MLB

ENGINEERING

Professional Civil Engineer and Land Surveyor

December 8, 2016

Howard Cooper
Development Manager
Harper Communities Inc.
8110 El Paseo Grande Ste 105
San Diego, CA 92037

RE: MUP 10-037 CHANGES TO PROJECT DESCRIPTION

Howard,

The changes in the project description, i.e. no preschool and the addition of solar power, will have no impact on either the project CEQA Drainage Study or the project Storm Water Quality Management Plan. The changes will not impact the amount of impervious surfaces of the proposed project or the potential storm water pollutants generated by the project.

I hope this clarifies the issue for you. If you have any questions, feel free to contact me.

REGISTERED PROFESSIONAL ENGINEER
MICHAEL BENESH
RCE 37893
CIVIL
STATE OF CALIFORNIA

Sincerely,

Michael L. Benesh, RCE 37893

404 SOUTH LIVE OAK PARK ROAD • FALLBROOK, CA 92028
PHONE 760 731-6603 • E-MAIL: MLBENESH@PACBELL.NET

MLB

ENGINEERING

Professional Civil Engineer and Land Surveyor

October 27, 2016

Howard Cooper
Development Manager
Harper Communities Inc.
8110 El Paseo Grande Ste 105
San Diego, CA 92037

RE: MUP 10-037 DRAINAGE STUDY BUILDING AREAS

Howard,

The building and other areas used in the calculations in the drainage study prepared for this site are based on the site plan for the project. The site plan used, which includes building locations and footprints, is reflected on Attachment B-2, Proposed Condition Hydrology Map, in the drainage study.

The areas of the buildings listed in Section 3.01 are approximate and meant to give the general scale of the project. The building areas listed are not used in the calculations in any way. The reason for their general nature is that the project was going through review and the site plan was being modified as part of that review, including changes to the sizes and configuration of the buildings. The differences in the areas listed in the description of the project and the architectural floor areas of the various buildings are the result of the very general nature of the numbers used in the Section 3.01, the use of building footprints which don't reflect multi-story elements of the buildings, and the fact that the areas are not all inclusive. For instance, the area of the sanctuary is listed but not the "ancillary fellowship halls".

I hope this clarifies the issue for you. If you have any questions, feel free to contact me.

REGISTERED PROFESSIONAL ENGINEER
MICHAEL BENESH
RCE 37893
CIVIL
STATE OF CALIFORNIA

Sincerely,

Michael L. Benesh, RCE 37893

O:\MLB Projects\County of San Diego\09-sd060 - SFV Church\Documents\Harper 161027 Building Areas.docx

404 SOUTH LIVE OAK PARK ROAD • FALLBROOK, CA 92028
PHONE 760 731-6603 • E-MAIL: MLBENESH@PACBELL.NET

MLB
ENGINEERING
Professional Civil Engineer and Land Surveyor

CEQA Drainage Study

for

MUP - 10-037

Prepared for:

Chinese Bible Church

16919 Four Gee Road

San Diego, CA 92127

-

Project Site Address

16919 Four Gee Road, San Diego, CA

Prepared by:

Michael L. Benesh, R.C.E. 37893

Date:

January 20, 2014

404 South Live Oak Park Road Fallbrook, CA 92028
760 731-6603

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Attachment A - Vicinity Map A-1

Attachment B - Hydrology Map B-1

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Attachment H - Hydraulic & Water Surface Calculations. H-1

Section 1.
Certification

Declaration of Responsible Charge

I hereby declare that I a m the engineer of work for this project as defined in Section 6703 of the Business and Professions Code, and that the design is consistent with current standards.

I understand that the check of prject drawing and specifications by the County of San Diego is confined to a review only and does not relieve me, as engineer of work, of my responsibilities for project design.

REGISTERED PROFESSIONAL ENGINEER
MICHAEL BENESH
RCE 37893
CIVIL
STATE OF CALIFORNIA

1/20/14

Michael L Benesh, RCE 37893 Date

Section 2.
Discussion

Section 2.01 Purpose

The purpose of this study is to determine the existing and anticipated 10 and 100-year storm runoff and required size of hydraulic structures to protect the proposed and existing slopes and structures on the site, and to identify existing drainage problems that may be caused, or aggravated, by project development.

Section 3.
Project

Section 3.01 Description

The project is a 9.1 acre site located in the unincorporated territory of the County of San Diego, California.

The site is bordered by an Open Space Lot to the north and west and the City of San Diego/County of San Diego boundary to the south. The site is adjacent to single family homes on the east, and multi-family residential to the south. There is also a 60 foot easement for the San Diego County Water Authority adjoining the project site along the southerly boundary.

The site includes approximately 0.7 acres of property that is located within a flowage easement and an open space easement along the northwesterly portion of the site as dedicated on Map No. 13985. These areas can not be developed and will be left in a "natural" state. These easements will limit the developable area of the site to 8.4 acres.

The proposed project will consist of the construction of a church on the site with a 1,500 seat main sanctuary. The main church building will include a 25,000 square foot santuary with ancillary fellowship halls. Classrooms and recreation areas will be located in four detached smaller structures of about 10,000 square feet each. The project will also include the construction of a parking lot to accommodate roughly 417 vehicles with overflow. There will also be outdoor patios, and walkways between

the buildings as well as londscaped areas around the preimeter of the parking lot, in islands within the parking lot and between the buildings.

A 300 foot long offsite access road will be built to serve the project connecting it to Four Gee Road. This access road will be located in approximately the same location as the existing driveway to the property. The construction of the access road will include grading and A.C. paving as well as the installation of some public utilities.

A detailed vicinity map is included in **Attachment A**.

Section 3.02 Topography and Land Use

The site contains a main residence with an attached garage, a second residence and a detached storage structure. The majority of the site is being used for agricultural purposes. At the time this report was prepared, the site was being used to cultivate strawberries. With the possible exception of the main residence, the existing structures will be demolished as part of the development. The main residence may be moved off-site or relocated on-site for the development.

Running northerly of the site within the open space easement is a natural drainage channel or wash. The wash also crosses onto the property near its northwest corner.

The surface of the land includes a small ridge or knoll on which the existing residences are located. The ridge runs from approximately the center of the site to the southeast. The portion of the site northerly and northeasterly of the ridge, Sub Area A-3 on the Existing Condition Hydrology Map in Attachment B, slopes generally northerly towards the open space lot and the natural drainage channel. The portion of the site westerly of the ridge slopes both to the northwest and southwest. Sub Area A-4 on the Existing Condition Hydrology Map in Attachment B slopes towards the open space lot, and the natural drainage channel. Sub Area A-5 on the Existing Condition Hydrology Map in Attachment B slopes to the southwest towards the existing driveway, then down the driveway to the west and northerly into the open space area and to the wash.

After development, the storm water runoff from the site will be directed by surface flow to the wash, essentially as it does now, then to the San Dieguito River and then the Pacific Ocean.

Section 3.03 Off-Site Drainage

The residential development to the south of the project, Map No. 14699, is located within the City of San Diego. When the residences were developed, the drainage from a 2.7 acre portion of the site that includes 4 residences, a portion of the northwesterly parking lot and the surrounding landscaping is directed by surface flow to the north to the SDCWA easement(Sub Area A-41 on Attachment B-1). The remainder of the property on Map No. 14699 is drained to the natural drainage channel southerly of the residential development via a storm drain system. This runoff from the SDCWA easement eventually flows across and under the existing driveway to the project and flows northerly into the open space area and to the creek. There is an existing 18 inch PVC pipe culvert under the existing driveway. The invert for the pipe, and the low spot for the SDCWA easement is at elevation 488.2±. The existing drainage channel or path that leads from the culvert outlet to the rip-rap for the cuvlert under Four Gee Road is fairly flat but does appear to have positive drainage. Thus, any significant runoff "ponding" on the SDCWA easement would flow both through the pipe culvert and over the low spot in the driveway, through this channel and to the existing creek north of the project. This runoff will be included in this report in order to properly size the culvert required under the proposed access road, Grace Way. The existing runoff from the southwest portion of the site currently drains down along the driveway to the existing channel along Four Gee Road and is included in Area A-42 on Attachment B-1. After development, this area of the site will drain via a storm drain system that connects to the headwall at the outlet of the proposed culvert after development.

To the east of the project site is Map No. 14747. There is also a small triangle of land that has been developed with a sherif's sub-station. The storm runoff from the sherif's substation, Sub Area A-1 on on the Existing Condition Hydrology Map in Attachment B-1, is conveyed via a drain pipe to a location southeasterly of the site. From this outlet, the runoff flows through a landscaped lot on Map No. 14747, Sub Area A-2 on the Existing Condition Hydrology Map in Attachment B-1, along the easterly line of the project property, in an earthen swale to a point northeasterly of the project. This storm runoff do not enter the site, but the amount of the flows are calculated in this report because it includes the runoff from a small tributary area along the east edge of the site.

Section 4. Methodology

Section 4.01 Rational Method

The Rational Method as described in the San Diego County Hydrology Manual, Section 3, (Revised June 2003) shall be used to determine storm runoff.

The Rational Method formula is expressed as follows:

$$Q = C\ I\ A$$

Where:

Q = peak discharge, in cubic feet per second (cfs)

C = runoff coefficient, proportion of the rainfall that runs off the surface.

The coefficient C has no units and is based on the soil group and the development type for the drainage sub-area. **Attachment F** includes calculations for the runoff coefficient for each drainage sub-area.

I = average rainfall intensity for a duration equal to the Tc for the area, (in/Hr.)

A = drainage area contributing to the design location, in acres

The following values are used in the calculations:

Soil Group D from San Diego County Soils Group Map.	See **Attachment C**.
C (Coefficient of Runoff) from Table 3-1.	See **Attachment D**.
100 year 6 Hr. Rainfall = 2.9"	See **Attachment E**.
100 year 24 Hr. Rainfall =4.9"	" " "

The site is first divided into drainage sub-areas. See the On-Site Hydrology Maps in **Attachment B.** The time of concentration, Tc, for each sub-area along the drainage path is computed based on the initial time of concentration for the initial area and the travel time to reach each succeeding node. Based on the time of concentration,

the rainfall intensity is determined using Figure 3-2 (See **Attachment D**). Then applying the rational method equation, the peak runoff is determined at each node along the drainage path. Q's are tabulated for each sub-area along the drainage path.

The travel time between each concentration point along the natural channel is determined using Figure 3-4: Time of Concentration or Travel Time for Natural Channels from the San Diego County Hydrology Manual (See **Attachment D**).

The rational method calculations are in **Attachment G**.

Section 5. Summary

Section 5.01 Post Construction Storm Runoff Impacts

The proposed project will substantially alter the drainage patterns on the site, but will not alter the off-site or the surrounding area drainage patterns. The Storm water discharge points after development will not divert runoff from existing conditions. The potential polutants generated by the additional impervious areas will be mitigated by directing the flows through bioretention BMPs prior to draining onto the existing natural drainage areas. These bioretention BMPs will be sized to both treat the storm runoff from the site and provide flow control per the County of San Diego Hydromodification Management Plan and therefore the project will not increase the rate or amount of surface runoff in a manner which would result in flooding on- or off-site.

The proposed project will not alter the course of a stream or river, in a manner which would result in erosion or siltation either on-site or off-site. The only on-site stream is located in the northwest portion of the site within the existing open-space easement and will not be modified by the development.

The proposed project will not create or contribute runoff water which would exceed the capacity of existing or planned storm water drainage systems. The potential increases in runoff flows flow from the site will be mitigated by the inclusion of hydromodification BMPs in the site drainage system.

The project will not place housing within a 100-year flood hazard area as mapped on a federal Flood Hazard Boundary or Flood Insurance Rate Map or County Floodplain Maps as the project is not a residential development and the portion of the site to be developed is not within a floodplain.

5.01.1 Storm Runoff Entering the Site

The project is not subject to storm run-on. The existing drainage pattern keeps water from the south and east from entering the property. The runoff from the development to the south passes under the existing driveway to the site and through the open space lot adjoining Four Gee Road. The runoff from the east runs along the easterly

property line of the project to a point north of the project where it enters the open space lot.

These areas are included in the drainage study as described in Section 3.03 and are part of the "drainage basin" in which this project is located.

5.01.2 Storm Runoff

Much of the parking lot will be constructed of pourous pavement or DG to reduce the total amount of impervious area created. The on-site walkways and patios will also be constructed of interlocking pavers to further limit the amount of impervious area. There will still be an increase to the amount of impervious area prredominantly due to the construction of the church buildings, impervious areas in the parking lot and the construction of Grace Way. This increase in impervious area will cause an increase the storm runoff from the project drainage area.

Prior to development the impervious area on the site is approximately 0.84 acres of the 9.1 acre site, or 9 percent of the site area. After the site is developed, the impervious area will increase to 3.7 acres, or 41 percent of the site area.

A comparison of pre- and post-construction runoff for the site drainage basin is included in Table 5.2 below.

Table 5.2 – Comparison of Q100

Node	Pre-Const. Area (Ac.)	Pre-Const. Runoff, Q100(CFS) (A)	Pre-Const. Runoff Velocity, V100(FPS) (4)	Post Const. Runoff, Q100(CFS) (3) (B)	Post-Const. Area (Ac.)	Post-Const. Runoff Velocity, V100(FPS)	Net Change (1)
A	4.3	7.6	2±	7.6	4.3	2±	0%
B	6.6	12.3	2±	13.1	6.2	4.2(5)	+6.5%
C	0.7	1.5	2±	1.6	0.8	2.0(6)	+6.7%
D	4.4	9.4	2±	10.6	4.6	2.0	+12.8%

(1) 100*(B-A)/A

(3) Does not take into account effect of Bio Retention Areas on peak flow.

(4)Pre-Construction runoff from site is through natural overland drainage channels. Two fett per second is assumed based on the calculations for the channel along Four Gee Road.
(5)Based on a 24" SD flowing full.
(6)Based on a 12" SD flowing full.

5.01.3 Mitigation of Increased Flows.

The total runoff flow contrubuted to the existing creek from the site in a 100 year storm event, after calculations for confluencing at the culvert under Four Gee Road, is shown in table 5.3 below.

Table 5.3 – Comparison of Total Flows

Pre-Construction Runoff, Q100(CFS) (1)	Post Construction Runoff, Q100(CFS) (1)	Incrrease in Site Runoff Q100(CFS)
21.7	23.8	2.1

(1)Attachment G Rational Method Calculations & based on assumption of 2 fps flow in the creek.

The 2.1 cfs increase is a 9.7 percent increase over the existing 100 year storm runoff for the site. The anticipated 100 year flow at the culvert under Four Gee Road is 1900 cfs as per the improvement plans for Tract No. 5070-2, which built the existing 48 foot wide by 5 foot high concrete box culvert (6 barrelled, 5' x 8' rectangular channel). The 2.1 cfs increase is one tenth of one percent (0.1%) of the expected culvert flow. The effect of this increase will have an immeasurably small affect of the water surface and velocity of the flows in the creek upstream and downstream of the culvert. Therefore, the development of the site will have a less than significant impact on the properties upstream and downstream of the development.

The site will also incorporate a number of bio-retention basins scattered throughout he development. These basins will be designed to address both water quality and flow control issues per the County of San Diego Hydromodification Management Plan. The San Diego Hydromodification Management Plan requires the project to implement hydromodification mitigation measures so that post-project runoff flow rates and durations do not exceed pre-project flow rates and durations.

5.01.4 Preservation of Natural Drainage Areas

All impervious areas created on site will drain into pervious areas prior to entering the wash northerly of the site, and natural drainage areas on site will be preserved to the maximum extent practical, while allowing for the development of the site.

5.01.5 100 Year Flood Innundation Limits near Four Gee Road

Plans approved by the County in 1998 for Tract No. 5070-2 included the construction of Four Gee Road and the existing concrete box culvert under Four Gee Road. It is assumed the county required hydraulic computations and a HEC-2 computer analysis or equivalent to establish the effect on the lines of innundation as these improvements are directly in the flood plain for the creek that crosses northerly of this site. The plans were prepared by RBF Engineering and approved by the County in October 1998 and indicate that the flood elevation at the culvert for the 100 year storm event is at 486.41 feet in the profile. The plan view indicates that the limits of the area subject to inundation near Four Gee Road is between contours with elevations of 486 and 488. This would place the area subject to innundation at between 75 and 100 feet north of the location of the proposed grading for Grace Way.

The flowage easement shown on Map No. 13985, County of San Diego Tract No. 5123-1, which recorded in June 2000, on sheet 8 indicates the location area subject to innundation per the 100 year flood extends all the way to southerly boundaries of the open space lot, Lot 1. This includes the area of the existing driveway and the existing 40 foot road easement. This same easement was also granted on Parcel Map 18105 in 1998.

It is apparent that the area subject to innundation by the 100 year flood on Map No. 13985 is shown the same as it is on Parcel Map 18105, which recorded in September 1998, prior to the plans for Four Gee Road by RBF being approved. It is not clear where this "approximate area subject to inundation by a 100 year flood" originated, but it is clear it predated the work by RBF for Tract No. 5070-2 and the design of the culver under Four Gee Road. This area exactly matches the flowage easement shown on both Map No. 13985 and Parcel Map 18105. When ploted, the flowage easement includes areas adjacent to Four Gee Road, in close proximity to the existing culvert, that are at an elevation of 495+. This is over 5 feet higher than the elevation of Four Gee Road as it crosses over the top of the existing culvert. (We have surveyed the road elevation and determined to be at elevation 489.6. The improvement plans indicate a design elevation of 490.6 in the same location.) In fact, at the point where the flowage easement enters the site near its northeast corner, the existing ground elevation is 489. The existing ground elevations along the easement line vary between 489 and 491 as one moves westerly along the line until the angle point just east of the westerly property line, then the ground elevation along the flowage easement line climbs up to 494 at the property line to the west, a direction that should be downstream, eventually topping out at over elevation 495,

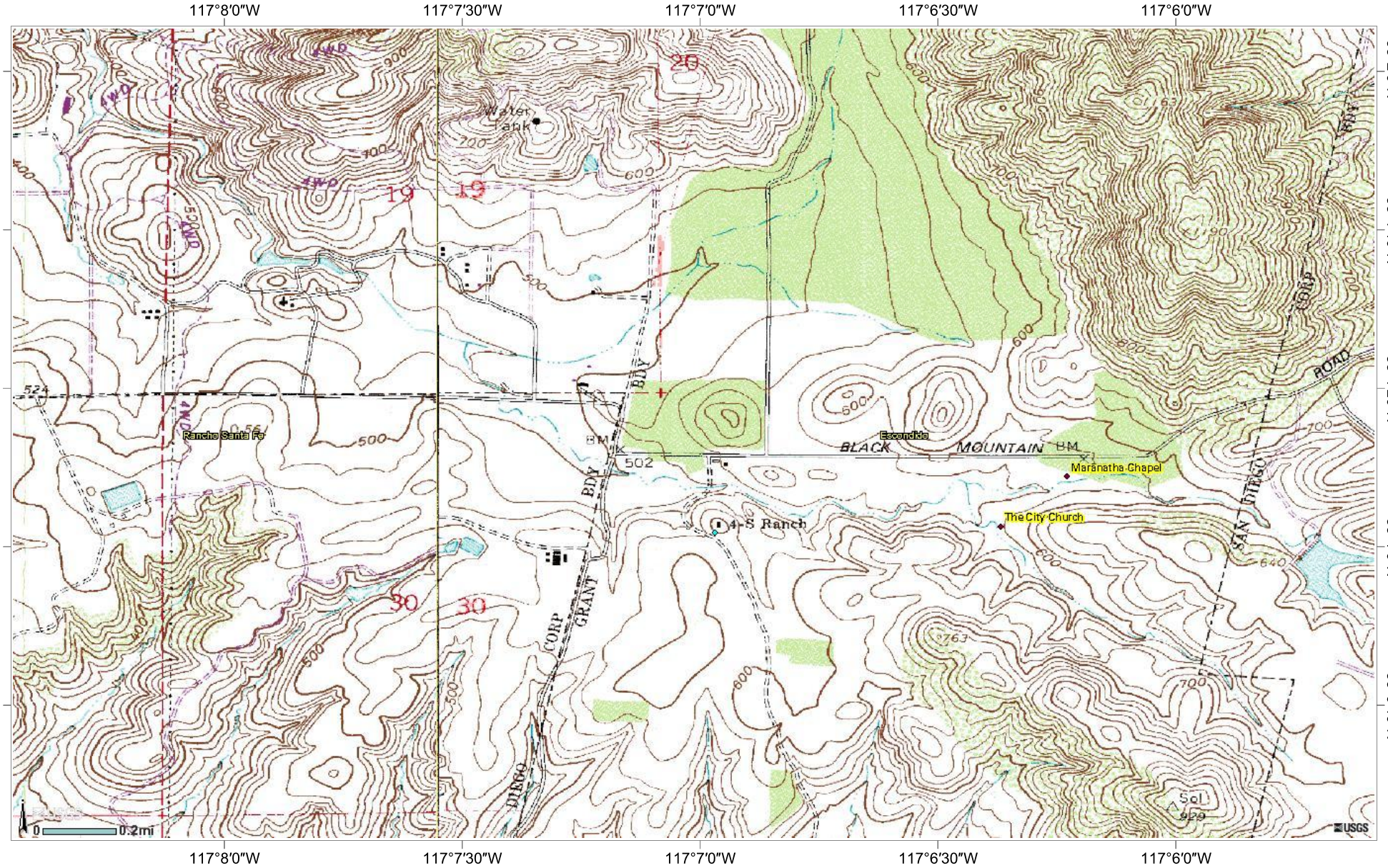
before droppping back down to elevation 492.5 near the southeast corner of the open space lot. The ground elevations continue to drop as one moves weterly along the south line of the open space lot to an elevation of 488.5. It is just not believable that the water surface of the 100 year flood will look anything like this.

It is not plausible that the county approved the plans for Four Gee Road and the culvert under it without hydraulic calculations to determine the effect of the culvert on the flood plain and the water surface elevation during a 100 year storm. It is clear these calculations were performed based on the information shown on the RBF improvement plans, and based on that information, it is also evident that the construction of Grace Way will not be anywhere within the area of innundation of a 100 year storm.

