Appendix H

PRELIMINARY HYDROLOGY ANALYSIS

PRELIMINARY
HYDROLOGY ANALYSIS
FOR
COASTAL RAIL TRAIL
ROSE CREEK ALIGNMENT
Segment 9B

Prepared for

SANDAG
San Diego Regional Planning Agency

Prepared by

Nasland Engineering

June, 2015

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PURPOSE

This Preliminary Hydrology Analysis has been prepared to provide an understanding of the potential, project specific impacts to the local storm water runoff characteristics that may be experienced due to the addition of a 14' wide improved bikeway path within unimproved or partially improved areas along the proposed alignment.

INTRODUCTION

The proposed project represents Segment 9B of the Coastal Rail Trail (CRT), as identified in the Regional Bike Plan (RBP). The CRT is a 44-mile bikeway facility extending from the City of Oceanside's San Luis Rey River Bikeway to the Santa Fe Train Depot in the City of San Diego. As illustrated in **Figure 1**, the proposed Segment 9B Coastal Rail Trail, the Rose Creek Alignment bikeway facility, would extend approximately 2.1 miles from the west side of Mission Bay Drive as it crosses over Rose Creek to the northern terminus of Santa Fe Street to the north.

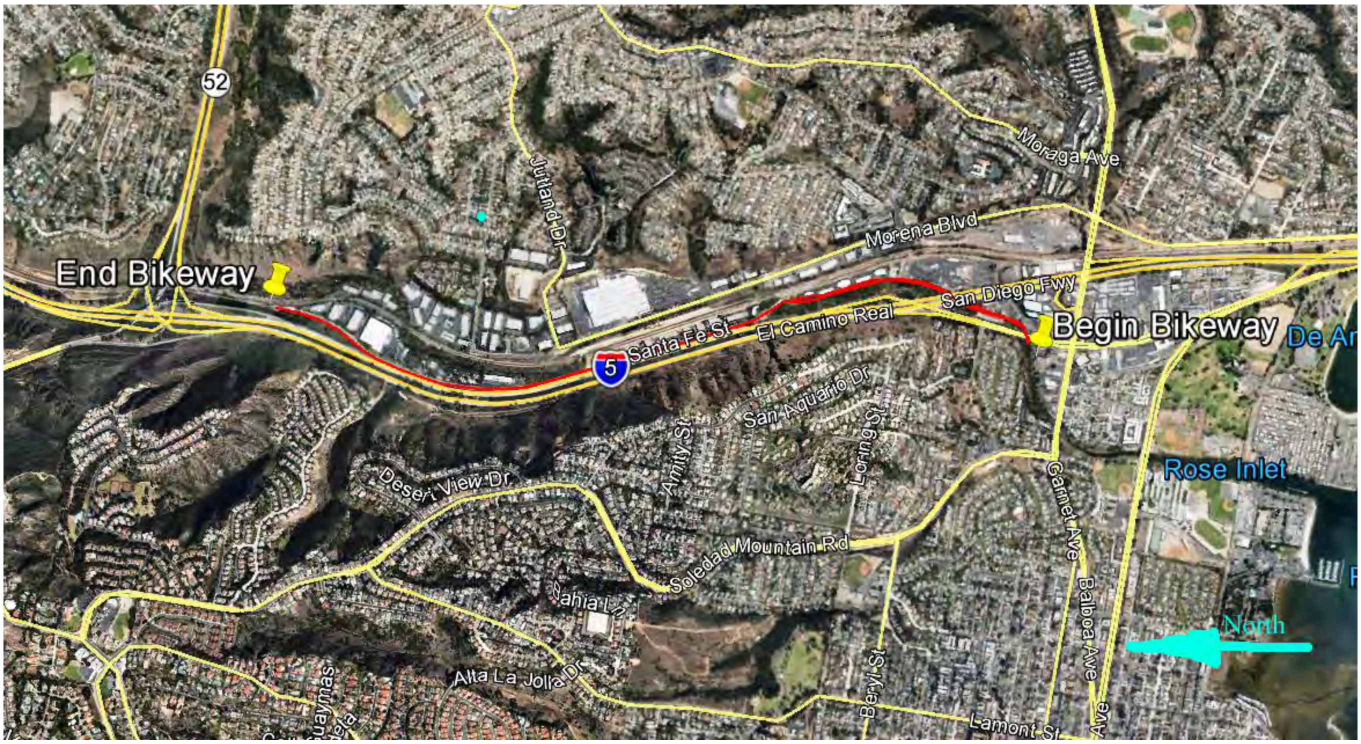


Figure 1

The project site is located at the west end of the Rose Creek watershed. The Rose Creek Watershed Alliance describes the watershed size as: "The Rose Creek Watershed drains a <u>23,427-acre or 36-square mile area</u> into Mission Bay. The main natural features that make up this watershed include Rose and San Clemente Canyons and their tributary canyons, including Stevenson and Lakehurst Canyons." **See Figure 2**.

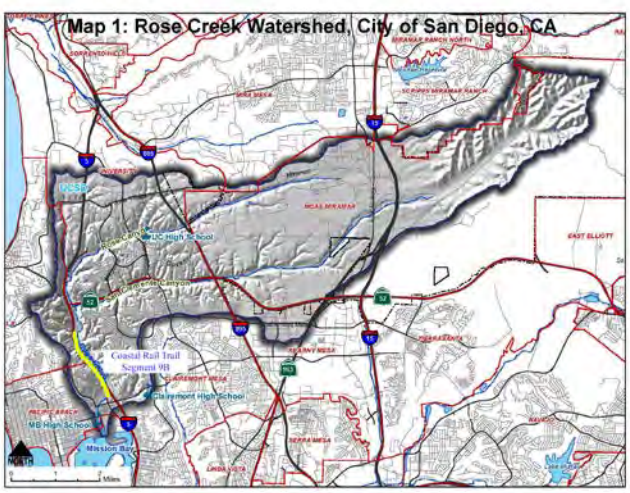


Figure 2 – Rose Creek Watershed

The San Diego Association of Governments (SANDAG) has initiated preliminary engineering, with plans prepared by Nasland Engineering, for Segment 9B of the Coastal Rail Trail, the Rose Creek Alignment project. The project proposes a 14-foot wide bikeway path along and adjacent to Rose Canyon Creek from Mission Bay Drive to Santa Fe Street (see the Vicinity Map). The path will extend along the east side of the creek with segments aligned either just above or within the existing channel bank. A retaining wall will be constructed to create a 14' wide bench to support the segments within the channel banks. (**See Figure 3**.)

