
Minimum Retention volume from this basin =	113115		balance of required retention for G2-ALL
Actual Basin Inflow =	151920	ft^4	*OK*

Flow Balance - determine maximum flow from basin

Predeveloped Peak 100-year Flow:	60.0	cfs	from G2-ALL
Post-Developed Peak Flow through Cross Culvert:	0.0	cfs	Independent of Culvert G2
Flow that does not reach detention basin (bypass per DA table):	9.6	cfs	Q_{100} from: G2.27.PVG2.27.SL
Maximum flow to be released by G2-North basin:	15.8	cfs	*31%* of G2-ALL (per retention ratios)
Maximum flow allowed to be released by this detention basin:	23.7	cfs	*69%* of G2-ALL (per retention ratios)

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 =	3.20 ft	515.20	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	0.00		0.00
16	515.20	3.20	8384	119168	*	515.20	0.00		0.00
17	515.40	3.40	8513	127681		515.40	0.15		0.15
18	515.60	3.60	8643	136325		515.60	0.59		0.59
19	515.80	3.80	8774	145099		515.80	1.30		1.30
20	516.00	4.00	8906	154004		516.00	2.25		2.25
21	516.20	4.20	9038	163042		516.20	3.42		3.42
22	516.40	4.40	9171	172213		516.40	4.79		4.79
23	516.60	4.60	9305	181518		516.60	6.32		6.32
24	516.80	4.80	9439	190957		516.80	7.99		7.99
25	517.00	5.00	9575	200532		517.00	9.77		9.77

Basin G2-South Routing

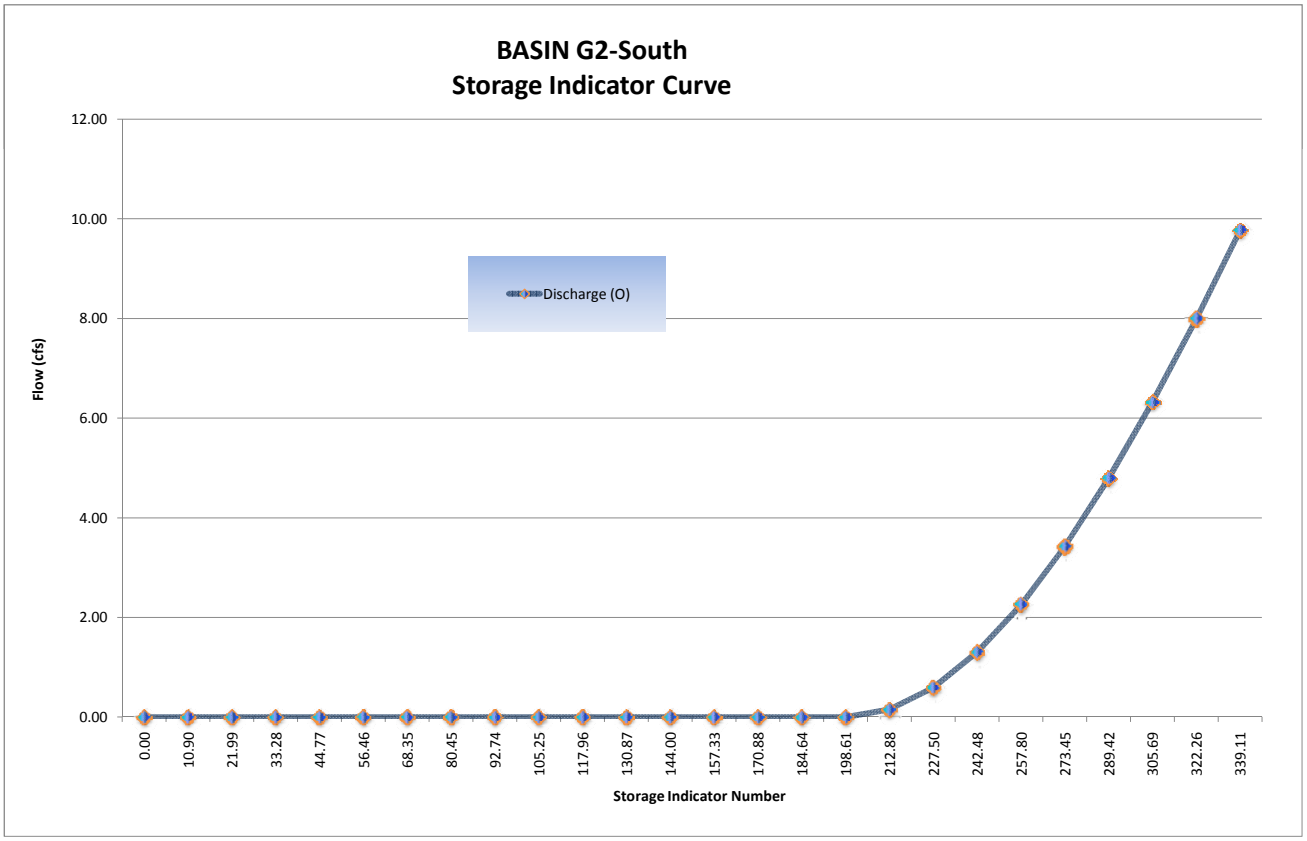
PROJECT:	SR-11			DESCRIPTION:	SR-11 Basin	
JOB #:	11A1190			STATION:	139+00	
BY:	M.BRUNING	DATE:	02.19.10	WATERSHED:	G2	
CHK:	G.DALZIEL	DATE:		SYSTEM:	Basin	G2-South

user input
linked input

STORAGE INDICATOR NUMBERS TABLE

					Storage Indicator #
(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)
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	0.00	110784	0.00	184.64	184.64
515.20	0.00	119168	0.00	198.61	198.61
515.40	0.15	127681	0.08	212.80	212.88
515.60	0.59	136325	0.30	227.21	227.50
515.80	1.30	145099	0.65	241.83	242.48
516.00	2.25	154004	1.13	256.67	257.80
516.20	3.42	163042	1.71	271.74	273.45
516.40	4.79	172213	2.40	287.02	289.42
516.60	6.32	181518	3.16	302.53	305.69
516.80	7.99	190957	4.00	318.26	322.26
517.00	9.77	200532	4.89	334.22	339.11

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



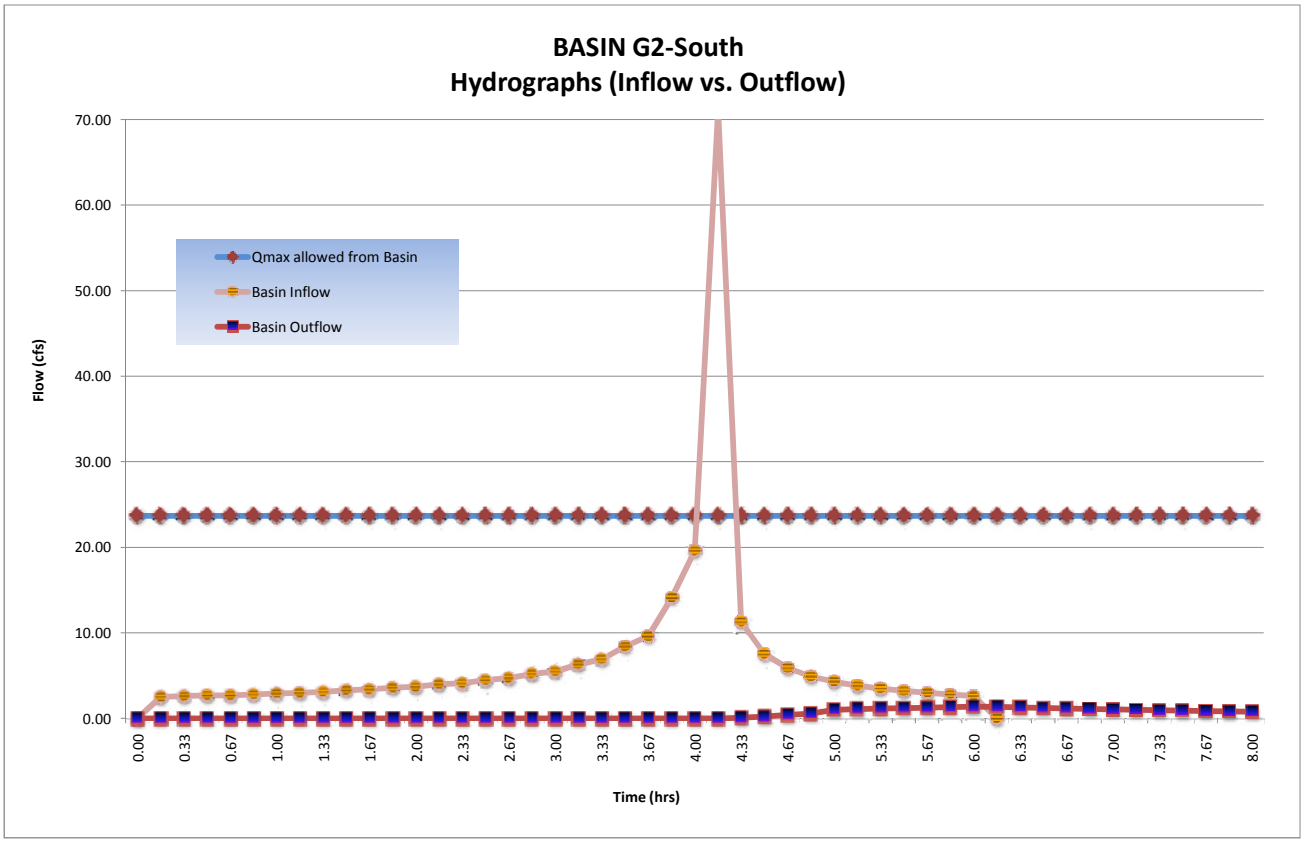
Basin G2-South Routing

FINAL ROUTING TABLE

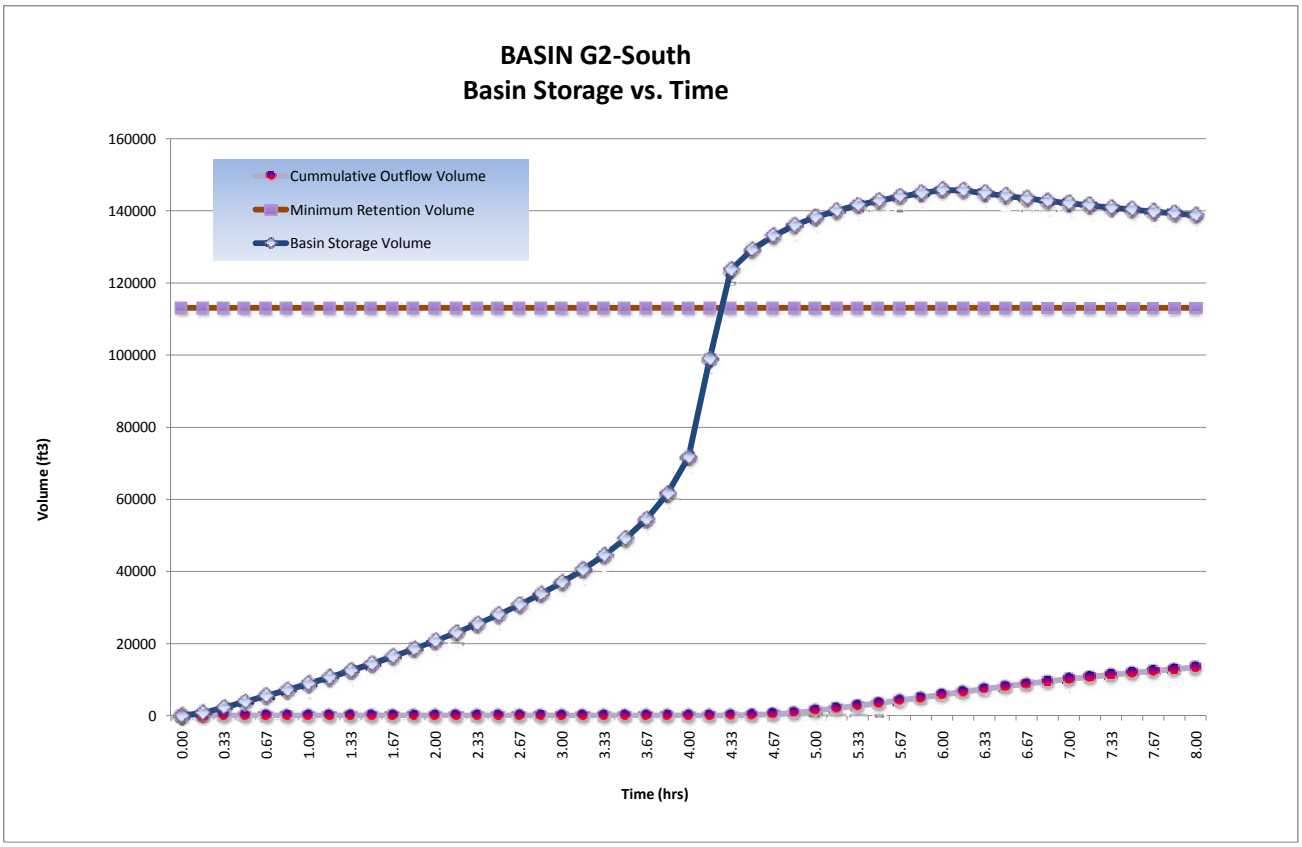
$$\frac{I_1 + I_2}{2} + \left(\frac{S_1}{\Delta t} - \frac{O_1}{2}\right) - O_1 = \left(\frac{S_2}{\Delta t} + \frac{O_2}{2}\right)$$

					Storage Indicator #			Volumes (ft3)	
(1) Time (hrs)	(2) Inflow (cfs) (Q_{post})	(3) $(I_1+I_2)/2$ (cfs)	(4) $(S_1/\Delta t + O_1/2)$ (cfs)	(5) O_1 (cfs)	(6) $S_2/\Delta t + O_2/2$ (cfs)	(7) O_2 (cfs)		Basin Storage *Volume*	Incremental Outflow *Volume*	Cummulative Outflow *Volume*
			col (6) from prev row	*col (7) from prev row*	*col (3)+(4)-(5)*	*(Hard input)*				
0.00	0.00	0.00	0.00	0.00	0.00	0.00		0	0	0
0.17	2.50	1.25	0.00	0.00	1.25	0.00		750	0	0
0.33	2.60	2.55	1.25	0.00	3.80	0.00		2280	0	0
0.50	2.70	2.65	3.80	0.00	6.45	0.00		3870	0	0
0.67	2.70	2.70	6.45	0.00	9.15	0.00		5490	0	0
0.83	2.80	2.75	9.15	0.00	11.90	0.00		7140	0	0
1.00	2.90	2.85	11.90	0.00	14.75	0.00		8850	0	0
1.17	3.00	2.95	14.75	0.00	17.70	0.00		10620	0	0
1.33	3.10	3.05	17.70	0.00	20.75	0.00		12450	0	0
1.50	3.30	3.20	20.75	0.00	23.95	0.00		14370	0	0
1.67	3.40	3.35	23.95	0.00	27.30	0.00		16380	0	0
1.83	3.60	3.50	27.30	0.00	30.80	0.00		18480	0	0
2.00	3.70	3.65	30.80	0.00	34.45	0.00		20670	0	0
2.17	4.00	3.85	34.45	0.00	38.30	0.00		22980	0	0
2.33	4.10	4.05	38.30	0.00	42.35	0.00		25410	0	0
2.50	4.50	4.30	42.35	0.00	46.65	0.00		27990	0	0
2.67	4.70	4.60	46.65	0.00	51.25	0.00		30750	0	0
2.83	5.20	4.95	51.25	0.00	56.20	0.00		33720	0	0
3.00	5.50	5.35	56.20	0.00	61.55	0.00		36930	0	0
3.17	6.30	5.90	61.55	0.00	67.45	0.00		40470	0	0
3.33	6.90	6.60	67.45	0.00	74.05	0.00		44430	0	0
3.50	8.40	7.65	74.05	0.00	81.70	0.00		49020	0	0
3.67	9.60	9.00	81.70	0.00	90.70	0.00		54420	0	0
3.83	14.10	11.85	90.70	0.00	102.55	0.00		61530	0	0
4.00	19.60	16.85	102.55	0.00	119.40	0.00		71640	0	0
4.17	71.20	45.40	119.40	0.00	164.80	0.00		98880	0	0
4.33	11.30	41.25	164.80	0.00	206.05	0.08		123606	48	48
4.50	7.50	9.40	206.05	0.08	215.37	0.22		129156	132	180
4.67	5.90	6.70	215.37	0.22	221.85	0.42		132984	252	432
4.83	4.90	5.40	221.85	0.42	226.83	0.57		135927	342	774
5.00	4.30	4.60	226.83	0.57	230.86	1.02		138210	612	1386
5.17	3.80	4.05	230.86	1.02	233.89	1.09		140007	654	2040
5.33	3.50	3.65	233.89	1.09	236.45	1.16		141522	696	2736
5.50	3.20	3.35	236.45	1.16	238.64	1.21		142821	726	3462
5.67	3.00	3.10	238.64	1.21	240.53	1.25		143943	750	4212
5.83	2.80	2.90	240.53	1.25	242.18	1.29		144921	774	4986
6.00	2.60	2.70	242.18	1.29	243.59	1.37		145743	822	5808
6.17	0.00	1.30	243.59	1.37	243.52	1.36		145704	816	6624
6.33		0.00	243.52	1.36	242.16	1.28		144912	768	7392
6.50		0.00	242.16	1.28	240.88	1.22		144162	732	8124
6.67		0.00	240.88	1.22	239.66	1.17		143445	702	8826
6.83		0.00	239.66	1.17	238.49	1.11		142761	666	9492
7.00		0.00	238.49	1.11	237.38	1.06		142110	636	10128
7.17		0.00	237.38	1.06	236.32	1.01		141489	606	10734
7.33		0.00	236.32	1.01	235.31	0.96		140898	576	11310
7.50		0.00	235.31	0.96	234.35	0.91		140337	546	11856
7.67		0.00	234.35	0.91	233.44	0.87		139803	522	12378
7.83		0.00	233.44	0.87	232.57	0.83		139293	498	12876
8.00		0.00	232.57	0.83	231.74	0.79		138807	474	13350

Basin G2-South Routing



Basin G2-South Routing



Detention/Retention Basin Volume Required:	**145,743**	**ft^3**
@ Stage:	**516.00**	**ft**
Freeboard:	**1.0**	**ft**
Final Total Basin Volume Provided:	**200,532**	**ft^3**
Maximum flow rate released from this basin:	**1.37**	**cfs**

> 1' Freeboard

Basin **G2-South**

X2 Onsite D.A. Table

PROJECT:	**SR-11**			**DESCRIPTION:**	**On-site Drainage Areas (D.A.)**
JOB #:	**11A1190**			**STATION:**	**40+00**
BY:	**M.BRUNING**	**DATE:**	**01.27.10**	**WATERSHED:**	**X2**
CHK:	**G.DALZIEL**	**DATE:**		**SYSTEM:**	**X2**

			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
PAVED	X2.1.PV	0.99	2900	0.1	5	4.0	0.26	6.6	0.43	~	X1.1	bypass*	40+00	Rt
	X2.2.PV	0.99	71300	1.6	5	4.0	6.46	6.6	10.67	~	X1.2	bypass*	40+50	Rt
	X2.3.PV	0.99	2850	0.1	5	4.0	0.26	6.6	0.43	~	X1.3	bypass*	40+00	Lt
	X2.4.PV	0.99	71100	1.6	5	4.0	6.44	6.6	10.64	~	X1.4	bypass*	40+50	Lt

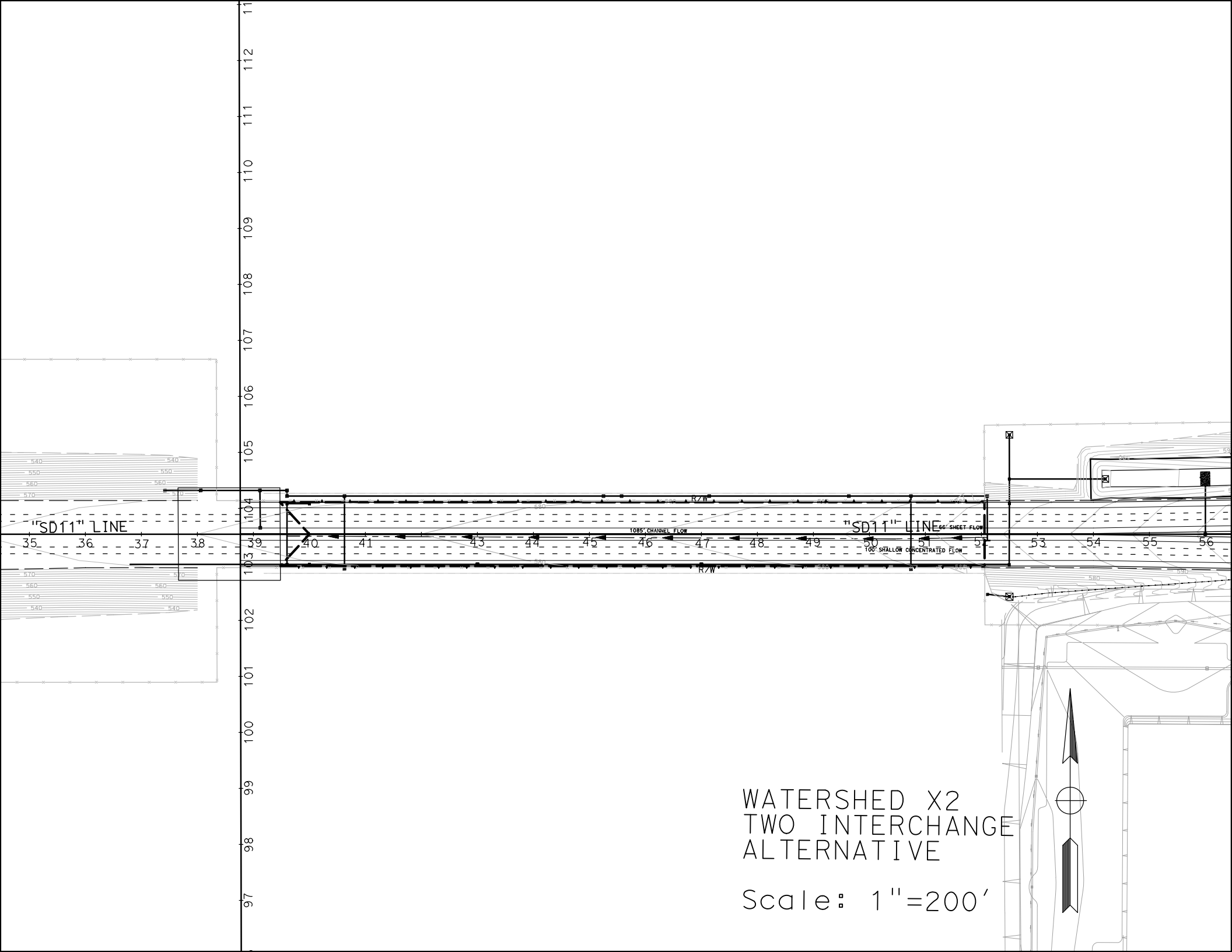
Σ 148150 *PAVED*

			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
SLOPE	~	0.61	0	0.0	~	~	~	~	~	~	~	~	~	~

Σ 0 *SLOPE*

*flow that does not reach the basin

Total :	148150	3.4
	SF	*ac*


"SD11" LINE
"SD11" LINE
R/W
R/W
1085' CHANNEL FLOW
66' SHEET FLOW
100' SHALLOW CONCENTRATED FLOW
35
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112
WATERSHED X2
TWO INTERCHANGE
ALTERNATIVE
Scale: 1"=200'

X2 Post-Developed TcQ

PROJECT:	**SR-11**			**DESCRIPTION:**	**SR-11 Post-Developed**
JOB #:	**11A1190**			**STATION:**	**40+00**
BY:	**M.BRUNING**	**DATE:**	**01.27.10**	**WATERSHED:**	**X2**
CHK:	**G.DALZIEL**	**DATE:**		**SYSTEM:**	**X2**

BASIN AREA:

A =	**140433**	**ft^2**	**SOURCE:**	**MICROSTATION/USGS**
	3.22	**acres**		**(SCALE = 1:1)**

COEFFICIENT OF RUNOFF:

KEY: User Input | Designer Tool

UNDEVELOPED AREA C (FROM HDM FIG. 819.2A)

		NOTES:
RELIEF (.08-.35)	0.22	Hilly Slopes ~ 15%
INFILTRATION (.04-.16)	0.12	Negligible infiltration capacity - See Geotechnical Report
VEGETATION (.04-.16)	0.08	Poor natural cover
STORAGE (.04-.12)	0.07	Normal
TOTAL C =	0.49	

UNDEVELOPED AREA	0%	AT	0.49	0.000
PAVED SURFACE	100%	AT	0.90	0.900
COMMERCIAL AREA	0%	AT	0.85	0.000
CUT SLOPE (2:1 and 4:1)	0%	AT	0.55	0.000
TOTAL	100%			
	(100%)			

$C_{2,10}$ =	0.90
C_{25} =	0.99
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	587.0	ft	SR-11 at Sta 52 CL
LOW POINT ELEVATION	586.0	ft	
ELEVATION DIFF (H)	1.0	ft	
LENGTH (L)	66	ft	
SLOPE (S) = (H/L)	1.5%		
MANNING'S n	0.016		< = FROM FIG 816.6A HMA
T_t (SFF)=	1.75	minutes	

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

NOTES:

HIGH PT ELEVATION	586.0	ft	assumed not channelized yet
LOW POINT ELEVATION	584.0	ft	
ELEVATION DIFF (H)	2.0	ft	
LENGTH (L)	100	ft	
SLOPE (S) = (H/L)	2.0%		
VELOCITY (SCF)	4.0	fps	<=V FROM FIG 816.5 HMA
T_C (SH)=	0.42	minutes	

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

NOTES:

HIGH PT ELEVATION	584.0	ft	channelizes in shoulder of structure
LOW POINT ELEVATION	578.0	ft	
ELEVATION DIFF (H)	6.0	ft	
LENGTH (L)	1085	ft	
SLOPE (S) = (H/L)	0.6%		
MANNING'S n	0.016		HMA
HYDRAULIC RADIUS R	0.3	ft	R=(bdsinA+d^2cosA)/(bsinA+2d)
VELOCITY (CHANNEL)	3.33	fps	From Manning's Equation assuming flowing full: $V=1.49/n(R^{2/3}S^{1/2})$
T_C (CH)=	5.43	minutes	

CHANNEL DATA	TYPE =	TRAP'Z
Z= 20	ANG-RAD	0.050
b = 10	ANG-DEG	2.862
d = 0.5	FLOWING FULL ASS'M	

Tc (TOTAL) =	7.60	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 =	Q_2 =	5.4
i_{10} =	2.7	in/hr	X CA =	Q_{10} =	7.8
i_{25} =	3.4	in/hr	X CA =	Q_{25} =	10.8
i_{50} =	4.0	in/hr	X CA =	Q_{50} =	13.0
i_{100} =	4.2	in/hr	X CA =	Q_{100} =	**13.6**

FLOW RESULTS:

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 X2 Retention

PROJECT:	SR-11			**DESCRIPTION:**	SR-11 Basin
JOB #:	11A1190			**STATION:**	40+00
BY:	M.BRUNING	**DATE:**	01.27.10	**WATERSHED:**	X2
CHK:	G.DALZIEL	**DATE:**		**SYSTEM:**	X2

Notes:

* The difference between pre-developed and post-developed values gives the approximate volume to detain.
Stage-Storage calculations will determine accurate volume

RETENTION BASIN VOLUME

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

Pre-Developed volume calculations

Q_{100}=	10.4	cfs			
Tc=	10.0	min	C=	0.76	
$P_{100,6}$=	2.5	in	A=	3.22	acres

$T_{T(N)}$ (MIN)	VOL (CF)	ORDINATE (CFS)
0	0	0
10	240	0.4
20	240	0.4
30	240	0.4
40	240	0.4
50	240	0.4
60	240	0.4
70	240	0.4
80	300	0.5
90	300	0.5
100	300	0.5
110	300	0.5
120	300	0.5
130	360	0.6
140	360	0.6
150	420	0.7
160	420	0.7
170	480	0.8
180	480	0.8
190	540	0.9
200	600	1
210	720	1.2
220	840	1.4
230	1200	2
240	1680	2.8
250	6240	10.4
260	960	1.6
270	660	1.1
280	540	0.9
290	420	0.7
300	360	0.6
310	360	0.6
320	300	0.5
330	300	0.5
340	240	0.4
350	240	0.4
360	240	0.4
370	0	0

SUM= 22140 ft^3
0.51 acre-feet

Check: $V = C*A*P_6$
V= 0.51 acre-feet
OK

Basin X2 Retention

Post-Developed volume calculations

Q_{100}=	13.6	cfs			
Tc=	10.0	min	C=	1.00	
$P_{100,6}$=	2.5	in	A=	3.22	acres

$T_{T(N)}$ (MIN)	VOL (CF)	ORDINATE (CFS)
0	0	0
10	300	0.5
20	300	0.5
30	300	0.5
40	300	0.5
50	300	0.5
60	360	0.6
70	360	0.6
80	360	0.6
90	360	0.6
100	360	0.6
110	420	0.7
120	420	0.7
130	480	0.8
140	480	0.8
150	540	0.9
160	540	0.9
170	600	1
180	660	1.1
190	720	1.2
200	780	1.3
210	960	1.6
220	1080	1.8
230	1620	2.7
240	2220	3.7
250	8160	13.6
260	1320	2.2
270	840	1.4
280	660	1.1
290	540	0.9
300	480	0.8
310	420	0.7
320	420	0.7
330	360	0.6
340	360	0.6
350	300	0.5
360	300	0.5
370	0	0

SUM= 28980 ft^3
0.67 acre-feet

Check: $V = C*A*P_6$
V= 0.67 acre-feet
OK

0.67
\- **0.51**
Attenuation volume = 0.16 acre-feet = 6840 ft^3

Basin Required
REFER TO BASIN Y

Basin X2 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= 3.22 acres

WQ_{72}: 0.73 in/area

Water Quality Volume (WQV) = **8543** ft^3

WQV to be added to retention volume = **1703** ft^3 **Add this Volume to Basin**

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:

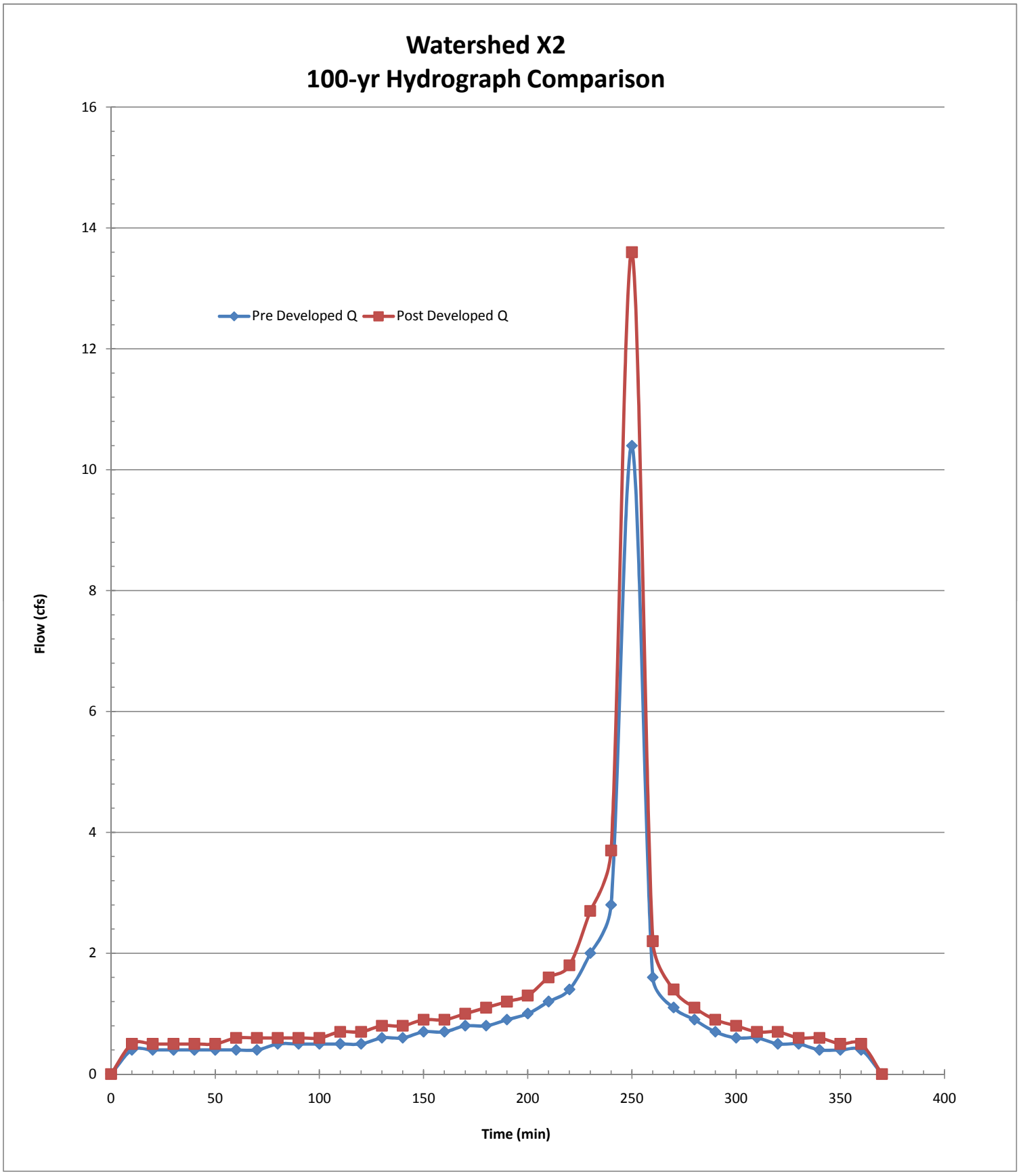
A_s = the computed soil loss in tons (dry weight)
R = the rainfall erosion index for the given storm period
K = the soil erodibility factor
L = the slope length factor
s = the slope gradient factor
C = cropping management (vegetation) factor
P = erosion control practice factor

Onsite Highway *Sloped* runoff area, A:		0	ft^2
	A:	0.00	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 = 0.00 tons

Silt Accumulation Basin volume = **0** ft^3

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


Watershed X2
100-yr Hydrograph Comparison
Pre Developed Q
Post Developed Q
Flow (cfs)
Time (min)
0
2
4
6
8
10
12
14
16
0
50
100
150
200
250
300
350
400