Thus, while the proposed grading is within the existing flowage easement, it is not within the area of inundation by a 100-year flood. Sheet 14 of 14 of the Improvement Plans for Tract No. 5070-2 are included in Attachment H in the back of this report. The area of innundation based on the water surface elevation within the open space easement between the site and Four Gee Road as shown on the RBF plans is indicated on the Hydrology Map, Attachment B-1. It is clear from the proposed plans that the grading for Grace Way is not within or close to this area of innundation. As part of this development a portion of the flowage easement, the southerly 142.90 feet of the easement within Lot 1 of Map No. 13985, will be abandoned.

Attachment A - Vicinity Map

See portion of U.S.G.S. Bonsall Quadrangle on following sheet.



USGS
science for a changing world

33°2′6″N
117°8′27″W Map Extent 117°5′35″W
33°0′24″N

The National Map
http://nationalmap.gov/

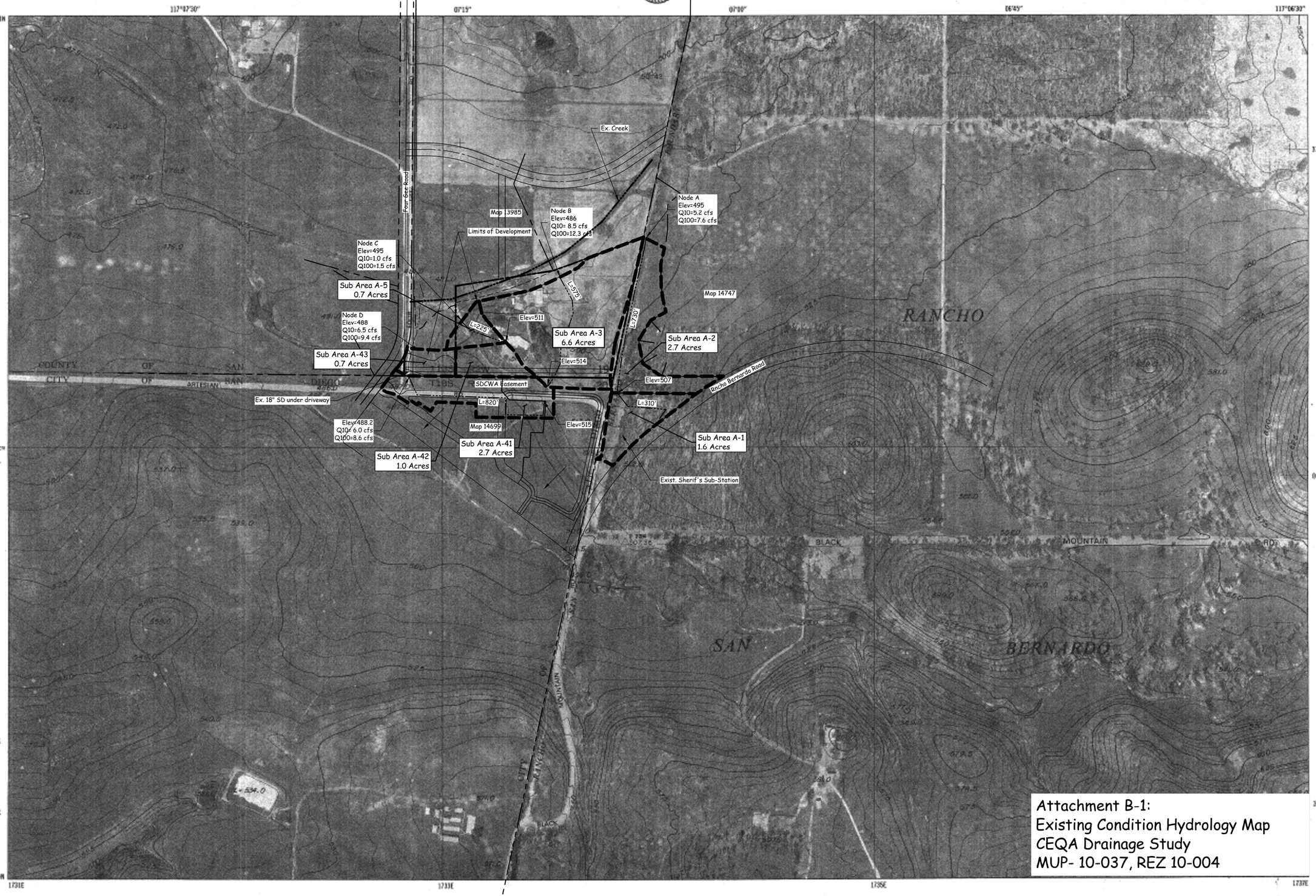
Geographic Coordinate System (WGS84)

Attachment B - Hydrology Map

Attachment B-1: Existing Condition Hydrology Map
Full size 1"=200' scale map is included in folder at back of report.

Attachment B-2: Proposed Condition Hydrology Map.
The full size map is included in folder at back of report.

COUNTY OF SAN DIEGO — TOPOGRAPHIC SURVEY



Attachment B-1:
Existing Condition Hydrology Map
CEQA Drainage Study
MUP- 10-037, REZ 10-004

-LEGEND-

- Horizontal Control Monument — Third Order; Vertical Control Monument — Second Order or Better
- Horizontal Control Monument — Second Order or Better; Vertical Control Monument — Third Order
- Horizontal Control Monument — Second Order or Better
- Horizontal Control Monument & Bench Mark — Second Order or Better
- Horizontal Control Monument — Third Order
- Horizontal Control Monument & Bench Mark — Third Order
- Bench Mark — Second Order or Better
- Vertical Control Monument — Third Order
- Property Corner Found & Coordinated (California Coordinate System, Zone 6)
- Found Section, Grant or Subdivision Corner
- Photograph, Ruler Point
- Geographic Tick

BOUNDARIES IN ORDER OF PRECEDENCE
(Land Lines Shown are Approximate)

- .025" National
- Name .025" Name — County
- .019" City
- Name within Dairy .033" — Reservation
- Name within Dairy .016" — National, State or County Park
- Name within Dairy .016" — Land Grant
- T.2S R.3W T.3S R.3W .012" — Township, Range or Section

PREPARED UNDER THE DIRECTION
of
DEPARTMENT OF PUBLIC WORKS
County of San Diego

CONTROL DATA FURNISHED
by
SURVEY SECTION
Department of Public Works

HORIZONTAL CONTROL BASED
on
NORTH AMERICAN 1927 DATUM

VERTICAL CONTROL BASED
on
U.S.C. & G.S. 1929 SEA LEVEL DATUM

ORTHOPHOTO IMAGE PREPARED
from
PHOTOGRAPHY DATED: APRIL 19, 1982
by
SAN-LO AERIAL SURVEYS, INC.

TOPOGRAPHY COMPILED
by
PHOTOGRAMMETRIC METHODS
from
PHOTOGRAPHY DATED: APRIL 19, 1982
by
SAN-LO AERIAL SURVEYS, INC.

FINAL MAP PREPARED
by
MAPPING SECTION
Department of Public Works

This Map Complies with
NATIONAL MAP ACCURACY STANDARDS

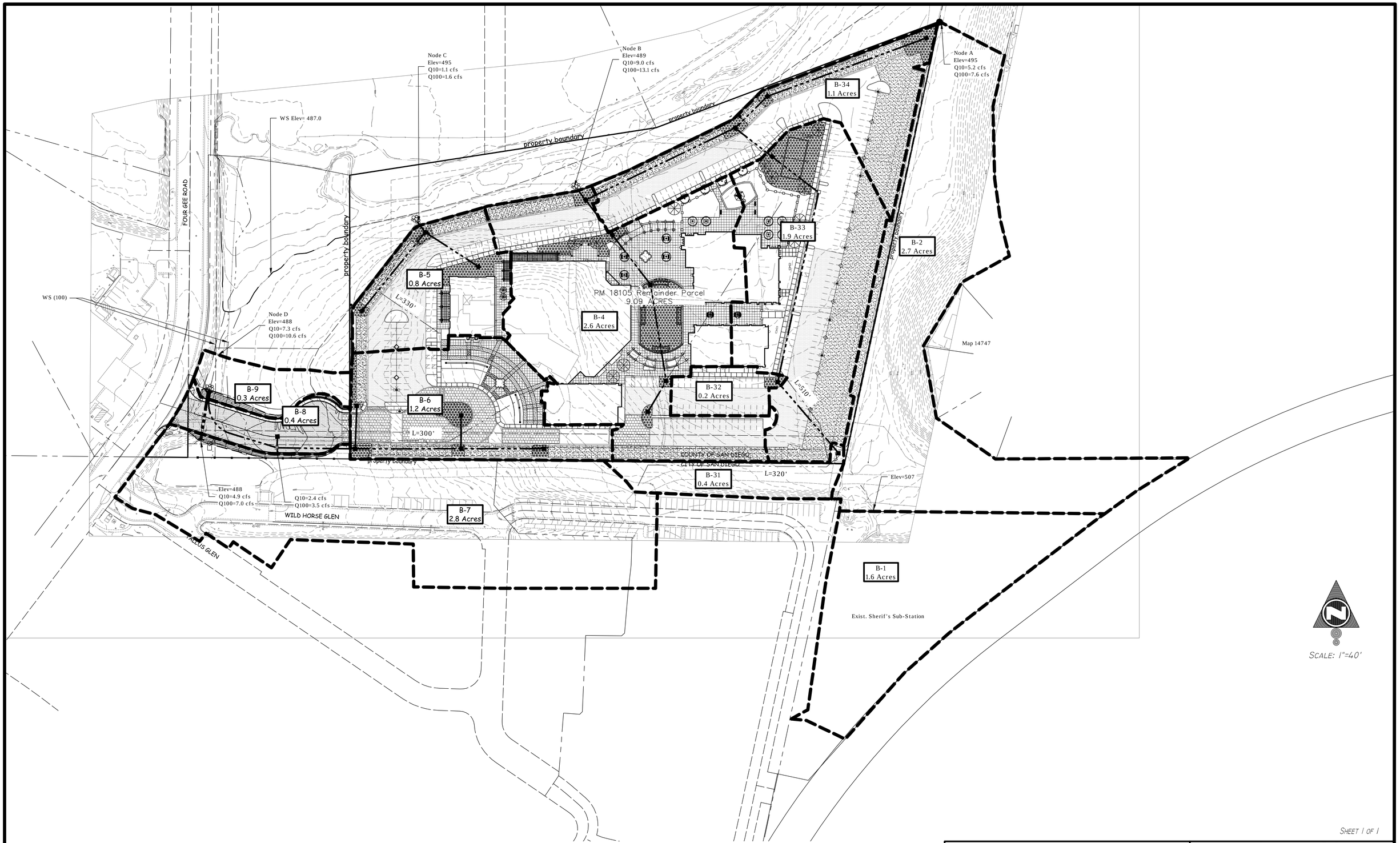
200 0 200 400 600 800 1000 (Feet)
100 0 100 200 300 (Meters)

SCALE 1: 2400 (1" = 200')
INDEX CONTOUR INTERVAL: 25 FEET
CONTOUR INTERVAL: 5 FEET
TWO THOUSAND FOOT CALIFORNIA RECTANGULAR GRID (ZONE VI)
THE LAST THREE DIGITS OF THE GRID NUMBERS ARE OMITTED
THE RECTANGULAR COORDINATE VALUES ARE SHOWN ON THE SOUTH AND WEST MARGINS
THE GEOGRAPHIC VALUES ARE SHOWN ON THE NORTH AND EAST MARGINS

INDEX TO ADJOINING SHEETS

314-1725	314-1731	314-1737
310-1725	310-1731	310-1737
306-1725	306-1731	306-1737

SAN DIEGO COUNTY
CALIFORNIA
SHEET NO. 310-1731



SHEET 1 OF 1

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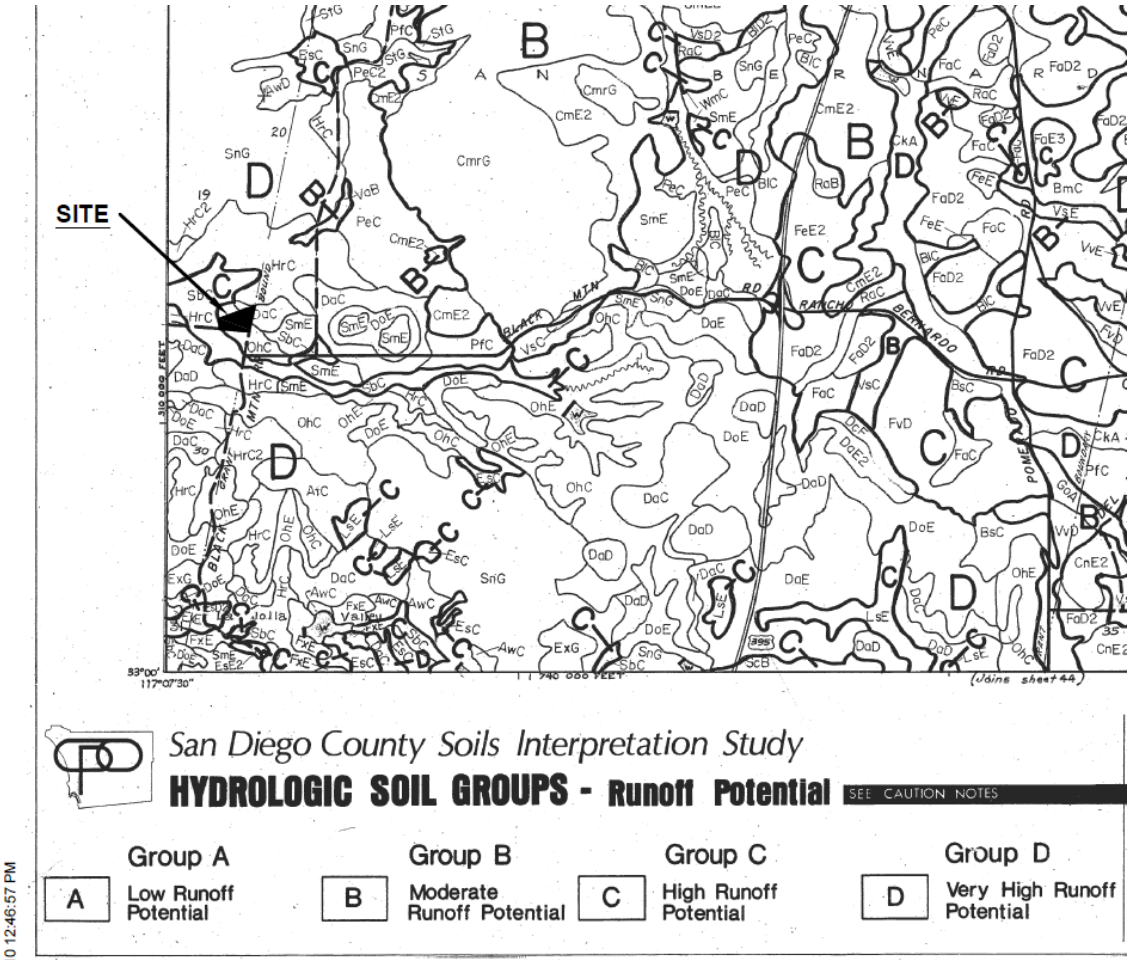
404 South Live Oak Park Road, Fallbrook, CA 92028
Phone 760 731-6603 FAX 760 897-2165
E-Mail: MBenesh@MLBEngineering.com

ATTACHMENT B-2
CEQA DRAINAGE STUDY
SANTA FE VALLEY CHINESE CHURCH
PROPOSED CONDITION HYDROLOGY MAP

Attachment C - San Diego County Soils Group Map

Soils Group Map

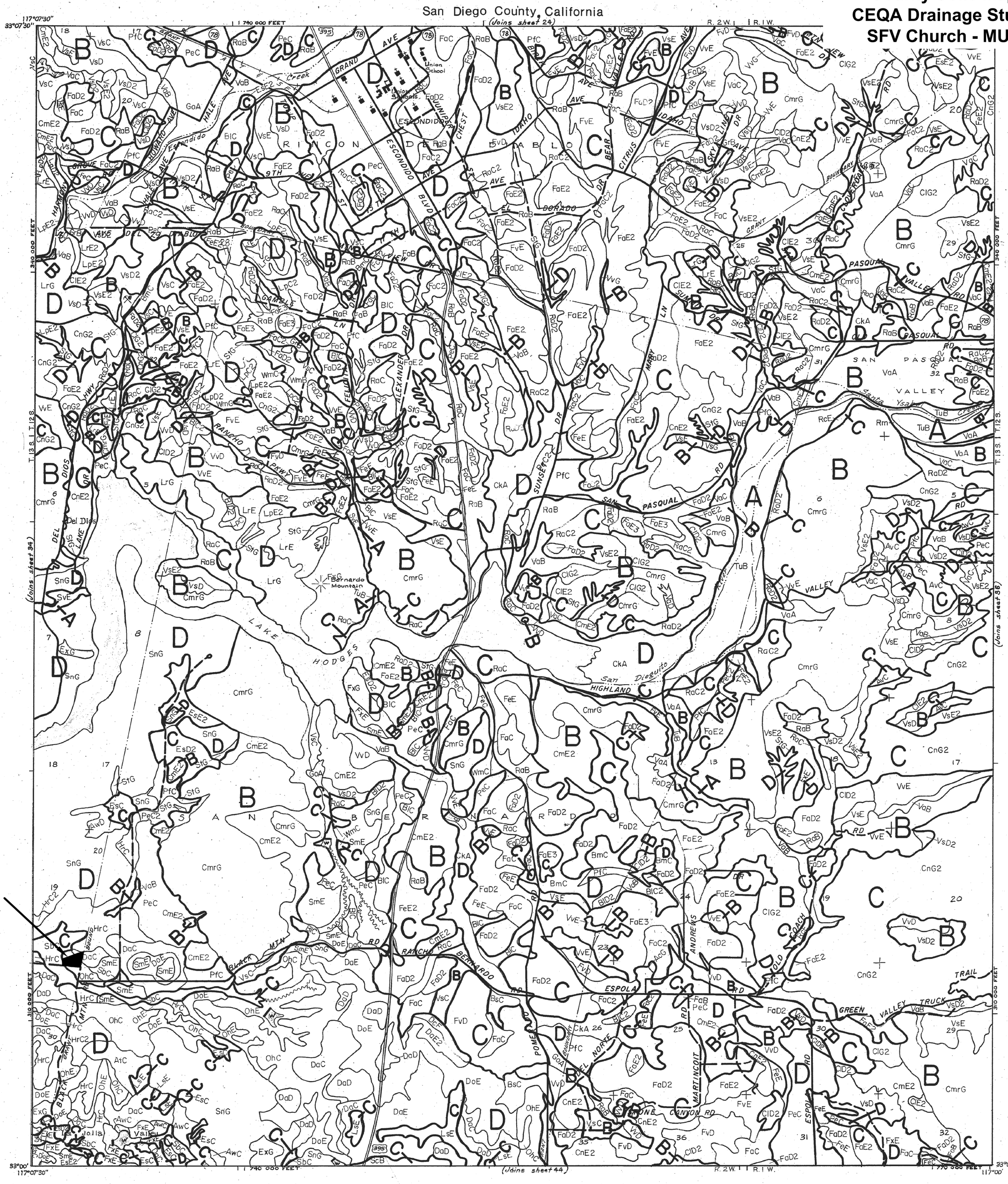
(Full size map is included in folder at back of report as Attachment C.)



Attachment C
County Soils Map
CEQA Drainage Study
SFV Church - MUP

Escondido

San Diego County, California



San Diego County Soils Interpretation Study

HYDROLOGIC SOIL GROUPS - Runoff Potential

SEE CAUTION NOTES

Group A	Group B	Group C	Group D
A — Low Runoff Potential	B — Moderate Runoff Potential	C — High Runoff Potential	D — Very High Runoff Potential

CAUTION NOTES:

1. User is urged to refer to corresponding SUPPLEMENTAL DATA SHEET for assumptions, criteria, map sources, additional legend items, and necessary explanation of ratings shown on map.

2. This map does not eliminate the need for detailed on-site investigation of the soil and site to determine precise soil conditions prior to undertaking any construction, grading, planting, or other soils related activity.

Base Map Source: U. S. Geological Survey with California State Coordinate System, Zone 6 Indicated

Prepared by: U. S. Department of Agriculture, Soil Conservation Service

Published by: San Diego County Planning Department for the Comprehensive Planning Organization — 1969

North

SCALE 1:24000

0 2000 4000 6000 feet

0 ¼ mile ½ mile 1 mile

Represents 40 acres

FEDERAL ASSISTANCE — The preparation of this map was financed in part through a comprehensive planning grant from the Department of Housing and Urban Development.

