DRAINAGE STUDY FOR
RADY CHILDREN'S HOSPITAL

CONDITIONAL USE PERMIT

CITY OF SAN DIEGO
PTS-0697308

CITY OF SAN DIEGO, CALIFORNIA

January 2023

Prepared for:
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Table of Contents

I. Project Location and Scope 3

II. Study Objectives 4

III. Existing Site Conditions 4

IV. Proposed Site Conditions 5

V. Hydrology Analysis 6

VI. Hydraulic Analysis 7

VII. Conclusions 8

VIII. References 8

Exhibit A – Existing Condition Drainage Area Map 9

Exhibit B – Proposed Condition Drainage Area Map 10

Exhibit C – Hydrology Calculations 11

Exhibit D – Hydraulic Calculations 13

Exhibit E – Federal Emergency Management Agency Special Flood Hazard Areas (SFHAs) 14

List of Figures

Figure 1 Site Vicinity Map

List of Tables

Table 1 Existing Condition Hydrology Results for 10-Year, 50-Year, and 100-Year Storm
Table 2 Proposed Condition Hydrology Results for 10-Year, 50-Year, and 100-Year Storm
Table 3 Hydraulic Calculation Summary
Table 4 Equations Used in Hydrology Study
Table 5 Definition of Variables in Hydrology Study Equations
Table 6 Area-Weighted Runoff Coefficient Calculations

I. Project Location and Scope

The 18-acre Rady Children's Hospital is located in the northeasterly corner of Frost Street and Children's Way, in the City of San Diego, California. The CUP project site is bounded by Frost Street to the north, Children's Way to the east, Birmingham Way to the south, and Sharp Hospital campus to the west. Access to the project site is provided off Birmingham Drive. The assessor's parcel number is 4275301300. A site vicinity map is shown in Figure 1 below.

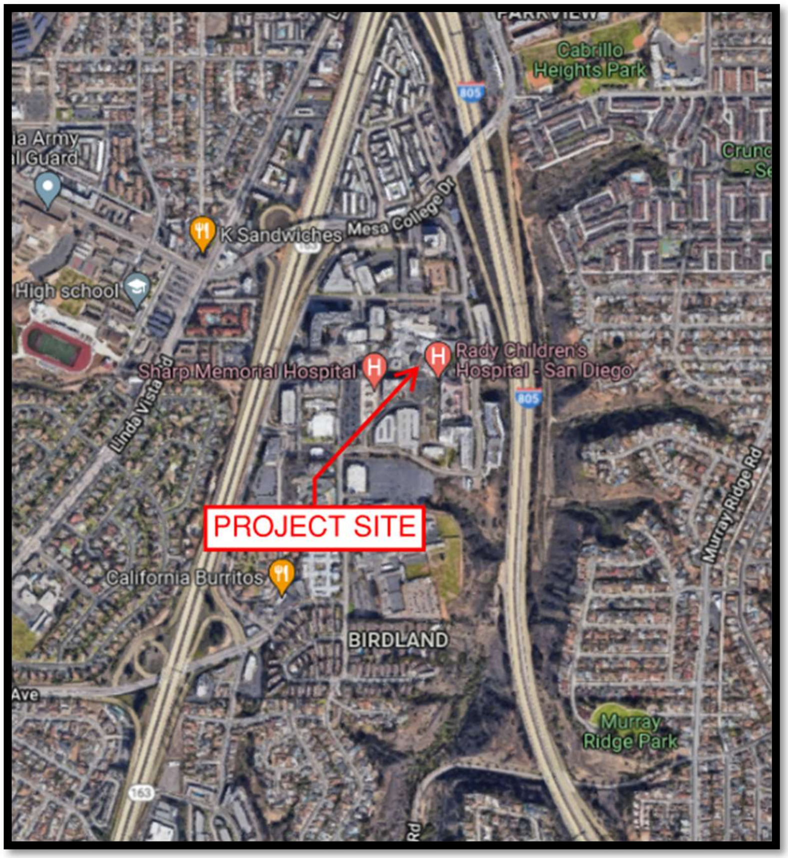


Figure 1: Site Vicinity Map

This report will focus on identifying the hydrologic and hydraulic effects of the proposed development by studying the 10-year, 50-year, and 100-year flow rates for the pre and post development conditions. This report will not discuss water quality measures or best management practices for stormwater mitigations. For information regarding best management practice requirements and implementation, refer to the concurrent project Final Site package PRJ-1067662 for the Storm Water Quality Management Plan (SWQMP).

No surface waters are present on the project site or nearby, and site runoff is captured and discharged into an onsite private storm drain system. A Stormwater Pollution Prevention Plan (SWPPP) will be provided prior to the start of construction, and construction stormwater BMPs will be implemented throughout the construction. As such, the project is not anticipated to require a separate CA Regional Water Quality Control Board approval under the Federal Clean Water Act Section 401/404.

The project consists of demolition of a portion of the existing Nelson Hahn Building, the existing surface parking lot, utilities, and rough grading of the site. The project consists of the construction of a proposed ICU/Beacon Pavilion, connector building, central utility plant, west access road, and surface improvements. This proposed site condition will increase storm runoff by 3% (0.62 cubic feet per second). No negative impacts to adjacent property are anticipated.

II. Study Objectives

The specific objectives of this drainage study are to:

- Calculate the pre and post development peak flow rates for the 10-year, 50-year, and 100-year storm events.

- Determine the capacity of the proposed off-site storm drain infrastructure under post development conditions.

- Calculate the effect of the post construction conditions on the existing hydrology and hydraulics for the 50-year storm events.

- Identify pre and post development areas of concern.

III. Existing Site Conditions

The existing site elevations varies roughly from 431 feet along the northern boundary (Frost Street) to approximately 396 feet along Birmingham Drive and 372 feet along the southern boundary (Birmingham Way).

The Federal Emergency Management Agency (FEMA) has not mapped any Special Flood Hazard Areas (SFHAs) for the project site. The FEMA Map and overall site vicinity map is provided in Exhibit E.

The existing site infrastructure includes a family care pavilion, surface parking lots near Frost Street, administrative buildings, and driveways. In the pre-developed condition, the site consist of approximately 78% impervious surfaces, with no expected off-site drainage. The pre-development condition is divided into 3 basins per grading and site features: E1, E2, and E3.

Basin E-1 consists of the drainage produced from the west section of the family pavilion and the motion analysis pavilion. Runoff within E-1 flows towards two catch basins—one at the southwest corner of the existing parking garage on the Sharp campus and one in the southwest corner of E-1 near the central utility plant (POD #1). These catch basins connect to a storm drain line running along the west property line and flows west of the southern catch basin.

Basin E-2 contains the drainage north of the family pavilion along with surface parking lot drains. Runoff within E-2 flows towards multiple catch basins within the impervious parking lot and is ultimately routed to a catch basin between the Medical Office Building (MOB) and Rose and directs the stormwater to an existing storm drain line (POD #2) in Children's Way.

Basin E-3 consists of drainage east of the family pavilion and surrounding landscape area. Runoff within E-3 is directed towards area drains within the landscape and is routed to an existing curb inlet on a private driveway south of the MOB near Children's Way, where stormwater then is directed eastwards to an existing storm drain line (POD #3) in Children's Way. The hydrology results for existing conditions are summarized in Table 1. In addition, refer to Exhibit A for the existing condition drainage area map.

IV. Proposed Site Conditions

The proposed infrastructure consists of an ICU/Beacon pavilion, central utility plant, driveways, and landscape redesign. The ICU pavilion will be built on top of the existing surface parking lot near Frost Street, and the central utility plant is proposed at the existing motion analysis pavilion. The proposed site will have four drainage management areas: P-1, P-2, P-3, and P-5, totaling 87% in imperviousness.