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Detention/Retention Basin Flows and Sizes – Two Interchange Alternative

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)	
X	40+00	10.38	13.58	3.20	22,140	28,980	6,840	~	~	~	Routed to Basin Y-EAST	~	~	~	~	~
A	53+00	23.50	44.61	21.12	50,220	116,340	66,120	69,656	11,849	34,261	115,766	350	30	5.6	1.0	A2
B	69+00	30.80	31.25	0.45	124,488	118,080	(6,408)	~	~	~	No Basin Required	~	~	~	~	~
C	78+00	16.38	9.18	(7.20)	35,100	19,620	(15,480)	~	~	~	No Basin Required	~	~	~	~	~
D	80+00	18.54	8.43	(10.10)	42,636	18,120	(24,516)	~	~	~	No Basin Required	~	~	~	~	~
E	96+00	61.90	87.94	26.04	232,050	325,266	93,216	110,043	25,134	50,041	185,217	285	75	6.0	1.2	E2
F	110+00	154.03	168.07	14.05	667,620	714,966	47,346	50,822	29,855	109,552	190,229	265	85	6.0	3.0	F2
G	127+00	59.99	134.01	74.02	180,846	340,548	159,702	51,890	48,364	27,056	127,310	200	58	6.6	1.0	G2-North
	139+00							119,168	26,575	54,789	200,532	180	180	5.0	1.0	G2-South

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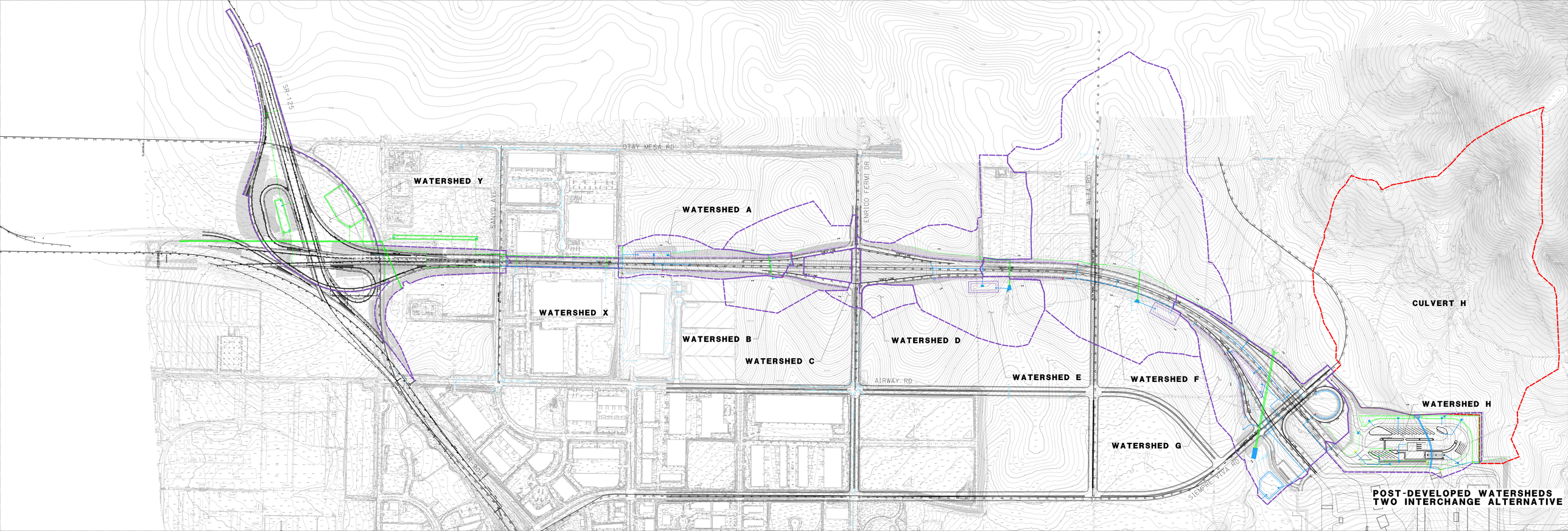

POST-DEVELOPED WATERSHEDS
TWO INTERCHANGE ALTERNATIVE

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Appendix E Commercial Vehicle Enforcement Facility (CVEF)

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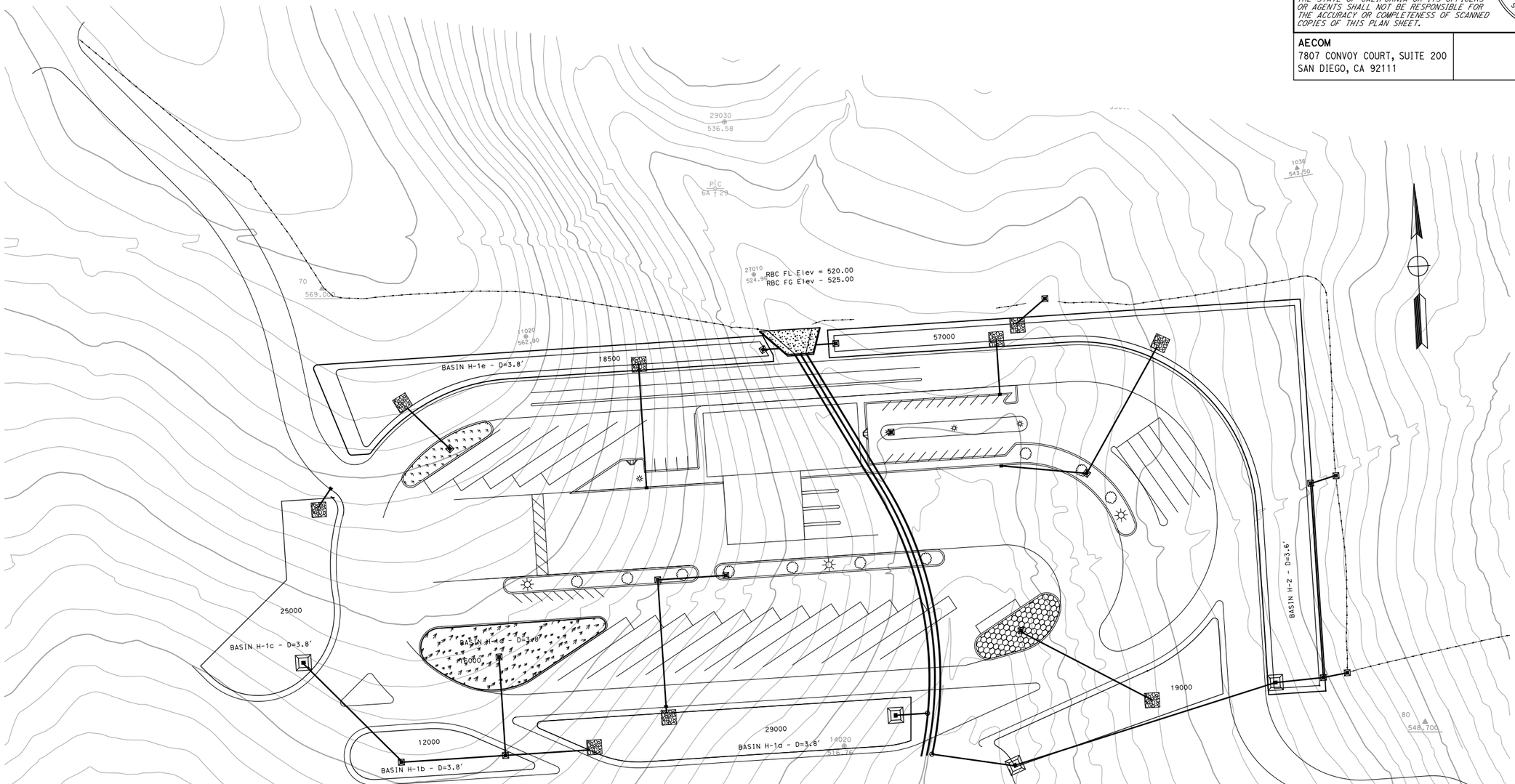
AECOM
7807 CONVOY COURT, SUITE 200
SAN DIEGO, CA 92111

NOTE:

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



THIS PLAN ACCURATE FOR DRAINAGE WORK ONLY.

ALL DIMENSIONS ARE IN FEET UNLESS OTHERWISE SHOWN

SCALE 1"=50'

DRAINAGE PLAN

D-CVEF

REVISED BY	DATE REVISED

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

CONSULTANT FUNCTIONAL SUPERVISOR: KIRK BRADBURY

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION
Caltrans

60099859

LAST REVISION: DATE PLOTTED => 2/3/2010
11-13-09 TIME PLOTTED => 5:16:05 PM

2/3/2010 5:16:04 PM YamanakaG H:\Caltrans\2208300\Cad\planset\b056300iaCVEF.dgn

BORDER LAST REVISED 4/11/2008

RELATIVE BORDER SCALE IS IN INCHES 0 1 2 3

USERNAME => YamanakaG
DGN FILE => ...\b056300iaCVEF.dgn

CU XXXXX

EA 06002

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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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NOTE:

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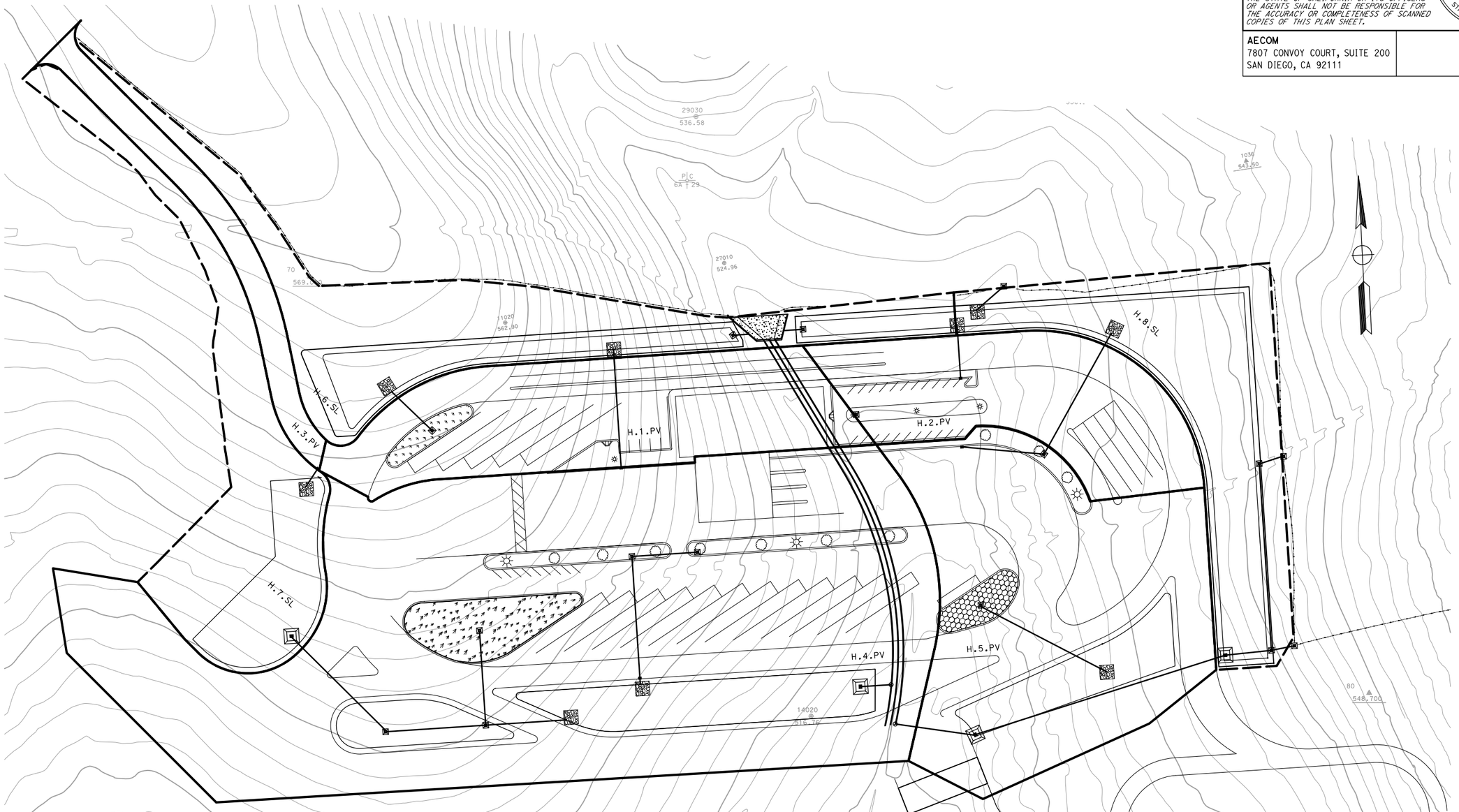

THIS PLAN ACCURATE FOR DRAINAGE WORK ONLY.

ALL DIMENSIONS ARE IN FEET UNLESS OTHERWISE SHOWN

DRAINAGE AREA PLAN

SCALE 1"=50'

DA-CVEF

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

60098859

LAST REVISION DATE PLOTTED => 2/3/2010
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2/3/2010 5:17:23 PM YamanakaG H:\Caltrans\2208300\Cad\planset\b056300faCVEF_DA.dgn
BORDER LAST REVISED 4/11/2008

RELATIVE BORDER SCALE IS IN INCHES 0 1 2 3

USERNAME => YamanakaG
DGN FILE => ...\b056300faCVEF_DA.dgn

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EA 06002

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H Onsite D.A. Table

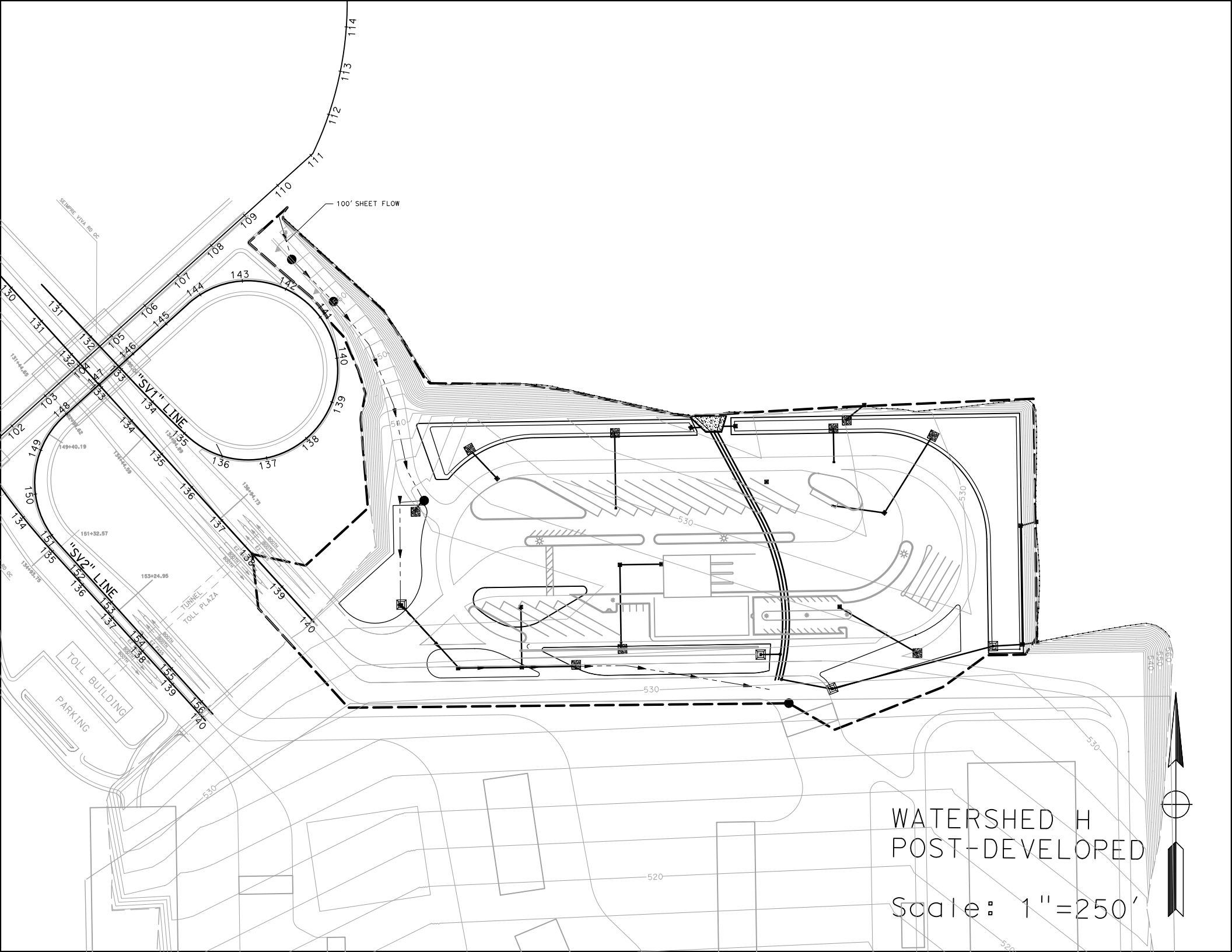
PROJECT:	**SR-11**	**DESCRIPTION:**	**On-site Drainage Areas (D.A.)**
JOB #:	**11A1190**	**STATION:**	**~**
BY:	**M.BRUNING** **DATE:** **01.12.10**	**WATERSHED:**	**H**
CHK:	**G.DALZIEL** **DATE:**	**SYSTEM:**	

			Area		Tc	Caltrans i_{25}	Caltrans Q_{25}	County i_{100}	County Q_{100}	Drains to:				
	Name	C_{25}	*SF*	*Acres*	*min*	*in/hr*	*cfs*	*in/hr*	*cfs*	Bioswale	Inlet	Destination	@ Station	Offset
PAVED	H.1.PV	0.99	104000	2.4	10	2.8	6.66	4.2	9.96	~	H.1	Basin H	CVEF	~
	H.2.PV	0.99	80500	1.8	10	2.8	5.15	4.2	7.71	~	H.2	Basin H	CVEF	~
	H.3.PV	0.99	29000	0.7	10	2.8	1.86	4.2	2.78	~	H.3	Basin H	CVEF	~
	H.4.PV	0.99	444000	10.2	10	2.8	28.43	4.2	42.51	~	H.4	Basin H	CVEF	~
	H.5.PV	0.99	167000	3.8	10	2.8	10.69	4.2	15.99	~	H.5	Basin H	CVEF	~
		Σ	824500	*PAVED*										

			Area		Tc	Caltrans i_{25}	Caltrans Q_{25}	County i_{100}	County Q_{100}	Drains to:				
	Name	C_{25}	*SF*	*Acres*	*min*	*in/hr*	*cfs*	*in/hr*	*cfs*	Bioswale	Inlet	Destination	@ Station	Offset
SLOPE	H.6.SL	0.61	107000	2.5	10	2.8	4.22	4.2	6.31	~	~	Basin H	CVEF	~
	H.7.SL	0.61	88000	2.0	10	2.8	3.47	4.2	5.19	~	~	Basin H	CVEF	~
	H.8.SL	0.61	98000	2.2	10	2.8	3.87	4.2	5.78	~	~	Basin H	CVEF	~
		Σ	293000	*SLOPE*										

Total :	1117500	25.65	
	SF	*ac*	

C:	0.89
C_{100}:	1.00


100' SHEET FLOW
"SV1" LINE
"SV2" LINE
TOLL BUILDING
PARKING
TUNNEL
TOLL PLAZA
WATERSHED H
POST-DEVELOPED
Scale: 1"=250'

H Post-Developed TcQ

PROJECT:	**SR-11**			**DESCRIPTION:**	**SR-11 Post-Developed**
JOB #:	**11A1190**			**STATION:**	**CVEF**
BY:	**M.BRUNING**	**DATE:**	**01.12.10**	**WATERSHED:**	**H**
CHK:	**G.DALZIEL**	**DATE:**		**SYSTEM:**	

BASIN AREA:

A = **1117500** **ft^2** | **25.65** **acres**

SOURCE: **MICROSTATION/USGS** **(SCALE = 1:1)**

COEFFICIENT OF RUNOFF:

KEY: User Input | Designer Tool

UNDEVELOPED AREA C (FROM HDM FIG. 819.2A)

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	74%	AT	0.90	0.664
COMMERCIAL AREA	0%	AT	0.85	0.000
CUT SLOPE (2:1 and 4:1)	26%	AT	0.55	0.144
TOTAL	100%			
	(100%)			

$C_{2,10}$ =	0.81
C_{25} =	0.89
C_{50} =	0.97
C_{100} =	1.00

TIME OF CONCENTRATION:

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

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

HIGH PT ELEVATION	570.0	ft
LOW POINT ELEVATION	566.0	ft
ELEVATION DIFF (H)	4.0	ft
LENGTH (L)	100	ft
SLOPE (S) = (H/L)	4.0%	
MANNING'S n	0.016	
T_t (SFF)=	1.65	minutes

CVEF Access Road from S.V.

< = from Table 816.6A HMA

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

NOTES:

HIGH PT ELEVATION	566.0	ft
LOW POINT ELEVATION	560.0	ft
ELEVATION DIFF (H)	6.0	ft
LENGTH (L)	120	ft
SLOPE (S) = (H/L)	5.0%	
VELOCITY (SCF)	5.0	fps
T_C (SH)=	0.40	minutes

down access road

<=V from Figure 816.5 Gutter, not concentrated

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

NOTES:

HIGH PT ELEVATION	560.0	ft
LOW POINT ELEVATION	532.0	ft
ELEVATION DIFF (H)	28.0	ft
LENGTH (L)	493	ft
SLOPE (S) = (H/L)	5.7%	
MANNING'S n	0.016	
HYDRAULIC RADIUS R	0.4	ft
VELOCITY (CHANNEL)	12.83	fps
T_C (CH)=	0.64	minutes

channelizes in gutter of access road

CHANNEL DATA		TYPE =	TRAP'Z
Z=	2	ANG-RAD	0.464
b =	8	ANG-DEG	26.565
d =	0.5	FLOWING FULL ASS'M	

HMA

R=(bdsinA+d^2cosA)/(bsinA+2d)

From Manning's Equation assuming flowing full: $V=1.49/n(R^{2/3}S^{1/2})$

H Post-Developed TcQ

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

HIGH PT ELEVATION	532.0	ft
LOW POINT ELEVATION	518.0	ft
ELEVATION DIFF (H)	14.0	ft
LENGTH (L)	1175	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)	12.5	fps
T_C (SD)=	1.57	minutes

NOTES:

Assume piped to Basin
Basin FL
R=D/4, Assume: flowing full
$V = \frac{K_u}{n} R^{2/3} S^{1/2}$

Tc (TOTAL) =	4.26	minutes
Minimum Tc =	10	minutes
USE Tc =	**10.00**	minutes

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

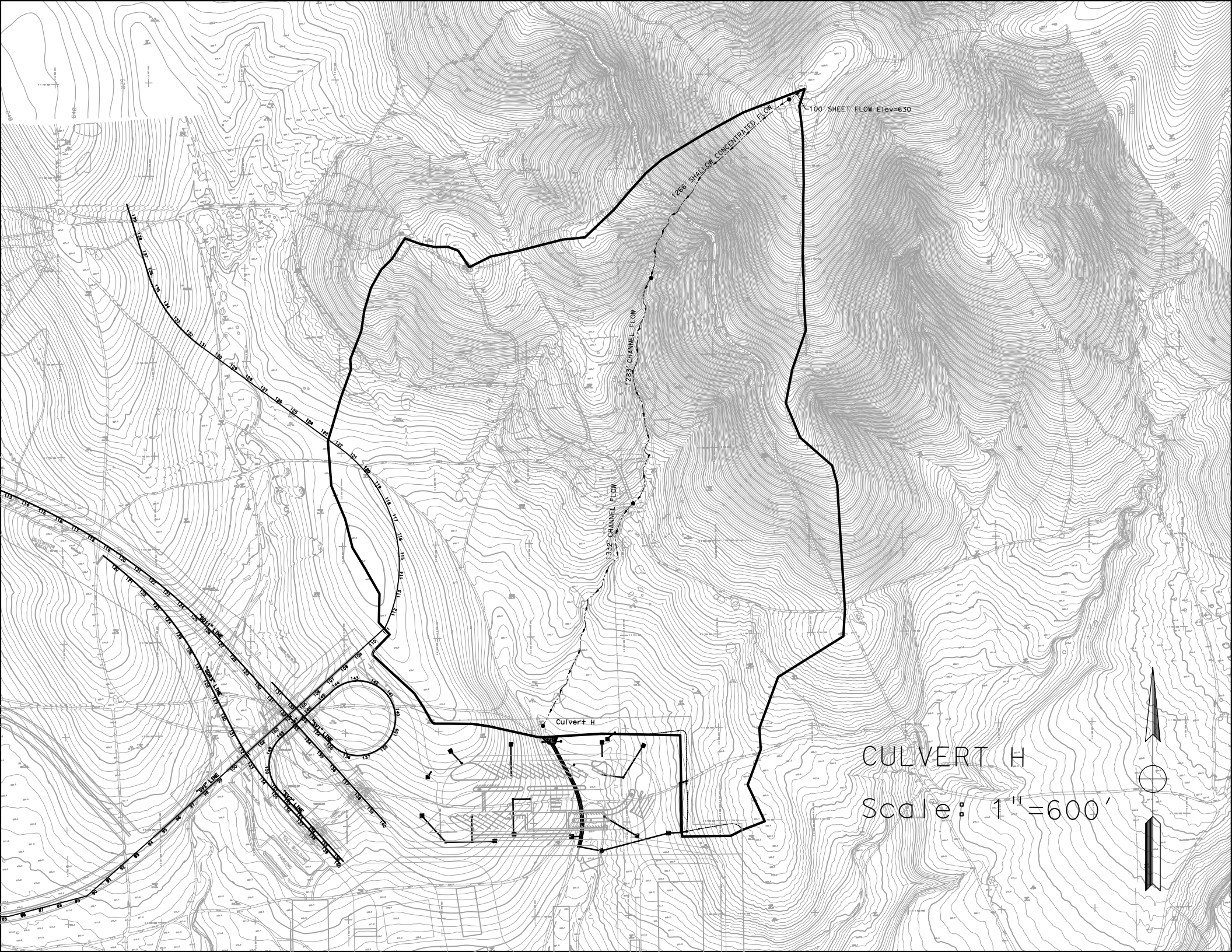
i_2 =	1.9	in/hr	X CA =
i_{10} =	2.7	in/hr	X CA =
i_{25} =	3.4	in/hr	X CA =
i_{50} =	4.0	in/hr	X CA =
i_{100} =	4.2	in/hr	X CA =

FLOW RESULTS:

	cfs
Q_2 =	38.4
Q_{10} =	55.9
Q_{25} =	76.9
Q_{50} =	100.6
Q_{100} =	**108.1**

COUNTY P_6

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


100' SHEET FLOW Elev=630
1266' SHALLOW CONCENTRATED FLOW
1283' CHANNEL FLOW
1332' CHANNEL FLOW
Culvert H
CULVERT H
Scale: 1"=600'

Culvert Calculator Report
H CVEF 10-yr

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	524.00	ft	Headwater Depth/Height	0.65	
Computed Headwater Elevation	522.61	ft	Discharge	123.90	cfs
Inlet Control HW Elev.	522.36	ft	Tailwater Elevation	511.76	ft
Outlet Control HW Elev.	522.61	ft	Control Type	Entrance Control	

Grades					
Upstream Invert	520.00	ft	Downstream Invert	510.00	ft
Length	694.00	ft	Constructed Slope	1.4	%

Hydraulic Profile					
Profile	CompositeS1S2		Depth, Downstream	1.76	ft
Slope Type	Steep		Normal Depth	0.94	ft
Flow Regime	N/A		Critical Depth	1.49	ft
Velocity Downstream	5.87	ft/s	Critical Slope	0.4	%

Section					
Section Shape	Box		Mannings Coefficient	0.013	
Section Material	Concrete		Span	6.00	ft
Section Size	6 x 4 ft		Rise	4.00	ft
Number Sections	2				

Outlet Control Properties					
Outlet Control HW Elev.	522.61	ft	Upstream Velocity Head	0.75	ft
Ke	0.50		Entrance Loss	0.37	ft

Inlet Control Properties					
Inlet Control HW Elev.	522.36	ft	Flow Control	Unsubmerged	
Inlet Type	45° bevels; 10 - 45° skewed headwall		Area Full	48.0	ft²
K	0.49800		HDS 5 Chart	11	
M	0.66700		HDS 5 Scale	4	
C	0.03270		Equation Form	2	
Y	0.75000				

Culvert Calculator Report
H CVEF 100-yr

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	525.00	ft	Headwater Depth/Height	1.05	
Computed Headwater Elevation	524.18	ft	Discharge	251.60	cfs
Inlet Control HW Elev.	523.79	ft	Tailwater Elevation	511.44	ft
Outlet Control HW Elev.	524.18	ft	Control Type	Entrance Control	

Grades					
Upstream Invert	520.00	ft	Downstream Invert	510.00	ft
Length	694.00	ft	Constructed Slope	1.4	%

Hydraulic Profile					
Profile	S2		Depth, Downstream	1.52	ft
Slope Type	Steep		Normal Depth	1.52	ft
Flow Regime	Supercritical		Critical Depth	2.39	ft
Velocity Downstream	13.80	ft/s	Critical Slope	0.4	%

Section					
Section Shape	Box		Mannings Coefficient	0.013	
Section Material	Concrete		Span	6.00	ft
Section Size	6 x 4 ft		Rise	4.00	ft
Number Sections	2				

Outlet Control Properties					
Outlet Control HW Elev.	524.18	ft	Upstream Velocity Head	1.20	ft
Ke	0.50		Entrance Loss	0.60	ft

Inlet Control Properties					
Inlet Control HW Elev.	523.79	ft	Flow Control	Unsubmerged	
Inlet Type	45° bevels; 10 - 45° skewed headwall		Area Full	48.0	ft²
K	0.49800		HDS 5 Chart	11	
M	0.66700		HDS 5 Scale	4	
C	0.03270		Equation Form	2	
Y	0.75000				

H Culvert TcQ

PROJECT:	**SR-11**			**DESCRIPTION:**	**SR-11 Culvert**
JOB #:	**11A1190**			**STATION:**	**CVEF**
BY:	**M.BRUNING**	**DATE:**	**01.12.10**	**WATERSHED:**	**H**
CHK:	**G.DALZIEL**	**DATE:**		**SYSTEM:**	**Culvert**

BASIN AREA:

A =	**7050716**	**ft^2**	**SOURCE:**	**MICROSTATION/USGS**
	161.86	**acres**		**(SCALE = 1:1)**

COEFFICIENT OF RUNOFF:

KEY: User Input | Designer Tool

UNDEVELOPED AREA C (FROM HDM FIG. 819.2A)

RELIEF (.08-.35)	0.22	Hilly Slopes ~ 15%
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 =	0.49	

UNDEVELOPED AREA	100%	AT	0.49	0.490
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%)			

$C_{2,10}$ =	0.49
C_{25} =	0.54
C_{50} =	0.59
C_{100} =	0.61

TIME OF CONCENTRATION:

SHEET FLOW: $T_t = \frac{0.42L^{.8}n^{.8}}{P_2^{.5}s^{.4}}$

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

HIGH PT ELEVATION	1023.9	ft	Northern watershed boundary
LOW POINT ELEVATION	1014.0	ft	
ELEVATION DIFF (H)	9.9	ft	
LENGTH (L)	100	ft	
SLOPE (S) = (H/L)	9.9%		
MANNING'S n	0.050		< = FROM TABLE 816.6A — Fallow
T_t (SFF)=	2.86	minutes	

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

NOTES:

HIGH PT ELEVATION	1014.0	ft	
LOW POINT ELEVATION	672.0	ft	
ELEVATION DIFF (H)	342.0	ft	
LENGTH (L)	1266	ft	
SLOPE (S) = (H/L)	27.0%		
VELOCITY (SCF)	3.3	fps	<=V FROM FIG 816.6 — Earthen/Grasses
T_C (SH)=	6.39	minutes	

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

NOTES:

HIGH PT ELEVATION	672.0	ft	channelizes
LOW POINT ELEVATION	581.1	ft	
ELEVATION DIFF (H)	90.9	ft	
LENGTH (L)	1283	ft	
SLOPE (S) = (H/L)	7.1%		
MANNING'S n	0.080		grass/earthen
HYDRAULIC RADIUS R	0.5	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)=	6.82	minutes	

CHANNEL DATA — TYPE = TRAP'Z

Z=	2	ANG-RAD	0.464
b =	0.5	ANG-DEG	26.565
d =	1	FLOWING FULL ASS'M	

H Culvert TcQ

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

HIGH PT ELEVATION	581.1	ft
LOW POINT ELEVATION	525.0	ft
ELEVATION DIFF (H)	56.1	ft
LENGTH (L)	1332	ft
SLOPE (S) = (H/L)	4.2%	
MANNING'S n	0.080	
HYDRAULIC RADIUS R	1.2	ft
VELOCITY (CHANNEL)	4.43	fps
T_C (CH)=	5.01	minutes

NOTES:

broader channel at confluence

CHANNEL DATA		TYPE =	TRAP'Z
Z=	3	ANG-RAD	0.322
b =	20	ANG-DEG	18.435
d =	1.5	FLOWING FULL ASS'M	

grass/earthen

R=(bdsinA+d^2cosA)/(bsinA+2d)

From Manning's Equation assuming flowing full: $V=1.49/n(R^{2/3}S^{1/2})$

Tc (TOTAL) =	21.09	minutes
Minimum Tc =	10	minutes
USE T_C =	**21.09**	minutes

INTENSITY CHART: **Caltrans IDF2000**

				FLOW RESULTS	**cfs**
i_2 =	0.8	in/hr	X CA =	**Q_2 =**	65.8
i_{10} =	1.6	in/hr	X CA =	**Q_{10} =**	123.6
i_{25} =	1.9	in/hr	X CA =	**Q_{25} =**	169.9
i_{50} =	2.2	in/hr	X CA =	**Q_{50} =**	213.2
i_{100} =	2.5	in/hr	X CA =	**Q_{100} =**	**250.9**

