Appendix 5.5-1 Stormwater Quality Management

Appendices

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The City of San Diego

PRIORITY DEVELOPMENT PROJECT (PDP) STORM WATER QUALITY MANAGEMENT PLAN (SWQMP) FOR

Fiesta Island – Mission Bay Park Master Plan Amendment

ENGINEER OF WORK:

Greg Kump, PE RCE 66416

PREPARED FOR:
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PREPARED BY:

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(858) 292-7770

DATE: September 27, 2017

Approved by: City of San Diego Date

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SUMMARY

Fiesta Island is located within the Mission Bay Park Master Plan area. The island was created through the dredging operations five decades ago that made Mission Bay Park the outstanding water park that it is today. The island currently functions as a multi-purpose recreation area with a portion of the island allocated to habitat preservation. The existing island is approximately 485 acres and is relatively flat with grades ranging from sea level to 15 to 20 feet above sea level. Only the shoreline is readily visible to the general public. Most of the island's acreage is hidden by the containment sand berms that were used to help create it more than five decades ago. Because of the topography, and the fact that most of the island consists of sandy material, much of the runoff does not drain directly into the bay. Runoff from a portion of the interior of the site ponds during a rain event and eventually storm water percolates into the soil or evaporates. However, the access road that runs along the perimeter of the island does drain into the bay as does much of the westerly beach area of the Island.

The only existing storm drainage system on Fiesta Island includes a series of culverts that convey runoff from the interior of the island within the dog park on the southwestern portion of the island.

The proposed project will include improvements of certain portions of Fiesta Island consistent with the Mission Bay Park Master Plan's intent. The majority of the work to be done will be located in the central and southern portions of the island. The improvements are to include grading to create flat and mounded areas, park and habitat areas, access road extensions, parking lots, walking trails, camping areas, restroom facilities, bridge structures, and the improvement of the entry road.

In a review of hydrology and stormwater quality treatment for the project, the Island is subdivided into four areas:

North Island
Central Island
Southwest Island
Southeast Island

Existing and proposed stormwater basins in each portion of the Island are indicated for a total of 32 separate basins. The tables of the existing and proposed surface runoff determine the existing and proposed 100 year runoff flows for each basin. Due to the proposed increase in impervious surfaces with the proposed project, some of the basins result in an increasing in 100 year runoff with a maximum of 5%:

	Existing 100yr Q	Proposed 100yr Q	Percent Increase
North Island	73.53 cfs	75.04 cfs	2%
Central Island	120.56 cfs	123.82 cfs	3%
Southwest Island	98.92 cfs	98.92 cfs	0%
Southeast Island	153.16 cfs	160.65 cfs	5%

However, these increases in 100 year runoff will be mitigated with the installation of infiltration basins which would also serve as retention basins to mimic the pre-project runoff and would not adversely affect the project area or downstream areas associated with substantial erosion, siltation, or flooding.

Major improvements that will significantly improve the water quality including in the project are:

- The creation of wetland areas will create an ecosystem full of plant and animal life and will also serve as a natural stormwater treatment system. Wetlands perform two important functions in relation to climate change. They have mitigation effects through their ability to sink carbon and adaptation effect through their ability to store and regulate water.
- Infiltration basins for the creation of impervious surfaces within the Island Plan. The infiltration basins will mimic the existing basins which drain the interior of the island and provide water quality treatment improvements
- Where roadways are constructed or re-constructed, they will slope to the interior of the island to a linear infiltration basin adjacent to the roadway.

An alternative layout includes a relocation of a proposed parking lot within the Southwestern portion of the island. These improvements will have minor affects on storm water. See Attachment 1A for additional information.

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ACRONYMS

APN	Assessor's Parcel Number
ASBS	Area of Special Biological Significance
BMP	Best Management Practice
CEQA	California Environmental Quality Act
CGP	Construction General Permit
DCV	Design Capture Volume
DMA	Drainage Management Areas
ESA	Environmentally Sensitive Area
GLU	Geomorphic Landscape Unit
GW	Ground Water
HMP	Hydromodification Management Plan
HSG	Hydrologic Soil Group
HU	Harvest and Use
INF	Infiltration
LID	Low Impact Development
LUP	Linear Underground/Overhead Projects
MS4	Municipal Separate Storm Sewer System
N/A	Not Applicable
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
PDP	Priority Development Project
PE	Professional Engineer
POC	Pollutant of Concern
SC	Source Control
SD	Site Design
SDRWQCB	San Diego Regional Water Quality Control Board
SIC	Standard Industrial Classification
SWPPP	Stormwater Pollutant Protection Plan
SWQMP	Storm Water Quality Management Plan
TMDL	Total Maximum Daily Load
WMAA	Watershed Management Area Analysis
WPCP	Water Pollution Control Program
WQIP	Water Quality Improvement Plan

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CERTIFICATION PAGE

Project Name: Fiesta Island – Mission Bay Park Master Plan Amendment
Permit Application Number:

I hereby declare that I am the Engineer in Responsible Charge of design of storm water BMPs for this project, and that I have exercised responsible charge over the design of the project as defined in Section 6703 of the Business and Professions Code, and that the design is consistent with the requirements of the Storm Water Standards, which is based on the requirements of SDRWQCB Order No. R9-2013-0001 as amended by R9-2015-0001 and R9-2015-0100 (MS4 Permit).

I have read and understand that the City Engineer has adopted minimum requirements for managing urban runoff, including storm water, from land development activities, as described in the Storm Water Standards. I certify that this PDP SWQMP has been completed to the best of my ability and accurately reflects the project being proposed and the applicable source control and site design BMPs proposed to minimize the potentially negative impacts of this project's land development activities on water quality. I understand and acknowledge that the plan check review of this PDP SWQMP by the City Engineer is confined to a review and does not relieve me, as the Engineer in Responsible Charge of design of storm water BMPs for this project, of my responsibilities for project design.

66416, Exp. 06/30/2018

Engineer of Work's Signature, PE Number & Expiration Date

Greg Kump

Print Name

Nasland Engineering

Company

9/27/2017

Date

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SUBMITTAL RECORD

Use this Table to keep a record of submittals of this PDP SWQMP. Each time the PDP SWQMP is re-submitted, provide the date and status of the project. In last column indicate changes that have been made or indicate if response to plan check comments is included. When applicable, insert response to plan check comments.

Submittal Number	Date	Project Status	Changes
1	8/11/2017	☒ Preliminary Design/Planning/CEQA ☐ Final Design	Initial Submittal
2	9/27/2017	☒ Preliminary Design/Planning/CEQA ☐ Final Design	Second Submittal
3		☐ Preliminary Design/Planning/CEQA ☐ Final Design	
4		☐ Preliminary Design/Planning/CEQA ☐ Final Design	

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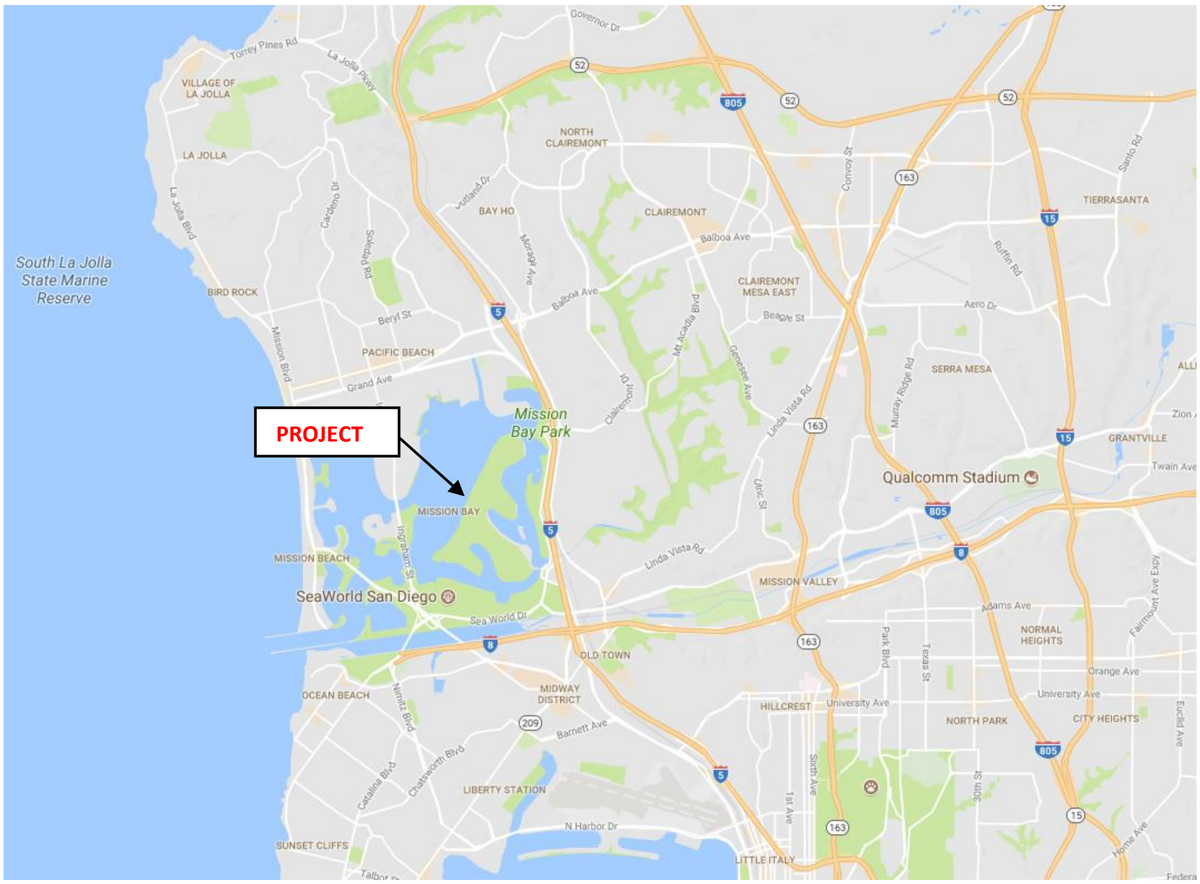
PROJECT VICINITY MAP

Project Name: Fiesta Island – Mission Bay Park Master Plan Amendment
Permit Application Number:



Source: Google Maps

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STORM WATER REQUIREMENTS APPLICABILITY CHECKLIST

Complete and attach DS-560 Form included in Appendix A.1

City of San Diego
Development Services
1222 First Ave., MS-302
San Diego, CA 92101
(619) 446-5000

Storm Water Requirements Applicability Checklist

FORM DS-560
OCTOBER 2016

Project Address: 1760 Fiesta Island Road, San Diego, CA 92109	Project Number *(for City Use Only)*:

SECTION 1. Construction Storm Water BMP Requirements:

All construction sites are required to implement construction BMPs in accordance with the performance standards in the Storm Water Standards Manual. Some sites are additionally required to obtain coverage under the State Construction General Permit (CGP)[1] , which is administered by the State Water Resources Control Board.

For all projects complete PART A: If project is required to submit a SWPPP or WPCP, continue to PART B.

PART A: Determine Construction Phase Storm Water Requirements.

1. Is the project subject to California's statewide General NPDES permit for Storm Water Discharges Associated with Construction Activities, also known as the State Construction General Permit (CGP)? (Typically projects with land disturbance greater than or equal to 1 acre.)

   ☒ Yes; SWPPP required, skip questions 2-4 ☐ No; next question

2. Does the project propose construction or demolition activity, including but not limited to, clearing, grading, grubbing, excavation, or any other activity resulting in ground disturbance and contact with storm water runoff?

   ☐ Yes; WPCP required, skip 3-4 ☐ No; next question

3. Does the project propose routine maintenance to maintain original line and grade, hydraulic capacity, or original purpose of the facility? (Projects such as pipeline/utility replacement)

   ☐ Yes; WPCP required, skip 4 ☐ No; next question

4. Does the project only include the following Permit types listed below?

   - Electrical Permit, Fire Alarm Permit, Fire Sprinkler Permit, Plumbing Permit, Sign Permit, Mechanical Permit, Spa Permit.
   - Individual Right of Way Permits that exclusively include only ONE of the following activities: water service, sewer lateral, or utility service.
   - Right of Way Permits with a project footprint less than 150 linear feet that exclusively include only ONE of the following activities: curb ramp, sidewalk and driveway apron replacement, pot holing, curb and gutter replacement, and retaining wall encroachments.

   ☐ Yes; no document required

Check one of the boxes below, and continue to PART B:

☒ If you checked "Yes" for question 1, **a SWPPP is REQUIRED. Continue to PART B**

☐ If you checked "No" for question 1, and checked "Yes" for question 2 or 3, **a WPCP is REQUIRED.** If the project proposes less than 5,000 square feet of ground disturbance AND has less than a 5-foot elevation change over the entire project area, a Minor WPCP may be required instead. **Continue to PART B.**

☐ If you checked "No" for all questions 1-3, and checked "Yes" for question 4 PART B **does not apply and no document is required. Continue to Section 2.**

1. More information on the City's construction BMP requirements as well as CGP requirements can be found at: www.sandiego.gov/stormwater/regulations/index.shtml

PART B: Determine Construction Site Priority

This prioritization must be completed within this form, noted on the plans, and included in the SWPPP or WPCP. The city reserves the right to adjust the priority of projects both before and after construction. Construction projects are assigned an inspection frequency based on if the project has a "high threat to water quality." The City has aligned the local definition of "high threat to water quality" to the risk determination approach of the State Construction General Permit (CGP). The CGP determines risk level based on project specific sediment risk and receiving water risk. Additional inspection is required for projects within the Areas of Special Biological Significance (ASBS) watershed. **NOTE:** The construction priority does **NOT** change construction BMP requirements that apply to projects; rather, it determines the frequency of inspections that will be conducted by city staff.

Complete PART B and continued to Section 2

1. ☐ **ASBS**

a. Projects located in the ASBS watershed.

2. ☐ **High Priority**

a. Projects 1 acre or more determined to be Risk Level 2 or Risk Level 3 per the Construction General Permit and not located in the ASBS watershed.

b. Projects 1 acre or more determined to be LUP Type 2 or LUP Type 3 per the Construction General Permit and not located in the ASBS watershed.

3. ☐ **Medium Priority**

a. Projects 1 acre or more but not subject to an ASBS or high priority designation.

b. Projects determined to be Risk Level 1 or LUP Type 1 per the Construction General Permit and not located in the ASBS watershed.

4. ☐ **Low Priority**

a. Projects requiring a Water Pollution Control Plan but not subject to ASBS, high, or medium priority designation.

SECTION 2. Permanent Storm Water BMP Requirements.

Additional information for determining the requirements is found in the Storm Water Standards Manual.

PART C: Determine if Not Subject to Permanent Storm Water Requirements.

Projects that are considered maintenance, or otherwise not categorized as "new development projects" or "redevelopment projects" according to the Storm Water Standards Manual are not subject to Permanent Storm Water BMPs.

If "yes" is checked for any number in Part C, proceed to Part F and check "Not Subject to Permanent Storm Water BMP Requirements".

If "no" is checked for all of the numbers in Part C continue to Part D.

1.	Does the project only include interior remodels and/or is the project entirely within an existing enclosed structure and does not have the potential to contact storm water?	☐ Yes ☐ No
2.	Does the project only include the construction of overhead or underground utilities without creating new impervious surfaces?	☐ Yes ☐ No
3.	Does the project fall under routine maintenance? Examples include, but are not limited to: roof or exterior structure surface replacement, resurfacing or reconfiguring surface parking lots or existing roadways without expanding the impervious footprint, and routine replacement of damaged pavement (grinding, overlay, and pothole repair).	☐ Yes ☐ No

Clear Page 2

PART D: PDP Exempt Requirements.

PDP Exempt projects are required to implement site design and source control BMPs.

If “yes” was checked for any questions in Part D, continue to Part F and check the box labeled “PDP Exempt.”

If “no” was checked for all questions in Part D, continue to Part E.

1. Does the project ONLY include new or retrofit sidewalks, bicycle lanes, or trails that:

- **Are designed and constructed to direct storm water runoff to adjacent vegetated areas, or other non-erodible permeable areas? Or;**
- **Are designed and constructed to be hydraulically disconnected from paved streets and roads? Or;**
- **Are designed and constructed with permeable pavements or surfaces in accordance with the Green Streets guidance in the City’s Storm Water Standards manual?**

☐ Yes; PDP exempt requirements apply ☐ No; next question

2. Does the project ONLY include retrofitting or redeveloping existing paved alleys, streets or roads designed and constructed in accordance with the Green Streets guidance in the City’s Storm Water Standards Manual?

☐ Yes; PDP exempt requirements apply ☐ No; project not exempt.

PART E: Determine if Project is a Priority Development Project (PDP).

Projects that match one of the definitions below are subject to additional requirements including preparation of a Storm Water Quality Management Plan (SWQMP).

If “yes” is checked for any number in PART E, continue to PART F and check the box labeled “Priority Development Project”.

If “no” is checked for every number in PART E, continue to PART F and check the box labeled “Standard Development Project”.

1. **New Development that creates 10,000 square feet or more of impervious surfaces collectively over the project site.** This includes commercial, industrial, residential, mixed-use, and public development projects on public or private land. ☒ Yes ☐ No

2. **Redevelopment project that creates and/or replaces 5,000 square feet or more of impervious surfaces on an existing site of 10,000 square feet or more of impervious surfaces.** This includes commercial, industrial, residential, mixed-use, and public development projects on public or private land. ☐ Yes ☐ No

3. **New development or redevelopment of a restaurant.** Facilities that sell prepared foods and drinks for consumption, including stationary lunch counters and refreshment stands selling prepared foods and drinks for immediate consumption (SIC 5812), and where the land development creates and/or replace 5,000 square feet or more of impervious surface. ☐ Yes ☐ No

4. **New development or redevelopment on a hillside.** The project creates and/or replaces 5,000 square feet or more of impervious surface (collectively over the project site) and where the development will grade on any natural slope that is twenty-five percent or greater. ☐ Yes ☐ No

5. **New development or redevelopment of a parking lot that creates and/or replaces 5,000 square feet or more of impervious surface (collectively over the project site).** ☒ Yes ☐ No

6. **New development or redevelopment of streets, roads, highways, freeways, and driveways.** The project creates and/or replaces 5,000 square feet or more of impervious surface (collectively over the project site). ☒ Yes ☐ No

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7. **New development or redevelopment discharging directly to an Environmentally Sensitive Area.** The project creates and/or replaces 2,500 square feet of impervious surface (collectively over project site), and discharges directly to an Environmentally Sensitive Area (ESA). "Discharging directly to" includes flow that is conveyed overland a distance of 200 feet or less from the project to the ESA, or conveyed in a pipe or open channel any distance as an isolated flow from the project to the ESA (i.e. not commingled with flows from adjacent lands). ☐ Yes ☐ No

8. **New development or redevelopment projects of a retail gasoline outlet (RGO) that create and/or replaces 5,000 square feet of impervious surface.** The development project meets the following criteria: (a) 5,000 square feet or more or (b) has a projected Average Daily Traffic (ADT) of 100 or more vehicles per day. ☐ Yes ☐ No

9. **New development or redevelopment projects of an automotive repair shops that creates and/or replaces 5,000 square feet or more of impervious surfaces.** Development projects categorized in any one of Standard Industrial Classification (SIC) codes 5013, 5014, 5541, 7532-7534, or 7536-7539. ☐ Yes ☐ No

10. **Other Pollutant Generating Project.** The project is not covered in the categories above, results in the disturbance of one or more acres of land and is expected to generate pollutants post construction, such as fertilizers and pesticides. This does not include projects creating less than 5,000 sf of impervious surface and where added landscaping does not require regular use of pesticides and fertilizers, such as slope stabilization using native plants. Calculation of the square footage of impervious surface need not include linear pathways that are for infrequent vehicle use, such as emergency maintenance access or bicycle pedestrian use, if they are built with pervious surfaces of if they sheet flow to surrounding pervious surfaces. ☐ Yes ☐ No

PART F: Select the appropriate category based on the outcomes of PART C through PART E.

1. The project is **NOT SUBJECT TO PERMANENT STORM WATER REQUIREMENTS**. ☐
2. The project is a **STANDARD DEVELOPMENT PROJECT**. Site design and source control BMP requirements apply. See the Storm Water Standards Manual for guidance. ☐
3. The project is **PDP EXEMPT**. Site design and source control BMP requirements apply. See the Storm Water Standards Manual for guidance. ☐
4. The project is a **PRIORITY DEVELOPMENT PROJECT**. Site design, source control, and structural pollutant control BMP requirements apply. See the Storm Water Standards Manual for guidance on determining if project requires a hydromodification plan management ☐

Name of Owner or Agent *(Please Print)*	Title
Signature	Date

Clear Page 4

Clear Form

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Applicability of Permanent, Post-Construction Storm Water BMP Requirements	**Form I-1**

Project Identification	
Project Name: Fiesta Island – Mission Bay Park Master Plan Amendment	
Permit Application Number:	Date: 8/16/2017

Determination of Requirements

The purpose of this form is to identify permanent, post-construction requirements that apply to the project. This form serves as a short summary of applicable requirements, in some cases referencing separate forms that will serve as the backup for the determination of requirements.

Answer each step below, starting with Step 1 and progressing through each step until reaching "Stop". Refer to Part 1 of Storm Water Standards sections and/or separate forms referenced in each step below.

Step	Answer	Progression
Step 1: Is the project a "development project"? See Section 1.3 of the BMP Design Manual (Part 1 of Storm Water Standards) for guidance.	☒ Yes	Go to Step 2.
	☐ No	Stop. Permanent BMP requirements do not apply. No SWQMP will be required. Provide discussion below.

Discussion / justification if the project is not a "development project" (e.g., the project includes only interior remodels within an existing building):

Step	Answer	Progression
Step 2: Is the project a Standard Project, Priority Development Project (PDP), or exception to PDP definitions? To answer this item, see Section 1.4 of the BMP Design Manual (Part 1 of Storm Water Standards) in its entirety for guidance, AND complete Storm Water Requirements Applicability Checklist.	☐ Standard Project	Stop. Standard Project requirements apply.
	☒ PDP	PDP requirements apply, including PDP SWQMP. Go to Step 3.
	☐ PDP Exempt	Stop. Standard Project requirements apply. Provide discussion and list any additional requirements below.

Discussion / justification, and additional requirements for exceptions to PDP definitions, if applicable:

Form I-1 Page 2		
Step	Answer	Progression
Step 3. Is the project subject to earlier PDP requirements due to a prior lawful approval? See Section 1.10 of the BMP Design Manual (Part 1 of Storm Water Standards) for guidance.	☐ Yes	Consult the City Engineer to determine requirements. Provide discussion and identify requirements below. Go to Step 4.
	☒ No	BMP Design Manual PDP requirements apply. Go to Step 4.
Discussion / justification of prior lawful approval, and identify requirements (<u>not required if prior lawful approval does not apply</u>):		
Step 4. Do hydromodification control requirements apply? See Section 1.6 of the BMP Design Manual (Part 1 of Storm Water Standards) for guidance.	☐ Yes	PDP structural BMPs required for pollutant control (Chapter 5) and hydromodification control (Chapter 6). Go to Step 5.
	☒ No	Stop. PDP structural BMPs required for pollutant control (Chapter 5) only. Provide brief discussion of exemption to hydromodification control below.
Discussion / justification if hydromodification control requirements do <u>not</u> apply: Project is located inside of Mission Bay and is exempt from hydromodification.		
Step 5. Does protection of critical coarse sediment yield areas apply? See Section 6.2 of the BMP Design Manual (Part 1 of Storm Water Standards) for guidance.	☐ Yes	Management measures required for protection of critical coarse sediment yield areas (Chapter 6.2). Stop.
	☒ No	Management measures not required for protection of critical coarse sediment yield areas. Provide brief discussion below. Stop.
Discussion / justification if protection of critical coarse sediment yield areas does <u>not</u> apply:		

Site Information Checklist For PDPs	Form I-3B
Project Summary Information	
Project Name	Fiesta Island – Mission Bay Park Master Plan Amendment
Project Address	1760 Fiesta Island Road San Diego, CA 92109
Assessor's Parcel Number(s) (APN(s))	N/A
Permit Application Number	
Project Watershed	Select One: ☐ San Dieguito River ☐ Penasquitos ☒ Mission Bay ☐ San Diego River ☐ San Diego Bay ☐ Tijuana River
Hydrologic subarea name with Numeric Identifier up to two decimal places (9XX.XX)	Clairemont (906.50)
Project Area (total area of Assessor's Parcel(s) associated with the project or total area of the right-of-way)	468 Acres (20,377,196 Square Feet)
Area to be disturbed by the project (Project Footprint)	371 Acres (16,150,572 Square Feet)
Project Proposed Impervious Area (subset of Project Footprint)	30 Acres (1,315,844 Square Feet)
Project Proposed Pervious Area (subset of Project Footprint)	341 Acres (14,834,728 Square Feet)
Note: Proposed Impervious Area + Proposed Pervious Area = Area to be Disturbed by the Project. This may be less than the Project Area.	
The proposed increase or decrease in impervious area in the proposed condition as compared to the pre-project condition.	+5.3 %

Form I-3B Page 2 of 11
Description of Existing Site Condition and Drainage Patterns
Current Status of the Site (select all that apply): ☒ Existing development ☒ Previously graded but not built out ☐ Agricultural or other non-impervious use ☒ Vacant, undeveloped/natural Description / Additional Information:
Existing Land Cover Includes (select all that apply): ☒ Vegetative Cover ☒ Non-Vegetated Pervious Areas ☒ Impervious Areas Description / Additional Information:
Underlying Soil belongs to Hydrologic Soil Group (select all that apply): ☐ NRCS Type A ☒ NRCS Type B ☐ NRCS Type C ☐ NRCS Type D
Approximate Depth to Groundwater (GW): ☐ GW Depth < 5 feet ☐ 5 feet < GW Depth < 10 feet ☒ 10 feet < GW Depth < 20 feet ☒ GW Depth > 20 feet
Existing Natural Hydrologic Features (select all that apply): ☐ Watercourses ☐ Seeps ☐ Springs ☒ Wetlands ☐ None Description / Additional Information:

Description of Existing Site Topography and Drainage:
How is storm water runoff conveyed from the site? At a minimum, this description should answer: 1. Whether existing drainage conveyance is natural or urban; 2. If runoff from offsite is conveyed through the site? If yes, quantification of all offsite drainage areas, design flows, and locations where offsite flows enter the project site and summarize how such flows are conveyed through the site; 3. Provide details regarding existing project site drainage conveyance network, including storm drains, concrete channels, swales, detention facilities, storm water treatment facilities, and natural and constructed channels; 4. Identify all discharge locations from the existing project along with a summary of the conveyance system size and capacity for each of the discharge locations. Provide summary of the pre-project drainage areas and design flows to each of the existing runoff discharge locations.
Description / Additional Information:
Existing drainage conveyance is considered to be natural. No offsite runoff is conveyed through the site. The project is located on an island within Mission Bay and does not receive additional storm water. For the majority of the island storm water is separated by a containment berm around the perimeter; on the interior side of the berm runoff sheet flows and infiltrates into existing informal basins, while on the exterior side of the berm runoff sheet flows across Fiesta Island Road and discharges directly towards Mission Bay. Within the dog park area in the southwest portion of the island, there are nine (9) known storm drain outlets which convey runoff from the dog park to Mission Bay. They vary from 24” HDPE and 30” CMP. A summary of existing and proposed drainage areas is included in Attachment 5; proposed drainage management areas is included in Attachment 1.