Basin P-1 will consist of the west portion of the proposed Beacon building roof, west access road, and the central utility plant. Runoff will be directed to a proposed hydromodification detention pipes and modular wetland system before discharging to a new private 21-inch storm drain line that runs through the site. The new private 21-inch storm drain line will connect to an existing 24-inch RCP storm drain line near Birmingham Way per as-built drawing no. 25310-D (POD #1).

Basin P-2 will consist of the northeast corner of the site which includes the east portion of the proposed Beacon building roof and landscape improvements running parallel to Children's Way. This portion of the site will be routed to a proposed detention pipe and modular wetland system before discharging to an existing manhole, POD #2, which connects to an existing 24" storm drain main per as-built drawing no. 25310-D.

Basin P-3 will consist of the area bounded by the existing Nelson Hahn building, the existing Medical Office Building, and the proposed Beacon Building. This area will drain to proposed detention pipes and a modular wetland system before discharging to a private 18" storm-drain POD #3 on Children's Way.

Basin P-5 will consist of the north portion of the Beacon building roof as well as a proposed driveway and walkway. This area will drain to a proposed modular wetland system and hydromodification detention pipes and will discharge onto Frost Street via parkway drain per DWG D-25 (POD #5).

The hydrology results for the proposed conditions are summarized in Table 2. In addition, refer to Exhibit B for the proposed condition drainage area map.

V. Hydrology Analysis

The hydrology calculations are based on the *City of San Diego Drainage Design Manual, January 2017 edition.* The project site is less than 1 square mile, and therefore the Rational Method was used to calculate the peak flow rate for the 10-year, 50-year, and 100-year storm events. The Rational Method calculates peak flow rate (Q) as a function of the runoff coefficient (C), rainfall intensity (I), and drainage area (A). All equations used in the hydrology study are identified in Table 4.

Table A-1, *Runoff Coefficient for Rational Method*, from the Drainage Design Manual was used to compute the runoff coefficient for both the existing and proposed drainage areas given the site's imperviousness, soil type, and land use. The site's imperviousness was determined by calculating the impervious area in the pre and post development conditions. Per the Drainage Design Manual, all sites are assumed to be made up of Type D soil.

Rainfall intensities were determined from Figure A-1, *Intensity-Duration-Frequency Design Chart* in the Drainage Design Manual. The design chart takes into consideration the time of concentration (Tc) and storm event frequency to calculate the rainfall intensity.

Drainage area was determined by inspecting the existing and proposed conditions and delineating areas according to grading and site features.

Tc was calculated using Figure A-4, *Rational Formula – Overland Time of Flow Nomograph*. To be conservative, the existing drainage analysis utilizes a 5-minute time of concentration, while surface drainage in the proposed drainage analysis uses the formula to compute the overland flow time in minutes.

Due to the increase in impervious area of the proposed site condition, the 100-year storm peak runoff rate increases from 20.89 cubic feet per second to 23.02 cubic feet per second, a 10% increase.

Table 1: Existing Condition Hydrology Results for 10-Year, 50-year, and 100-Year Storm

Existing Rady Children's Hospital Hydrology Calculations																
								10-Year Storm Event			50-Year Storm Event			100-Year Storm Event		
Area ID	$A_{catchment}$ (sf)	Area (ac)	Pervious Area (sf)	Impervious Area (sf)	Percent Impervious	Runoff Coefficient	Tc (min)	I_{10} (in/hr)	V_{10} (fps)	Q_{10} (cfs)	I_{50} (in/hr)	V_{50} (fps)	Q_{50} (cfs)	I_{100} (in/hr)	V_{100} (fps)	Q_{100} (cfs)
E1	82,270	1.89	14,860	67,410	82%	0.87	5.00	3.4	8.44	5.59	4.2	8.97	6.90	4.4	9.10	7.23
E2	158,580	3.64	46,040	112,540	71%	0.75	5.00	3.4	11.37	9.28	4.2	12.04	11.47	4.4	12.19	12.01
E3	30,220	0.69	14,740	15,480	51%	0.54	5.00	3.4	6.46	1.27	4.2	6.87	1.57	4.4	6.97	1.65
Total	271,070	6.22	75,640	195,430	72%	0.76				**16.14**			**19.94**			**20.89**

Table 2: Proposed Condition Hydrology Results for 10-Year, 50-Year, and 100-Year Storm

Proposed Rady Children's Hospital Hydrology Calculations																					
													10-Year Storm Event			50-Year Storm Event			100-Year Storm Event		
Area ID	$A_{catchment}$ (sf)	Area (ac)	Pervious Area (sf)	Impervious Area (sf)	Percent Impervious	Runoff Coefficient	Flow Path (ft)	High Point (ft)	Low Point (ft)	Flow Path Delta Height (ft)	Flow Path Slope (vft/hft)*100	Tc (min)	I_{10} (in/hr)	V_{10} (fps)	Q_{10} (cfs)	I_{50} (in/hr)	V_{50} (fps)	Q_{50} (cfs)	I_{100} (in/hr)	V_{100} (fps)	Q_{100} (cfs)
Basin P1																					
1	107,321	2.46	21,167	86,154	80%	0.85	614	430.38	397.77	33	5.3	6.39	3.1		6.49	3.8		7.96	4.1		8.59
1.1	10,400	0.24	0	10,400	100%	0.95						5.00	3.4		0.77	4.2		0.95	4.4		1.00
1.2	5,600	0.13	0	5,600	100%	0.95						5.00	3.4		0.42	4.2		0.51	4.4		0.54
1.3	7,200	0.17	0	7,200	100%	0.95						5.00	3.4		0.53	4.2		0.66	4.4		0.69
1.4	10,400	0.24	0	10,400	100%	0.95						5.00	3.4		0.77	4.2		0.95	4.4		1.00
Total	140,921	3.24	21,167	119,754	85%	0.87								**8.27**	**8.98**		**8.71**	**11.04**		**8.86**	**11.81**
Basin P2																					
2	6,914	0.16	3,995	2,920	42%	0.45	247	408.60	397.53	11	4.5	11.16	2.5		0.18	3.1		0.22	3.3		0.24
2.1	7,500	0.17	0	7,500	100%	0.95						5.00	3.4		0.56	4.2		0.69	4.4		0.72
Total	14,414	0.33	3,995	10,420	72%	0.71								**4.30**	**0.73**		**4.58**	**0.91**		**4.64**	**0.95**
Basin P3																					
3	36,623	0.84	8,823	27,800	76%	0.81	366	409.84	395.43	14	3.9	6.41	3.1		2.10	3.8		2.58	4.1		2.78
3.1	4,300	0.10	0	4,300	100%	0.95						5.00	3.4		0.32	4.2		0.39	4.4		0.41
3.2	10,400	0.24	0	10,400	100%	0.95						5.00	3.4		0.77	4.2		0.95	4.4		1.00
3.3	13,600	0.31	0	13,600	100%	0.95						5.00	3.4		1.01	4.2		1.25	4.4		1.31
3.4	1,200	0.03	0	1,200	100%	0.95						5.00	3.4		0.09	4.2		0.11	4.4		0.12
3.5	550	0.01	0	550	100%	0.95						5.00	3.4		0.04	4.2		0.05	4.4		0.05
3.6	550	0.01	0	550	100%	0.95						5.00	3.4		0.04	4.2		0.05	4.4		0.05
3.7	800	0.02	0	800	100%	0.95						5.00	3.4		0.06	4.2		0.07	4.4		0.08
3.8	2,500	0.06	0	2,500	100%	0.95						5.00	3.4		0.19	4.2		0.23	4.4		0.24
Total	70,523	1.62	8,823	61,700	87%	0.88								**5.35**	**4.62**		**5.51**	**5.68**		**5.51**	**6.03**
Basin P5																					
5	19,302	0.44	2,211	17,091	89%	0.95	130	428.88	424.67	4	3.2	5.00	3.4		1.43	4.2		1.77	4.4		1.85
5.1	6,400	0.15	0	6,400	100%	0.95						5.00	3.4		0.47	4.2		0.59	4.4		0.61
5.2	6,400	0.15	0	6,400	100%	0.95						5.00	3.4		0.47	4.2		0.59	4.4		0.61
5.3	11,900	0.27	0	11,900	100%	0.95						5.00	3.4		0.88	4.2		1.09	4.4		1.14
Total	44,002	1.01	2,211	41,791	95%	0.95								**6.39**	**3.26**		**6.64**	**4.03**		**6.68**	**4.22**
Project Total	269,861	6.20	36,197	233,664	87%	0.88									**17.60**			**21.66**			**23.02**