~Use Caltrans 'i' for culvert sizing

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

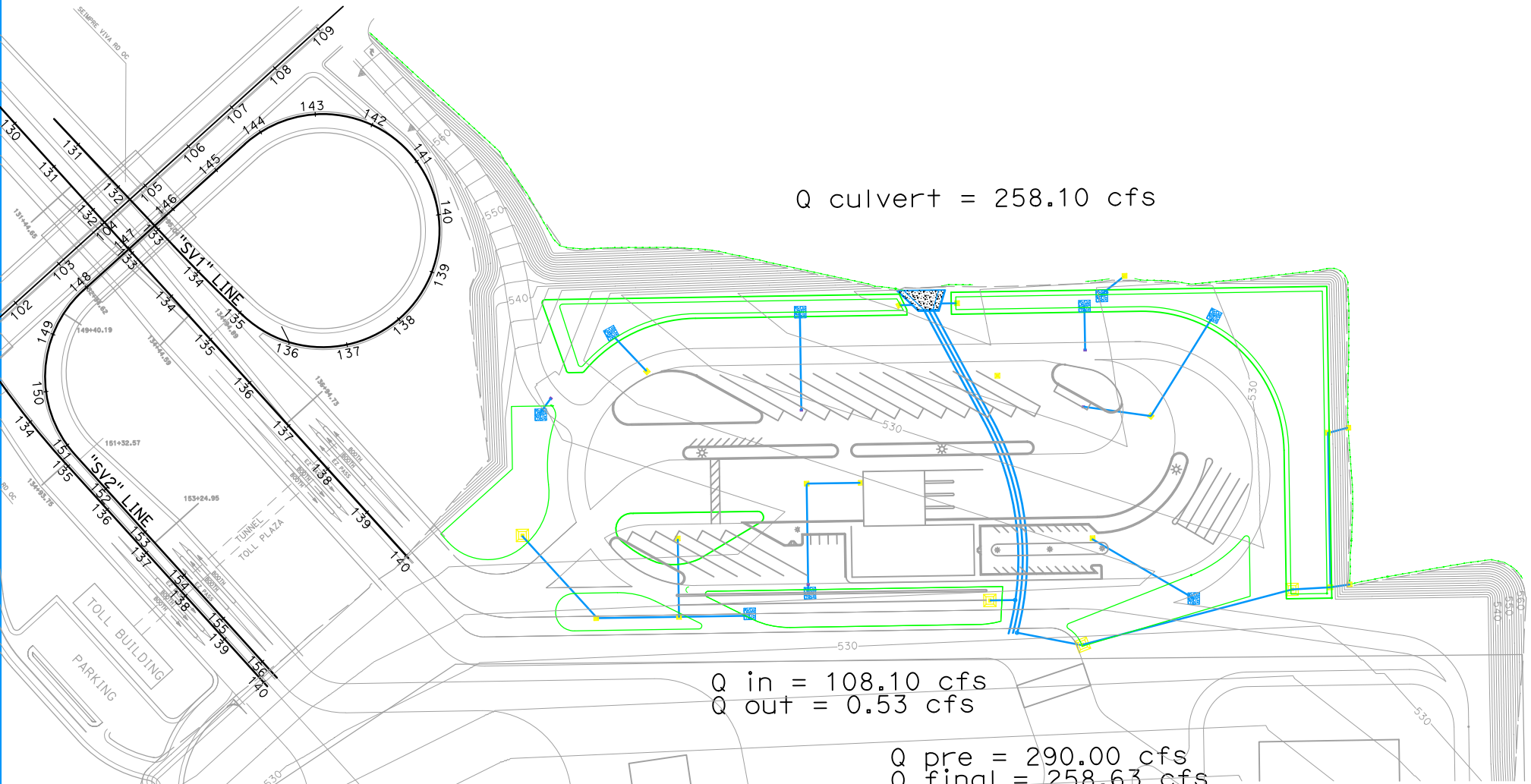
				FLOW RESULTS	**cfs**
i_2 =	1.1	in/hr	X CA =	**Q_2 =**	90.8
i_{10} =	1.7	in/hr	X CA =	**Q_{10} =**	132.1
i_{25} =	2.1	in/hr	X CA =	**Q_{25} =**	181.7
i_{50} =	2.5	in/hr	X CA =	**Q_{50} =**	237.8
i_{100} =	2.6	in/hr	X CA =	**Q_{100} =**	**258.1**

~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



Q culvert = 258.10 cfs

Q in = 108.10 cfs
Q out = 0.53 cfs

Q pre = 290.00 cfs
Q final = 258.63 cfs

BASIN H
FLOW SUMMARY

Scale: 1"=250'

Basin H Retention

PROJECT:	**SR-11**			**DESCRIPTION:**	**SR-11 Basin**
JOB #:	**11A1190**			**STATION:**	**CVEF**
BY:	**M.BRUNING**	**DATE:**	**01.12.10**	**WATERSHED:**	**H**
CHK:	**G.DALZIEL**	**DATE:**		**SYSTEM:**	

Notes:

* The difference between pre-developed and post-developed values gives the approximate volume to detain. Stage-Storage calculations will determine accurate volume

RETENTION BASIN VOLUME

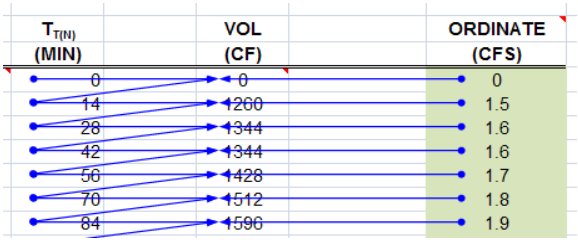
100-year, 6 hour duration storm event, use the Rational Method Hydrograph Procedure (SDCHM 6-1) ~ RatHydro

Pre-Developed volume calculations

Q_{100}=	31.9	cfs			
Tc=	12.6	min	C=	0.61	
$P_{100,6}$=	2.5	in	A=	14.33	acres

$T_{T(N)}$ (MIN)	VOL (CF)	ORDINATE (CFS)
0	0	0
13	0	0
26	1014	1.3
39	1092	1.4
52	1092	1.4
65	1170	1.5
78	1248	1.6
91	1248	1.6
104	1326	1.7
117	1404	1.8
130	1560	2
143	1638	2.1
156	1794	2.3
169	1872	2.4
182	2184	2.8
195	2340	3
208	2886	3.7
221	3276	4.2
234	4836	6.2
247	6162	7.9
260	24882	31.9
273	3822	4.9
286	2574	3.3
299	2028	2.6
312	1716	2.2
325	1482	1.9
338	1326	1.7
351	1170	1.5
364	1092	1.4
377	0	0

Example of Steps:



SUM= 78234 ft^3
1.80 acre-feet

Check: $V = C*A*P_6$
V= 1.83 acre-feet
OK

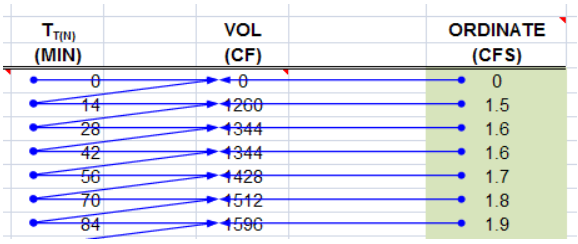
Basin H Retention

Post-Developed volume calculations

Q_{100}=	108.1	cfs			
Tc=	10.0	min	C=	1.00	
$P_{100,6}$=	2.5	in	A=	25.65	acres

$T_{T(N)}$ (MIN)	VOL (CF)	ORDINATE (CFS)
0	0	0
10	2280	3.8
20	2340	3.9
30	2460	4.1
40	2460	4.1
50	2580	4.3
60	2640	4.4
70	2760	4.6
80	2820	4.7
90	3000	5
100	3060	5.1
110	3300	5.5
120	3360	5.6
130	3660	6.1
140	3780	6.3
150	4080	6.8
160	4320	7.2
170	4740	7.9
180	5040	8.4
190	5820	9.7
200	6300	10.5
210	7680	12.8
220	8760	14.6
230	12840	21.4
240	18060	30.1
250	64860	108.1
260	10320	17.2
270	6900	11.5
280	5400	9
290	4500	7.5
300	3900	6.5
310	3480	5.8
320	3180	5.3
330	2940	4.9
340	2700	4.5
350	2520	4.2
360	2400	4
370	0	0

Example of Steps:



SUM= 231240 ft^3
5.31 acre-feet

Check: $V = C*A*P_6$
V= 5.34 acre-feet
OK

5.31
\- **1.80**
Attenuation volume = 3.51 acre-feet = 153006 ft^3 Basin Required

Basin H 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= 25.65 acres

WQ_{72}: 0.73 in/area

Water Quality Volume (WQV) = **67981** ft^3

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

If the WQV 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

Universal Soil Loss Equation (SDCHM 5.2.3)

$A_s = RKLsCP$

where:

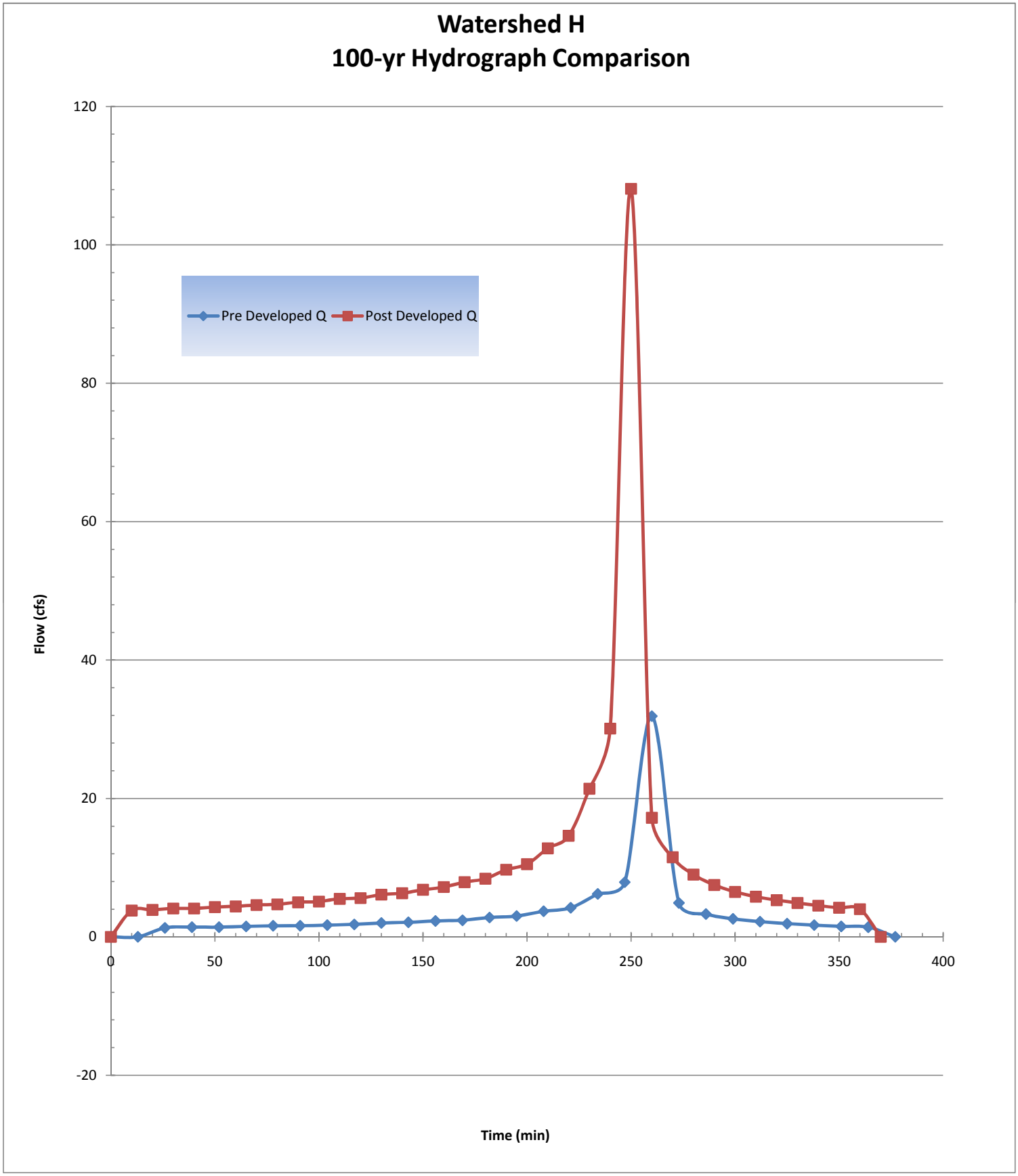
A_s = the computed soil loss in tons (dry weight)
R = the rainfall erosion index for the given storm period
K = the soil erodibility factor
L = the slope length factor
s = the slope gradient factor
C = cropping management (vegetation) factor
P = erosion control practice factor

Onsite Highway *Sloped* runoff area, A:		293000	ft^2
	A:	6.73	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 = 104.61 tons

Silt Accumulation Basin volume = **2325** ft^3

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


Watershed H
100-yr Hydrograph Comparison
Pre Developed Q
Post Developed Q
Flow (cfs)
Time (min)
120
100
80
60
40
20
0
-20
0
50
100
150
200
250
300
350
400

Basin H Inflow Hydrograph

PROJECT:	**SR-11**			**DESCRIPTION:**	**SR-11 Basin**
JOB #:	**11A1190**			**STATION:**	**~**
BY:	**M.BRUNING**	**DATE:**	**01.12.10**	**WATERSHED:**	**H**
CHK:	**G.DALZIEL**	**DATE:**		**SYSTEM:**	**Basin H**

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}=	108.1	cfs	C_{100}=	1.00	
Tc=	10.0	min	A=	25.65	acres
$P_{100,6}$=	2.5	in			

$T_{T(N)}$ (MIN)	VOL (CF)	ORDINATE (CFS)
0	0	0
10	2280	3.8
20	2340	3.9
30	2460	4.1
40	2460	4.1
50	2580	4.3
60	2640	4.4
70	2760	4.6
80	2820	4.7
90	3000	5
100	3060	5.1
110	3300	5.5
120	3360	5.6
130	3660	6.1
140	3780	6.3
150	4080	6.8
160	4320	7.2
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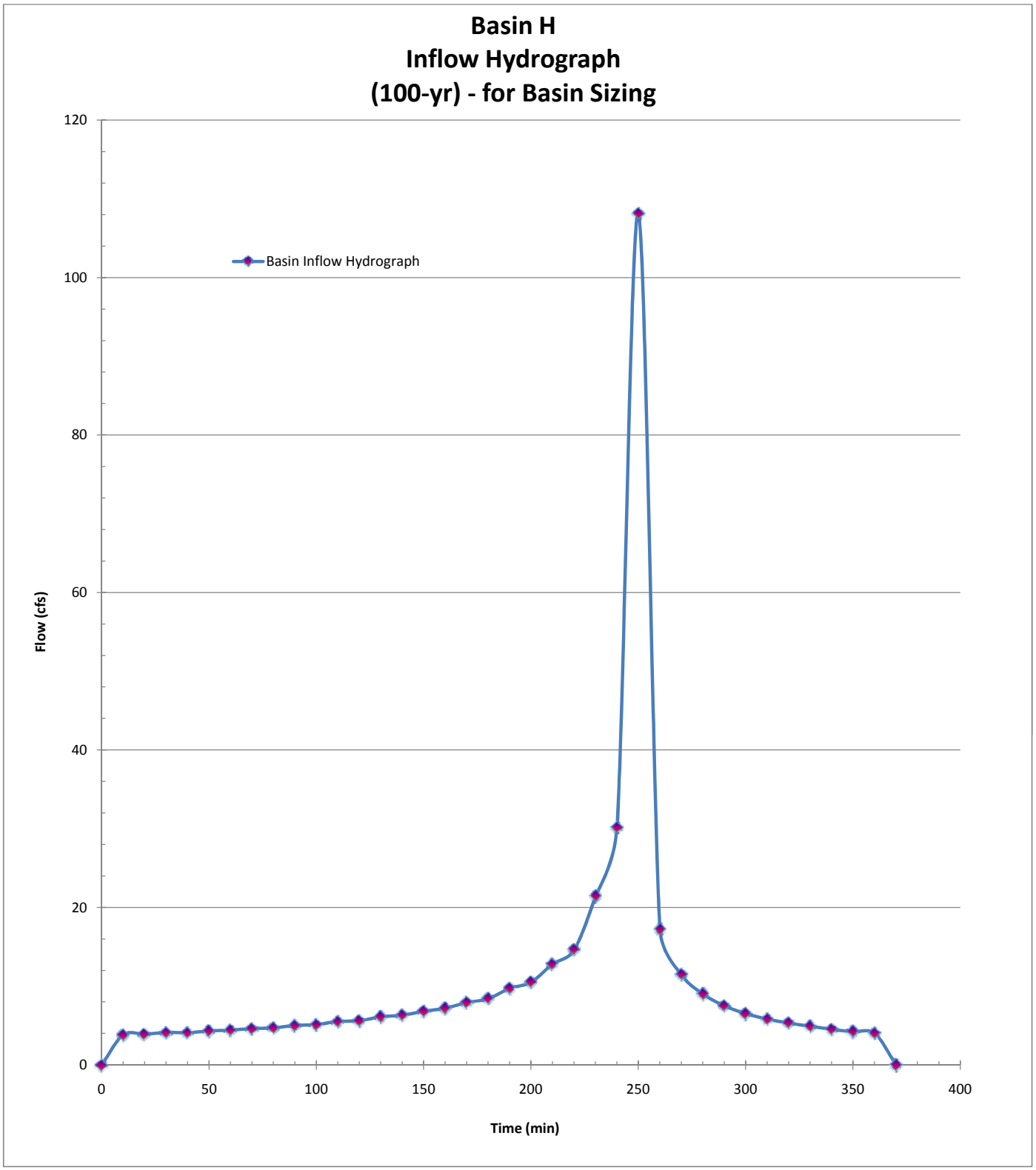
300	3900	6.5
310	3480	5.8
320	3180	5.3
330	2940	4.9
340	2700	4.5
350	2520	4.2
360	2400	4
370	0	0

SUM= 231240 ft^3
5.31 acre-feet

Onsite Runoff Volume

Check: $V = C*A*P_6$
V= 5.34 acre-feet
OK


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

Basin H Outlet

PROJECT:	**SR-11**			**DESCRIPTION:**	**SR-11 Basin**
JOB #:	**11A1190**			**STATION:**	**CVEF**
BY:	**M.BRUNING**	**DATE:**	**02.19.10**	**WATERSHED:**	**H**
CHK:	**G.DALZIEL**	**DATE:**		**SYSTEM:**	**Basin H**

Notes:

Required Retention Basin Volume = 155331 ft^3
Actual Basin Inflow = 231240 ft^4 *OK*

Flow Balance - determine maximum flow from basin

Predeveloped Peak 100-year Flow:	31.9	cfs	
Post-Developed Peak Flow through Cross Culvert:	0.0	cfs	Culvert flow is separate in this run
Flow that does not reach detention basin (bypass per DA table):	0.0	cfs	~ Q_{100} from:
Maximum flow allowed to be released by this detention basin:	31.9	cfs	

Outlet Pipe

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

Basin - Top of basin berm elevation =		528.00	ft
Basin flowline elevation =		524.00	ft
Maximum Basin Depth =		4.00	ft
Assume Culvert Design: free outfall, square-edge w/headwall			
Outlet pipe invert from basin floor =	1.20 ft	525.20	ft
Outlet pipe diameter =	2.00 ft		

Basin Characteristics

Base Length (L)	652	ft
Base Width (W)	215	ft
W/L Ratio ®	0.33	
Side Slopes (Z)	1: 4	
Total Volume (V):	617750	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	524.00	0.00	0	0		524.00	0.00		0.00
1	524.20	0.20	28187	28187		524.20	0.00		0.00
2	524.40	0.40	28466	56653		524.40	0.00		0.00
3	524.60	0.60	28745	85398		524.60	0.00		0.00
4	524.80	0.80	29026	114423		524.80	0.00		0.00
5	525.00	1.00	29307	143731		525.00	0.00		0.00
6	525.20	1.20	29590	173320	*	525.20	0.00		0.00
7	525.40	1.40	29873	203194		525.40	0.15		0.15
8	525.60	1.60	30158	233352		525.60	0.59		0.59
9	525.80	1.80	30444	263796		525.80	1.30	0.00	1.30
10	526.00	2.00	30730	294526		526.00	2.25		2.25
11	526.20	2.20	31018	325544		526.20	3.42		3.42
12	526.40	2.40	31307	356851		526.40	4.79		4.79
13	526.60	2.60	31597	388448		526.60	6.32		6.32
14	526.80	2.80	31887	420335		526.80	7.99		7.99
15	527.00	3.00	32179	452514		527.00	9.77		9.77
16	527.20	3.20	32472	484987		527.20	11.63		11.63
17	527.40	3.40	32766	517753		527.40	13.53		13.53
18	527.60	3.60	33061	550814		527.60	15.46		15.46

Basin H Routing

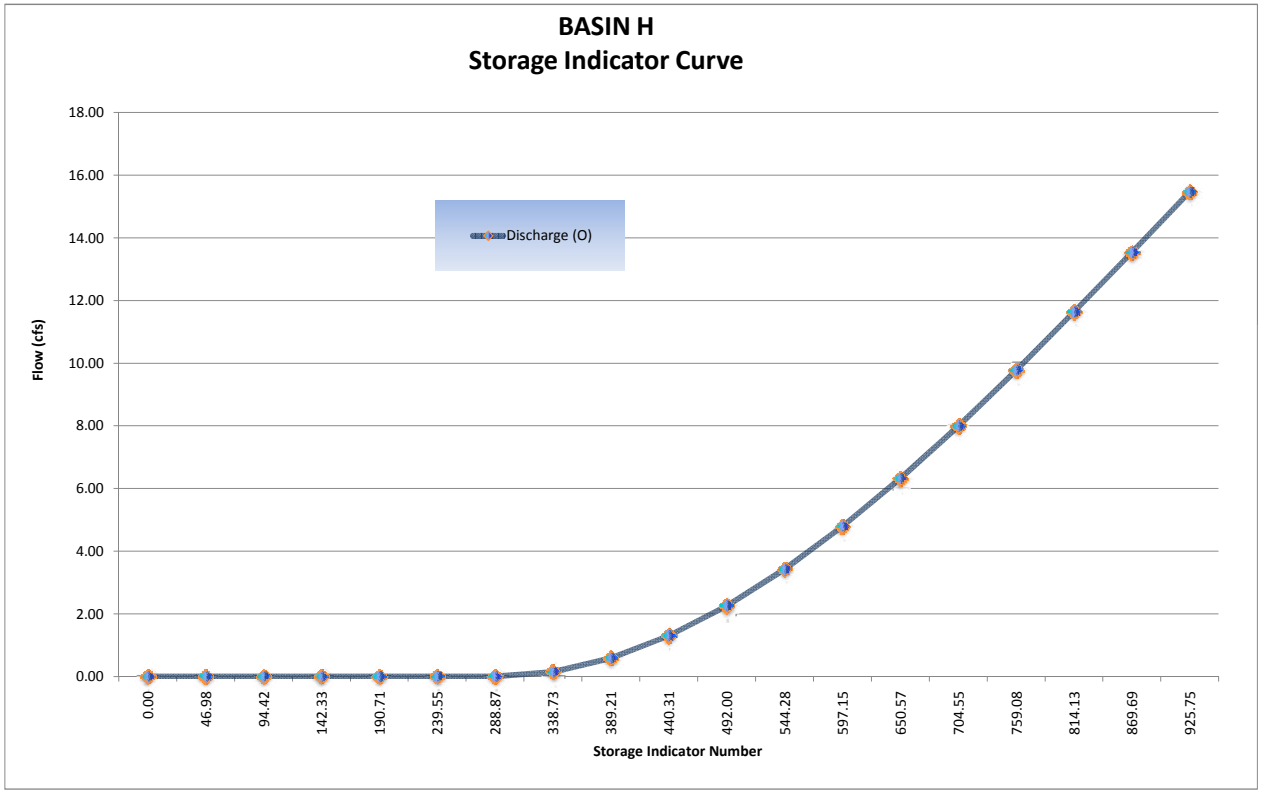
PROJECT:	SR-11			DESCRIPTION:	SR-11 Basin
JOB #:	11A1190			STATION:	CVEF
BY:	M.BRUNING	DATE:	02.19.10	WATERSHED:	H
CHK:	G.DALZIEL	DATE:		SYSTEM:	Basin H

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)	*Storage Indicator #* (6) $S_2/delta\ t + O_2/2$ (cfs)
524.00	0.00	0	0.00	0.00	0.00
524.20	0.00	28187	0.00	46.98	46.98
524.40	0.00	56653	0.00	94.42	94.42
524.60	0.00	85398	0.00	142.33	142.33
524.80	0.00	114423	0.00	190.71	190.71
525.00	0.00	143731	0.00	239.55	239.55
525.20	0.00	173320	0.00	288.87	288.87
525.40	0.15	203194	0.08	338.66	338.73
525.60	0.59	233352	0.30	388.92	389.21
525.80	1.30	263796	0.65	439.66	440.31
526.00	2.25	294526	1.13	490.88	492.00
526.20	3.42	325544	1.71	542.57	544.28
526.40	4.79	356851	2.40	594.75	597.15
526.60	6.32	388448	3.16	647.41	650.57
526.80	7.99	420335	4.00	700.56	704.55
527.00	9.77	452514	4.89	754.19	759.08
527.20	11.63	484987	5.82	808.31	814.13
527.40	13.53	517753	6.77	862.92	869.69
527.60	15.46	550814	7.73	918.02	925.75

delta t =	0.17	hrs
delta t =	10.00	min
delta t =	600	sec



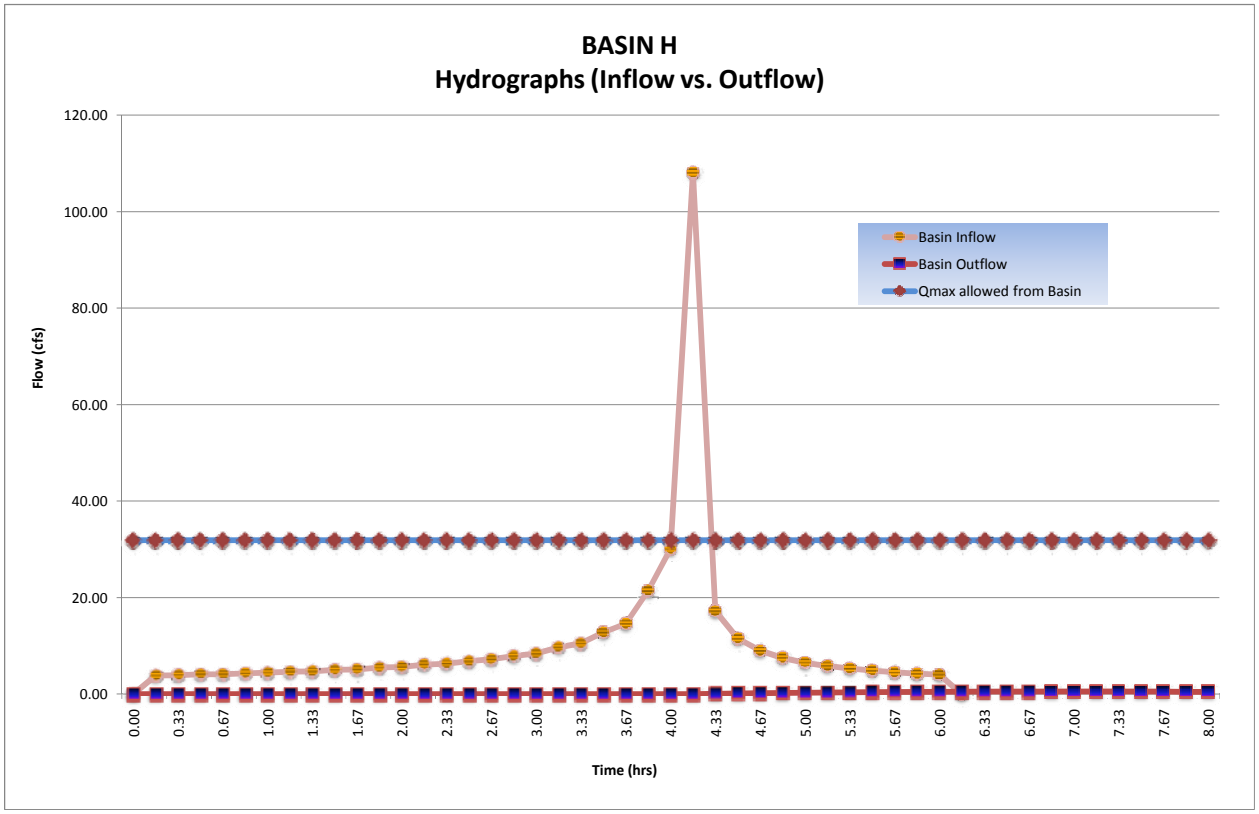
Basin H Routing

FINAL ROUTING TABLE

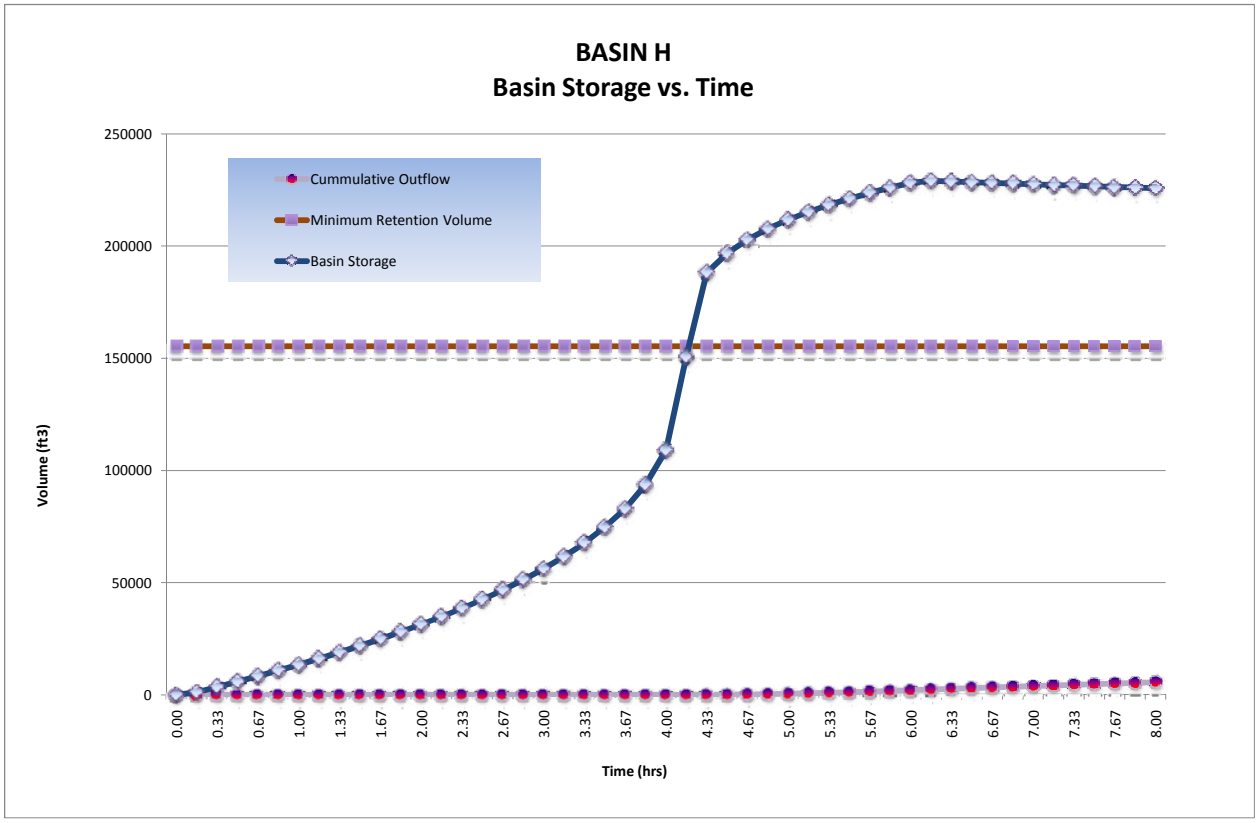
$$\frac{I_1 + I_2}{2} + \left(\frac{S_1}{\Delta t} + \frac{O_1}{2}\right) - O_1 - \left(\frac{S_2}{\Delta t} + \frac{O_2}{2}\right)$$

					Storage Indicator #			Volumes	
(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*	(6) $S_2/\text{delta t} + O_2/2$ (cfs) *col (3)+(4)-(5)*	(7) O_2 (cfs) *(Hard input)*		Basin Storage *(ft3)*	Incremental Outflow *(ft3)*	Cummulative Outflow *(ft3)*
0.00	0.00	0.00	0.00	0.00	0.00	0.00		0	0	0
0.17	3.80	1.90	0.00	0.00	1.90	0.00		1140	0	0
0.33	3.90	3.85	1.90	0.00	5.75	0.00		3450	0	0
0.50	4.10	4.00	5.75	0.00	9.75	0.00		5850	0	0
0.67	4.10	4.10	9.75	0.00	13.85	0.00		8310	0	0
0.83	4.30	4.20	13.85	0.00	18.05	0.00		10830	0	0
1.00	4.40	4.35	18.05	0.00	22.40	0.00		13440	0	0
1.17	4.60	4.50	22.40	0.00	26.90	0.00		16140	0	0
1.33	4.70	4.65	26.90	0.00	31.55	0.00		18930	0	0
1.50	5.00	4.85	31.55	0.00	36.40	0.00		21840	0	0
1.67	5.10	5.05	36.40	0.00	41.45	0.00		24870	0	0
1.83	5.50	5.30	41.45	0.00	46.75	0.00		28050	0	0
2.00	5.60	5.55	46.75	0.00	52.30	0.00		31380	0	0
2.17	6.10	5.85	52.30	0.00	58.15	0.00		34890	0	0
2.33	6.30	6.20	58.15	0.00	64.35	0.00		38610	0	0
2.50	6.80	6.55	64.35	0.00	70.90	0.00		42540	0	0
2.67	7.20	7.00	70.90	0.00	77.90	0.00		46740	0	0
2.83	7.90	7.55	77.90	0.00	85.45	0.00		51270	0	0
3.00	8.40	8.15	85.45	0.00	93.60	0.00		56160	0	0
3.17	9.70	9.05	93.60	0.00	102.65	0.00		61590	0	0
3.33	10.50	10.10	102.65	0.00	112.75	0.00		67650	0	0
3.50	12.80	11.65	112.75	0.00	124.40	0.00		74640	0	0
3.67	14.60	13.70	124.40	0.00	138.10	0.00		82860	0	0
3.83	21.40	18.00	138.10	0.00	156.10	0.00		93660	0	0
4.00	30.10	25.75	156.10	0.00	181.85	0.00		109110	0	0
4.17	108.10	69.10	181.85	0.00	250.95	0.00		150570	0	0
4.33	17.20	62.65	250.95	0.00	313.60	0.07		188139	42	42
4.50	11.50	14.35	313.60	0.07	327.88	0.12		196692	72	114
4.67	9.00	10.25	327.88	0.12	338.01	0.15		202761	90	204
4.83	7.50	8.25	338.01	0.15	346.11	0.21		207603	126	330
5.00	6.50	7.00	346.11	0.21	352.90	0.27		211659	162	492
5.17	5.80	6.15	352.90	0.27	358.78	0.32		215172	192	684
5.33	5.30	5.55	358.78	0.32	364.01	0.37		218295	222	906
5.50	4.90	5.10	364.01	0.37	368.74	0.41		221121	246	1152
5.67	4.50	4.70	368.74	0.41	373.03	0.45		223683	270	1422
5.83	4.20	4.35	373.03	0.45	376.93	0.48		226014	288	1710
6.00	4.00	4.10	376.93	0.48	380.55	0.51		228177	306	2016
6.17	0.00	2.00	380.55	0.51	382.04	0.53		229065	318	2334
6.33		0.00	382.04	0.53	381.51	0.52		228750	312	2646
6.50		0.00	381.51	0.52	380.99	0.52		228438	312	2958
6.67		0.00	380.99	0.52	380.47	0.51		228129	306	3264
6.83		0.00	380.47	0.51	379.96	0.51		227823	306	3570
7.00		0.00	379.96	0.51	379.45	0.50		227520	300	3870
7.17		0.00	379.45	0.50	378.95	0.50		227220	300	4170
7.33		0.00	378.95	0.50	378.45	0.50		226920	300	4470
7.50		0.00	378.45	0.50	377.95	0.49		226623	294	4764
7.67		0.00	377.95	0.49	377.46	0.49		226329	294	5058
7.83		0.00	377.46	0.49	376.97	0.48		226038	288	5346
8.00		0.00	376.97	0.48	376.49	0.48		225750	288	5634