City of San Diego
TRANSPORTATION & STORM WATER

Description of Proposed Site Development and Drainage Patterns

Project Description / Proposed Land Use and/or Activities:

Proposed land use includes the following:

- Regional Park
- Natural Recreation Area
- Sand Management Area
- Shoreline Park
- Primitive Camping Area
- Expanded Youth Camping
- Fenced Habitat Areas
- Sand Recreation Areas
- Dog Beach Area
- Swimming Beach
- Dredged Shoreline

List/describe proposed impervious features of the project (e.g., buildings, roadways, parking lots, courtyards, athletic courts, other impervious features):

- Park Roadways
- Parking Lots (portions of parking lots may be determined to be permeable)
- Park Structures

List/describe proposed pervious features of the project (e.g., landscape areas):

- Improvements of natural habitats: salt marshes, mudflats, wetlands
- Decomposed granite
- Landscaping/Parkland
- Undisturbed island terrain
- Unpaved maintenance area

Does the project include grading and changes to site topography?

☒ Yes

☐ No

Description / Additional Information:

Proposed features include new paved roads, parking lots, playground areas, and walkways. General direction of flow remains the same, however sheet flow from impervious areas will drain towards proposed infiltration basins.

Does the project include changes to site drainage (e.g., installation of new storm water conveyance systems)?

☒ Yes
☐ No

If yes, provide details regarding the proposed project site drainage conveyance network, including storm drains, concrete channels, swales, detention facilities, storm water treatment facilities, natural and constructed channels, and the method for conveying offsite flows through or around the proposed project site. Identify all discharge locations from the proposed project site along with a summary of the conveyance system size and capacity for each of the discharge locations. Provide a summary of pre and post-project drainage areas and design flows to each of the runoff discharge locations. Reference the drainage study for detailed calculations.

Description / Additional Information:

Fiesta Island Road spans the perimeter of Fiesta Island, and currently drains towards Mission Bay. Where new roadways are constructed or re-construced, the roadways will be re-sloped to direct storm water away from the bay to an adjacent infiltrating bio-swales that will run alongside Fiesta Island Road. These will treat the pollutants generated from the proposed street replacement.

The interior of the island will memic the existing drainage patterns by included infiltration basins that will receive sheet flow runoff from proposed impervious surfaces. For heavier storm events, the basins will include overflow conveyance systems.

Discharge locations vary throughout the site. See Attachment 5 for Preliminary Hydrology Study. That portion of the Southwest Island around the dog park includes existing piped conveyance systems. The other areas have overland flow.

Form I-3B Page 6 of 11

Identify whether any of the following features, activities, and/or pollutant source areas will be present (select all that apply):

- ☒ On-site storm drain inlets
- ☐ Interior floor drains and elevator shaft sump pumps
- ☐ Interior parking garages
- ☐ Need for future indoor & structural pest control
- ☒ Landscape/Outdoor Pesticide Use
- ☐ Pools, spas, ponds, decorative fountains, and other water features
- ☐ Food service
- ☒ Refuse areas
- ☐ Industrial processes
- ☒ Outdoor storage of equipment or materials
- ☐ Vehicle and Equipment Cleaning
- ☐ Vehicle/Equipment Repair and Maintenance
- ☐ Fuel Dispensing Areas
- ☐ Loading Docks
- ☐ Fire Sprinkler Test Water
- ☐ Miscellaneous Drain or Wash Water
- ☒ Plazas, sidewalks, and parking lots
- ☐ Large Trash Generating Facilities
- ☒ Animal Facilities
- ☐ Plant Nurseries and Garden Centers
- ☐ Automotive-related Uses

Description / Additional

Information:

Form I-3B Page 7 of 11
Identification and Narrative of Receiving Water
Narrative describing flow path from discharge location(s), through urban storm conveyance system, to receiving creeks, rivers, and lagoons and ultimate discharge location to Pacific Ocean (or bay, lagoon, lake or reservoir, as applicable) All discharge locations outlet directly to Mission Bay, which connects to the Pacific Ocean.
Provide a summary of all beneficial uses of receiving waters downstream of the project discharge locations. Beneficial uses include: Industrial Service Supply (IND), Contact Water Recreation (REC1), Non-Contact Water Recreation (REC2), Commercial and Sport Fishing (COMM), Estuarine Habitat (EST), Wildlife Habitat (WILD), Rare, Threatened, or Endangered Species (RARE), Marine Habitat (MAR), Migration of Aquatic Organisms (MIGR), Spawning, Reproduction, and/or Early Development (SPWN), Shellfish Harvesting (SHELL)
Identify all ASBS (areas of special biological significance) receiving waters downstream of the project discharge locations N/A.
Provide distance from project outfall location to impaired or sensitive receiving waters. N/A.
Summarize information regarding the proximity of the permanent, post-construction storm water BMPs to the City's Multi-Habitat Planning Area and environmentally sensitive lands Proposed permanent BMPs include infiltration basins. The northern portion of island and the southwestern tip of the islands have considered to be part of the multi-habitat planning area. Permanent BMPs will be located outside of these areas.

Form I-3B Page 8 of 11		
Identification of Receiving Water Pollutants of Concern		
List any 303(d) impaired water bodies within the path of storm water from the project site to the Pacific Ocean (or bay, lagoon, lake or reservoir, as applicable), identify the pollutant(s)/stressor(s) causing impairment, and identify any TMDLs and/or Highest Priority Pollutants from the WQIP for the impaired water bodies:		
303(d) Impaired Water Body	Pollutant(s)/Stressor(s)	TMDLs/ WQIP Highest Priority Pollutant
Mission Bay	Eutrophic, Lead	Eutrophic, Lead

Identification of Project Site Pollutants*			
*Identification of project site pollutants is only required if flow-thru treatment BMPs are implemented onsite in lieu of retention or biofiltration BMPs (note the project must also participate in an alternative compliance program unless prior lawful approval to meet earlier PDP requirements is demonstrated) Identify pollutants anticipated from the project site based on all proposed use(s) of the site (see BMP Design Manual (Part 1 of Storm Water Standards) Appendix B.6):			
Pollutant	Not Applicable to the Project Site	Anticipated from the Project Site	Also a Receiving Water Pollutant of Concern
Sediment			
Nutrients			
Heavy Metals			
Organic Compounds			
Trash & Debris			
Oxygen Demanding Substances			
Oil & Grease			
Bacteria & Viruses			
Pesticides			

Form I-3B Page 9 of 11

Hydromodification Management Requirements

Do hydromodification management requirements apply (see Section 1.6 of the BMP Design Manual)?

- ☐ Yes, hydromodification management flow control structural BMPs required.
- ☒ No, the project will discharge runoff directly to existing underground storm drains discharging directly to water storage reservoirs, lakes, enclosed embayments, or the Pacific Ocean.
- ☐ No, the project will discharge runoff directly to conveyance channels whose bed and bank are concrete-lined all the way from the point of discharge to water storage reservoirs, lakes, enclosed embayments, or the Pacific Ocean.
- ☐ No, the project will discharge runoff directly to an area identified as appropriate for an exemption by the WMAA for the watershed in which the project resides.

Description / Additional Information (to be provided if a 'No' answer has been selected above):

Critical Coarse Sediment Yield Areas*

*This Section only required if hydromodification management requirements apply

Based on Section 6.2 and Appendix H does CCSYA exist on the project footprint or in the upstream area draining through the project footprint?

- ☐ Yes
- ☐ No

Discussion / Additional Information:

Flow Control for Post-Project Runoff* *This Section only required if hydromodification management requirements apply
List and describe point(s) of compliance (POCs) for flow control for hydromodification management (see Section 6.3.1). For each POC, provide a POC identification name or number correlating to the project's HMP Exhibit and a receiving channel identification name or number correlating to the project's HMP Exhibit.
Has a geomorphic assessment been performed for the receiving channel(s)? ☐ No, the low flow threshold is 0.1Q2 (default low flow threshold) ☐ Yes, the result is the low flow threshold is 0.1Q2 ☐ Yes, the result is the low flow threshold is 0.3Q2 ☐ Yes, the result is the low flow threshold is 0.5Q2 If a geomorphic assessment has been performed, provide title, date, and preparer:
Discussion / Additional Information: (optional)

Form I-3B Page 11 of 11
Other Site Requirements and Constraints
When applicable, list other site requirements or constraints that will influence storm water management design, such as zoning requirements including setbacks and open space, or local codes governing minimum street width, sidewalk construction, allowable pavement types, and drainage requirements.
Optional Additional Information or Continuation of Previous Sections As Needed
This space provided for additional information or continuation of information from previous sections as needed.

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Source Control BMP Checklist for All Development Projects			Form I-4
Source Control BMPs			
All development projects must implement source control BMPs SC-1 through SC-6 where applicable and feasible. See Chapter 4 and Appendix E of the BMP Design Manual (Part 1 of the Storm Water Standards) for information to implement source control BMPs shown in this checklist. Answer each category below pursuant to the following. • "Yes" means the project will implement the source control BMP as described in Chapter 4 and/or Appendix E of the BMP Design Manual. Discussion / justification is not required. • "No" means the BMP is applicable to the project but it is not feasible to implement. Discussion / justification must be provided. • "N/A" means the BMP is not applicable at the project site because the project does not include the feature that is addressed by the BMP (e.g., the project has no outdoor materials storage areas). Discussion / justification may be provided.			
Source Control Requirement	Applied?		
SC-1 Prevention of Illicit Discharges into the MS4	☒ Yes	☐ No	☐ N/A
Discussion / justification if SC-1 not implemented:			
SC-2 Storm Drain Stenciling or Signage	☒ Yes	☐ No	☐ N/A
Discussion / justification if SC-2 not implemented:			
SC-3 Protect Outdoor Materials Storage Areas from Rainfall, Run-On, Runoff, and Wind Dispersal	☒ Yes	☐ No	☐ N/A
Discussion / justification if SC-3 not implemented:			
SC-4 Protect Materials Stored in Outdoor Work Areas from Rainfall, Run-On, Runoff, and Wind Dispersal	☒ Yes	☐ No	☐ N/A
Discussion / justification if SC-4 not implemented:			
SC-5 Protect Trash Storage Areas from Rainfall, Run-On, Runoff, and Wind Dispersal	☒ Yes	☐ No	☐ N/A
Discussion / justification if SC-5 not implemented:			

Form I-4 Page 2 of 2			
Source Control Requirement	Applied?		
SC-6 Additional BMPs Based on Potential Sources of Runoff Pollutants (must answer for each source listed below)			
On-site storm drain inlets	☒ Yes	☐ No	☐ N/A
Interior floor drains and elevator shaft sump pumps	☐ Yes	☐ No	☒ N/A
Interior parking garages	☐ Yes	☐ No	☒ N/A
Need for future indoor & structural pest control	☐ Yes	☐ No	☒ N/A
Landscape/Outdoor Pesticide Use	☒ Yes	☐ No	☐ N/A
Pools, spas, ponds, decorative fountains, and other water features	☐ Yes	☐ No	☒ N/A
Food service	☐ Yes	☐ No	☒ N/A
Refuse areas	☒ Yes	☐ No	☐ N/A
Industrial processes	☐ Yes	☐ No	☒ N/A
Outdoor storage of equipment or materials	☒ Yes	☐ No	☐ N/A
Vehicle/Equipment Repair and Maintenance	☐ Yes	☐ No	☒ N/A
Fuel Dispensing Areas	☐ Yes	☐ No	☒ N/A
Loading Docks	☐ Yes	☐ No	☒ N/A
Fire Sprinkler Test Water	☐ Yes	☐ No	☒ N/A
Miscellaneous Drain or Wash Water	☐ Yes	☐ No	☒ N/A
Plazas, sidewalks, and parking lots	☒ Yes	☐ No	☐ N/A
SC-6A: Large Trash Generating Facilities	☐ Yes	☐ No	☒ N/A
SC-6B: Animal Facilities	☒ Yes	☐ No	☐ N/A
SC-6C: Plant Nurseries and Garden Centers	☐ Yes	☐ No	☒ N/A
SC-6D: Automotive-related Uses	☐ Yes	☐ No	☒ N/A
Discussion / justification if SC-6 not implemented. Clearly identify which sources of runoff pollutants are discussed. Justification must be provided for all "No" answers shown above. All Source Control BMPs labeled as "N/A" do not apply to this project.			

Site Design BMP Checklist for All Development Projects	Form I-5		
Site Design BMPs			
All development projects must implement site design BMPs SD-1 through SD-8 where applicable and feasible. See Chapter 4 and Appendix E of the BMP Design Manual (Part 1 of Storm Water Standards) for information to implement site design BMPs shown in this checklist. Answer each category below pursuant to the following. • "Yes" means the project will implement the site design BMP as described in Chapter 4 and/or Appendix E of the BMP Design Manual. Discussion / justification is not required. • "No" means the BMP is applicable to the project but it is not feasible to implement. Discussion / justification must be provided. • "N/A" means the BMP is not applicable at the project site because the project does not include the feature that is addressed by the BMP (e.g., the project site has no existing natural areas to conserve). Discussion / justification may be provided. A site map with implemented site design BMPs must be included at the end of this checklist.			
Site Design Requirement	Applied?		
SD-1 Maintain Natural Drainage Pathways and Hydrologic Features	☒ Yes	☐ No	☐ N/A
Discussion / justification if SD-1 not implemented: All existing environmentally sensitive areas are to be conserved. No trees are proposed at this time due to island be completely made of sand and not providing ideal conditions for tree growth.			
1-1 Are existing natural drainage pathways and hydrologic features mapped on the site map?	☐ Yes	☐ No	☒ N/A
1-2 Are trees implemented? If yes, are they shown on the site map?	☐ Yes	☒ No	☐ N/A
1-3 Implemented trees meet the design criteria in SD-1 Fact Sheet (e.g. soil volume, maximum credit, etc.)?	☐ Yes	☐ No	☒ N/A
1-4 Is tree credit volume calculated using Appendix B.2.2.1 and SD-1 Fact Sheet in Appendix E?	☐ Yes	☐ No	☒ N/A
SD-2 Have natural areas, soils and vegetation been conserved?	☒ Yes	☐ No	☐ N/A
Discussion / justification if SD-2 not implemented:			

Site Design Requirement	Applied?		
SD-3 Minimize Impervious Area	☒ Yes	☐ No	☐ N/A
Discussion / justification if SD-3 not implemented:			
SD-4 Minimize Soil Compaction	☒ Yes	☐ No	☐ N/A
Discussion / justification if SD-4 not implemented:			
SD-5 Impervious Area Dispersion	☐ Yes	☐ No	☒ N/A
Discussion / justification if SD-5 not implemented: Impervious areas will drain towards BMPs.			
5-1 Is the pervious area receiving runon from impervious area identified on the site map?	☐ Yes	☐ No	☒ N/A
5-2 Does the pervious area satisfy the design criteria in SD-5 Fact Sheet in Appendix E (e.g. maximum slope, minimum length, etc.)	☐ Yes	☐ No	☒ N/A
5-3 Is impervious area dispersion credit volume calculated using Appendix B.2.1.1 and SD-5 Fact Sheet in Appendix E?	☐ Yes	☐ No	☒ N/A

Form I-5 Page 3 of 3			
Site Design Requirement	Applied?		
SD-6 Runoff Collection	☒ Yes	☐ No	☐ N/A
Discussion / justification if SD-6 not implemented: Permeable pavement within parking lots may be proposed.			
6a-1 Are green roofs implemented in accordance with design criteria in SD-6A Fact Sheet? If yes, are they shown on the site map?	☐ Yes	☐ No	☒ N/A
6a-2 Is green roof credit volume calculated using Appendix B.2.1.2 and SD-6A Fact Sheet in Appendix E?	☐ Yes	☐ No	☒ N/A
6b-1 Are permeable pavements implemented in accordance with design criteria in SD-6B Fact Sheet? If yes, are they shown on the site map?	☐ Yes	☐ No	☒ N/A
6b-2 Is permeable pavement credit volume calculated using Appendix B.2.1.3 and SD-6B Fact Sheet in Appendix E?	☐ Yes	☐ No	☒ N/A
SD-7 Landscaping with Native or Drought Tolerant Species	☒ Yes	☐ No	☐ N/A
Discussion / justification if SD-7 not implemented:			
SD-8 Harvesting and Using Precipitation	☐ Yes	☐ No	☒ N/A
Discussion / justification if SD-8 not implemented: Per Form I-7, harvest and use was not deemed feasible.			
8-1 Are rain barrels implemented in accordance with design criteria in SD-8 Fact Sheet? If yes, are they shown on the site map?	☐ Yes	☐ No	☒ N/A
8-2 Is rain barrel credit volume calculated using Appendix B.2.2.2 and SD-8 Fact Sheet in Appendix E?	☐ Yes	☐ No	☒ N/A

Summary of PDP Structural BMPs	Form I-6

PDP Structural BMPs

All PDPs must implement structural BMPs for storm water pollutant control (see Chapter 5 of the BMP Design Manual, Part 1 of Storm Water Standards). Selection of PDP structural BMPs for storm water pollutant control must be based on the selection process described in Chapter 5. PDPs subject to hydromodification management requirements must also implement structural BMPs for flow control for hydromodification management (see Chapter 6 of the BMP Design Manual). Both storm water pollutant control and flow control for hydromodification management can be achieved within the same structural BMP(s).

PDP structural BMPs must be verified by the City at the completion of construction. This includes requiring the project owner or project owner's representative to certify construction of the structural BMPs (complete Form DS-563). PDP structural BMPs must be maintained into perpetuity (see Chapter 7 of the BMP Design Manual).

Use this form to provide narrative description of the general strategy for structural BMP implementation at the project site in the box below. Then complete the PDP structural BMP summary information sheet (page 3 of this form) for each structural BMP within the project (copy the BMP summary information page as many times as needed to provide summary information for each individual structural BMP).

Describe the general strategy for structural BMP implementation at the site. This information must describe how the steps for selecting and designing storm water pollutant control BMPs presented in Section 5.1 of the BMP Design Manual were followed, and the results (type of BMPs selected). For projects requiring hydromodification flow control BMPs, indicate whether pollutant control and flow control BMPs are integrated or separate.

Per Chapter 5 of the BMP Design Manual, steps 1-4 have been met for selecting pollutant control bmps. DMAs PR-1A, 1B, 1C, 1D, 1G, 2D, 2G, 2I, 3B, and 4D are all considered to be self mitigating areas. Design capture volumes (DCV) were factored into the regionally approved BMP sizing calculator V2.0.

Bioretention basins (INF-2) were considered feasible per form I-8 (see Attachment 1). Street runoff will be collected in bio-swales that meet design parameters per INF-2. Impervious sheet flow from proposed parking lots, paths, and other impervious features, will be collected in larger basins throughout the site.

See Attachment 1A for additional information on required sizing and DMA maps.

Form I-6 Page 1 of 1	
Structural BMP Summary Information	
Structural BMP ID No.: INF-1	
Construction Plan Sheet No.	
Type of structural BMP: ☐ Retention by harvest and use (HU-1) ☐ Retention by infiltration basin (INF-1) ☒ Retention by bioretention (INF-2) ☐ Retention by permeable pavement (INF-3) ☐ Partial Retention by biofiltration with partial retention (PR-1) ☐ Biofiltration (BF-1) ☐ Flow-thru treatment control with prior lawful approval to meet earlier PDP requirements (provide BMP type/description in discussion section below) ☐ Flow-thru treatment control included as pre-treatment/forebay for an onsite retention or biofiltration BMP (provide BMP type/description and indicate which onsite retention or biofiltration BMP it serves in discussion section below) ☐ Flow-thru treatment control with alternative compliance (provide BMP type/description in discussion section below) ☐ Detention pond or vault for hydromodification management ☐ Other (describe in discussion section below	
Purpose: ☒ Pollutant control only ☐ Hydromodification control only ☐ Combined pollutant control and hydromodification control ☐ Pre-treatment / forebay for another structural BMP ☐ Other (describe in discussion section below)	
Who will certify construction of this BMP? Provide name and contact information for the party responsible to sign BMP verification form DS-563	Engineer of work for final design phase
Who will be the final owner of this BMP?	The City of San Diego
Who will maintain this BMP into perpetuity?	The City of San Diego
What is the funding mechanism for maintenance?	The City of San Diego

City of San Diego
Development Services
1222 First Ave., MD-302
San Diego, CA 92101
(619) 446-5000

THE CITY OF SAN DIEGO

Permanent BMP Construction

Self Certification Form

FORM
DS-563
February 2016

Date Prepared:	Project No.:
Project Applicant:	Phone:
Project Address:	
Project Engineer:	Phone:

The purpose of this form is to verify that the site improvements for the project, identified above, have been constructed in conformance with the approved Storm Water Quality Management Plan (SWQMP) documents and drawings.

This form must be completed by the engineer and submitted prior to final inspection of the construction permit. Completion and submittal of this form is required for all new development and redevelopment projects in order to comply with the City's Storm Water ordinances and NDPES Permit Order No. R9-2013-0001 as amended by R9-2015-0001 and R9-2015-0100. Final inspection for occupancy and/or release of grading or public improvement bonds may be delayed if this form is not submitted and approved by the City of San Diego.

CERTIFICATION:
As the professional in responsible charge for the design of the above project, I certify that I have inspected all constructed Low Impact Development (LID) site design, source control and structural BMP's required per the approved SWQMP and Construction Permit No.________________________; and that said BMP's have been constructed in compliance with the approved plans and all applicable specifications, permits, ordinances and Order No. R9-2013-0001 as amended by R9-2015-0001 and R9-2015-0100 of the San Diego Regional Water Quality Control Board.

I understand that this BMP certification statement does not constitute an operation and maintenance verification.

Signature: ________________________________

Date of Signature: ____________________________

Printed Name: ____________________________

Title: ____________________________

Phone No. ____________________________

Engineer's Stamp

DS-563 (01-16)

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ATTACHMENT 1
BACKUP FOR PDP POLLUTANT CONTROL BMPS

This is the cover sheet for Attachment 1.

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Indicate which Items are Included:

Attachment Sequence	Contents	Checklist
Attachment 1a	DMA Exhibit (Required) See DMA Exhibit Checklist.	☒ Included
Attachment 1b	Tabular Summary of DMAs Showing DMA ID matching DMA Exhibit, DMA Area, and DMA Type (Required)* *Provide table in this Attachment OR on DMA Exhibit in Attachment 1a	○ Included on DMA Exhibit in Attachment 1a ◉ Included as Attachment 1b, separate from DMA Exhibit
Attachment 1c	Form I-7, Harvest and Use Feasibility Screening Checklist (Required unless the entire project will use infiltration BMPs) Refer to Appendix B.3-1 of the BMP Design Manual to complete Form I-7.	○ Included ◉ Not included because the entire project will use infiltration BMPs
Attachment 1d	Form I-8, Categorization of Infiltration Feasibility Condition (Required unless the project will use harvest and use BMPs) Refer to Appendices C and D of the BMP Design Manual to complete Form I-8.	◉ Included ○ Not included because the entire project will use harvest and use BMPs
Attachment 1e	Pollutant Control BMP Design Worksheets / Calculations (Required) Refer to Appendices B and E of the BMP Design Manual for structural pollutant control BMP design guidelines and site design credit calculations	☒ Included

Use this checklist to ensure the required information has been included on the DMA Exhibit:

The DMA Exhibit must identify:

- ☒ Underlying hydrologic soil group
- ☒ Approximate depth to groundwater
- ☒ Existing natural hydrologic features (watercourses, seeps, springs, wetlands)
- ☐ Critical coarse sediment yield areas to be protected
- ☒ Existing topography and impervious areas
- ☒ Existing and proposed site drainage network and connections to drainage offsite
- ☒ Proposed grading
- ☒ Proposed impervious features
- ☒ Proposed design features and surface treatments used to minimize imperviousness
- ☒ Drainage management area (DMA) boundaries, DMA ID numbers, and DMA areas (square footage or acreage), and DMA type (i.e., drains to BMP, self-retaining, or self-mitigating)
- ☒ Potential pollutant source areas and corresponding required source controls (see Chapter 4, Appendix E.1, and Form I-3B)
- ☒ Structural BMPs (identify location, type of BMP, and size/detail)

NOTES:
1. UNDERLYING HYDROLOGIC SOIL GROUP IS CONSIDERED TO BE TYPE B.
2. GROUNDWATER DEPTH VARIES FROM 15–25 FT.
3. DMAS PR–1A, PR–1B, PR–1C, PR–1D, AND PR–1G ARE SELF MITIGATING AREAS.

DRAINAGE MANAGEMENT AREA (DMA) EXHIBIT - NORTH ISLAND

1" = 300'

REQUIRED BMP SIZES PER INF–1
FOR PROPOSED DMAS:

PR–1A = 0 SF
PR–1B = 0 SF
PR–1C = 0 SF
PR–1D = 0 SF
PR–1E = 5,150 SF
PR–1F = 5,550 SF
PR–1G = 0 SF
PR–1H = 3,100 SF
PR–1I = 1,600 SF

LEGEND:

DMA NAME WITH PROPOSED IMPERVIOUS AREA/TOTAL AREA . (PR-1A 15,865 SF IMP 49,637 SF TOT)

BOUNDARY OF DMA. . . . .

PROPOSED IMPERVIOUS SURFACE . . . .