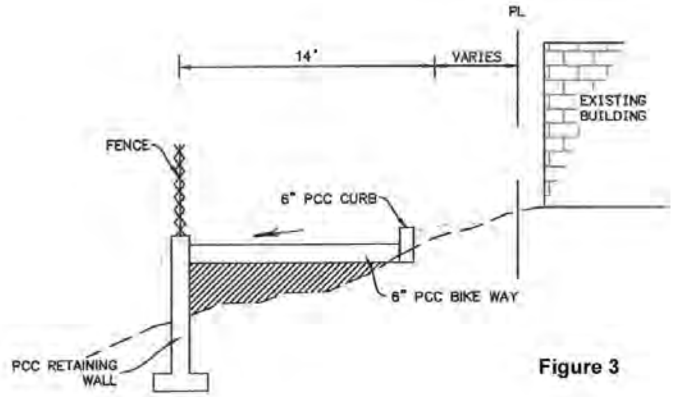


Figure 3

The path will pass under the existing bridges at Mission Bay Drive and Interstate 5. The existing Rose Canyon Creek channel in the vicinity of Mission Bay Drive is a concrete rectangular channel. A concrete structure is to extend along wall/floor at Mission Bay Drive to create the path under the bridge. (**See Figure 4**.)

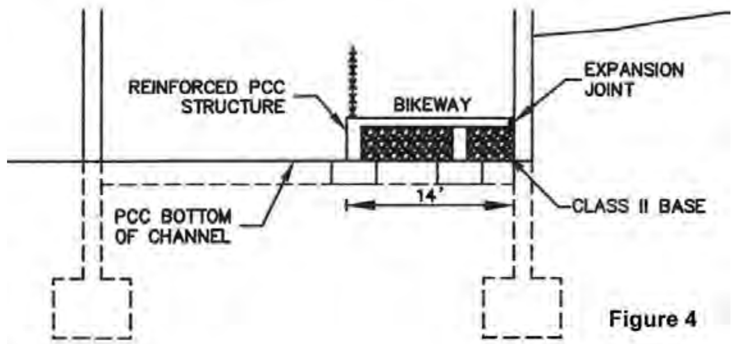


Figure 4

Similarly, a concrete structure will be aligned adjacent to the southerly pier of the Interstate 5 bridge so that the path runs under this bridge, adjacent to the pier. (**See Figure 4**.) The path will continue along and adjacent to Rose Canyon Creek to the downstream side of the existing Santa Fe Street bridge. A proposed bikeway path bridge with a 14-foot wide travel way will be constructed for the Rose Canyon Creek crossing. Once across the creek, the path will run along Santa Fe Street to the north terminus of Santa Fe Street where it will join an existing bikeway.

A LOCATION HYDRAULIC STUDY COASTAL RAIL TRAIL, ROSE CREEK BIKEWAY dated April 27, 2015, has been prepared by Wayne Chang of Chang Consultants. The purpose of this report is to evaluate the impact on the 100-year storm event water surface elevations within Rose Creek due to the addition of the 14' wide bikeway bench within the Rose Creek floodway and floodplain. The 100-year flow (Q) in Rose Creek within the project limits based on FEMA data is 12,000 cubic feet per second (CFS). Mr. Chang's analyses incorporates, where appropriate, data prepared for SANDAG's Mid-Coast Corridor Transit Project, as well as available FEMA data. Mr. Chang's conclusions are: *"The results indicate that the project will increase water surface elevations within portions of Rose Canyon Creek, which is anticipated because portions of the project encroach within the 100-year floodplain. However, the increases are primarily contained within the channel banks. The 100-year water surface can exceed the rectangular concrete channel banks just downstream of Mission Bay Drive, but is contained within the adjacent earthen slopes. The water surface impacts upstream of the project are 0.1 feet or less and generally diminish before the upstream railroad bridge."*

Mr. Chang's report is included herein by this reference.

PROJECT SCOPE

This analysis is concerned with the potential increase in runoff due to the addition of a 14' wide improved bikeway path within unimproved or partially improved areas along the proposed path alignment. The analysis is divided into several segments related to the varying site conditions within the alignment. These segments are identified by the approximate project stationing, as follows:

10+00 to 13+23.5: Trail begins about 100' south of Mission Bay Drive, extends into the existing Rose Creek channel. The channel in this area is an existing concrete rectangular channel. Trail runs beneath the Mission Bay Drive bridge.

13+23.5 to 13+38.2: Trail leaves the channel bottom and turns right to proceed along the top of concrete rectangular channel wall.

13+38.2 to 21+50: Trail runs along the top of the channel wall along an existing compacted earth path.

21+50 to 26+00: Rectangular concrete channel ends. Trail leaves top of wall and generally follows existing compacted earth path within the natural channel, passing beneath the Interstate 5 (I-5) bridge.

26+00 to 47+60: Trail climbs channel embankment and proceeds along top of channel generally within an existing compacted earth path for the initial 400' west of the SDG&E maintenance yard, and continues along the rear of an existing industrial park to a point where it approaches the existing Santa Fe Street bridge that crosses Rose Creek.

47+60 to 50+95: 14' clear width bikeway bridge with related approaches on south and north ends. Bridge deck length is 244'.

50+95 to 52+22 (11+90 Santa Fe Street): Trail continues to point where it will join and proceed along the west side of Santa Fe Street.

10+50 to 81+80 (Santa Fe Street): Santa Fe Street widening along west side to provide the required 14' bikeway path, including a 2' wide median and a 2' wide shoulder adjacent to the I-5 right-of-way. Existing Santa Fe Street paved driving lane improvements range between approximately 32' to 41' in width within the existing 48' right-of-way. Curb, gutter, and driveway approaches are to be added along portions of the east side of Santa Fe Street within an 8' parkway.