SHEET NAME	SHEET NUMBER
Escondido	35

7/19/2010 12:46:57 PM

Attachment D - San Diego County Hydrology Manual Excerpts

Table 3-1
RUNOFF COEFFICIENTS FOR URBAN AREAS

Land Use		Runoff Coefficient "C"				
			Soil Type			
NRCS Elements	County Elements	% IMPER.	A	B	C	D
Undisturbed Natural Terrain (Natural)	Permanent Open Space	0*	0.20	0.25	0.30	0.35
Low Density Residential (LDR)	Residential, 1.0 DU/A or less	10	0.27	0.32	0.36	0.41
Low Density Residential (LDR)	Residential, 2.0 DU/A or less	20	0.34	0.38	0.42	0.46
Low Density Residential (LDR)	Residential, 2.9 DU/A or less	25	0.38	0.41	0.45	0.49
Medium Density Residential (MDR)	Residential, 4.3 DU/A or less	30	0.41	0.45	0.48	0.52
Medium Density Residential (MDR)	Residential, 7.3 DU/A or less	40	0.48	0.51	0.54	0.57
Medium Density Residential (MDR)	Residential, 10.9 DU/A or less	45	0.52	0.54	0.57	0.60
Medium Density Residential (MDR)	Residential, 14.5 DU/A or less	50	0.55	0.58	0.60	0.63
High Density Residential (HDR)	Residential, 24.0 DU/A or less	65	0.66	0.67	0.69	0.71
High Density Residential (HDR)	Residential, 43.0 DU/A or less	80	0.76	0.77	0.78	0.79
Commercial/Industrial (N. Com)	Neighborhood Commercial	80	0.76	0.77	0.78	0.79
Commercial/Industrial (G. Com)	General Commercial	85	0.80	0.80	0.81	0.82
Commercial/Industrial (O.P. Com)	Office Professional/Commercial	90	0.83	0.84	0.84	0.85
Commercial/Industrial (Limited I.)	Limited Industrial	90	0.83	0.84	0.84	0.85
Commercial/Industrial (General I.)	General Industrial	95	0.87	0.87	0.87	0.87

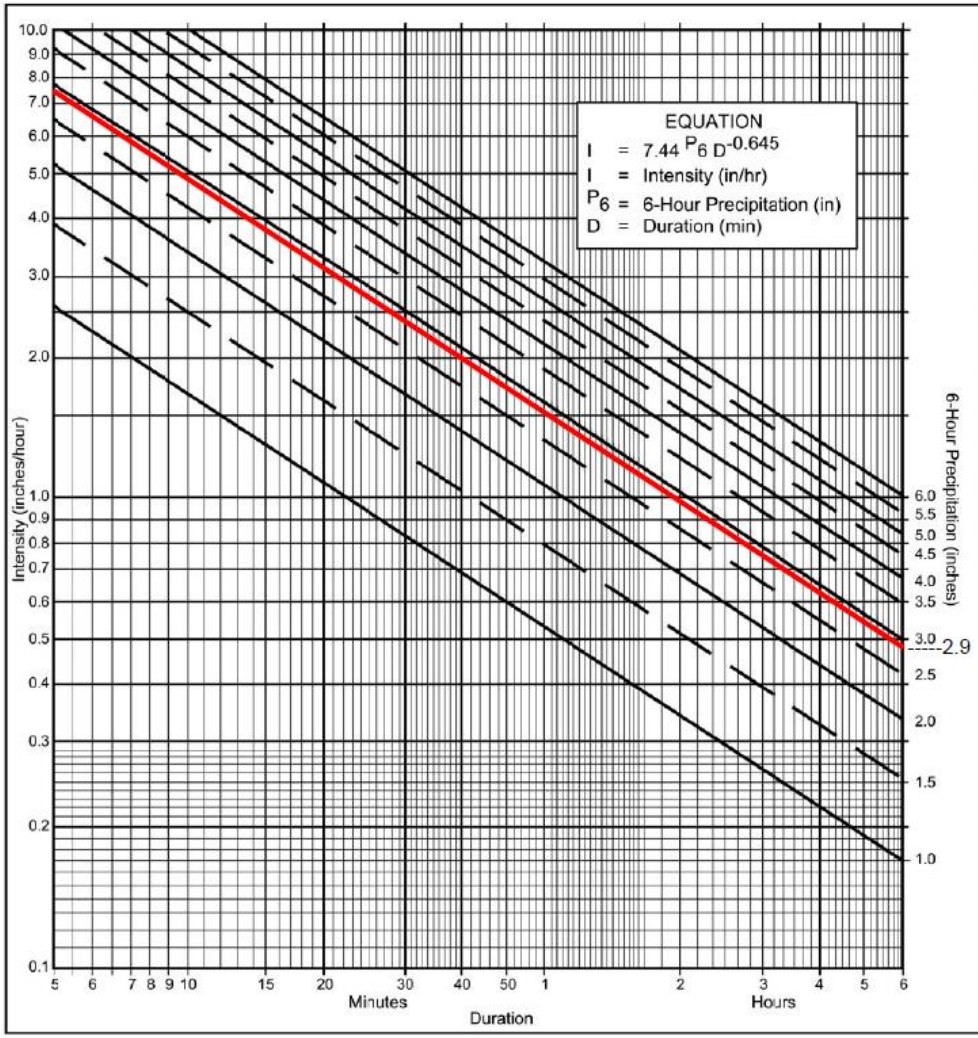
*The values associated with 0% impervious may be used for direct calculation of the runoff coefficient as described in Section 3.1.2 (representing the pervious runoff coefficient, Cp, for the soil type), or for areas that will remain undisturbed in perpetuity. Justification must be given that the area will remain natural forever (e.g., the area is located in Cleveland National Forest).
DU/A = dwelling units per acre
NRCS = National Resources Conservation Service

Table 3-2

MAXIMUM OVERLAND FLOW LENGTH (L_M) & INITIAL TIME OF CONCENTRATION (T_i)

Element*	DU/ Acre	.5%		1%		2%		3%		5%		10%	
		L_M	T_i	L_M	T_i	L_M	T_i	L_M	T_i	L_M	T_i	L_M	T_i
Natural		50	13.2	70	12.5	85	10.9	100	10.3	100	8.7	100	6.9
LDR	1	50	12.2	70	11.5	85	10.0	100	9.5	100	8.0	100	6.4
LDR	2	50	11.3	70	10.5	85	9.2	100	8.8	100	7.4	100	5.8
LDR	2.9	50	10.7	70	10.0	85	8.8	95	8.1	100	7.0	100	5.6
MDR	4.3	50	10.2	70	9.6	80	8.1	95	7.8	100	6.7	100	5.3
MDR	7.3	50	9.2	65	8.4	80	7.4	95	7.0	100	6.0	100	4.8
MDR	10.9	50	8.7	65	7.9	80	6.9	90	6.4	100	5.7	100	4.5
MDR	14.5	50	8.2	65	7.4	80	6.5	90	6.0	100	5.4	100	4.3
HDR	24	50	6.7	65	6.1	75	5.1	90	4.9	95	4.3	100	3.5
HDR	43	50	5.3	65	4.7	75	4.0	85	3.8	95	3.4	100	2.7
N. Com		50	5.3	60	4.5	75	4.0	85	3.8	95	3.4	100	2.7
G. Com		50	4.7	60	4.1	75	3.6	85	3.4	90	2.9	100	2.4
O.P./Com		50	4.2	60	3.7	70	3.1	80	2.9	90	2.6	100	2.2
Limited I.		50	4.2	60	3.7	70	3.1	80	2.9	90	2.6	100	2.2
General I.		50	3.7	60	3.2	70	2.7	80	2.6	90	2.3	100	1.9

*See Table 3-1 for more detailed description



Directions for Application:

(1) From precipitation maps determine 6 hr and 24 hr amounts for the selected frequency. These maps are included in the County Hydrology Manual (10, 50, and 100 yr maps included in the Design and Procedure Manual).

(2) Adjust 6 hr precipitation (if necessary) so that it is within the range of 45% to 65% of the 24 hr precipitation (not applicaple to Desert).

(3) Plot 6 hr precipitation on the right side of the chart.

(4) Draw a line through the point parallel to the plotted lines.

(5) This line is the intensity-duration curve for the location being analyzed.

Application Form:

(a) Selected frequency 100 year

(b) P_6 = 2.9 in., P_{24} = 4.9 , $\frac{P_6}{P_{24}}$ = 59 %(2)

(c) Adjusted P_6(2) = 2.9 in.

(d) t_x = _____ min.

(e) I = _____ in./hr.

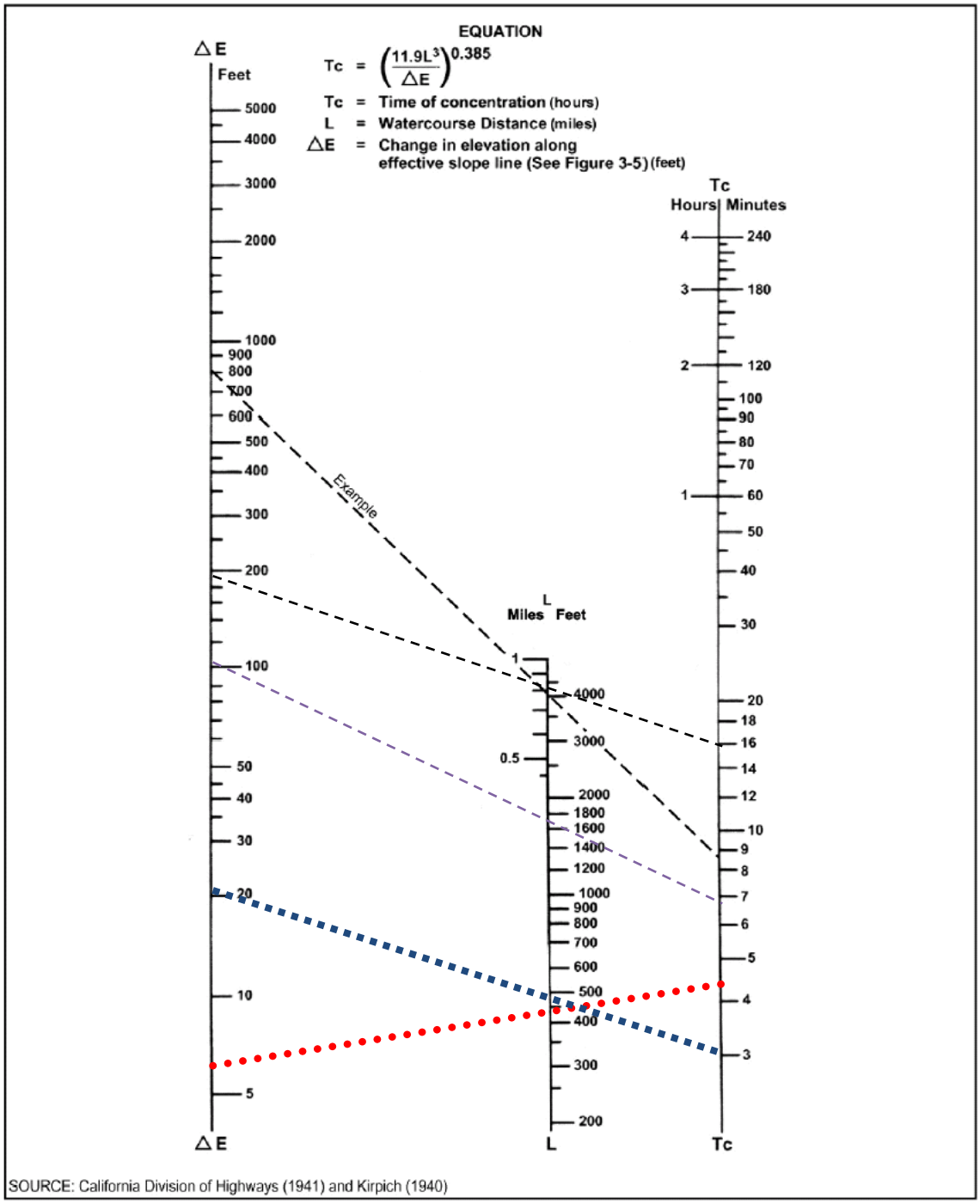
Note: This chart replaces the Intensity-Duration-Frequency curves used since 1965.

P6	1	1.5	2	2.5	3	3.5	4	4.5	5	5.5	6
Duration	I	I	I	I	I	I	I	I	I	I	I
5	2.63	3.95	5.27	6.59	7.90	9.22	10.54	11.86	13.17	14.49	15.81
7	2.12	3.18	4.24	5.30	6.36	7.42	8.48	9.54	10.60	11.66	12.72
10	1.68	2.53	3.37	4.21	5.05	5.90	6.74	7.58	8.42	9.27	10.11
15	1.30	1.95	2.59	3.24	3.89	4.54	5.19	5.84	6.49	7.13	7.78
20	1.08	1.62	2.15	2.69	3.23	3.77	4.31	4.85	5.39	5.93	6.46
25	0.93	1.40	1.87	2.33	2.80	3.27	3.73	4.20	4.67	5.13	5.60
30	0.83	1.24	1.66	2.07	2.49	2.90	3.32	3.73	4.15	4.56	4.98
40	0.69	1.03	1.38	1.72	2.07	2.41	2.76	3.10	3.45	3.79	4.13
50	0.60	0.90	1.19	1.49	1.79	2.09	2.39	2.69	2.98	3.28	3.58
60	0.53	0.80	1.06	1.33	1.59	1.86	2.12	2.39	2.65	2.92	3.18
90	0.41	0.61	0.82	1.02	1.23	1.43	1.63	1.84	2.04	2.25	2.45
120	0.34	0.51	0.68	0.85	1.02	1.19	1.36	1.53	1.70	1.87	2.04
150	0.29	0.44	0.59	0.73	0.88	1.03	1.18	1.32	1.47	1.62	1.76
180	0.26	0.39	0.52	0.65	0.78	0.91	1.04	1.18	1.31	1.44	1.57
240	0.22	0.33	0.43	0.54	0.65	0.76	0.87	0.98	1.08	1.19	1.30
300	0.19	0.28	0.38	0.47	0.56	0.66	0.75	0.85	0.94	1.03	1.13
360	0.17	0.25	0.33	0.42	0.50	0.58	0.67	0.75	0.84	0.92	1.00

FIGURE

3-1

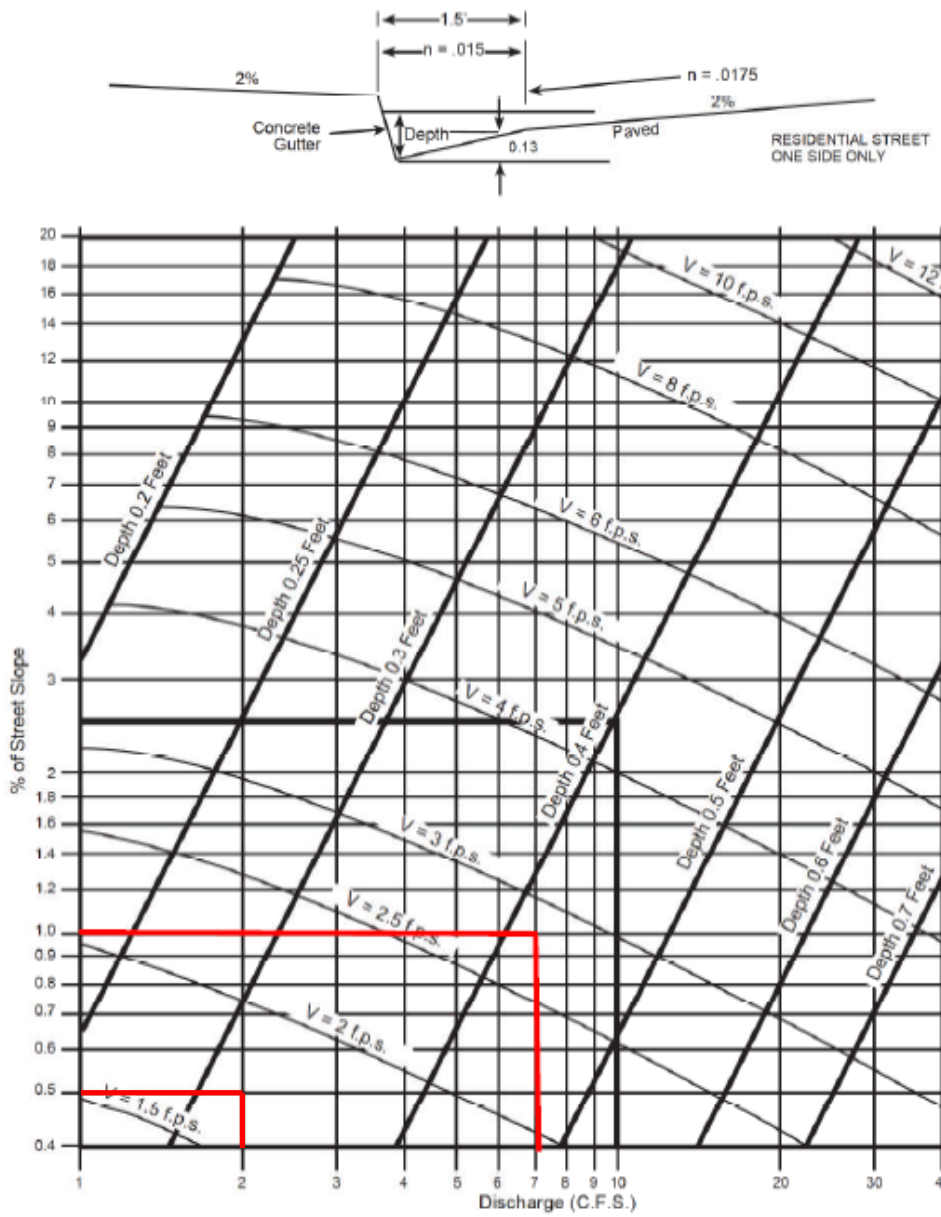
Intensity-Duration Design Chart - Template



FIGURE

3-4

Nomograph for Determination of
Time of Concentration (Tc) or Travel Time (Tt) for Natural Watersheds

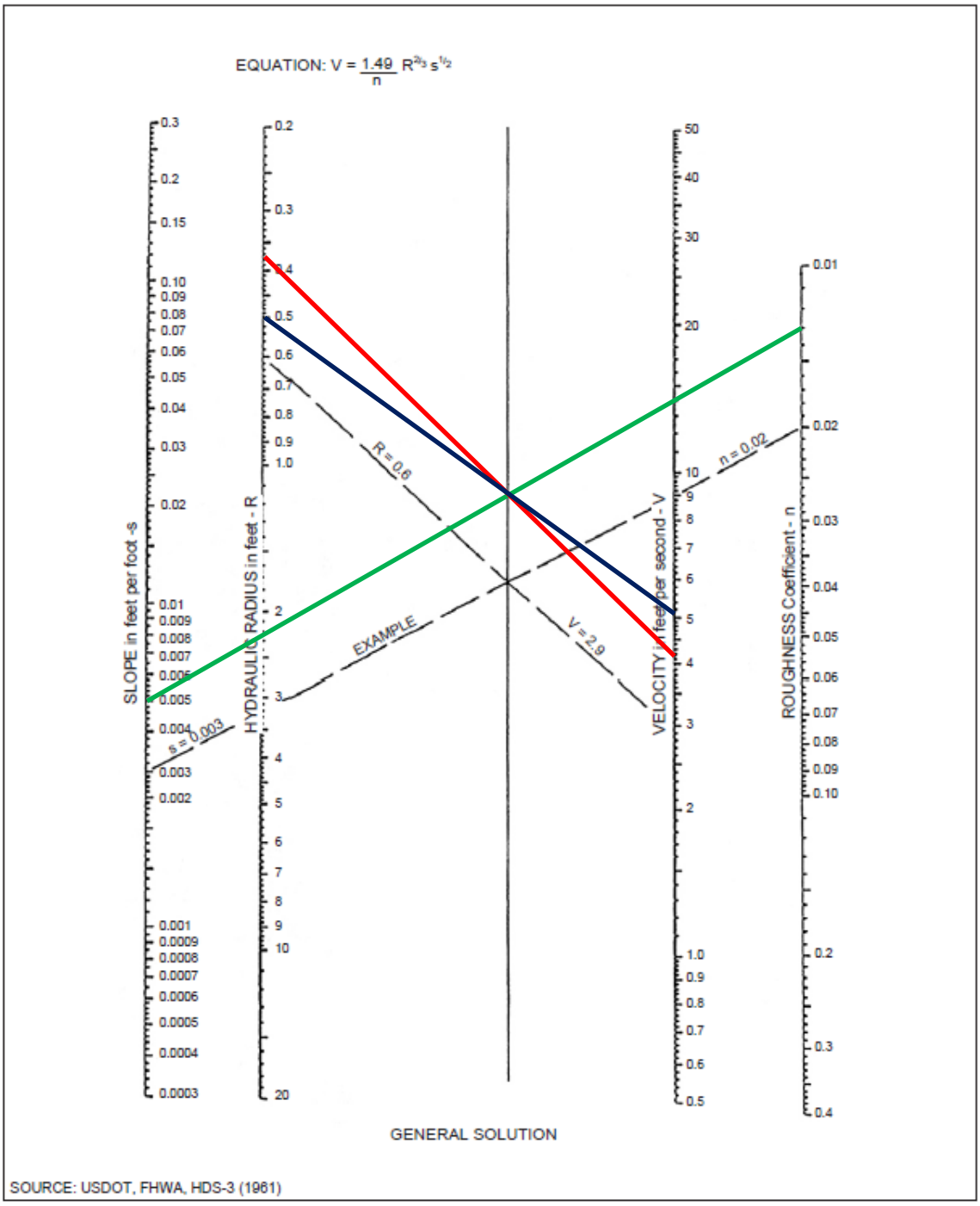


EXAMPLE:
Given: Q = 10 S = 2.5%
Chart gives: Depth = 0.4, Velocity = 4.4 f.p.s.