Basin H Routing



Basin H Routing



Detention/Retention Basin Volume Required:	**229,065**	ft^3	
@ Stage:	**525.60**	ft	
Freeboard:	**1.4**	ft	>1' Freeboard
Final Total Basin Volume Provided:	**617,750**	ft^3	Basin **H**
Maximum flow rate released from this basin:	**0.53**	cfs	

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Detention/Retention Basin Flows and Sizes – Watershed H

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	Freeboard	Name
Name	(Sta)	(cfs)	(cfs)	(cfs)	(ft^3)	(ft^3)	(ft^3)	(ft^3)	(ft^3)	(ft^3)	(ft^3)	(ft)	(ft)	(ft)	(ft)	
H	CVEF	31.89	108.06	76.17	78,234	231,240	153,006	173,320	55,745	388,685	617,750	652	215	4.0	1.4	H

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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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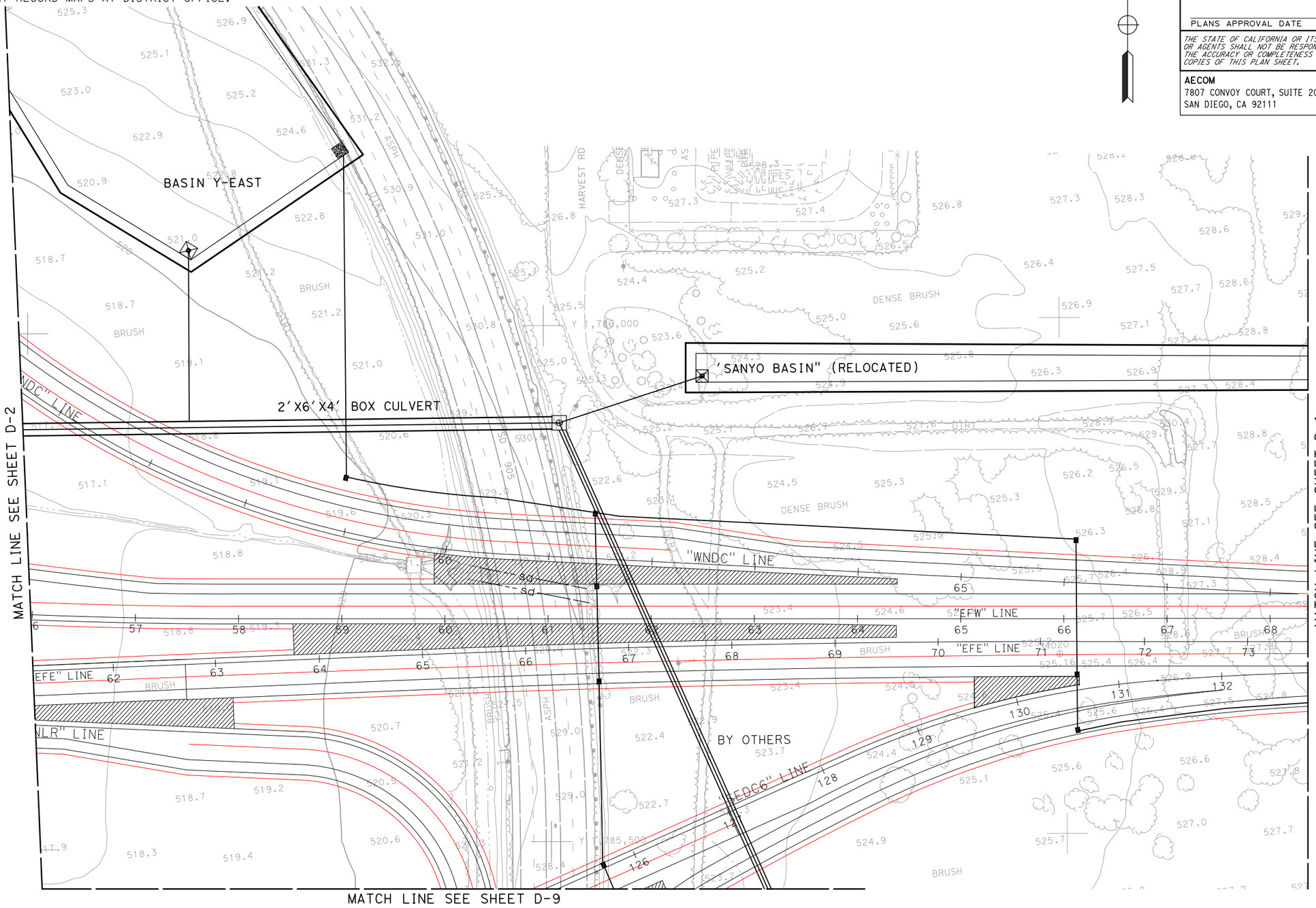

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ALL DIMENSIONS ARE IN FEET UNLESS OTHERWISE SHOWN

SCALE 1"=50'

DRAINAGE PLAN

D-1

REVISED BY | DATE REVISED
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BORDER LAST REVISED 4/11/2008

RELATIVE BORDER SCALE IS IN INCHES 0 1 2 3

USERNAME => CarrilloG
DGN FILE => ...\b056300ia001.dgn

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EA 06002

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
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KIRK BRADBURY
No. 71673
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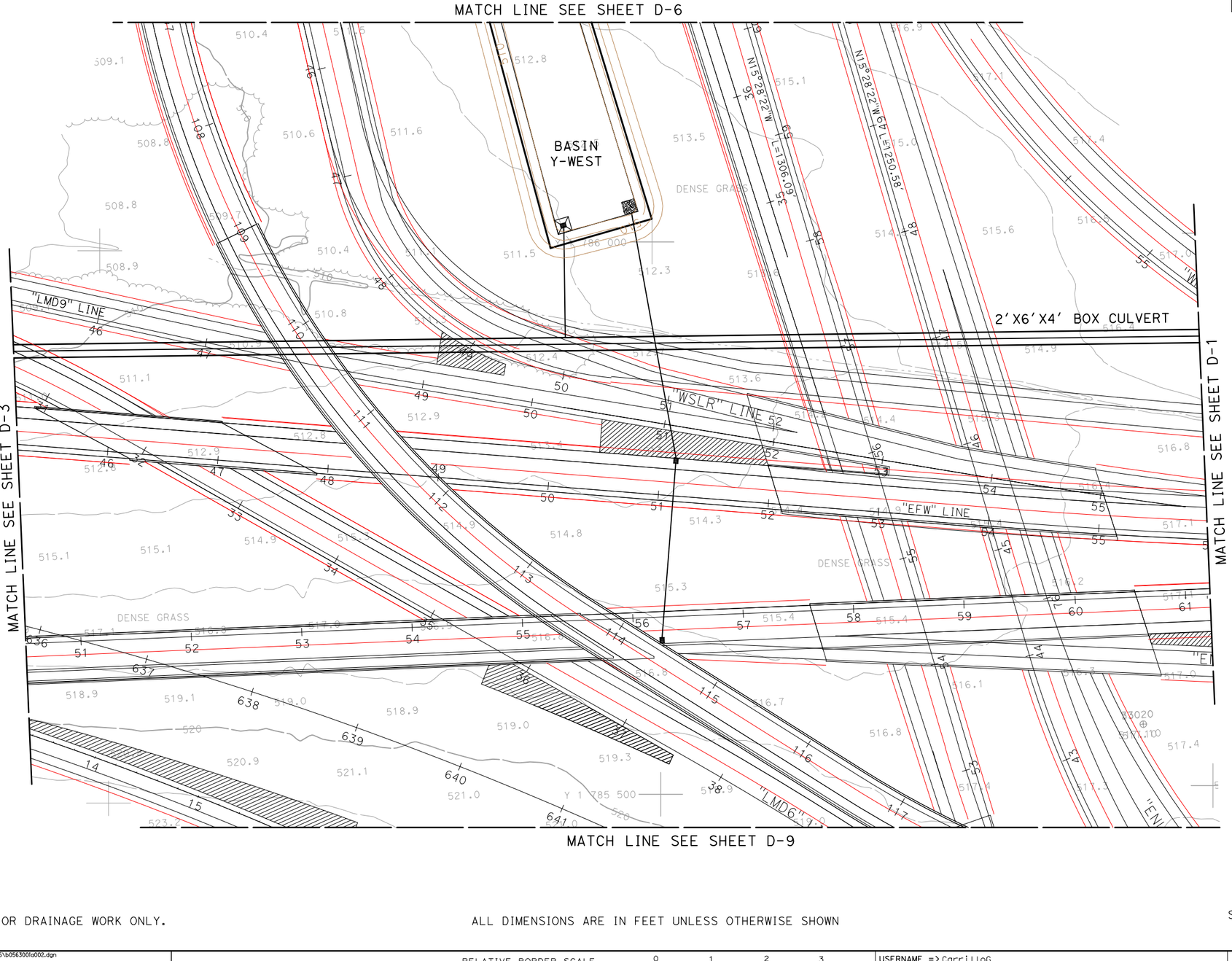

DRAINAGE PLAN

D-2

SCALE 1"=50'

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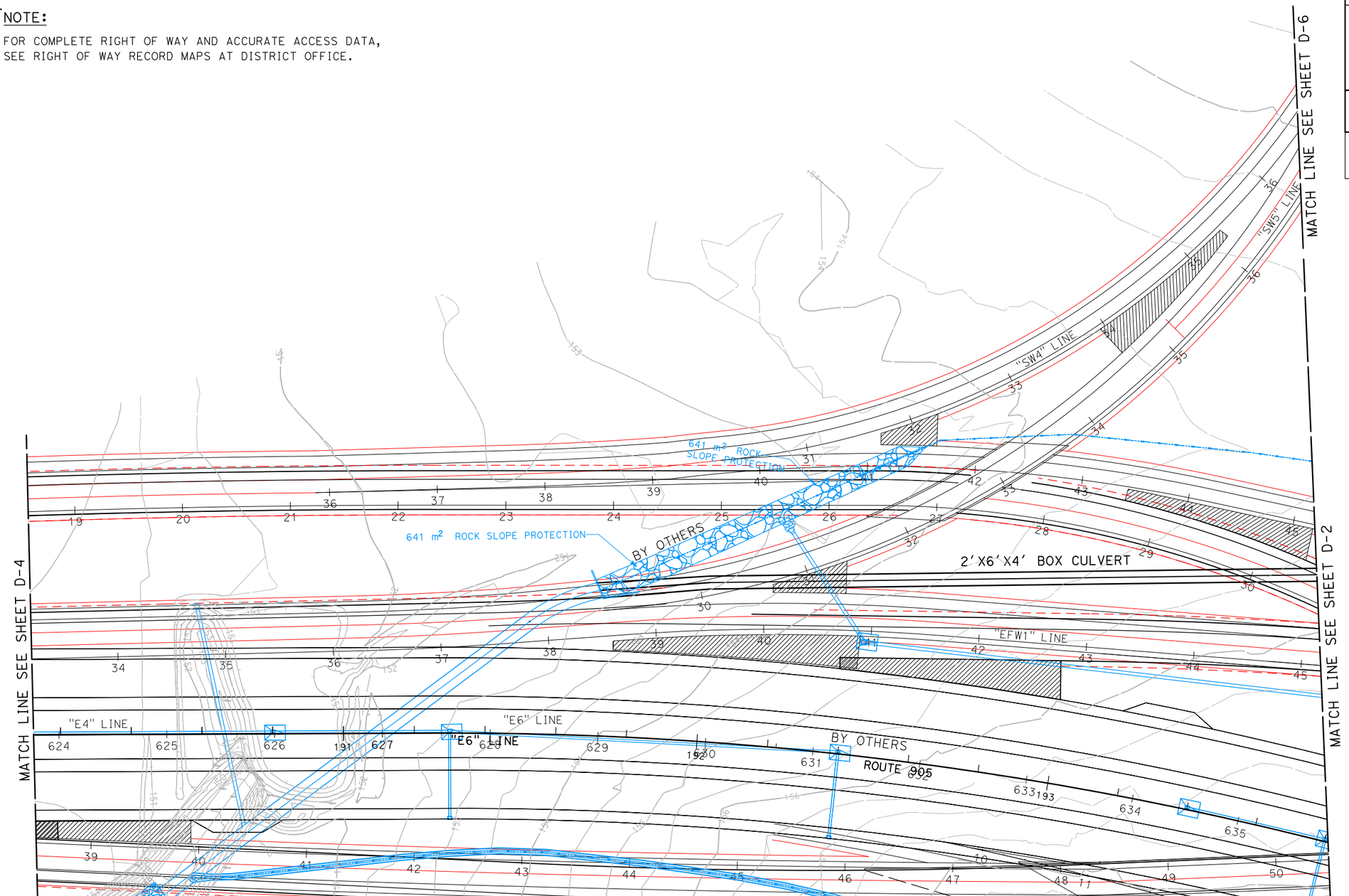

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SCALE 1"=50'

DRAINAGE PLAN

D-3

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

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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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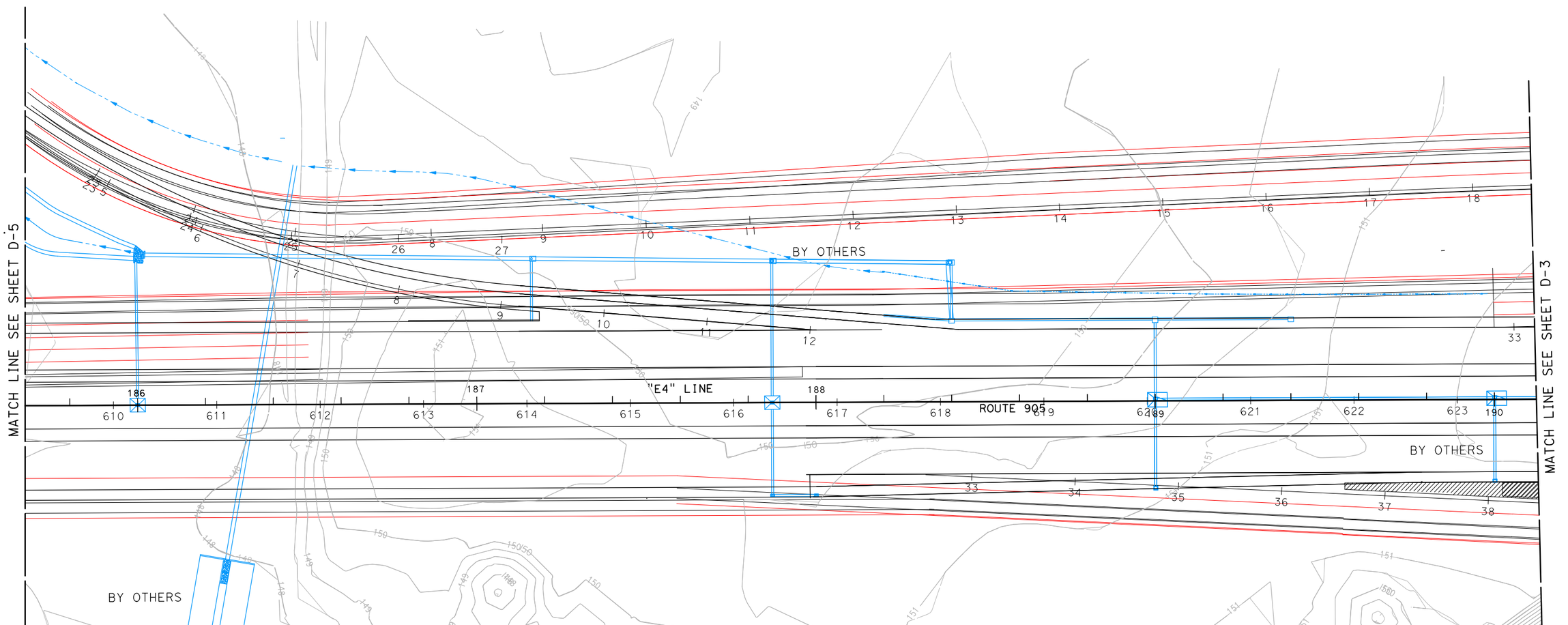

DRAINAGE PLAN

D-4

SCALE 1"=50'

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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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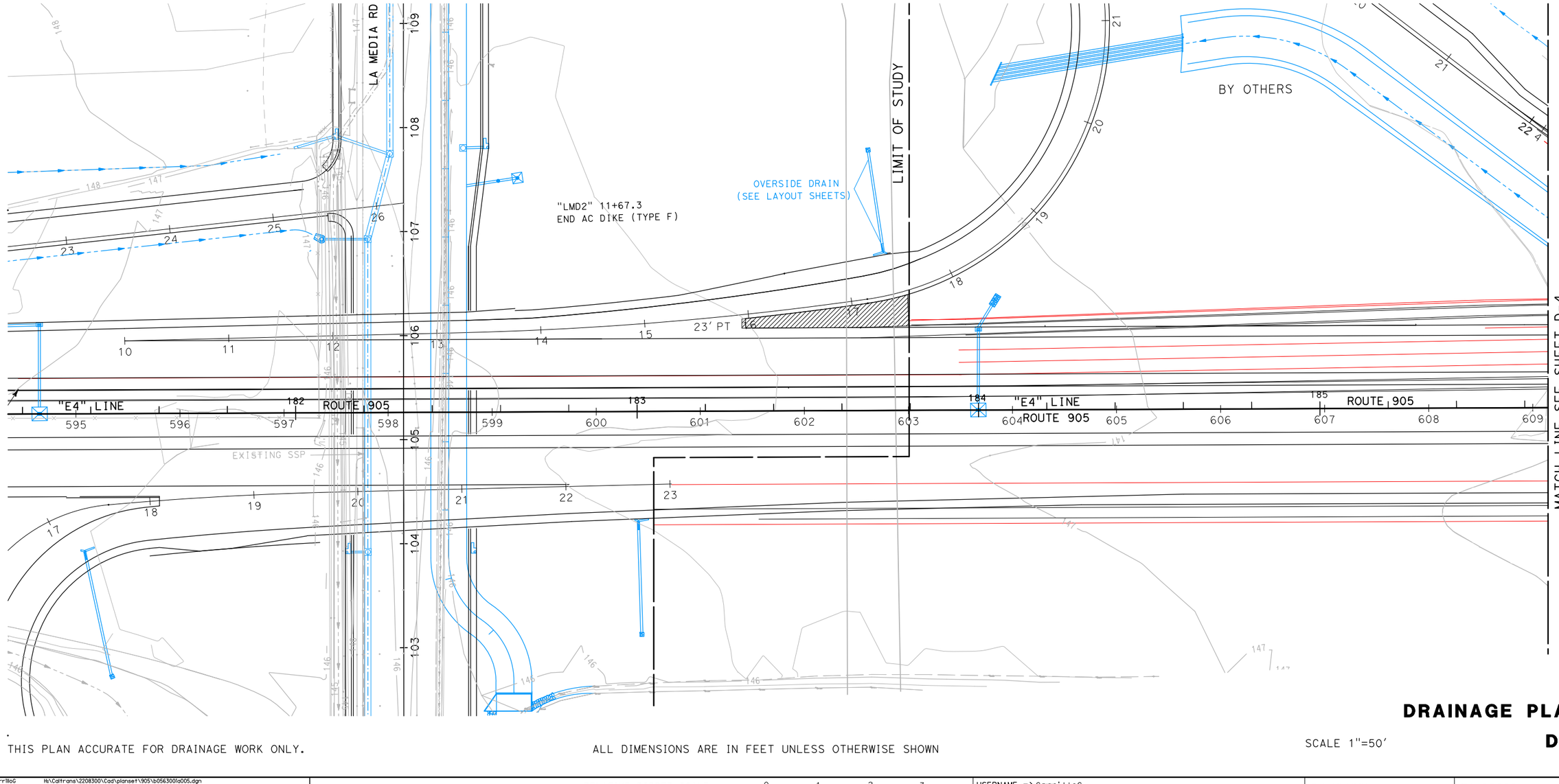

DRAINAGE PLAN

SCALE 1"=50'

D-5

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11	SD	11	23.3/26.6		

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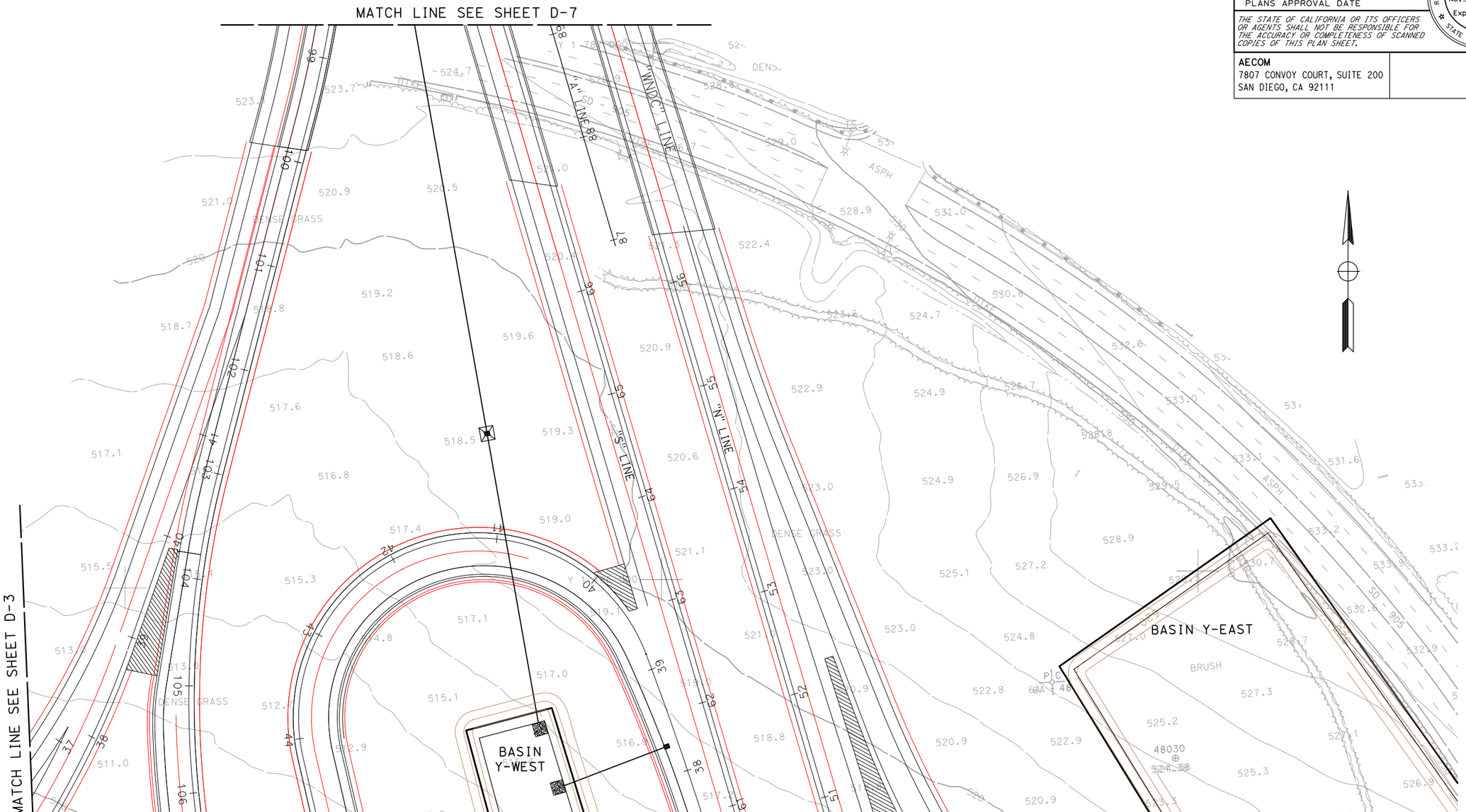

DRAINAGE PLAN

D-6

SCALE 1"=50'

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GERARD DALZIEL	

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DGN FILE => ...\b056300ia006.dgn

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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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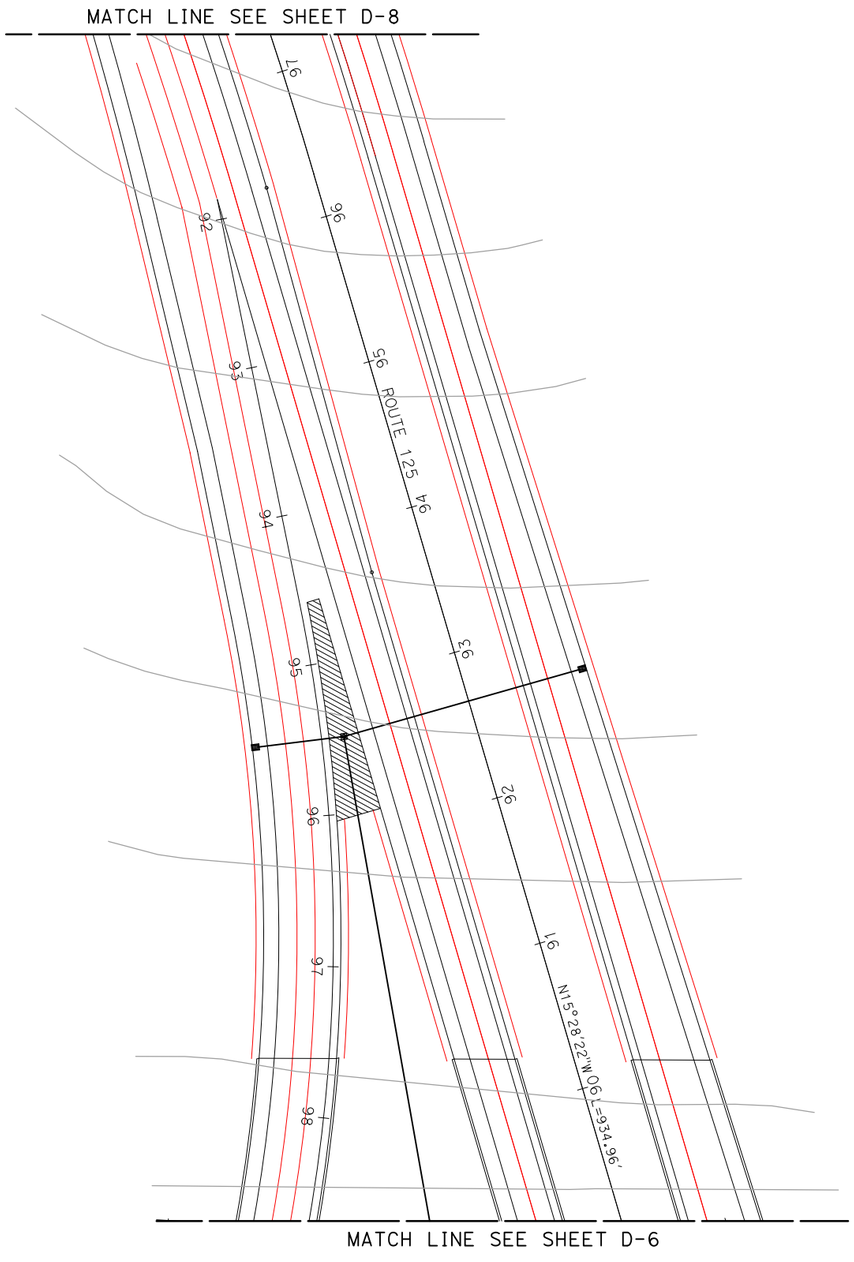

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SCALE 1"=50'

DRAINAGE PLAN

D-7

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GERARD DALZIEL	

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USERNAME => CarrilloG
DGN FILE => ...\b056300ia007.dgn

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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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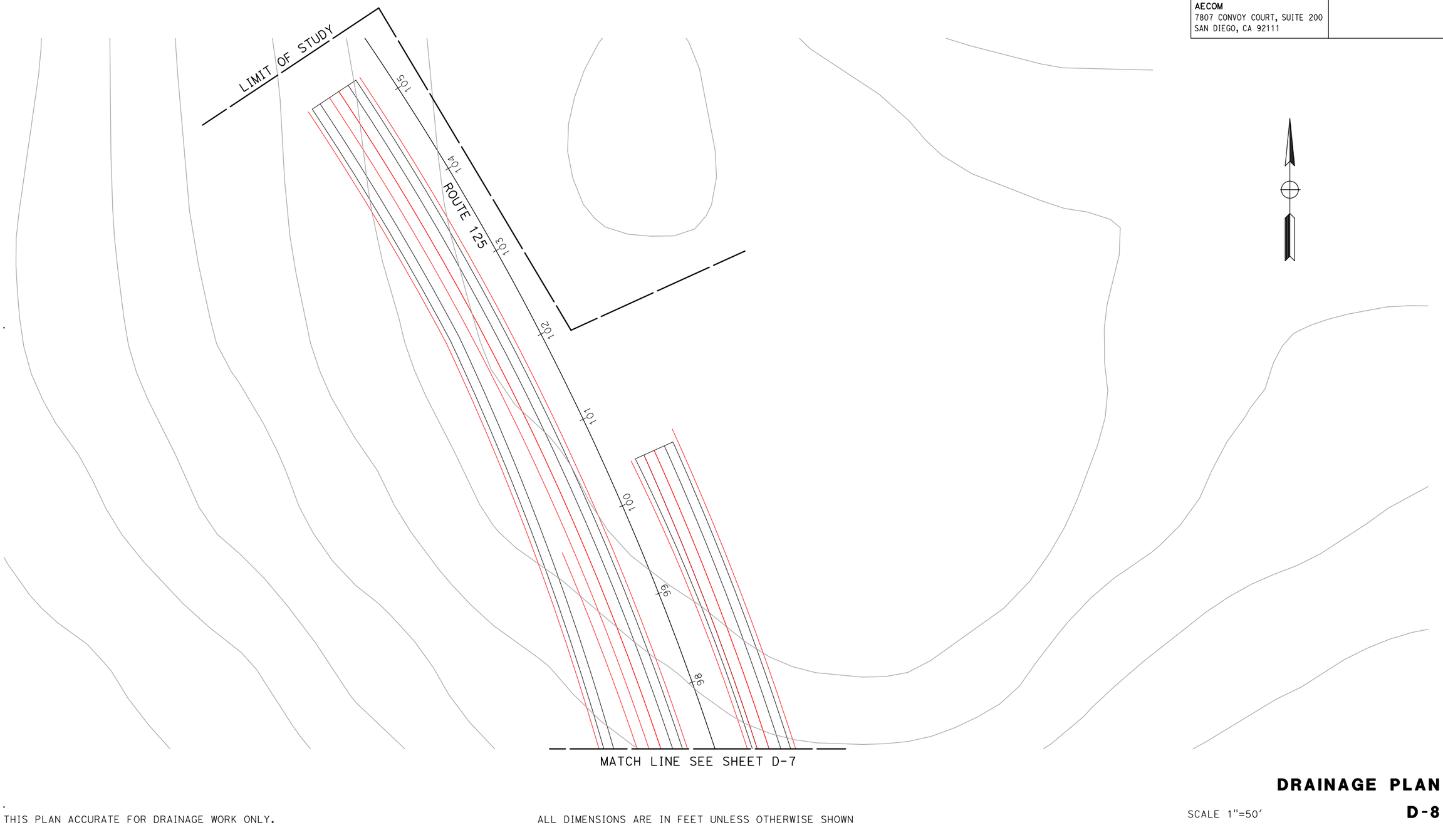

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DRAINAGE PLAN

SCALE 1"=50'

D-8

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USERNAME => CarrilloG
DGN FILE => ...\b056300ia008.dgn