APPROACH & ANALYSIS

Each of the segments, or combination of segments, noted above in PROJECT SCOPE are evaluated individually because the potential impacts due to the 14' bikeway path installation will vary. The evaluation will compare the pre-project runoff potential with the post-construction project runoff potential. Much of the following hydrology analysis will be in a narrative form because the overall impact of adding a 14' wide impervious path on the 100-year flow of 12,000 CFS within Rose Creek is insignificant.

Rational Method Hydrology:

Individual segments that are evaluated will use the rational formula Q=CIA

Where: Q = peak discharge in cubic feet per second
C = runoff coefficient (unit-less)

I = average rainfall intensity in inches per hour for a duration equal to the time of concentration (Tc)
A = tributary area in acres

For the small areas involved a time of concentration (Tc) of 10 minutes is used. This is a conservative value as the time of concentration for the 12,000 CFS in Rose Creek would be considerably greater and the resulting intensity value would be much lower, resulting in much smaller flow values.

The C-values used for this analysis are based on the attached **Runoff Coefficient Fact Sheet 5.1.3,** pages 1 and 2. (**See Exhibit 1**).

This analysis is based on the 100-year storm event. Based on the **NOAA Atlas 14 Point Precipitation Frequency Estimates, CA (See Exhibit 2)** the precipitation values for a 100-year, 6-hour and 24-hour storm event are:

$P6_{100}$ = 2.37
$P24_{100}$ = 4.05

For a 10 minute Tc, P6 = 2.37**, I_{100} = 3.99 inches per hour**.

Station-to-Station Evaluation

10+00 to 25+00: Rose Creek is contained within a rectangular concrete channel within this reach. Placing a 14' wide impervious bikeway within the concrete channel structure will not increase storm water runoff. The runoff coefficients (C-value) are the same. Pre-project and post-project runoff are the same. No additional analysis is provided for this reach.

25+00 to 29+00: This portion of the bikeway will follow an existing compacted earthen path.

The C-value used for the compacted ground is 0.6.
The C-value used for the 14' bikeway is 0.9.
Tc = 10 minutes
I_{100} is 3.99
The area (A) of this segment of bikeway is 14'x400' = 0 .13 acres
Pre-project Q=CIA =(0 .6)(3.99)(.13) = 0.31 CFS
Post-project Q=CIA =(0.9)(3.99)(.13) = 0.47 CFS
Projected 100-year runoff rate increase = **0.16 CFS**

29+00 to 45+00: This is a relatively steep slope bank with heavy vegetation. However, a C= 0.3 is used due to the general nature of the heavy soils in the area.

The C-value used for the slope area and heavy soils is 0.3.
The C-value used for the 14' bikeway is 0.9.
Tc = 10 minutes
I_{100} is 3.99
The area (A) of this segment of bikeway is 14'x 1,600' =00 .51 acres
Pre-project Q=CIA = (0 .3)(3.99)(.51) = 0.61 CFS
Post-project Q=CIA = (0 .9)(3.99)(.51) = 1.83 CFS
Projected 100-year runoff rate increase = **1.23 CFS**

45+00 to 47+60: This portion of the bikeway will follow an existing compacted earthen path.

The C-value used for the compacted ground is 0.6.
The C-value used for the 14’ bikeway is 0.9.
Tc = 10 minutes
I_{100} is 3.99
The area (A) of this segment of bikeway is 14’x260’ = 00.08 acres
Pre-project Q=CIA =(0 .6)(3.99)(.08) = 0.19 CFS
Post-project Q=CIA =(0 .9)(3.99)(.08) = 0.29 CFS
Projected 100-year runoff rate increase = **0.10 CFS**

47+60 to 50+95: 14’ clear width bikeway bridge with related approaches on south and north ends.

The C-value used for the Rose Creek channel is 0.1.
The C-value used for the 14’ bikeway is 0.9.
Tc = 10 minutes
I_{100} is 3.99
The area (A) of this segment of bikeway is 14’x335’ = 0.11 acres
Pre-project Q=CIA =(0 .1)(3.99)(.11) = 0.04 CFS
Post-project Q=CIA =(0 .9)(3.99)(.11) = 0.40 CFS
Projected 100-year runoff rate increase = **0.36 CFS**

50+95 to 52+22: This portion of the bikeway will follow an existing compacted earthen path.

The C-value used for the compacted ground is 0.6.
The C-value used for the 14’ bikeway is 0.9.
Tc = 10 minutes
I_{100} is 3.99
The area (A) of this segment of bikeway is 14’x127’ = 0.04 acres
Pre-project Q=CIA =(.6)(3.99)(.04) = 0.10 CFS
Post-project Q=CIA =(0.9)(3.99)(.04) = 0.14 CFS
Projected 100-year runoff rate increase = **0.04 CFS**

52+22 Bikeway = 11+90 Santa Fe Street – Stationing Equation

Santa Fe Street reach: Between 10+50 and 81+58 a number of buildings have driveway connections to Santa Fe Street. These buildings are typically below the grade of Santa Fe Street, and drain toward the Rose Creek channel. Based on a recent site visit it appears most of these driveways are built to keep storm water from entering the sites. Existing drainage conditions will remain mostly intact with the addition of two new inlets.

10+50 to 80+00 Santa Fe Street: This reach has been divided into four (4) project related drainage basins. (**See Exhibit 3.**)The southerly end of each basin aligns with either an existing storm drain or a proposed storm drain location. Tabulation tables for the 100-year storm event for each of the four basins, for both the existing condition and the proposed condition with the bike trail and sidewalks installed, are provide as **Exhibits 4 and 5**. The results from the tabulations are used in the following discussions for the four basins.

10+50 to 40+00: Sta 40+00 is at a high point in the Santa Fe Street alignment. Storm water will flow south until it reaches an existing inlet at the northeast corner of the Santa Fe Street bridge. This water outlets directly into Rose Creek.