N

0 300 600

SCALE 1" = 300'

NE JOB NO. 115–138.1

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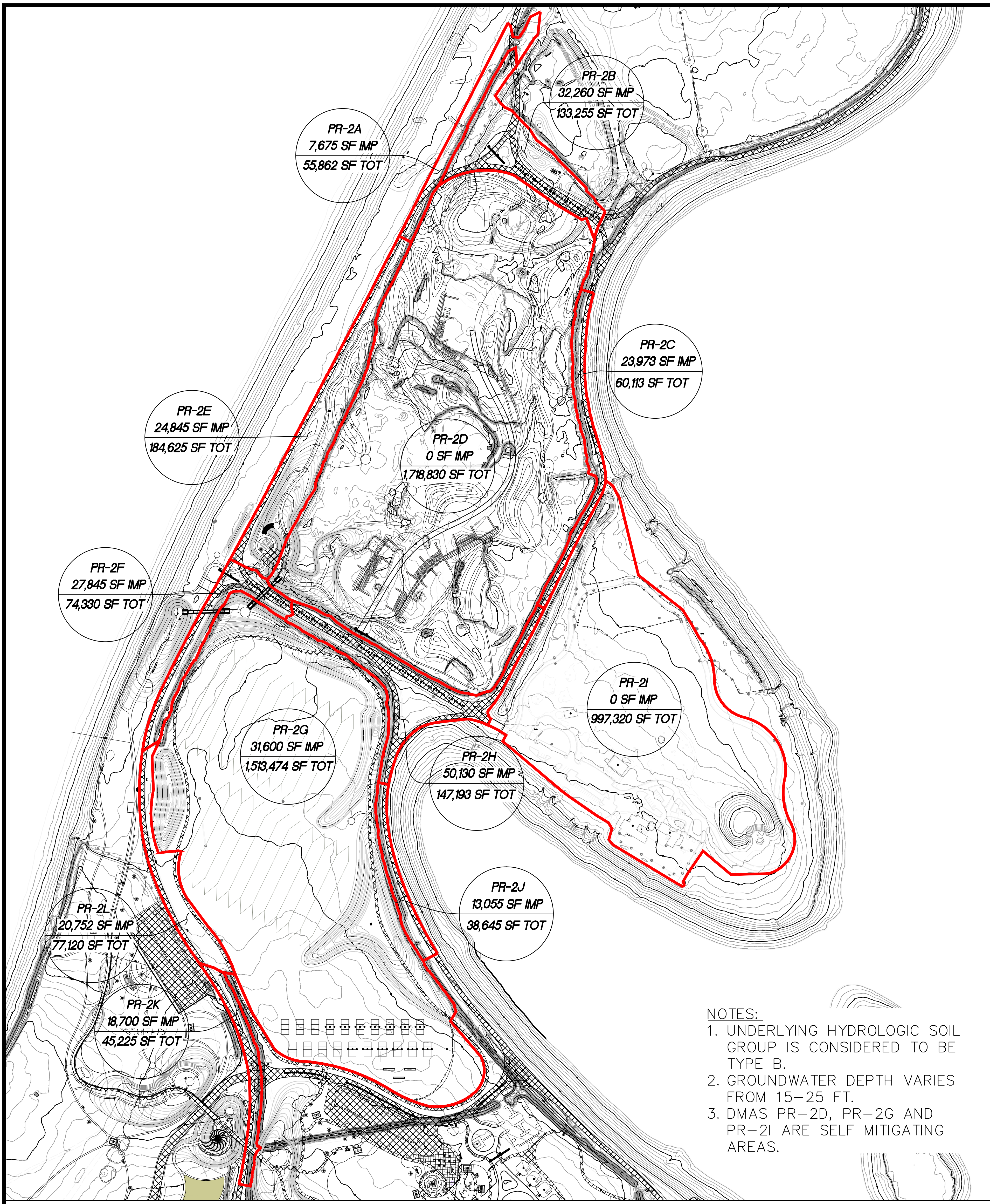

NOTES:
1. UNDERLYING HYDROLOGIC SOIL GROUP IS CONSIDERED TO BE TYPE B.
2. GROUNDWATER DEPTH VARIES FROM 15–25 FT.
3. DMAS PR–2D, PR–2G AND PR–2I ARE SELF MITIGATING AREAS.

DRAINAGE MANAGEMENT AREA (DMA) EXHIBIT – CENTRAL ISLAND

1" = 400'

REQUIRED BMP SIZES PER INF–1 FOR PROPOSED DMAS:

PR–2A = 1,400 SF
PR–2B = 4,400 SF
PR–2C = 2,750 SF
PR–2D = 0 SF
PR–2E = 4,600 SF
PR–2F = 3,250 SF
PR–2G = 0 SF
PR–2H = 6,100 SF
PR–2I = 0 SF
PR–2J = 1,600 SF
PR–2K = 2,100 SF
PR–2L = 2,750 SF

LEGEND:

DMA NAME WITH PROPOSED IMPERVIOUS AREA/TOTAL AREA . (PR-1A 15,865 SF IMP 49,637 SF TOT)

BOUNDARY OF DMA. . . . .

PROPOSED IMPERVIOUS SURFACE . . . .

N

0 400 400

SCALE 1" = 400'

NE JOB NO. 115-138.1

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NOTES:

1. UNDERLYING HYDROLOGIC SOIL GROUP IS CONSIDERED TO BE TYPE B.
2. GROUNDWATER DEPTH VARIES FROM 15–25 FT.
3. DMA PR–3B IS A SELF MITIGATING AREA.

DRAINAGE MANAGEMENT AREA (DMA) EXHIBIT – SOUTHWEST ISLAND

1" = 400'

REQUIRED BMP SIZES PER INF–1 FOR PROPOSED DMAS:

PR–3A = 18,100 SF
PR–3B = 0 SF
PR–3C = 17,050 SF

LEGEND:

DMA NAME WITH PROPOSED IMPERVIOUS AREA/TOTAL AREA	PR-1A 15,865 SF IMP 49,637 SF TOT
BOUNDARY OF DMA	(red line)
PROPOSED IMPERVIOUS SURFACE	(crosshatch)

0 400 800

SCALE 1" = 400'

N

NE JOB NO. 115–138.1

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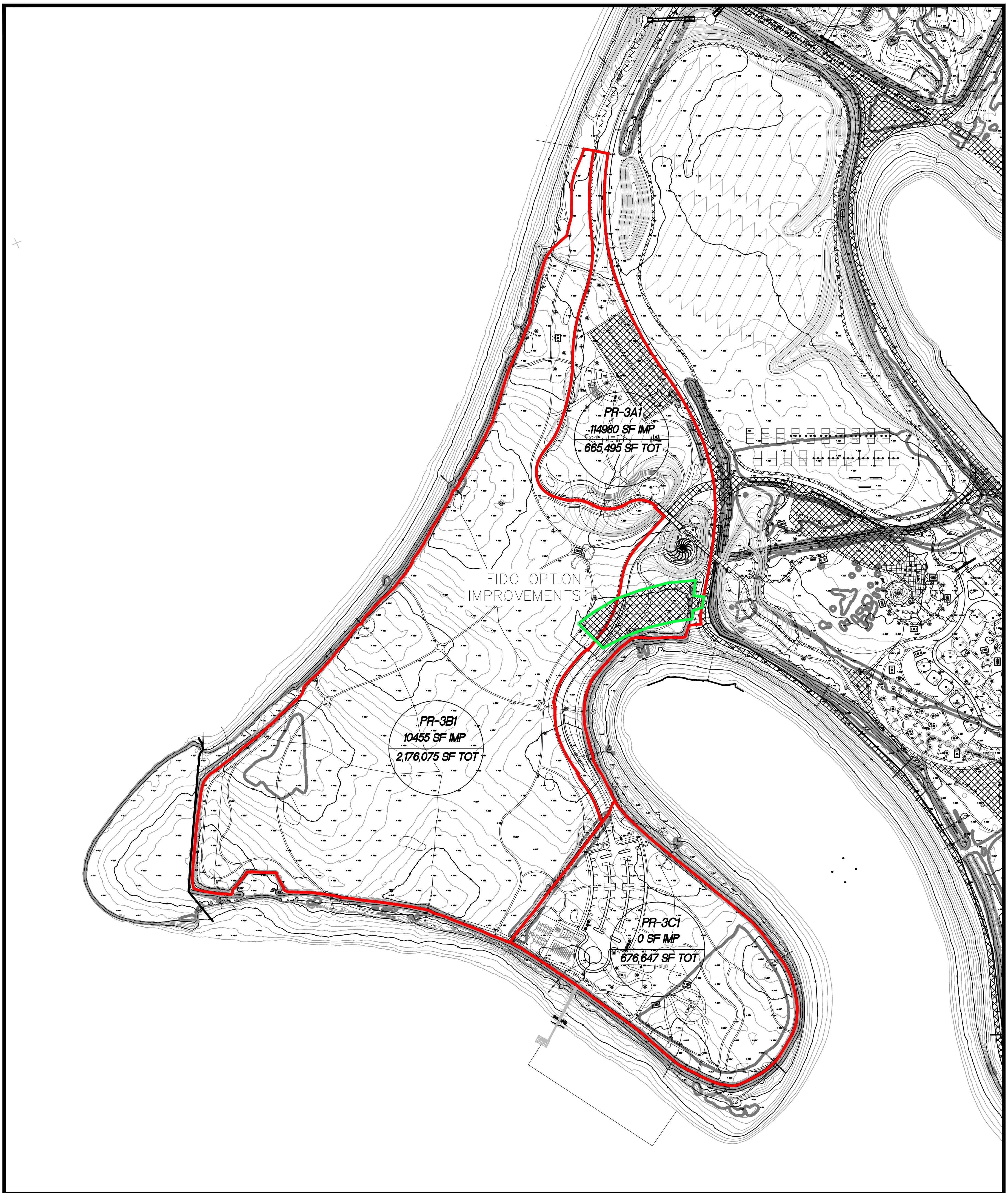

PROPOSED HYDROLOGY - SOUTHWEST ISLAND (FIDO OPTION)

1" = 400'

LEGEND:

BASIN NAME WITH IMPERVIOUS AREA/TOTAL AREA . . . . . PR-1A 15,865 SF IMP / 49,637 SF TOT

BOUNDARY OF BASIN . . . .

FIDO OPTION IMPROVEMENTS . . . .

PROPOSED IMPERVIOUS SURFACE . . . .

0 300 600

SCALE 1" = 300'

NE JOB NO. 115-138.1

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NOTES:

1. UNDERLYING HYDROLOGIC SOIL GROUP IS CONSIDERED TO BE TYPE B.
2. GROUNDWATER DEPTH VARIES FROM 15-25 FT.
3. DMA PR-4D IS A SELF MITIGATING AREA.

DRAINAGE MANAGEMENT AREA (DMA) EXHIBIT - SOUTHEAST ISLAND

1" = 400'

REQUIRED BMP SIZES PER INF-1
FOR PROPOSED DMAS:

PR-4A = 22,500 SF
PR-4B = 4,000 SF
PR-4C = 6,300 SF
PR-4D = 0 SF
PR-4E = 33,200 SF
PR-4F = 3,500 SF
PR-4G = 3,650 SF
PR-4H = 20,000 SF

0 400 800

SCALE 1" = 400'

N

LEGEND:

DMA NAME WITH PROPOSED IMPERVIOUS AREA/TOTAL AREA .	PR-1A 15,865 SF IMP 49,637 SF TOT
BOUNDARY OF DMA.	
PROPOSED IMPERVIOUS SURFACE	

NE JOB NO. 115-138.1

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DMA ID	DMA Area, A (ft^2)	Hydrologic Soil Group (A, B, C, or D)	Post-Project Surface Type From Table B.1-1	Post-Project Surface Runoff Factor From Table B.1-1	DMA Excluded from Pollutant Control Design Capture Volume (DCV) Calculations in Accordance with BMP Design Manual Chapter 5.2? (Yes/No)	Un-Adjusted DCV (Ft^3)	DCV Reduction Through Site Design BMPs Applied? (Yes/No)	Site Design Adjusted DCV (ft^3)	Retention BMPs Implemented	DCV Remaining after Retention BMPs Implemented (ft^3)	Biofiltration BMPs Implemented? (Yes/No)	DCV Remaining After Biofiltration BMPs Implemented (ft^3)	Offsite Alternative Compliance and Onsite Flow-Thru Treatment Control BMPs Required? (Yes/No)
1A	343,178	B	Natural (B Soil)	0.14	Yes	N/A	No	N/A	No	N/A	No	N/A	No
1B	452,030	B	Natural (B Soil)	0.14	Yes	N/A	No	N/A	No	N/A	No	N/A	No
1C	700,592	B	Natural (B Soil)	0.14	Yes	N/A	No	N/A	No	N/A	No	N/A	No
1D	220,191	B	Natural (B Soil)	0.14	Yes	N/A	No	N/A	No	N/A	No	N/A	No
1E	103,996	B	Landscape/Asphalt	0.48	No	2290	No	N/A	Yes	0	No	N/A	No
1F	124,855	B	Landscape/Asphalt	0.31	No	1756	No	N/A	Yes	0	No	N/A	No
1G	67,619	B	Natural (B Soil)	0.14	No	433	No	N/A	Yes	0	No	N/A	No
1H	197,700	B	Landscape/Asphalt	0.15	No	1388	No	N/A	Yes	0	No	N/A	No
1I	73,517	B	Landscape/Asphalt	0.34	No	1148	No	N/A	Yes	0	No	N/A	No
2A	55,862	B	Landscape/Asphalt	0.24	No	625	No	N/A	Yes	0	No	N/A	No
2B	133,255	B	Landscape/Asphalt	0.32	No	1979	No	N/A	Yes	0	No	N/A	No
2C	60,113	B	Landscape/Asphalt	0.44	No	1221	No	N/A	Yes	0	No	N/A	No
2D	1,718,830	B	Compacted	0.14	No	11029	No	N/A	Yes	0	No	N/A	No
2E	184,625	B	Landscape/Asphalt	0.24	No	2051	No	N/A	Yes	0	No	N/A	No
2F	74,330	B	Landscape/Asphalt	0.42	No	1450	No	N/A	Yes	0	No	N/A	No
2G	1,513,474	B	Landscape/Asphalt	0.16	Yes	N/A	No	N/A	No	N/A	No	N/A	No
2H	147,193	B	Landscape/Asphalt	0.40	No	2691	No	N/A	Yes	0	No	N/A	No
2I	997,320	B	Landscape/Asphalt	0.21	Yes	N/A	No	N/A	No	N/A	No	N/A	No
2J	38,645	B	Landscape/Asphalt	0.40	No	705	No	N/A	Yes	0	No	N/A	No
2K	45,225	B	Landscape/Asphalt	0.45	No	943	No	N/A	Yes	0	No	N/A	No
2L	77,120	B	Landscape/Asphalt	0.34	No	1217	No	N/A	Yes	0	No	N/A	No
3A	665,495	B	Landscape/Asphalt	0.27	No	8277	No	N/A	Yes	0	No	N/A	No
3A1	665,495	B	Landscape/Asphalt	0.27	No	8277	No	N/A	Yes	0	No	N/A	No
3B	2,176,075	B	Landscape/Asphalt	0.14	No	13964	No	N/A	Yes	0	No	N/A	No
3B1	2,176,075	B	Landscape/Asphalt	0.14	No	13964	No	N/A	Yes	0	No	N/A	No
3C	676,647	B	Landscape/Asphalt	0.25	No	7855	No	N/A	Yes	0	No	N/A	No
3C1	676,647	B	Landscape/Asphalt	0.14	No	4341	No	N/A	Yes	0	No	N/A	No
4A	938,790	B	Landscape/Asphalt	0.33	No	14360	No	N/A	Yes	0	No	N/A	No
4B	95,590	B	Landscape/Asphalt	0.43	No	1865	No	N/A	Yes	0	No	N/A	No
4C	155,765	B	Landscape/Asphalt	0.39	No	2799	No	N/A	Yes	0	No	N/A	No
4D	2,416,120	B	Landscape/Asphalt	0.16	Yes	N/A	No	N/A	No	N/A	No	N/A	No
4E	1,006,760	B	Landscape/Asphalt	0.33	No	15446	No	N/A	Yes	0	No	N/A	No
4F	111,140	B	Landscape/Asphalt	0.23	No	1168	No	N/A	Yes	0	No	N/A	No
4G	95,270	B	Landscape/Asphalt	0.37	No	1622	No	N/A	Yes	0	No	N/A	No
4H	483,250	B	Landscape/Asphalt	0.40	No	8832	No	N/A	Yes	0	No	N/A	No

Categorization of Infiltration Feasibility Condition			Form I-8
Part 1 - Full Infiltration Feasibility Screening Criteria Would infiltration of the full design volume be feasible from a physical perspective without any undesirable consequences that cannot be reasonably mitigated?			
Criteria	Screening Question	Yes	No
1	Is the estimated reliable infiltration rate below proposed facility locations greater than 0.5 inches per hour? The response to this Screening Question shall be based on a comprehensive evaluation of the factors presented in Appendix C.2 and Appendix D.	X	
Provide basis: Per the report titled "Geotechnical Summary Report Fiesta Island, Mission Bay" surface infiltration is considered to be a minimum of 0.5 in/hr in most locations.			
2	Can infiltration greater than 0.5 inches per hour be allowed without increasing risk of geotechnical hazards (slope stability, groundwater mounding, utilities, or other factors) that cannot be mitigated to an acceptable level? The response to this Screening Question shall be based on a comprehensive evaluation of the factors presented in Appendix C.2.	X	
Provide basis: Per the report titled "Geotechnical Summary Report Fiesta Island, Mission Bay" groundwater depths were encountered at approximately mean sea level, corresponding to within a few feet of the bottom of the hydraulic fill material. This height varies throughout the site, however, it is our opinion that groundwater mounding will not be a problem as there are no existing or proposed utilities or structures within a close distance.			

Form I-8 Page 2 of 4			
Criteria	Screening Question	Yes	No
3	Can infiltration greater than 0.5 inches per hour be allowed without increasing risk of groundwater contamination (shallow water table, storm water pollutants or other factors) that cannot be mitigated to an acceptable level? The response to this Screening Question shall be based on a comprehensive evaluation of the factors presented in Appendix C.3.	X	
Provide basis: Per the report titled "Geotechnical Summary Report Fiesta Island, Mission Bay" groundwater depths were encountered at approximately mean sea level, corresponding to within a few feet of the bottom of the hydraulic fill material. Groundwater contamination is not considered to be problematic as this storm water is already discharging to Mission Bay.			
4	Can infiltration greater than 0.5 inches per hour be allowed without causing potential water balance issues such as change of seasonality of ephemeral streams or increased discharge of contaminated groundwater to surface waters? The response to this Screening Question shall be based on a comprehensive evaluation of the factors presented in Appendix C.3.	X	
Provide basis: Water balance issues are not considered to be problematic because Mission Bay does not have a chance of seasonality of ephemeral streams, nor is groundwater contaminated.			
Part 1 Result*	If all answers to rows 1 - 4 are "Yes" a full infiltration design is potentially feasible. The feasibility screening category is Full Infiltration If any answer from row 1-4 is "No", infiltration may be possible to some extent but would not generally be feasible or desirable to achieve a "full infiltration" design. Proceed to Part 2		Yes

*To be completed using gathered site information and best professional judgment considering the definition of MEP in the MS4 Permit. Additional testing and/or studies may be required by the City Engineer to substantiate findings

Form I-8 Page 3 of 4			
Part 2 – Partial Infiltration vs. No Infiltration Feasibility Screening Criteria Would infiltration of water in any appreciable amount be physically feasible without any negative consequences that cannot be reasonably mitigated?			
Criteria	Screening Question	Yes	No
5	Do soil and geologic conditions allow for infiltration in any appreciable rate or volume? The response to this Screening Question shall be based on a comprehensive evaluation of the factors presented in Appendix C.2 and Appendix D.	X	
Provide basis: Per the report titled "Geotechnical Summary Report Fiesta Island, Mission Bay" surface infiltration is considered to be a minimum of 0.5 in/hr in most locations.			
6	Can Infiltration in any appreciable quantity be allowed without increasing risk of geotechnical hazards (slope stability, groundwater mounding, utilities, or other factors) that cannot be mitigated to an acceptable level? The response to this Screening Question shall be based on a comprehensive evaluation of the factors presented in Appendix C.2.	X	
Provide basis: Per the report titled "Geotechnical Summary Report Fiesta Island, Mission Bay" groundwater depths were encountered at approximately mean sea level, corresponding to within a few feet of the bottom of the hydraulic fill material. This height varies throughout the site, however, it is our opinion that groundwater mounding will not be a problem as there are no existing or proposed utilities or structures within a close distance.			

Form I-8 Page 4 of 4			
Criteria	Screening Question	Yes	No
7	Can Infiltration in any appreciable quantity be allowed without posing significant risk for groundwater related concerns (shallow water table, storm water pollutants or other factors)? The response to this Screening Question shall be based on a comprehensive evaluation of the factors presented in Appendix C.3.	X	
Provide basis: Per the report titled "Geotechnical Summary Report Fiesta Island, Mission Bay" groundwater depths were encountered at approximately mean sea level, corresponding to within a few feet of the bottom of the hydraulic fill material. Groundwater contamination is not considered to be problematic as this storm water is already discharging to Mission Bay.			
8	Can infiltration be allowed without violating downstream water rights? The response to this Screening Question shall be based on a comprehensive evaluation of the factors presented in Appendix C.3.	X	
Provide basis: Water balance issues are not considered to be problematic because Mission Bay does not have a chance of seasonality of ephemeral streams, nor is groundwater contaminated.			
Part 2 Result*	If all answers from row 1-4 are yes then partial infiltration design is potentially feasible. The feasibility screening category is Partial Infiltration. If any answer from row 5-8 is no, then infiltration of any volume is considered to be infeasible within the drainage area. The feasibility screening category is No Infiltration.	Yes	

*To be completed using gathered site information and best professional judgment considering the definition of MEP in the MS4 Permit. Additional testing and/or studies may be required by the City Engineer to substantiate findings

Factor of Safety and Design Infiltration Rate Worksheet				Form I-9	
Factor Category		Factor Description	Assigned Weight (w)	Factor Value (v)	Product (p) p = w x v
A	Suitability Assessment	Soil assessment methods	0.25	2	0.5
		Predominant soil texture	0.25	2	0.5
		Site soil variability	0.25	2	0.5
		Depth to groundwater / impervious layer	0.25	2	0.5
		Suitability Assessment Safety Factor, S_A = □p			2
B	Design	Level of pretreatment/ expected sediment loads	0.5	2	1
		Redundancy/resiliency	0.25	2	0.5
		Compaction during construction	0.25	2	0.5
		Design Safety Factor, S_B = □p			2
Combined Safety Factor, $S_{total} = S_A \times S_B$				4	
Observed Infiltration Rate, inch/hr, $K_{observed}$ (corrected for test-specific bias)				0.5	
Design Infiltration Rate, in/hr, $K_{design} = K_{observed} / S_{total}$				0.125	
Supporting Data					

Briefly describe infiltration test and provide reference to test forms:

No infiltration testing has been recorded at this time, however, per the report titled "Geotechnical Summary Report Fiesta Island, Mission Bay", surface infiltration is considered to be feasible with mitigation as necessary such as seepage pits.

Worksheet B.2-1 DCV (DMA PR-1E)

	Design Capture Volume	Worksheet B.2-1		
1	85th percentile 24-hr storm depth from Figure B.1-1	d=	0.550	inches
2	Area tributary to BMP (s)	A=	2.39	acres
3	Area weighted runoff factor (estimate using Appendix B.1.1 and B.2.1)	C=	0.48	unitless
4	Trees Credit Volume	TCV=	0	cubic-feet
5	Rain barrels Credit Volume	RCV=	0	cubic-feet
6	Calculate DCV = (3630 x C x d x A) – TCV - RCV	DCV=	2,290	cubic-feet

Worksheet B.2-1 DCV (DMA PR-1F)

Design Capture Volume		Worksheet B.2-1		
1	85th percentile 24-hr storm depth from Figure B.1-1	d=	0.550	inches
2	Area tributary to BMP (s)	A=	2.87	acres
3	Area weighted runoff factor (estimate using Appendix B.1.1 and B.2.1)	C=	0.31	unitless
4	Trees Credit Volume	TCV=	0	cubic-feet
5	Rain barrels Credit Volume	RCV=	0	cubic-feet
6	Calculate DCV = (3630 x C x d x A) – TCV - RCV	DCV=	1,756	cubic-feet

Worksheet B.2-1 DCV (DMA PR-1G)

Design Capture Volume		Worksheet B.2-1		
1	85th percentile 24-hr storm depth from Figure B.1-1	d=	0.550	inches
2	Area tributary to BMP (s)	A=	1.55	acres
3	Area weighted runoff factor (estimate using Appendix B.1.1 and B.2.1)	C=	0.14	unitless
4	Trees Credit Volume	TCV=	0	cubic-feet
5	Rain barrels Credit Volume	RCV=	0	cubic-feet
6	Calculate DCV = (3630 x C x d x A) – TCV - RCV	DCV=	433	cubic-feet

Worksheet B.2-1 DCV (DMA PR-1H)

Design Capture Volume		Worksheet B.2-1		
1	85th percentile 24-hr storm depth from Figure B.1-1	d=	0.550	inches
2	Area tributary to BMP (s)	A=	4.54	acres
3	Area weighted runoff factor (estimate using Appendix B.1.1 and B.2.1)	C=	0.15	unitless
4	Trees Credit Volume	TCV=	0	cubic-feet
5	Rain barrels Credit Volume	RCV=	0	cubic-feet
6	Calculate DCV = (3630 x C x d x A) – TCV - RCV	DCV=	1,388	cubic-feet

Worksheet B.2-1 DCV (DMA PR-1I)

Design Capture Volume		Worksheet B.2-1		
1	85th percentile 24-hr storm depth from Figure B.1-1	d=	0.550	inches
2	Area tributary to BMP (s)	A=	1.69	acres
3	Area weighted runoff factor (estimate using Appendix B.1.1 and B.2.1)	C=	0.34	unitless
4	Trees Credit Volume	TCV=	0	cubic-feet
5	Rain barrels Credit Volume	RCV=	0	cubic-feet
6	Calculate DCV = (3630 x C x d x A) – TCV - RCV	DCV=	1,148	cubic-feet

Worksheet B.2-1 DCV (DMA PR-2A)

Design Capture Volume		Worksheet B.2-1		
1	85th percentile 24-hr storm depth from Figure B.1-1	d=	0.550	inches
2	Area tributary to BMP (s)	A=	1.28	acres
3	Area weighted runoff factor (estimate using Appendix B.1.1 and B.2.1)	C=	0.24	unitless
4	Trees Credit Volume	TCV=	0	cubic-feet
5	Rain barrels Credit Volume	RCV=	0	cubic-feet
6	Calculate DCV = (3630 x C x d x A) – TCV - RCV	DCV=	625	cubic-feet

Worksheet B.2-1 DCV (DMA PR-2B)

Design Capture Volume		Worksheet B.2-1		
1	85th percentile 24-hr storm depth from Figure B.1-1	d=	0.550	inches
2	Area tributary to BMP (s)	A=	3.06	acres
3	Area weighted runoff factor (estimate using Appendix B.1.1 and B.2.1)	C=	0.32	unitless
4	Trees Credit Volume	TCV=	0	cubic-feet
5	Rain barrels Credit Volume	RCV=	0	cubic-feet
6	Calculate DCV = (3630 x C x d x A) – TCV - RCV	DCV=	1,979	cubic-feet

Worksheet B.2-1 DCV (DMA PR-2C)

Design Capture Volume		Worksheet B.2-1		
1	85th percentile 24-hr storm depth from Figure B.1-1	d=	0.550	inches
2	Area tributary to BMP (s)	A=	1.38	acres
3	Area weighted runoff factor (estimate using Appendix B.1.1 and B.2.1)	C=	0.44	unitless
4	Trees Credit Volume	TCV=	0	cubic-feet
5	Rain barrels Credit Volume	RCV=	0	cubic-feet
6	Calculate DCV = (3630 x C x d x A) – TCV - RCV	DCV=	1,221	cubic-feet

Worksheet B.2-1 DCV (DMA PR-2D)

Design Capture Volume		Worksheet B.2-1		
1	85th percentile 24-hr storm depth from Figure B.1-1	d=	0.550	inches
2	Area tributary to BMP (s)	A=	39.46	acres
3	Area weighted runoff factor (estimate using Appendix B.1.1 and B.2.1)	C=	0.14	unitless
4	Trees Credit Volume	TCV=	0	cubic-feet
5	Rain barrels Credit Volume	RCV=	0	cubic-feet
6	Calculate DCV = (3630 x C x d x A) – TCV - RCV	DCV=	11,029	cubic-feet

Worksheet B.2-1 DCV (DMA PR-2E)