VI. Hydraulic Analysis

The hydraulic calculation was conducted using Bentley Flowmaster V8i software. Please refer to Exhibit D for Hydraulic Calculations. The private storm drain within the project limit are designed to convey the peak runoff rate for a 50-year storm. The existing 24-inch public storm drain pipe (SD-E1 and SD-P1) will be protected in place during construction and utilized in the proposed condition to convey storm water. The hydraulic calculations for this proposed private storm drain pipes at point of discharge are summarized in Table 3 below with calculations shown in Exhibit D.

Table 3: Hydraulic Calculation Summary

Rady Children's Hospital Hydraulic Calculations for Storm Drain Sizing				
Area ID	**Storm Drain Size and Type**	**Q50 (cfs)**	**Minimum Pipe Slope**	**Full Flow Discharge Capacity (cfs)**
Existing Drainage Condition at Point of Discharge				
E1	24" RCP	6.90	1.0%	22.62
E2	24" RCP	11.47	1.0%	22.62
E3	18" PVC	1.57	1.0%	13.65
Proposed Drainage Condition at Point of Discharge				
P1	21" PVC	11.04	0.5%	14.56
P2	8" PVC	0.91	0.5%	1.11
P3	15" PVC	5.68	0.5%	5.94
P5	12" PVC	4.03	1.0%	4.63
	36"x4.5" Outlet Drain*		1.5%	4.77

*Drawing No. D-25A from San Diego Regional Standards Drawing.

VII. Conclusions

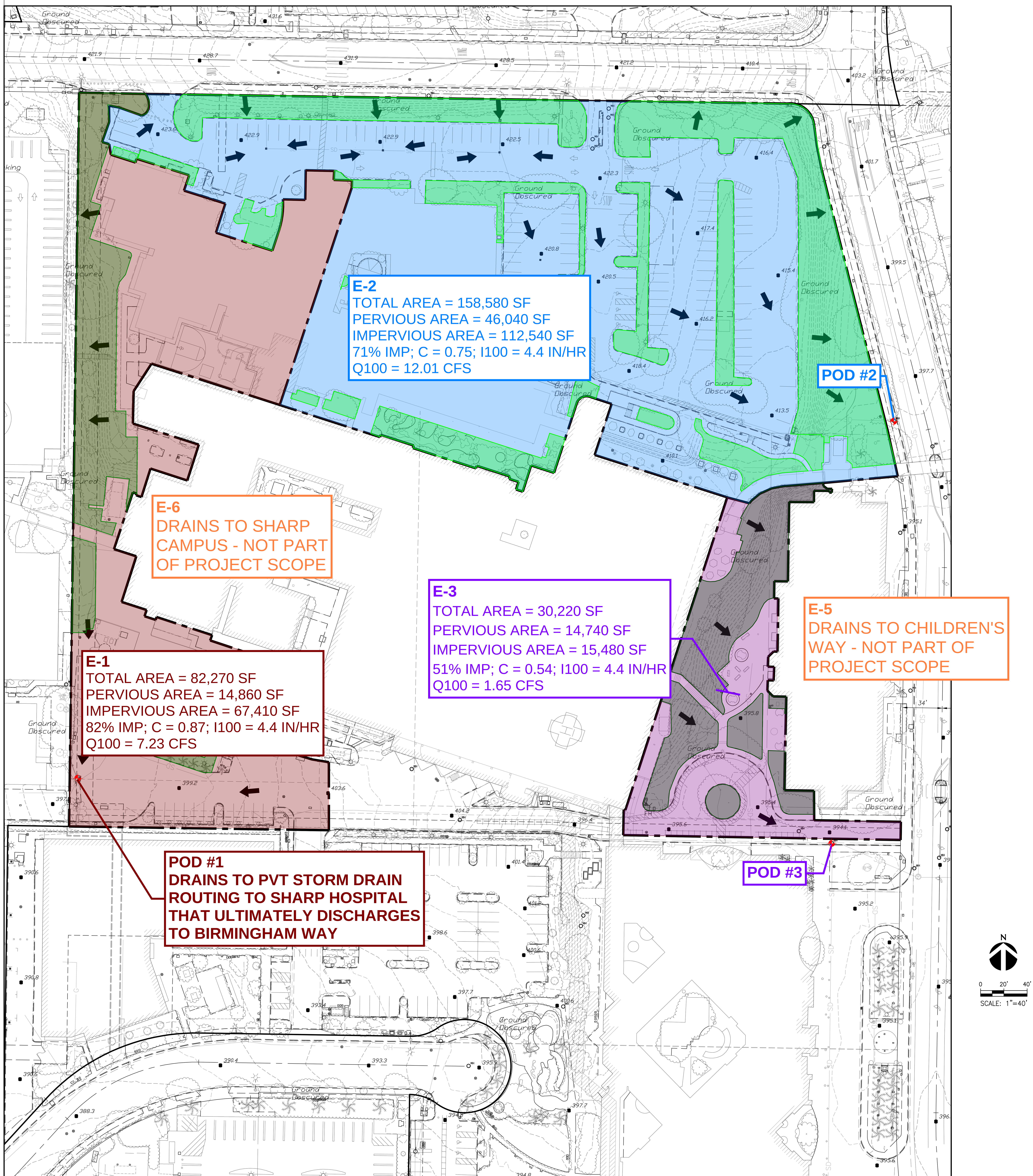
Evidence of the drainage change from existing to proposed conditions demonstrate an increase of 2.13 cubic feet per second for a 100-year storm event. As such, the project site will not be significantly impacted in terms of hydrology or hydraulics. Proposed landscape area and various post construction BMPs identified in the project SWQMP will further alleviate the effects of additional hydrological or hydraulic demands which is typically expected from development.

VIII. References

The City of San Diego Transportation & Storm Water Design Manuals – *Drainage Design Manual* (January 2017).

Federal Emergency Management Agency (FEMA) – *FEMA Flood Map Service Center, City of San Diego May 2012* (Date accessed January 23, 2023).