Existing condition Q_{100} flow rate = 10.63 cfs
Proposed condition Q_{100} flow rate = 11.77 cfs
Projected 100-year runoff rate increase = **1.14 CFS**

40+00 to 52+25: According to records an existing 18” storm drain crosses Santa Fe Street at Sta 52+25. Santa Fe Street is in a “sump” condition at this location. An existing grate inlet and curb inlet will remain and be protected in place at this location to collect the storm water from this stretch of Santa Fe Street as well as runoff between Sta 52+25 and 71+00.

Existing condition Q_{100} flow rate = 4.31 cfs
Proposed condition Q_{100} flow rate = 4.69 cfs
Projected 100-year runoff rate increase = **0.38 CFS**

52+25 to 71+00: As noted above, this reach of Santa Fe Street would also drain to the 18” storm drain at the low point in the road at 52+25.

Existing condition Q_{100} flow rate = 7.54 cfs
Proposed condition Q_{100} flow rate = 7.70 cfs
Projected 100-year runoff rate increase = **0.16 CFS**

71+00 to 80+15: Sta 71+00 is at a high point in the Santa Fe Street alignment. According to records an existing 48” pipe crosses diagonally across Sant Fe Street near Sta 80+15. An inlet structure would be constructed on the west side of Santa Fe Street within the proposed 2’ wide bike trail median and connected to the 48” pipe.

Existing condition Q_{100} flow rate = 4.75 cfs
Proposed condition Q_{100} flow rate = 4.92 cfs
Projected 100-year runoff rate increase = **0.17 CFS**

80+15 to end of Project: This final leg of the Segment 9B bike trail terminates at Sta 81+75 at the existing turnaround at the north end of Santa Fe Street. Santa Fe Street in this location surface drains easterly into a large swale along the west side of the railroad tracks. Only the replacement of the existing hard earth path along the west side of the street with the new bike trail is accounted for below. Storm water from this area passes under the railroad tracks through a pair of 48” culverts and into Rose Creek.

The C-value used for the compacted ground is 0.6.
The C-value used for the 14’ bikeway is 0.9.
Tc = 10 minutes
I_{100} is 3.99
The area (A) of this segment of bikeway is 1448sf = 0.033 acres
Pre-project Q=CIA =(.6)(3.99)(.033) = 0.079 CFS
Post-project Q=CIA =(0.9)(3.99)(.033) = 0.119 CFS
Projected 100-year runoff rate increase = **0.04 CFS**

SUMMARY OF POTENTIAL IMPACTS:

The potential impacts resulting from the bike trail construction are:

- Increase in peak storm water runoff
- Changing pervious areas to impervious area

The potential 100-year increase in peak runoff is approximately 3.8 cfs. (See **Runoff Summary**, **Exhibit 6.)**

Area changed from pervious to impervious is approximately 2.0 acres. (See **Pervious to Impervious Comparison, Exhibit 7.)**

CONCLUSIONS AND OBSERVATIONS:

The 3.8 cfs increase in peak runoff for a 100-year storm event from the roughly 2 mile bike trail construction will have virtually no impact on the Rose Creek channel hydraulics. The runoff from the project site will peak long before the peak flow for the projected 12,000 cfs for the Rose Creek watershed.

Installation of curb inlets and catch basins along the Santa Fe Street corridor are to collect local runoff from the roadway and adjacent areas. This will minimize the potential for street runoff to enter private parking areas along the east side of Santa Fe Street.

The cumulative impact of the 2.0 acre increase in impervious area, which accounts for the increase in peak runoff increase, is considered insignificant when compared to the 23,427 acre Rose Creek watershed. Most of this watershed between the project site and Interstate 15 is built out. Future upstream developments will be required to accommodate runoff increases onsite. Areas downstream of the project site are fully developed.

Prepared under the supervision of:

_______________________________ Date: _______
Cory Schrack, RCE 65976

EXHIBITS

Runoff Coefficient (C) Fact Sheet

What is It?

The runoff coefficient (C) is a dimensionless coefficient relating the amount of runoff to the amount of precipitation received. It is a larger value for areas with low infiltration and high runoff (pavement, steep gradient), and lower for permeable, well vegetated areas (forest, flat land).

Why is It Important?

It is important for flood control channel construction and for possible flood zone hazard delineation. A high runoff coefficient (C) value may indicate flash flooding areas during storms as water moves fast overland on its way to a river channel or a valley floor.

How is It Measured?

It is measured by determining the soil type, gradient, permeability and land use. The values are taken from the table below. The larger values correspond to higher runoff and lower infiltration.

Land Use	C	Land Use	C
		Lawns:	
		Sandy soil, flat, 2%	0.05 - 0.10
Business:		Sandy soil, avg., 2-7%	0.10 - 0.15
Downtown areas	0.70 - 0.95	Sandy soil, steep, 7%	0.15 - 0.20
Neighborhood areas	0.50 - 0.70	Heavy soil, flat, 2%	0.13 - 0.17
		Heavy soil, avg., 2-7%	0.18 - 0.22
		Heavy soil, steep, 7%	0.25 - 0.35
		Agricultural land:	
		Bare packed soil	
		*Smooth	0.30 - 0.60
		*Rough	0.20 - 0.50
Residential:		*Cultivated rows*	
Single-family areas	0.30 - 0.50	*Heavy soil, no crop	0.30 - 0.60
Multi units, detached	0.40 - 0.60	*Heavy soil, with crop	0.20 - 0.50
Munti units, attached	0.60 - 0.75	*Sandy soil, no crop	0.20 - 0.40
Suburban	0.25 - 0.40	*Sandy soil, with crop	0.10 - 0.25
		Pasture	
		*Heavy soil	0.15 - 0.45
		*Sandy soil	0.05 - 0.25
		Woodlands	0.05 - 0.25

Industrial: Light areas Heavy areas	 0.50 - 0.80 0.60 - 0.90	*Streets:* Asphaltic Concrete Brick	 0.70 - 0.95 0.80 - 0.95 0.70 - 0.85
Parks, cemeteries	0.10 - 0.25	Unimproved areas	0.10 - 0.30
Playgrounds	0.20 - 0.35	Drives and walks	0.75 - 0.85
Railroad yard areas	0.20 - 0.40	Roofs	0.75 - 0.95