Design Capture Volume		Worksheet B.2-1		
1	85th percentile 24-hr storm depth from Figure B.1-1	d=	0.550	inches
2	Area tributary to BMP (s)	A=	4.24	acres
3	Area weighted runoff factor (estimate using Appendix B.1.1 and B.2.1)	C=	0.24	unitless
4	Trees Credit Volume	TCV=	0	cubic-feet
5	Rain barrels Credit Volume	RCV=	0	cubic-feet
6	Calculate DCV = (3630 x C x d x A) – TCV - RCV	DCV=	2,051	cubic-feet

Worksheet B.2-1 DCV (DMA PR-2F)

	Design Capture Volume	Worksheet B.2-1		
1	85th percentile 24-hr storm depth from Figure B.1-1	d=	0.550	inches
2	Area tributary to BMP (s)	A=	1.71	acres
3	Area weighted runoff factor (estimate using Appendix B.1.1 and B.2.1)	C=	0.42	unitless
4	Trees Credit Volume	TCV=	0	cubic-feet
5	Rain barrels Credit Volume	RCV=	0	cubic-feet
6	Calculate DCV = (3630 x C x d x A) – TCV - RCV	DCV=	1,450	cubic-feet

Worksheet B.2-1 DCV (DMA PR-2H)

Design Capture Volume		Worksheet B.2-1		
1	85th percentile 24-hr storm depth from Figure B.1-1	d=	0.550	inches
2	Area tributary to BMP (s)	A=	3.38	acres
3	Area weighted runoff factor (estimate using Appendix B.1.1 and B.2.1)	C=	0.40	unitless
4	Trees Credit Volume	TCV=	0	cubic-feet
5	Rain barrels Credit Volume	RCV=	0	cubic-feet
6	Calculate DCV = (3630 x C x d x A) – TCV - RCV	DCV=	2.691	cubic-feet

Worksheet B.2-1 DCV (DMA PR-2J)

Design Capture Volume		Worksheet B.2-1		
1	85th percentile 24-hr storm depth from Figure B.1-1	d=	0.550	inches
2	Area tributary to BMP (s)	A=	0.89	acres
3	Area weighted runoff factor (estimate using Appendix B.1.1 and B.2.1)	C=	0.40	unitless
4	Trees Credit Volume	TCV=	0	cubic-feet
5	Rain barrels Credit Volume	RCV=	0	cubic-feet
6	Calculate DCV = (3630 x C x d x A) – TCV - RCV	DCV=	705	cubic-feet

Worksheet B.2-1 DCV (DMA PR-2K)

Design Capture Volume		Worksheet B.2-1		
1	85th percentile 24-hr storm depth from Figure B.1-1	d=	0.550	inches
2	Area tributary to BMP (s)	A=	1.04	acres
3	Area weighted runoff factor (estimate using Appendix B.1.1 and B.2.1)	C=	0.45	unitless
4	Trees Credit Volume	TCV=	0	cubic-feet
5	Rain barrels Credit Volume	RCV=	0	cubic-feet
6	Calculate DCV = (3630 x C x d x A) – TCV - RCV	DCV=	943	cubic-feet

Worksheet B.2-1 DCV (DMA PR-2L)

Design Capture Volume		Worksheet B.2-1		
1	85th percentile 24-hr storm depth from Figure B.1-1	d=	0.550	inches
2	Area tributary to BMP (s)	A=	1.77	acres
3	Area weighted runoff factor (estimate using Appendix B.1.1 and B.2.1)	C=	0.34	unitless
4	Trees Credit Volume	TCV=	0	cubic-feet
5	Rain barrels Credit Volume	RCV=	0	cubic-feet
6	Calculate DCV = (3630 x C x d x A) – TCV - RCV	DCV=	1,217	cubic-feet

Worksheet B.2-1 DCV (DMA PR-3A)

Design Capture Volume		Worksheet B.2-1		
1	85th percentile 24-hr storm depth from Figure B.1-1	d=	0.550	inches
2	Area tributary to BMP (s)	A=	15.28	acres
3	Area weighted runoff factor (estimate using Appendix B.1.1 and B.2.1)	C=	0.27	unitless
4	Trees Credit Volume	TCV=	0	cubic-feet
5	Rain barrels Credit Volume	RCV=	0	cubic-feet
6	Calculate DCV = (3630 x C x d x A) – TCV - RCV	DCV=	8,277	cubic-feet

Worksheet B.2-1 DCV (DMA PR-3A1)

Design Capture Volume		Worksheet B.2-1		
1	85^{th} percentile 24-hr storm depth from Figure B.1-1	d=	0.550	inches
2	Area tributary to BMP (s)	A=	15.28	acres
3	Area weighted runoff factor (estimate using Appendix B.1.1 and B.2.1)	C=	0.27	unitless
4	Trees Credit Volume	TCV=	0	cubic-feet
5	Rain barrels Credit Volume	RCV=	0	cubic-feet
6	Calculate DCV = (3630 x C x d x A) – TCV - RCV	DCV=	8,277	cubic-feet

Worksheet B.2-1 DCV (DMA PR-3B)

Design Capture Volume		Worksheet B.2-1		
1	85th percentile 24-hr storm depth from Figure B.1-1	d=	0.550	inches
2	Area tributary to BMP (s)	A=	49.96	acres
3	Area weighted runoff factor (estimate using Appendix B.1.1 and B.2.1)	C=	0.14	unitless
4	Trees Credit Volume	TCV=	0	cubic-feet
5	Rain barrels Credit Volume	RCV=	0	cubic-feet
6	Calculate DCV = (3630 x C x d x A) – TCV - RCV	DCV=	13,964	cubic-feet

Worksheet B.2-1 DCV (DMA PR-3B1)

Design Capture Volume		Worksheet B.2-1		
1	85th percentile 24-hr storm depth from Figure B.1-1	d=	0.550	inches
2	Area tributary to BMP (s)	A=	49.96	acres
3	Area weighted runoff factor (estimate using Appendix B.1.1 and B.2.1)	C=	0.14	unitless
4	Trees Credit Volume	TCV=	0	cubic-feet
5	Rain barrels Credit Volume	RCV=	0	cubic-feet
6	Calculate DCV = (3630 x C x d x A) – TCV - RCV	DCV=	13,964	cubic-feet

Worksheet B.2-1 DCV (DMA PR-3C)

Design Capture Volume		Worksheet B.2-1		
1	85^{th} percentile 24-hr storm depth from Figure B.1-1	d=	0.550	inches
2	Area tributary to BMP (s)	A=	15.53	acres
3	Area weighted runoff factor (estimate using Appendix B.1.1 and B.2.1)	C=	0.25	unitless
4	Trees Credit Volume	TCV=	0	cubic-feet
5	Rain barrels Credit Volume	RCV=	0	cubic-feet
6	Calculate DCV = (3630 x C x d x A) – TCV - RCV	DCV=	7,855	cubic-feet

Worksheet B.2-1 DCV (DMA PR-3C1)

Design Capture Volume		Worksheet B.2-1		
1	85th percentile 24-hr storm depth from Figure B.1-1	d=	0.550	inches
2	Area tributary to BMP (s)	A=	15.53	acres
3	Area weighted runoff factor (estimate using Appendix B.1.1 and B.2.1)	C=	0.14	unitless
4	Trees Credit Volume	TCV=	0	cubic-feet
5	Rain barrels Credit Volume	RCV=	0	cubic-feet
6	Calculate DCV = (3630 x C x d x A) – TCV - RCV	DCV=	4,341	cubic-feet

Worksheet B.2-1 DCV (DMA PR-4A)

Design Capture Volume		Worksheet B.2-1		
1	85th percentile 24-hr storm depth from Figure B.1-1	d=	0.550	inches
2	Area tributary to BMP (s)	A=	21.55	acres
3	Area weighted runoff factor (estimate using Appendix B.1.1 and B.2.1)	C=	0.33	unitless
4	Trees Credit Volume	TCV=	0	cubic-feet
5	Rain barrels Credit Volume	RCV=	0	cubic-feet
6	Calculate DCV = (3630 x C x d x A) – TCV - RCV	DCV=	14,360	cubic-feet

Worksheet B.2-1 DCV (DMA PR-4B)

Design Capture Volume		Worksheet B.2-1		
1	85th percentile 24-hr storm depth from Figure B.1-1	d=	0.550	inches
2	Area tributary to BMP (s)	A=	2.19	acres
3	Area weighted runoff factor (estimate using Appendix B.1.1 and B.2.1)	C=	0.43	unitless
4	Trees Credit Volume	TCV=	0	cubic-feet
5	Rain barrels Credit Volume	RCV=	0	cubic-feet
6	Calculate DCV = (3630 x C x d x A) – TCV - RCV	DCV=	1,865	cubic-feet

Worksheet B.2-1 DCV (DMA PR-4C)

Design Capture Volume		Worksheet B.2-1		
1	85th percentile 24-hr storm depth from Figure B.1-1	d=	0.550	inches
2	Area tributary to BMP (s)	A=	3.58	acres
3	Area weighted runoff factor (estimate using Appendix B.1.1 and B.2.1)	C=	0.39	unitless
4	Trees Credit Volume	TCV=	0	cubic-feet
5	Rain barrels Credit Volume	RCV=	0	cubic-feet
6	Calculate DCV = (3630 x C x d x A) – TCV - RCV	DCV=	2,799	cubic-feet

Worksheet B.2-1 DCV (DMA PR-4E)

Design Capture Volume		Worksheet B.2-1		
1	85th percentile 24-hr storm depth from Figure B.1-1	d=	0.550	inches
2	Area tributary to BMP (s)	A=	23.11	acres
3	Area weighted runoff factor (estimate using Appendix B.1.1 and B.2.1)	C=	0.33	unitless
4	Trees Credit Volume	TCV=	0	cubic-feet
5	Rain barrels Credit Volume	RCV=	0	cubic-feet
6	Calculate DCV = (3630 x C x d x A) – TCV - RCV	DCV=	15,446	cubic-feet

Worksheet B.2-1 DCV (DMA PR-4F)

Design Capture Volume		Worksheet B.2-1		
1	85th percentile 24-hr storm depth from Figure B.1-1	d=	0.550	inches
2	Area tributary to BMP (s)	A=	2.55	acres
3	Area weighted runoff factor (estimate using Appendix B.1.1 and B.2.1)	C=	0.23	unitless
4	Trees Credit Volume	TCV=	0	cubic-feet
5	Rain barrels Credit Volume	RCV=	0	cubic-feet
6	Calculate DCV = (3630 x C x d x A) – TCV - RCV	DCV=	1,168	cubic-feet

Worksheet B.2-1 DCV (DMA PR-4G)

Design Capture Volume		Worksheet B.2-1		
1	85th percentile 24-hr storm depth from Figure B.1-1	d=	0.550	inches
2	Area tributary to BMP (s)	A=	2.19	acres
3	Area weighted runoff factor (estimate using Appendix B.1.1 and B.2.1)	C=	0.37	unitless
4	Trees Credit Volume	TCV=	0	cubic-feet
5	Rain barrels Credit Volume	RCV=	0	cubic-feet
6	Calculate DCV = (3630 x C x d x A) – TCV - RCV	DCV=	1,622	cubic-feet

Worksheet B.2-1 DCV (DMA PR-4H)

Design Capture Volume		Worksheet B.2-1		
1	85th percentile 24-hr storm depth from Figure B.1-1	d=	0.550	inches
2	Area tributary to BMP (s)	A=	11.09	acres
3	Area weighted runoff factor (estimate using Appendix B.1.1 and B.2.1)	C=	0.40	unitless
4	Trees Credit Volume	TCV=	0	cubic-feet
5	Rain barrels Credit Volume	RCV=	0	cubic-feet
6	Calculate DCV = (3630 x C x d x A) – TCV - RCV	DCV=	8,832	cubic-feet

Worksheet B.5-1: Simple Sizing Method for Biofiltration BMPs (DMA PR-1E)

Simple Sizing Method for Biofiltration BMPs		Worksheet B.5-1 (Page 1 of 2)	
1	Remaining DCV after implementing retention BMPs	2290	cubic-feet
Partial Retention			
2	Infiltration rate from Worksheet D.5-1 if partial infiltration is feasible	0.125	in/hr.
3	Allowable drawdown time for aggregate storage below the underdrain	36	hours
4	Depth of runoff that can be infiltrated [Line 2 x Line 3]	4.5	inches
5	Aggregate pore space	0.40	in/in
6	Required depth of gravel below the underdrain [Line 4/ Line 5]	11.25	inches
7	Assumed surface area of the biofiltration BMP	1,636	sq-ft
8	Media retained pore storage	0.1	in/in
9	Volume retained by BMP [[Line 4 + (Line 12 x Line 8)]/12] x Line 7	859	cubic-feet
10	DCV that requires biofiltration [Line 1 – Line 9]	1,431	cubic-feet
BMP Parameters			
11	Surface Ponding [6 inch minimum, 12 inch maximum]	6	inches
12	Media Thickness [18 inches minimum], also add mulch layer thickness to this line for sizing calculations	18	inches
13	Aggregate Storage above underdrain invert (12 inches typical) – use 0 inches for sizing if the aggregate is not over the entire bottom surface area	18	inches
14	Freely drained pore storage	0.2	in/in
15	Media filtration rate to be used for sizing (5 in/hr. with no outlet control; if the filtration rate is controlled by the outlet use the outlet controlled rate which will be less than 5 in/hr.)	5	in/hr.
Baseline Calculations			
16	Allowable Routing Time for sizing	6	hours
17	Depth filtered during storm [Line 15 x Line 16]	30	inches
18	Depth of Detention Storage [Line 11 + (Line 12 x Line 14) + (Line 13 x Line 5)]	15	inches
19	Total Depth Treated [Line 17 + Line 18]	45	inches

Note: Line 7 is used to estimate the amount of volume retained by the BMP. Update assumed surface area in Line 7 until its equivalent to the required biofiltration footprint (either Line 21 or Line 23)

Worksheet B.5-1: Simple Sizing Method for Biofiltration BMPs (continued)

Simple Sizing Method for Biofiltration BMPs		Worksheet B.5-1 (Page 2 of 2)	
Option 1 – Biofilter 1.5 times the DCV			
20	Required biofiltered volume [1.5 x Line 10]	2147	cubic-feet
21	Required Footprint [Line 20/ Line 19] x 12	573	sq-ft
Option 2 - Store 0.75 of remaining DCV in pores and ponding			
22	Required Storage (surface + pores) Volume [0.75 x Line 10]	1074	cubic-feet
23	Required Footprint [Line 22/ Line 18] x 12	859	sq-ft
Footprint of the BMP			
24	Area draining to the BMP	103,996	sq-ft
25	Adjusted Runoff Factor for drainage area (Refer to Appendix B.1 and B.2)	0.48	
26	BMP Footprint Sizing Factor (Default 0.03 or an alternative minimum footprint sizing factor from Worksheet B.5-2, Line 11)	0.03	
27	Minimum BMP Footprint [Line 24 x Line 25 x Line 26]	1,498	sq-ft
28	Footprint of the BMP = Maximum(Minimum(Line 21, Line 23), Line 27)	1,498	sq-ft
Check for Volume Reduction [Not applicable for No Infiltration Condition]			
29	Calculate the fraction of DCV retained in the BMP [Line 9/Line 1]	0.375	unitless
30	Minimum required fraction of DCV retained for partial infiltration condition	0.375	unitless
31	Is the retained DCV ≥ 0.375? If the answer is no increase the footprint sizing factor in Line 26 until the answer is yes for this criterion.	☑ Yes	☐ No

Note:

1. Line 7 is used to estimate the amount of volume retained by the BMP. Update assumed surface area in Line 7 until its equivalent to the required biofiltration footprint (either Line 21 or Line 23)
2. The DCV fraction of 0.375 is based on a 40% average annual percent capture and a 36-hour drawdown time.
3. The increase in footprint for volume reduction can be optimized using the approach presented in Appendix B.5.2. The optimized footprint cannot be smaller than the alternative minimum footprint sizing factor from Worksheet B.5-2.
4. If the proposed biofiltration BMP footprint is smaller than the alternative minimum footprint sizing factor from Worksheet B.5-2, but satisfies Option 1 or Option 2 sizing, it is considered a compact biofiltration BMP and may be allowed at the discretion of the City Engineer, if it meets the requirements in Appendix F.

Worksheet B.5-1: Simple Sizing Method for Biofiltration BMPs (DMA PR-1F)

Simple Sizing Method for Biofiltration BMPs		Worksheet B.5-1 (Page 1 of 2)	
1	Remaining DCV after implementing retention BMPs	1,756	cubic-feet
Partial Retention			
2	Infiltration rate from Worksheet D.5-1 if partial infiltration is feasible	0.125	in/hr.
3	Allowable drawdown time for aggregate storage below the underdrain	36	hours
4	Depth of runoff that can be infiltrated [Line 2 x Line 3]	4.5	inches
5	Aggregate pore space	0.40	in/in
6	Required depth of gravel below the underdrain [Line 4/ Line 5]	11.25	inches
7	Assumed surface area of the biofiltration BMP	1,254	sq-ft
8	Media retained pore storage	0.1	in/in
9	Volume retained by BMP [[Line 4 + (Line 12 x Line 8)]/12] x Line 7	659	cubic-feet
10	DCV that requires biofiltration [Line 1 – Line 9]	1,098	cubic-feet
BMP Parameters			
11	Surface Ponding [6 inch minimum, 12 inch maximum]	6	inches
12	Media Thickness [18 inches minimum], also add mulch layer thickness to this line for sizing calculations	18	inches
13	Aggregate Storage above underdrain invert (12 inches typical) – use 0 inches for sizing if the aggregate is not over the entire bottom surface area	18	inches
14	Freely drained pore storage	0.2	in/in
15	Media filtration rate to be used for sizing (5 in/hr. with no outlet control; if the filtration rate is controlled by the outlet use the outlet controlled rate which will be less than 5 in/hr.)	5	in/hr.
Baseline Calculations			
16	Allowable Routing Time for sizing	6	hours
17	Depth filtered during storm [Line 15 x Line 16]	30	inches
18	Depth of Detention Storage [Line 11 + (Line 12 x Line 14) + (Line 13 x Line 5)]	15	inches
19	Total Depth Treated [Line 17 + Line 18]	45	inches

Note: Line 7 is used to estimate the amount of volume retained by the BMP. Update assumed surface area in Line 7 until its equivalent to the required biofiltration footprint (either Line 21 or Line 23)

Worksheet B.5-1: Simple Sizing Method for Biofiltration BMPs (continued)

Simple Sizing Method for Biofiltration BMPs		Worksheet B.5-1 (Page 2 of 2)	
Option 1 – Biofilter 1.5 times the DCV			
20	Required biofiltered volume [1.5 x Line 10]	1,646	cubic-feet
21	Required Footprint [Line 20/ Line 19] x 12	439	sq-ft
Option 2 - Store 0.75 of remaining DCV in pores and ponding			
22	Required Storage (surface + pores) Volume [0.75 x Line 10]	823	cubic-feet
23	Required Footprint [Line 22/ Line 18] x 12	203	sq-ft
Footprint of the BMP			
24	Area draining to the BMP	124,855	sq-ft
25	Adjusted Runoff Factor for drainage area (Refer to Appendix B.1 and B.2)	0.31	
26	BMP Footprint Sizing Factor (Default 0.03 or an alternative minimum footprint sizing factor from Worksheet B.5-2, Line 11)	0.03	
27	Minimum BMP Footprint [Line 24 x Line 25 x Line 26]	1,148	sq-ft
28	Footprint of the BMP = Maximum(Minimum(Line 21, Line 23), Line 27)	1,148	sq-ft
Check for Volume Reduction [Not applicable for No Infiltration Condition]			
29	Calculate the fraction of DCV retained in the BMP [Line 9/Line 1]	0.375	unitless
30	Minimum required fraction of DCV retained for partial infiltration condition	0.375	unitless
31	Is the retained DCV ≥ 0.375? If the answer is no increase the footprint sizing factor in Line 26 until the answer is yes for this criterion.	☑ Yes	☐ No

Note:

1. Line 7 is used to estimate the amount of volume retained by the BMP. Update assumed surface area in Line 7 until its equivalent to the required biofiltration footprint (either Line 21 or Line 23)
2. The DCV fraction of 0.375 is based on a 40% average annual percent capture and a 36-hour drawdown time.
3. The increase in footprint for volume reduction can be optimized using the approach presented in Appendix B.5.2. The optimized footprint cannot be smaller than the alternative minimum footprint sizing factor from Worksheet B.5-2.
4. If the proposed biofiltration BMP footprint is smaller than the alternative minimum footprint sizing factor from Worksheet B.5-2, but satisfies Option 1 or Option 2 sizing, it is considered a compact biofiltration BMP and may be allowed at the discretion of the City Engineer, if it meets the requirements in Appendix F.

Worksheet B.5-1: Simple Sizing Method for Biofiltration BMPs (DMA PR-1G)

Simple Sizing Method for Biofiltration BMPs		Worksheet B.5-1 (Page 1 of 2)	
1	Remaining DCV after implementing retention BMPs	433	cubic-feet
Partial Retention			
2	Infiltration rate from Worksheet D.5-1 if partial infiltration is feasible	0.125	in/hr.
3	Allowable drawdown time for aggregate storage below the underdrain	36	hours
4	Depth of runoff that can be infiltrated [Line 2 x Line 3]	4.5	inches
5	Aggregate pore space	0.40	in/in
6	Required depth of gravel below the underdrain [Line 4/ Line 5]	11.25	inches
7	Assumed surface area of the biofiltration BMP	309	sq-ft
8	Media retained pore storage	0.1	in/in
9	Volume retained by BMP [[Line 4 + (Line 12 x Line 8)]/12] x Line 7	162	cubic-feet
10	DCV that requires biofiltration [Line 1 – Line 9]	271	cubic-feet
BMP Parameters			
11	Surface Ponding [6 inch minimum, 12 inch maximum]	6	inches
12	Media Thickness [18 inches minimum], also add mulch layer thickness to this line for sizing calculations	18	inches
13	Aggregate Storage above underdrain invert (12 inches typical) – use 0 inches for sizing if the aggregate is not over the entire bottom surface area	18	inches
14	Freely drained pore storage	0.2	in/in
15	Media filtration rate to be used for sizing (5 in/hr. with no outlet control; if the filtration rate is controlled by the outlet use the outlet controlled rate which will be less than 5 in/hr.)	5	in/hr.
Baseline Calculations			
16	Allowable Routing Time for sizing	6	hours
17	Depth filtered during storm [Line 15 x Line 16]	30	inches
18	Depth of Detention Storage [Line 11 + (Line 12 x Line 14) + (Line 13 x Line 5)]	15	inches
19	Total Depth Treated [Line 17 + Line 18]	45	inches

Note: Line 7 is used to estimate the amount of volume retained by the BMP. Update assumed surface area in Line 7 until its equivalent to the required biofiltration footprint (either Line 21 or Line 23)

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Worksheet B.5-1: Simple Sizing Method for Biofiltration BMPs (continued)

	Simple Sizing Method for Biofiltration BMPs	Worksheet B.5-1 (Page 2 of 2)	
Option 1 – Biofilter 1.5 times the DCV			
20	Required biofiltered volume [1.5 x Line 10]	406	cubic-feet
21	Required Footprint [Line 20/ Line 19] x 12	108	sq-ft
Option 2 - Store 0.75 of remaining DCV in pores and ponding			
22	Required Storage (surface + pores) Volume [0.75 x Line 10]	203	cubic-feet
23	Required Footprint [Line 22/ Line 18] x 12	162	sq-ft
Footprint of the BMP			
24	Area draining to the BMP	67,619	sq-ft
25	Adjusted Runoff Factor for drainage area (Refer to Appendix B.1 and B.2)	0.14	
26	BMP Footprint Sizing Factor (Default 0.03 or an alternative minimum footprint sizing factor from Worksheet B.5-2, Line 11)	0.03	
27	Minimum BMP Footprint [Line 24 x Line 25 x Line 26]	284	sq-ft
28	Footprint of the BMP = Maximum(Minimum(Line 21, Line 23), Line 27)	284	sq-ft
Check for Volume Reduction [Not applicable for No Infiltration Condition]			
29	Calculate the fraction of DCV retained in the BMP [Line 9/Line 1]	0.375	unitless
30	Minimum required fraction of DCV retained for partial infiltration condition	0.375	unitless
31	Is the retained DCV ≥ 0.375? If the answer is no increase the footprint sizing factor in Line 26 until the answer is yes for this criterion.	☑ Yes	☐ No

Note:

1. Line 7 is used to estimate the amount of volume retained by the BMP. Update assumed surface area in Line 7 until its equivalent to the required biofiltration footprint (either Line 21 or Line 23)
2. The DCV fraction of 0.375 is based on a 40% average annual percent capture and a 36-hour drawdown time.
3. The increase in footprint for volume reduction can be optimized using the approach presented in Appendix B.5.2. The optimized footprint cannot be smaller than the alternative minimum footprint sizing factor from Worksheet B.5-2.
4. If the proposed biofiltration BMP footprint is smaller than the alternative minimum footprint sizing factor from Worksheet B.5-2, but satisfies Option 1 or Option 2 sizing, it is considered a compact biofiltration BMP and may be allowed at the discretion of the City Engineer, if it meets the requirements in Appendix F.