Exhibit A – Existing Condition Drainage Area Map



LEGEND:

GENERAL

- FLOW PATH
- EX. DRAINAGE BDRY
- EX. STORM DRAIN
- 1-FT CONTOUR LINE
- POINTS OF DISCHARGE

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Client and Project Information

Rady Children's Hospital San Diego

CONDITIONAL USE PERMIT

3020 Children's Way
San Diego, CA 92123

Client Project Number: -

First Issue

KEY MAP

Construction Permit

Sheet Status: FOR PERMIT

Scope Package: DRAINAGE PLAN

Sheet Title: EXISTING DRAINAGE PLAN

Sheet Number: EXHIBIT

Current Issue: DR 15

Current Issue Date: 01/27/2023

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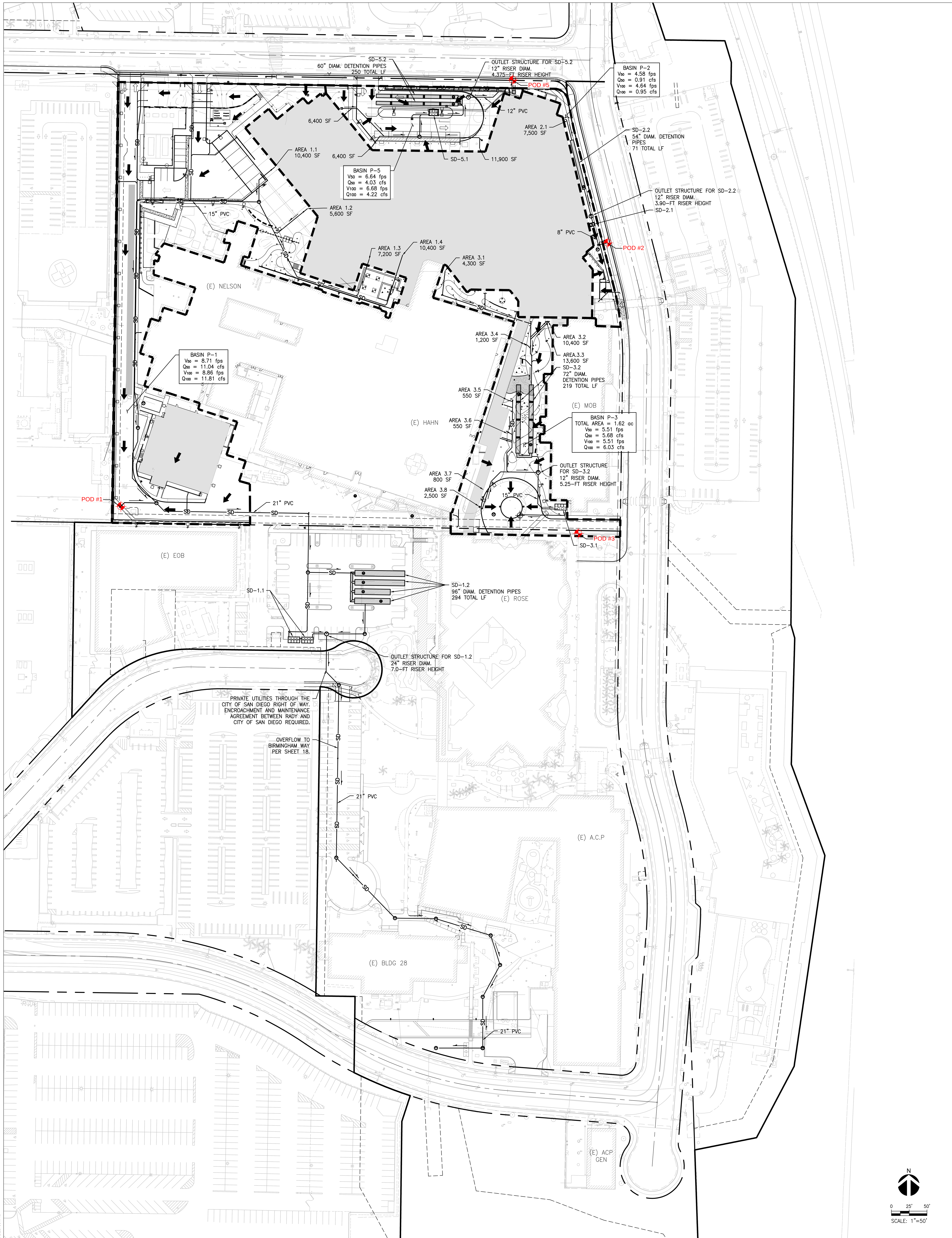
Exhibit B – Proposed Condition Drainage Area Map



DMA	AREA (AC)	IMPERVIOUS AREA (AC)	% IMPERVIOUS	AREA WEIGHTED RUNOFF COEFFICIENT	DCV (CF)	TREATED BY (BMP ID)	POLLUTANT CONTROL TYPE	DRAINS TO (POD ID)
BASIN P-1	3.34	2.75	85	0.87	5,935	SD-1.1 SD-1.2	MODULAR WETLANDS	POD 1
BASIN P-2	0.33	0.24	72	0.71	494	SD-2.1 SD-2.2	MODULAR WETLANDS	POD 2
BASIN P-3	1.62	1.42	87	0.88	3,002	SD-3.1 SD-3.2	MODULAR WETLANDS	POD 3
BASIN P-4	1.01	0.96	95	0.95	2,021	SD-5.1 SD-5.2	MODULAR WETLANDS	POD 5
TOTAL	6.2	5.40	87	0.88	11,452			

HYDROMODIFICATION BMP SUMMARY

BMP	MAX. REQUIRED ORIFICE DIAMETER (IN)	PROVIDED ORIFICE DIAMETER (IN)	REQUIRED DETENTION VOLUME (CF)	PROVIDED DETENTION VOLUME (CF)
SD-1.2	2.25	2.25	12,000	12,054
SD-2.1	0.80	0.80	1,080	1,094
SD-3.1	1.63	1.63	5,300	5,443
SD-5.1	1.25	1.25	4,600	4,600

MODULAR WETLANDS BMP SUMMARY

BMP	MODEL NO.	REQUIRED TREATMENT FLOW RATE (CFS)	PROVIDED TREATMENT FLOW RATE (CFS)
SD-1.1	(2) MWS-L-8-16-V	0.846	0.924
SD-2.1	MWS-L-4-6-V	0.070	0.073
SD-3.1	MWS-L-8-16-V	0.428	0.462
SD-5.1	MWS-L-8-12-V	0.288	0.346

LEGEND:

- PROPERTY LINE
- SD — STORM DRAIN
- DRAINAGE AREA BOUNDARY

NOTE:

1. UNDERLYING HYDROLOGIC SOIL GROUP: D.
2. APPROXIMATE DEPTH TO GROUNDWATER: >50 FT.
3. EXISTING NATURAL HYDROLOGIC FEATURES: NONE.
4. CRITICAL COARSE SEDIMENT YIELD AREAS: NONE.
5. SEE SHEET C1.650-C1.653 FOR PRELIMINARY GRADING AND DRAINAGE PLAN.

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Consultant Project Number #
Client and Project Information
Rady Children's Hospital San Diego

ICU / EMERGENCY SERVICES PAVILION
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Client Project Number
First Issue
INITIAL SUBMITTAL 10/27/2021
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1 CUP/PDP BC#1 07/19/2022
2 CUP/PDP BC#2 01/30/2023

Agency Approval

Permit No.
PTS-0697308
Sheet Status
NOT FOR CONSTRUCTION

Scope Package
CUP/PDP
Sheet Title
PROPOSED DRAINAGE PLAN
Sheet Number
EXHIBIT
Current Issue:
Current Issue Date:
01/27/2023

Sheet Size: 36 x 48
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Exhibit C – Hydrology Calculations

Table 4: Equations Used in Hydrology Study

Equations Used	
1.	$C:\ Table\ A-1. Runoff\ Coefficients\ for\ Rational\ Method$
2.	$T_c = \frac{1.8 * (1.1 - C) * sqrt(D)}{(s)^{\frac{1}{3}}}$
3.	$I: Figure\ A-1.\ Intensity - Duration - Frequency\ Design\ Chart$
4.	$Q = C * I * A$

Table 5: Definition of Variables in Hydrology Study Equations

Definition of Variables	
C	Area- Weighted Runoff Coefficient, proportion of rainfall that runs off the surface
% Impervious	The percentage of project site area that is hardscape
D	Watercourse distance
s (%)	Slope along watercourse distance
T_c(min)	Time of concentration (minimum 5 minutes)
I (in/hr)	Average rainfall Intensity for a selected storm frequency
A (acres)	Drainage Area
Q (cfs)	Peak discharge in cubic feet per second