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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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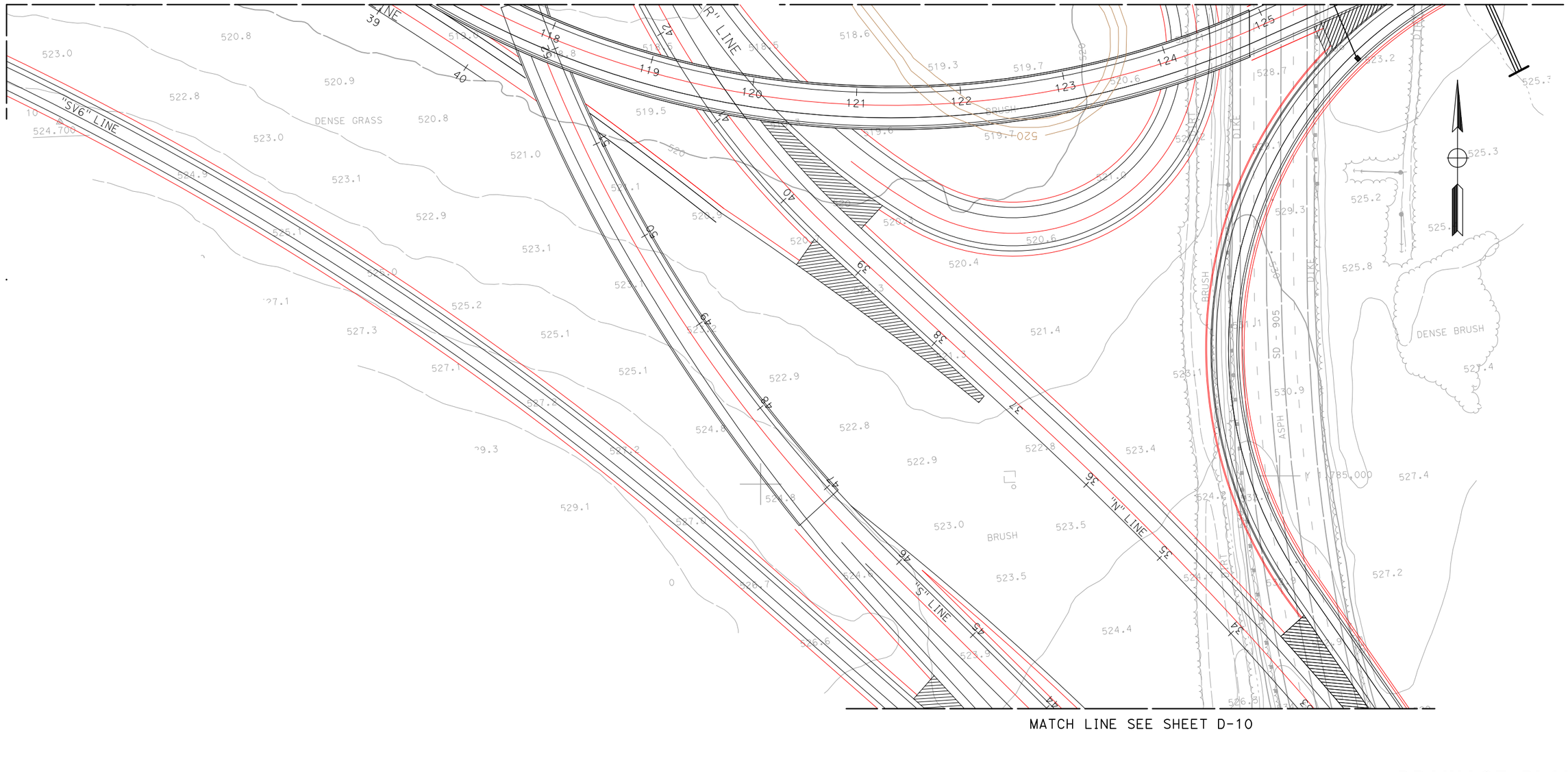
MATCH LINE SEE SHEET D-2

MATCH LINE SEE SHEET D-1



MATCH LINE SEE SHEET D-10

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DRAINAGE PLAN

SCALE 1"=50'

D-9

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USERNAME => CarrilloG
DGN FILE => ...\b056300ia009.dgn

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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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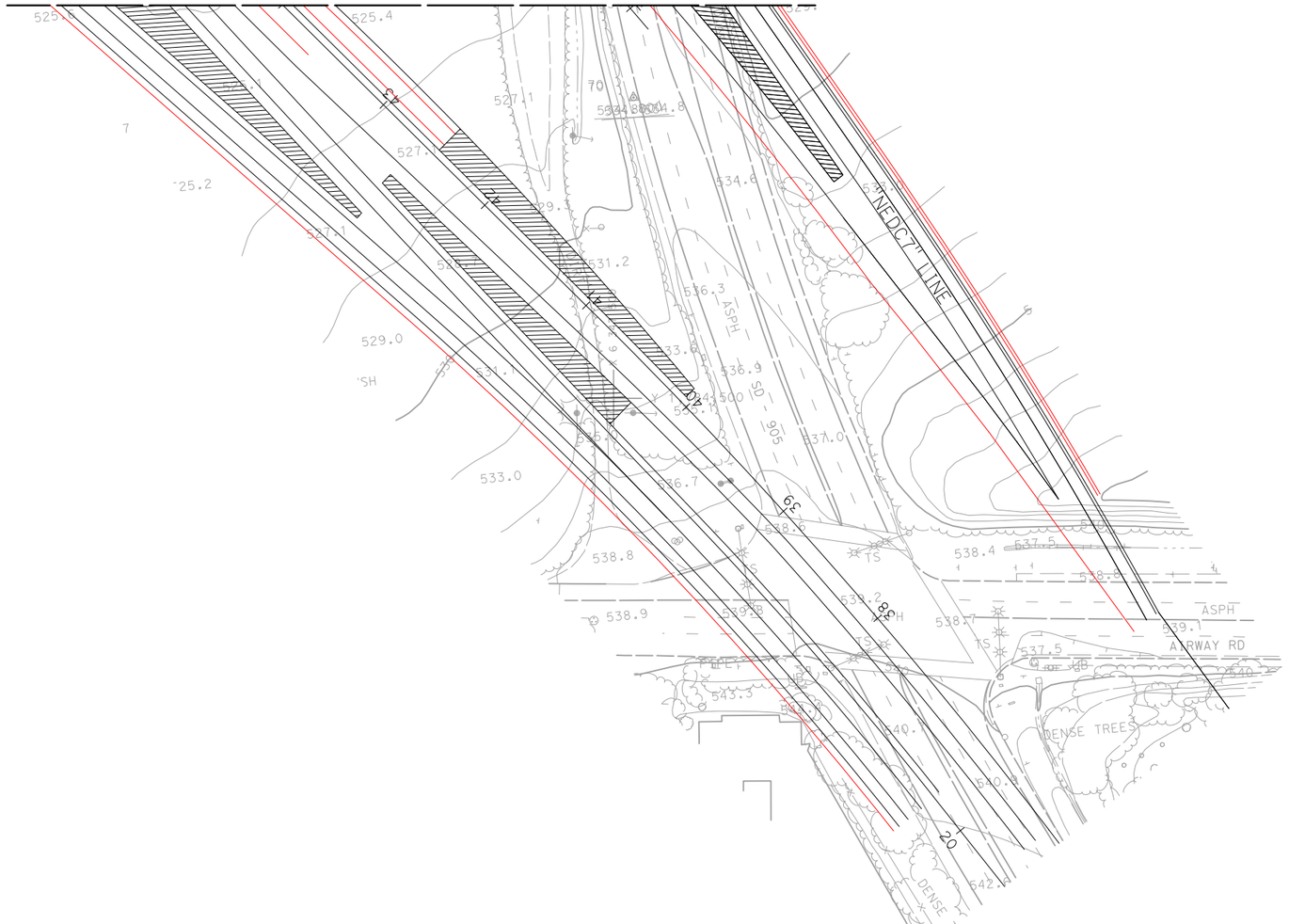
MATCH LINE SEE SHEET D-9



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SCALE 1"=50'

DRAINAGE PLAN

D-10

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DGN FILE => ...\b056300ia010.dgn

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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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No. 71673
Exp. 12/31/09
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STATE OF CALIFORNIA

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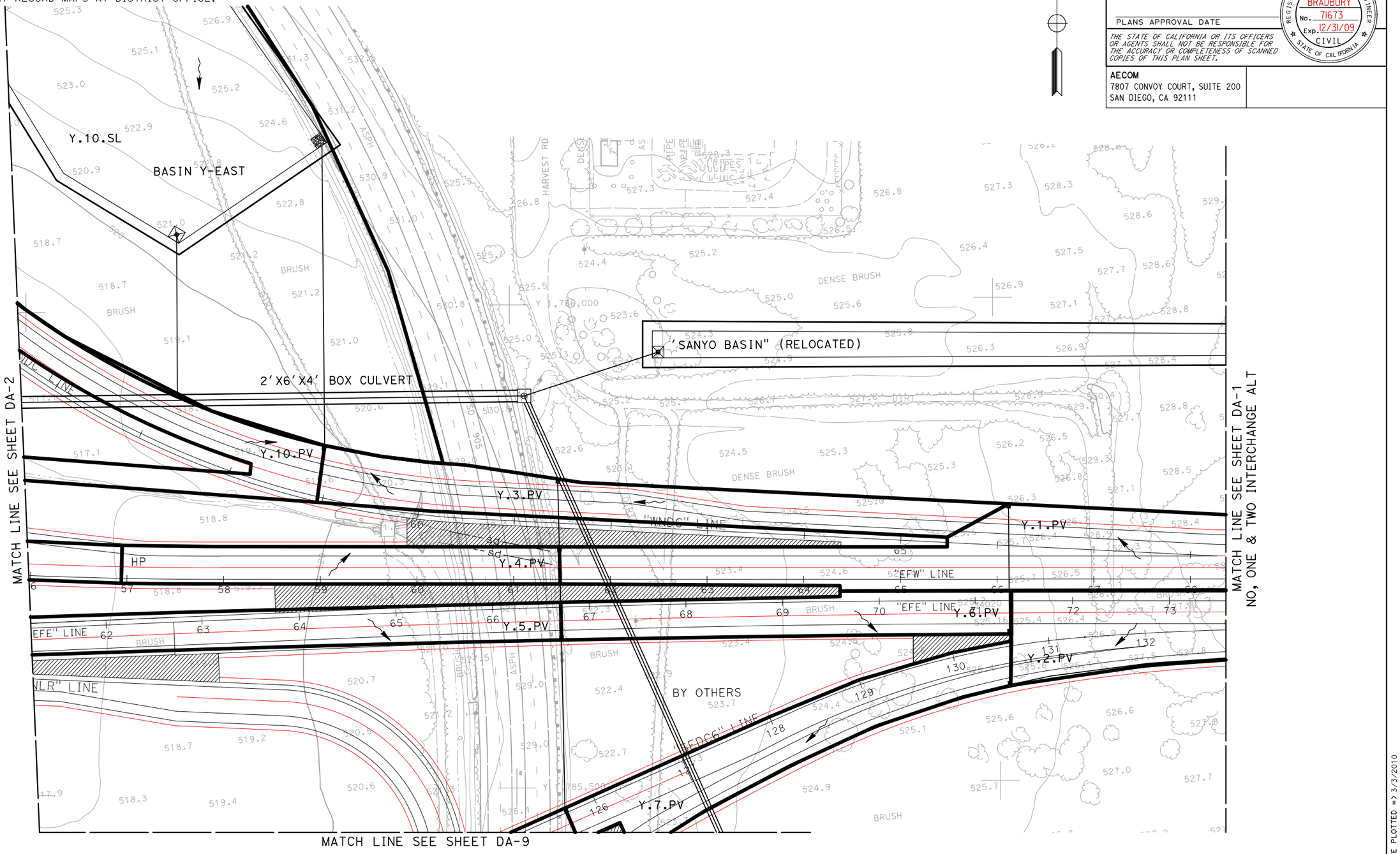
SAN DIEGO, CA 92111

NOTE:

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



THIS PLAN ACCURATE FOR DRAINAGE WORK ONLY.

ALL DIMENSIONS ARE IN FEET UNLESS OTHERWISE SHOWN

DRAINAGE AREA PLAN

SCALE 1"=50'

DA-1

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

60099859

LAST REVISION DATE PLOTTED => 3/3/2010
11-13-09 TIME PLOTTED => 5:07:09 PM

3/3/2010 5:07:09 PM CarrilloG H:\Caltrans\2208300\Cad\planset\905\b056300ia001da.dgn
BORDER LAST REVISED 4/11/2008

RELATIVE BORDER SCALE IS IN INCHES 0 1 2 3

USERNAME => CarrilloG
DGN FILE => ...\b056300ia001da.dgn

CU XXXXX

EA 06002

NOTE:

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

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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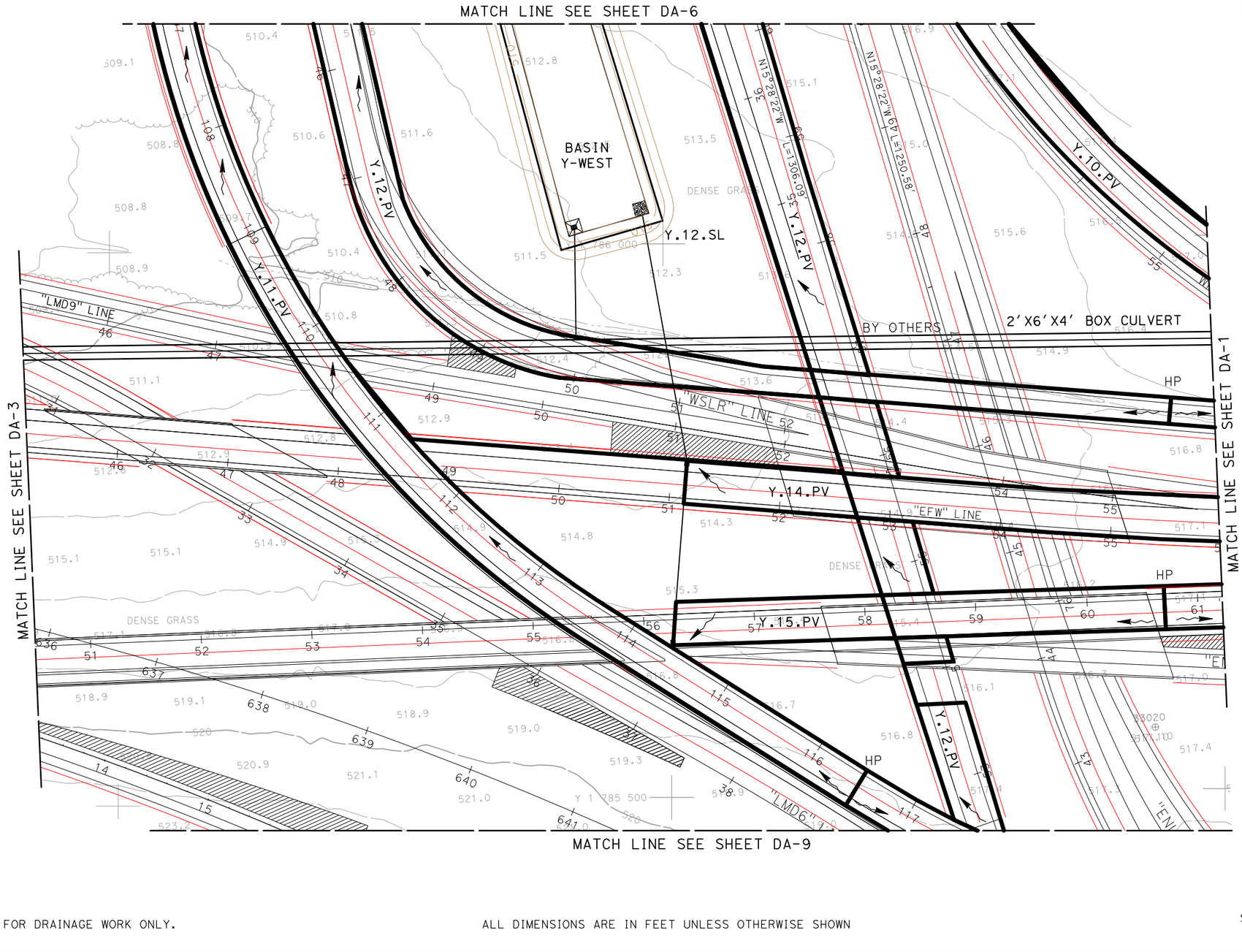

DRAINAGE AREA PLAN

SCALE 1"=50'

DA-2

THIS PLAN ACCURATE FOR DRAINAGE WORK ONLY.

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

LAST REVISION DATE PLOTTED => 3/3/2010
TIME PLOTTED => 5:06:29 PM
11-13-09

60099859

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BORDER LAST REVISED 4/11/2008

RELATIVE BORDER SCALE IS IN INCHES 0 1 2 3

USERNAME => CarrilloG
DGN FILE => ...\b056300ia002da.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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SAN DIEGO, CA 92111

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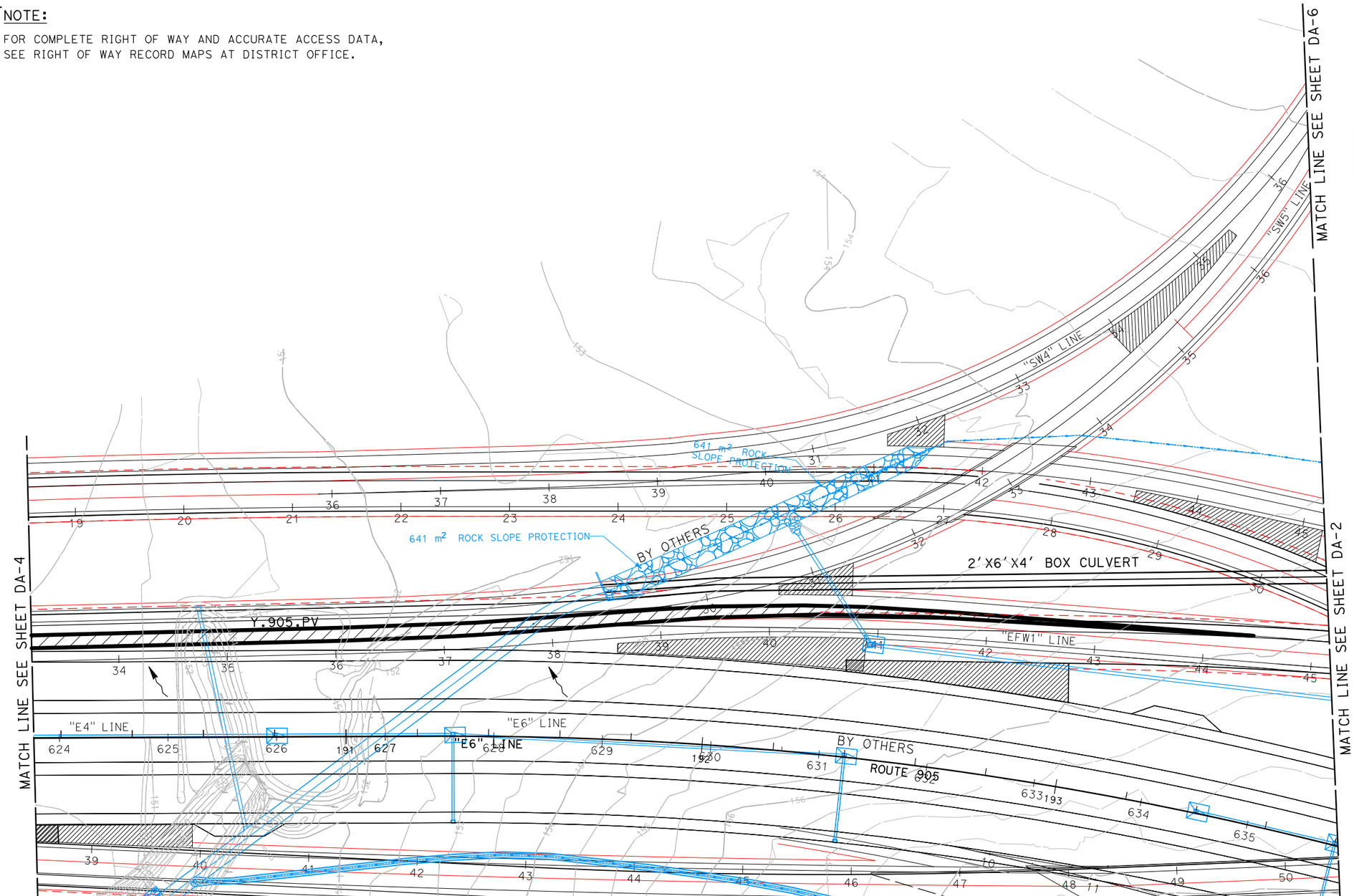

DRAINAGE AREA PLAN

SCALE 1"=50'

DA-3

THIS PLAN ACCURATE FOR DRAINAGE WORK ONLY.

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REVISED BY | DATE REVISED

MIKE BRUNING | GERARD DALZIEL

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CONSULTANT FUNCTIONAL SUPERVISOR: KIRK BRADBURY

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LAST REVISION | DATE PLOTTED => 3/3/2010
11-13-09 | TIME PLOTTED => 5:05:38 PM

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BORDER LAST REVISED 4/11/2008

RELATIVE BORDER SCALE IS IN INCHES 0 1 2 3

USERNAME => CarrilloG
DGN FILE => ...\b056300ia003da.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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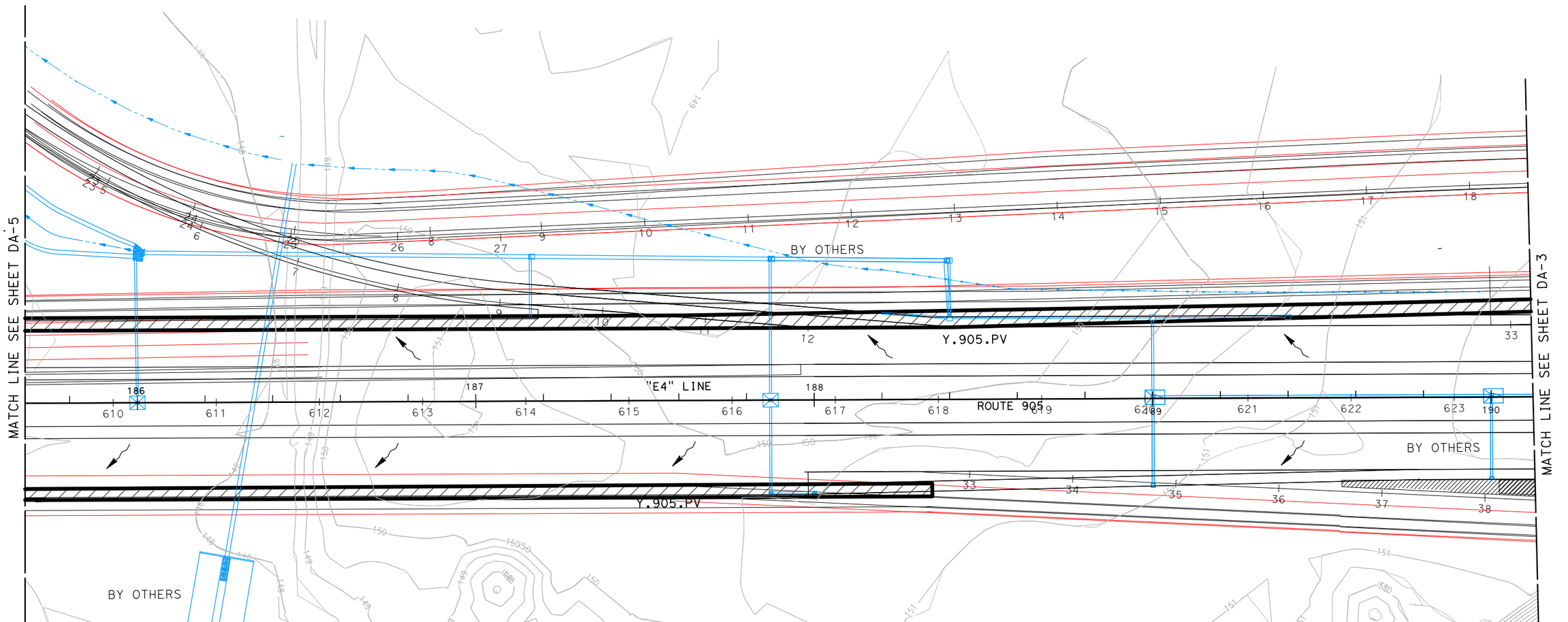

THIS PLAN ACCURATE FOR DRAINAGE WORK ONLY.

ALL DIMENSIONS ARE IN FEET UNLESS OTHERWISE SHOWN

DRAINAGE AREA PLAN

SCALE 1"=50'

DA-4

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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60099859

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BORDER LAST REVISED 4/11/2008

RELATIVE BORDER SCALE IS IN INCHES 0 1 2 3

USERNAME => CarrilloG
DGN FILE => ...\b056300ia004da.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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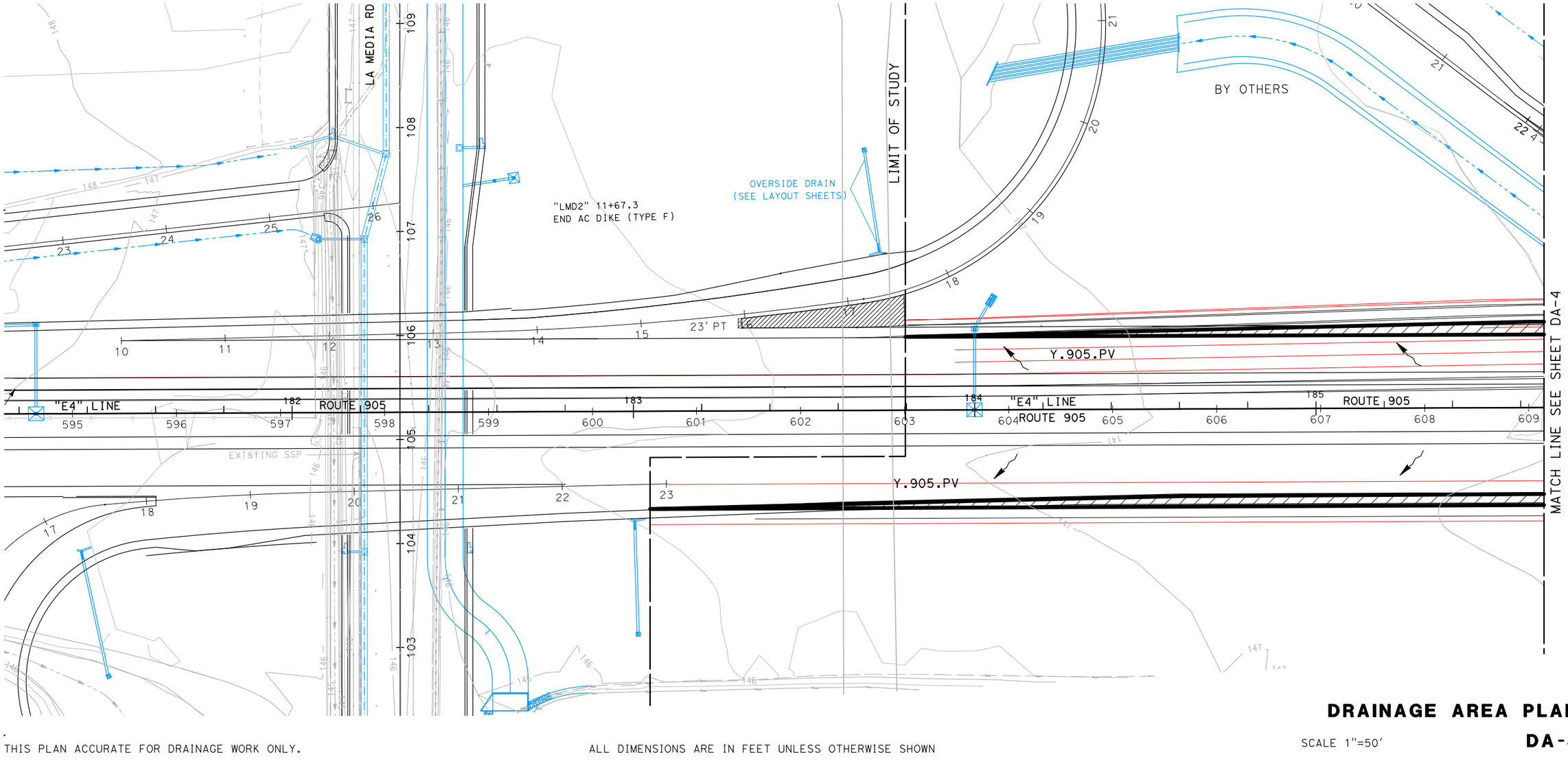

DRAINAGE AREA PLAN

SCALE 1"=50'

DA-5

THIS PLAN ACCURATE FOR DRAINAGE WORK ONLY.

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REVISED BY | DATE REVISED
MIKE BRUNING | GERARD DALZIEL
CALCULATED-DESIGNED BY | CHECKED BY
CONSULTANT FUNCTIONAL SUPERVISOR: KIRK BRADBURY

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TIME PLOTTED => 5:07:52 PM

60099859

3/3/2010 5:07:52 PM CarrilloG H:\Caltrans\2208300\Cad\planset\905\b056300ia005da.dgn
BORDER LAST REVISED 4/11/2008

RELATIVE BORDER SCALE IS IN INCHES 0 1 2 3

USERNAME => CarrilloG
DGN FILE => ...\b056300ia005da.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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SAN DIEGO, CA 92111

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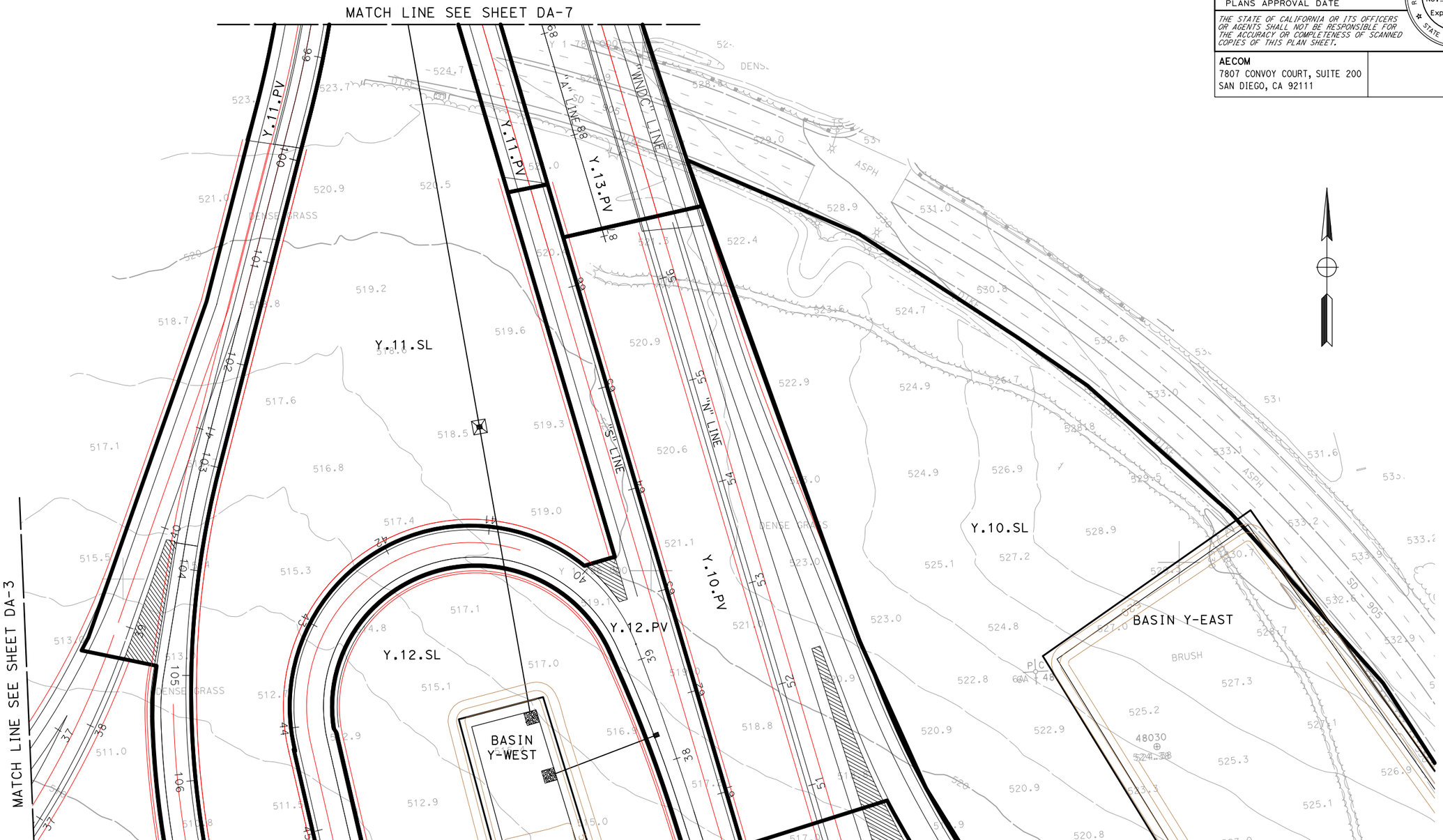

DRAINAGE AREA PLAN

SCALE 1"=50'

DA-6

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REVISED BY	MIKE BRUNING	CALCULATED-DESIGNED BY	CONSULTANT FUNCTIONAL SUPERVISOR
DATE REVISED	GERARD DALZIEL	CHECKED BY	KIRK BRADBURY

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Caltrans

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11-13-09 | TIME PLOTTED => 5:08:43 PM

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BORDER LAST REVISED 4/11/2008

RELATIVE BORDER SCALE IS IN INCHES 0 1 2 3

USERNAME => CarrilloG
DGN FILE => ...\b056300ia006da.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
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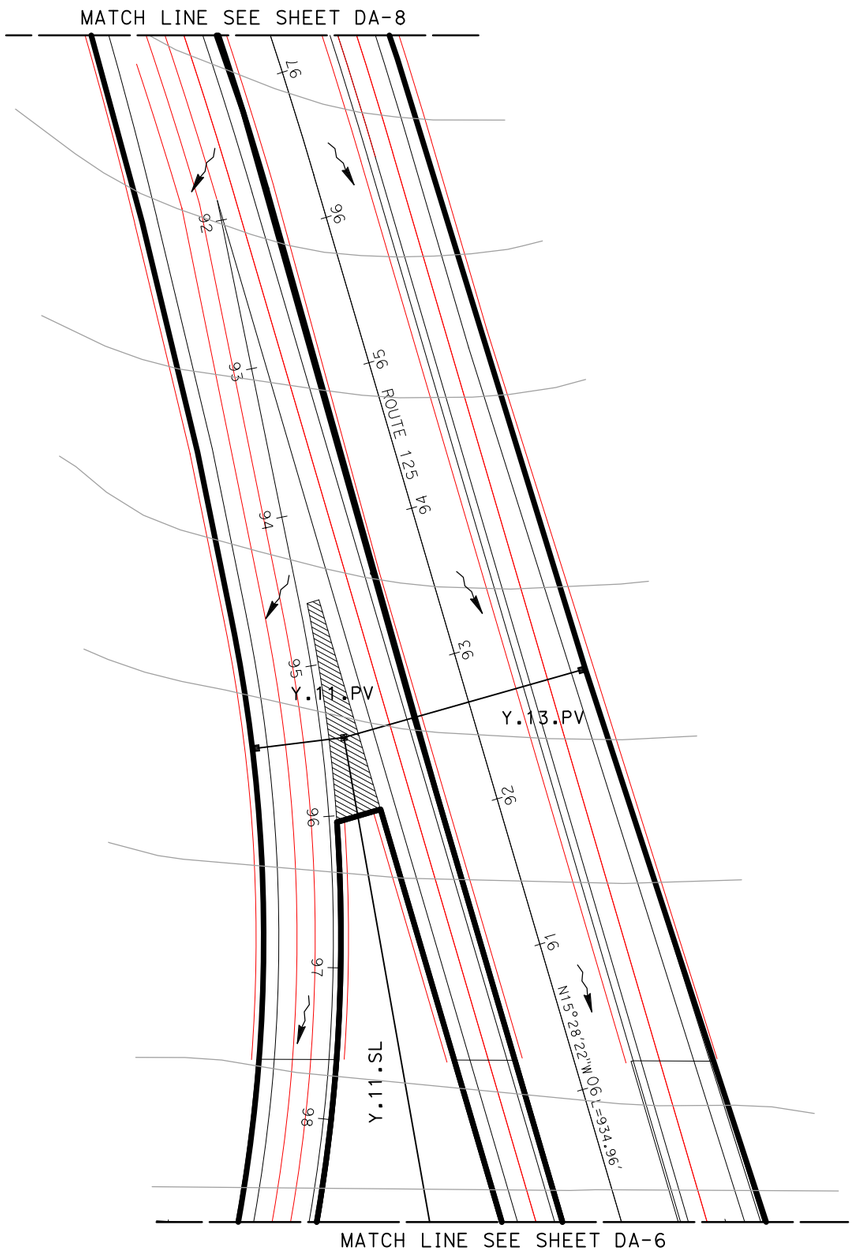