Worksheet B.5-1: Simple Sizing Method for Biofiltration BMPs (DMA PR-1H)

Simple Sizing Method for Biofiltration BMPs		Worksheet B.5-1 (Page 1 of 2)	
1	Remaining DCV after implementing retention BMPs	1,388	cubic-feet
Partial Retention			
2	Infiltration rate from Worksheet D.5-1 if partial infiltration is feasible	0.125	in/hr.
3	Allowable drawdown time for aggregate storage below the underdrain	36	hours
4	Depth of runoff that can be infiltrated [Line 2 x Line 3]	4.5	inches
5	Aggregate pore space	0.40	in/in
6	Required depth of gravel below the underdrain [Line 4/ Line 5]	11.25	inches
7	Assumed surface area of the biofiltration BMP	991	sq-ft
8	Media retained pore storage	0.1	in/in
9	Volume retained by BMP [[Line 4 + (Line 12 x Line 8)]/12] x Line 7	521	cubic-feet
10	DCV that requires biofiltration [Line 1 – Line 9]	868	cubic-feet
BMP Parameters			
11	Surface Ponding [6 inch minimum, 12 inch maximum]	6	inches
12	Media Thickness [18 inches minimum], also add mulch layer thickness to this line for sizing calculations	18	inches
13	Aggregate Storage above underdrain invert (12 inches typical) – use 0 inches for sizing if the aggregate is not over the entire bottom surface area	18	inches
14	Freely drained pore storage	0.2	in/in
15	Media filtration rate to be used for sizing (5 in/hr. with no outlet control; if the filtration rate is controlled by the outlet use the outlet controlled rate which will be less than 5 in/hr.)	5	in/hr.
Baseline Calculations			
16	Allowable Routing Time for sizing	6	hours
17	Depth filtered during storm [Line 15 x Line 16]	30	inches
18	Depth of Detention Storage [Line 11 + (Line 12 x Line 14) + (Line 13 x Line 5)]	15	inches
19	Total Depth Treated [Line 17 + Line 18]	45	inches

Note: Line 7 is used to estimate the amount of volume retained by the BMP. Update assumed surface area in Line 7 until its equivalent to the required biofiltration footprint (either Line 21 or Line 23)

Worksheet B.5-1: Simple Sizing Method for Biofiltration BMPs (continued)

Simple Sizing Method for Biofiltration BMPs		Worksheet B.5-1 (Page 2 of 2)	
Option 1 – Biofilter 1.5 times the DCV			
20	Required biofiltered volume [1.5 x Line 10]	1,301	cubic-feet
21	Required Footprint [Line 20/ Line 19] x 12	347	sq-ft
Option 2 - Store 0.75 of remaining DCV in pores and ponding			
22	Required Storage (surface + pores) Volume [0.75 x Line 10]	651	cubic-feet
23	Required Footprint [Line 22/ Line 18] x 12	521	sq-ft
Footprint of the BMP			
24	Area draining to the BMP	197,700	sq-ft
25	Adjusted Runoff Factor for drainage area (Refer to Appendix B.1 and B.2)	0.15	
26	BMP Footprint Sizing Factor (Default 0.03 or an alternative minimum footprint sizing factor from Worksheet B.5-2, Line 11)	0.03	
27	Minimum BMP Footprint [Line 24 x Line 25 x Line 26]	908	sq-ft
28	Footprint of the BMP = Maximum(Minimum(Line 21, Line 23), Line 27)	908	sq-ft
Check for Volume Reduction [Not applicable for No Infiltration Condition]			
29	Calculate the fraction of DCV retained in the BMP [Line 9/Line 1]	0.375	unitless
30	Minimum required fraction of DCV retained for partial infiltration condition	0.375	unitless
31	Is the retained DCV ≥ 0.375? If the answer is no increase the footprint sizing factor in Line 26 until the answer is yes for this criterion.	☑ Yes	☐ No

Note:

1. Line 7 is used to estimate the amount of volume retained by the BMP. Update assumed surface area in Line 7 until its equivalent to the required biofiltration footprint (either Line 21 or Line 23)
2. The DCV fraction of 0.375 is based on a 40% average annual percent capture and a 36-hour drawdown time.
3. The increase in footprint for volume reduction can be optimized using the approach presented in Appendix B.5.2. The optimized footprint cannot be smaller than the alternative minimum footprint sizing factor from Worksheet B.5-2.
4. If the proposed biofiltration BMP footprint is smaller than the alternative minimum footprint sizing factor from Worksheet B.5-2, but satisfies Option 1 or Option 2 sizing, it is considered a compact biofiltration BMP and may be allowed at the discretion of the City Engineer, if it meets the requirements in Appendix F.

Worksheet B.5-1: Simple Sizing Method for Biofiltration BMPs (DMA PR-1I)

Simple Sizing Method for Biofiltration BMPs		Worksheet B.5-1 (Page 1 of 2)	
1	Remaining DCV after implementing retention BMPs	1,148	cubic-feet
Partial Retention			
2	Infiltration rate from Worksheet D.5-1 if partial infiltration is feasible	0.125	in/hr.
3	Allowable drawdown time for aggregate storage below the underdrain	36	hours
4	Depth of runoff that can be infiltrated [Line 2 x Line 3]	4.5	inches
5	Aggregate pore space	0.40	in/in
6	Required depth of gravel below the underdrain [Line 4/ Line 5]	11.25	inches
7	Assumed surface area of the biofiltration BMP	820	sq-ft
8	Media retained pore storage	0.1	in/in
9	Volume retained by BMP [[Line 4 + (Line 12 x Line 8)]/12] x Line 7	431	cubic-feet
10	DCV that requires biofiltration [Line 1 – Line 9]	718	cubic-feet
BMP Parameters			
11	Surface Ponding [6 inch minimum, 12 inch maximum]	6	inches
12	Media Thickness [18 inches minimum], also add mulch layer thickness to this line for sizing calculations	18	inches
13	Aggregate Storage above underdrain invert (12 inches typical) – use 0 inches for sizing if the aggregate is not over the entire bottom surface area	18	inches
14	Freely drained pore storage	0.2	in/in
15	Media filtration rate to be used for sizing (5 in/hr. with no outlet control; if the filtration rate is controlled by the outlet use the outlet controlled rate which will be less than 5 in/hr.)	5	in/hr.
Baseline Calculations			
16	Allowable Routing Time for sizing	6	hours
17	Depth filtered during storm [Line 15 x Line 16]	30	inches
18	Depth of Detention Storage [Line 11 + (Line 12 x Line 14) + (Line 13 x Line 5)]	15	inches
19	Total Depth Treated [Line 17 + Line 18]	45	inches

Note: Line 7 is used to estimate the amount of volume retained by the BMP. Update assumed surface area in Line 7 until its equivalent to the required biofiltration footprint (either Line 21 or Line 23)

Worksheet B.5-1: Simple Sizing Method for Biofiltration BMPs (continued)

Simple Sizing Method for Biofiltration BMPs		Worksheet B.5-1 (Page 2 of 2)	
Option 1 – Biofilter 1.5 times the DCV			
20	Required biofiltered volume [1.5 x Line 10]	1,076	cubic-feet
21	Required Footprint [Line 20/ Line 19] x 12	287	sq-ft
Option 2 - Store 0.75 of remaining DCV in pores and ponding			
22	Required Storage (surface + pores) Volume [0.75 x Line 10]	538	cubic-feet
23	Required Footprint [Line 22/ Line 18] x 12	431	sq-ft
Footprint of the BMP			
24	Area draining to the BMP	73,517	sq-ft
25	Adjusted Runoff Factor for drainage area (Refer to Appendix B.1 and B.2)	0.34	
26	BMP Footprint Sizing Factor (Default 0.03 or an alternative minimum footprint sizing factor from Worksheet B.5-2, Line 11)	0.03	
27	Minimum BMP Footprint [Line 24 x Line 25 x Line 26]	751	sq-ft
28	Footprint of the BMP = Maximum(Minimum(Line 21, Line 23), Line 27)	751	sq-ft
Check for Volume Reduction [Not applicable for No Infiltration Condition]			
29	Calculate the fraction of DCV retained in the BMP [Line 9/Line 1]	0.375	unitless
30	Minimum required fraction of DCV retained for partial infiltration condition	0.375	unitless
31	Is the retained DCV ≥ 0.375? If the answer is no increase the footprint sizing factor in Line 26 until the answer is yes for this criterion.	☑ Yes	☐ No

Note:

1. Line 7 is used to estimate the amount of volume retained by the BMP. Update assumed surface area in Line 7 until its equivalent to the required biofiltration footprint (either Line 21 or Line 23)
2. The DCV fraction of 0.375 is based on a 40% average annual percent capture and a 36-hour drawdown time.
3. The increase in footprint for volume reduction can be optimized using the approach presented in Appendix B.5.2. The optimized footprint cannot be smaller than the alternative minimum footprint sizing factor from Worksheet B.5-2.
4. If the proposed biofiltration BMP footprint is smaller than the alternative minimum footprint sizing factor from Worksheet B.5-2, but satisfies Option 1 or Option 2 sizing, it is considered a compact biofiltration BMP and may be allowed at the discretion of the City Engineer, if it meets the requirements in Appendix F.

Worksheet B.5-1: Simple Sizing Method for Biofiltration BMPs (DMA PR-2A)

Simple Sizing Method for Biofiltration BMPs		Worksheet B.5-1 (Page 1 of 2)	
1	Remaining DCV after implementing retention BMPs	625	cubic-feet
Partial Retention			
2	Infiltration rate from Worksheet D.5-1 if partial infiltration is feasible	0.125	in/hr.
3	Allowable drawdown time for aggregate storage below the underdrain	36	hours
4	Depth of runoff that can be infiltrated [Line 2 x Line 3]	4.5	inches
5	Aggregate pore space	0.40	in/in
6	Required depth of gravel below the underdrain [Line 4/ Line 5]	11.25	inches
7	Assumed surface area of the biofiltration BMP	446	sq-ft
8	Media retained pore storage	0.1	in/in
9	Volume retained by BMP [[Line 4 + (Line 12 x Line 8)]/12] x Line 7	234	cubic-feet
10	DCV that requires biofiltration [Line 1 – Line 9]	391	cubic-feet
BMP Parameters			
11	Surface Ponding [6 inch minimum, 12 inch maximum]	6	inches
12	Media Thickness [18 inches minimum], also add mulch layer thickness to this line for sizing calculations	18	inches
13	Aggregate Storage above underdrain invert (12 inches typical) – use 0 inches for sizing if the aggregate is not over the entire bottom surface area	18	inches
14	Freely drained pore storage	0.2	in/in
15	Media filtration rate to be used for sizing (5 in/hr. with no outlet control; if the filtration rate is controlled by the outlet use the outlet controlled rate which will be less than 5 in/hr.)	5	in/hr.
Baseline Calculations			
16	Allowable Routing Time for sizing	6	hours
17	Depth filtered during storm [Line 15 x Line 16]	30	inches
18	Depth of Detention Storage [Line 11 + (Line 12 x Line 14) + (Line 13 x Line 5)]	15	inches
19	Total Depth Treated [Line 17 + Line 18]	45	inches

Note: Line 7 is used to estimate the amount of volume retained by the BMP. Update assumed surface area in Line 7 until its equivalent to the required biofiltration footprint (either Line 21 or Line 23)

Worksheet B.5-1: Simple Sizing Method for Biofiltration BMPs (continued)

Simple Sizing Method for Biofiltration BMPs		Worksheet B.5-1 (Page 2 of 2)	
Option 1 – Biofilter 1.5 times the DCV			
20	Required biofiltered volume [1.5 x Line 10]	586	cubic-feet
21	Required Footprint [Line 20/ Line 19] x 12	156	sq-ft
Option 2 - Store 0.75 of remaining DCV in pores and ponding			
22	Required Storage (surface + pores) Volume [0.75 x Line 10]	293	cubic-feet
23	Required Footprint [Line 22/ Line 18] x 12	234	sq-ft
Footprint of the BMP			
24	Area draining to the BMP	55,862	sq-ft
25	Adjusted Runoff Factor for drainage area (Refer to Appendix B.1 and B.2)	0.24	
26	BMP Footprint Sizing Factor (Default 0.03 or an alternative minimum footprint sizing factor from Worksheet B.5-2, Line 11)	0.03	
27	Minimum BMP Footprint [Line 24 x Line 25 x Line 26]	410	sq-ft
28	Footprint of the BMP = Maximum(Minimum(Line 21, Line 23), Line 27)	410	sq-ft
Check for Volume Reduction [Not applicable for No Infiltration Condition]			
29	Calculate the fraction of DCV retained in the BMP [Line 9/Line 1]	0.375	unitless
30	Minimum required fraction of DCV retained for partial infiltration condition	0.375	unitless
31	Is the retained DCV ≥ 0.375? If the answer is no increase the footprint sizing factor in Line 26 until the answer is yes for this criterion.	☑ Yes	☐ No

Note:

1. Line 7 is used to estimate the amount of volume retained by the BMP. Update assumed surface area in Line 7 until its equivalent to the required biofiltration footprint (either Line 21 or Line 23)
2. The DCV fraction of 0.375 is based on a 40% average annual percent capture and a 36-hour drawdown time.
3. The increase in footprint for volume reduction can be optimized using the approach presented in Appendix B.5.2. The optimized footprint cannot be smaller than the alternative minimum footprint sizing factor from Worksheet B.5-2.
4. If the proposed biofiltration BMP footprint is smaller than the alternative minimum footprint sizing factor from Worksheet B.5-2, but satisfies Option 1 or Option 2 sizing, it is considered a compact biofiltration BMP and may be allowed at the discretion of the City Engineer, if it meets the requirements in Appendix F.

Worksheet B.5-1: Simple Sizing Method for Biofiltration BMPs (DMA PR-2B)

Simple Sizing Method for Biofiltration BMPs		Worksheet B.5-1 (Page 1 of 2)	
1	Remaining DCV after implementing retention BMPs	1,979	cubic-feet
Partial Retention			
2	Infiltration rate from Worksheet D.5-1 if partial infiltration is feasible	0.125	in/hr.
3	Allowable drawdown time for aggregate storage below the underdrain	36	hours
4	Depth of runoff that can be infiltrated [Line 2 x Line 3]	4.5	inches
5	Aggregate pore space	0.40	in/in
6	Required depth of gravel below the underdrain [Line 4/ Line 5]	11.25	inches
7	Assumed surface area of the biofiltration BMP	1,414	sq-ft
8	Media retained pore storage	0.1	in/in
9	Volume retained by BMP [[Line 4 + (Line 12 x Line 8)]/12] x Line 7	742	cubic-feet
10	DCV that requires biofiltration [Line 1 – Line 9]	1,237	cubic-feet
BMP Parameters			
11	Surface Ponding [6 inch minimum, 12 inch maximum]	6	inches
12	Media Thickness [18 inches minimum], also add mulch layer thickness to this line for sizing calculations	18	inches
13	Aggregate Storage above underdrain invert (12 inches typical) – use 0 inches for sizing if the aggregate is not over the entire bottom surface area	18	inches
14	Freely drained pore storage	0.2	in/in
15	Media filtration rate to be used for sizing (5 in/hr. with no outlet control; if the filtration rate is controlled by the outlet use the outlet controlled rate which will be less than 5 in/hr.)	5	in/hr.
Baseline Calculations			
16	Allowable Routing Time for sizing	6	hours
17	Depth filtered during storm [Line 15 x Line 16]	30	inches
18	Depth of Detention Storage [Line 11 + (Line 12 x Line 14) + (Line 13 x Line 5)]	15	inches
19	Total Depth Treated [Line 17 + Line 18]	45	inches

Note: Line 7 is used to estimate the amount of volume retained by the BMP. Update assumed surface area in Line 7 until its equivalent to the required biofiltration footprint (either Line 21 or Line 23)

Worksheet B.5-1: Simple Sizing Method for Biofiltration BMPs (continued)

Simple Sizing Method for Biofiltration BMPs		Worksheet B.5-1 (Page 2 of 2)	
Option 1 – Biofilter 1.5 times the DCV			
20	Required biofiltered volume [1.5 x Line 10]	1,855	cubic-feet
21	Required Footprint [Line 20/ Line 19] x 12	495	sq-ft
Option 2 - Store 0.75 of remaining DCV in pores and ponding			
22	Required Storage (surface + pores) Volume [0.75 x Line 10]	928	cubic-feet
23	Required Footprint [Line 22/ Line 18] x 12	742	sq-ft
Footprint of the BMP			
24	Area draining to the BMP	133,255	sq-ft
25	Adjusted Runoff Factor for drainage area (Refer to Appendix B.1 and B.2)	0.32	
26	BMP Footprint Sizing Factor (Default 0.03 or an alternative minimum footprint sizing factor from Worksheet B.5-2, Line 11)	0.03	
27	Minimum BMP Footprint [Line 24 x Line 25 x Line 26]	1,295	sq-ft
28	Footprint of the BMP = Maximum(Minimum(Line 21, Line 23), Line 27)	1,295	sq-ft
Check for Volume Reduction [Not applicable for No Infiltration Condition]			
29	Calculate the fraction of DCV retained in the BMP [Line 9/Line 1]	0.375	unitless
30	Minimum required fraction of DCV retained for partial infiltration condition	0.375	unitless
31	Is the retained DCV ≥ 0.375? If the answer is no increase the footprint sizing factor in Line 26 until the answer is yes for this criterion.	☑ Yes	☐ No

Note:
1. Line 7 is used to estimate the amount of volume retained by the BMP. Update assumed surface area in Line 7 until its equivalent to the required biofiltration footprint (either Line 21 or Line 23)
2. The DCV fraction of 0.375 is based on a 40% average annual percent capture and a 36-hour drawdown time.
3. The increase in footprint for volume reduction can be optimized using the approach presented in Appendix B.5.2. The optimized footprint cannot be smaller than the alternative minimum footprint sizing factor from Worksheet B.5-2.
4. If the proposed biofiltration BMP footprint is smaller than the alternative minimum footprint sizing factor from Worksheet B.5-2, but satisfies Option 1 or Option 2 sizing, it is considered a compact biofiltration BMP and may be allowed at the discretion of the City Engineer, if it meets the requirements in Appendix F.

Worksheet B.5-1: Simple Sizing Method for Biofiltration BMPs (DMA PR-2C)

Simple Sizing Method for Biofiltration BMPs		Worksheet B.5-1 (Page 1 of 2)	
1	Remaining DCV after implementing retention BMPs	1,221	cubic-feet
Partial Retention			
2	Infiltration rate from Worksheet D.5-1 if partial infiltration is feasible	0.125	in/hr.
3	Allowable drawdown time for aggregate storage below the underdrain	36	hours
4	Depth of runoff that can be infiltrated [Line 2 x Line 3]	4.5	inches
5	Aggregate pore space	0.40	in/in
6	Required depth of gravel below the underdrain [Line 4/ Line 5]	11.25	inches
7	Assumed surface area of the biofiltration BMP	872	sq-ft
8	Media retained pore storage	0.1	in/in
9	Volume retained by BMP [[Line 4 + (Line 12 x Line 8)]/12] x Line 7	458	cubic-feet
10	DCV that requires biofiltration [Line 1 – Line 9]	763	cubic-feet
BMP Parameters			
11	Surface Ponding [6 inch minimum, 12 inch maximum]	6	inches
12	Media Thickness [18 inches minimum], also add mulch layer thickness to this line for sizing calculations	18	inches
13	Aggregate Storage above underdrain invert (12 inches typical) – use 0 inches for sizing if the aggregate is not over the entire bottom surface area	18	inches
14	Freely drained pore storage	0.2	in/in
15	Media filtration rate to be used for sizing (5 in/hr. with no outlet control; if the filtration rate is controlled by the outlet use the outlet controlled rate which will be less than 5 in/hr.)	5	in/hr.
Baseline Calculations			
16	Allowable Routing Time for sizing	6	hours
17	Depth filtered during storm [Line 15 x Line 16]	30	inches
18	Depth of Detention Storage [Line 11 + (Line 12 x Line 14) + (Line 13 x Line 5)]	15	inches
19	Total Depth Treated [Line 17 + Line 18]	45	inches

Note: Line 7 is used to estimate the amount of volume retained by the BMP. Update assumed surface area in Line 7 until its equivalent to the required biofiltration footprint (either Line 21 or Line 23)

Worksheet B.5-1: Simple Sizing Method for Biofiltration BMPs (continued)

Simple Sizing Method for Biofiltration BMPs		Worksheet B.5-1 (Page 2 of 2)	
Option 1 – Biofilter 1.5 times the DCV			
20	Required biofiltered volume [1.5 x Line 10]	1,145	cubic-feet
21	Required Footprint [Line 20/ Line 19] x 12	305	sq-ft
Option 2 - Store 0.75 of remaining DCV in pores and ponding			
22	Required Storage (surface + pores) Volume [0.75 x Line 10]	572	cubic-feet
23	Required Footprint [Line 22/ Line 18] x 12	458	sq-ft
Footprint of the BMP			
24	Area draining to the BMP	60,113	sq-ft
25	Adjusted Runoff Factor for drainage area (Refer to Appendix B.1 and B.2)	0.44	
26	BMP Footprint Sizing Factor (Default 0.03 or an alternative minimum footprint sizing factor from Worksheet B.5-2, Line 11)	0.03	
27	Minimum BMP Footprint [Line 24 x Line 25 x Line 26]	799	sq-ft
28	Footprint of the BMP = Maximum(Minimum(Line 21, Line 23), Line 27)	799	sq-ft
Check for Volume Reduction [Not applicable for No Infiltration Condition]			
29	Calculate the fraction of DCV retained in the BMP [Line 9/Line 1]	0.375	unitless
30	Minimum required fraction of DCV retained for partial infiltration condition	0.375	unitless
31	Is the retained DCV ≥ 0.375? If the answer is no increase the footprint sizing factor in Line 26 until the answer is yes for this criterion.	☑ Yes	☐ No

Note:

1. Line 7 is used to estimate the amount of volume retained by the BMP. Update assumed surface area in Line 7 until its equivalent to the required biofiltration footprint (either Line 21 or Line 23)
2. The DCV fraction of 0.375 is based on a 40% average annual percent capture and a 36-hour drawdown time.
3. The increase in footprint for volume reduction can be optimized using the approach presented in Appendix B.5.2. The optimized footprint cannot be smaller than the alternative minimum footprint sizing factor from Worksheet B.5-2.
4. If the proposed biofiltration BMP footprint is smaller than the alternative minimum footprint sizing factor from Worksheet B.5-2, but satisfies Option 1 or Option 2 sizing, it is considered a compact biofiltration BMP and may be allowed at the discretion of the City Engineer, if it meets the requirements in Appendix F.

Worksheet B.5-1: Simple Sizing Method for Biofiltration BMPs (DMA PR-2D)

Simple Sizing Method for Biofiltration BMPs		Worksheet B.5-1 (Page 1 of 2)	
1	Remaining DCV after implementing retention BMPs	11,029	cubic-feet
Partial Retention			
2	Infiltration rate from Worksheet D.5-1 if partial infiltration is feasible	0.125	in/hr.
3	Allowable drawdown time for aggregate storage below the underdrain	36	hours
4	Depth of runoff that can be infiltrated [Line 2 x Line 3]	4.5	inches
5	Aggregate pore space	0.40	in/in
6	Required depth of gravel below the underdrain [Line 4/ Line 5]	11.25	inches
7	Assumed surface area of the biofiltration BMP	7,878	sq-ft
8	Media retained pore storage	0.1	in/in
9	Volume retained by BMP [[Line 4 + (Line 12 x Line 8)]/12] x Line 7	4,139	cubic-feet
10	DCV that requires biofiltration [Line 1 – Line 9]	6,893	cubic-feet
BMP Parameters			
11	Surface Ponding [6 inch minimum, 12 inch maximum]	6	inches
12	Media Thickness [18 inches minimum], also add mulch layer thickness to this line for sizing calculations	18	inches
13	Aggregate Storage above underdrain invert (12 inches typical) – use 0 inches for sizing if the aggregate is not over the entire bottom surface area	18	inches
14	Freely drained pore storage	0.2	in/in
15	Media filtration rate to be used for sizing (5 in/hr. with no outlet control; if the filtration rate is controlled by the outlet use the outlet controlled rate which will be less than 5 in/hr.)	5	in/hr.
Baseline Calculations			
16	Allowable Routing Time for sizing	6	hours
17	Depth filtered during storm [Line 15 x Line 16]	30	inches
18	Depth of Detention Storage [Line 11 + (Line 12 x Line 14) + (Line 13 x Line 5)]	15	inches
19	Total Depth Treated [Line 17 + Line 18]	45	inches

Note: Line 7 is used to estimate the amount of volume retained by the BMP. Update assumed surface area in Line 7 until its equivalent to the required biofiltration footprint (either Line 21 or Line 23)

Worksheet B.5-1: Simple Sizing Method for Biofiltration BMPs (continued)

Simple Sizing Method for Biofiltration BMPs		Worksheet B.5-1 (Page 2 of 2)	
Option 1 – Biofilter 1.5 times the DCV			
20	Required biofiltered volume [1.5 x Line 10]	10,340	cubic-feet
21	Required Footprint [Line 20/ Line 19] x 12	2,757	sq-ft
Option 2 - Store 0.75 of remaining DCV in pores and ponding			
22	Required Storage (surface + pores) Volume [0.75 x Line 10]	5,170	cubic-feet
23	Required Footprint [Line 22/ Line 18] x 12	4,139	sq-ft
Footprint of the BMP			
24	Area draining to the BMP	1,718,830	sq-ft
25	Adjusted Runoff Factor for drainage area (Refer to Appendix B.1 and B.2)	0.14	
26	BMP Footprint Sizing Factor (Default 0.03 or an alternative minimum footprint sizing factor from Worksheet B.5-2, Line 11)	0.03	
27	Minimum BMP Footprint [Line 24 x Line 25 x Line 26]	7,219	sq-ft
28	Footprint of the BMP = Maximum(Minimum(Line 21, Line 23), Line 27)	7,219	sq-ft
Check for Volume Reduction [Not applicable for No Infiltration Condition]			
29	Calculate the fraction of DCV retained in the BMP [Line 9/Line 1]	0.375	unitless
30	Minimum required fraction of DCV retained for partial infiltration condition	0.375	unitless
31	Is the retained DCV ≥ 0.375? If the answer is no increase the footprint sizing factor in Line 26 until the answer is yes for this criterion.	☑ Yes	☐ No

Note:

1. Line 7 is used to estimate the amount of volume retained by the BMP. Update assumed surface area in Line 7 until its equivalent to the required biofiltration footprint (either Line 21 or Line 23)
2. The DCV fraction of 0.375 is based on a 40% average annual percent capture and a 36-hour drawdown time.
3. The increase in footprint for volume reduction can be optimized using the approach presented in Appendix B.5.2. The optimized footprint cannot be smaller than the alternative minimum footprint sizing factor from Worksheet B.5-2.
4. If the proposed biofiltration BMP footprint is smaller than the alternative minimum footprint sizing factor from Worksheet B.5-2, but satisfies Option 1 or Option 2 sizing, it is considered a compact biofiltration BMP and may be allowed at the discretion of the City Engineer, if it meets the requirements in Appendix F.