SOURCE: San Diego County Department of Special District Services Design Manual

Gutter and Roadway Discharge - Velocity Chart

FIGURE **3-6**



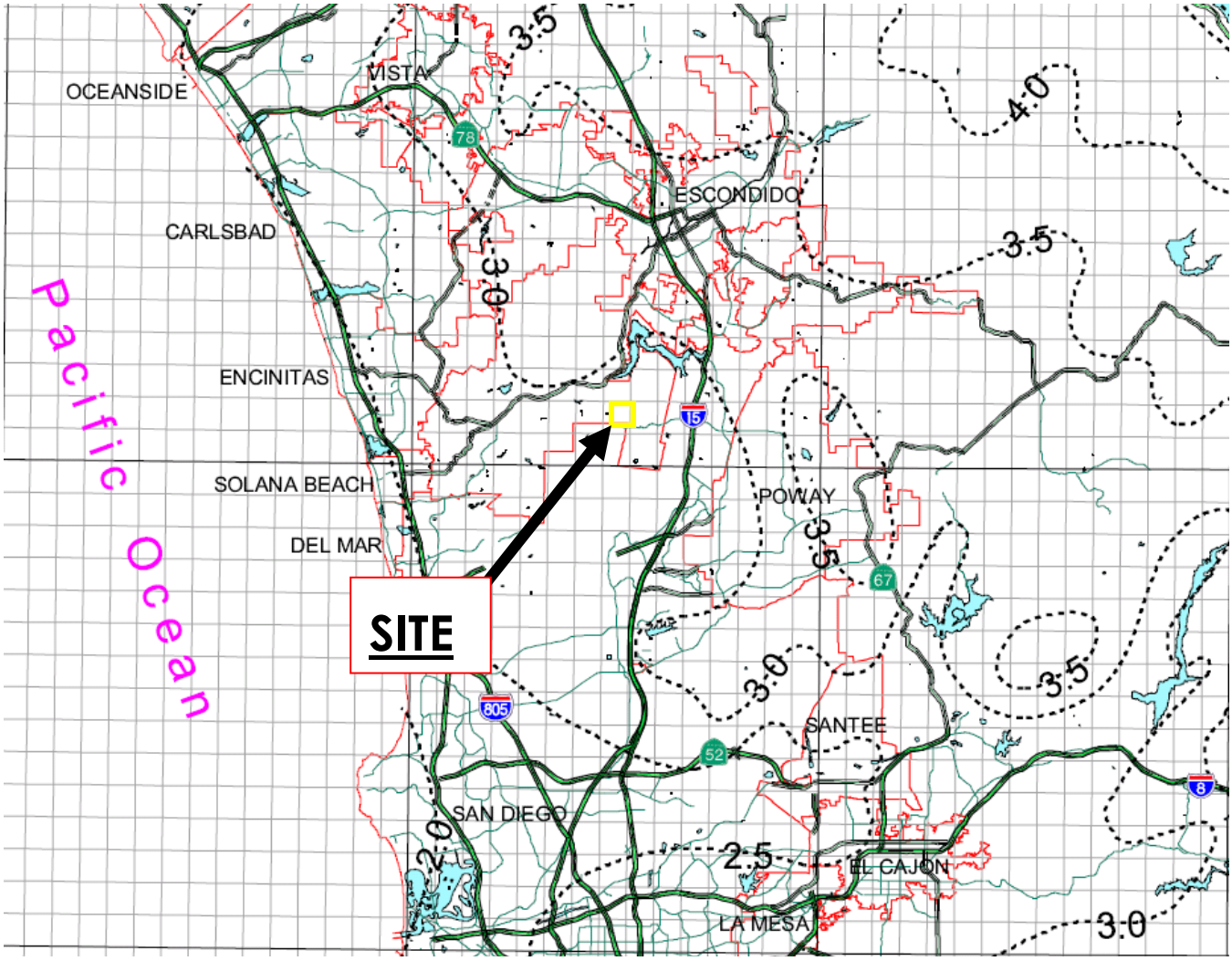
SOURCE: USDOT, FHWA, HDS-3 (1961)

Manning's Equation Nomograph

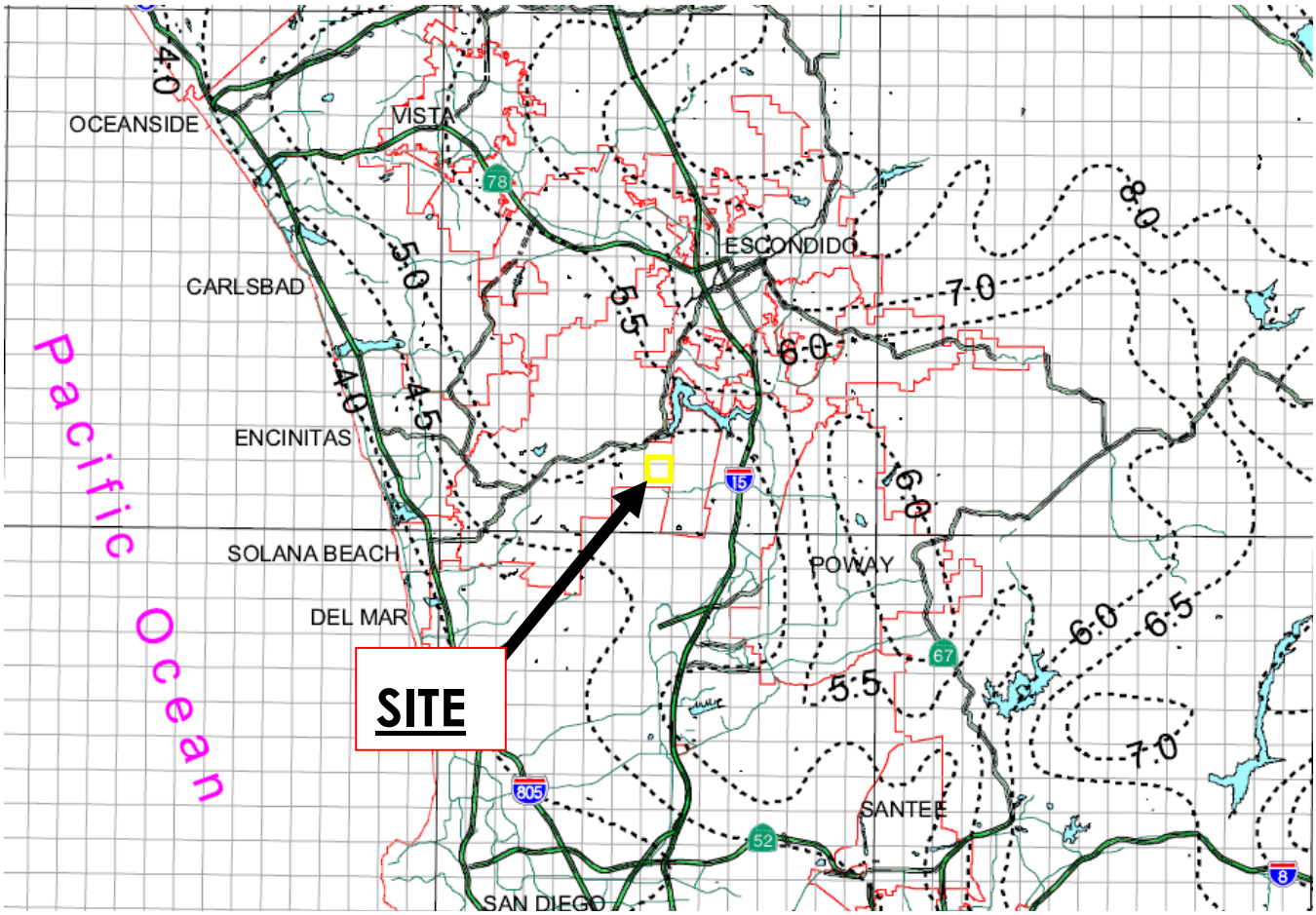
F I G U R E

3-7

Attachment E - San Diego County Point Rainfall Maps



100 Year – 6 Hour Rainfall



100 Year – 24 Hour Rainfall

Attachment F - TC Calculations

Existing Condition

Tc, Initial Area A-1

Total Area = 1.6 Acres
% Imp = 50% Use MDR 14.5 DU/A
L=310'
Initial Slope 1%
Ti=7.4 Min., Lm=65' Table 3-2
Given: Curb Slope = 0.5%, Qavg=2.5 cfs
V = 1.8 fps Fig. 3-6
Tt= (320 – 65)/(1.8 x 60) = 2.4 min.
Tc=7.4 + 2.4 = 9.8 min.

Tc, Initial Area A-3

Total Area = 6.6 Acres
% Imp = 5% Use LDR 1.0 DU/A
L=575'
Initial Slope 5%
Ti=8.0 Min., Lm=100' Table 3-2
Tt= 3.0 min. Fig. 3-4, L=475', H=21'
Tc=8.0 + 3.0 = 11.0 min.

Tc, Initial Area A-41

Total Area = 2.7 Acres, 1.1 Acres Imp.
% Imp = 40% Use MDR 7.3 DU/A
L=820'
Initial Slope 1%
Ti=8.4 Min., Lm=65' Table 3-2
Given: Curb Slope = 3%, Qavg=3.5 cfs
V = 3.9 fps Fig. 3-6
Tt= (820 – 65)/(3.8 x 60) = 3.2 min.
Tc=8.4 + 3.2 = 11.6 min.

Tc, Initial Area A-5

Total Area = 0.7 Acres
% Imp = 5% Use LDR 1.0 DU/A
L=225'
Initial Slope 5%
Ti=8.0 Min., Lm=100' Table 3-2
Tt= 0.8 min. Fig. 3-4, L=125', H=11'
Tc=8.0 + 0.8 = 8.8 min.

Proposed Condition

Tc, Initial Area B-1

Total Area = 1.6 Acres
% Imp = 50% Use MDR 14.5 DU/A
L=310'
Initial Slope 1%
Ti=7.4 Min., Lm=65' Table 3-2
Given: Curb Slope = 0.5%, Qavg=2.5 cfs
V = 1.8 fps Fig. 3-6
Tt= (320 – 65)/(1.8 x 60) = 2.4 min.
Tc=7.4 + 2.4 = 9.8 min.

Tc, Initial Area B-33

Total Area = 1.9 Acres, , 0.6 Acres Imp.
% Imp = 30% Use MDR 4.3 DU/A
L=510'
Initial Slope 1%
Ti=9.6 Min., Lm=70' Table 3-2
Given: Curb Slope = 0.5%, Qavg=2 cfs
V = 1.7 fps Fig. 3-6
Tt= (510 – 70)/(1.8 x 60) = 4.1 min.
Tc=9.6+4.1 = 13.7 min.

Tc, Initial Area B-5

Total Area = 0.8 Acres, 0.2 Acres Imp
% Imp = 25% Use MDR 2.9 DU/A
L=330'
Initial Slope 1%
Ti=10.0 Min., Lm=70' Table 3-2
Given: Curb Slope = 0.5%, Qavg=0.8 cfs
V = 1.5 fps Fig. 3-6
Tt= (330 – 70)/(1.5 x 60) = 2.9 min.
Tc=10.0+2.9 = 12.9 min.

Tc, Initial Area B-6

Total Area = 1.2 Acres, 0.12 Acres Imp.
% Imp = 10% Use LDR 1.0 DU/A
L=300'
Initial Slope 1%
Ti=11.5 Min., Lm=70' Table 3-2
Given: Curb Slope = 0.5%, Qavg=1.0 cfs
V = 1.5 fps Fig. 3-6

Tt= (300-70)/(1.5 x 60) = 2.6 min.
Tc=11.5+2.6 = 14.1 min.

Tc, Initial Area B-7

Total Area = 2.8 Acres, 1.1 Acres Imp.
% Imp = 40% Use MDR 7.3 DU/A
L=820'
Initial Slope 1%
Ti=8.4 Min., Lm=65' Table 3-2
Given: Curb Slope = 3%, Qavg=3.5 cfs
V = 3.9 fps Fig. 3-6
Tt= (820 – 65)/(3.9 x 60) = 3.2 min.
Tc=8.4 + 3.2 = 11.6 min.

Attachment G - Rational Method Calculations

The Rational Method as described in the San Diego County Hydrology Manual, Section 3, (Revised June 2003) shall be used to determine storm runoff.

The Rational Method formula is expressed as follows:

$$Q = C\ I\ A$$

Where:

Q = peak discharge, in cubic feet per second (cfs)

C = runoff coefficient, proportion of the rainfall that runs off the surface.

The coefficient C has no units and is based on the soil group and the development type for the drainage sub-area. **Attachment F** includes calculations for the runoff coefficient for each drainage sub-area.

I = average rainfall intensity for a duration equal to the Tc for the area, (in/Hr.)

A = drainage area contributing to the design location, in acres

The following values are used in the calculations:

Soil Groups from San Diego County Soils Group Maps. See **Attachment C**.

C (Coefficient of Runoff) from Table 3-1. See **Attachment D**.

100 year 6 Hr. Rainfall = 2.9" See **Attachment E**.

100 year 24 Hr. Rainfall =4.9" " " "

See calculations on the folowing pages.

Rational Method Calculation Form
Project: MUP 10-037

Frequency 100 Year
Existing Condition
P6=2.9 in./hr.

Calculated by MB
Date: 5/28/2013

Drainage Area	Soil Type	% Imp Area	A Acres	C	CA	ΣCA	I In./Hr.	Q CFS	Slope	Section	V '/Sec.	L Ft.	Tt Min.	Tc Min.	Remarks
A-1	D	50%	1.6	0.63	1.00	1.00	4.95	5.0						9.8	See Attachment F
										Nat		730	6.1		
A-2	D	10%	2.7	0.41	1.09	2.09	3.62	**7.6**						15.9	Figure 3-4 (L=730', h=12')
										Creek	2	1200	10.0		
For Confl. @ 4-G Culvert						2.09	2.64	**5.5**						25.9	Assumed Channel Flow
A-3	D	10%	6.6	0.41	2.67	2.67	4.59	**12.3**						11.0	See Attachment F
										Creek	2	700	5.8		
For Confl. @ 4-G Culvert						2.67	3.49	**9.3**						16.8	Assumed Channel Flow
A-41	D	40%	2.7	0.57	1.54	1.54	4.44	6.8						11.6	See Attachment F
A-42	D	10%	1.0	0.41	0.41	1.95	4.44	8.7						11.6	Add In Area
									0.002	swale	2	120	1.0		
A-43	D	10%	0.7	0.41	0.28	2.23	4.21	**9.4**						12.6	Flow Thru Area
										Creek	2	225	1.9		
For Confl. @ 4-G Culvert						2.23	3.85	**8.6**						14.5	Assumed Channel Flow
A-5	D	10%	0.7	0.41	0.28	0.28	5.31	**1.5**						8.8	See Attachment F
										Creek	2	250	2.1		
For Confl. @ 4-G Culvert						0.28	4.63	**1.3**						10.9	Assumed Channel Flow
Confl. @ 4-G Culvert for Total Flow Comparison Purposes								**21.7**						**16.8**	Use for study.
								20.8						14.5	
								16.1						10.9	
								19.2						25.9	

Rational Method Calculation Form
Project: MUP 10-037

Frequency 10 Year
Existing Condition
P6=2.0 in./hr.

Calculated by MB
Date: 5/28/2013

Drainage Area	Soil Type	% Imp Area	A Acres	C	CA	ΣCA	I In./Hr.	Q CFS	Slope	Section	V '/Sec.	L Ft.	Tt Min.	Tc Min.	Remarks
A-1	D	50%	1.6	0.63	1.0	1.0	3.41	3.4						9.8	See Attachment F
A-2	D	10%	2.7	0.41	1.1	2.1	2.50	**5.2**		Nat		730	6.1	15.9	Figure 3-4 (L=730', h=12')
A-3	D	10%	6.6	0.41	2.7	2.7	3.17	**8.5**						11.0	See Attachment F
A-41	D	40%	2.7	0.57	1.5	1.5	3.06	**4.7**						11.6	See Attachment F
A-42	D	10%	1.0	0.41	0.4	1.9	3.06	**6.0**						11.6	Add In Area
A-42	D	10%	0.7	0.41	0.3	2.2	2.90	**6.5**	0.002	swale	2	120	1.0	12.6	Flow Thru Area
A-5	D	10%	0.7	0.41	0.3	0.3	3.66	**1.0**						8.8	See Attachment F

Rational Method Calculation Form
Project: MUP 10-037

Frequency 100 Year
Proposed Condition
P6=2.9 in./hr.

Calculated by MB
Date: 5/28/2013

Drainage Area	Soil & Development		A Acres	C	CA	ΣCA	I In./Hr.	Q CFS	Slope	Section	V '/Sec.	L Ft.	Tt Min.	Tc Min.	Remarks
B-1	D	50%	1.6	0.63	1.00	1.00	4.95	5.0						9.8	See Attachment F
B-2	D	10%	2.7	0.41	1.09	2.09	3.62	**7.6**		Nat		730	6.1	15.9	Figure 3-4 (L=730', h=12')
For Confl. @ 4-G Culvert						2.1	2.64	5.5		Creek	2	1200	10.0	25.9	Assumed Channel Flow
B-33	D	30%	1.9	0.52	0.98	0.98	3.99	3.9						13.7	See Attachment F
B-32	D	35%	0.2	0.54	0.11	1.09	3.99	4.3						13.7	Add In Area
B-31	D	0%	0.4	0.35	0.14	1.23	3.99	4.9						13.7	Add In Area
B-34	D	40%	1.1	0.57	0.63	1.86	3.76	7.0	0.005	18" SD	4.2	320	1.3	15.0	Add in Area
B-4	D	50%	2.6	0.63	1.63	3.49	3.76	**13.1**						15.0	Add in Area
For Confl. @ 4-G Culvert						3.5	3.05	10.6		Creek	2	700	5.8	20.8	Assumed Channel Flow
B-5	D	25%	0.8	0.49	0.39	0.39	4.15	**1.6**						12.9	See Attachment F
For Confl. @ 4-G Culvert						0.4	3.64	1.4		Creek	2.0	350	2.9	15.8	Assumed Channel Flow
B-6	D	10%	1.1	0.41	0.45	0.45	3.91	1.8						14.1	See Attachment F
B-8	D	90%	0.4	0.85	0.34	0.79	3.83	3.0	0.005	18" SD	4.2	120	0.5	14.6	Add in Area
To Conf D1					-	0.79	3.76	3.0	0.005	18" SD	4.2	110	0.4	15.0	
B-7	D	40%	2.8	0.57	1.60	1.60	4.44	**7.1**						11.6	See Attachment F
To Conf D1					-	1.60	4.42	7.1	0.01	2-24" SD	4.0	25	0.1	11.7	Add in Area
					-										
Conf D1	D		4.3		-	2.39	4.42	10.6						11.7	
B-9	D	0%	0.3	0.35	0.11	2.50	4.39	11.0	0.002	2-24" SD	5.6	50	0.1	11.8	Culvert Flow
					-	2.50	4.30	**10.8**	0.002	Ditch	2.0	50	0.4	12.2	Ditch Flow
For Confl. @ 4-G Culvert						2.50	3.91	9.8		Creek	2.0	225	1.9	14.1	Assumed Channel Flow
Confl. @ 4-G Culvert for Flow Comparison Purposes								**23.8**						20.8	

Rational Method Calculation Form
Project: MUP 10-037

Frequency 10 Year
Porposed Condition
P6=2.0 in./hr.

Calculated by MB
Date: November 5, 2010

Drainage Area	Soil & Development		A Acres	C	CA	ΣCA	I In./Hr.	Q CFS	Slope	Section	V '/Sec.	L Ft.	Tt Min.	Tc Min.	Remarks
B-1	D	50%	1.6	0.63	1.00	1.00	3.41	3.4						9.8	See Attachment F
B-2	D	10%	2.7	0.41	1.09	2.09	2.50	**5.2**		Nat		730	6.1	15.9	Figure 3-4 (L=730', h=12')
B-33	D	30%	1.9	0.52	0.98	0.98	2.75	2.7						13.7	See Attachment F
B-32	D	35%	0.2	0.54	0.11	1.09	2.75	3.0						13.7	Add In Area
B-31	D	0%	0.4	0.35	0.14	1.23	2.75	3.4						13.7	Add In Area
B-34	D	40%	1.1	0.57	0.63	1.85	2.60	4.8	0.005	18" SD	4.2	320	1.3	15.0	Fig. 3-7
B-4	D	50%	2.6	0.63	1.63	3.48	2.60	**9.0**						15.0	Add in Area
B-5	D	25%	0.8	0.49	0.39	0.39	2.86	**1.1**						12.9	See Attachment F
B-6	D	10%	1.1	0.41	0.45	0.45	2.70	1.2						14.1	See Attachment F
B-8	D	90%	0.4	0.85	0.34	0.78	2.64	2.1	0.005	18" SD	4.2	120	0.5	14.6	Add in Area
To Conf D1					-	0.78	2.59	2.0	0.005	18" SD	4.2	110	0.4	15.0	
B-7	D	40%	2.8	0.57	1.60	1.60	3.06	4.9						11.6	See Attachment F
To Conf D1					-	1.60	3.04	4.9	0.01	2-24" SD	4.0	25	0.1	11.7	Add in Area
Conf D1	D		4.3		-	2.38	3.04	7.2						11.7	
B-9	D	0%	0.3	0.35	0.11	2.48	3.02	7.5	0.002	2-24" SD	5.6	50	0.1	11.9	Culvert Flow
					-	2.48	2.95	**7.3**	0.002	Ditch	2.0	50	0.4	12.3	Ditch Flow

Attachment H - Hydraulic & Water Surface Calculations.

Channel along Four Gee Road:

The water surface upstream of the existing 18" and proposed double 24" culverts under Grace Way is calculated using the Hydraflow Express Culvert Calculator. The results of the calculations are included on the following pages. The HEC-RAS program is used to determine the water surface elevation in the channel downstream of the culverts. The results of the HEC-RAS calculations are also on the following pages. In the existing condition, the anticipated flow is 9.4 cfs in the channel. In the proposed condition, the expected flow is 10.6 cfs. The water surface elevation at the downstream end of the culvert is: Proposed 488.34, Existing 488.32.

Proposed Culvert Under Grace Way:

The proposed culvert is 72 feet long with a slope of 0.28%. The upstream elevation is 488.0 and the downstream elevation is 487.80. The water surface elevation upstream of the culvert is 488.89 feet when conveying 7.0 cfs of flow.

Existing Culvert Under Driveway:

The existing culvert is 36 feet long with a slope of 1%. The upstream elevation is 488.2 and the downstream elevation is 487.84. the low point on the existing driveway is at elevation 488.8, just 0.6 feet higher than the inlet of the pipe. Only 1.4 cfs of water can flow through the existing culvert before the water surface at the inlet tops the driveway at elevation 488.8. The total flow through the culvert and over the top of the driveway is 6.8 cfs. At elevation 488.89 the existing culvert can carry 1.8 cfs.

The amount of water that drains across the existing driveway at elevation 488.89 is determined using the weir equation. Assumming the cross section of flow is rectangular, (It is actually a flattened triangle, using a rectangular section rectanglar section will give a higher estimate of the flows.), the capacity would be:

$Q=CLH^{3/2}$

Where:

H is the depth of flow and will be assumed to be a uniform 0.09 feet across the flooded width of the driveway.

L is the length of the driveway that will be flooded at elevtion 488.89. According to the topographic survey of the site, this is 22 feet.

C is the weir coefficient. As per King's Handbook of Hydraulics, 6th Edition, Table 5-3, it is roughly 2.7. The values in the table vary, but for small heads on wide crested weirs the values are at or just under 2.7.

Therefore,

$Q=2.7(22)(0.09)^{1.5}=1.6$ cfs

The total flow that could travel through the existing pipe and over the driveway in the current conditions, without exceeding elevation 488.89 upstream of the culvert is 3.4 cfs (1.8 cfs + 1.6 cfs).

This is only half of the expected flow in a 100 year storm, therefore the water surface necessary to convey the existing flows of 6.8 cfs must be higher than elevation 488.89.

At a water surface elevation of 488.95, the calculations indicate the pipe culvert would carry a flow of 2.0 cfs.

The flooded width of the driveway at that elevation would be about 33 feet. The amount of water that would cross the driveway at that elevation would be:

$Q=2.7(33)(0.14)^{1.5}=4.7$ cfs

This gives a total flow of 6.7 cfs with the water surface elevation at 488.94. The water surface elevation to convey 6.8 cfs through the culvert and over the driveway must be slightly higher than 488.94. Therefore, the proposed double 24 inch culvert will lower the expected ponding depth south of Grace Way by slightly more than 0.05 feet, which will have a less than significant effect on the upstream properties.