Table 6: Area-Weighted Runoff Coefficient Calculations

Drainage Area	% Impervious	Runoff Coefficient per Table A-1 of COSD Drainage Design Manual (2017)	Revised Runoff Coefficient per Table A-1 Note
E-1	0.82	0.85	(0.82/0.80)*0.85 = 0.87
E-2	0.71	0.85	0.75
E-3	0.51	0.85	0.54
P-1	0.85	0.85	0.87
P-2	0.72	0.85	0.71
P-3	0.87	0.95	0.88
P-5	0.95	0.95	0.95

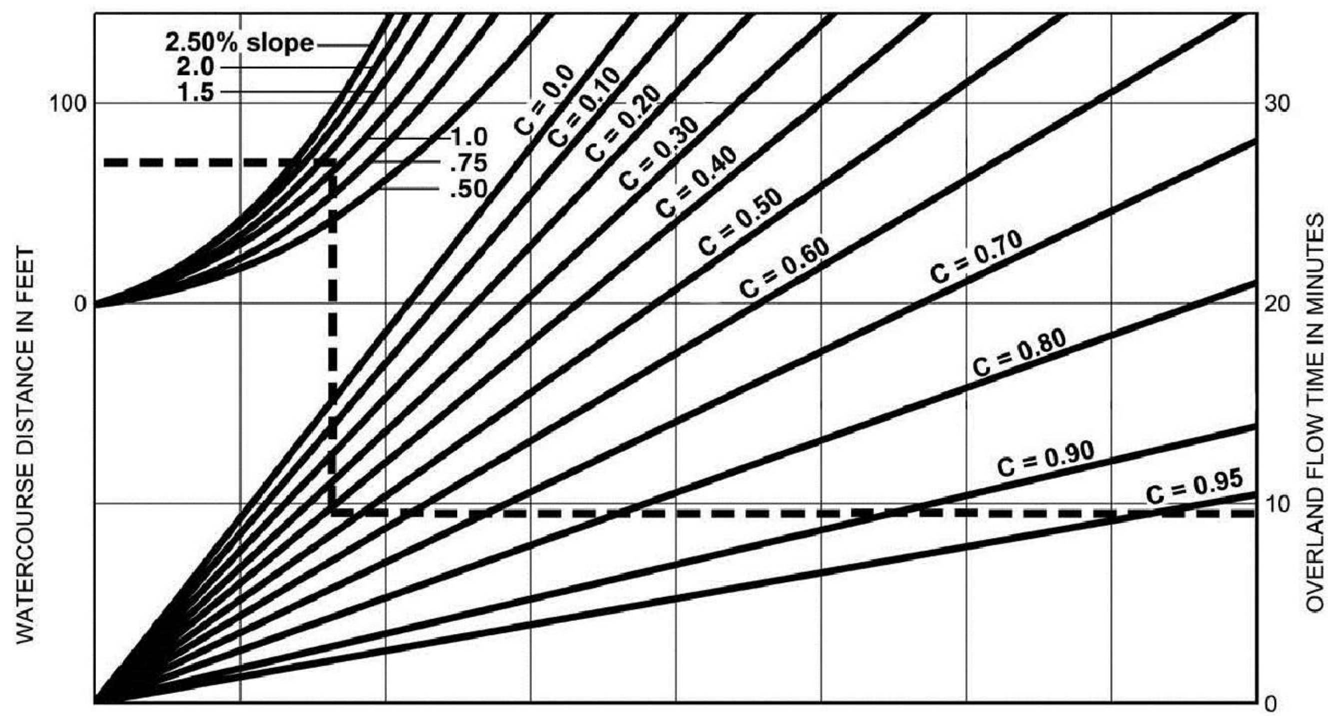
Note: $Revised\ C = \frac{Actual\ Imperviousness}{Tabulated\ Imperviousness} * Tabulated\ Runoff\ Coefficient$

Table A-1. Runoff Coefficients for Rational Method

Land Use	Runoff Coefficient (C)
	Soil Type [1]
Residential:	
Single Family	0.55
Multi-Units	0.70
Mobile Homes	0.65
Rural (lots greater than ½ acre)	0.45
Commercial [2]	
80% Impervious	0.85
Industrial [2]	
90% Impervious	0.95

Note:
[1] Type D soil to be used for all areas.
[2] Where actual conditions deviate significantly from the tabulated imperviousness values of 80% or 90%, the values given for coefficient C, may be revised by multiplying 80% or 90% by the ratio of actual imperviousness to the tabulated imperviousness. However, in case shall the final coefficient be less than 0.50. For example: Consider commercial property on D soil.

Actual imperviousness = 50%
Tabulated imperviousness = 80%
Revised C = (50/80) x 0.85 = 0.53



EXAMPLE:

Given: Watercourse Distance (D) = 70 Feet
Slope (s) = 1.3%
Runoff Coefficient (C) = 0.41
Overland Flow Time (T) = 9.5 Minutes

$$T = \frac{1.8\,(1.1 - C)\sqrt{D}}{\sqrt[3]{s}}$$

SOURCE: Airport Drainage, Federal Aviation Administration, 1965

Figure A-4. Rational Formula – Overland Time of Flow Nomograph

Note: Use formula for watercourse distances in excess of 100 feet.