Note: The designer must use judgment to select the appropriate "C" value within the range. Generally, larger areas with permeable soils, flat slopes and dense vegetation should have the lowest "C" values. Smaller areas with dense soils, moderate to steep slopes, and sparse vegetation should assigned the highest "C" values.

http://water.me.vccs.edu/courses/CIV246/table2b.htm accessed 11/19/09

EXHIBIT 1

General Info
Homepage
Current Projects
FAQ
Glossary

Precipitation Frequency (PF)
PF Data Server
- PF in GIS Format
- PF Maps
- Temporal Distr.
- Time Series Data
- PFDS Perform.
PF Documents

Probable Maximum Precipitation (PMP)
PMP Documents

Miscellaneous
Publications
AEP Storm Analysis
Record Precipitation

Contact Us
Inquiries
List-server

USA.gov

NOAA ATLAS 14 POINT PRECIPITATION FREQUENCY ESTIMATES: CA

DATA DESCRIPTION

Data type: precipitation depth **Units:** english **Time series type:** partial duration

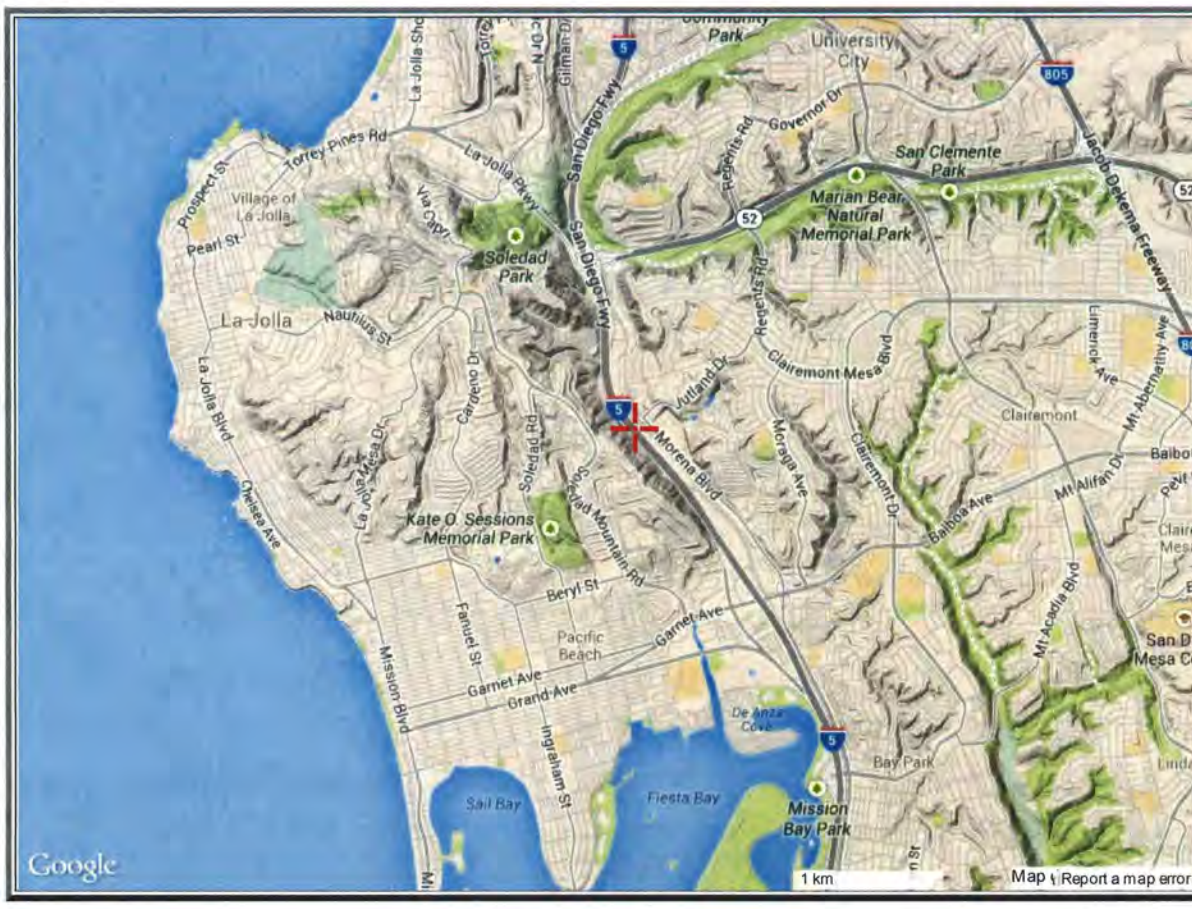
SELECT LOCATION

1. Manually:

a) Enter location (decimal degrees, use "-" for S and W): latitude: 32.8172 longitude: -117.2233

b) Select station (click here for a list of stations used in frequency analysis for CA): select station

2. Use map:



a) Select location
(move crosshair or double click)
b) Click on station icon
(show stations on map)

LOCATION INFORMATION:
Name: San Diego, California, US*
Latitude: 32.8228°
Longitude: -117.2297°
Elevation: 87 ft*

* source: Google Maps

POINT PRECIPITATION FREQUENCY (PF) ESTIMATES

WITH 90% CONFIDENCE INTERVALS AND SUPPLEMENTARY INFORMATION
NOAA Atlas 14, Volume 6, Version 2