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DRAINAGE AREA PLAN

SCALE 1"=50'

DA-7

REVISED BY	DATE REVISED

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

CONSULTANT FUNCTIONAL SUPERVISOR: KIRK BRADBURY

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BORDER LAST REVISED 4/11/2008

RELATIVE BORDER SCALE IS IN INCHES 0 1 2 3

USERNAME => CarrilloG
DGN FILE => ...\b056300ia007da.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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DRAINAGE AREA PLAN

SCALE 1"=50'

DA-8

REVISED BY	DATE REVISED
MIKE BRUNING	
GERARD DALZIEL	

CALCULATED-DESIGNED BY

CHECKED BY

CONSULTANT FUNCTIONAL SUPERVISOR
KIRK BRADBURY

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LAST REVISION
DATE PLOTTED => 3/3/2010
TIME PLOTTED => 5:10:17 PM

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BORDER LAST REVISED 4/11/2008

RELATIVE BORDER SCALE IS IN INCHES 0 1 2 3

USERNAME => CarrilloG
DGN FILE => ...\b056300ia008da.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
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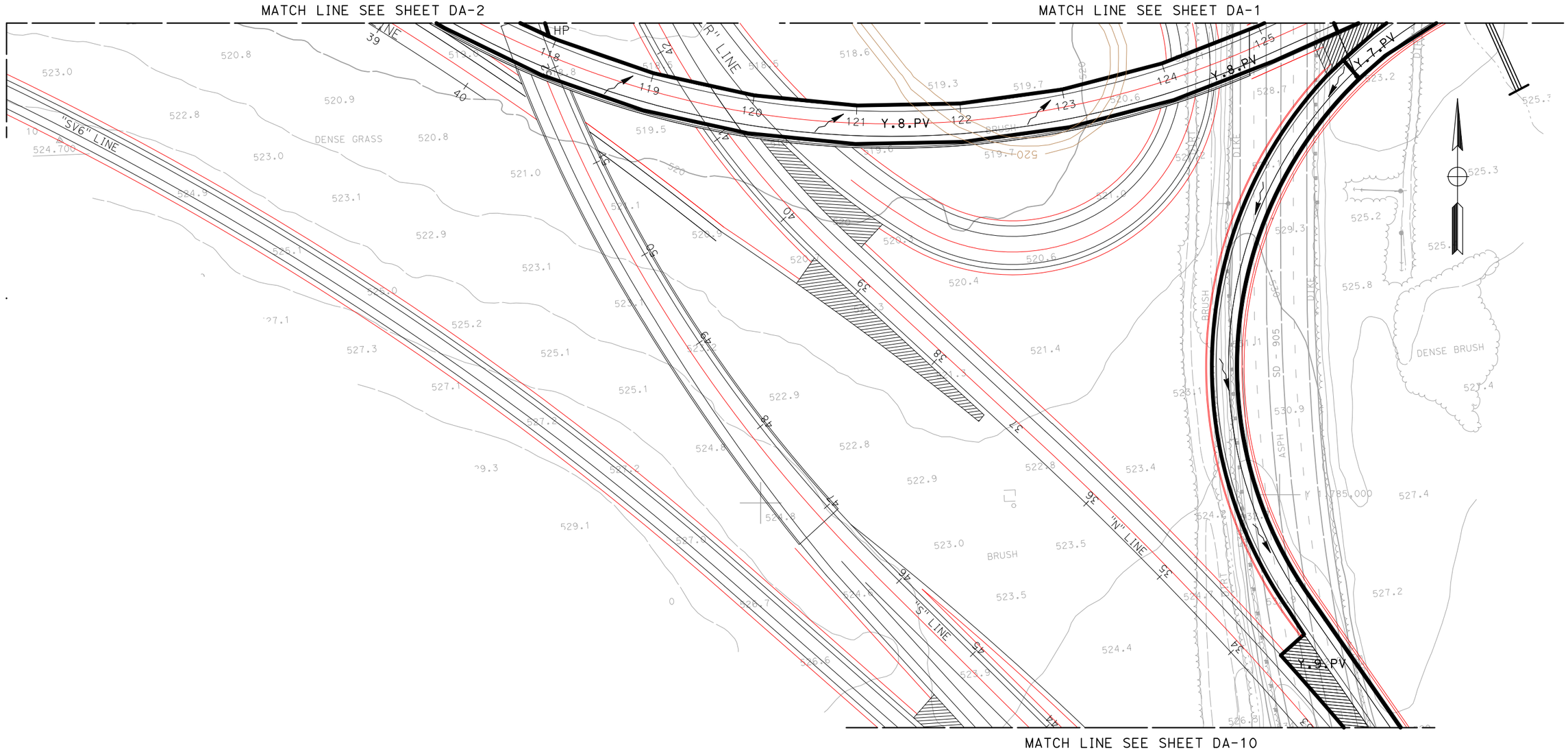

DRAINAGE AREA PLAN

SCALE 1"=50'

DA-9

THIS PLAN ACCURATE FOR DRAINAGE WORK ONLY.

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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 => 3/3/2010
TIME PLOTTED => 5:10:55 PM

60099859

3/3/2010 5:10:55 PM CarrilloG Ht\Caltrans\2208300\Cad\planset\905\b056300ia009da.dgn
BORDER LAST REVISED 4/11/2008

RELATIVE BORDER SCALE IS IN INCHES 0 1 2 3

USERNAME => CarrilloG
DGN FILE => ...\b056300ia009da.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
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No. 71673
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NOTE:

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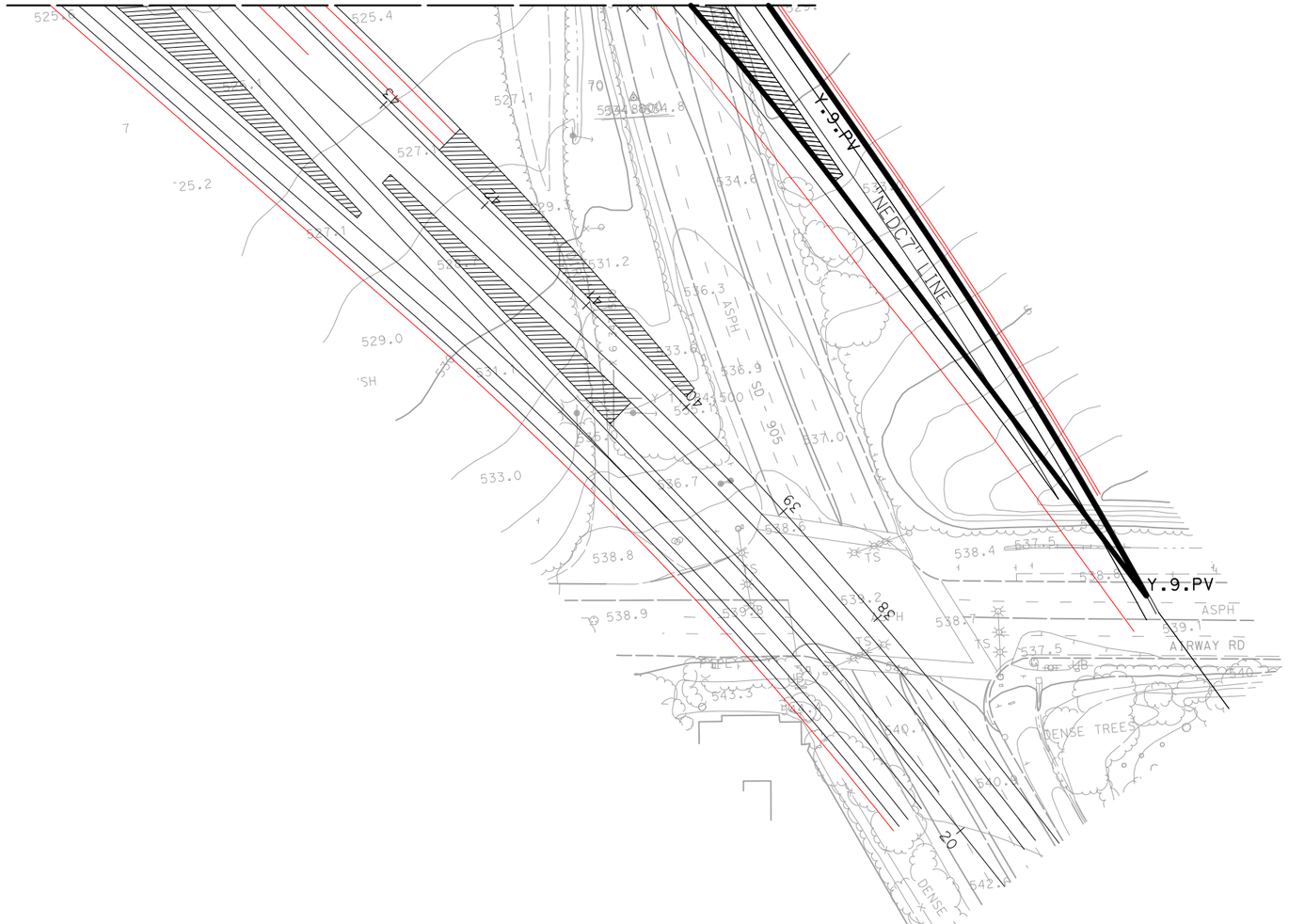
MATCH LINE SEE SHEET DA-9



THIS PLAN ACCURATE FOR DRAINAGE WORK ONLY.

ALL DIMENSIONS ARE IN FEET UNLESS OTHERWISE SHOWN

DRAINAGE AREA PLAN

SCALE 1"=50'

DA-10

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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11-13-09 TIME PLOTTED => 5:11:23 PM

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3/3/2010 5:11:23 PM CarrilloG H:\Caltrans\2208300\Cad\planset\905\b056300ia010da.dgn
BORDER LAST REVISED 4/11/2008

RELATIVE BORDER SCALE IS IN INCHES 0 1 2 3

USERNAME => CarrilloG
DGN FILE => ...\b056300ia010da.dgn

CU XXXXX | EA 06002

Y Onsite D.A. Table

PROJECT:	**SR-11**	**DESCRIPTION:**	**Onsite Drainage Areas (D.A.)**
JOB #:	**11A1190**	**STATION:**	**125/905**
BY:	**M.BRUNING** **DATE:** **02.19.10**	**WATERSHED:**	**Y**
CHK:	**G.DALZIEL** **DATE:**	**SYSTEM:**	

			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
PAVED	A2.1.PV	0.99	99500	2.3	5	4.0	9.05	6.6	14.90	A2.1	~	Basin Y-East	56+00	Lt
	A2.2.PV	0.99	104500	2.4	5	4.0	9.50	6.6	15.64	A2.2	A2.2	Basin Y-East	57+00	Rt
	A2.3.PV	0.99	35100	0.8	5	4.0	3.19	6.6	5.25	~	A2.3	Basin Y-East	52+50	Lt
	A2.4.PV	0.99	26200	0.6	5	4.0	2.38	6.6	3.92	~	A2.4	Basin Y-East	52+50	Rt
	X2.1.PV	0.99	2900	0.1	5	4.0	0.26	6.6	0.43	~	X1.1	Basin Y-East	40+00	Rt
	X2.2.PV	0.99	71300	1.6	5	4.0	6.46	6.6	10.67	~	X1.2	Basin Y-East	40+50	Rt
	X2.3.PV	0.99	2900	0.1	5	4.0	0.26	6.6	0.43	~	X1.3	Basin Y-East	40+00	Lt
	X2.4.PV	0.99	71100	1.6	5	4.0	6.44	6.6	10.64	~	X1.4	Basin Y-East	40+50	Lt
	Y.1.PV	0.99	84300	1.9	5	4.0	7.63	6.6	12.62	~	Y.1	Basin Y-East	~	~
	Y.2.PV	0.99	61500	1.4	5	4.0	5.57	6.6	9.21	~	Y.2	Basin Y-East	~	~
	Y.3.PV	0.99	28600	0.7	5	4.0	2.59	6.6	4.28	~	Y.3	Basin Y-East	~	~
	Y.4.PV	0.99	17600	0.4	5	4.0	1.59	6.6	2.63	~	Y.4	Basin Y-East	~	~
	Y.5.PV	0.99	23300	0.5	5	4.0	2.11	6.6	3.49	~	Y.5	Basin Y-East	~	~
	Y.6.PV	0.99	19500	0.4	5	4.0	1.77	6.6	2.92	~	Y.6	Basin Y-East	~	~
	Y.7.PV	0.99	27200	0.6	5	4.0	2.46	6.6	4.07	~	Y.7	Basin Y-East	~	~
	Y.8.PV	0.99	34400	0.8	5	4.0	3.11	6.6	5.15	~	Y.8	Basin Y-East	~	~
	Y.9.PV	0.99	32100	0.7	5	4.0	2.91	6.6	4.81	~	Y.9	bypass*	~	~
	Y.10.PV	0.99	128200	2.9	5	4.0	11.61	6.6	19.19	~	Y.10	Basin Y-East	~	~
	Y.11.PV	0.99	210900	4.8	5	4.0	19.09	6.6	31.57	~	Y.11	Basin Y-West	~	~
	Y.12.PV	0.99	115500	2.7	5	4.0	10.46	6.6	17.29	~	Y.12	Basin Y-West	~	~
	Y.13.PV	0.99	171400	3.9	5	4.0	15.52	6.6	25.66	~	Y.13	Basin Y-West	~	~
	Y.14.PV	0.99	22800	0.5	5	4.0	2.06	6.6	3.41	~	Y.14	Basin Y-West	~	~
	Y.15.PV	0.99	17300	0.4	5	4.0	1.57	6.6	2.59	~	Y.15	Basin Y-West	~	~
	Y.905.PV	0.99	49600	1.1	5	4.0	4.49	6.6	7.43	~	~	Basin Y-West	~	~
		Σ	1457700	*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
SLOPE	A2.1.SL	0.61	94700	2.2	10	2.8	3.75	4.2	5.59	A2.1	~	Basin Y-East	56+00	Lt
	A2.2.SL	0.61	81400	1.9	10	2.8	3.22	4.2	4.80	A2.2	A2.2	Basin Y-East	57+00	Rt
	A2.5.SL	0.61	38800	0.9	10	2.8	1.54	4.2	2.29	~	A2.5	bypass*	52+50	Rt
	A2.6.SL	0.61	83900	1.9	10	2.8	3.32	4.2	4.95	~	A2.6	Basin Y-East	53+00	Lt
	Y.10.SL	0.61	369500	8.5	10	2.8	14.64	4.2	21.80	~	Y.10	Basin Y-East	~	~
	Y.11.SL	0.61	236600	5.4	10	2.8	9.37	4.2	13.96	~	Y.11	Basin Y-West	~	~
	Y.12.SL	0.61	169500	3.9	10	2.8	6.71	4.2	10.00	~	Y.12	Basin Y-West	~	~
	Y.905.SL	0.61	890473	20.4	10	2.8	35.28	4.2	52.53	~	~	bypass*	~	~
		Σ	1964873	*SLOPE*										

** flow that does not reach the basin*

Total :	3422573	78.6
	SF	*ac*

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Y Post-Developed TcQ

PROJECT:	**SR-11**			**DESCRIPTION:**	**SR-11 Post-Developed**
JOB #:	**11A1190**			**STATION:**	**125/905**
BY:	**M.BRUNING**	**DATE:**	**02.19.10**	**WATERSHED:**	**Y**
CHK:	**G.DALZIEL**	**DATE:**		**SYSTEM:**	

BASIN AREA:

A =	**3422573**	**ft^2**	**SOURCE:**	**MICROSTATION/USGS**
	78.57	**acres**		**(SCALE = 1:1)**

COEFFICIENT OF RUNOFF:

KEY: User Input | Designer Tool

UNDEVELOPED AREA C (FROM HDM FIG. 819.2A)

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	43%	AT	0.90	0.383
COMMERCIAL AREA	0%	AT	0.85	0.000
CUT SLOPE (2:1 and 4:1)	57%	AT	0.55	0.316
TOTAL	100%			
	(100%)			

$C_{2,10}$ =	0.70
C_{25} =	0.77
C_{50} =	0.84
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	611.5	ft	SR-11 CL
LOW POINT ELEVATION	610.0	ft	SR-11 ES
ELEVATION DIFF (H)	1.5	ft	
LENGTH (L)	125	ft	To Bioswale
SLOPE (S) = (H/L)	1.2%		
MANNING'S n	0.016		<= From Table 816.6A AC
T_t (SFF)=	3.20	minutes	

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

NOTES:

HIGH PT ELEVATION	610.0	ft	Origin of Bioswale
LOW POINT ELEVATION	609.0	ft	
ELEVATION DIFF (H)	1.0	ft	
LENGTH (L)	200	ft	Assumed bioswale does not have enough flow to be channelized
SLOPE (S) = (H/L)	0.5%		
VELOCITY (SCF)	1.8	fps	0.5% ,V From Figure 816.6 Grassed Waterway
T_c (SH)=	1.85	minutes	

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

NOTES:

HIGH PT ELEVATION	609.0	ft	Begin channel flow in bioswale
LOW POINT ELEVATION	590.0	ft	CHANNEL DATA TYPE = TRAP'Z
ELEVATION DIFF (H)	19.0	ft	Z= 4 ANG-RAD 0.245
LENGTH (L)	1158	ft	b = 13 ANG-DEG 14.036
SLOPE (S) = (H/L)	1.6%		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)	3.29	fps	From Manning's Equation assuming flowing full: $V=1.49/n(R^{2/3}S^{1/2})$
T_c (CH)=	5.87	minutes	

Y Post-Developed TcQ

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

HIGH PT ELEVATION	590.0	ft
LOW POINT ELEVATION	584.0	ft
ELEVATION DIFF (H)	6.0	ft
LENGTH (L)	345	ft
SLOPE (S) = (H/L)	1.7%	
MANNING'S n	0.013	
HYDRAULIC RADIUS R	0.80	ft
VELOCITY (CHANNEL)	13.03	fps
T_C (CH)=	0.44	minutes

NOTES:

Assume former basin is conc channel

CHANNEL DATA		TYPE =	TRAP'Z
Z=	4	ANG-RAD	0.245
b =	13	ANG-DEG	14.036
d =	1	FLOWING FULL ASS'M	

Concrete

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	579.0	ft
LOW POINT ELEVATION	520.0	ft
ELEVATION DIFF (H)	59.0	ft
LENGTH (L)	3725	ft
SLOPE (S) = (H/L)	1.6%	
MANNING'S n	0.013	
PIPE DIAMETER d	2.0	ft
HYDRAULIC RADIUS R	0.5	ft
VELOCITY (STORMDRAIN)	9.1	fps
T_C (SD)=	6.83	minutes

NOTES:

Proposed basin outlet pipe

Discharge at basin Y

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)	176	ft
SLOPE (S) = (H/L)	3.4%	
MANNING'S n	0.050	
HYDRAULIC RADIUS R	0.80	ft
VELOCITY (CHANNEL)	4.74	fps
T_C (CH)=	0.62	minutes

NOTES:

basin Y

CHANNEL DATA		TYPE =	TRAP'Z
Z=	4	ANG-RAD	0.245
b =	13	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	514.0	ft
LOW POINT ELEVATION	511.0	ft
ELEVATION DIFF (H)	3.0	ft
LENGTH (L)	171	ft
SLOPE (S) = (H/L)	1.8%	
MANNING'S n	0.013	
PIPE DIAMETER d	2.0	ft
HYDRAULIC RADIUS R	0.5	ft
VELOCITY (STORMDRAIN)	9.6	fps
T_C (SD)=	0.30	minutes

NOTES:

Discharge at basin Y

Discharge at burried box culvert

RCP

R=D/4, Assume: flowing full

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

Y Post-Developed TcQ

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

HIGH PT ELEVATION	511.0	ft	
LOW POINT ELEVATION	500.0	ft	
ELEVATION DIFF (H)	11.0	ft	
LENGTH (L)	994	ft	
SLOPE (S) = (H/L)	1.1%		
MANNING'S n	0.013		RCP
PIPE DIAMETER d	6.0	ft	
HYDRAULIC RADIUS R	1.5	ft	R=D/4, Assume: flowing full
VELOCITY (STORMDRAIN)	15.8	fps	$V = \frac{K_u}{n} R^{2/3} S^{1/2}$
T_C (SD)=	1.05	minutes	

NOTES:

Tc (TOTAL) =	20.15	minutes
Minimum Tc =	10	minutes
USE Tc =	**20.15**	minutes

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

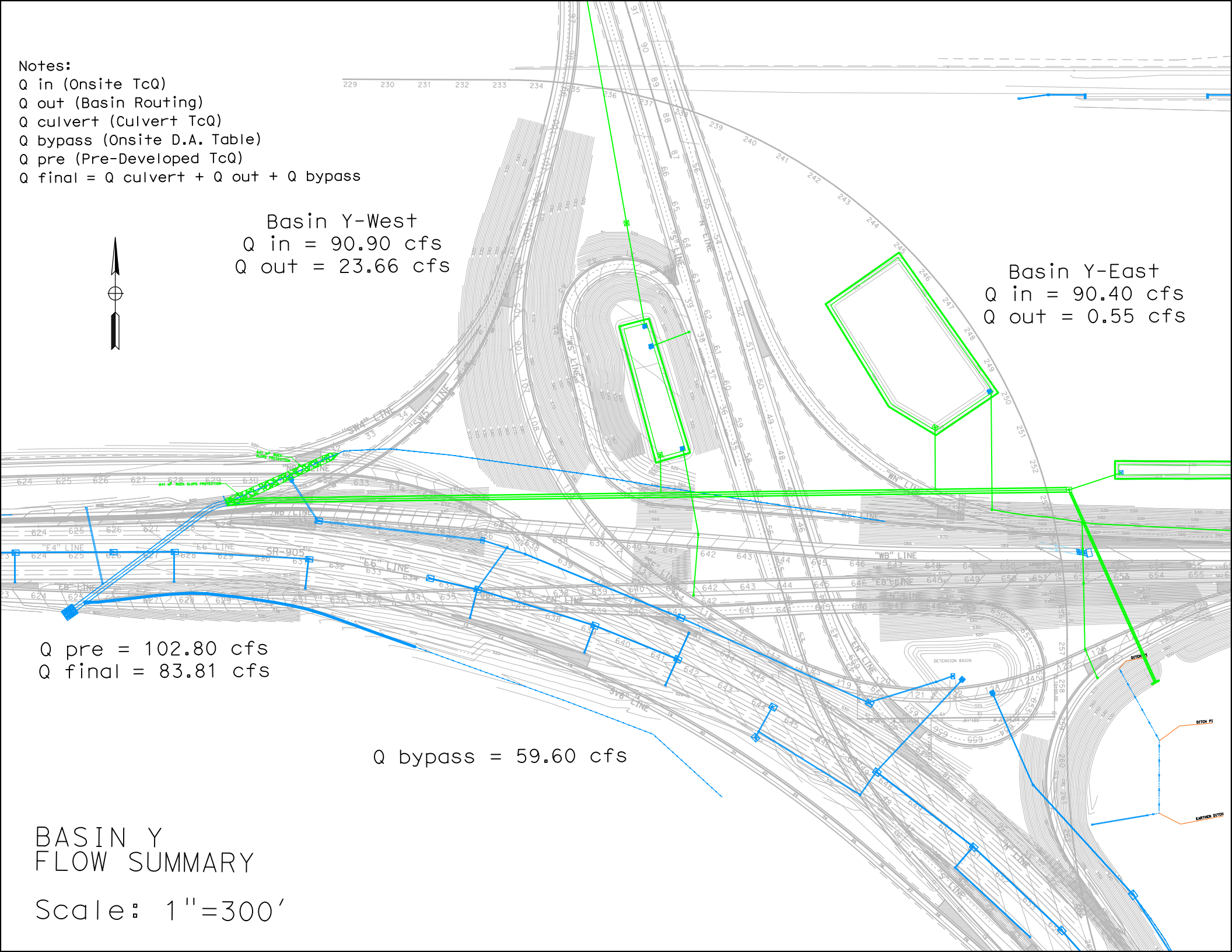
i_2 =	1.2	in/hr	X CA =
i_{10} =	1.7	in/hr	X CA =
i_{25} =	2.1	in/hr	X CA =
i_{50} =	2.6	in/hr	X CA =
i_{100} =	2.7	in/hr	X CA =

FLOW RESULTS:

	cfs
Q_2 =	64.8
Q_{10} =	94.2
Q_{25} =	129.6
Q_{50} =	169.6
Q_{100} =	**184.0**

COUNTY P_6

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


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 Y-West
Q in = 90.90 cfs
Q out = 23.66 cfs
Basin Y-East
Q in = 90.40 cfs
Q out = 0.55 cfs
Q pre = 102.80 cfs
Q final = 83.81 cfs
Q bypass = 59.60 cfs
BASIN Y
FLOW SUMMARY
Scale: 1"=300'

Basin Y-East Retention

PROJECT:	**SR-11**			**DESCRIPTION:**	**SR-11 Basin**
JOB #:	**11A1190**			**STATION:**	**125/905**
BY:	**M.BRUNING**	**DATE:**	**02.19.10**	**WATERSHED:**	**Y-East**
CHK:	**G.DALZIEL**	**DATE:**		**SYSTEM:**	

Notes:

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

RETENTION BASIN VOLUME

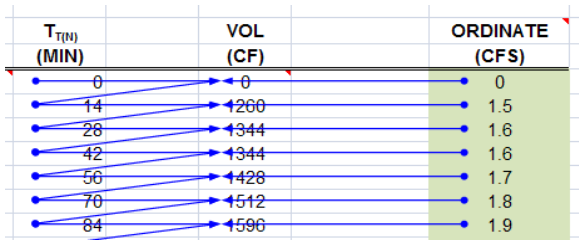
100-year, 6 hour duration storm event, use the Rational Method Hydrograph Procedure (SDCHM 6-1) ~ RatHydro

Pre-Developed volume calculations

Q_{100}=	102.8	cfs			
Tc=	23.5	min	C=	0.58	
$P_{100,6}$=	2.5	in	A=	72.78	acres

$T_{T(N)}$ (MIN)	VOL (CF)	ORDINATE (CFS)
0	0	0
24	9216	6.4
48	9648	6.7
72	10656	7.4
96	11376	7.9
120	12960	9
144	14112	9.8
168	17280	12
192	19584	13.6
216	28800	20
240	38160	26.5
264	148032	102.8
288	23184	16.1
312	15408	10.7
336	12096	8.4
360	10080	7
384	0	0

Example of Steps:



SUM= 380592 ft^3
8.74 acre-feet

Check: $V = C*A*P_6$
V= 8.81 acre-feet
OK

Basin Y-East Retention

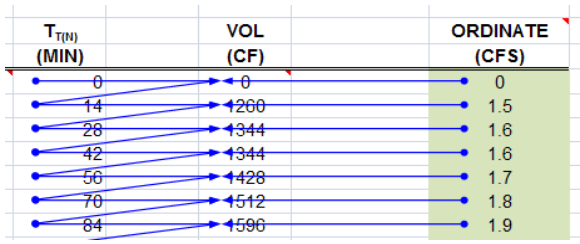
Post-Developed volume calculations

Q_{100}= 184.0 cfs
Tc= 20.2 min
$P_{100,6}$= 2.5 in

C= 0.87
A= 78.57 acres

$T_{T(N)}$ (MIN)	VOL (CF)	ORDINATE (CFS)
0	0	0
20	12360	10.3
40	12840	10.7
60	14040	11.7
80	14640	12.2
100	16200	13.5
120	17280	14.4
140	19680	16.4
160	21360	17.8
180	26160	21.8
200	29760	24.8
220	43800	36.5
240	61800	51.5
260	220800	184
280	35040	29.2
300	23520	19.6
320	18360	15.3
340	15360	12.8
360	13440	11.2
380	0	0

Example of Steps:



SUM= 616440 ft^3
14.15 acre-feet

Check: $V = C*A*P_6$
V= 14.30 acre-feet
OK

		14.15	*(Post)*		
	-	**8.74**	*(Pre)*		
Retention volume =		**5.41**	**acre-feet**	=	**235848 ft^3**

Basin Required

Basin Y-East 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}= 0.94
A= 33.69 acres

WQ_{72}: 0.73 in/area

Water Quality Volume (WQV) = **89279** **ft³**

WQV to be added to retention volume = **0** **ft³** **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:

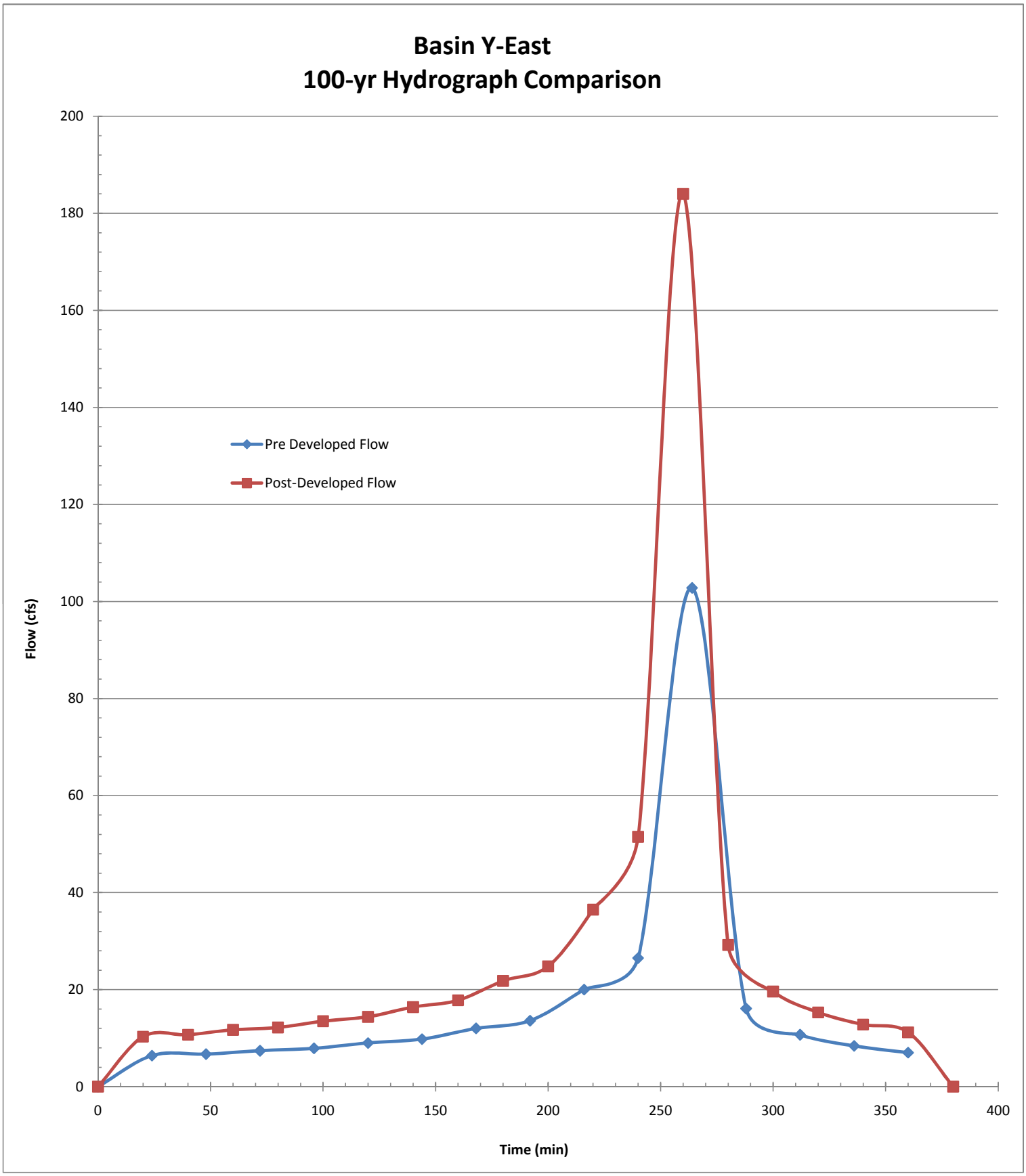
A_s = the computed soil loss in tons (dry weight)
R = the rainfall erosion index for the given storm period
K = the soil erodibility factor
L = the slope length factor
s = the slope gradient factor
C = cropping management (vegetation) factor
P = erosion control practice factor

Onsite Highway *Sloped* runoff area, A:		629500	ft²
	A:	14.45	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 = 224.75 tons

Silt Accumulation Basin volume = **4994** **ft³** **Add this volume to Basin**

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


Basin Y-East
100-yr Hydrograph Comparison
Pre Developed Flow
Post-Developed Flow
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 Y-East Inflow TcQ

PROJECT:	**SR-11**			**DESCRIPTION:**	**SR-11 Basin**
JOB #:	**11A1190**			**STATION:**	**125/905**
BY:	**M.BRUNING**	**DATE:**	**02.19.10**	**WATERSHED:**	**Y-East**
CHK:	**G.DALZIEL**	**DATE:**		**SYSTEM:**	

BASIN AREA:

A = **1467600** **ft^2** **SOURCE:** **MICROSTATION/USGS**
33.69 **acres** **(SCALE = 1:1)**

COEFFICIENT OF RUNOFF:

KEY: User Input | Designer Tool

UNDEVELOPED AREA C (FROM HDM FIG. 819.2A)

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	57%	AT	0.90	0.514
COMMERCIAL AREA	0%	AT	0.85	0.000
CUT SLOPE (2:1 and 4:1)	43%	AT	0.55	0.236
TOTAL	100%			
	(100%)			