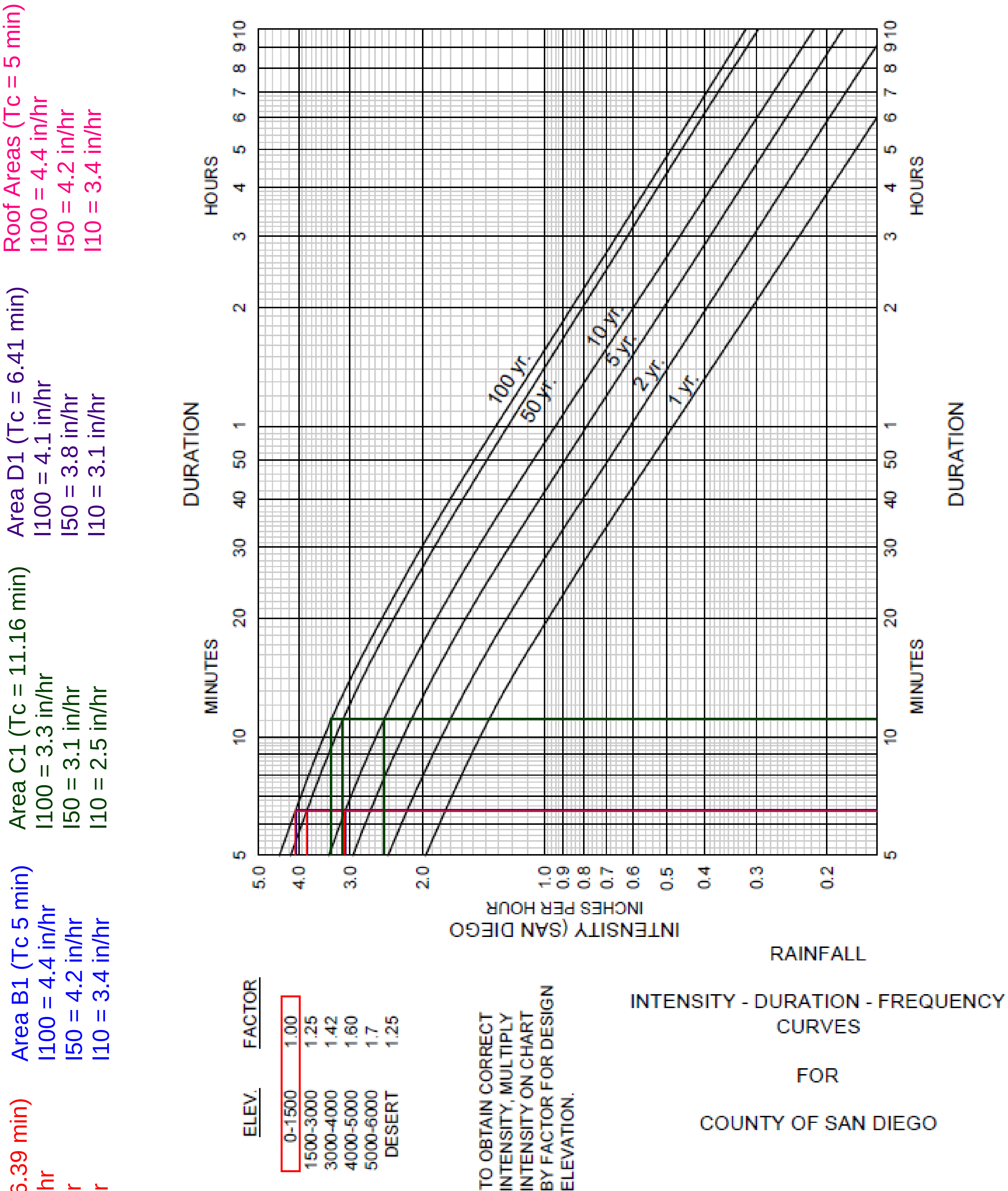


Figure A-1. Intensity-Duration-Frequency Design Chart

Exhibit D – Hydraulic Calculations

Worksheet for Basin E1 - Full Capacity

Project Description

Friction Method	Manning Formula
Solve For	Full Flow Capacity

Input Data

Roughness Coefficient	0.013	
Channel Slope	0.01000	ft/ft
Normal Depth	24.00	in
Diameter	24.00	in
Discharge	22.62	ft^3/s

Results

Discharge	22.62	ft^3/s
Normal Depth	24.00	in
Flow Area	3.14	ft^2
Wetted Perimeter	6.28	ft
Hydraulic Radius	6.00	in
Top Width	0.00	ft
Critical Depth	1.69	ft
Percent Full	100.0	%
Critical Slope	0.00946	ft/ft
Velocity	7.20	ft/s
Velocity Head	0.81	ft
Specific Energy	2.81	ft
Froude Number	0.00	
Maximum Discharge	24.33	ft^3/s
Discharge Full	22.62	ft^3/s
Slope Full	0.01000	ft/ft

Worksheet for Basin E1 - Full Capacity

Results

Flow Type	SubCritical	

GVF Input Data

Downstream Depth	0.00	in
Length	0.00	in
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	in
Profile Description		
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.00	%
Normal Depth Over Rise	100.00	%
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	24.00	in
Critical Depth	1.69	ft
Channel Slope	0.01000	ft/ft
Critical Slope	0.00946	ft/ft

Worksheet for Basin E2 - Full Capacity

Project Description

Friction Method	Manning Formula
Solve For	Full Flow Capacity

Input Data

Roughness Coefficient	0.013	
Channel Slope	0.01000	ft/ft
Normal Depth	24.00	in
Diameter	24.00	in
Discharge	22.62	ft^3/s

Results

Discharge	22.62	ft^3/s
Normal Depth	24.00	in
Flow Area	3.14	ft^2
Wetted Perimeter	6.28	ft
Hydraulic Radius	6.00	in
Top Width	0.00	ft
Critical Depth	1.69	ft
Percent Full	100.0	%
Critical Slope	0.00946	ft/ft
Velocity	7.20	ft/s
Velocity Head	0.81	ft
Specific Energy	2.81	ft
Froude Number	0.00	
Maximum Discharge	24.33	ft^3/s
Discharge Full	22.62	ft^3/s
Slope Full	0.01000	ft/ft

Worksheet for Basin E2 - Full Capacity

Results

Flow Type	SubCritical	

GVF Input Data

Downstream Depth	0.00	in
Length	0.00	in
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	in
Profile Description		
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.00	%
Normal Depth Over Rise	100.00	%
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	24.00	in
Critical Depth	1.69	ft
Channel Slope	0.01000	ft/ft
Critical Slope	0.00946	ft/ft

Worksheet for Basin E3 - Full Capacity

Project Description

Friction Method	Manning Formula
Solve For	Full Flow Capacity

Input Data

Roughness Coefficient	0.010	
Channel Slope	0.01000	ft/ft
Normal Depth	18.00	in
Diameter	18.00	in
Discharge	13.65	ft^3/s

Results

Discharge	13.65	ft^3/s
Normal Depth	18.00	in
Flow Area	1.77	ft^2
Wetted Perimeter	4.71	ft
Hydraulic Radius	4.50	in
Top Width	0.00	ft
Critical Depth	1.37	ft
Percent Full	100.0	%
Critical Slope	0.00871	ft/ft
Velocity	7.73	ft/s
Velocity Head	0.93	ft
Specific Energy	2.43	ft
Froude Number	0.00	
Maximum Discharge	14.69	ft^3/s
Discharge Full	13.65	ft^3/s
Slope Full	0.01000	ft/ft

Worksheet for Basin E3 - Full Capacity

Results

Flow Type	SubCritical	

GVF Input Data

Downstream Depth	0.00	in
Length	0.00	in
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	in
Profile Description		
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.00	%
Normal Depth Over Rise	100.00	%
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	18.00	in
Critical Depth	1.37	ft
Channel Slope	0.01000	ft/ft
Critical Slope	0.00871	ft/ft

Worksheet for Basin P1 - Full Flow Capacity

Project Description

Friction Method	Manning Formula
Solve For	Full Flow Capacity

Input Data

Roughness Coefficient	0.010	
Channel Slope	0.00500	ft/ft
Normal Depth	21.00	in
Diameter	21.00	in
Discharge	14.56	ft³/s

Results

Discharge	14.56	ft³/s
Normal Depth	21.00	in
Flow Area	2.41	ft²
Wetted Perimeter	5.50	ft
Hydraulic Radius	5.25	in
Top Width	0.00	ft
Critical Depth	1.42	ft
Percent Full	100.0	%
Critical Slope	0.00512	ft/ft
Velocity	6.06	ft/s
Velocity Head	0.57	ft
Specific Energy	2.32	ft
Froude Number	0.00	
Maximum Discharge	15.67	ft³/s
Discharge Full	14.56	ft³/s
Slope Full	0.00500	ft/ft

Worksheet for Basin P1 - Full Flow Capacity

Results

Flow Type	SubCritical	

GVF Input Data

Downstream Depth	0.00	in
Length	0.00	in
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	in
Profile Description		
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.00	%
Normal Depth Over Rise	100.00	%
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	21.00	in
Critical Depth	1.42	ft
Channel Slope	0.00500	ft/ft
Critical Slope	0.00512	ft/ft

Worksheet for Basin P2 - Full Flow Capacity

Project Description

Friction Method	Manning Formula
Solve For	Full Flow Capacity

Input Data

Roughness Coefficient	0.010	
Channel Slope	0.00500	ft/ft
Normal Depth	8.00	in
Diameter	8.00	in
Discharge	1.11	ft^3/s

Results

Discharge	1.11	ft^3/s
Normal Depth	8.00	in
Flow Area	0.35	ft^2
Wetted Perimeter	2.09	ft
Hydraulic Radius	2.00	in
Top Width	0.00	ft
Critical Depth	0.50	ft
Percent Full	100.0	%
Critical Slope	0.00601	ft/ft
Velocity	3.18	ft/s
Velocity Head	0.16	ft
Specific Energy	0.82	ft
Froude Number	0.00	
Maximum Discharge	1.19	ft^3/s
Discharge Full	1.11	ft^3/s
Slope Full	0.00500	ft/ft