PF tabular | PF graphical | Supplementary information | Print Page

PDS-based precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	**0.115** (0.096-0.138)	**0.144** (0.121-0.174)	**0.183** (0.153-0.222)	**0.215** (0.178-0.262)	**0.258** (0.206-0.326)	**0.291** (0.227-0.376)	**0.325** (0.247-0.431)	**0.360** (0.266-0.492)	**0.408** (0.289-0.582)	**0.445** (0.304-0.659)
10-min	**0.165** (0.138-0.198)	**0.207** (0.173-0.250)	**0.262** (0.219-0.318)	**0.308** (0.255-0.376)	**0.369** (0.295-0.467)	**0.417** (0.326-0.539)	**0.466** (0.355-0.618)	**0.516** (0.382-0.705)	**0.585** (0.414-0.834)	**0.639** (0.436-0.944)
15-min	**0.199** (0.167-0.240)	**0.250** (0.209-0.302)	**0.317** (0.265-0.384)	**0.372** (0.308-0.455)	**0.447** (0.357-0.565)	**0.505** (0.394-0.652)	**0.563** (0.429-0.747)	**0.624** (0.462-0.852)	**0.707** (0.501-1.01)	**0.772** (0.528-1.14)
30-min	**0.276** (0.231-0.333)	**0.347** (0.290-0.419)	**0.440** (0.367-0.533)	**0.516** (0.427-0.631)	**0.620** (0.495-0.784)	**0.700** (0.547-0.905)	**0.782** (0.595-1.04)	**0.866** (0.641-1.18)	**0.981** (0.695-1.40)	**1.07** (0.732-1.58)
60-min	**0.392** (0.328-0.473)	**0.493** (0.413-0.595)	**0.625** (0.522-0.757)	**0.733** (0.607-0.896)	**0.881** (0.703-1.11)	**0.994** (0.777-1.29)	**1.11** (0.845-1.47)	**1.23** (0.910-1.68)	**1.39** (0.987-1.99)	**1.52** (1.04-2.25)
2-hr	**0.545** (0.456-0.657)	**0.677** (0.566-0.817)	**0.850** (0.709-1.03)	**0.991** (0.820-1.21)	**1.18** (0.945-1.50)	**1.33** (1.04-1.72)	**1.48** (1.13-1.96)	**1.64** (1.21-2.23)	**1.85** (1.31-2.63)	**2.01** (1.37-2.97)
3-hr	**0.655** (0.549-0.790)	**0.812** (0.679-0.980)	**1.02** (0.848-1.23)	**1.18** (0.979-1.45)	**1.41** (1.13-1.78)	**1.58** (1.24-2.05)	**1.76** (1.34-2.33)	**1.94** (1.43-2.65)	**2.19** (1.55-3.12)	**2.38** (1.62-3.51)
6-hr	**0.886** (0.742-1.07)	**1.10** (0.921-1.33)	**1.38** (1.15-1.67)	**1.60** (1.33-1.96)	**1.91** (1.52-2.41)	**2.14** (1.67-2.76)	**2.37** (1.80-3.14)	**2.61** (1.93-3.56)	**2.92** (2.07-4.17)	**3.17** (2.17-4.69)
12-hr	**1.18** (0.984-1.42)	**1.47** (1.23-1.78)	**1.86** (1.55-2.25)	**2.16** (1.79-2.64)	**2.57** (2.05-3.25)	**2.88** (2.25-3.72)	**3.18** (2.42-4.22)	**3.49** (2.58-4.77)	**3.90** (2.77-5.57)	**4.22** (2.88-6.24)
24-hr	**1.46** (1.28-1.70)	**1.86** (1.63-2.16)	**2.36** (2.06-2.75)	**2.75** (2.39-3.24)	**3.28** (2.76-3.97)	**3.67** (3.03-4.53)	**4.05** (3.28-5.12)	**4.44** (3.50-5.76)	**4.96** (3.75-6.67)	**5.34** (3.92-7.43)
2-day	**1.79** (1.57-2.08)	**2.29** (2.01-2.67)	**2.93** (2.56-3.42)	**3.43** (2.98-4.03)	**4.09** (3.45-4.96)	**4.59** (3.79-5.67)	**5.08** (4.10-6.42)	**5.57** (4.39-7.22)	**6.22** (4.71-8.38)	**6.71** (4.93-9.34)
3-day	**2.00** (1.75-2.32)	**2.58** (2.26-3.00)	**3.31** (2.89-3.86)	**3.89** (3.38-4.57)	**4.65** (3.92-5.64)	**5.22** (4.32-6.45)	**5.79** (4.68-7.31)	**6.36** (5.01-8.24)	**7.11** (5.39-9.58)	**7.68** (5.64-10.7)
4-day	**2.17** (1.91-2.52)	**2.81** (2.47-3.28)	**3.63** (3.17-4.23)	**4.27** (3.71-5.02)	**5.12** (4.32-6.21)	**5.76** (4.76-7.11)	**6.39** (5.16-8.07)	**7.03** (5.53-9.11)	**7.87** (5.96-10.6)	**8.51** (6.24-11.8)
7-day	**2.56** (2.25-2.97)	**3.36** (2.95-3.91)	**4.38** (3.83-5.11)	**5.19** (4.51-6.10)	**6.26** (5.27-7.58)	**7.06** (5.83-8.72)	**7.85** (6.35-9.92)	**8.65** (6.82-11.2)	**9.71** (7.36-13.1)	**10.5** (7.72-14.6)
10-day	**2.84** (2.49-3.30)	**3.77** (3.30-4.38)	**4.95** (4.33-5.77)	**5.88** (5.11-6.92)	**7.12** (6.00-8.63)	**8.05** (6.65-9.94)	**8.97** (7.25-11.3)	**9.90** (7.80-12.8)	**11.1** (8.44-15.0)	**12.1** (8.87-16.8)
20-day	**3.40** (2.99-3.96)	**4.57** (4.01-5.32)	**6.06** (5.30-7.07)	**7.25** (6.29-8.52)	**8.82** (7.43-10.7)	**10.0** (8.26-12.3)	**11.2** (9.03-14.1)	**12.4** (9.74-16.0)	**14.0** (10.6-18.8)	**15.2** (11.1-21.1)
30-day	**4.04** (3.54-4.69)	**5.44** (4.77-6.33)	**7.23** (6.32-8.43)	**8.65** (7.51-10.2)	**10.5** (8.88-12.8)	**12.0** (9.89-14.8)	**13.4** (10.8-16.9)	**14.9** (11.7-19.3)	**16.8** (12.7-22.6)	**18.3** (13.4-25.4)
45-day	**4.75** (4.17-5.52)	**6.38** (5.59-7.42)	**8.47** (7.41-9.88)	**10.1** (8.80-11.9)	**12.4** (10.4-15.0)	**14.1** (11.6-17.4)	**15.7** (12.7-19.9)	**17.5** (13.8-22.7)	**19.8** (15.0-26.7)	**21.6** (15.9-30.0)
60-day	**5.51** (4.84-6.41)	**7.34** (6.44-8.55)	**9.70** (8.49-11.3)	**11.6** (10.1-13.6)	**14.1** (11.9-17.1)	**16.1** (13.3-19.8)	**18.0** (14.5-22.7)	**20.0** (15.8-25.9)	**22.7** (17.2-30.6)	**24.8** (18.2-34.5)