Culvert Report

Hydraflow Express Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. Sunday, Aug 5 2012

Exist. Culvert Under driveway

Invert Elev Dn (ft)	=	487.84
Pipe Length (ft)	=	36.00
Slope (%)	=	1.00
Invert Elev Up (ft)	=	488.20
Rise (in)	=	18.0
Shape	=	Circular
Span (in)	=	18.0
No. Barrels	=	1
n-Value	=	0.013
Culvert Type	=	Circular Culvert
Culvert Entrance	=	Rough tapered inlet throat
Coeff. K,M,c,Y,k	=	0.519, 0.64, 0.021, 0.9, 0.5

Embankment

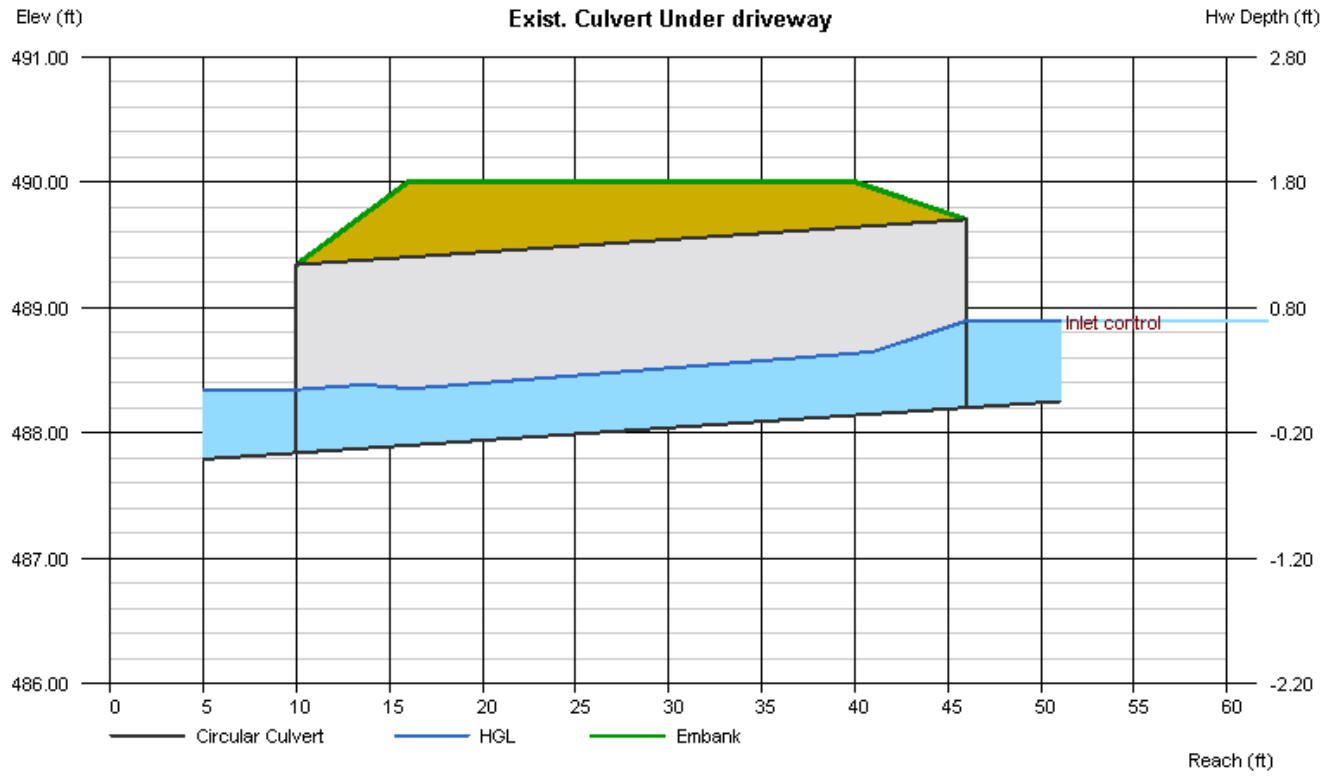
Top Elevation (ft)	=	490.00
Top Width (ft)	=	24.00
Crest Width (ft)	=	40.00

Calculations

Qmin (cfs)	=	0.00
Qmax (cfs)	=	6.80
Tailwater Elev (ft)	=	488.34

Highlighted

Qtotal (cfs)	=	1.80
Qpipe (cfs)	=	1.80
Qovertop (cfs)	=	0.00
Veloc Dn (ft/s)	=	3.45
Veloc Up (ft/s)	=	3.45
HGL Dn (ft)	=	488.34
HGL Up (ft)	=	488.70
Hw Elev (ft)	=	488.89
Hw/D (ft)	=	0.46
Flow Regime	=	Inlet Control



Culvert Report

Hydraflow Express Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. Sunday, Aug 5 2012

Propsed Culvert Under Grace way

Invert Elev Dn (ft)	=	487.84
Pipe Length (ft)	=	36.00
Slope (%)	=	1.00
Invert Elev Up (ft)	=	488.20
Rise (in)	=	18.0
Shape	=	Circular
Span (in)	=	18.0
No. Barrels	=	1
n-Value	=	0.013
Culvert Type	=	Circular Culvert
Culvert Entrance	=	Rough tapered inlet throat
Coeff. K,M,c,Y,k	=	0.519, 0.64, 0.021, 0.9, 0.5

Embankment

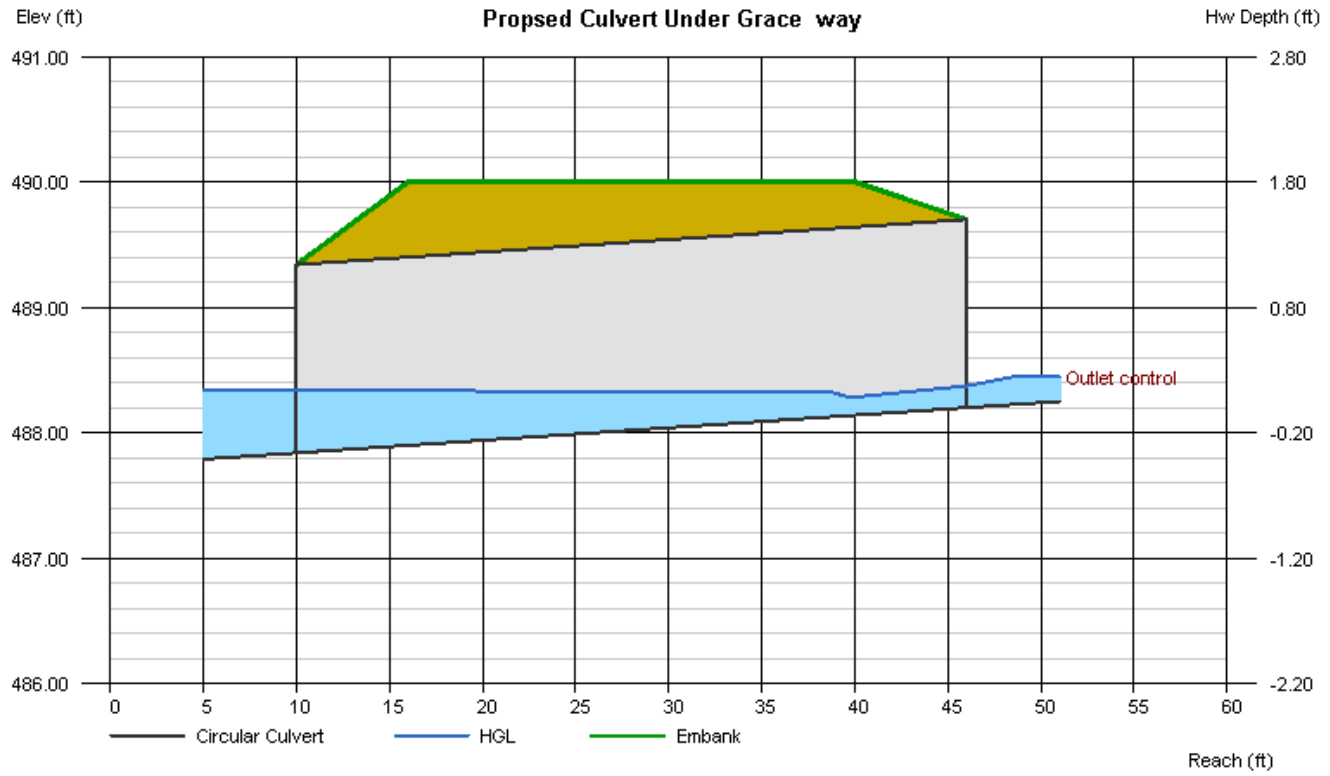
Top Elevation (ft)	=	490.00
Top Width (ft)	=	24.00
Crest Width (ft)	=	40.00

Calculations

Qmin (cfs)	=	0.00
Qmax (cfs)	=	6.80
Tailwater Elev (ft)	=	488.34

Highlighted

Qtotal (cfs)	=	0.20
Qpipe (cfs)	=	0.20
Qovertop (cfs)	=	0.00
Veloc Dn (ft/s)	=	0.39
Veloc Up (ft/s)	=	1.75
HGL Dn (ft)	=	488.34
HGL Up (ft)	=	488.37
Hw Elev (ft)	=	488.45
Hw/D (ft)	=	0.16
Flow Regime	=	Outlet Control



Q			Veloc		Depth		HGL			
Total	Pipe	Over	Dn	Up	Dn	Up	Dn	Up	Hw	Hw/D
(cfs)	(cfs)	(cfs)	(ft/s)	(ft/s)	(in)	(in)	(ft)	(ft)	(ft)	
0.20	0.20	0.00	0.39	1.75	6.00	2.09	488.34	488.37	488.45	0.16
0.40	0.40	0.00	0.78	2.28	6.00	2.80	488.34	488.43	488.55	0.24
0.60	0.60	0.00	1.16	2.54	6.00	3.44	488.34	488.49	488.54	0.23
0.80	0.80	0.00	1.55	2.75	6.00	3.99	488.34	488.53	488.61	0.27
1.00	1.00	0.00	1.94	2.92	6.00	4.47	488.34	488.57	488.68	0.32
1.20	1.20	0.00	2.33	3.07	6.00	4.91	488.34	488.61	488.73	0.36
1.40	1.40	0.00	2.72	3.21	6.00	5.32	488.34	488.64	488.79	0.39
1.60	1.60	0.00	3.10	3.33	6.00	5.70	488.34	488.67	488.84	0.43
1.80	1.80	0.00	3.45	3.45	6.06	6.06	488.34	488.70	488.89	0.46
2.00	2.00	0.00	3.56	3.56	6.39	6.39	488.37	488.73	488.94	0.49
2.20	2.20	0.00	3.66	3.66	6.72	6.72	488.40	488.76	488.99	0.52
2.40	2.40	0.00	3.75	3.75	7.03	7.03	488.43	488.79	489.03	0.55
2.60	2.60	0.00	4.86	3.85	6.16	7.33	488.35	488.81	489.08	0.58
2.80	2.80	0.00	4.95	3.94	6.42	7.62	488.38	488.83	489.12	0.61
3.00	3.00	0.00	5.03	4.02	6.68	7.90	488.40	488.86	489.16	0.64
3.20	3.20	0.00	5.14	4.11	6.90	8.17	488.41	488.88	489.20	0.67
3.40	3.40	0.00	5.23	4.18	7.12	8.43	488.43	488.90	489.24	0.69
3.60	3.60	0.00	5.32	4.26	7.34	8.69	488.45	488.92	489.28	0.72
3.80	3.80	0.00	5.40	4.34	7.56	8.93	488.47	488.94	489.32	0.74
4.00	4.00	0.00	5.47	4.42	7.78	9.18	488.49	488.96	489.35	0.77
4.20	4.20	0.00	5.53	4.49	8.01	9.42	488.51	488.98	489.39	0.79
4.40	4.40	0.00	5.59	4.56	8.23	9.65	488.53	489.00	489.43	0.82
4.60	4.60	0.00	5.68	4.63	8.41	9.87	488.54	489.02	489.46	0.84
4.80	4.80	0.00	5.73	4.70	8.63	10.10	488.56	489.04	489.50	0.86
5.00	5.00	0.00	5.77	4.77	8.86	10.32	488.58	489.06	489.53	0.89
5.20	5.20	0.00	5.85	4.84	9.04	10.53	488.59	489.08	489.56	0.91
5.40	5.40	0.00	5.89	4.91	9.26	10.74	488.61	489.09	489.60	0.93
5.60	5.60	0.00	5.96	4.98	9.44	10.94	488.63	489.11	489.63	0.95
5.80	5.80	0.00	6.00	5.05	9.67	11.15	488.65	489.13	489.66	0.98
6.00	6.00	0.00	6.07	5.12	9.85	11.34	488.66	489.15	489.70	1.00
6.20	6.20	0.00	6.10	5.18	10.07	11.54	488.68	489.16	489.73	1.02
6.40	6.40	0.00	6.16	5.25	10.25	11.73	488.69	489.18	489.76	1.04
6.60	6.60	0.00	6.22	5.31	10.43	11.92	488.71	489.19	489.79	1.06
6.80	6.80	0.00	6.25	5.38	10.65	12.10	488.73	489.21	489.82	1.08

Culvert Report

Hydraflow Express Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. Monday, Aug 6 2012

Proposed Culvert Under Grace Way

Invert Elev Dn (ft)	=	487.80
Pipe Length (ft)	=	72.00
Slope (%)	=	0.28
Invert Elev Up (ft)	=	488.00
Rise (in)	=	24.0
Shape	=	Circular
Span (in)	=	24.0
No. Barrels	=	2
n-Value	=	0.013
Culvert Type	=	Circular Concrete
Culvert Entrance	=	Groove end w/headwall (C)
Coeff. K,M,c,Y,k	=	0.0018, 2, 0.0292, 0.74, 0.2

Embankment

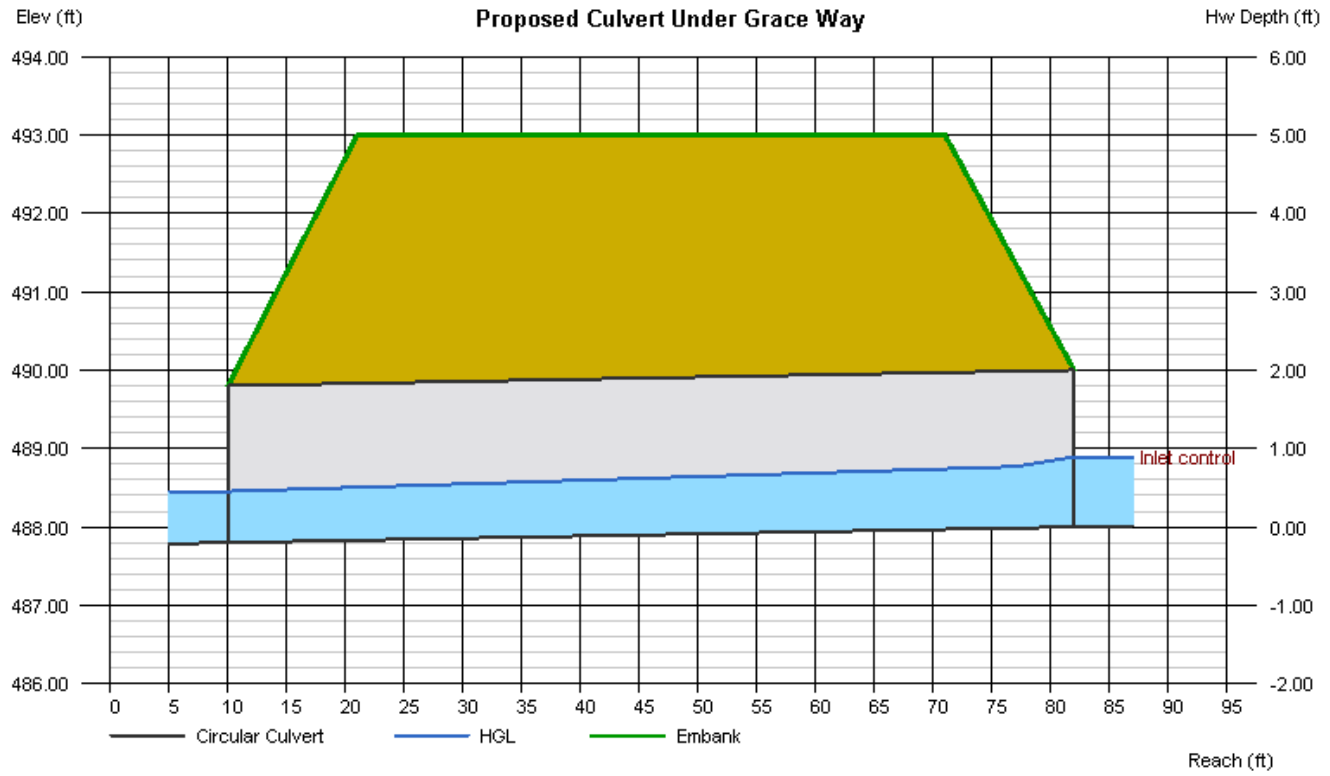
Top Elevation (ft)	=	493.00
Top Width (ft)	=	50.00
Crest Width (ft)	=	75.00

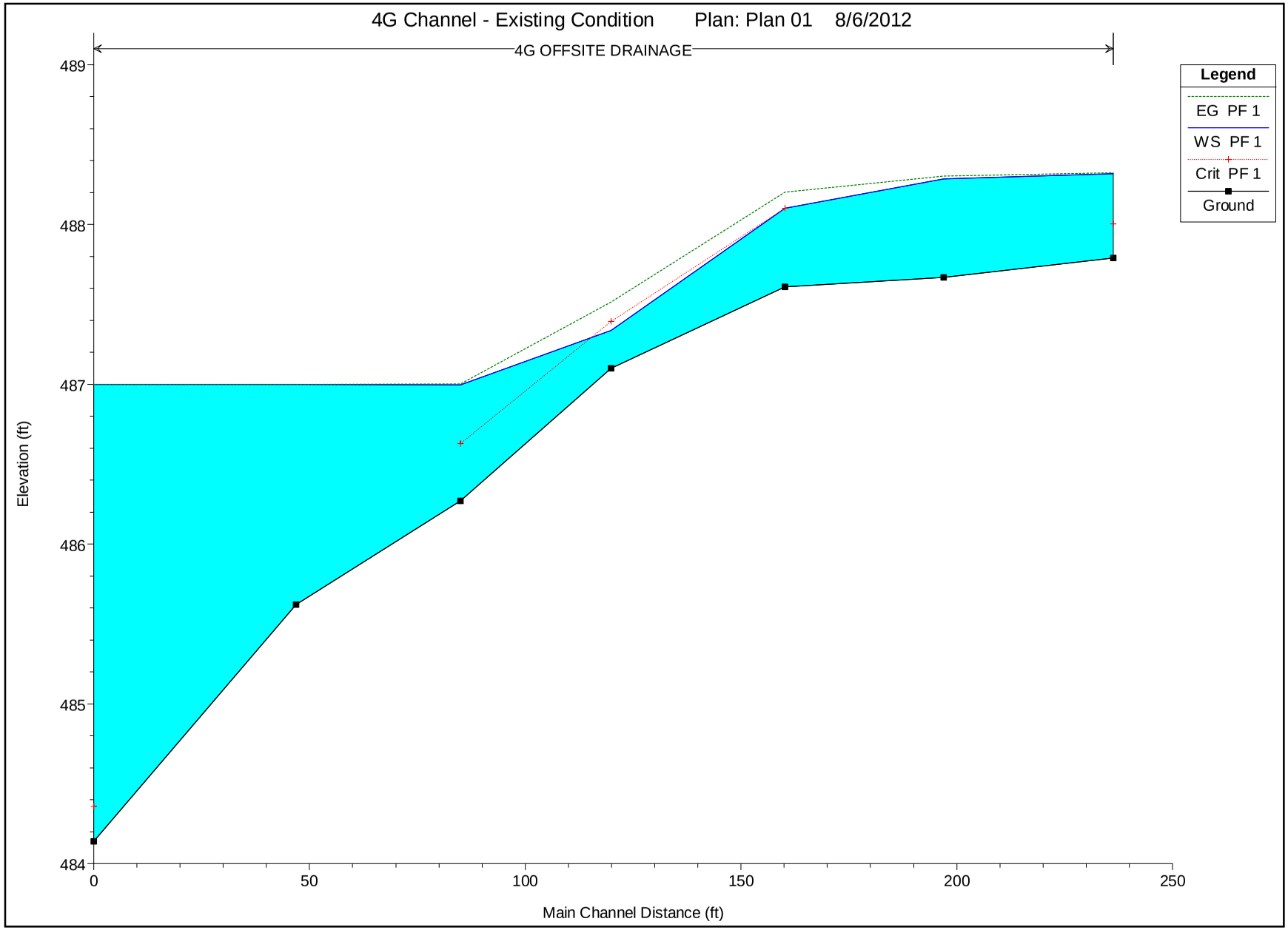
Calculations

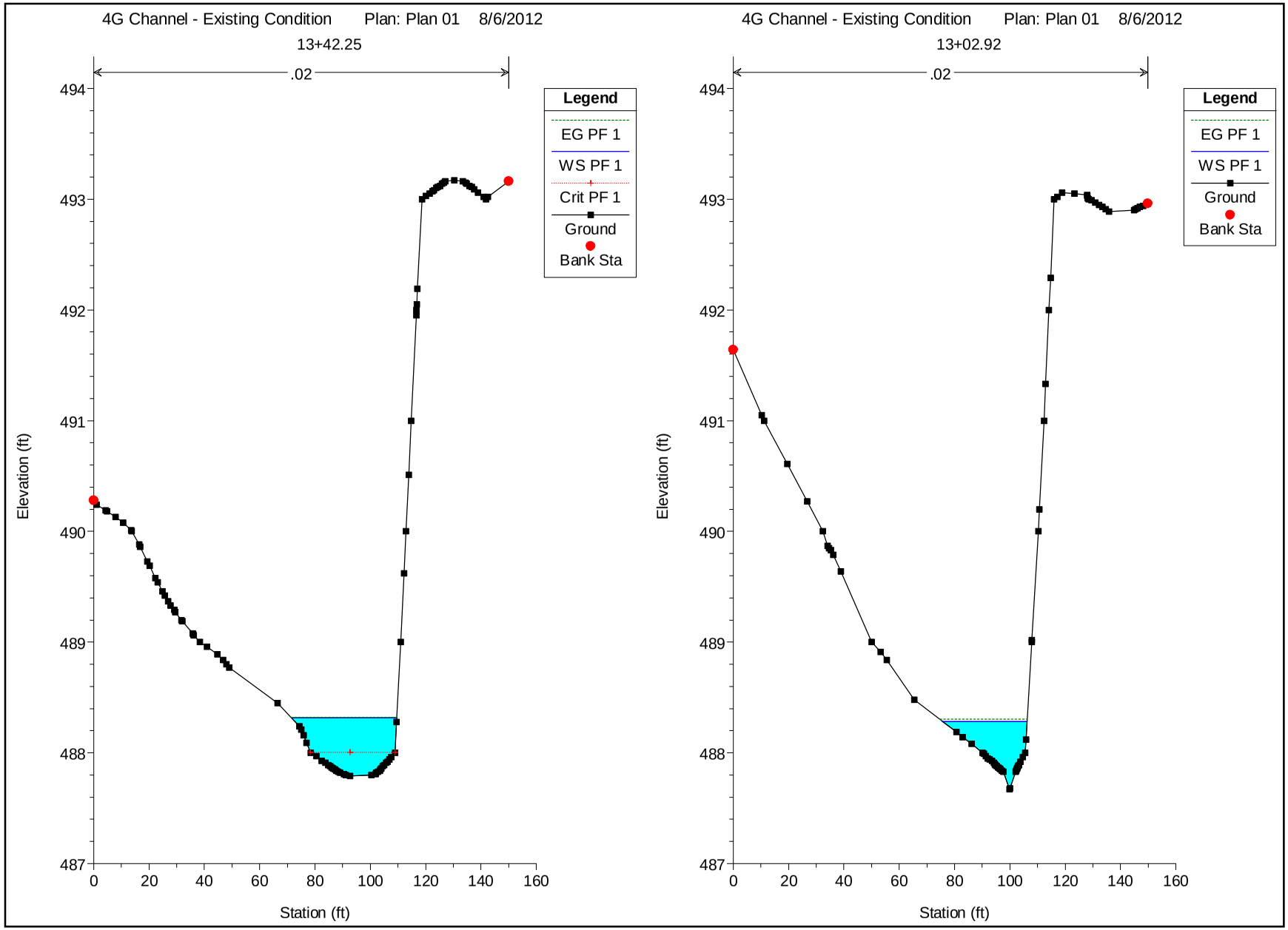
Qmin (cfs)	=	7.00
Qmax (cfs)	=	7.00
Tailwater Elev (ft)	=	0.00