Worksheet for Basin P2 - Full Flow Capacity

Results

Flow Type	SubCritical	

GVF Input Data

Downstream Depth	0.00	in
Length	0.00	in
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	in
Profile Description		
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.00	%
Normal Depth Over Rise	100.00	%
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	8.00	in
Critical Depth	0.50	ft
Channel Slope	0.00500	ft/ft
Critical Slope	0.00601	ft/ft

Worksheet for Basin P3 - Full Flow Capacity

Project Description

Friction Method	Manning Formula
Solve For	Full Flow Capacity

Input Data

Roughness Coefficient	0.010	
Channel Slope	0.00500	ft/ft
Normal Depth	15.00	in
Diameter	15.00	in
Discharge	5.94	ft^3/s

Results

Discharge	5.94	ft^3/s
Normal Depth	15.00	in
Flow Area	1.23	ft^2
Wetted Perimeter	3.93	ft
Hydraulic Radius	3.75	in
Top Width	0.00	ft
Critical Depth	0.99	ft
Percent Full	100.0	%
Critical Slope	0.00539	ft/ft
Velocity	4.84	ft/s
Velocity Head	0.36	ft
Specific Energy	1.61	ft
Froude Number	0.00	
Maximum Discharge	6.39	ft^3/s
Discharge Full	5.94	ft^3/s
Slope Full	0.00500	ft/ft

Worksheet for Basin P3 - Full Flow Capacity

Results

Flow Type	SubCritical	

GVF Input Data

Downstream Depth	0.00	in
Length	0.00	in
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	in
Profile Description		
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.00	%
Normal Depth Over Rise	100.00	%
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	15.00	in
Critical Depth	0.99	ft
Channel Slope	0.00500	ft/ft
Critical Slope	0.00539	ft/ft

Worksheet for Basin P5 Box Outlet - Full Flow Capacity

Project Description

Friction Method	Manning Formula
Solve For	Full Flow Capacity

Input Data

Roughness Coefficient	0.013	
Channel Slope	0.01500	ft/ft
Normal Depth	4.50	in
Height	4.50	in
Bottom Width	36.00	in
Discharge	4.77	ft^3/s

Results

Flow Area	1.13	ft^2
Wetted Perimeter	6.75	ft
Hydraulic Radius	2.00	in
Top Width	3.00	ft
Critical Depth	0.43	ft
Percent Full	100.0	%
Critical Slope	0.00457	ft/ft
Velocity	4.24	ft/s
Velocity Head	0.28	ft
Specific Energy	0.65	ft
Froude Number	1.22	
Discharge Full	4.77	ft^3/s
Slope Full	0.01500	ft/ft
Flow Type	Supercritical	

Worksheet for Basin P5 Box Outlet - Full Flow Capacity

GVF Input Data

Downstream Depth	0.00	in
Length	0.00	in
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	in
Profile Description		
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.00	%
Normal Depth Over Rise	100.00	%
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	4.50	in
Critical Depth	0.43	ft
Channel Slope	0.01500	ft/ft
Critical Slope	0.00457	ft/ft

Worksheet for Basin P5 - Full Flow Capacity

Project Description

Friction Method	Manning Formula
Solve For	Full Flow Capacity

Input Data

Roughness Coefficient	0.010	
Channel Slope	0.01000	ft/ft
Normal Depth	12.00	in
Diameter	12.00	in
Discharge	4.63	ft^3/s

Results

Discharge	4.63	ft^3/s
Normal Depth	12.00	in
Flow Area	0.79	ft^2
Wetted Perimeter	3.14	ft
Hydraulic Radius	3.00	in
Top Width	0.00	ft
Critical Depth	0.90	ft
Percent Full	100.0	%
Critical Slope	0.00884	ft/ft
Velocity	5.90	ft/s
Velocity Head	0.54	ft
Specific Energy	1.54	ft
Froude Number	0.00	
Maximum Discharge	4.98	ft^3/s
Discharge Full	4.63	ft^3/s
Slope Full	0.01000	ft/ft

Worksheet for Basin P5 - Full Flow Capacity

Results

Flow Type	SubCritical	

GVF Input Data

Downstream Depth	0.00	in
Length	0.00	in
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	in
Profile Description		
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.00	%
Normal Depth Over Rise	100.00	%
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	12.00	in
Critical Depth	0.90	ft
Channel Slope	0.01000	ft/ft
Critical Slope	0.00884	ft/ft

Exhibit E – Federal Emergency Management Agency Special Flood Hazard Areas (SFHAs)

NOTES TO USERS

This map is for use in administering the National Flood Insurance Program. It does not necessarily identify all areas subject to flooding, particularly from local drainage sources of small size. The **community map repository** should be consulted for possible updated or additional flood hazard information.

To obtain more detailed information in areas where **Base Flood Elevations** (BFEs) and/or **floodways** have been determined, users are encouraged to consult the Flood Profiles and Floodway Data and/or Summary of Stillwater Elevations tables contained within the Flood Insurance Study (FIS) report that accompanies this FIRM. Users should be aware that BFEs shown on the FIRM represent rounded whole-foot elevations. These BFEs are intended for flood insurance rating purposes only and should not be used as the sole source of flood elevation information. Accordingly, flood elevation data presented in the FIS report should be utilized in conjunction with the FIRM for purposes of construction and/or floodplain management.

Coastal Base Flood Elevations (BFEs) shown on this map apply only landward of 0.0' North American Vertical Datum of 1988 (NAVD 88). Users of this FIRM should be aware that coastal flood elevations are also provided in the Summary of Stillwater Elevations table in the Flood Insurance Study report for this jurisdiction. Elevations shown in the Summary of Stillwater Elevations table should be used for construction and/or floodplain management purposes when they are higher than the elevations shown on this FIRM.

Boundaries of the **floodways** were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the National Flood Insurance Program. Floodway widths and other pertinent floodway data are provided in the Flood Insurance Study report for this jurisdiction.

Certain areas not in Special Flood Hazard Areas may be protected by **flood control structures**. Refer to Section 2.4 "Flood Protection Measures" of the Flood Insurance Study report for information on flood control structures for this jurisdiction.

The **projection** used in the preparation of this map was Universal Transverse Mercator (UTM) Zone 11. The **horizontal datum** was NAD83, GRS1980 spheroid. Differences in datum, spheroid, projection or UTM zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of this FIRM.

Flood elevations on this map are referenced to the North American Vertical Datum of 1988. These flood elevations must be compared to structure and ground elevations referenced to the same **vertical datum**. For information regarding conversion between the National Geodetic Vertical Datum of 1929 and the North American Vertical Datum of 1988, visit the National Geodetic Survey website at http://www.ngs.noaa.gov/ or contact the National Geodetic Survey at the following address:

NGS Information Services
NOAA, N/NGS12
National Geodetic Survey
SSMC-3, #9202
1315 East-West Highway
Silver Spring, Maryland 20910-3282
(301) 713-3242

To obtain current elevation, description, and/or location information for **bench marks** shown on this map, please contact the Information Services Branch of the National Geodetic Survey at **(301) 713-3242** or visit its website at http://www.ngs.noaa.gov/.

Base map information shown on this FIRM was provided in digital format by the USDA National Agriculture Imagery Program (NAIP). this information was photogrammetrically compiled at a scale of 1:24,000 from aerial photography dated 2009.

This map reflects more detailed and up-to-date **stream channel configurations** than those shown on the previous FIRM for this jurisdiction. The floodplains and floodways that were transferred from the previous FIRM may have been adjusted to conform to these new stream channel configurations. As a result, the Flood Profiles and Floodway Data tables *in the Flood Insurance Study report (which contains authoritative hydraulic data)* may reflect stream channel distances that differ from what is shown on this map.