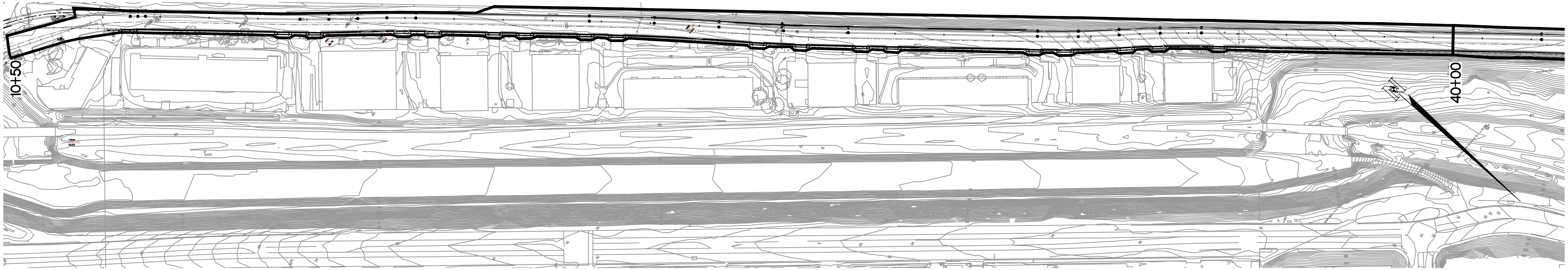
[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

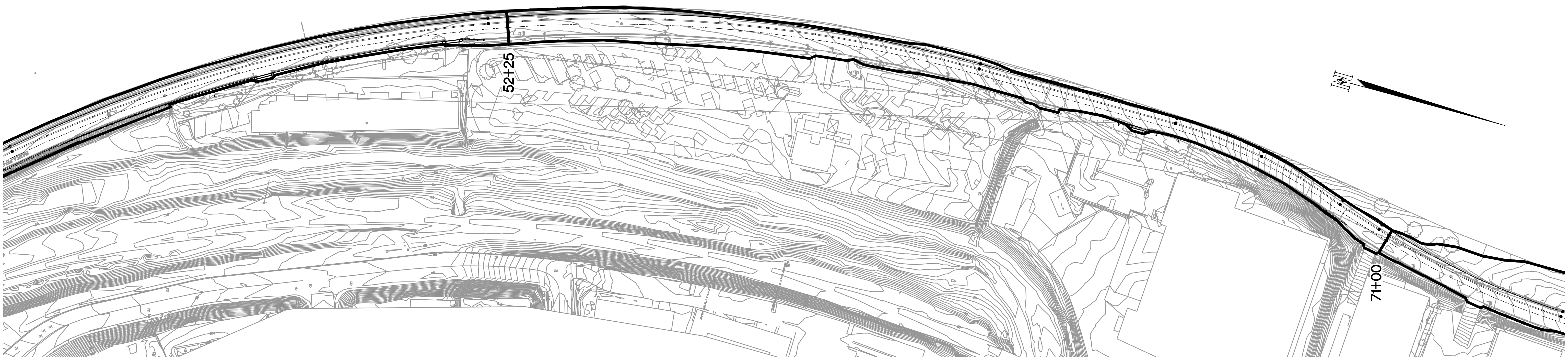
Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

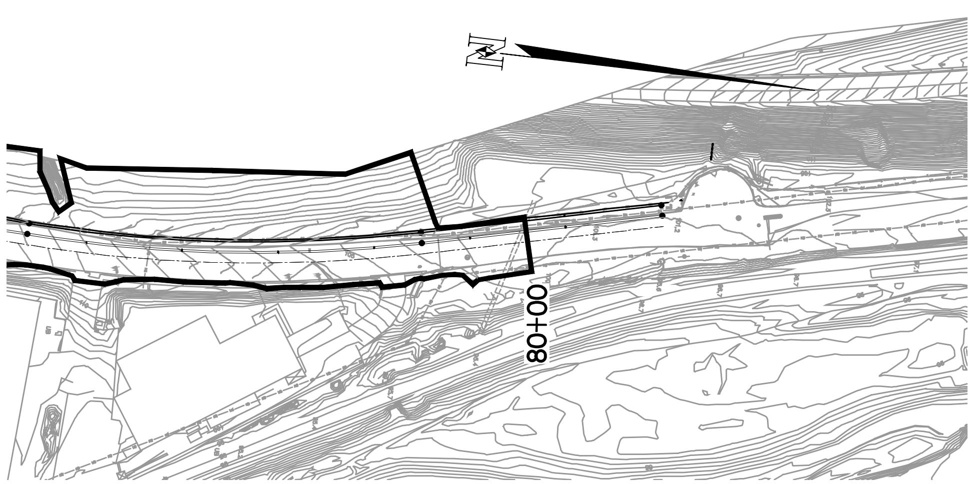
Please refer to NOAA Atlas 14 document for more information.