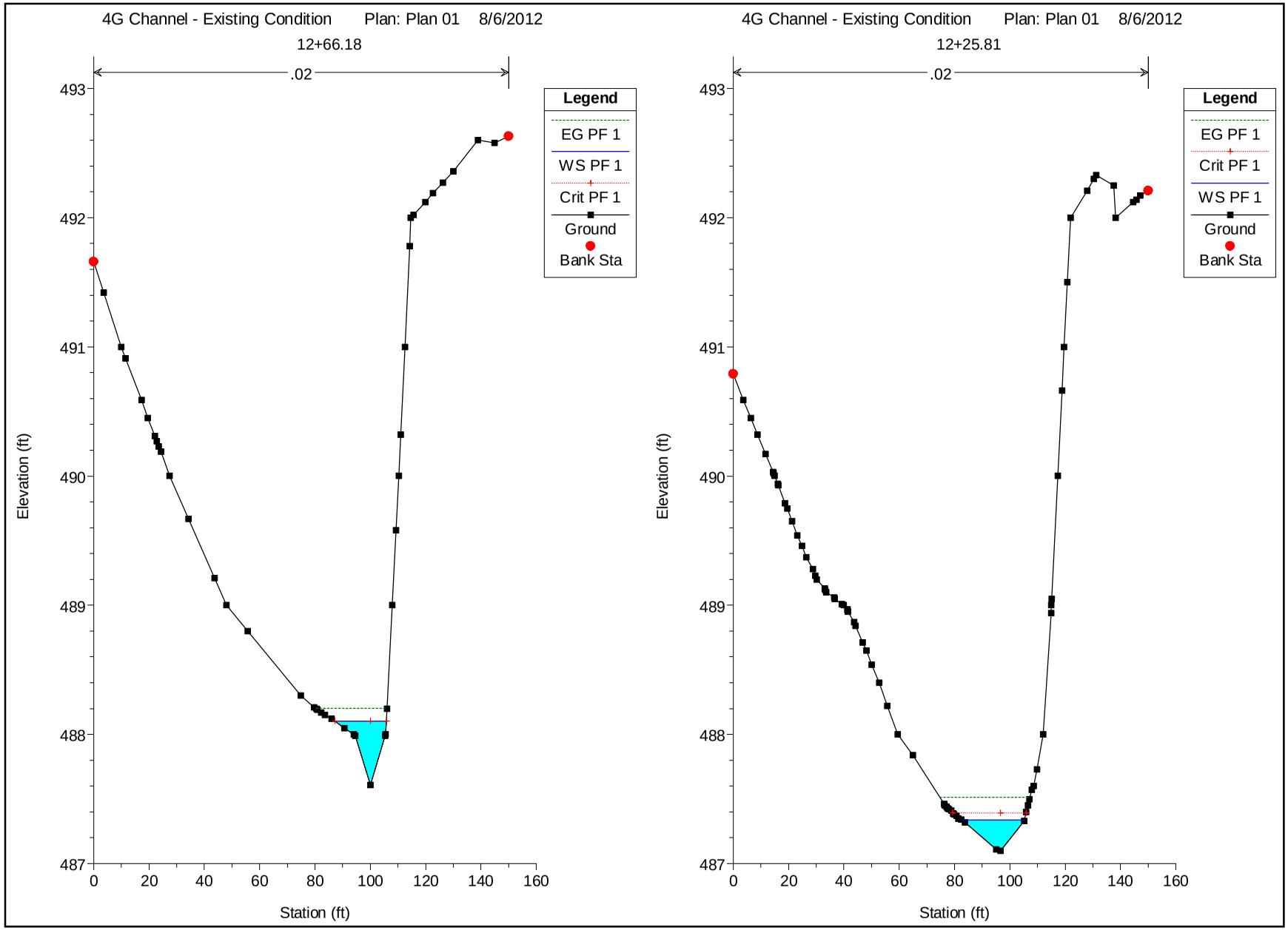
Highlighted

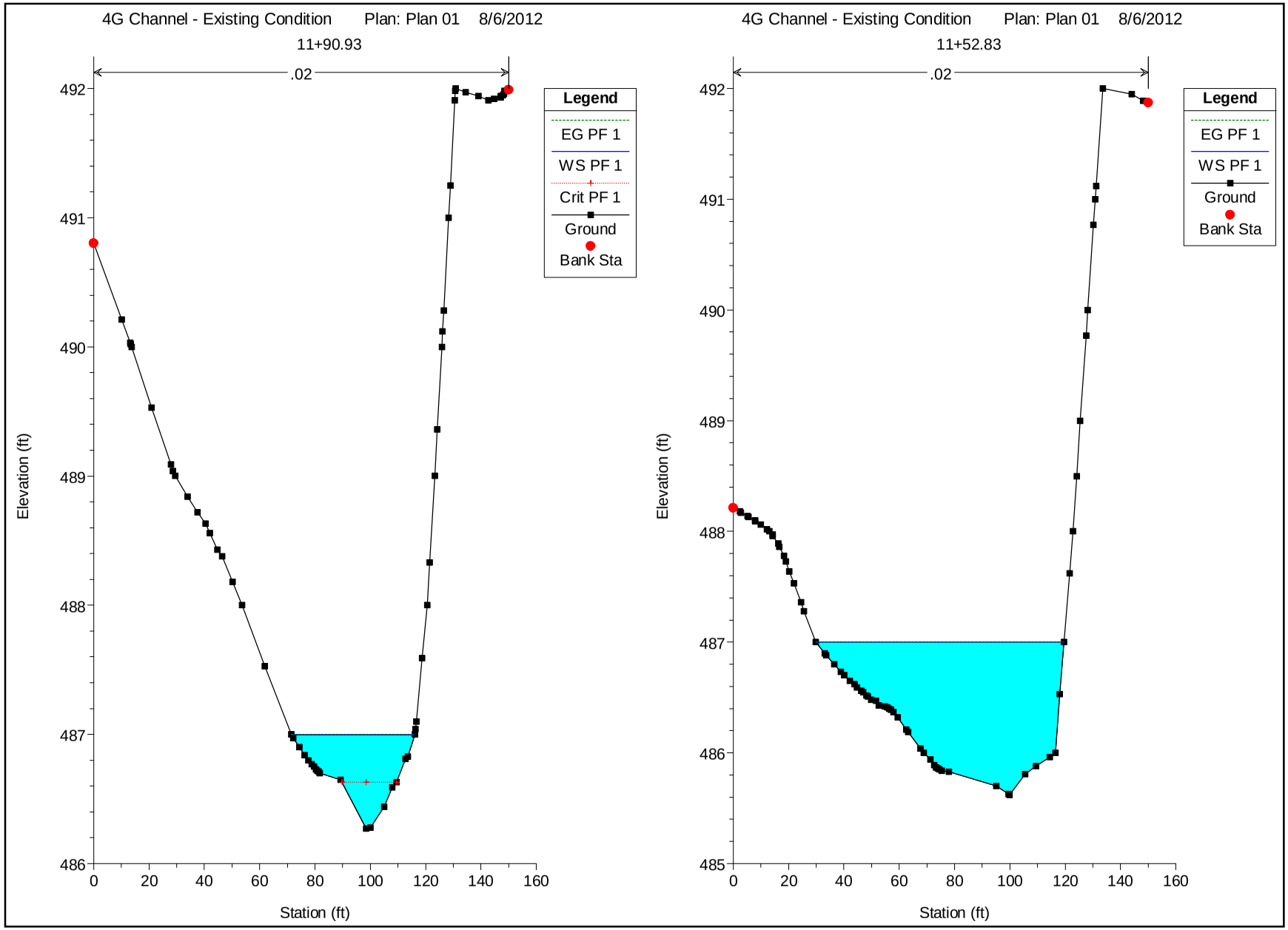
Qtotal (cfs)	=	7.00
Qpipe (cfs)	=	7.00
Qovertop (cfs)	=	0.00
Veloc Dn (ft/s)	=	3.92
Veloc Up (ft/s)	=	3.02
HGL Dn (ft)	=	488.45
HGL Up (ft)	=	488.79
Hw Elev (ft)	=	488.89
Hw/D (ft)	=	0.45
Flow Regime	=	Inlet Control

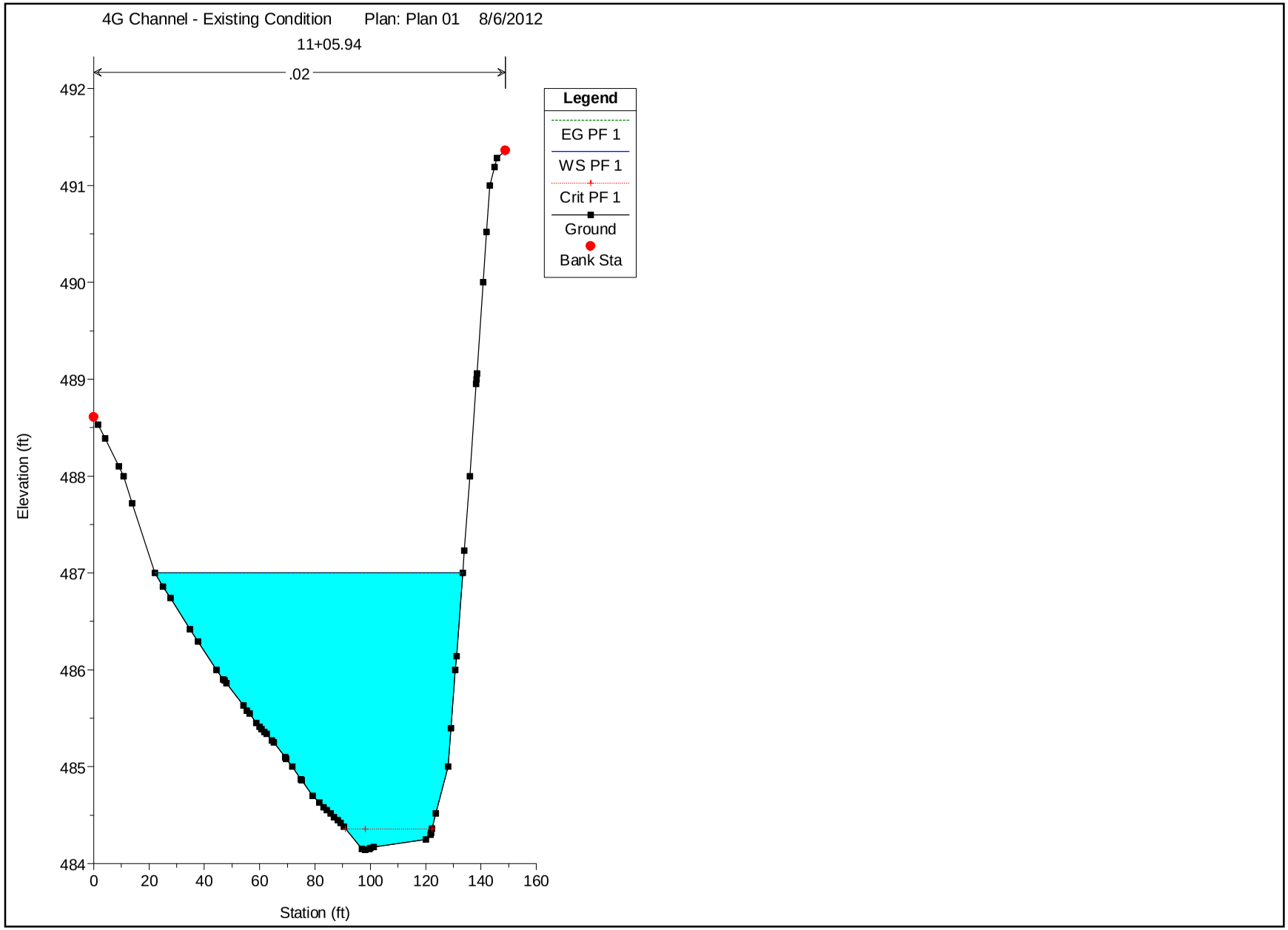



4G Channel - Existing Condition Plan: Plan 01 8/6/2012
4G OFFSITE DRAINAGE
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Elevation (ft)
489
488
487
486
485
484
0
50
100
150
200
250
Main Channel Distance (ft)


4G Channel - Existing Condition Plan: Plan 01 8/6/2012
13+42.25
.02
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Bank Sta
Elevation (ft)
Station (ft)
4G Channel - Existing Condition Plan: Plan 01 8/6/2012
13+02.92
.02
Legend
EG PF 1
WS PF 1
Ground
Bank Sta
Elevation (ft)
Station (ft)


4G Channel - Existing Condition Plan: Plan 01 8/6/2012
12+66.18
.02
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Bank Sta
Elevation (ft)
Station (ft)
4G Channel - Existing Condition Plan: Plan 01 8/6/2012
12+25.81
.02
Legend
EG PF 1
Crit PF 1
WS PF 1
Ground
Bank Sta
Elevation (ft)
Station (ft)


4G Channel - Existing Condition Plan: Plan 01 8/6/2012
11+90.93
.02
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Bank Sta
Elevation (ft)
Station (ft)
4G Channel - Existing Condition Plan: Plan 01 8/6/2012
11+52.83
.02
Legend
EG PF 1
WS PF 1
Ground
Bank Sta
Elevation (ft)
Station (ft)


4G Channel - Existing Condition Plan: Plan 01 8/6/2012
11+05.94
.02
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Bank Sta
Elevation (ft)
Station (ft)
492
491
490
489
488
487
486
485
484
0
20
40
60
80
100
120
140
160

Plan: Plan 01 4G OFFSITE DRAINAGE RS: 1342.25 Profile: PF 1

E.G. Elev (ft)	488.32	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.01	Wt. n-Val.		0.020	
W.S. Elev (ft)	488.32	Reach Len. (ft)	39.33	39.33	39.33
Crit W.S. (ft)	488.01	Flow Area (sq ft)		14.89	
E.G. Slope (ft/ft)	0.000253	Area (sq ft)		14.89	
Q Total (cfs)	9.40	Flow (cfs)		9.40	
Top Width (ft)	38.04	Top Width (ft)		38.04	
Vel Total (ft/s)	0.63	Avg. Vel. (ft/s)		0.63	
Max Chl Dpth (ft)	0.53	Hydr. Depth (ft)		0.39	
Conv. Total (cfs)	591.4	Conv. (cfs)		591.4	
Length Wtd. (ft)	39.33	Wetted Per. (ft)		38.13	
Min Ch El (ft)	487.79	Shear (lb/sq ft)		0.01	
Alpha	1.00	Stream Power (lb/ft s)		0.00	
Frctn Loss (ft)	0.02	Cum Volume (acre-ft)		0.22	
C & E Loss (ft)	0.00	Cum SA (acres)		0.26	

Plan: Plan 01 4G OFFSITE DRAINAGE RS: 1302.92 Profile: PF 1

E.G. Elev (ft)	488.30	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.02	Wt. n-Val.		0.020	
W.S. Elev (ft)	488.28	Reach Len. (ft)	36.74	36.74	36.74
Crit W.S. (ft)		Flow Area (sq ft)		8.58	
E.G. Slope (ft/ft)	0.001185	Area (sq ft)		8.58	
Q Total (cfs)	9.40	Flow (cfs)		9.40	
Top Width (ft)	30.56	Top Width (ft)		30.56	
Vel Total (ft/s)	1.10	Avg. Vel. (ft/s)		1.10	
Max Chl Dpth (ft)	0.61	Hydr. Depth (ft)		0.28	
Conv. Total (cfs)	273.0	Conv. (cfs)		273.0	
Length Wtd. (ft)	36.74	Wetted Per. (ft)		30.64	
Min Ch El (ft)	487.67	Shear (lb/sq ft)		0.02	
Alpha	1.00	Stream Power (lb/ft s)		0.02	
Frctn Loss (ft)	0.10	Cum Volume (acre-ft)		0.21	
C & E Loss (ft)	0.01	Cum SA (acres)		0.23	

Plan: Plan 01 4G OFFSITE DRAINAGE RS: 1266.18 Profile: PF 1

E.G. Elev (ft)	488.20	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.10	Wt. n-Val.		0.020	
W.S. Elev (ft)	488.10	Reach Len. (ft)	40.37	40.37	40.37
Crit W.S. (ft)	488.10	Flow Area (sq ft)		3.72	
E.G. Slope (ft/ft)	0.009947	Area (sq ft)		3.72	
Q Total (cfs)	9.40	Flow (cfs)		9.40	
Top Width (ft)	18.69	Top Width (ft)		18.69	
Vel Total (ft/s)	2.52	Avg. Vel. (ft/s)		2.52	
Max Chl Dpth (ft)	0.49	Hydr. Depth (ft)		0.20	
Conv. Total (cfs)	94.2	Conv. (cfs)		94.2	

Plan: Plan 01 4G OFFSITE DRAINAGE RS: 1266.18 Profile: PF 1 (Continued)

Length Wtd. (ft)	40.37	Wetted Per. (ft)		18.74	
Min Ch El (ft)	487.61	Shear (lb/sq ft)		0.12	
Alpha	1.00	Stream Power (lb/ft s)		0.31	
Frctn Loss (ft)	0.42	Cum Volume (acre-ft)		0.20	
C & E Loss (ft)	0.01	Cum SA (acres)		0.21	

Plan: Plan 01 4G OFFSITE DRAINAGE RS: 1225.81 Profile: PF 1

E.G. Elev (ft)	487.51	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.18	Wt. n-Val.		0.020	
W.S. Elev (ft)	487.34	Reach Len. (ft)	34.88	34.88	34.88
Crit W.S. (ft)	487.39	Flow Area (sq ft)		2.78	
E.G. Slope (ft/ft)	0.033999	Area (sq ft)		2.78	
Q Total (cfs)	9.40	Flow (cfs)		9.40	
Top Width (ft)	22.56	Top Width (ft)		22.56	
Vel Total (ft/s)	3.39	Avg. Vel. (ft/s)		3.39	
Max Chl Dpth (ft)	0.24	Hydr. Depth (ft)		0.12	
Conv. Total (cfs)	51.0	Conv. (cfs)		51.0	
Length Wtd. (ft)	34.88	Wetted Per. (ft)		22.57	
Min Ch El (ft)	487.10	Shear (lb/sq ft)		0.26	
Alpha	1.00	Stream Power (lb/ft s)		0.88	
Frctn Loss (ft)	0.68	Cum Volume (acre-ft)		0.20	
C & E Loss (ft)	0.01	Cum SA (acres)		0.19	