Worksheet B.5-1: Simple Sizing Method for Biofiltration BMPs (DMA PR-2E)

Simple Sizing Method for Biofiltration BMPs		Worksheet B.5-1 (Page 1 of 2)	
1	Remaining DCV after implementing retention BMPs	2,051	cubic-feet
Partial Retention			
2	Infiltration rate from Worksheet D.5-1 if partial infiltration is feasible	0.125	in/hr.
3	Allowable drawdown time for aggregate storage below the underdrain	36	hours
4	Depth of runoff that can be infiltrated [Line 2 x Line 3]	4.5	inches
5	Aggregate pore space	0.40	in/in
6	Required depth of gravel below the underdrain [Line 4/ Line 5]	11.25	inches
7	Assumed surface area of the biofiltration BMP	1,465	sq-ft
8	Media retained pore storage	0.1	in/in
9	Volume retained by BMP [[Line 4 + (Line 12 x Line 8)]/12] x Line 7	769	cubic-feet
10	DCV that requires biofiltration [Line 1 – Line 9]	1,282	cubic-feet
BMP Parameters			
11	Surface Ponding [6 inch minimum, 12 inch maximum]	6	inches
12	Media Thickness [18 inches minimum], also add mulch layer thickness to this line for sizing calculations	18	inches
13	Aggregate Storage above underdrain invert (12 inches typical) – use 0 inches for sizing if the aggregate is not over the entire bottom surface area	18	inches
14	Freely drained pore storage	0.2	in/in
15	Media filtration rate to be used for sizing (5 in/hr. with no outlet control; if the filtration rate is controlled by the outlet use the outlet controlled rate which will be less than 5 in/hr.)	5	in/hr.
Baseline Calculations			
16	Allowable Routing Time for sizing	6	hours
17	Depth filtered during storm [Line 15 x Line 16]	30	inches
18	Depth of Detention Storage [Line 11 + (Line 12 x Line 14) + (Line 13 x Line 5)]	15	inches
19	Total Depth Treated [Line 17 + Line 18]	45	inches

Note: Line 7 is used to estimate the amount of volume retained by the BMP. Update assumed surface area in Line 7 until its equivalent to the required biofiltration footprint (either Line 21 or Line 23)

Worksheet B.5-1: Simple Sizing Method for Biofiltration BMPs (continued)

Simple Sizing Method for Biofiltration BMPs		Worksheet B.5-1 (Page 2 of 2)	
Option 1 – Biofilter 1.5 times the DCV			
20	Required biofiltered volume [1.5 x Line 10]	1,923	cubic-feet
21	Required Footprint [Line 20/ Line 19] x 12	513	sq-ft
Option 2 - Store 0.75 of remaining DCV in pores and ponding			
22	Required Storage (surface + pores) Volume [0.75 x Line 10]	961	cubic-feet
23	Required Footprint [Line 22/ Line 18] x 12	769	sq-ft
Footprint of the BMP			
24	Area draining to the BMP	184,625	sq-ft
25	Adjusted Runoff Factor for drainage area (Refer to Appendix B.1 and B.2)	0.24	
26	BMP Footprint Sizing Factor (Default 0.03 or an alternative minimum footprint sizing factor from Worksheet B.5-2, Line 11)	0.03	
27	Minimum BMP Footprint [Line 24 x Line 25 x Line 26]	1,342	sq-ft
28	Footprint of the BMP = Maximum(Minimum(Line 21, Line 23), Line 27)	1,342	sq-ft
Check for Volume Reduction [Not applicable for No Infiltration Condition]			
29	Calculate the fraction of DCV retained in the BMP [Line 9/Line 1]	0.375	unitless
30	Minimum required fraction of DCV retained for partial infiltration condition	0.375	unitless
31	Is the retained DCV ≥ 0.375? If the answer is no increase the footprint sizing factor in Line 26 until the answer is yes for this criterion.	☑ Yes	☐ No

Note:

1. Line 7 is used to estimate the amount of volume retained by the BMP. Update assumed surface area in Line 7 until its equivalent to the required biofiltration footprint (either Line 21 or Line 23)
2. The DCV fraction of 0.375 is based on a 40% average annual percent capture and a 36-hour drawdown time.
3. The increase in footprint for volume reduction can be optimized using the approach presented in Appendix B.5.2. The optimized footprint cannot be smaller than the alternative minimum footprint sizing factor from Worksheet B.5-2.
4. If the proposed biofiltration BMP footprint is smaller than the alternative minimum footprint sizing factor from Worksheet B.5-2, but satisfies Option 1 or Option 2 sizing, it is considered a compact biofiltration BMP and may be allowed at the discretion of the City Engineer, if it meets the requirements in Appendix F.

Worksheet B.5-1: Simple Sizing Method for Biofiltration BMPs (DMA PR-2F)

Simple Sizing Method for Biofiltration BMPs		Worksheet B.5-1 (Page 1 of 2)	
1	Remaining DCV after implementing retention BMPs	1,450	cubic-feet
Partial Retention			
2	Infiltration rate from Worksheet D.5-1 if partial infiltration is feasible	0.125	in/hr.
3	Allowable drawdown time for aggregate storage below the underdrain	36	hours
4	Depth of runoff that can be infiltrated [Line 2 x Line 3]	4.5	inches
5	Aggregate pore space	0.40	in/in
6	Required depth of gravel below the underdrain [Line 4/ Line 5]	11.25	inches
7	Assumed surface area of the biofiltration BMP	1,036	sq-ft
8	Media retained pore storage	0.1	in/in
9	Volume retained by BMP [[Line 4 + (Line 12 x Line 8)]/12] x Line 7	544	cubic-feet
10	DCV that requires biofiltration [Line 1 – Line 9]	906	cubic-feet
BMP Parameters			
11	Surface Ponding [6 inch minimum, 12 inch maximum]	6	inches
12	Media Thickness [18 inches minimum], also add mulch layer thickness to this line for sizing calculations	18	inches
13	Aggregate Storage above underdrain invert (12 inches typical) – use 0 inches for sizing if the aggregate is not over the entire bottom surface area	18	inches
14	Freely drained pore storage	0.2	in/in
15	Media filtration rate to be used for sizing (5 in/hr. with no outlet control; if the filtration rate is controlled by the outlet use the outlet controlled rate which will be less than 5 in/hr.)	5	in/hr.
Baseline Calculations			
16	Allowable Routing Time for sizing	6	hours
17	Depth filtered during storm [Line 15 x Line 16]	30	inches
18	Depth of Detention Storage [Line 11 + (Line 12 x Line 14) + (Line 13 x Line 5)]	15	inches
19	Total Depth Treated [Line 17 + Line 18]	45	inches

Note: Line 7 is used to estimate the amount of volume retained by the BMP. Update assumed surface area in Line 7 until its equivalent to the required biofiltration footprint (either Line 21 or Line 23)

Worksheet B.5-1: Simple Sizing Method for Biofiltration BMPs (continued)

Simple Sizing Method for Biofiltration BMPs		Worksheet B.5-1 (Page 2 of 2)	
Option 1 – Biofilter 1.5 times the DCV			
20	Required biofiltered volume [1.5 x Line 10]	1,359	cubic-feet
21	Required Footprint [Line 20/ Line 19] x 12	363	sq-ft
Option 2 - Store 0.75 of remaining DCV in pores and ponding			
22	Required Storage (surface + pores) Volume [0.75 x Line 10]	680	cubic-feet
23	Required Footprint [Line 22/ Line 18] x 12	544	sq-ft
Footprint of the BMP			
24	Area draining to the BMP	74,330	sq-ft
25	Adjusted Runoff Factor for drainage area (Refer to Appendix B.1 and B.2)	0.42	
26	BMP Footprint Sizing Factor (Default 0.03 or an alternative minimum footprint sizing factor from Worksheet B.5-2, Line 11)	0.03	
27	Minimum BMP Footprint [Line 24 x Line 25 x Line 26]	947	sq-ft
28	Footprint of the BMP = Maximum(Minimum(Line 21, Line 23), Line 27)	947	sq-ft
Check for Volume Reduction [Not applicable for No Infiltration Condition]			
29	Calculate the fraction of DCV retained in the BMP [Line 9/Line 1]	0.375	unitless
30	Minimum required fraction of DCV retained for partial infiltration condition	0.375	unitless
31	Is the retained DCV ≥ 0.375? If the answer is no increase the footprint sizing factor in Line 26 until the answer is yes for this criterion.	☑ Yes	☐ No

Note:

1. Line 7 is used to estimate the amount of volume retained by the BMP. Update assumed surface area in Line 7 until its equivalent to the required biofiltration footprint (either Line 21 or Line 23)
2. The DCV fraction of 0.375 is based on a 40% average annual percent capture and a 36-hour drawdown time.
3. The increase in footprint for volume reduction can be optimized using the approach presented in Appendix B.5.2. The optimized footprint cannot be smaller than the alternative minimum footprint sizing factor from Worksheet B.5-2.
4. If the proposed biofiltration BMP footprint is smaller than the alternative minimum footprint sizing factor from Worksheet B.5-2, but satisfies Option 1 or Option 2 sizing, it is considered a compact biofiltration BMP and may be allowed at the discretion of the City Engineer, if it meets the requirements in Appendix F.

Worksheet B.5-1: Simple Sizing Method for Biofiltration BMPs (DMA PR-2H)

Simple Sizing Method for Biofiltration BMPs		Worksheet B.5-1 (Page 1 of 2)	
1	Remaining DCV after implementing retention BMPs	2,691	cubic-feet
Partial Retention			
2	Infiltration rate from Worksheet D.5-1 if partial infiltration is feasible	0.125	in/hr.
3	Allowable drawdown time for aggregate storage below the underdrain	36	hours
4	Depth of runoff that can be infiltrated [Line 2 x Line 3]	4.5	inches
5	Aggregate pore space	0.40	in/in
6	Required depth of gravel below the underdrain [Line 4/ Line 5]	11.25	inches
7	Assumed surface area of the biofiltration BMP	1,922	sq-ft
8	Media retained pore storage	0.1	in/in
9	Volume retained by BMP [[Line 4 + (Line 12 x Line 8)]/12] x Line 7	1,009	cubic-feet
10	DCV that requires biofiltration [Line 1 – Line 9]	1,682	cubic-feet
BMP Parameters			
11	Surface Ponding [6 inch minimum, 12 inch maximum]	6	inches
12	Media Thickness [18 inches minimum], also add mulch layer thickness to this line for sizing calculations	18	inches
13	Aggregate Storage above underdrain invert (12 inches typical) – use 0 inches for sizing if the aggregate is not over the entire bottom surface area	18	inches
14	Freely drained pore storage	0.2	in/in
15	Media filtration rate to be used for sizing (5 in/hr. with no outlet control; if the filtration rate is controlled by the outlet use the outlet controlled rate which will be less than 5 in/hr.)	5	in/hr.
Baseline Calculations			
16	Allowable Routing Time for sizing	6	hours
17	Depth filtered during storm [Line 15 x Line 16]	30	inches
18	Depth of Detention Storage [Line 11 + (Line 12 x Line 14) + (Line 13 x Line 5)]	15	inches
19	Total Depth Treated [Line 17 + Line 18]	45	inches

Note: Line 7 is used to estimate the amount of volume retained by the BMP. Update assumed surface area in Line 7 until its equivalent to the required biofiltration footprint (either Line 21 or Line 23)

Worksheet B.5-1: Simple Sizing Method for Biofiltration BMPs (continued)

Simple Sizing Method for Biofiltration BMPs		Worksheet B.5-1 (Page 2 of 2)	
Option 1 – Biofilter 1.5 times the DCV			
20	Required biofiltered volume [1.5 x Line 10]	2,523	cubic-feet
21	Required Footprint [Line 20/ Line 19] x 12	673	sq-ft
Option 2 - Store 0.75 of remaining DCV in pores and ponding			
22	Required Storage (surface + pores) Volume [0.75 x Line 10]	1,261	cubic-feet
23	Required Footprint [Line 22/ Line 18] x 12	1,009	sq-ft
Footprint of the BMP			
24	Area draining to the BMP	38,645	sq-ft
25	Adjusted Runoff Factor for drainage area (Refer to Appendix B.1 and B.2)	0.40	
26	BMP Footprint Sizing Factor (Default 0.03 or an alternative minimum footprint sizing factor from Worksheet B.5-2, Line 11)	0.03	
27	Minimum BMP Footprint [Line 24 x Line 25 x Line 26]	1,761	sq-ft
28	Footprint of the BMP = Maximum(Minimum(Line 21, Line 23), Line 27)	1,761	sq-ft
Check for Volume Reduction [Not applicable for No Infiltration Condition]			
29	Calculate the fraction of DCV retained in the BMP [Line 9/Line 1]	0.375	unitless
30	Minimum required fraction of DCV retained for partial infiltration condition	0.375	unitless
31	Is the retained DCV ≥ 0.375? If the answer is no increase the footprint sizing factor in Line 26 until the answer is yes for this criterion.	☑ Yes	☐ No

Note:

1. Line 7 is used to estimate the amount of volume retained by the BMP. Update assumed surface area in Line 7 until its equivalent to the required biofiltration footprint (either Line 21 or Line 23)
2. The DCV fraction of 0.375 is based on a 40% average annual percent capture and a 36-hour drawdown time.
3. The increase in footprint for volume reduction can be optimized using the approach presented in Appendix B.5.2. The optimized footprint cannot be smaller than the alternative minimum footprint sizing factor from Worksheet B.5-2.
4. If the proposed biofiltration BMP footprint is smaller than the alternative minimum footprint sizing factor from Worksheet B.5-2, but satisfies Option 1 or Option 2 sizing, it is considered a compact biofiltration BMP and may be allowed at the discretion of the City Engineer, if it meets the requirements in Appendix F.

Worksheet B.5-1: Simple Sizing Method for Biofiltration BMPs (DMA PR-2J)

Simple Sizing Method for Biofiltration BMPs		Worksheet B.5-1 (Page 1 of 2)	
1	Remaining DCV after implementing retention BMPs	705	cubic-feet
Partial Retention			
2	Infiltration rate from Worksheet D.5-1 if partial infiltration is feasible	0.125	in/hr.
3	Allowable drawdown time for aggregate storage below the underdrain	36	hours
4	Depth of runoff that can be infiltrated [Line 2 x Line 3]	4.5	inches
5	Aggregate pore space	0.40	in/in
6	Required depth of gravel below the underdrain [Line 4/ Line 5]	11.25	inches
7	Assumed surface area of the biofiltration BMP	504	sq-ft
8	Media retained pore storage	0.1	in/in
9	Volume retained by BMP [[Line 4 + (Line 12 x Line 8)]/12] x Line 7	264	cubic-feet
10	DCV that requires biofiltration [Line 1 – Line 9]	441	cubic-feet
BMP Parameters			
11	Surface Ponding [6 inch minimum, 12 inch maximum]	6	inches
12	Media Thickness [18 inches minimum], also add mulch layer thickness to this line for sizing calculations	18	inches
13	Aggregate Storage above underdrain invert (12 inches typical) – use 0 inches for sizing if the aggregate is not over the entire bottom surface area	18	inches
14	Freely drained pore storage	0.2	in/in
15	Media filtration rate to be used for sizing (5 in/hr. with no outlet control; if the filtration rate is controlled by the outlet use the outlet controlled rate which will be less than 5 in/hr.)	5	in/hr.
Baseline Calculations			
16	Allowable Routing Time for sizing	6	hours
17	Depth filtered during storm [Line 15 x Line 16]	30	inches
18	Depth of Detention Storage [Line 11 + (Line 12 x Line 14) + (Line 13 x Line 5)]	15	inches
19	Total Depth Treated [Line 17 + Line 18]	45	inches

Note: Line 7 is used to estimate the amount of volume retained by the BMP. Update assumed surface area in Line 7 until its equivalent to the required biofiltration footprint (either Line 21 or Line 23)

Worksheet B.5-1: Simple Sizing Method for Biofiltration BMPs (continued)

Simple Sizing Method for Biofiltration BMPs		Worksheet B.5-1 (Page 2 of 2)	
Option 1 – Biofilter 1.5 times the DCV			
20	Required biofiltered volume [1.5 x Line 10]	661	cubic-feet
21	Required Footprint [Line 20/ Line 19] x 12	176	sq-ft
Option 2 - Store 0.75 of remaining DCV in pores and ponding			
22	Required Storage (surface + pores) Volume [0.75 x Line 10]	330	cubic-feet
23	Required Footprint [Line 22/ Line 18] x 12	264	sq-ft
Footprint of the BMP			
24	Area draining to the BMP	38,645	sq-ft
25	Adjusted Runoff Factor for drainage area (Refer to Appendix B.1 and B.2)	0.40	
26	BMP Footprint Sizing Factor (Default 0.03 or an alternative minimum footprint sizing factor from Worksheet B.5-2, Line 11)	0.03	
27	Minimum BMP Footprint [Line 24 x Line 25 x Line 26]	460	sq-ft
28	Footprint of the BMP = Maximum(Minimum(Line 21, Line 23), Line 27)	460	sq-ft
Check for Volume Reduction [Not applicable for No Infiltration Condition]			
29	Calculate the fraction of DCV retained in the BMP [Line 9/Line 1]	0.375	unitless
30	Minimum required fraction of DCV retained for partial infiltration condition	0.375	unitless
31	Is the retained DCV ≥ 0.375? If the answer is no increase the footprint sizing factor in Line 26 until the answer is yes for this criterion.	☑ Yes	☐ No

Note:

1. Line 7 is used to estimate the amount of volume retained by the BMP. Update assumed surface area in Line 7 until its equivalent to the required biofiltration footprint (either Line 21 or Line 23)
2. The DCV fraction of 0.375 is based on a 40% average annual percent capture and a 36-hour drawdown time.
3. The increase in footprint for volume reduction can be optimized using the approach presented in Appendix B.5.2. The optimized footprint cannot be smaller than the alternative minimum footprint sizing factor from Worksheet B.5-2.
4. If the proposed biofiltration BMP footprint is smaller than the alternative minimum footprint sizing factor from Worksheet B.5-2, but satisfies Option 1 or Option 2 sizing, it is considered a compact biofiltration BMP and may be allowed at the discretion of the City Engineer, if it meets the requirements in Appendix F.

Worksheet B.5-1: Simple Sizing Method for Biofiltration BMPs (DMA PR-2K)

Simple Sizing Method for Biofiltration BMPs		Worksheet B.5-1 (Page 1 of 2)	
1	Remaining DCV after implementing retention BMPs	943	cubic-feet
Partial Retention			
2	Infiltration rate from Worksheet D.5-1 if partial infiltration is feasible	0.125	in/hr.
3	Allowable drawdown time for aggregate storage below the underdrain	36	hours
4	Depth of runoff that can be infiltrated [Line 2 x Line 3]	4.5	inches
5	Aggregate pore space	0.40	in/in
6	Required depth of gravel below the underdrain [Line 4/ Line 5]	11.25	inches
7	Assumed surface area of the biofiltration BMP	674	sq-ft
8	Media retained pore storage	0.1	in/in
9	Volume retained by BMP [[Line 4 + (Line 12 x Line 8)]/12] x Line 7	354	cubic-feet
10	DCV that requires biofiltration [Line 1 – Line 9]	589	cubic-feet
BMP Parameters			
11	Surface Ponding [6 inch minimum, 12 inch maximum]	6	inches
12	Media Thickness [18 inches minimum], also add mulch layer thickness to this line for sizing calculations	18	inches
13	Aggregate Storage above underdrain invert (12 inches typical) – use 0 inches for sizing if the aggregate is not over the entire bottom surface area	18	inches
14	Freely drained pore storage	0.2	in/in
15	Media filtration rate to be used for sizing (5 in/hr. with no outlet control; if the filtration rate is controlled by the outlet use the outlet controlled rate which will be less than 5 in/hr.)	5	in/hr.
Baseline Calculations			
16	Allowable Routing Time for sizing	6	hours
17	Depth filtered during storm [Line 15 x Line 16]	30	inches
18	Depth of Detention Storage [Line 11 + (Line 12 x Line 14) + (Line 13 x Line 5)]	15	inches
19	Total Depth Treated [Line 17 + Line 18]	45	inches

Note: Line 7 is used to estimate the amount of volume retained by the BMP. Update assumed surface area in Line 7 until its equivalent to the required biofiltration footprint (either Line 21 or Line 23)

Worksheet B.5-1: Simple Sizing Method for Biofiltration BMPs (continued)

Simple Sizing Method for Biofiltration BMPs		Worksheet B.5-1 (Page 2 of 2)	
Option 1 – Biofilter 1.5 times the DCV			
20	Required biofiltered volume [1.5 x Line 10]	884	cubic-feet
21	Required Footprint [Line 20/ Line 19] x 12	236	sq-ft
Option 2 - Store 0.75 of remaining DCV in pores and ponding			
22	Required Storage (surface + pores) Volume [0.75 x Line 10]	442	cubic-feet
23	Required Footprint [Line 22/ Line 18] x 12	354	sq-ft
Footprint of the BMP			
24	Area draining to the BMP	45,225	sq-ft
25	Adjusted Runoff Factor for drainage area (Refer to Appendix B.1 and B.2)	0.45	
26	BMP Footprint Sizing Factor (Default 0.03 or an alternative minimum footprint sizing factor from Worksheet B.5-2, Line 11)	0.03	
27	Minimum BMP Footprint [Line 24 x Line 25 x Line 26]	616	sq-ft
28	Footprint of the BMP = Maximum(Minimum(Line 21, Line 23), Line 27)	616	sq-ft
Check for Volume Reduction [Not applicable for No Infiltration Condition]			
29	Calculate the fraction of DCV retained in the BMP [Line 9/Line 1]	0.375	unitless
30	Minimum required fraction of DCV retained for partial infiltration condition	0.375	unitless
31	Is the retained DCV ≥ 0.375? If the answer is no increase the footprint sizing factor in Line 26 until the answer is yes for this criterion.	☑ Yes	☐ No

Note:

1. Line 7 is used to estimate the amount of volume retained by the BMP. Update assumed surface area in Line 7 until its equivalent to the required biofiltration footprint (either Line 21 or Line 23)
2. The DCV fraction of 0.375 is based on a 40% average annual percent capture and a 36-hour drawdown time.
3. The increase in footprint for volume reduction can be optimized using the approach presented in Appendix B.5.2. The optimized footprint cannot be smaller than the alternative minimum footprint sizing factor from Worksheet B.5-2.
4. If the proposed biofiltration BMP footprint is smaller than the alternative minimum footprint sizing factor from Worksheet B.5-2, but satisfies Option 1 or Option 2 sizing, it is considered a compact biofiltration BMP and may be allowed at the discretion of the City Engineer, if it meets the requirements in Appendix F.

Worksheet B.5-1: Simple Sizing Method for Biofiltration BMPs (DMA PR-2L)

Simple Sizing Method for Biofiltration BMPs		Worksheet B.5-1 (Page 1 of 2)	
1	Remaining DCV after implementing retention BMPs	1,217	cubic-feet
Partial Retention			
2	Infiltration rate from Worksheet D.5-1 if partial infiltration is feasible	0.125	in/hr.
3	Allowable drawdown time for aggregate storage below the underdrain	36	hours
4	Depth of runoff that can be infiltrated [Line 2 x Line 3]	4.5	inches
5	Aggregate pore space	0.40	in/in
6	Required depth of gravel below the underdrain [Line 4/ Line 5]	11.25	inches
7	Assumed surface area of the biofiltration BMP	869	sq-ft
8	Media retained pore storage	0.1	in/in
9	Volume retained by BMP [[Line 4 + (Line 12 x Line 8)]/12] x Line 7	456	cubic-feet
10	DCV that requires biofiltration [Line 1 – Line 9]	761	cubic-feet
BMP Parameters			
11	Surface Ponding [6 inch minimum, 12 inch maximum]	6	inches
12	Media Thickness [18 inches minimum], also add mulch layer thickness to this line for sizing calculations	18	inches
13	Aggregate Storage above underdrain invert (12 inches typical) – use 0 inches for sizing if the aggregate is not over the entire bottom surface area	18	inches
14	Freely drained pore storage	0.2	in/in
15	Media filtration rate to be used for sizing (5 in/hr. with no outlet control; if the filtration rate is controlled by the outlet use the outlet controlled rate which will be less than 5 in/hr.)	5	in/hr.
Baseline Calculations			
16	Allowable Routing Time for sizing	6	hours
17	Depth filtered during storm [Line 15 x Line 16]	30	inches
18	Depth of Detention Storage [Line 11 + (Line 12 x Line 14) + (Line 13 x Line 5)]	15	inches
19	Total Depth Treated [Line 17 + Line 18]	45	inches

Note: Line 7 is used to estimate the amount of volume retained by the BMP. Update assumed surface area in Line 7 until its equivalent to the required biofiltration footprint (either Line 21 or Line 23)

Worksheet B.5-1: Simple Sizing Method for Biofiltration BMPs (continued)

Simple Sizing Method for Biofiltration BMPs		Worksheet B.5-1 (Page 2 of 2)	
Option 1 – Biofilter 1.5 times the DCV			
20	Required biofiltered volume [1.5 x Line 10]	1,141	cubic-feet
21	Required Footprint [Line 20/ Line 19] x 12	304	sq-ft
Option 2 - Store 0.75 of remaining DCV in pores and ponding			
22	Required Storage (surface + pores) Volume [0.75 x Line 10]	570	cubic-feet
23	Required Footprint [Line 22/ Line 18] x 12	456	sq-ft
Footprint of the BMP			
24	Area draining to the BMP	77,120	sq-ft
25	Adjusted Runoff Factor for drainage area (Refer to Appendix B.1 and B.2)	0.34	
26	BMP Footprint Sizing Factor (Default 0.03 or an alternative minimum footprint sizing factor from Worksheet B.5-2, Line 11)	0.03	
27	Minimum BMP Footprint [Line 24 x Line 25 x Line 26]	797	sq-ft
28	Footprint of the BMP = Maximum(Minimum(Line 21, Line 23), Line 27)	797	sq-ft
Check for Volume Reduction [Not applicable for No Infiltration Condition]			
29	Calculate the fraction of DCV retained in the BMP [Line 9/Line 1]	0.375	unitless
30	Minimum required fraction of DCV retained for partial infiltration condition	0.375	unitless
31	Is the retained DCV ≥ 0.375? If the answer is no increase the footprint sizing factor in Line 26 until the answer is yes for this criterion.	☑ Yes	☐ No

Note:

1. Line 7 is used to estimate the amount of volume retained by the BMP. Update assumed surface area in Line 7 until its equivalent to the required biofiltration footprint (either Line 21 or Line 23)
2. The DCV fraction of 0.375 is based on a 40% average annual percent capture and a 36-hour drawdown time.
3. The increase in footprint for volume reduction can be optimized using the approach presented in Appendix B.5.2. The optimized footprint cannot be smaller than the alternative minimum footprint sizing factor from Worksheet B.5-2.
4. If the proposed biofiltration BMP footprint is smaller than the alternative minimum footprint sizing factor from Worksheet B.5-2, but satisfies Option 1 or Option 2 sizing, it is considered a compact biofiltration BMP and may be allowed at the discretion of the City Engineer, if it meets the requirements in Appendix F.