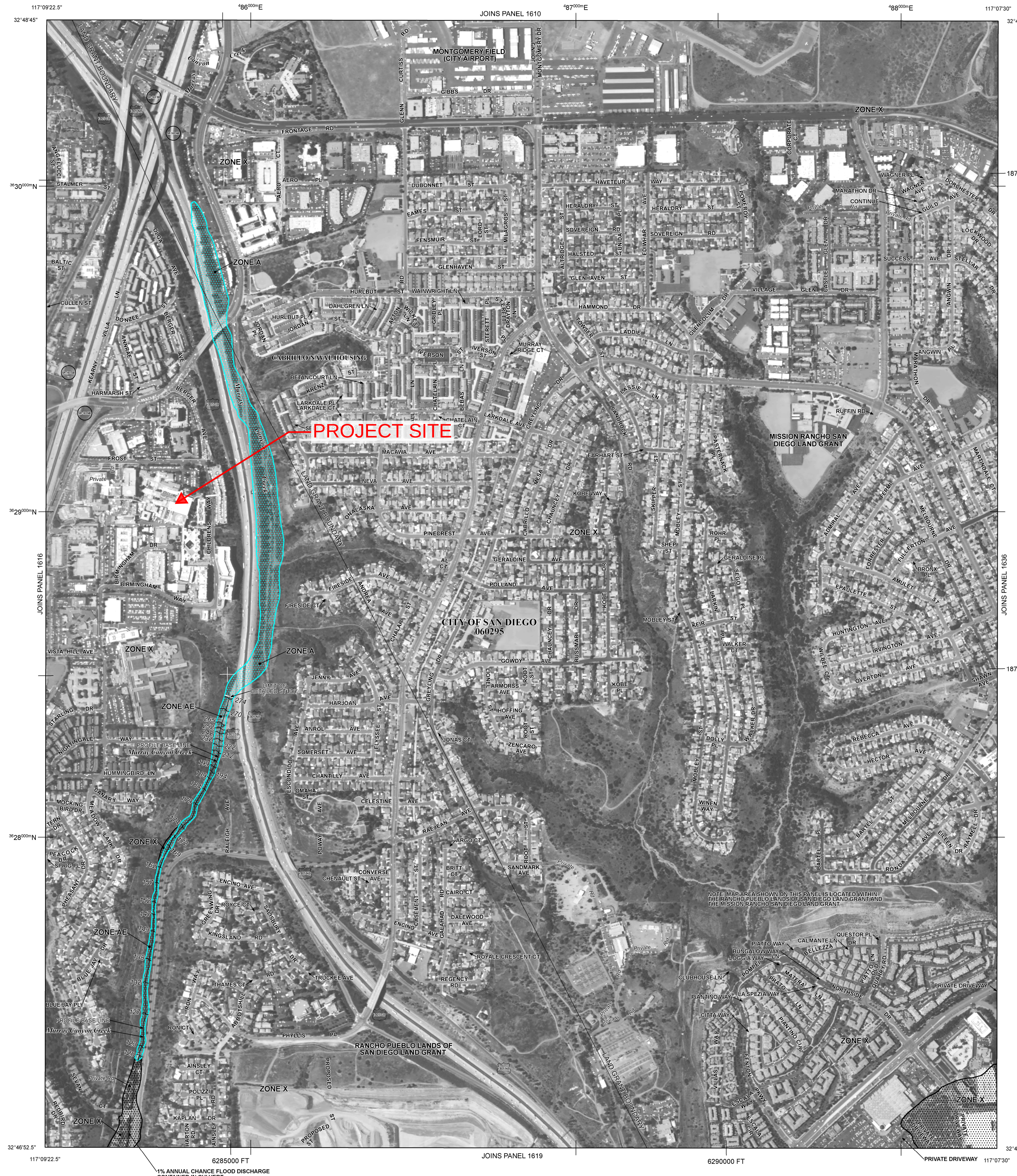
Corporate limits shown on this map are based on the best data available at the time of publication. Because changes due to annexations or de-annexations may have occurred after this map was published, map users should contact appropriate community officials to verify current corporate limit locations.

Please refer to the separately printed **Map Index** for an overview map of the county showing the layout of map panels; community map repository addresses; and a Listing of Communities table containing National Flood Insurance Program dates for each community as well as a listing of the panels on which each community is located.

Contact the **FEMA Map Service Center** at 1-877-FEMA MAP (1-877-336-2627) for information on available products associated with this FIRM. Available products may include previously issued Letters of Map Change, a Flood Insurance Study report, and/or digital versions of this map. The FEMA Map Service Center may also be reached by Fax at 1-800-358-9620 and its website at http://msc.fema.gov/.

If you have **questions about this map** or questions concerning the National Flood Insurance Program in general, please call **1-877-FEMA MAP** (1-877-336-2627) or visit the FEMA website at http://www.fema.gov/business/nfip/.

The **"profile base lines"** depicted on this map represent the hydraulic modeling baselines that match the flood profiles in the FIS report. As a result of improved topographic data, the "profile base line", in some cases, may deviate significantly from the channel centerline or appear outside the SFHA.



LEGEND

SPECIAL FLOOD HAZARD AREAS SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual chance flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V, and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

ZONE A	No Base Flood Elevations determined.
ZONE AE	Base Flood Elevations determined.
ZONE AH	Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.
ZONE AO	Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.
ZONE AR	Special Flood Hazard Area formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.
ZONE A99	Areas to be protected from 1% annual chance flood event by a Federal flood protection system under construction; no Base Flood Elevations determined.
ZONE V	Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.
ZONE VE	Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

ZONE X	Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

OTHER AREAS

ZONE X	Areas determined to be outside the 0.2% annual chance floodplain.
ZONE D	Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

1% annual chance floodplain boundary
0.2% annual chance floodplain boundary
Floodway boundary
Zone D boundary
CBRS and OPA boundary
Boundary dividing Special Flood Hazard Area Zones and boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths, or flood velocities

513	Base Flood Elevation line and value; elevation in feet*
(EL 987)	Base Flood Elevation value where uniform within zone; elevation in feet*

* Referenced to the North American Vertical Datum of 1988

A—A	Cross section line
23- - - -23	Transect line
97°07'30", 32°22'30"	Geographic coordinates referenced to the North American Datum of 1983 (NAD 83), Western Hemisphere
$^{42}75^{000m}$E	1000-meter Universal Transverse Mercator grid ticks, zone 11
6000000 FT	5000-foot grid values: California State Plane coordinate system, Zone VI (FIPSZONE = 406), Lambert projection
DX5510 ×	Bench mark (see explanation in Notes to Users section of this FIRM panel)
● M1.5	River Mile

MAP REPOSITORIES
Refer to Map Repositories list on Map Index

EFFECTIVE DATE OF COUNTYWIDE
FLOOD INSURANCE RATE MAP
June 19, 1997

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL
May 16, 2012 – to update corporate limits, to add roads and road names, to incorporate previously issued Letters of Map Revision, and to update map elevations to North American Vertical Datum of 1988.

For community map revision history prior to countywide mapping, refer to the Community Map History table located in the Flood Insurance Study report for this jurisdiction.

To determine if flood insurance is available in this community, contact your insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

MAP SCALE 1" = 500'

250 0 250 500 750 1,000 FEET
150 0 150 300 METERS

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 1617G

FIRM
FLOOD INSURANCE RATE MAP
SAN DIEGO COUNTY, CALIFORNIA
AND INCORPORATED AREAS

PANEL 1617 OF 2375
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
SAN DIEGO, CITY OF	060295	1617	G

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER 06073C1617G

MAP REVISED MAY 16, 2012

Federal Emergency Management Agency

Vicinity Map
Rady Children's Hospital
MESA COLLEGE DR
PROJECT SITE
FROST ST
163
805
BIRMINGHAM DR
CHILDREN'S WAY
BIRMINGHAM WAY
MEADOW LARK DR
Google Earth
Image Landsat / Copernicus
700 ft
N