$C_{2,10}$ =	0.75
C_{25} =	0.82
C_{50} =	0.90
C_{100} =	0.94

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	611.5	ft	SR-11 CL
LOW POINT ELEVATION	610.0	ft	SR-11 ES
ELEVATION DIFF (H)	1.5	ft	
LENGTH (L)	125	ft	To Bioswale
SLOPE (S) = (H/L)	1.2%		
MANNING'S n	0.016		<= From Table 816.6A AC
T_t (SFF)=	3.20	minutes	

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

NOTES:

HIGH PT ELEVATION	610.0	ft	Origin of Bioswale
LOW POINT ELEVATION	609.0	ft	
ELEVATION DIFF (H)	1.0	ft	
LENGTH (L)	200	ft	Assumed bioswale does not have enough flow to be channelized
SLOPE (S) = (H/L)	0.5%		
VELOCITY (SCF)	1.8	fps	0.5% ,V From Figure 816.6 Grassed Waterway
T_c (SH)=	1.85	minutes	

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

NOTES:

HIGH PT ELEVATION	609.0	ft	Begin channel flow in bioswale
LOW POINT ELEVATION	590.0	ft	CHANNEL DATA TYPE = TRAP'Z
ELEVATION DIFF (H)	19.0	ft	Z= 4 ANG-RAD 0.245
LENGTH (L)	1158	ft	b = 13 ANG-DEG 14.036
SLOPE (S) = (H/L)	1.6%		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)	3.29	fps	From Manning's Equation assuming flowing full: $V=1.49/n(R^{2/3}S^{1/2})$
T_c (CH)=	5.87	minutes	

Basin Y-East Inflow TcQ

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

HIGH PT ELEVATION	590.0	ft
LOW POINT ELEVATION	584.0	ft
ELEVATION DIFF (H)	6.0	ft
LENGTH (L)	345	ft
SLOPE (S) = (H/L)	1.7%	
MANNING'S n	0.013	
HYDRAULIC RADIUS R	0.80	ft
VELOCITY (CHANNEL)	13.03	fps
T_C (CH)=	0.44	minutes

NOTES:

Assume former basin is conc channel			
CHANNEL DATA		TYPE =	TRAP'Z
Z=	4	ANG-RAD	0.245
b =	13	ANG-DEG	14.036
d =	1	FLOWING FULL ASS'M	
Concrete			
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	579.0	ft
LOW POINT ELEVATION	520.0	ft
ELEVATION DIFF (H)	59.0	ft
LENGTH (L)	3725	ft
SLOPE (S) = (H/L)	1.6%	
MANNING'S n	0.013	
PIPE DIAMETER d	2.0	ft
HYDRAULIC RADIUS R	0.5	ft
VELOCITY (STORMDRAIN)	9.1	fps
T_C (SD)=	6.83	minutes

NOTES:

Proposed basin outlet pipe
Discharge at Basin Y-East
RCP
R=D/4, Assume: flowing full
$V = \frac{K_u}{n} R^{2/3} S^{1/2}$

Tc (TOTAL) =	18.19	minutes
Minimum Tc =	10	minutes
USE Tc =	**18.19**	minutes

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

i_2 =	1.3	in/hr	X CA =
i_{10} =	1.8	in/hr	X CA =
i_{25} =	2.3	in/hr	X CA =
i_{50} =	2.7	in/hr	X CA =
i_{100} =	2.9	in/hr	X CA =

FLOW RESULTS:

	cfs
Q_2 =	31.8
Q_{10} =	46.3
Q_{25} =	63.7
Q_{50} =	83.3
Q_{100} =	**90.4**

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 Y-East Inflow Hydrograph

PROJECT:	**SR-11**			**DESCRIPTION:**	**SR-11 Basin**
JOB #:	**11A1190**			**STATION:**	**125/905**
BY:	**M.BRUNING**	**DATE:**	**02.19.10**	**WATERSHED:**	**Y-East**
CHK:	**G.DALZIEL**	**DATE:**		**SYSTEM:**	

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

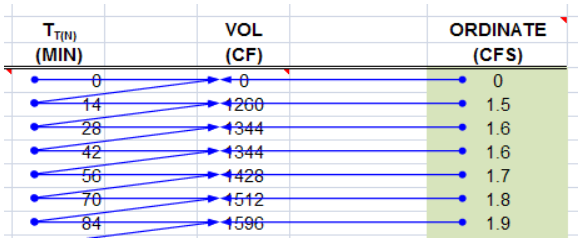
Basin Inflow Hydrograph

Basin Inflow Q

Q_{100}=	90.4	cfs	C_{100}=	0.94	
Tc=	18.2	min	A=	33.69	acres
$P_{100,6}$=	2.5	in			

$T_{T(N)}$ (MIN)	VOL (CF)	ORDINATE (CFS)
0	0	0
18	5184	4.8
36	5508	5.1
54	5724	5.3
72	6264	5.8
90	6588	6.1
108	7236	6.7
126	7668	7.1
144	8856	8.2
162	9504	8.8
180	11664	10.8
198	13284	12.3
216	19548	18.1
234	28512	26.4
252	97632	90.4
270	15660	14.5
288	10476	9.7
306	8208	7.6
324	6912	6.4
342	5940	5.5
360	5292	4.9
378	0	0

Example of Steps:



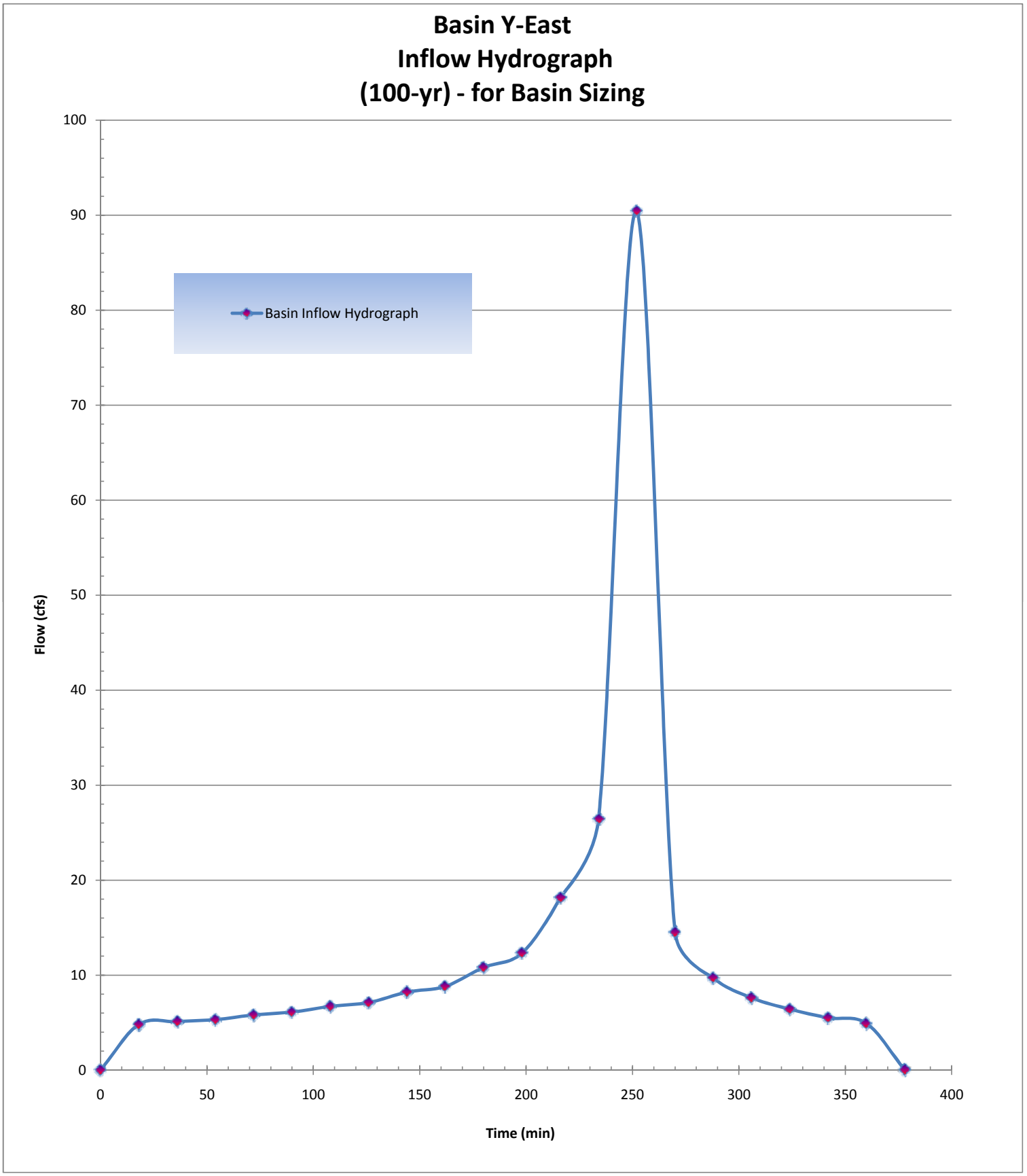
SUM= 285660 ft³
6.56 acre-feet

Onsite Runoff Volume

Check: $V = C*A*P_6$

V= 6.58 acre-feet

OK


Basin Y-East
Inflow Hydrograph
(100-yr) - for Basin Sizing
Basin Inflow Hydrograph
Flow (cfs)
Time (min)
0
10
20
30
40
50
60
70
80
90
100
0
50
100
150
200
250
300
350
400

Basin Y-East Outlet

PROJECT:	**SR-11**			**DESCRIPTION:**	**SR-11 Basin**
JOB #:	**11A1190**			**STATION:**	**125/905**
BY:	**M.BRUNING**	**DATE:**	**02.19.10**	**WATERSHED:**	**Y-East**
CHK:	**G.DALZIEL**	**DATE:**		**SYSTEM:**	

Notes:

Volumes:

Required retention volume =	240842	ft^3	
Retention volume from this basin =	244765		at 2.4' depth
Actual Basin Inflow =	285660	ft^4	*OK*

Flow Balance - determine maximum flow from basin

Predeveloped Peak 100-year Flow:	102.8	cfs	
Post-Developed Peak Flow through Cross Culvert:	0.0	cfs	Independent of Culvert Y
Flow that does not reach detention basin (bypass per DA table):	59.6	cfs	Q_{100} from: Y.9.PV A2.5.SL Y.905.SL
Maximum flow allowed to be released by this basin:	43.2	cfs	

Outlet Pipe

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

Basin - Top of basin berm elevation =			520.00	ft
Basin flowline elevation =			514.00	ft
Maximum Basin Depth =			6.00	ft
Assume Culvert Design: free outfall, square-edge w/headwall				
Outlet pipe invert from basin floor =	2.40	ft	516.40	ft
Outlet pipe diameter =	2	ft		

Basin Characteristics

Base Length (L)	425	ft	
Base Width (W)	225	ft	
W/L Ratio ®	0.53		
Side Slopes (Z)	1: 4		
Total Volume (V):	671445	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	514.00	0.00	0	0		514.00	0.00		0.00
1	514.20	0.20	19229	19229		514.20	0.00		0.00
2	514.40	0.40	19439	38668		514.40	0.00		0.00
3	514.60	0.60	19649	58318		514.60	0.00		0.00
4	514.80	0.80	19860	78178		514.80	0.00		0.00
5	515.00	1.00	20072	98250		515.00	0.00		0.00
6	515.20	1.20	20285	118536		515.20	0.00		0.00
7	515.40	1.40	20499	139035		515.40	0.00		0.00
8	515.60	1.60	20714	159748		515.60	0.00		0.00
9	515.80	1.80	20929	180677		515.80	0.00		0.00
10	516.00	2.00	21145	201822		516.00	0.00		0.00
11	516.20	2.20	21362	223185		516.20	0.00		0.00
12	516.40	2.40	21580	244765	*	516.40	0.00		0.00
13	516.60	2.60	21799	266564		516.60	0.15		0.15
14	516.80	2.80	22019	288583		516.80	0.59		0.59
15	517.00	3.00	22239	310822		517.00	1.30	0.00	1.30
16	517.20	3.20	22461	333282		517.20	2.25		2.25
17	517.40	3.40	22683	355965		517.40	3.42		3.42
18	517.60	3.60	22906	378871		517.60	4.79		4.79
19	517.80	3.80	23130	402000		517.80	6.32		6.32
20	518.00	4.00	23354	425355		518.00	7.99		7.99
21	518.20	4.20	23580	448935		518.20	9.77		9.77
22	518.40	4.40	23806	472741		518.40	11.63		11.63
23	518.60	4.60	24034	496775		518.60	13.53		13.53
24	518.80	4.80	24262	521036		518.80	15.46		15.46
25	519.00	5.00	24491	545527		519.00	17.37		17.37
26	519.20	5.20	24721	570248		519.20	19.16		19.16
27	519.40	5.40	24951	595199		519.40	20.41		20.41
28	519.60	5.60	25183	620382		519.60	21.59		21.59
29	519.80	5.80	25415	645797		519.80	22.71		22.71
30	520.00	6.00	25648	671445		520.00	23.78		23.78

Basin Y-East Routing

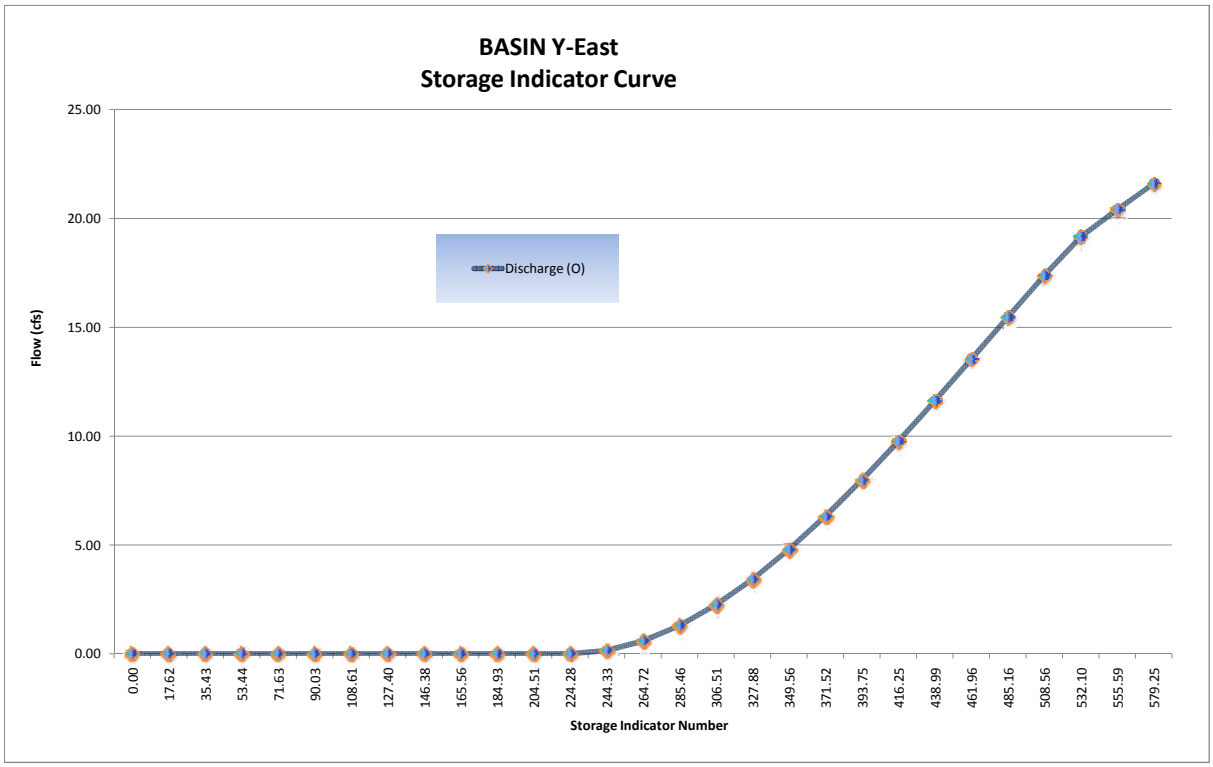
PROJECT:	SR-11			DESCRIPTION:	SR-11 Basin
JOB #:	11A1190			STATION:	125/905
BY:	M.BRUNING	DATE:	02.19.10	WATERSHED:	Y-East
CHK:	G.DALZIEL	DATE:		SYSTEM:	Basin Y-East

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)	*Storage Indicator #* (6) $S_2/delta\ t + O_2/2$ (cfs)
514.00	0.00	0	0.00	0.00	0.00
514.20	0.00	19229	0.00	17.62	17.62
514.40	0.00	38668	0.00	35.43	35.43
514.60	0.00	58318	0.00	53.44	53.44
514.80	0.00	78178	0.00	71.63	71.63
515.00	0.00	98250	0.00	90.03	90.03
515.20	0.00	118536	0.00	108.61	108.61
515.40	0.00	139035	0.00	127.40	127.40
515.60	0.00	159748	0.00	146.38	146.38
515.80	0.00	180677	0.00	165.56	165.56
516.00	0.00	201822	0.00	184.93	184.93
516.20	0.00	223185	0.00	204.51	204.51
516.40	0.00	244765	0.00	224.28	224.28
516.60	0.15	266564	0.08	244.25	244.33
516.80	0.59	288583	0.30	264.43	264.72
517.00	1.30	310822	0.65	284.81	285.46
517.20	2.25	333282	1.13	305.39	306.51
517.40	3.42	355965	1.71	326.17	327.88
517.60	4.79	378871	2.40	347.16	349.56
517.80	6.32	402000	3.16	368.36	371.52
518.00	7.99	425355	4.00	389.76	393.75
518.20	9.77	448935	4.89	411.36	416.25
518.40	11.63	472741	5.82	433.18	438.99
518.60	13.53	496775	6.77	455.20	461.96
518.80	15.46	521036	7.73	477.43	485.16
519.00	17.37	545527	8.69	499.87	508.56
519.20	19.16	570248	9.58	522.52	532.10
519.40	20.41	595199	10.21	545.38	555.59
519.60	21.59	620382	10.80	568.46	579.25
519.80	22.71	645797	11.36	591.75	603.10
520.00	23.78	671445	11.89	615.25	627.14

delta t = 0.30 hrs
delta t = 18 min
delta t = 1091.338 sec

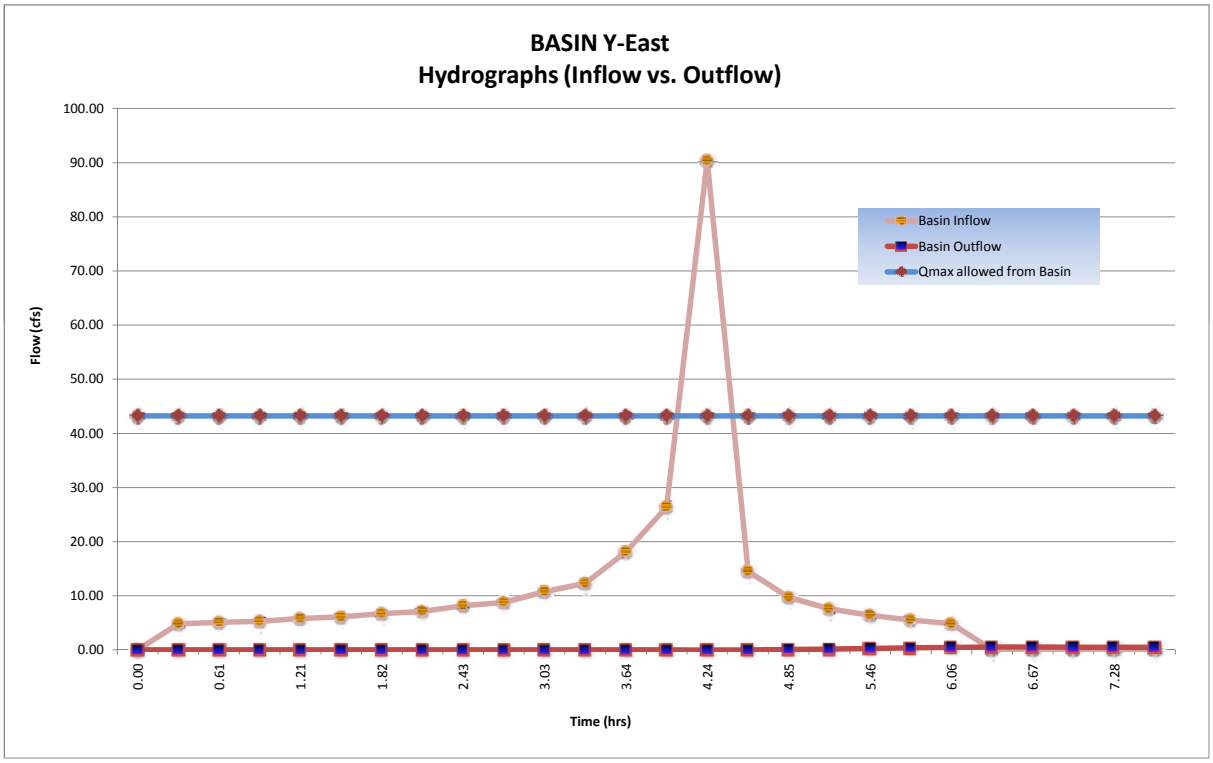


Basin Y-East Routing

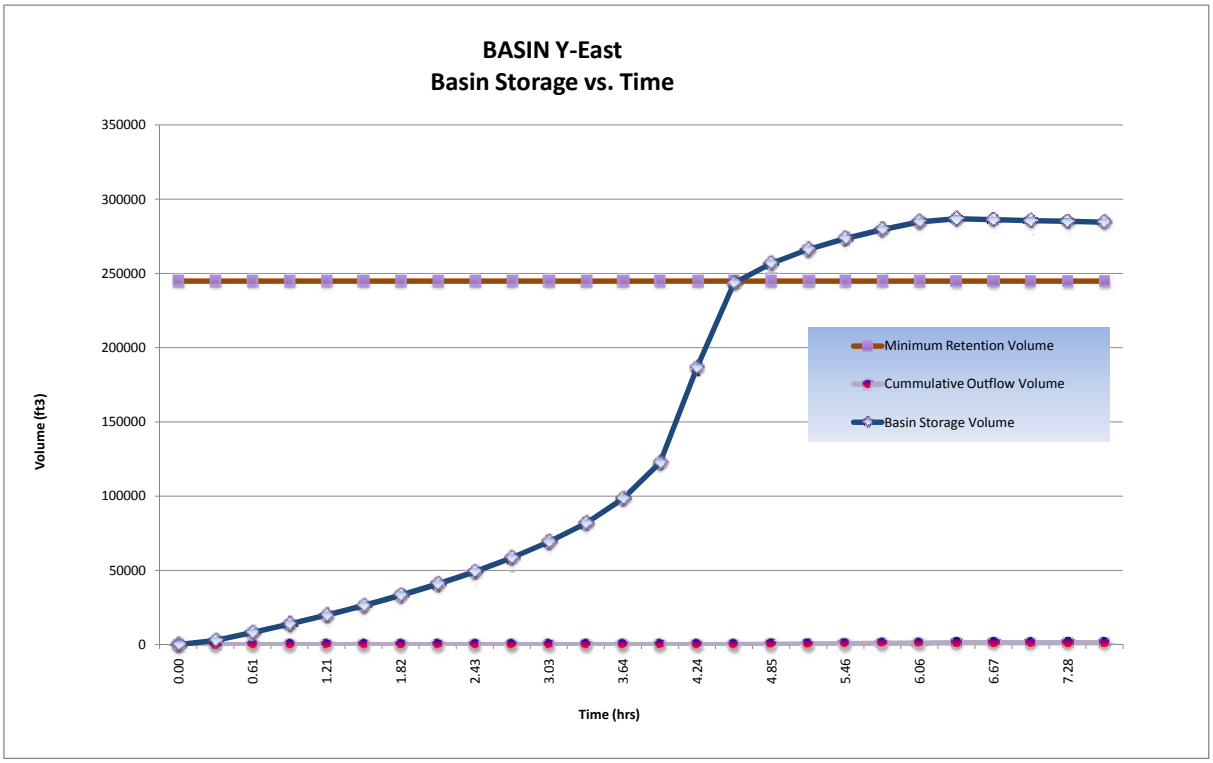
FINAL ROUTING TABLE

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

(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
0.30	4.80	2.40	0.00	0.00	2.40	0.00	2619	0	0
0.61	5.10	4.95	2.40	0.00	7.35	0.00	8021	0	0
0.91	5.30	5.20	7.35	0.00	12.55	0.00	13696	0	0
1.21	5.80	5.55	12.55	0.00	18.10	0.00	19753	0	0
1.52	6.10	5.95	18.10	0.00	24.05	0.00	26247	0	0
1.82	6.70	6.40	24.05	0.00	30.45	0.00	33231	0	0
2.12	7.10	6.90	30.45	0.00	37.35	0.00	40761	0	0
2.43	8.20	7.65	37.35	0.00	45.00	0.00	49110	0	0
2.73	8.80	8.50	45.00	0.00	53.50	0.00	58387	0	0
3.03	10.80	9.80	53.50	0.00	63.30	0.00	69082	0	0
3.33	12.30	11.55	63.30	0.00	74.85	0.00	81687	0	0
3.64	18.10	15.20	74.85	0.00	90.05	0.00	98275	0	0
3.94	26.40	22.25	90.05	0.00	112.30	0.00	122557	0	0
4.24	90.40	58.40	112.30	0.00	170.70	0.00	186291	0	0
4.55	14.50	52.45	170.70	0.00	223.15	0.00	243532	0	0
4.85	9.70	12.10	223.15	0.00	235.25	0.08	256694	87	87
5.15	7.60	8.65	235.25	0.08	243.82	0.15	266008	164	251
5.46	6.40	7.00	243.82	0.15	250.67	0.29	273407	316	480
5.76	5.50	5.95	250.67	0.29	256.33	0.41	279519	447	764
6.06	4.90	5.20	256.33	0.41	261.12	0.51	284692	557	1004
6.37	0.00	2.45	261.12	0.51	263.06	0.55	286787	600	1157
6.67	0.00	0.00	263.06	0.55	262.51	0.54	286192	589	1190
6.97	0.00	0.00	262.51	0.54	261.97	0.53	285609	578	1168
7.28	0.00	0.00	261.97	0.53	261.44	0.52	285036	567	1146
7.58	0.00	0.00	261.44	0.52	260.92	0.51	284474	557	1124
7.88	0.00	0.00	260.92	0.51	260.41	0.50	283923	546	1102
8.19	0.00	0.00	260.41	0.50	259.91	0.49	283382	535	1080



Basin Y-East Routing



Detention/Retention Basin Volume Required:	**286,787**	**ft^3**	
@ Stage:	**516.80**	**ft**	
Freeboard:	**3.2**	**ft**	>1' Freeboard
Final Total Basin Volume Provided:	**671,445**	**ft^3**	Basin **Y-East**
Maximum flow rate released from this basin:	**0.55**	**cfs**	

Basin Y-West Retention

PROJECT:	**SR-11**			**DESCRIPTION:**	**SR-11 Basin**
JOB #:	**11A1190**			**STATION:**	**125/905**
BY:	**M.BRUNING**	**DATE:**	**02.19.10**	**WATERSHED:**	**Y-West**
CHK:	**G.DALZIEL**	**DATE:**		**SYSTEM:**	

Notes:

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

RETENTION BASIN VOLUME

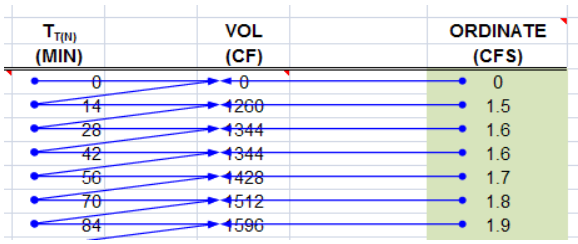
100-year, 6 hour duration storm event, use the Rational Method Hydrograph Procedure (SDCHM 6-1) ~ RatHydro

Pre-Developed volume calculations

Q_{100}=	102.8	cfs			
Tc=	23.5	min	C=	0.58	
$P_{100,6}$=	2.5	in	A=	72.78	acres

$T_{T(N)}$ (MIN)	VOL (CF)	ORDINATE (CFS)
0	0	0
24	9216	6.4
48	9648	6.7
72	10656	7.4
96	11376	7.9
120	12960	9
144	14112	9.8
168	17280	12
192	19584	13.6
216	28800	20
240	38160	26.5
264	148032	102.8
288	23184	16.1
312	15408	10.7
336	12096	8.4
360	10080	7
384	0	0

Example of Steps:



SUM= 380592 ft^3
8.74 acre-feet

Check: V = C*A*P_6
V= 8.81 acre-feet
OK

Basin Y-West Retention

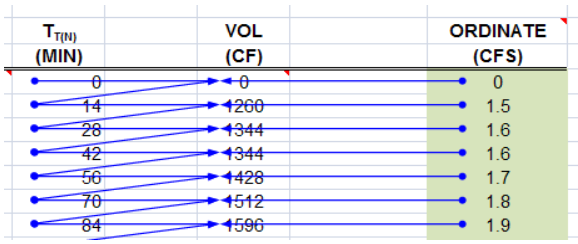
Post-Developed volume calculations

Q_{100}= 184.0 cfs
Tc= 20.2 min
$P_{100,6}$= 2.5 in

C= 0.87
A= 78.57 acres

$T_{T(N)}$ (MIN)	VOL (CF)	ORDINATE (CFS)
0	0	0
20	12360	10.3
40	12840	10.7
60	14040	11.7
80	14640	12.2
100	16200	13.5
120	17280	14.4
140	19680	16.4
160	21360	17.8
180	26160	21.8
200	29760	24.8
220	43800	36.5
240	61800	51.5
260	220800	184
280	35040	29.2
300	23520	19.6
320	18360	15.3
340	15360	12.8
360	13440	11.2
380	0	0

Example of Steps:



SUM= 616440 ft^3
14.15 acre-feet

Check: $V = C*A*P_6$
V= 14.30 acre-feet
OK

		14.15	*(Post)*		
	-	**8.74**	*(Pre)*		
Retention volume =		**5.41**	**acre-feet**	=	**235848 ft^3**

Basin Required

Basin Y-West 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}= 0.95
A= 22.81 acres

WQ_{72}: 0.73 in/area

Water Quality Volume (WQV) = **60444** 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:

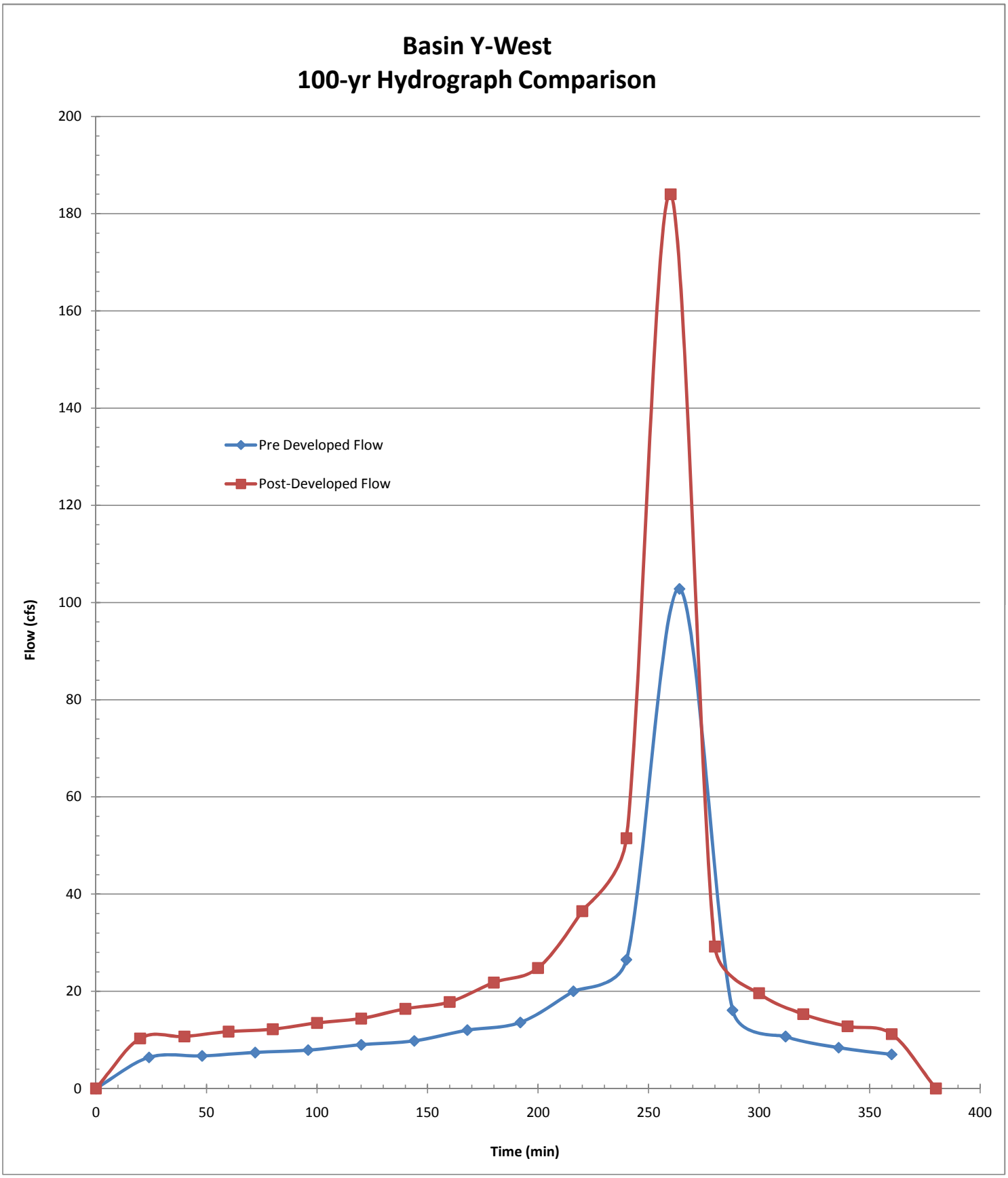
A_s = the computed soil loss in tons (dry weight)
R = the rainfall erosion index for the given storm period
K = the soil erodibility factor
L = the slope length factor
s = the slope gradient factor
C = cropping management (vegetation) factor
P = erosion control practice factor

Onsite Highway *Sloped* runoff area, A:		406100	ft^2
	A:	9.32	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 = 144.99 tons

Silt Accumulation Basin volume = **3222** ft^3 **Add this volume to Basin**

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


Basin Y-West
100-yr Hydrograph Comparison
Pre Developed Flow
Post-Developed Flow
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 Y-West Inflow TcQ