Worksheet B.5-1: Simple Sizing Method for Biofiltration BMPs (DMA PR-3A)

Simple Sizing Method for Biofiltration BMPs		Worksheet B.5-1 (Page 1 of 2)	
1	Remaining DCV after implementing retention BMPs	8,277	cubic-feet
Partial Retention			
2	Infiltration rate from Worksheet D.5-1 if partial infiltration is feasible	0.125	in/hr.
3	Allowable drawdown time for aggregate storage below the underdrain	36	hours
4	Depth of runoff that can be infiltrated [Line 2 x Line 3]	4.5	inches
5	Aggregate pore space	0.40	in/in
6	Required depth of gravel below the underdrain [Line 4/ Line 5]	11.25	inches
7	Assumed surface area of the biofiltration BMP	5,912	sq-ft
8	Media retained pore storage	0.1	in/in
9	Volume retained by BMP [[Line 4 + (Line 12 x Line 8)]/12] x Line 7	3,104	cubic-feet
10	DCV that requires biofiltration [Line 1 – Line 9]	5,173	cubic-feet
BMP Parameters			
11	Surface Ponding [6 inch minimum, 12 inch maximum]	6	inches
12	Media Thickness [18 inches minimum], also add mulch layer thickness to this line for sizing calculations	18	inches
13	Aggregate Storage above underdrain invert (12 inches typical) – use 0 inches for sizing if the aggregate is not over the entire bottom surface area	18	inches
14	Freely drained pore storage	0.2	in/in
15	Media filtration rate to be used for sizing (5 in/hr. with no outlet control; if the filtration rate is controlled by the outlet use the outlet controlled rate which will be less than 5 in/hr.)	5	in/hr.
Baseline Calculations			
16	Allowable Routing Time for sizing	6	hours
17	Depth filtered during storm [Line 15 x Line 16]	30	inches
18	Depth of Detention Storage [Line 11 + (Line 12 x Line 14) + (Line 13 x Line 5)]	15	inches
19	Total Depth Treated [Line 17 + Line 18]	45	inches

Note: Line 7 is used to estimate the amount of volume retained by the BMP. Update assumed surface area in Line 7 until its equivalent to the required biofiltration footprint (either Line 21 or Line 23)

Worksheet B.5-1: Simple Sizing Method for Biofiltration BMPs (continued)

Simple Sizing Method for Biofiltration BMPs		Worksheet B.5-1 (Page 2 of 2)	
Option 1 – Biofilter 1.5 times the DCV			
20	Required biofiltered volume [1.5 x Line 10]	7,760	cubic-feet
21	Required Footprint [Line 20/ Line 19] x 12	2,069	sq-ft
Option 2 - Store 0.75 of remaining DCV in pores and ponding			
22	Required Storage (surface + pores) Volume [0.75 x Line 10]	3,880	cubic-feet
23	Required Footprint [Line 22/ Line 18] x 12	3,104	sq-ft
Footprint of the BMP			
24	Area draining to the BMP	665,495	sq-ft
25	Adjusted Runoff Factor for drainage area (Refer to Appendix B.1 and B.2)	0.27	
26	BMP Footprint Sizing Factor (Default 0.03 or an alternative minimum footprint sizing factor from Worksheet B.5-2, Line 11)	0.03	
27	Minimum BMP Footprint [Line 24 x Line 25 x Line 26]	5,417	sq-ft
28	Footprint of the BMP = Maximum(Minimum(Line 21, Line 23), Line 27)	5,417	sq-ft
Check for Volume Reduction [Not applicable for No Infiltration Condition]			
29	Calculate the fraction of DCV retained in the BMP [Line 9/Line 1]	0.375	unitless
30	Minimum required fraction of DCV retained for partial infiltration condition	0.375	unitless
31	Is the retained DCV ≥ 0.375? If the answer is no increase the footprint sizing factor in Line 26 until the answer is yes for this criterion.	☑ Yes	☐ No

Note:

1. Line 7 is used to estimate the amount of volume retained by the BMP. Update assumed surface area in Line 7 until its equivalent to the required biofiltration footprint (either Line 21 or Line 23)
2. The DCV fraction of 0.375 is based on a 40% average annual percent capture and a 36-hour drawdown time.
3. The increase in footprint for volume reduction can be optimized using the approach presented in Appendix B.5.2. The optimized footprint cannot be smaller than the alternative minimum footprint sizing factor from Worksheet B.5-2.
4. If the proposed biofiltration BMP footprint is smaller than the alternative minimum footprint sizing factor from Worksheet B.5-2, but satisfies Option 1 or Option 2 sizing, it is considered a compact biofiltration BMP and may be allowed at the discretion of the City Engineer, if it meets the requirements in Appendix F.

Worksheet B.5-1: Simple Sizing Method for Biofiltration BMPs (DMA PR-3A1)

Simple Sizing Method for Biofiltration BMPs		Worksheet B.5-1 (Page 1 of 2)	
1	Remaining DCV after implementing retention BMPs	8,277	cubic-feet
Partial Retention			
2	Infiltration rate from Worksheet D.5-1 if partial infiltration is feasible	0.125	in/hr.
3	Allowable drawdown time for aggregate storage below the underdrain	36	hours
4	Depth of runoff that can be infiltrated [Line 2 x Line 3]	4.5	inches
5	Aggregate pore space	0.40	in/in
6	Required depth of gravel below the underdrain [Line 4/ Line 5]	11.25	inches
7	Assumed surface area of the biofiltration BMP	5,912	sq-ft
8	Media retained pore storage	0.1	in/in
9	Volume retained by BMP [[Line 4 + (Line 12 x Line 8)]/12] x Line 7	3,104	cubic-feet
10	DCV that requires biofiltration [Line 1 – Line 9]	5,173	cubic-feet
BMP Parameters			
11	Surface Ponding [6 inch minimum, 12 inch maximum]	6	inches
12	Media Thickness [18 inches minimum], also add mulch layer thickness to this line for sizing calculations	18	inches
13	Aggregate Storage above underdrain invert (12 inches typical) – use 0 inches for sizing if the aggregate is not over the entire bottom surface area	18	inches
14	Freely drained pore storage	0.2	in/in
15	Media filtration rate to be used for sizing (5 in/hr. with no outlet control; if the filtration rate is controlled by the outlet use the outlet controlled rate which will be less than 5 in/hr.)	5	in/hr.
Baseline Calculations			
16	Allowable Routing Time for sizing	6	hours
17	Depth filtered during storm [Line 15 x Line 16]	30	inches
18	Depth of Detention Storage [Line 11 + (Line 12 x Line 14) + (Line 13 x Line 5)]	15	inches
19	Total Depth Treated [Line 17 + Line 18]	45	inches

Note: Line 7 is used to estimate the amount of volume retained by the BMP. Update assumed surface area in Line 7 until its equivalent to the required biofiltration footprint (either Line 21 or Line 23)

Worksheet B.5-1: Simple Sizing Method for Biofiltration BMPs (continued)

Simple Sizing Method for Biofiltration BMPs		Worksheet B.5-1 (Page 2 of 2)	
Option 1 – Biofilter 1.5 times the DCV			
20	Required biofiltered volume [1.5 x Line 10]	7,760	cubic-feet
21	Required Footprint [Line 20/ Line 19] x 12	2,069	sq-ft
Option 2 - Store 0.75 of remaining DCV in pores and ponding			
22	Required Storage (surface + pores) Volume [0.75 x Line 10]	3,880	cubic-feet
23	Required Footprint [Line 22/ Line 18] x 12	3,104	sq-ft
Footprint of the BMP			
24	Area draining to the BMP	665,495	sq-ft
25	Adjusted Runoff Factor for drainage area (Refer to Appendix B.1 and B.2)	0.27	
26	BMP Footprint Sizing Factor (Default 0.03 or an alternative minimum footprint sizing factor from Worksheet B.5-2, Line 11)	0.03	
27	Minimum BMP Footprint [Line 24 x Line 25 x Line 26]	5,417	sq-ft
28	Footprint of the BMP = Maximum(Minimum(Line 21, Line 23), Line 27)	5,417	sq-ft
Check for Volume Reduction [Not applicable for No Infiltration Condition]			
29	Calculate the fraction of DCV retained in the BMP [Line 9/Line 1]	0.375	unitless
30	Minimum required fraction of DCV retained for partial infiltration condition	0.375	unitless
31	Is the retained DCV ≥ 0.375? If the answer is no increase the footprint sizing factor in Line 26 until the answer is yes for this criterion.	☑ Yes	☐ No

Note:

1. Line 7 is used to estimate the amount of volume retained by the BMP. Update assumed surface area in Line 7 until its equivalent to the required biofiltration footprint (either Line 21 or Line 23)
2. The DCV fraction of 0.375 is based on a 40% average annual percent capture and a 36-hour drawdown time.
3. The increase in footprint for volume reduction can be optimized using the approach presented in Appendix B.5.2. The optimized footprint cannot be smaller than the alternative minimum footprint sizing factor from Worksheet B.5-2.
4. If the proposed biofiltration BMP footprint is smaller than the alternative minimum footprint sizing factor from Worksheet B.5-2, but satisfies Option 1 or Option 2 sizing, it is considered a compact biofiltration BMP and may be allowed at the discretion of the City Engineer, if it meets the requirements in Appendix F.

Worksheet B.5-1: Simple Sizing Method for Biofiltration BMPs (DMA PR-3B)

Simple Sizing Method for Biofiltration BMPs		Worksheet B.5-1 (Page 1 of 2)	
1	Remaining DCV after implementing retention BMPs	13,964	cubic-feet
Partial Retention			
2	Infiltration rate from Worksheet D.5-1 if partial infiltration is feasible	0.125	in/hr.
3	Allowable drawdown time for aggregate storage below the underdrain	36	hours
4	Depth of runoff that can be infiltrated [Line 2 x Line 3]	4.5	inches
5	Aggregate pore space	0.40	in/in
6	Required depth of gravel below the underdrain [Line 4/ Line 5]	11.25	inches
7	Assumed surface area of the biofiltration BMP	9,974	sq-ft
8	Media retained pore storage	0.1	in/in
9	Volume retained by BMP [[Line 4 + (Line 12 x Line 8)]/12] x Line 7	5,237	cubic-feet
10	DCV that requires biofiltration [Line 1 – Line 9]	8,728	cubic-feet
BMP Parameters			
11	Surface Ponding [6 inch minimum, 12 inch maximum]	6	inches
12	Media Thickness [18 inches minimum], also add mulch layer thickness to this line for sizing calculations	18	inches
13	Aggregate Storage above underdrain invert (12 inches typical) – use 0 inches for sizing if the aggregate is not over the entire bottom surface area	18	inches
14	Freely drained pore storage	0.2	in/in
15	Media filtration rate to be used for sizing (5 in/hr. with no outlet control; if the filtration rate is controlled by the outlet use the outlet controlled rate which will be less than 5 in/hr.)	5	in/hr.
Baseline Calculations			
16	Allowable Routing Time for sizing	6	hours
17	Depth filtered during storm [Line 15 x Line 16]	30	inches
18	Depth of Detention Storage [Line 11 + (Line 12 x Line 14) + (Line 13 x Line 5)]	15	inches
19	Total Depth Treated [Line 17 + Line 18]	45	inches

Note: Line 7 is used to estimate the amount of volume retained by the BMP. Update assumed surface area in Line 7 until its equivalent to the required biofiltration footprint (either Line 21 or Line 23)

Worksheet B.5-1: Simple Sizing Method for Biofiltration BMPs (continued)

	Simple Sizing Method for Biofiltration BMPs	Worksheet B.5-1 (Page 2 of 2)	
Option 1 – Biofilter 1.5 times the DCV			
20	Required biofiltered volume [1.5 x Line 10]	13,091	cubic-feet
21	Required Footprint [Line 20/ Line 19] x 12	3,491	sq-ft
Option 2 - Store 0.75 of remaining DCV in pores and ponding			
22	Required Storage (surface + pores) Volume [0.75 x Line 10]	6,546	cubic-feet
23	Required Footprint [Line 22/ Line 18] x 12	5,237	sq-ft
Footprint of the BMP			
24	Area draining to the BMP	12,176,075	sq-ft
25	Adjusted Runoff Factor for drainage area (Refer to Appendix B.1 and B.2)	0.14	
26	BMP Footprint Sizing Factor (Default 0.03 or an alternative minimum footprint sizing factor from Worksheet B.5-2, Line 11)	0.03	
27	Minimum BMP Footprint [Line 24 x Line 25 x Line 26]	9,140	sq-ft
28	Footprint of the BMP = Maximum(Minimum(Line 21, Line 23), Line 27)	9,140	sq-ft
Check for Volume Reduction [Not applicable for No Infiltration Condition]			
29	Calculate the fraction of DCV retained in the BMP [Line 9/Line 1]	0.375	unitless
30	Minimum required fraction of DCV retained for partial infiltration condition	0.375	unitless
31	Is the retained DCV ≥ 0.375? If the answer is no increase the footprint sizing factor in Line 26 until the answer is yes for this criterion.	☑ Yes	☐ No

Note:

1. Line 7 is used to estimate the amount of volume retained by the BMP. Update assumed surface area in Line 7 until its equivalent to the required biofiltration footprint (either Line 21 or Line 23)
2. The DCV fraction of 0.375 is based on a 40% average annual percent capture and a 36-hour drawdown time.
3. The increase in footprint for volume reduction can be optimized using the approach presented in Appendix B.5.2. The optimized footprint cannot be smaller than the alternative minimum footprint sizing factor from Worksheet B.5-2.
4. If the proposed biofiltration BMP footprint is smaller than the alternative minimum footprint sizing factor from Worksheet B.5-2, but satisfies Option 1 or Option 2 sizing, it is considered a compact biofiltration BMP and may be allowed at the discretion of the City Engineer, if it meets the requirements in Appendix F.

Worksheet B.5-1: Simple Sizing Method for Biofiltration BMPs (DMA PR-3B1)

Simple Sizing Method for Biofiltration BMPs		Worksheet B.5-1 (Page 1 of 2)	
1	Remaining DCV after implementing retention BMPs	13,964	cubic-feet
Partial Retention			
2	Infiltration rate from Worksheet D.5-1 if partial infiltration is feasible	0.125	in/hr.
3	Allowable drawdown time for aggregate storage below the underdrain	36	hours
4	Depth of runoff that can be infiltrated [Line 2 x Line 3]	4.5	inches
5	Aggregate pore space	0.40	in/in
6	Required depth of gravel below the underdrain [Line 4/ Line 5]	11.25	inches
7	Assumed surface area of the biofiltration BMP	9,974	sq-ft
8	Media retained pore storage	0.1	in/in
9	Volume retained by BMP [[Line 4 + (Line 12 x Line 8)]/12] x Line 7	5,237	cubic-feet
10	DCV that requires biofiltration [Line 1 – Line 9]	8,728	cubic-feet
BMP Parameters			
11	Surface Ponding [6 inch minimum, 12 inch maximum]	6	inches
12	Media Thickness [18 inches minimum], also add mulch layer thickness to this line for sizing calculations	18	inches
13	Aggregate Storage above underdrain invert (12 inches typical) – use 0 inches for sizing if the aggregate is not over the entire bottom surface area	18	inches
14	Freely drained pore storage	0.2	in/in
15	Media filtration rate to be used for sizing (5 in/hr. with no outlet control; if the filtration rate is controlled by the outlet use the outlet controlled rate which will be less than 5 in/hr.)	5	in/hr.
Baseline Calculations			
16	Allowable Routing Time for sizing	6	hours
17	Depth filtered during storm [Line 15 x Line 16]	30	inches
18	Depth of Detention Storage [Line 11 + (Line 12 x Line 14) + (Line 13 x Line 5)]	15	inches
19	Total Depth Treated [Line 17 + Line 18]	45	inches

Note: Line 7 is used to estimate the amount of volume retained by the BMP. Update assumed surface area in Line 7 until its equivalent to the required biofiltration footprint (either Line 21 or Line 23)

Worksheet B.5-1: Simple Sizing Method for Biofiltration BMPs (continued)

Simple Sizing Method for Biofiltration BMPs		Worksheet B.5-1 (Page 2 of 2)	
Option 1 – Biofilter 1.5 times the DCV			
20	Required biofiltered volume [1.5 x Line 10]	13,091	cubic-feet
21	Required Footprint [Line 20/ Line 19] x 12	3,491	sq-ft
Option 2 - Store 0.75 of remaining DCV in pores and ponding			
22	Required Storage (surface + pores) Volume [0.75 x Line 10]	6,546	cubic-feet
23	Required Footprint [Line 22/ Line 18] x 12	5,237	sq-ft
Footprint of the BMP			
24	Area draining to the BMP	12,176,075	sq-ft
25	Adjusted Runoff Factor for drainage area (Refer to Appendix B.1 and B.2)	0.14	
26	BMP Footprint Sizing Factor (Default 0.03 or an alternative minimum footprint sizing factor from Worksheet B.5-2, Line 11)	0.03	
27	Minimum BMP Footprint [Line 24 x Line 25 x Line 26]	9,140	sq-ft
28	Footprint of the BMP = Maximum(Minimum(Line 21, Line 23), Line 27)	9,140	sq-ft
Check for Volume Reduction [Not applicable for No Infiltration Condition]			
29	Calculate the fraction of DCV retained in the BMP [Line 9/Line 1]	0.375	unitless
30	Minimum required fraction of DCV retained for partial infiltration condition	0.375	unitless
31	Is the retained DCV ≥ 0.375? If the answer is no increase the footprint sizing factor in Line 26 until the answer is yes for this criterion.	☑ Yes	☐ No

Note:

1. Line 7 is used to estimate the amount of volume retained by the BMP. Update assumed surface area in Line 7 until its equivalent to the required biofiltration footprint (either Line 21 or Line 23)
2. The DCV fraction of 0.375 is based on a 40% average annual percent capture and a 36-hour drawdown time.
3. The increase in footprint for volume reduction can be optimized using the approach presented in Appendix B.5.2. The optimized footprint cannot be smaller than the alternative minimum footprint sizing factor from Worksheet B.5-2.
4. If the proposed biofiltration BMP footprint is smaller than the alternative minimum footprint sizing factor from Worksheet B.5-2, but satisfies Option 1 or Option 2 sizing, it is considered a compact biofiltration BMP and may be allowed at the discretion of the City Engineer, if it meets the requirements in Appendix F.

Worksheet B.5-1: Simple Sizing Method for Biofiltration BMPs (DMA PR-3C)

Simple Sizing Method for Biofiltration BMPs		Worksheet B.5-1 (Page 1 of 2)	
1	Remaining DCV after implementing retention BMPs	7,855	cubic-feet
Partial Retention			
2	Infiltration rate from Worksheet D.5-1 if partial infiltration is feasible	0.125	in/hr.
3	Allowable drawdown time for aggregate storage below the underdrain	36	hours
4	Depth of runoff that can be infiltrated [Line 2 x Line 3]	4.5	inches
5	Aggregate pore space	0.40	in/in
6	Required depth of gravel below the underdrain [Line 4/ Line 5]	11.25	inches
7	Assumed surface area of the biofiltration BMP	5,611	sq-ft
8	Media retained pore storage	0.1	in/in
9	Volume retained by BMP [[Line 4 + (Line 12 x Line 8)]/12] x Line 7	2,946	cubic-feet
10	DCV that requires biofiltration [Line 1 – Line 9]	4,909	cubic-feet
BMP Parameters			
11	Surface Ponding [6 inch minimum, 12 inch maximum]	6	inches
12	Media Thickness [18 inches minimum], also add mulch layer thickness to this line for sizing calculations	18	inches
13	Aggregate Storage above underdrain invert (12 inches typical) – use 0 inches for sizing if the aggregate is not over the entire bottom surface area	18	inches
14	Freely drained pore storage	0.2	in/in
15	Media filtration rate to be used for sizing (5 in/hr. with no outlet control; if the filtration rate is controlled by the outlet use the outlet controlled rate which will be less than 5 in/hr.)	5	in/hr.
Baseline Calculations			
16	Allowable Routing Time for sizing	6	hours
17	Depth filtered during storm [Line 15 x Line 16]	30	inches
18	Depth of Detention Storage [Line 11 + (Line 12 x Line 14) + (Line 13 x Line 5)]	15	inches
19	Total Depth Treated [Line 17 + Line 18]	45	inches

Note: Line 7 is used to estimate the amount of volume retained by the BMP. Update assumed surface area in Line 7 until its equivalent to the required biofiltration footprint (either Line 21 or Line 23)

Worksheet B.5-1: Simple Sizing Method for Biofiltration BMPs (continued)

Simple Sizing Method for Biofiltration BMPs		Worksheet B.5-1 (Page 2 of 2)	
Option 1 – Biofilter 1.5 times the DCV			
20	Required biofiltered volume [1.5 x Line 10]	7,364	cubic-feet
21	Required Footprint [Line 20/ Line 19] x 12	1,964	sq-ft
Option 2 - Store 0.75 of remaining DCV in pores and ponding			
22	Required Storage (surface + pores) Volume [0.75 x Line 10]	3,682	cubic-feet
23	Required Footprint [Line 22/ Line 18] x 12	2,946	sq-ft
Footprint of the BMP			
24	Area draining to the BMP	676,647	sq-ft
25	Adjusted Runoff Factor for drainage area (Refer to Appendix B.1 and B.2)	0.25	
26	BMP Footprint Sizing Factor (Default 0.03 or an alternative minimum footprint sizing factor from Worksheet B.5-2, Line 11)	0.03	
27	Minimum BMP Footprint [Line 24 x Line 25 x Line 26]	5,143	sq-ft
28	Footprint of the BMP = Maximum(Minimum(Line 21, Line 23), Line 27)	5,143	sq-ft
Check for Volume Reduction [Not applicable for No Infiltration Condition]			
29	Calculate the fraction of DCV retained in the BMP [Line 9/Line 1]	0.375	unitless
30	Minimum required fraction of DCV retained for partial infiltration condition	0.375	unitless
31	Is the retained DCV ≥ 0.375? If the answer is no increase the footprint sizing factor in Line 26 until the answer is yes for this criterion.	☑ Yes	☐ No

Note:

1. Line 7 is used to estimate the amount of volume retained by the BMP. Update assumed surface area in Line 7 until its equivalent to the required biofiltration footprint (either Line 21 or Line 23)
2. The DCV fraction of 0.375 is based on a 40% average annual percent capture and a 36-hour drawdown time.
3. The increase in footprint for volume reduction can be optimized using the approach presented in Appendix B.5.2. The optimized footprint cannot be smaller than the alternative minimum footprint sizing factor from Worksheet B.5-2.
4. If the proposed biofiltration BMP footprint is smaller than the alternative minimum footprint sizing factor from Worksheet B.5-2, but satisfies Option 1 or Option 2 sizing, it is considered a compact biofiltration BMP and may be allowed at the discretion of the City Engineer, if it meets the requirements in Appendix F.

Worksheet B.5-1: Simple Sizing Method for Biofiltration BMPs (DMA PR-3C1)

Simple Sizing Method for Biofiltration BMPs		Worksheet B.5-1 (Page 1 of 2)	
1	Remaining DCV after implementing retention BMPs	4,341	cubic-feet
Partial Retention			
2	Infiltration rate from Worksheet D.5-1 if partial infiltration is feasible	0.125	in/hr.
3	Allowable drawdown time for aggregate storage below the underdrain	36	hours
4	Depth of runoff that can be infiltrated [Line 2 x Line 3]	4.5	inches
5	Aggregate pore space	0.40	in/in
6	Required depth of gravel below the underdrain [Line 4/ Line 5]	11.25	inches
7	Assumed surface area of the biofiltration BMP	3,101	sq-ft
8	Media retained pore storage	0.1	in/in
9	Volume retained by BMP [[Line 4 + (Line 12 x Line 8)]/12] x Line 7	1,628	cubic-feet
10	DCV that requires biofiltration [Line 1 – Line 9]	2,713	cubic-feet
BMP Parameters			
11	Surface Ponding [6 inch minimum, 12 inch maximum]	6	inches
12	Media Thickness [18 inches minimum], also add mulch layer thickness to this line for sizing calculations	18	inches
13	Aggregate Storage above underdrain invert (12 inches typical) – use 0 inches for sizing if the aggregate is not over the entire bottom surface area	18	inches
14	Freely drained pore storage	0.2	in/in
15	Media filtration rate to be used for sizing (5 in/hr. with no outlet control; if the filtration rate is controlled by the outlet use the outlet controlled rate which will be less than 5 in/hr.)	5	in/hr.
Baseline Calculations			
16	Allowable Routing Time for sizing	6	hours
17	Depth filtered during storm [Line 15 x Line 16]	30	inches
18	Depth of Detention Storage [Line 11 + (Line 12 x Line 14) + (Line 13 x Line 5)]	15	inches
19	Total Depth Treated [Line 17 + Line 18]	45	inches

Note: Line 7 is used to estimate the amount of volume retained by the BMP. Update assumed surface area in Line 7 until its equivalent to the required biofiltration footprint (either Line 21 or Line 23)

Worksheet B.5-1: Simple Sizing Method for Biofiltration BMPs (continued)

Simple Sizing Method for Biofiltration BMPs		Worksheet B.5-1 (Page 2 of 2)	
Option 1 – Biofilter 1.5 times the DCV			
20	Required biofiltered volume [1.5 x Line 10]	4,070	cubic-feet
21	Required Footprint [Line 20/ Line 19] x 12	1,085	sq-ft
Option 2 - Store 0.75 of remaining DCV in pores and ponding			
22	Required Storage (surface + pores) Volume [0.75 x Line 10]	2,035	cubic-feet
23	Required Footprint [Line 22/ Line 18] x 12	1,628	sq-ft
Footprint of the BMP			
24	Area draining to the BMP	676,647	sq-ft
25	Adjusted Runoff Factor for drainage area (Refer to Appendix B.1 and B.2)	0.25	
26	BMP Footprint Sizing Factor (Default 0.03 or an alternative minimum footprint sizing factor from Worksheet B.5-2, Line 11)	0.03	
27	Minimum BMP Footprint [Line 24 x Line 25 x Line 26]	2,842	sq-ft
28	Footprint of the BMP = Maximum(Minimum(Line 21, Line 23), Line 27)	2,842	sq-ft
Check for Volume Reduction [Not applicable for No Infiltration Condition]			
29	Calculate the fraction of DCV retained in the BMP [Line 9/Line 1]	0.375	unitless
30	Minimum required fraction of DCV retained for partial infiltration condition	0.375	unitless
31	Is the retained DCV ≥ 0.375? If the answer is no increase the footprint sizing factor in Line 26 until the answer is yes for this criterion.	☑ Yes	☐ No

Note:

1. Line 7 is used to estimate the amount of volume retained by the BMP. Update assumed surface area in Line 7 until its equivalent to the required biofiltration footprint (either Line 21 or Line 23)
2. The DCV fraction of 0.375 is based on a 40% average annual percent capture and a 36-hour drawdown time.
3. The increase in footprint for volume reduction can be optimized using the approach presented in Appendix B.5.2. The optimized footprint cannot be smaller than the alternative minimum footprint sizing factor from Worksheet B.5-2.
4. If the proposed biofiltration BMP footprint is smaller than the alternative minimum footprint sizing factor from Worksheet B.5-2, but satisfies Option 1 or Option 2 sizing, it is considered a compact biofiltration BMP and may be allowed at the discretion of the City Engineer, if it meets the requirements in Appendix F.