Plan: Plan 01 4G OFFSITE DRAINAGE RS: 1190.93 Profile: PF 1

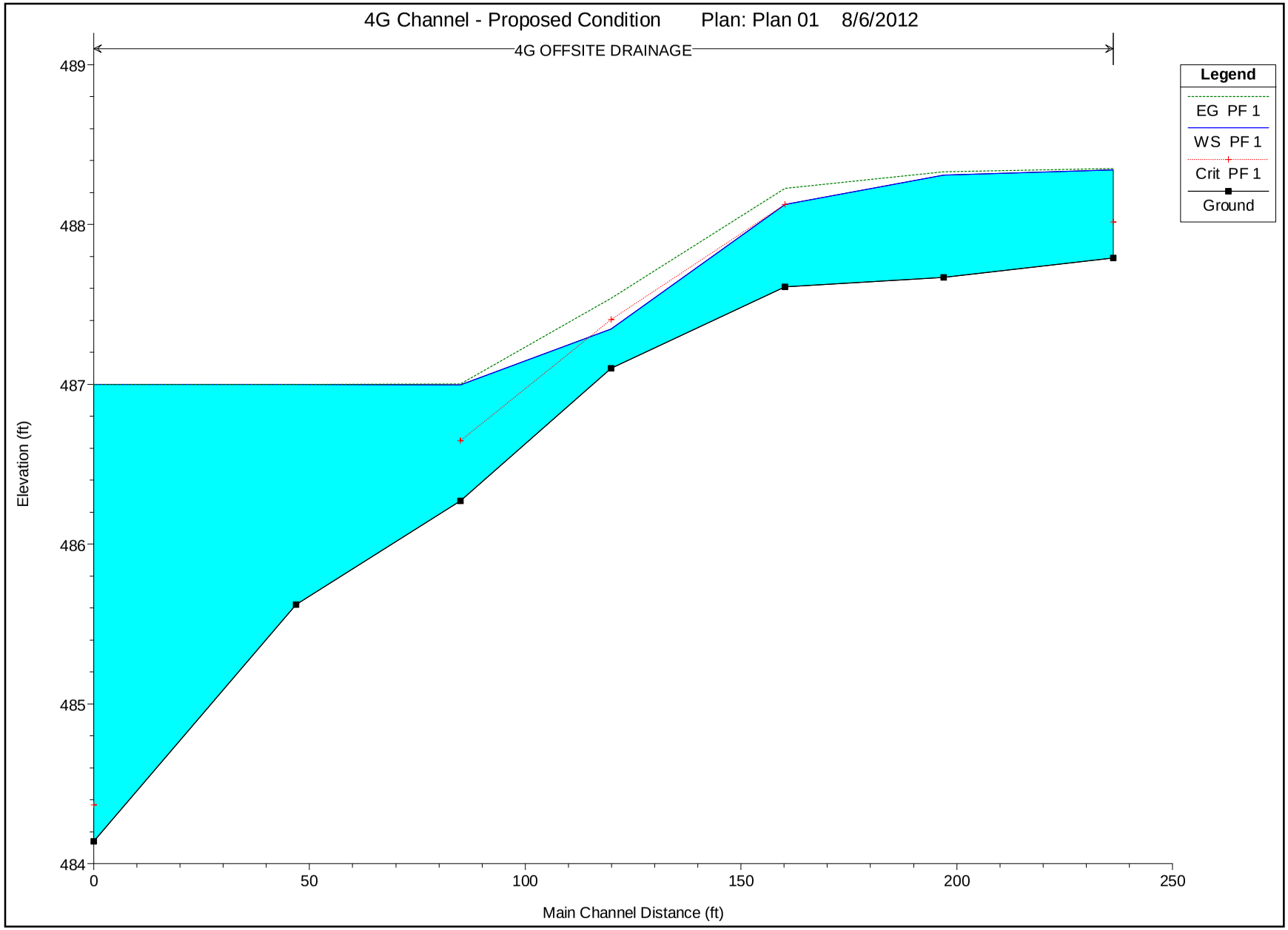
E.G. Elev (ft)	487.00	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.01	Wt. n-Val.		0.020	
W.S. Elev (ft)	487.00	Reach Len. (ft)	38.10	38.10	38.10
Crit W.S. (ft)	486.63	Flow Area (sq ft)		16.57	
E.G. Slope (ft/ft)	0.000219	Area (sq ft)		16.57	
Q Total (cfs)	9.40	Flow (cfs)		9.40	
Top Width (ft)	44.61	Top Width (ft)		44.61	
Vel Total (ft/s)	0.57	Avg. Vel. (ft/s)		0.57	
Max Chl Dpth (ft)	0.73	Hydr. Depth (ft)		0.37	
Conv. Total (cfs)	635.5	Conv. (cfs)		635.5	
Length Wtd. (ft)	38.10	Wetted Per. (ft)		44.64	
Min Ch El (ft)	486.27	Shear (lb/sq ft)		0.01	
Alpha	1.00	Stream Power (lb/ft s)		0.00	
Frctn Loss (ft)	0.00	Cum Volume (acre-ft)		0.19	
C & E Loss (ft)	0.00	Cum SA (acres)		0.17	

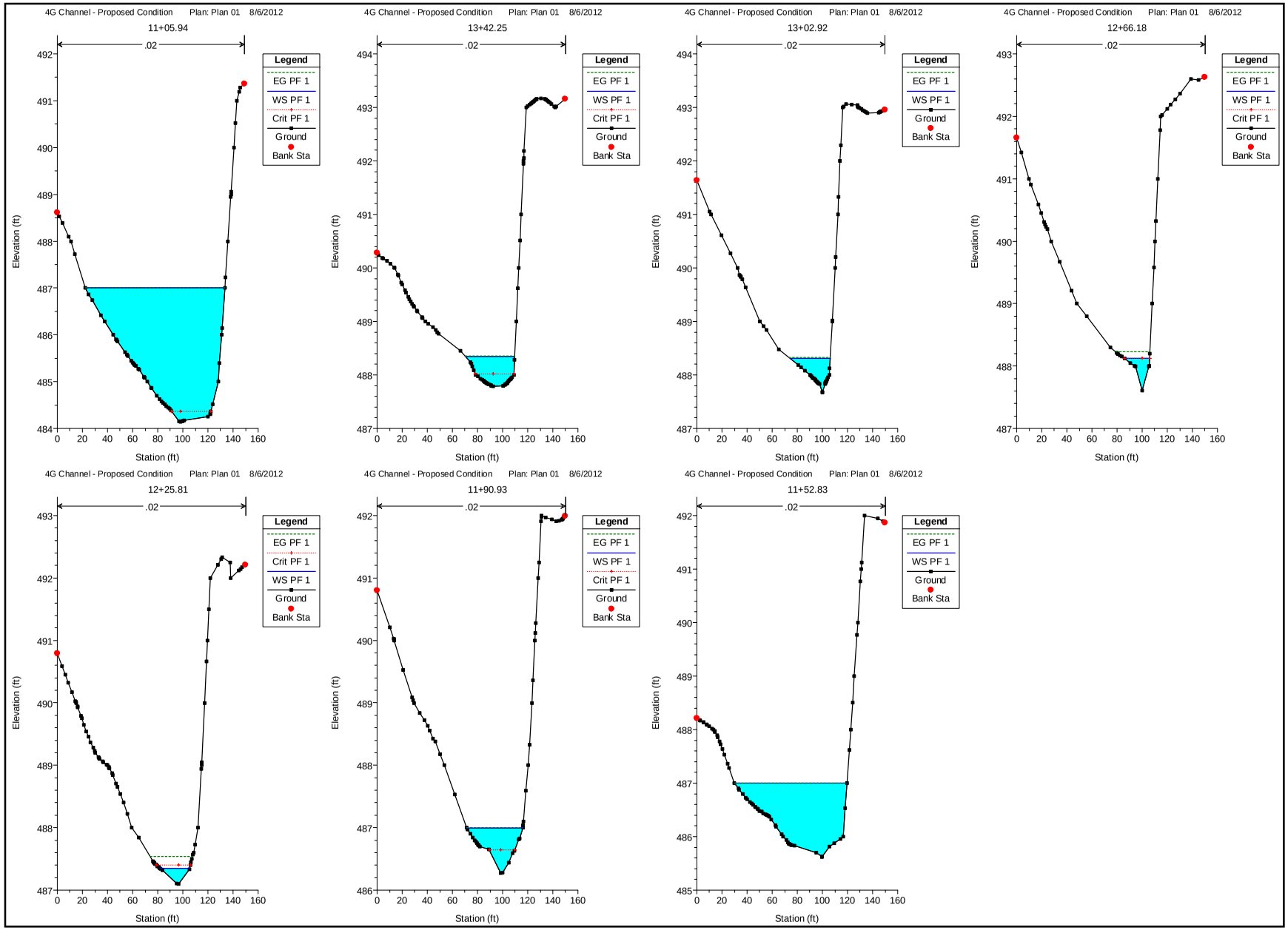
Plan: Plan 01 4G OFFSITE DRAINAGE RS: 1152.83 Profile: PF 1

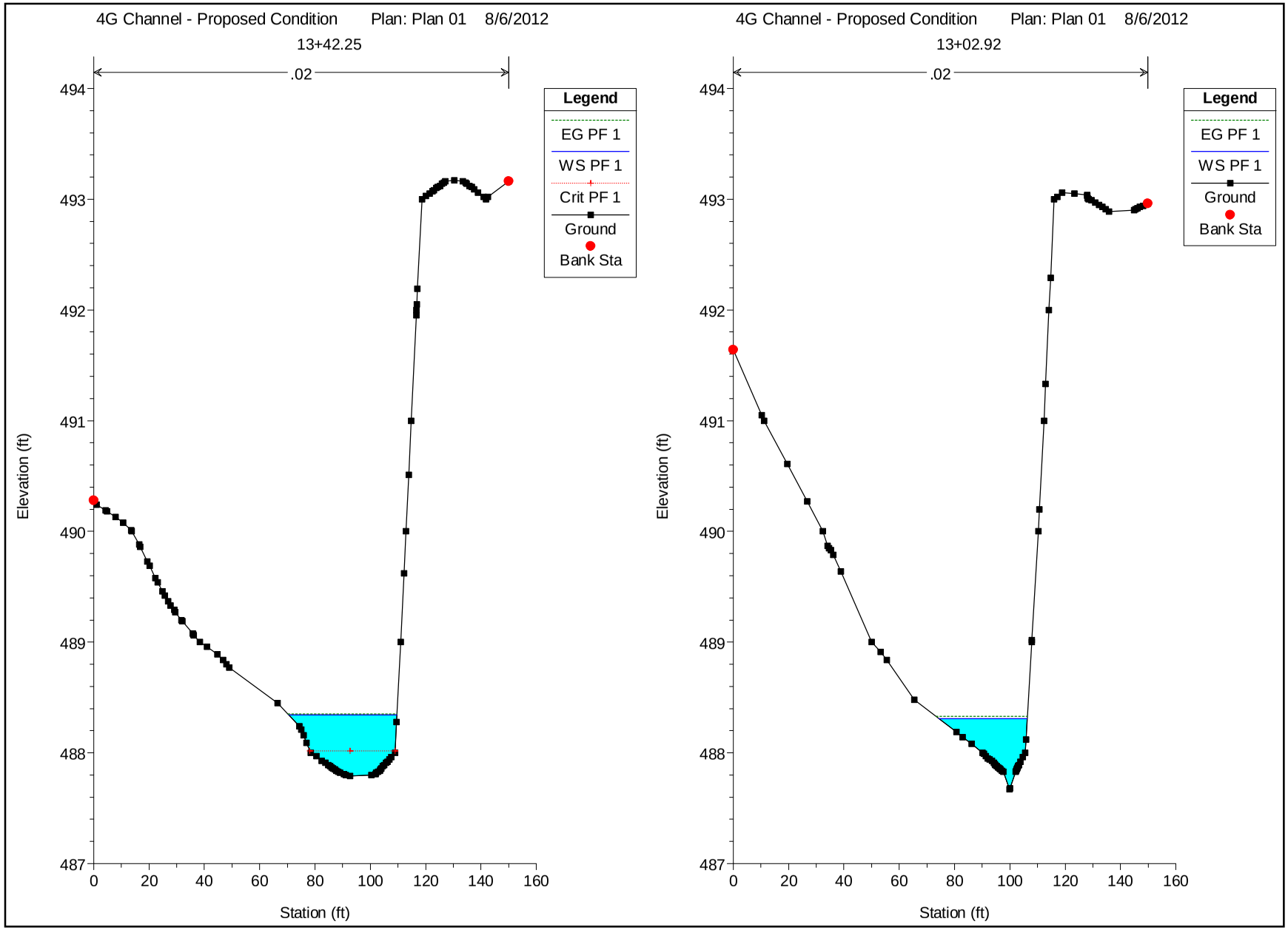
E.G. Elev (ft)	487.00	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.00	Wt. n-Val.		0.020	
W.S. Elev (ft)	487.00	Reach Len. (ft)	46.89	46.89	46.89
Crit W.S. (ft)		Flow Area (sq ft)		77.58	
E.G. Slope (ft/ft)	0.000003	Area (sq ft)		77.58	
Q Total (cfs)	9.40	Flow (cfs)		9.40	
Top Width (ft)	89.77	Top Width (ft)		89.77	
Vel Total (ft/s)	0.12	Avg. Vel. (ft/s)		0.12	
Max Chl Dpth (ft)	1.38	Hydr. Depth (ft)		0.86	
Conv. Total (cfs)	5222.7	Conv. (cfs)		5222.7	
Length Wtd. (ft)	46.89	Wetted Per. (ft)		89.94	
Min Ch El (ft)	485.62	Shear (lb/sq ft)		0.00	
Alpha	1.00	Stream Power (lb/ft s)		0.00	
Frctn Loss (ft)	0.00	Cum Volume (acre-ft)		0.15	
C & E Loss (ft)	0.00	Cum SA (acres)		0.11	

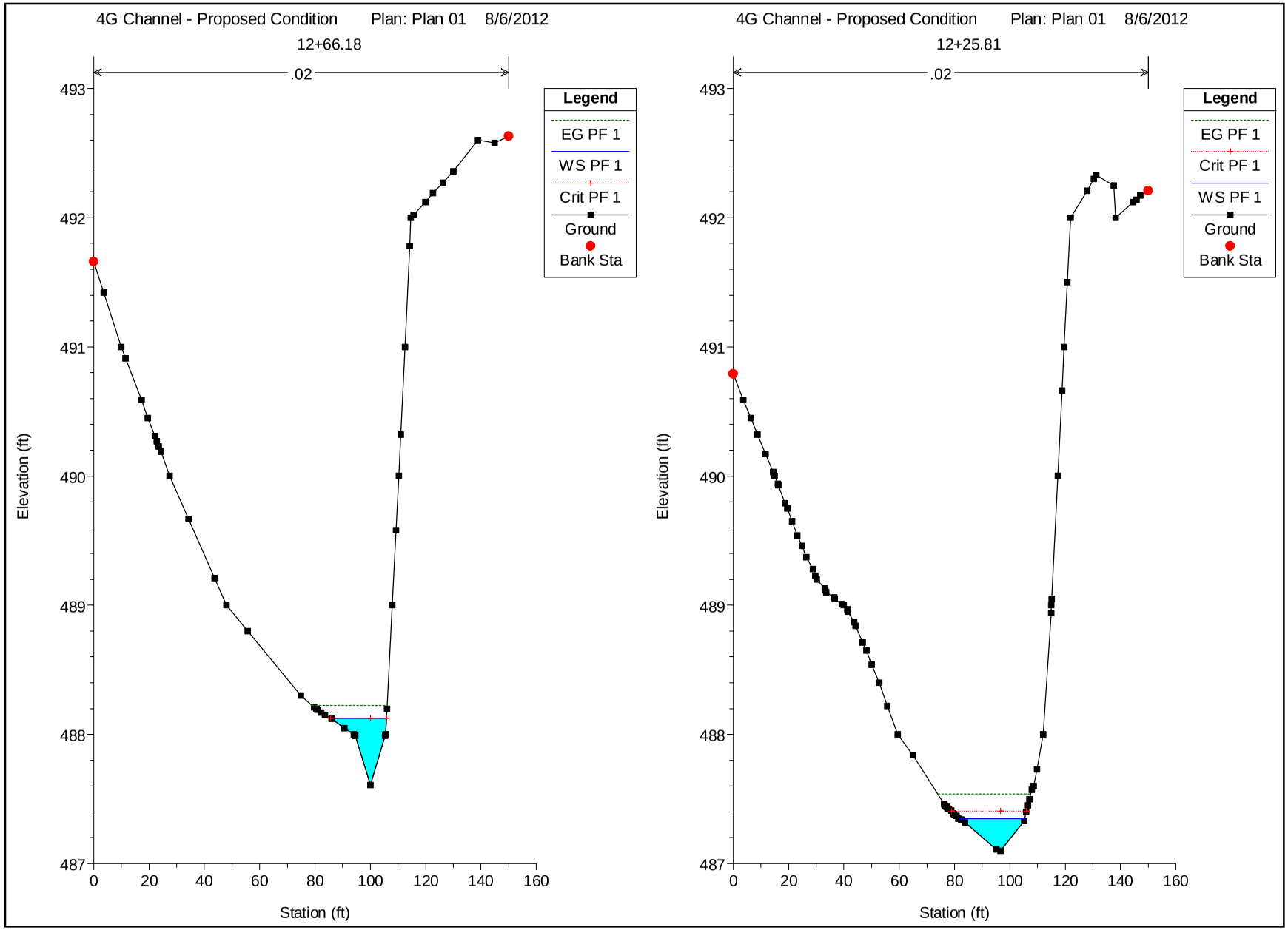
Plan: Plan 01 4G OFFSITE DRAINAGE RS: 1105.94 Profile: PF 1

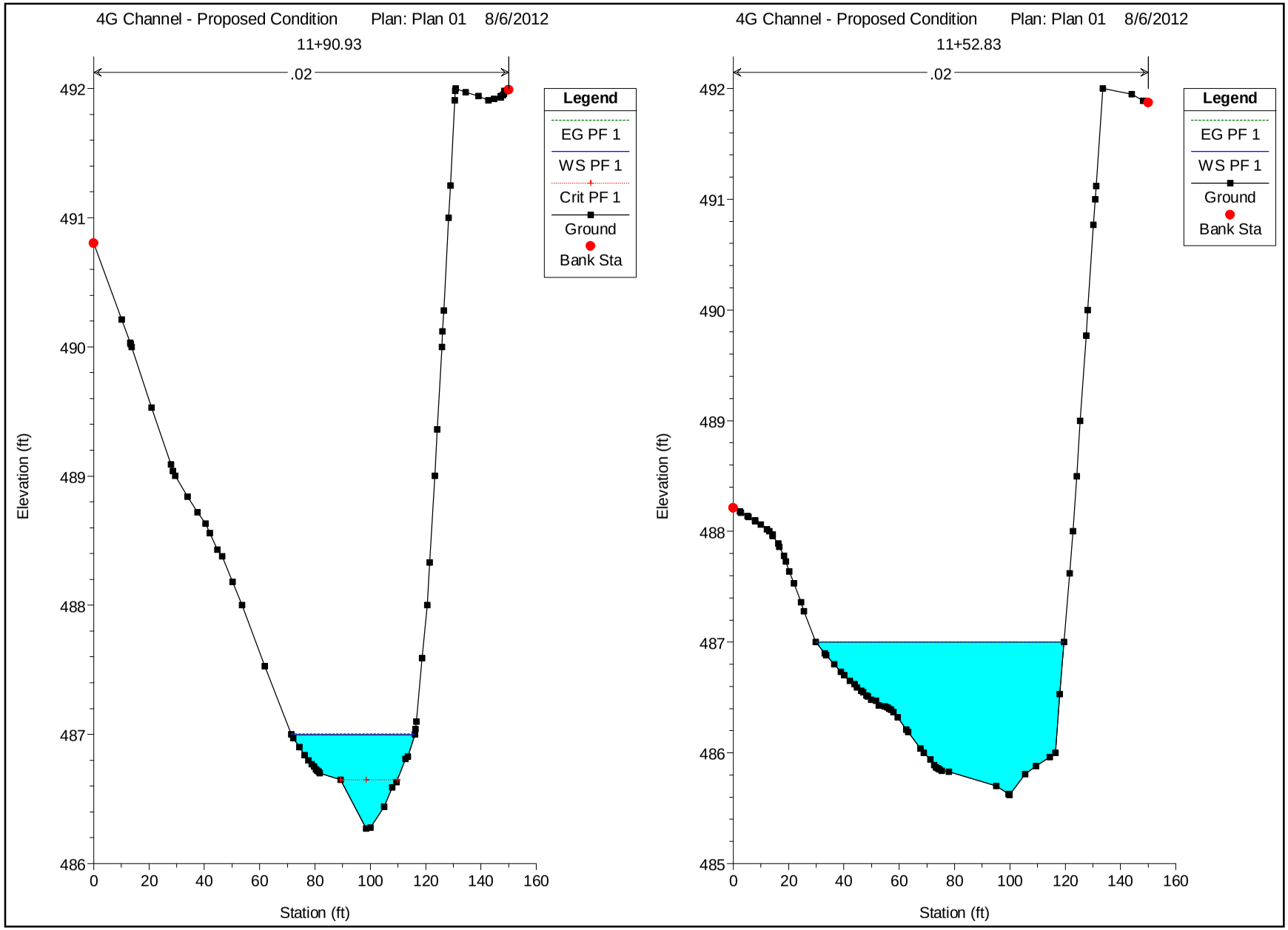
E.G. Elev (ft)	487.00	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.00	Wt. n-Val.		0.020	
W.S. Elev (ft)	487.00	Reach Len. (ft)			
Crit W.S. (ft)	484.36	Flow Area (sq ft)		203.68	
E.G. Slope (ft/ft)	0.000000	Area (sq ft)		203.68	
Q Total (cfs)	9.40	Flow (cfs)		9.40	
Top Width (ft)	111.34	Top Width (ft)		111.34	
Vel Total (ft/s)	0.05	Avg. Vel. (ft/s)		0.05	
Max Chl Dpth (ft)	2.86	Hydr. Depth (ft)		1.83	
Conv. Total (cfs)	22573.3	Conv. (cfs)		22573.3	
Length Wtd. (ft)		Wetted Per. (ft)		111.80	
Min Ch El (ft)	484.14	Shear (lb/sq ft)		0.00	
Alpha	1.00	Stream Power (lb/ft s)		0.00	
Frctn Loss (ft)		Cum Volume (acre-ft)			
C & E Loss (ft)		Cum SA (acres)			