PROJECT:	**SR-11**			**DESCRIPTION:**	**SR-11 Basin**
JOB #:	**11A1190**			**STATION:**	**125/905**
BY:	**M.BRUNING**	**DATE:**	**02.19.10**	**WATERSHED:**	**Y-West**
CHK:	**G.DALZIEL**	**DATE:**		**SYSTEM:**	

BASIN AREA:

A = **993600** **ft^2** | **22.81** **acres**

SOURCE: **MICROSTATION/USGS** **(SCALE = 1:1)**

COEFFICIENT OF RUNOFF:

KEY: User Input | Designer Tool

UNDEVELOPED AREA C (FROM HDM FIG. 819.2A)

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	59%	AT	0.90	0.532
COMMERCIAL AREA	0%	AT	0.85	0.000
CUT SLOPE (2:1 and 4:1)	41%	AT	0.55	0.225
TOTAL	100%			
	(100%)			

$C_{2,10}$ =	0.76
C_{25} =	0.83
C_{50} =	0.91
C_{100} =	0.95

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	565.0	ft
LOW POINT ELEVATION	564.0	ft
ELEVATION DIFF (H)	1.0	ft
LENGTH (L)	111	ft
SLOPE (S) = (H/L)	0.9%	
MANNING'S n	0.016	
T_t (SFF)=	3.26	minutes

<= From Table 816.6A AC

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

NOTES:

HIGH PT ELEVATION	564.0	ft
LOW POINT ELEVATION	558.0	ft
ELEVATION DIFF (H)	6.0	ft
LENGTH (L)	787	ft
SLOPE (S) = (H/L)	0.8%	
MANNING'S n	0.016	
HYDRAULIC RADIUS R	0.80	ft
VELOCITY (CHANNEL)	7.01	fps
T_C (CH)=	1.87	minutes

CHANNEL DATA		TYPE =	TRAP'Z
Z=	4	ANG-RAD	0.245
b =	13	ANG-DEG	14.036
d =	1	FLOWING FULL ASS'M	

AC

R=(bdsinA+d^2cosA)/(bsinA+2d)

From Manning's Equation assuming flowing full: $V=1.49/n(R^{2/3}S^{1/2})$

Basin Y-West Inflow TcQ

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

HIGH PT ELEVATION	554.0	ft
LOW POINT ELEVATION	510.0	ft
ELEVATION DIFF (H)	44.0	ft
LENGTH (L)	1046	ft
SLOPE (S) = (H/L)	4.2%	
MANNING'S n	0.013	
PIPE DIAMETER d	2.0	ft
HYDRAULIC RADIUS R	0.5	ft
VELOCITY (STORMDRAIN)	14.8	fps
T_C (SD)=	1.18	minutes

NOTES:

Proposed pipe to basin
Discharge into Basin Y-West
RCP
R=D/4, Assume: flowing full
$V = \frac{K_u}{n} R^{2/3} S^{1/2}$

Tc (TOTAL) =	6.31	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 =	32.0
Q_{10} =	46.5
Q_{25} =	64.0
Q_{50} =	83.8
Q_{100} =	**90.9**

COUNTY P_6

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

Basin Y-West Inflow Hydrograph

PROJECT:	**SR-11**			**DESCRIPTION:**	**SR-11 Basin**
JOB #:	**11A1190**			**STATION:**	**125/905**
BY:	**M.BRUNING**	**DATE:**	**02.19.10**	**WATERSHED:**	**Y-West**
CHK:	**G.DALZIEL**	**DATE:**		**SYSTEM:**	

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

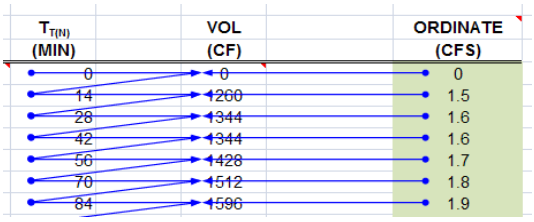
Basin Inflow Hydrograph

Basin Inflow Q

Q_{100}=	90.9	cfs	C_{100}=	0.95	
Tc=	10.0	min	A=	22.81	acres
$P_{100,6}$=	2.5	in			

$T_{T(N)}$ (MIN)	VOL (CF)	ORDINATE (CFS)
0	0	0
10	1920	3.2
20	1980	3.3
30	2040	3.4
40	2100	3.5
50	2220	3.7
60	2220	3.7
70	2340	3.9
80	2400	4
90	2520	4.2
100	2580	4.3
110	2760	4.6
120	2880	4.8
130	3060	5.1
140	3180	5.3
150	3480	5.8
160	3600	6
170	4020	6.7
180	4260	7.1
190	4920	8.2
200	5280	8.8
210	6480	10.8
220	7380	12.3
230	10860	18.1
240	15480	25.8
250	54540	90.9
260	8700	14.5
270	5820	9.7
280	4560	7.6
290	3840	6.4
300	3300	5.5
310	2940	4.9
320	2700	4.5
330	2460	4.1
340	2280	3.8
350	2160	3.6
360	2040	3.4
370	0	0

Example of Steps:



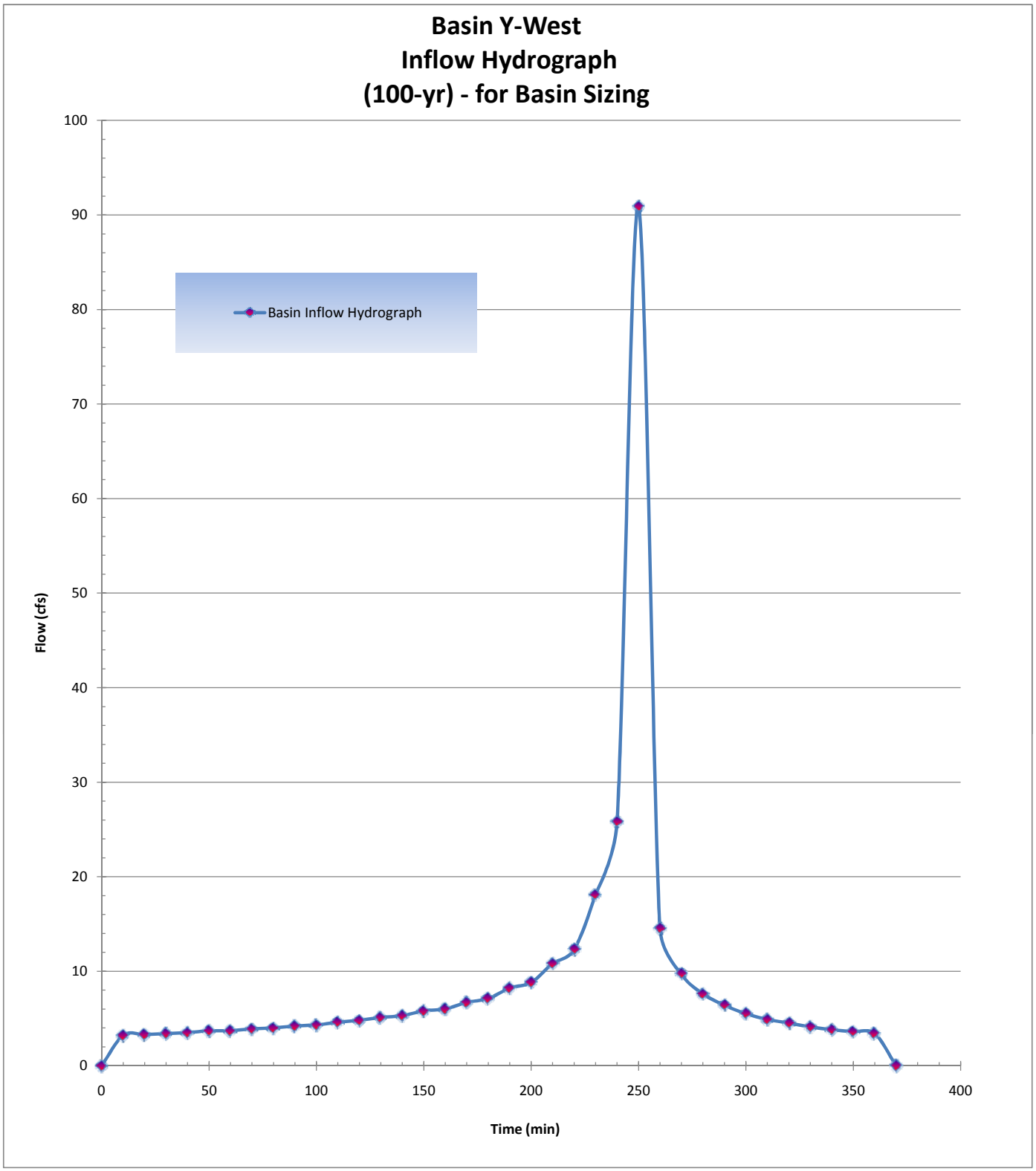
SUM= 195300 ft^3
4.48 acre-feet

Onsite Runoff Volume

Check: $V = C*A*P_6$

V= 4.50 acre-feet

OK


Basin Y-West
Inflow Hydrograph
(100-yr) - for Basin Sizing
Basin Inflow Hydrograph
Flow (cfs)
Time (min)
0
10
20
30
40
50
60
70
80
90
100
0
50
100
150
200
250
300
350
400

Basin Y-West Outlet

PROJECT:	**SR-11**			**DESCRIPTION:**	**SR-11 Basin**
JOB #:	**11A1190**			**STATION:**	**125/905**
BY:	**M.BRUNING**	**DATE:**	**02.19.10**	**WATERSHED:**	**Y-West**
CHK:	**G.DALZIEL**	**DATE:**		**SYSTEM:**	

Notes:

Volumes:

Required retention volume =	3222	ft^3	Silt only
Retention volume from this basin =	3564		at 0.2' depth
Actual Basin Inflow =	195300	ft^4	*OK*

Flow Balance - determine maximum flow from basin

Predeveloped Peak 100-year Flow:	102.8	cfs	
Post-Developed Peak Flow through Cross Culvert:	0.0	cfs	Independent of Culvert Y
Flow that does not reach detention basin (bypass per DA table):	60.2	cfs	Q_{100} from: A2.5.SL Y.905.SL Y-East Basin
Maximum flow allowed to be released by this basin:	42.6	cfs	

Outlet Pipe

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

Basin - Top of basin berm elevation =			512.00 ft
Basin flowline elevation =			507.00 ft
Maximum Basin Depth =			5.00 ft
Assume Culvert Design: free outfall, square-edge w/headwall			
Outlet pipe invert from basin floor =	0.20 ft		507.20 ft
Outlet pipe diameter =	2 ft		

Basin Characteristics

Base Length (L)	350	ft
Base Width (W)	50	ft
W/L Ratio ®	0.14	
Side Slopes (Z)	1: 4	
Total Volume (V):	131854	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	507.00	0.00	0	0		507.00	0.00		0.00
1	507.20	0.20	3564	3564	*	507.20	0.00		0.00
2	507.40	0.40	3693	7257		507.40	0.15		0.15
3	507.60	0.60	3824	11081		507.60	0.59		0.59
4	507.80	0.80	3956	15037		507.80	1.30		1.30
5	508.00	1.00	4091	19128		508.00	2.25		2.25
6	508.20	1.20	4227	23355		508.20	3.42		3.42
7	508.40	1.40	4365	27719		508.40	4.79		4.79
8	508.60	1.60	4504	32223		508.60	6.32		6.32
9	508.80	1.80	4646	36869		508.80	7.99		7.99
10	509.00	2.00	4789	41658		509.00	9.77		9.77
11	509.20	2.20	4934	46591		509.20	11.63		11.63
12	509.40	2.40	5080	51671		509.40	13.53		13.53
13	509.60	2.60	5229	56900		509.60	15.46	0.00	15.46
14	509.80	2.80	5379	62278		509.80	17.37		17.37
15	510.00	3.00	5531	67809		510.00	19.16		19.16
16	510.20	3.20	5684	73493		510.20	20.41		20.41
17	510.40	3.40	5840	79333		510.40	21.59		21.59
18	510.60	3.60	5997	85329		510.60	22.71		22.71
19	510.80	3.80	6156	91485		510.80	23.78		23.78
20	511.00	4.00	6316	97801		511.00	24.80		24.80
21	511.20	4.20	6479	104280		511.20	25.78		25.78
22	511.40	4.40	6643	110923		511.40	26.72		26.72
23	511.60	4.60	6809	117731		511.60	27.64		27.64
24	511.80	4.80	6976	124708		511.80	28.52		28.52
25	512.00	5.00	7146	131854		512.00	29.38		29.38

Basin Y-West Routing

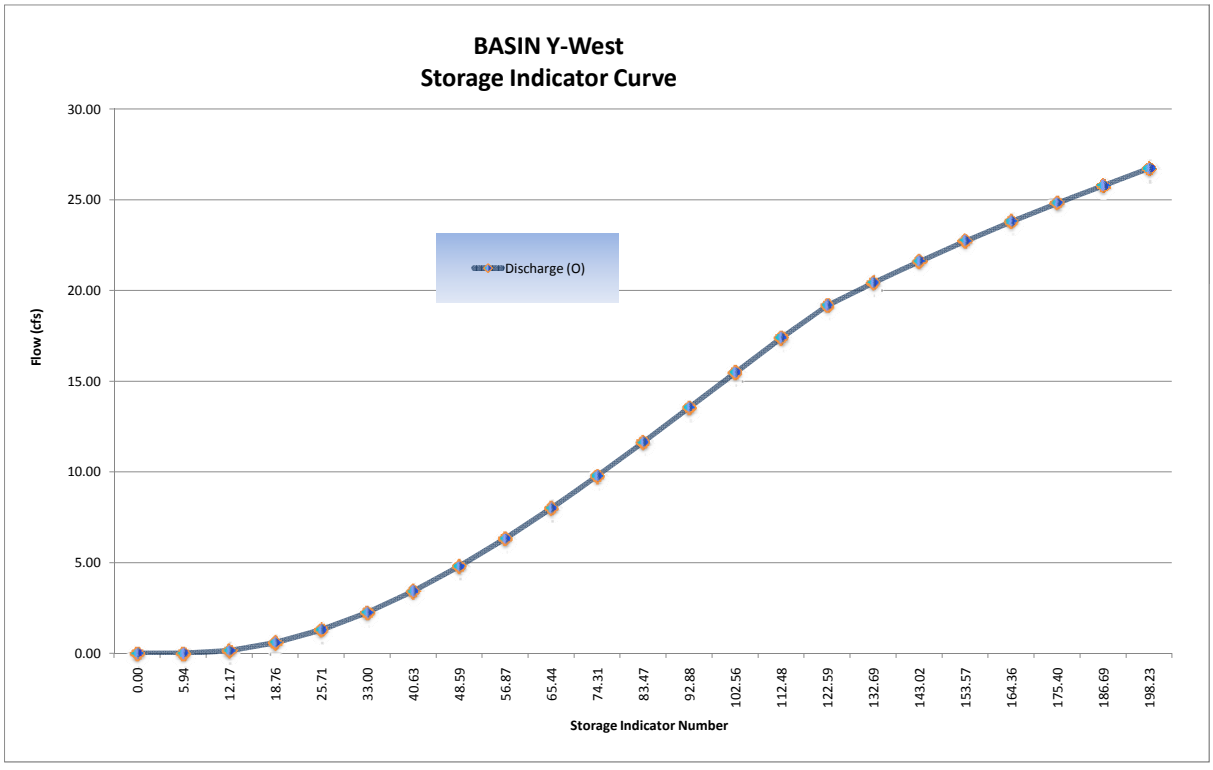
PROJECT:	SR-11			DESCRIPTION:	SR-11 Basin
JOB #:	11A1190			STATION:	125/905
BY:	M.BRUNING	DATE:	02.19.10	WATERSHED:	Y-West
CHK:	G.DALZIEL	DATE:		SYSTEM:	Basin Y-West

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)	*Storage Indicator #* (6) S_2/delta t + $O_2/2$ (cfs)
507.00	0.00	0	0.00	0.00	0.00
507.20	0.00	3564	0.00	5.94	5.94
507.40	0.15	7257	0.08	12.09	12.17
507.60	0.59	11081	0.30	18.47	18.76
507.80	1.30	15037	0.65	25.06	25.71
508.00	2.25	19128	1.13	31.88	33.00
508.20	3.42	23355	1.71	38.92	40.63
508.40	4.79	27719	2.40	46.20	48.59
508.60	6.32	32223	3.16	53.71	56.87
508.80	7.99	36869	4.00	61.45	65.44
509.00	9.77	41658	4.89	69.43	74.31
509.20	11.63	46591	5.82	77.65	83.47
509.40	13.53	51671	6.77	86.12	92.88
509.60	15.46	56900	7.73	94.83	102.56
509.80	17.37	62278	8.69	103.80	112.48
510.00	19.16	67809	9.58	113.01	122.59
510.20	20.41	73493	10.21	122.49	132.69
510.40	21.59	79333	10.80	132.22	143.02
510.60	22.71	85329	11.36	142.22	153.57
510.80	23.78	91485	11.89	152.47	164.36
511.00	24.80	97801	12.40	163.00	175.40
511.20	25.78	104280	12.89	173.80	186.69
511.40	26.72	110923	13.36	184.87	198.23

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



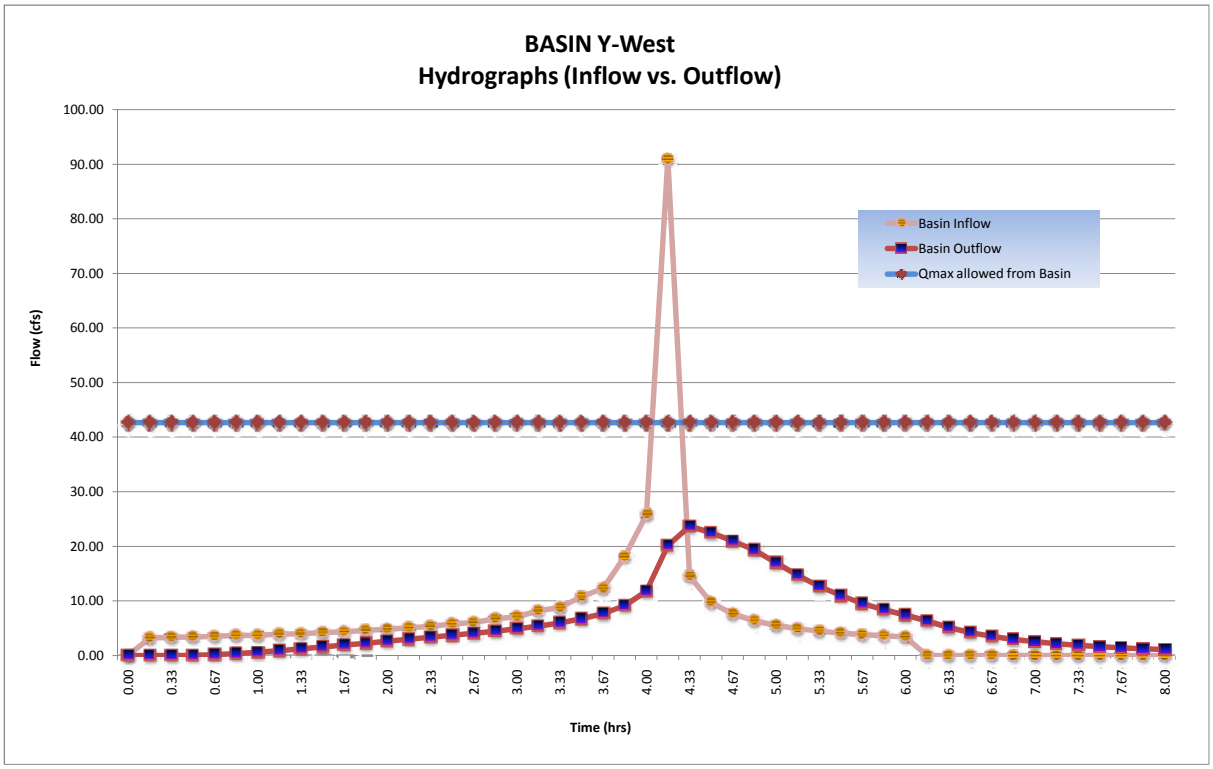
Basin Y-West Routing

FINAL ROUTING TABLE

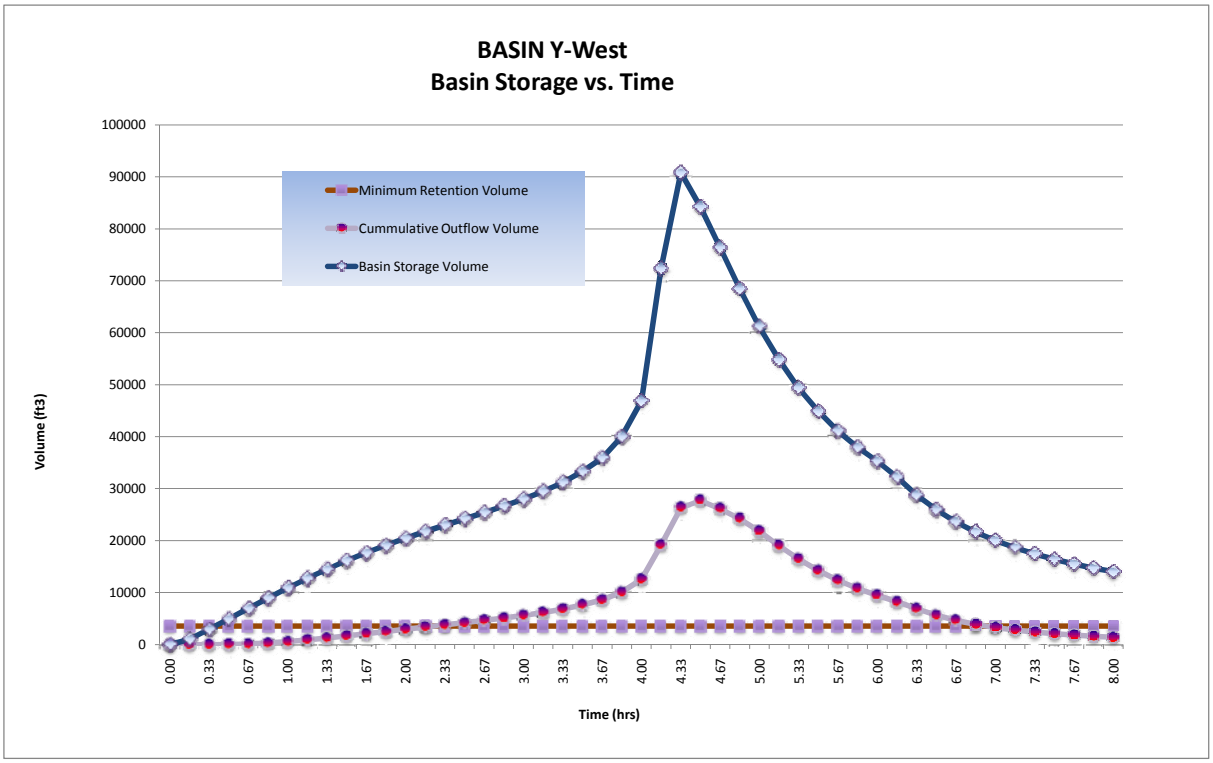
$$\frac{I_1 + I_2}{2} + \left(\frac{S_1}{\Delta t} - \frac{O_1}{2}\right) = O_1 + \left(\frac{S_2}{\Delta t} + \frac{O_2}{2}\right)$$

					Storage Indicator #				
(1)	(2)	(3)	(4)	(5)	(6)	(7)	Volumes (ft3)		
Time	Inflow	$(I_1+I_2)/2$	$(S_1/\text{delta t} + O_1/2)$	O_1	$S_2/\text{delta t} + O_2/2$	O_2	Basin	Incremental	Cummulative
(hrs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	Storage	Outflow	Outflow
	(Q_{post})		*col (6) from prev row*	*col (7) from prev row*	*col (3)+(4)-(5)*	*(Hard input)*	*Volume*	*Volume*	*Volume*
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
0.17	3.20	1.60	0.00	0.00	1.60	0.00	960	0	0
0.33	3.30	3.25	1.60	0.00	4.85	0.00	2910	0	0
0.50	3.40	3.35	4.85	0.00	8.20	0.05	4905	30	30
0.67	3.50	3.45	8.20	0.05	11.60	0.14	6918	84	114
0.83	3.70	3.60	11.60	0.14	15.06	0.34	8934	204	288
1.00	3.70	3.70	15.06	0.34	18.42	0.57	10881	342	546
1.17	3.90	3.80	18.42	0.57	21.65	0.88	12726	528	870
1.33	4.00	3.95	21.65	0.88	24.72	1.20	14472	720	1248
1.50	4.20	4.10	24.72	1.20	27.62	1.55	16107	930	1650
1.67	4.30	4.25	27.62	1.55	30.32	1.90	17622	1140	2070
1.83	4.60	4.45	30.32	1.90	32.87	2.23	19053	1338	2478
2.00	4.80	4.70	32.87	2.23	35.34	2.61	20421	1566	2904
2.17	5.10	4.95	35.34	2.61	37.68	2.97	21717	1782	3348
2.33	5.30	5.20	37.68	2.97	39.91	3.31	22953	1986	3768
2.50	5.80	5.55	39.91	3.31	42.15	3.68	24186	2208	4194
2.67	6.00	5.90	42.15	3.68	44.37	4.06	25404	2436	4644
2.83	6.70	6.35	44.37	4.06	46.66	4.46	26658	2676	5112
3.00	7.10	6.90	46.66	4.46	49.10	4.88	27996	2928	5604
3.17	8.20	7.65	49.10	4.88	51.87	5.40	29502	3240	6168
3.33	8.80	8.50	51.87	5.40	54.97	5.97	31191	3582	6822
3.50	10.80	9.80	54.97	5.97	58.80	6.70	33270	4020	7602
3.67	12.30	11.55	58.80	6.70	63.65	7.64	35898	4584	8604
3.83	18.10	15.20	63.65	7.64	71.21	9.15	39981	5490	10074
4.00	25.80	21.95	71.21	9.15	84.01	11.74	46884	7044	12534
4.17	90.90	58.35	84.01	11.74	130.62	20.15	72327	12090	19134
4.33	14.50	52.70	130.62	20.15	163.17	23.66	90804	14196	26286
4.50	9.70	12.10	163.17	23.66	151.61	22.50	84216	13500	27696
4.67	7.60	8.65	151.61	22.50	137.76	20.99	76359	12594	26094
4.83	6.40	7.00	137.76	20.99	123.77	19.31	68469	11586	24180
5.00	5.50	5.95	123.77	19.31	110.41	16.97	61155	10182	21768
5.17	4.90	5.20	110.41	16.97	98.64	14.68	54780	8808	18990
5.33	4.50	4.70	98.64	14.68	88.66	12.68	49392	7608	16416
5.50	4.10	4.30	88.66	12.68	80.28	10.98	44874	6588	14196
5.67	3.80	3.95	80.28	10.98	73.25	9.56	41082	5736	12324
5.83	3.60	3.70	73.25	9.56	67.39	8.38	37920	5028	10764
6.00	3.40	3.50	67.39	8.38	62.51	7.42	35280	4452	9480
6.17	0.00	1.70	62.51	7.42	56.79	6.31	32181	3786	8238
6.33	0.00	0.00	56.79	6.31	50.48	5.14	28746	3084	6870
6.50	0.00	0.00	50.48	5.14	45.34	4.23	25935	2538	5622
6.67	0.00	0.00	45.34	4.23	41.11	3.50	23616	2100	4638
6.83	0.00	0.00	41.11	3.50	37.61	2.96	21678	1776	3876
7.00	0.00	0.00	37.61	2.96	34.65	2.50	20040	1500	3276
7.17	0.00	0.00	34.65	2.50	32.15	2.14	18648	1284	2784
7.33	0.00	0.00	32.15	2.14	30.01	1.86	17448	1116	2400
7.50	0.00	0.00	30.01	1.86	28.15	1.62	16404	972	2088
7.67	0.00	0.00	28.15	1.62	26.53	1.41	15495	846	1818
7.83	0.00	0.00	26.53	1.41	25.12	1.24	14700	744	1590
8.00	0.00	0.00	25.12	1.24	23.88	1.11	13995	666	1410

Basin Y-West Routing



Basin Y-West Routing



Detention/Retention Basin Volume Required:	**90,804**	**ft^3**	
@ Stage:	**510.80**	**ft**	
Freeboard:	**1.2**	**ft**	>1' Freeboard
Final Total Basin Volume Provided:	**131,854**	**ft^3**	Basin **Y-West**
Maximum flow rate released from this basin:	**23.66**	**cfs**	

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Detention/Retention Basin Flows and Sizes – Watershed Y

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	Freeboard	Name
Name	(Sta)	(cfs)	(cfs)	(cfs)	(ft^3)	(ft^3)	(ft^3)	(ft^3)	(ft^3)	(ft^3)	(ft^3)	(ft)	(ft)	(ft)	(ft)	
Y	905/125	102.82	184.03	81.21	380,592	616,440	235,848	244,765	42,022	384,658	671,445	425	225	6.0	3.2	Y-EAST
								3,564	87,240	41,050	131,854	350	50	5.0	1.2	Y-WEST

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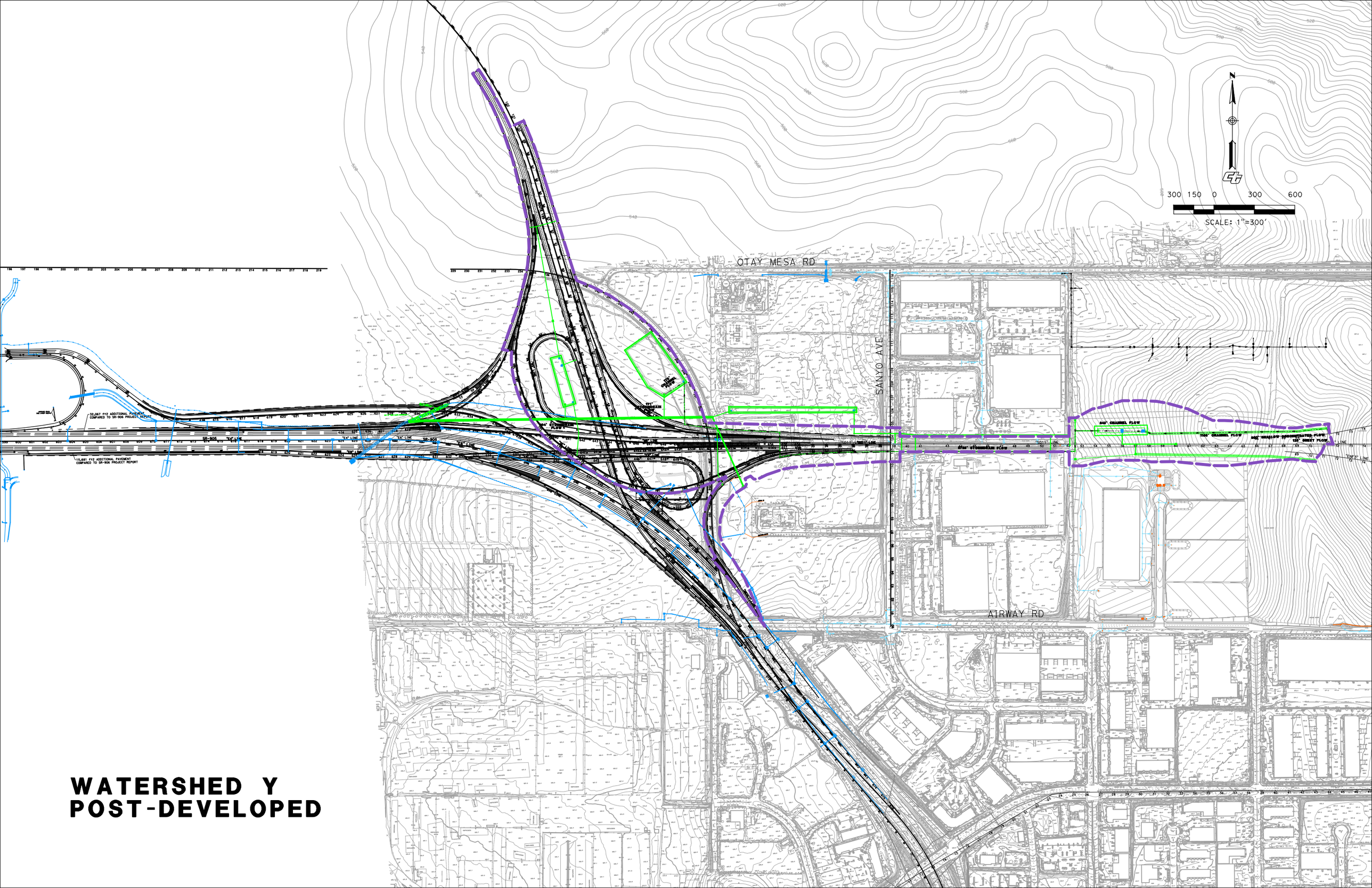
WATERSHED Y
POST-DEVELOPED



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Appendix G

IBWC and County Correspondence

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County of San Diego

DEPARTMENT OF PUBLIC WORKS

JOHN L. SNYDER
DIRECTOR

5555 OVERLAND AVE, SUITE 2188
SAN DIEGO, CALIFORNIA 92123-1295

(858) 694-2212 FAX: (858) 268-0461
Web Site: sdcdpw.org

July 3, 2007

Mr. Tim Brownson
District Hydraulic Engineer
California Department of Transportation – District 11
4050 Taylor Street
San Diego, CA 92110

FLOODPLAIN IMPACT ASSESSMENT OF PROPOSED OTAY MESA EAST POE AND SR-11

Dear Mr. Brownson:

We have reviewed your letter of May 14, 2007, requesting our endorsement of your conclusion that there is no need for a Floodplain Impact Assessment of the proposed Otay Mesa East POE and SR-11.

The subject proposed project as depicted on Exhibit 2A is partially located within the FIRM No. 06073C2183F, which determined the area as Zone X outside the 500-year floodplain. Therefore, we concurred with your conclusion that the subject proposed project does not require a Floodplain Impact Assessment.

However, with regard to flood management in East Otay Mesa all developments are subject to guidelines of the County's East Otay Mesa Specific Plan Comprehensive Flood Control Master Plan 1994. Essentially, developments within East Otay Mesa area are required to provide local or regional detention basins.

If you have any questions or need additional information, please contact me at (858) 694-3672 or by email Cid.Tesoro@sdcounty.gov.

Sincerely,

CID TESORO, Manager
Watershed Protection Program

CT/ez

cc: Hung Tran, Department of Public Works, MS 0384