Estimates from the table in csv format: precipitation frequency estimates

Exhibit 2







Coastal Rail Trail
Santa Fe Street Improvements Segment
10+50 to 80+00
Drainage Basins

100 0 100 200 300 400

SCALE 1" = 200'

Exhibit 3

Coastal Rail Trail Segment 9B
Santa Fe Street Hydrology
Sta 10+50 to 80+00

Existing Condition

Precipitation Values & Intensity

$I = 7.44 x P_6 x D^{-.645}$

Frequency	Precip	Precip	P6/P24	D	I
(YR)	**P6**	P24	%	min	in/hr
2	**1.10**	1.86	59%	10	1.85
5	**1.38**	2.36	58%	10	2.33
10	**1.60**	2.75	58%	10	2.70
25	**1.91**	3.28	58%	10	3.22
50	**2.14**	3.67	58%	10	3.61
100	**2.37**	4.05	59%	10	3.99

Precipitation Values from NOAA Atlwas 14, Vol 6, Ver 2

Composite C Values

Basin	Gross Area	C (Road)	C (L&I)	Comp C
		0.90	0.35	
Sta to Sta	ac	ac	ac	**C**
1050-4000	4.06	2.26	1.81	0.66
4000-5225	1.51	1.00	0.52	0.71
5225-7100	2.34	1.94	0.40	0.81
7100-8000	2.01	0.88	1.12	0.59

Basin Q's

Basin	Frequency	Area	C	Tc	I	**Q**	Basin Length
Sta to Sta	yr	ac		min	in/hr	cfs	ft
1050-4000	100	4.06	0.66	10	3.99	10.63	5050
4000-5225	100	1.51	0.71	10	3.99	4.31	1225
5225-7100	100	2.34	0.81	10	3.99	7.54	1875
7100-8000	100	2.01	0.59	10	3.99	4.75	900
						27.23	

Exhibit 4

Coastal Rail Trail Segment 9B
Santa Fe Street Hydrology
Sta 10+50 to 80+00

Proposed Condition (Trail & sidewalks added)

Precipitation Values & Intensity $I = 7.44 x P_6 x D^{-.645}$

Frequency	Precip	Precip	P6/P24	D	I
(YR)	**P6**	P24	%	min	in/hr
2	**1.10**	1.86	59%	10	1.85
5	**1.38**	2.36	58%	10	2.33
10	**1.60**	2.75	58%	10	2.70
25	**1.91**	3.28	58%	10	3.22
50	**2.14**	3.67	58%	10	3.61
100	**2.37**	4.05	59%	10	3.99

Precipitation Values from NOAA Atlwas 14, Vol 6, Ver 2

Composite C Values

Basin	Gross Area	C (Road)	C (L&I)	Comp C
		0.90	0.35	
Sta to Sta	ac	ac	ac	**C**
1050-4000	4.06	2.77	1.29	0.73
4000-5225	1.51	1.17	0.34	0.78
5225-7100	2.34	2.01	0.33	0.82
7100-8000	2.01	0.96	1.04	0.61

Basin Q's

Basin	Frequency	Area	C	Tc	I	**Q**	Basin Length
Sta to Sta	yr	ac		min	in/hr	cfs	ft
1050-4000	100	4.06	0.73	10	3.99	11.77	5050
4000-5225	100	1.51	0.78	10	3.99	4.69	1225
5225-7100	100	2.34	0.82	10	3.99	7.70	1875
7100-8000	100	2.01	0.61	10	3.99	4.92	900
						29.08	

Exhibit 5

Coastal Rail Trail Segment 9B
Runoff Increase Projection

Stat to Sta	Runoff Increase - Q100			Comments
	Existing	Proposed	Increase	
	cfs	cfs	cfs	
10+00 to 25+00	no increase			Trail in concrete channel
25+00 to 29+00	0.310	0.470	0.160	Bike trail only
29+00 to 45+00	0.610	1.830	1.220	Bike trail only
45+00 to 47+60	0.190	0.290	0.100	Bike trail only
47+60 to 50+95	0.040	0.400	0.360	Bike trail only
50+95 to 52+22	0.100	0.140	0.040	Bike trail only
10+50 to 40+00	10.630	11.770	1.140	Santa Fe St Basin
40+00 to 52.25	4.310	4.690	0.380	Santa Fe St Basin
52+25 to 71+00	7.540	7.700	0.160	Santa Fe St Basin
71+00 to 80+00	4.750	4.920	0.170	Santa Fe St Basin
80+00 to 81+75	0.079	0.119	0.040	Bike trail only
	28.559	32.329	3.770	Project runoff increase

Exhibit 6

Coastal Rail Trail Segment 9B
Pervious to Impervious Comparison
Sta 10+00 South to 81+75 North

Existing Condition

	Sta	Sta	Gross Area	Roadway	L&I (pervious)	
			sf	C=.9	C=.35	
14' Trail width only for area from pervious to impervious	1000	1325	4,550	4,550	na	Trail in pcc channel
	1325	2200	12,250		12,250	
	2200	2475	3,850		3,850	Under I-5 bridge
	2475	4750	31,850		31,850	
	4750	5054	4,256	4,256	na	Bike trail bridge over Rose Creek
	5054	5222	2,352		2,352	
Drainage basins to each concentration point used for pervious to impervious comparison	10+50	40+00	176,957	98,283	78,674	
	40+00	52+25	65,904	43,467	22,437	
	52+25	71+00	102,104	84,626	17,478	
	71+00	80+00	87,465	38,531	48,934	
	80+00	81+75	1,448		1,448	Bike trail only
	Total area (sf)		492,986	273,713	219,273	
	Total area (ac)		11.3	6.3	5.0	

Proposed Condition

	Sta	Sta	Gross Area	Roadway	L&I (pervious)	
			sf	C=.9	C=.35	
14' Trail width only for area from pervious to impervious	1000	1325	4,550	4,550	na	Trail in pcc channel
	1325	2200	12,250	12,250		
	2200	2475	3,850	3,850		Under I-5 bridge
	2475	4750	31,850	31,850		
	4750	5054	4,256	4,256	na	Bike trail bridge over Rose Creek
	5054	5222	2,352	2,352		
Drainage basins to each concentration point used for pervious to impervious comparison	10+50	40+00	176,957	120,807	56,150	Transition to Santa Fe St
	40+00	52+25	65,904	51,056	14,848	
	52+25	71+00	102,104	87,703	14,401	
	71+00	80+00	87,465	41,965	45,500	
	80+00	81+75	1,448	1,448	0	Bike trail only
	Total area (sf)		492,986	362,087	130,899	
	Total area (ac)		11.3	8.3	3.0	

2.0	Net increast in impervious area (ac)

Exhibit 7