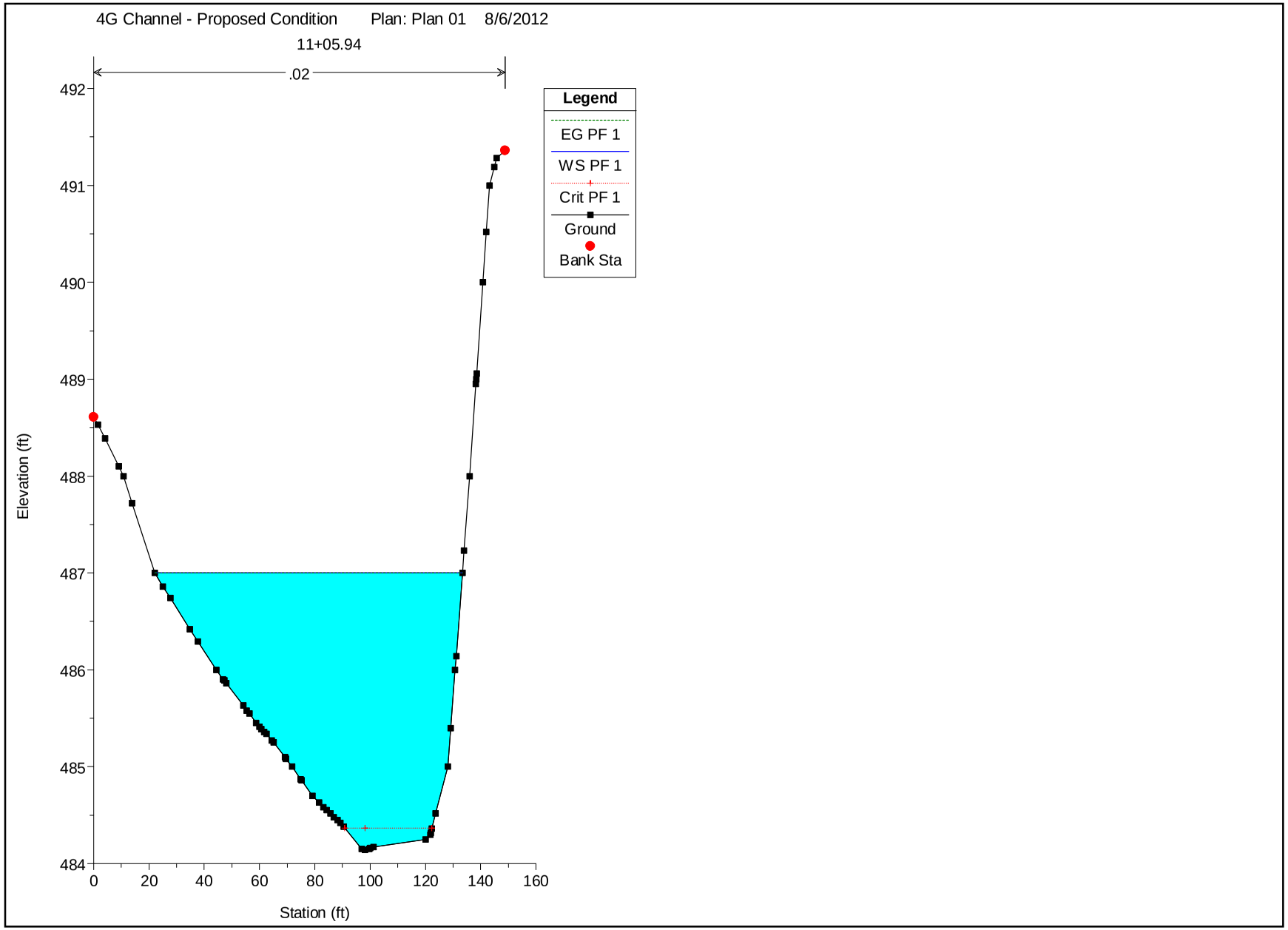

4G Channel - Proposed Condition Plan: Plan 01 8/6/2012
4G OFFSITE DRAINAGE
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Elevation (ft)
489
488
487
486
485
484
0
50
100
150
200
250
Main Channel Distance (ft)


4G Channel - Proposed Condition Plan: Plan 01 8/6/2012
11+05.94
.02
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Bank Sta
Elevation (ft)
Station (ft)
4G Channel - Proposed Condition Plan: Plan 01 8/6/2012
13+42.25
.02
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Bank Sta
Elevation (ft)
Station (ft)
4G Channel - Proposed Condition Plan: Plan 01 8/6/2012
13+02.92
.02
Legend
EG PF 1
WS PF 1
Ground
Bank Sta
Elevation (ft)
Station (ft)
4G Channel - Proposed Condition Plan: Plan 01 8/6/2012
12+66.18
.02
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Bank Sta
Elevation (ft)
Station (ft)
4G Channel - Proposed Condition Plan: Plan 01 8/6/2012
12+25.81
.02
Legend
EG PF 1
Crit PF 1
WS PF 1
Ground
Bank Sta
Elevation (ft)
Station (ft)
4G Channel - Proposed Condition Plan: Plan 01 8/6/2012
11+90.93
.02
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Bank Sta
Elevation (ft)
Station (ft)
4G Channel - Proposed Condition Plan: Plan 01 8/6/2012
11+52.83
.02
Legend
EG PF 1
WS PF 1
Ground
Bank Sta
Elevation (ft)
Station (ft)


4G Channel - Proposed Condition Plan: Plan 01 8/6/2012
13+42.25
.02
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Bank Sta
Elevation (ft)
Station (ft)
4G Channel - Proposed Condition Plan: Plan 01 8/6/2012
13+02.92
.02
Legend
EG PF 1
WS PF 1
Ground
Bank Sta
Elevation (ft)
Station (ft)


4G Channel - Proposed Condition Plan: Plan 01 8/6/2012
12+66.18
.02
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Bank Sta
Elevation (ft)
Station (ft)
4G Channel - Proposed Condition Plan: Plan 01 8/6/2012
12+25.81
.02
Legend
EG PF 1
Crit PF 1
WS PF 1
Ground
Bank Sta
Elevation (ft)
Station (ft)


4G Channel - Proposed Condition Plan: Plan 01 8/6/2012
11+90.93
.02
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Bank Sta
Elevation (ft)
Station (ft)
4G Channel - Proposed Condition Plan: Plan 01 8/6/2012
11+52.83
.02
Legend
EG PF 1
WS PF 1
Ground
Bank Sta
Elevation (ft)
Station (ft)


4G Channel - Proposed Condition
Plan: Plan 01
8/6/2012
11+05.94
.02
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Bank Sta
Elevation (ft)
Station (ft)
492
491
490
489
488
487
486
485
484
0
20
40
60
80
100
120
140
160

Plan: Plan 01 4G OFFSITE DRAINAGE RS: 1342.25 Profile: PF 1

E.G. Elev (ft)	488.35	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.01	Wt. n-Val.		0.020	
W.S. Elev (ft)	488.34	Reach Len. (ft)	39.33	39.33	39.33
Crit W.S. (ft)	488.02	Flow Area (sq ft)		15.89	
E.G. Slope (ft/ft)	0.000268	Area (sq ft)		15.89	
Q Total (cfs)	10.60	Flow (cfs)		10.60	
Top Width (ft)	39.07	Top Width (ft)		39.07	
Vel Total (ft/s)	0.67	Avg. Vel. (ft/s)		0.67	
Max Chl Dpth (ft)	0.55	Hydr. Depth (ft)		0.41	
Conv. Total (cfs)	647.3	Conv. (cfs)		647.3	
Length Wtd. (ft)	39.33	Wetted Per. (ft)		39.16	
Min Ch El (ft)	487.79	Shear (lb/sq ft)		0.01	
Alpha	1.00	Stream Power (lb/ft s)		0.00	
Frctn Loss (ft)	0.02	Cum Volume (acre-ft)		0.22	
C & E Loss (ft)	0.00	Cum SA (acres)		0.27	

Plan: Plan 01 4G OFFSITE DRAINAGE RS: 1302.92 Profile: PF 1

E.G. Elev (ft)	488.33	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.02	Wt. n-Val.		0.020	
W.S. Elev (ft)	488.31	Reach Len. (ft)	36.74	36.74	36.74
Crit W.S. (ft)		Flow Area (sq ft)		9.34	
E.G. Slope (ft/ft)	0.001203	Area (sq ft)		9.34	
Q Total (cfs)	10.60	Flow (cfs)		10.60	
Top Width (ft)	31.89	Top Width (ft)		31.89	
Vel Total (ft/s)	1.13	Avg. Vel. (ft/s)		1.13	
Max Chl Dpth (ft)	0.64	Hydr. Depth (ft)		0.29	
Conv. Total (cfs)	305.7	Conv. (cfs)		305.7	
Length Wtd. (ft)	36.74	Wetted Per. (ft)		31.98	
Min Ch El (ft)	487.67	Shear (lb/sq ft)		0.02	
Alpha	1.00	Stream Power (lb/ft s)		0.02	
Frctn Loss (ft)	0.10	Cum Volume (acre-ft)		0.21	
C & E Loss (ft)	0.01	Cum SA (acres)		0.24	

Plan: Plan 01 4G OFFSITE DRAINAGE RS: 1266.18 Profile: PF 1

E.G. Elev (ft)	488.23	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.10	Wt. n-Val.		0.020	
W.S. Elev (ft)	488.12	Reach Len. (ft)	40.37	40.37	40.37
Crit W.S. (ft)	488.12	Flow Area (sq ft)		4.15	
E.G. Slope (ft/ft)	0.009813	Area (sq ft)		4.15	
Q Total (cfs)	10.60	Flow (cfs)		10.60	
Top Width (ft)	20.26	Top Width (ft)		20.26	
Vel Total (ft/s)	2.55	Avg. Vel. (ft/s)		2.55	
Max Chl Dpth (ft)	0.51	Hydr. Depth (ft)		0.20	
Conv. Total (cfs)	107.0	Conv. (cfs)		107.0	

Plan: Plan 01 4G OFFSITE DRAINAGE RS: 1266.18 Profile: PF 1 (Continued)

Length Wtd. (ft)	40.37	Wetted Per. (ft)		20.31	
Min Ch El (ft)	487.61	Shear (lb/sq ft)		0.13	
Alpha	1.00	Stream Power (lb/ft s)		0.32	
Frctn Loss (ft)	0.42	Cum Volume (acre-ft)		0.20	
C & E Loss (ft)	0.00	Cum SA (acres)		0.21	

Plan: Plan 01 4G OFFSITE DRAINAGE RS: 1225.81 Profile: PF 1

E.G. Elev (ft)	487.54	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.19	Wt. n-Val.		0.020	
W.S. Elev (ft)	487.35	Reach Len. (ft)	34.88	34.88	34.88
Crit W.S. (ft)	487.41	Flow Area (sq ft)		3.02	
E.G. Slope (ft/ft)	0.034722	Area (sq ft)		3.02	
Q Total (cfs)	10.60	Flow (cfs)		10.60	
Top Width (ft)	23.62	Top Width (ft)		23.62	
Vel Total (ft/s)	3.51	Avg. Vel. (ft/s)		3.51	
Max Chl Dpth (ft)	0.25	Hydr. Depth (ft)		0.13	
Conv. Total (cfs)	56.9	Conv. (cfs)		56.9	
Length Wtd. (ft)	34.88	Wetted Per. (ft)		23.62	
Min Ch El (ft)	487.10	Shear (lb/sq ft)		0.28	
Alpha	1.00	Stream Power (lb/ft s)		0.97	
Frctn Loss (ft)	0.68	Cum Volume (acre-ft)		0.20	
C & E Loss (ft)	0.01	Cum SA (acres)		0.19	

Plan: Plan 01 4G OFFSITE DRAINAGE RS: 1190.93 Profile: PF 1

E.G. Elev (ft)	487.00	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.01	Wt. n-Val.		0.020	
W.S. Elev (ft)	487.00	Reach Len. (ft)	38.10	38.10	38.10
Crit W.S. (ft)	486.65	Flow Area (sq ft)		16.53	
E.G. Slope (ft/ft)	0.000280	Area (sq ft)		16.53	
Q Total (cfs)	10.60	Flow (cfs)		10.60	
Top Width (ft)	44.58	Top Width (ft)		44.58	
Vel Total (ft/s)	0.64	Avg. Vel. (ft/s)		0.64	
Max Chl Dpth (ft)	0.73	Hydr. Depth (ft)		0.37	
Conv. Total (cfs)	633.5	Conv. (cfs)		633.5	
Length Wtd. (ft)	38.10	Wetted Per. (ft)		44.61	
Min Ch El (ft)	486.27	Shear (lb/sq ft)		0.01	
Alpha	1.00	Stream Power (lb/ft s)		0.00	
Frctn Loss (ft)	0.00	Cum Volume (acre-ft)		0.19	
C & E Loss (ft)	0.00	Cum SA (acres)		0.17	

Plan: Plan 01 4G OFFSITE DRAINAGE RS: 1152.83 Profile: PF 1

E.G. Elev (ft)	487.00	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.00	Wt. n-Val.		0.020	
W.S. Elev (ft)	487.00	Reach Len. (ft)	46.89	46.89	46.89
Crit W.S. (ft)		Flow Area (sq ft)		77.58	
E.G. Slope (ft/ft)	0.000004	Area (sq ft)		77.58	
Q Total (cfs)	10.60	Flow (cfs)		10.60	
Top Width (ft)	89.76	Top Width (ft)		89.76	
Vel Total (ft/s)	0.14	Avg. Vel. (ft/s)		0.14	
Max Chl Dpth (ft)	1.38	Hydr. Depth (ft)		0.86	
Conv. Total (cfs)	5222.4	Conv. (cfs)		5222.4	
Length Wtd. (ft)	46.89	Wetted Per. (ft)		89.94	
Min Ch El (ft)	485.62	Shear (lb/sq ft)		0.00	
Alpha	1.00	Stream Power (lb/ft s)		0.00	
Frctn Loss (ft)	0.00	Cum Volume (acre-ft)		0.15	
C & E Loss (ft)	0.00	Cum SA (acres)		0.11	

Plan: Plan 01 4G OFFSITE DRAINAGE RS: 1105.94 Profile: PF 1

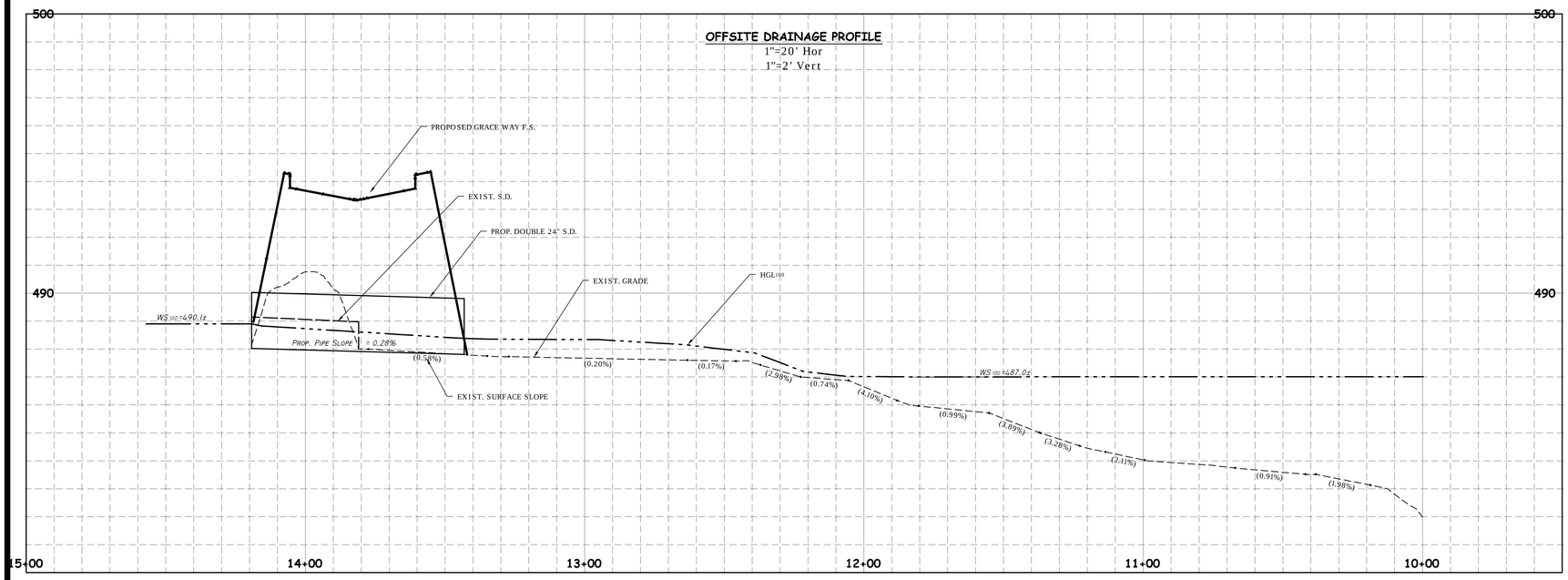
E.G. Elev (ft)	487.00	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.00	Wt. n-Val.		0.020	
W.S. Elev (ft)	487.00	Reach Len. (ft)			
Crit W.S. (ft)	484.37	Flow Area (sq ft)		203.68	
E.G. Slope (ft/ft)	0.000000	Area (sq ft)		203.68	
Q Total (cfs)	10.60	Flow (cfs)		10.60	
Top Width (ft)	111.34	Top Width (ft)		111.34	
Vel Total (ft/s)	0.05	Avg. Vel. (ft/s)		0.05	
Max Chl Dpth (ft)	2.86	Hydr. Depth (ft)		1.83	
Conv. Total (cfs)	22573.3	Conv. (cfs)		22573.3	
Length Wtd. (ft)		Wetted Per. (ft)		111.80	
Min Ch El (ft)	484.14	Shear (lb/sq ft)		0.00	
Alpha	1.00	Stream Power (lb/ft s)		0.00	
Frctn Loss (ft)		Cum Volume (acre-ft)			
C & E Loss (ft)		Cum SA (acres)			

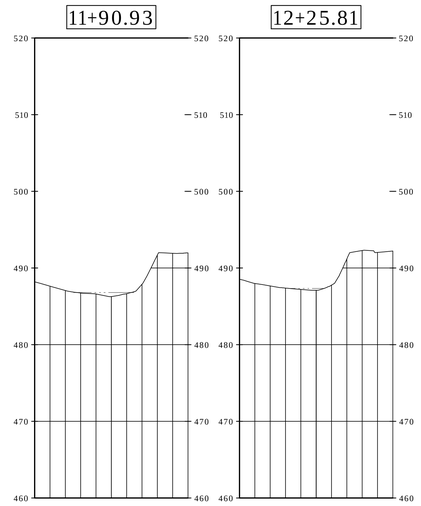
GRAPHIC SCALE:

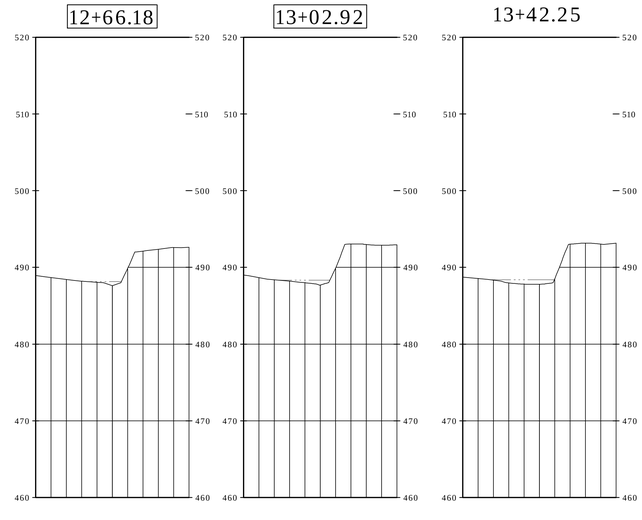
20 0 10 20 40 80

(IN FEET)
1 INCH = 20 FT.

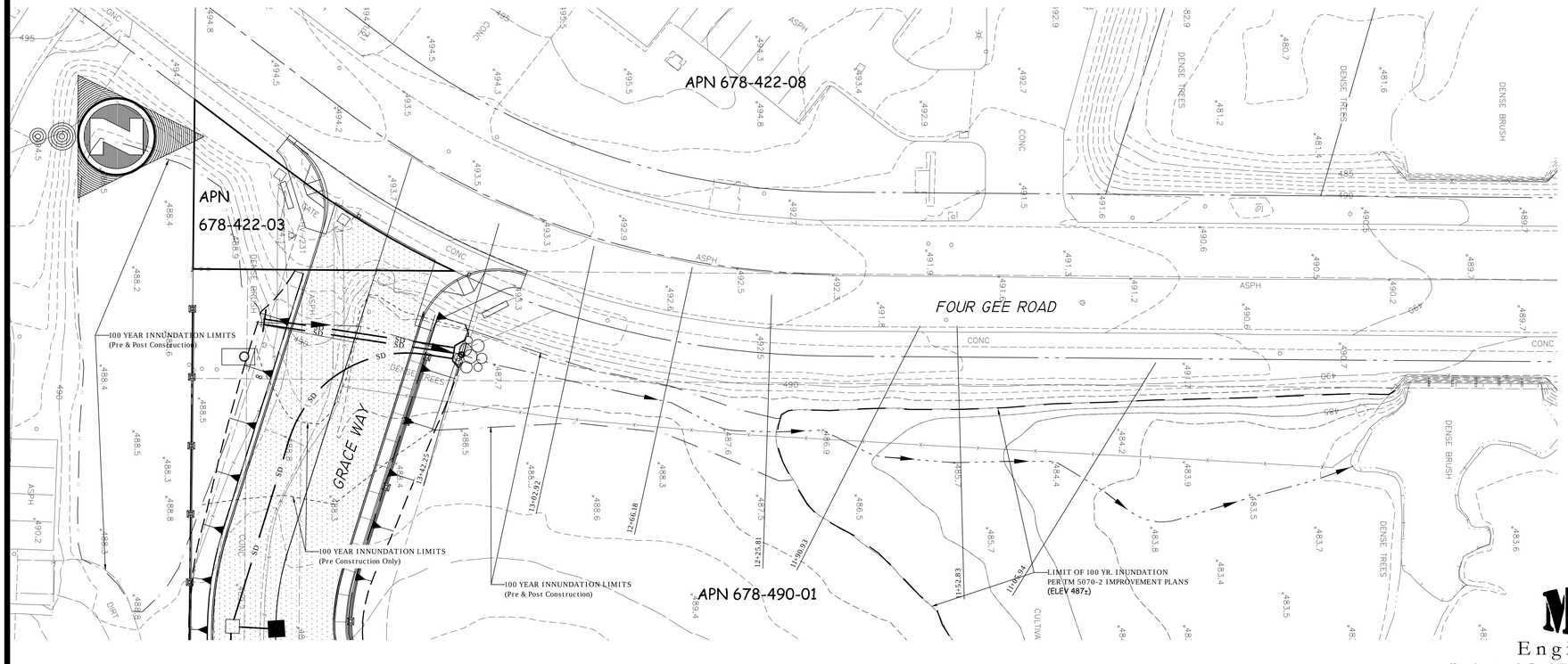
ATTACHMENT H
OFF-SITE CHANNEL PROFILE & SECTIONS







SECTIONS:
1"=40' HOR, 1"=4' VERT.



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1/20/2014

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