Worksheet B.5-1: Simple Sizing Method for Biofiltration BMPs (DMA PR-4A)

Simple Sizing Method for Biofiltration BMPs		Worksheet B.5-1 (Page 1 of 2)	
1	Remaining DCV after implementing retention BMPs	14,360	cubic-feet
Partial Retention			
2	Infiltration rate from Worksheet D.5-1 if partial infiltration is feasible	0.125	in/hr.
3	Allowable drawdown time for aggregate storage below the underdrain	36	hours
4	Depth of runoff that can be infiltrated [Line 2 x Line 3]	4.5	inches
5	Aggregate pore space	0.40	in/in
6	Required depth of gravel below the underdrain [Line 4/ Line 5]	11.25	inches
7	Assumed surface area of the biofiltration BMP	10,257	sq-ft
8	Media retained pore storage	0.1	in/in
9	Volume retained by BMP [[Line 4 + (Line 12 x Line 8)]/12] x Line 7	5,385	cubic-feet
10	DCV that requires biofiltration [Line 1 – Line 9]	8,975	cubic-feet
BMP Parameters			
11	Surface Ponding [6 inch minimum, 12 inch maximum]	6	inches
12	Media Thickness [18 inches minimum], also add mulch layer thickness to this line for sizing calculations	18	inches
13	Aggregate Storage above underdrain invert (12 inches typical) – use 0 inches for sizing if the aggregate is not over the entire bottom surface area	18	inches
14	Freely drained pore storage	0.2	in/in
15	Media filtration rate to be used for sizing (5 in/hr. with no outlet control; if the filtration rate is controlled by the outlet use the outlet controlled rate which will be less than 5 in/hr.)	5	in/hr.
Baseline Calculations			
16	Allowable Routing Time for sizing	6	hours
17	Depth filtered during storm [Line 15 x Line 16]	30	inches
18	Depth of Detention Storage [Line 11 + (Line 12 x Line 14) + (Line 13 x Line 5)]	15	inches
19	Total Depth Treated [Line 17 + Line 18]	45	inches

Note: Line 7 is used to estimate the amount of volume retained by the BMP. Update assumed surface area in Line 7 until its equivalent to the required biofiltration footprint (either Line 21 or Line 23)

Worksheet B.5-1: Simple Sizing Method for Biofiltration BMPs (continued)

Simple Sizing Method for Biofiltration BMPs		Worksheet B.5-1 (Page 2 of 2)	
Option 1 – Biofilter 1.5 times the DCV			
20	Required biofiltered volume [1.5 x Line 10]	13,463	cubic-feet
21	Required Footprint [Line 20/ Line 19] x 12	3,590	sq-ft
Option 2 - Store 0.75 of remaining DCV in pores and ponding			
22	Required Storage (surface + pores) Volume [0.75 x Line 10]	6,731	cubic-feet
23	Required Footprint [Line 22/ Line 18] x 12	5,385	sq-ft
Footprint of the BMP			
24	Area draining to the BMP	938,790	sq-ft
25	Adjusted Runoff Factor for drainage area (Refer to Appendix B.1 and B.2)	0.33	
26	BMP Footprint Sizing Factor (Default 0.03 or an alternative minimum footprint sizing factor from Worksheet B.5-2, Line 11)	0.03	
27	Minimum BMP Footprint [Line 24 x Line 25 x Line 26]	9,400	sq-ft
28	Footprint of the BMP = Maximum(Minimum(Line 21, Line 23), Line 27)	9,400	sq-ft
Check for Volume Reduction [Not applicable for No Infiltration Condition]			
29	Calculate the fraction of DCV retained in the BMP [Line 9/Line 1]	0.375	unitless
30	Minimum required fraction of DCV retained for partial infiltration condition	0.375	unitless
31	Is the retained DCV ≥ 0.375? If the answer is no increase the footprint sizing factor in Line 26 until the answer is yes for this criterion.	☑ Yes	☐ No

Note:

1. Line 7 is used to estimate the amount of volume retained by the BMP. Update assumed surface area in Line 7 until its equivalent to the required biofiltration footprint (either Line 21 or Line 23)
2. The DCV fraction of 0.375 is based on a 40% average annual percent capture and a 36-hour drawdown time.
3. The increase in footprint for volume reduction can be optimized using the approach presented in Appendix B.5.2. The optimized footprint cannot be smaller than the alternative minimum footprint sizing factor from Worksheet B.5-2.
4. If the proposed biofiltration BMP footprint is smaller than the alternative minimum footprint sizing factor from Worksheet B.5-2, but satisfies Option 1 or Option 2 sizing, it is considered a compact biofiltration BMP and may be allowed at the discretion of the City Engineer, if it meets the requirements in Appendix F.

Worksheet B.5-1: Simple Sizing Method for Biofiltration BMPs (DMA PR-4B)

Simple Sizing Method for Biofiltration BMPs		Worksheet B.5-1 (Page 1 of 2)	
1	Remaining DCV after implementing retention BMPs	1,865	cubic-feet
Partial Retention			
2	Infiltration rate from Worksheet D.5-1 if partial infiltration is feasible	0.125	in/hr.
3	Allowable drawdown time for aggregate storage below the underdrain	36	hours
4	Depth of runoff that can be infiltrated [Line 2 x Line 3]	4.5	inches
5	Aggregate pore space	0.40	in/in
6	Required depth of gravel below the underdrain [Line 4/ Line 5]	11.25	inches
7	Assumed surface area of the biofiltration BMP	1,332	sq-ft
8	Media retained pore storage	0.1	in/in
9	Volume retained by BMP [[Line 4 + (Line 12 x Line 8)]/12] x Line 7	699	cubic-feet
10	DCV that requires biofiltration [Line 1 – Line 9]	1,166	cubic-feet
BMP Parameters			
11	Surface Ponding [6 inch minimum, 12 inch maximum]	6	inches
12	Media Thickness [18 inches minimum], also add mulch layer thickness to this line for sizing calculations	18	inches
13	Aggregate Storage above underdrain invert (12 inches typical) – use 0 inches for sizing if the aggregate is not over the entire bottom surface area	18	inches
14	Freely drained pore storage	0.2	in/in
15	Media filtration rate to be used for sizing (5 in/hr. with no outlet control; if the filtration rate is controlled by the outlet use the outlet controlled rate which will be less than 5 in/hr.)	5	in/hr.
Baseline Calculations			
16	Allowable Routing Time for sizing	6	hours
17	Depth filtered during storm [Line 15 x Line 16]	30	inches
18	Depth of Detention Storage [Line 11 + (Line 12 x Line 14) + (Line 13 x Line 5)]	15	inches
19	Total Depth Treated [Line 17 + Line 18]	45	inches

Note: Line 7 is used to estimate the amount of volume retained by the BMP. Update assumed surface area in Line 7 until its equivalent to the required biofiltration footprint (either Line 21 or Line 23)

Worksheet B.5-1: Simple Sizing Method for Biofiltration BMPs (continued)

Simple Sizing Method for Biofiltration BMPs		Worksheet B.5-1 (Page 2 of 2)	
Option 1 – Biofilter 1.5 times the DCV			
20	Required biofiltered volume [1.5 x Line 10]	1,748	cubic-feet
21	Required Footprint [Line 20/ Line 19] x 12	466	sq-ft
Option 2 - Store 0.75 of remaining DCV in pores and ponding			
22	Required Storage (surface + pores) Volume [0.75 x Line 10]	6,731	cubic-feet
23	Required Footprint [Line 22/ Line 18] x 12	5,385	sq-ft
Footprint of the BMP			
24	Area draining to the BMP	95,590	sq-ft
25	Adjusted Runoff Factor for drainage area (Refer to Appendix B.1 and B.2)	0.43	
26	BMP Footprint Sizing Factor (Default 0.03 or an alternative minimum footprint sizing factor from Worksheet B.5-2, Line 11)	0.03	
27	Minimum BMP Footprint [Line 24 x Line 25 x Line 26]	1,223	sq-ft
28	Footprint of the BMP = Maximum(Minimum(Line 21, Line 23), Line 27)	1,223	sq-ft
Check for Volume Reduction [Not applicable for No Infiltration Condition]			
29	Calculate the fraction of DCV retained in the BMP [Line 9/Line 1]	0.375	unitless
30	Minimum required fraction of DCV retained for partial infiltration condition	0.375	unitless
31	Is the retained DCV ≥ 0.375? If the answer is no increase the footprint sizing factor in Line 26 until the answer is yes for this criterion.	☑ Yes	☐ No

Note:

1. Line 7 is used to estimate the amount of volume retained by the BMP. Update assumed surface area in Line 7 until its equivalent to the required biofiltration footprint (either Line 21 or Line 23)
2. The DCV fraction of 0.375 is based on a 40% average annual percent capture and a 36-hour drawdown time.
3. The increase in footprint for volume reduction can be optimized using the approach presented in Appendix B.5.2. The optimized footprint cannot be smaller than the alternative minimum footprint sizing factor from Worksheet B.5-2.
4. If the proposed biofiltration BMP footprint is smaller than the alternative minimum footprint sizing factor from Worksheet B.5-2, but satisfies Option 1 or Option 2 sizing, it is considered a compact biofiltration BMP and may be allowed at the discretion of the City Engineer, if it meets the requirements in Appendix F.

Worksheet B.5-1: Simple Sizing Method for Biofiltration BMPs (DMA PR-4C)

Simple Sizing Method for Biofiltration BMPs		Worksheet B.5-1 (Page 1 of 2)	
1	Remaining DCV after implementing retention BMPs	2,799	cubic-feet
Partial Retention			
2	Infiltration rate from Worksheet D.5-1 if partial infiltration is feasible	0.125	in/hr.
3	Allowable drawdown time for aggregate storage below the underdrain	36	hours
4	Depth of runoff that can be infiltrated [Line 2 x Line 3]	4.5	inches
5	Aggregate pore space	0.40	in/in
6	Required depth of gravel below the underdrain [Line 4/ Line 5]	11.25	inches
7	Assumed surface area of the biofiltration BMP	1,999	sq-ft
8	Media retained pore storage	0.1	in/in
9	Volume retained by BMP [[Line 4 + (Line 12 x Line 8)]/12] x Line 7	1,050	cubic-feet
10	DCV that requires biofiltration [Line 1 – Line 9]	1,749	cubic-feet
BMP Parameters			
11	Surface Ponding [6 inch minimum, 12 inch maximum]	6	inches
12	Media Thickness [18 inches minimum], also add mulch layer thickness to this line for sizing calculations	18	inches
13	Aggregate Storage above underdrain invert (12 inches typical) – use 0 inches for sizing if the aggregate is not over the entire bottom surface area	18	inches
14	Freely drained pore storage	0.2	in/in
15	Media filtration rate to be used for sizing (5 in/hr. with no outlet control; if the filtration rate is controlled by the outlet use the outlet controlled rate which will be less than 5 in/hr.)	5	in/hr.
Baseline Calculations			
16	Allowable Routing Time for sizing	6	hours
17	Depth filtered during storm [Line 15 x Line 16]	30	inches
18	Depth of Detention Storage [Line 11 + (Line 12 x Line 14) + (Line 13 x Line 5)]	15	inches
19	Total Depth Treated [Line 17 + Line 18]	45	inches

Note: Line 7 is used to estimate the amount of volume retained by the BMP. Update assumed surface area in Line 7 until its equivalent to the required biofiltration footprint (either Line 21 or Line 23)

Worksheet B.5-1: Simple Sizing Method for Biofiltration BMPs (continued)

Simple Sizing Method for Biofiltration BMPs		Worksheet B.5-1 (Page 2 of 2)	
Option 1 – Biofilter 1.5 times the DCV			
20	Required biofiltered volume [1.5 x Line 10]	2,624	cubic-feet
21	Required Footprint [Line 20/ Line 19] x 12	700	sq-ft
Option 2 - Store 0.75 of remaining DCV in pores and ponding			
22	Required Storage (surface + pores) Volume [0.75 x Line 10]	1,312	cubic-feet
23	Required Footprint [Line 22/ Line 18] x 12	1,050	sq-ft
Footprint of the BMP			
24	Area draining to the BMP	155,765	sq-ft
25	Adjusted Runoff Factor for drainage area (Refer to Appendix B.1 and B.2)	0.39	
26	BMP Footprint Sizing Factor (Default 0.03 or an alternative minimum footprint sizing factor from Worksheet B.5-2, Line 11)	0.03	
27	Minimum BMP Footprint [Line 24 x Line 25 x Line 26]	1,830	sq-ft
28	Footprint of the BMP = Maximum(Minimum(Line 21, Line 23), Line 27)	1,830	sq-ft
Check for Volume Reduction [Not applicable for No Infiltration Condition]			
29	Calculate the fraction of DCV retained in the BMP [Line 9/Line 1]	0.375	unitless
30	Minimum required fraction of DCV retained for partial infiltration condition	0.375	unitless
31	Is the retained DCV ≥ 0.375? If the answer is no increase the footprint sizing factor in Line 26 until the answer is yes for this criterion.	☑ Yes	☐ No

Note:

1. Line 7 is used to estimate the amount of volume retained by the BMP. Update assumed surface area in Line 7 until its equivalent to the required biofiltration footprint (either Line 21 or Line 23)
2. The DCV fraction of 0.375 is based on a 40% average annual percent capture and a 36-hour drawdown time.
3. The increase in footprint for volume reduction can be optimized using the approach presented in Appendix B.5.2. The optimized footprint cannot be smaller than the alternative minimum footprint sizing factor from Worksheet B.5-2.
4. If the proposed biofiltration BMP footprint is smaller than the alternative minimum footprint sizing factor from Worksheet B.5-2, but satisfies Option 1 or Option 2 sizing, it is considered a compact biofiltration BMP and may be allowed at the discretion of the City Engineer, if it meets the requirements in Appendix F.

Worksheet B.5-1: Simple Sizing Method for Biofiltration BMPs (DMA PR-4E)

Simple Sizing Method for Biofiltration BMPs		Worksheet B.5-1 (Page 1 of 2)	
1	Remaining DCV after implementing retention BMPs	15,466	cubic-feet
Partial Retention			
2	Infiltration rate from Worksheet D.5-1 if partial infiltration is feasible	0.125	in/hr.
3	Allowable drawdown time for aggregate storage below the underdrain	36	hours
4	Depth of runoff that can be infiltrated [Line 2 x Line 3]	4.5	inches
5	Aggregate pore space	0.40	in/in
6	Required depth of gravel below the underdrain [Line 4/ Line 5]	11.25	inches
7	Assumed surface area of the biofiltration BMP	11,033	sq-ft
8	Media retained pore storage	0.1	in/in
9	Volume retained by BMP [[Line 4 + (Line 12 x Line 8)]/12] x Line 7	5,792	cubic-feet
10	DCV that requires biofiltration [Line 1 – Line 9]	9,654	cubic-feet
BMP Parameters			
11	Surface Ponding [6 inch minimum, 12 inch maximum]	6	inches
12	Media Thickness [18 inches minimum], also add mulch layer thickness to this line for sizing calculations	18	inches
13	Aggregate Storage above underdrain invert (12 inches typical) – use 0 inches for sizing if the aggregate is not over the entire bottom surface area	18	inches
14	Freely drained pore storage	0.2	in/in
15	Media filtration rate to be used for sizing (5 in/hr. with no outlet control; if the filtration rate is controlled by the outlet use the outlet controlled rate which will be less than 5 in/hr.)	5	in/hr.
Baseline Calculations			
16	Allowable Routing Time for sizing	6	hours
17	Depth filtered during storm [Line 15 x Line 16]	30	inches
18	Depth of Detention Storage [Line 11 + (Line 12 x Line 14) + (Line 13 x Line 5)]	15	inches
19	Total Depth Treated [Line 17 + Line 18]	45	inches

Note: Line 7 is used to estimate the amount of volume retained by the BMP. Update assumed surface area in Line 7 until its equivalent to the required biofiltration footprint (either Line 21 or Line 23)

Worksheet B.5-1: Simple Sizing Method for Biofiltration BMPs (continued)

Simple Sizing Method for Biofiltration BMPs		Worksheet B.5-1 (Page 2 of 2)	
Option 1 – Biofilter 1.5 times the DCV			
20	Required biofiltered volume [1.5 x Line 10]	14,481	cubic-feet
21	Required Footprint [Line 20/ Line 19] x 12	3,862	sq-ft
Option 2 - Store 0.75 of remaining DCV in pores and ponding			
22	Required Storage (surface + pores) Volume [0.75 x Line 10]	7,240	cubic-feet
23	Required Footprint [Line 22/ Line 18] x 12	5,792	sq-ft
Footprint of the BMP			
24	Area draining to the BMP	1,006,760	sq-ft
25	Adjusted Runoff Factor for drainage area (Refer to Appendix B.1 and B.2)	0.33	
26	BMP Footprint Sizing Factor (Default 0.03 or an alternative minimum footprint sizing factor from Worksheet B.5-2, Line 11)	0.03	
27	Minimum BMP Footprint [Line 24 x Line 25 x Line 26]	10,011	sq-ft
28	Footprint of the BMP = Maximum(Minimum(Line 21, Line 23), Line 27)	10,011	sq-ft
Check for Volume Reduction [Not applicable for No Infiltration Condition]			
29	Calculate the fraction of DCV retained in the BMP [Line 9/Line 1]	0.375	unitless
30	Minimum required fraction of DCV retained for partial infiltration condition	0.375	unitless
31	Is the retained DCV ≥ 0.375? If the answer is no increase the footprint sizing factor in Line 26 until the answer is yes for this criterion.	☑ Yes	☐ No

Note:

1. Line 7 is used to estimate the amount of volume retained by the BMP. Update assumed surface area in Line 7 until its equivalent to the required biofiltration footprint (either Line 21 or Line 23)
2. The DCV fraction of 0.375 is based on a 40% average annual percent capture and a 36-hour drawdown time.
3. The increase in footprint for volume reduction can be optimized using the approach presented in Appendix B.5.2. The optimized footprint cannot be smaller than the alternative minimum footprint sizing factor from Worksheet B.5-2.
4. If the proposed biofiltration BMP footprint is smaller than the alternative minimum footprint sizing factor from Worksheet B.5-2, but satisfies Option 1 or Option 2 sizing, it is considered a compact biofiltration BMP and may be allowed at the discretion of the City Engineer, if it meets the requirements in Appendix F.

Worksheet B.5-1: Simple Sizing Method for Biofiltration BMPs (DMA PR-4F)

Simple Sizing Method for Biofiltration BMPs		Worksheet B.5-1 (Page 1 of 2)	
1	Remaining DCV after implementing retention BMPs	1,168	cubic-feet
Partial Retention			
2	Infiltration rate from Worksheet D.5-1 if partial infiltration is feasible	0.125	in/hr.
3	Allowable drawdown time for aggregate storage below the underdrain	36	hours
4	Depth of runoff that can be infiltrated [Line 2 x Line 3]	4.5	inches
5	Aggregate pore space	0.40	in/in
6	Required depth of gravel below the underdrain [Line 4/ Line 5]	11.25	inches
7	Assumed surface area of the biofiltration BMP	834	sq-ft
8	Media retained pore storage	0.1	in/in
9	Volume retained by BMP [[Line 4 + (Line 12 x Line 8)]/12] x Line 7	438	cubic-feet
10	DCV that requires biofiltration [Line 1 – Line 9]	730	cubic-feet
BMP Parameters			
11	Surface Ponding [6 inch minimum, 12 inch maximum]	6	inches
12	Media Thickness [18 inches minimum], also add mulch layer thickness to this line for sizing calculations	18	inches
13	Aggregate Storage above underdrain invert (12 inches typical) – use 0 inches for sizing if the aggregate is not over the entire bottom surface area	18	inches
14	Freely drained pore storage	0.2	in/in
15	Media filtration rate to be used for sizing (5 in/hr. with no outlet control; if the filtration rate is controlled by the outlet use the outlet controlled rate which will be less than 5 in/hr.)	5	in/hr.
Baseline Calculations			
16	Allowable Routing Time for sizing	6	hours
17	Depth filtered during storm [Line 15 x Line 16]	30	inches
18	Depth of Detention Storage [Line 11 + (Line 12 x Line 14) + (Line 13 x Line 5)]	15	inches
19	Total Depth Treated [Line 17 + Line 18]	45	inches

Note: Line 7 is used to estimate the amount of volume retained by the BMP. Update assumed surface area in Line 7 until its equivalent to the required biofiltration footprint (either Line 21 or Line 23)

Worksheet B.5-1: Simple Sizing Method for Biofiltration BMPs (continued)

Simple Sizing Method for Biofiltration BMPs		Worksheet B.5-1 (Page 2 of 2)	
Option 1 – Biofilter 1.5 times the DCV			
20	Required biofiltered volume [1.5 x Line 10]	1,095	cubic-feet
21	Required Footprint [Line 20/ Line 19] x 12	292	sq-ft
Option 2 - Store 0.75 of remaining DCV in pores and ponding			
22	Required Storage (surface + pores) Volume [0.75 x Line 10]	548	cubic-feet
23	Required Footprint [Line 22/ Line 18] x 12	438	sq-ft
Footprint of the BMP			
24	Area draining to the BMP	111,140	sq-ft
25	Adjusted Runoff Factor for drainage area (Refer to Appendix B.1 and B.2)	0.23	
26	BMP Footprint Sizing Factor (Default 0.03 or an alternative minimum footprint sizing factor from Worksheet B.5-2, Line 11)	0.03	
27	Minimum BMP Footprint [Line 24 x Line 25 x Line 26]	765	sq-ft
28	Footprint of the BMP = Maximum(Minimum(Line 21, Line 23), Line 27)	765	sq-ft
Check for Volume Reduction [Not applicable for No Infiltration Condition]			
29	Calculate the fraction of DCV retained in the BMP [Line 9/Line 1]	0.375	unitless
30	Minimum required fraction of DCV retained for partial infiltration condition	0.375	unitless
31	Is the retained DCV ≥ 0.375? If the answer is no increase the footprint sizing factor in Line 26 until the answer is yes for this criterion.	☑ Yes	☐ No

Note:

1. Line 7 is used to estimate the amount of volume retained by the BMP. Update assumed surface area in Line 7 until its equivalent to the required biofiltration footprint (either Line 21 or Line 23)
2. The DCV fraction of 0.375 is based on a 40% average annual percent capture and a 36-hour drawdown time.
3. The increase in footprint for volume reduction can be optimized using the approach presented in Appendix B.5.2. The optimized footprint cannot be smaller than the alternative minimum footprint sizing factor from Worksheet B.5-2.
4. If the proposed biofiltration BMP footprint is smaller than the alternative minimum footprint sizing factor from Worksheet B.5-2, but satisfies Option 1 or Option 2 sizing, it is considered a compact biofiltration BMP and may be allowed at the discretion of the City Engineer, if it meets the requirements in Appendix F.

Worksheet B.5-1: Simple Sizing Method for Biofiltration BMPs (DMA PR-4G)

Simple Sizing Method for Biofiltration BMPs		Worksheet B.5-1 (Page 1 of 2)	
1	Remaining DCV after implementing retention BMPs	1,622	cubic-feet
Partial Retention			
2	Infiltration rate from Worksheet D.5-1 if partial infiltration is feasible	0.125	in/hr.
3	Allowable drawdown time for aggregate storage below the underdrain	36	hours
4	Depth of runoff that can be infiltrated [Line 2 x Line 3]	4.5	inches
5	Aggregate pore space	0.40	in/in
6	Required depth of gravel below the underdrain [Line 4/ Line 5]	11.25	inches
7	Assumed surface area of the biofiltration BMP	1,159	sq-ft
8	Media retained pore storage	0.1	in/in
9	Volume retained by BMP [[Line 4 + (Line 12 x Line 8)]/12] x Line 7	608	cubic-feet
10	DCV that requires biofiltration [Line 1 – Line 9]	1,014	cubic-feet
BMP Parameters			
11	Surface Ponding [6 inch minimum, 12 inch maximum]	6	inches
12	Media Thickness [18 inches minimum], also add mulch layer thickness to this line for sizing calculations	18	inches
13	Aggregate Storage above underdrain invert (12 inches typical) – use 0 inches for sizing if the aggregate is not over the entire bottom surface area	18	inches
14	Freely drained pore storage	0.2	in/in
15	Media filtration rate to be used for sizing (5 in/hr. with no outlet control; if the filtration rate is controlled by the outlet use the outlet controlled rate which will be less than 5 in/hr.)	5	in/hr.
Baseline Calculations			
16	Allowable Routing Time for sizing	6	hours
17	Depth filtered during storm [Line 15 x Line 16]	30	inches
18	Depth of Detention Storage [Line 11 + (Line 12 x Line 14) + (Line 13 x Line 5)]	15	inches
19	Total Depth Treated [Line 17 + Line 18]	45	inches

Note: Line 7 is used to estimate the amount of volume retained by the BMP. Update assumed surface area in Line 7 until its equivalent to the required biofiltration footprint (either Line 21 or Line 23)

Worksheet B.5-1: Simple Sizing Method for Biofiltration BMPs (continued)

Simple Sizing Method for Biofiltration BMPs		Worksheet B.5-1 (Page 2 of 2)	
Option 1 – Biofilter 1.5 times the DCV			
20	Required biofiltered volume [1.5 x Line 10]	1,521	cubic-feet
21	Required Footprint [Line 20/ Line 19] x 12	406	sq-ft
Option 2 - Store 0.75 of remaining DCV in pores and ponding			
22	Required Storage (surface + pores) Volume [0.75 x Line 10]	760	cubic-feet
23	Required Footprint [Line 22/ Line 18] x 12	608	sq-ft
Footprint of the BMP			
24	Area draining to the BMP	95,270	sq-ft
25	Adjusted Runoff Factor for drainage area (Refer to Appendix B.1 and B.2)	0.37	
26	BMP Footprint Sizing Factor (Default 0.03 or an alternative minimum footprint sizing factor from Worksheet B.5-2, Line 11)	0.03	
27	Minimum BMP Footprint [Line 24 x Line 25 x Line 26]	1,060	sq-ft
28	Footprint of the BMP = Maximum(Minimum(Line 21, Line 23), Line 27)	1,060	sq-ft
Check for Volume Reduction [Not applicable for No Infiltration Condition]			
29	Calculate the fraction of DCV retained in the BMP [Line 9/Line 1]	0.375	unitless
30	Minimum required fraction of DCV retained for partial infiltration condition	0.375	unitless
31	Is the retained DCV ≥ 0.375? If the answer is no increase the footprint sizing factor in Line 26 until the answer is yes for this criterion.	☑ Yes	☐ No

Note:

1. Line 7 is used to estimate the amount of volume retained by the BMP. Update assumed surface area in Line 7 until its equivalent to the required biofiltration footprint (either Line 21 or Line 23)
2. The DCV fraction of 0.375 is based on a 40% average annual percent capture and a 36-hour drawdown time.
3. The increase in footprint for volume reduction can be optimized using the approach presented in Appendix B.5.2. The optimized footprint cannot be smaller than the alternative minimum footprint sizing factor from Worksheet B.5-2.
4. If the proposed biofiltration BMP footprint is smaller than the alternative minimum footprint sizing factor from Worksheet B.5-2, but satisfies Option 1 or Option 2 sizing, it is considered a compact biofiltration BMP and may be allowed at the discretion of the City Engineer, if it meets the requirements in Appendix F.

Worksheet B.5-1: Simple Sizing Method for Biofiltration BMPs (DMA PR-4H)

Simple Sizing Method for Biofiltration BMPs		Worksheet B.5-1 (Page 1 of 2)	
1	Remaining DCV after implementing retention BMPs	8,832	cubic-feet
Partial Retention			
2	Infiltration rate from Worksheet D.5-1 if partial infiltration is feasible	0.125	in/hr.
3	Allowable drawdown time for aggregate storage below the underdrain	36	hours
4	Depth of runoff that can be infiltrated [Line 2 x Line 3]	4.5	inches
5	Aggregate pore space	0.40	in/in
6	Required depth of gravel below the underdrain [Line 4/ Line 5]	11.25	inches
7	Assumed surface area of the biofiltration BMP	6,309	sq-ft
8	Media retained pore storage	0.1	in/in
9	Volume retained by BMP [[Line 4 + (Line 12 x Line 8)]/12] x Line 7	3,312	cubic-feet
10	DCV that requires biofiltration [Line 1 – Line 9]	5,520	cubic-feet
BMP Parameters			
11	Surface Ponding [6 inch minimum, 12 inch maximum]	6	inches
12	Media Thickness [18 inches minimum], also add mulch layer thickness to this line for sizing calculations	18	inches
13	Aggregate Storage above underdrain invert (12 inches typical) – use 0 inches for sizing if the aggregate is not over the entire bottom surface area	18	inches
14	Freely drained pore storage	0.2	in/in
15	Media filtration rate to be used for sizing (5 in/hr. with no outlet control; if the filtration rate is controlled by the outlet use the outlet controlled rate which will be less than 5 in/hr.)	5	in/hr.
Baseline Calculations			
16	Allowable Routing Time for sizing	6	hours
17	Depth filtered during storm [Line 15 x Line 16]	30	inches
18	Depth of Detention Storage [Line 11 + (Line 12 x Line 14) + (Line 13 x Line 5)]	15	inches
19	Total Depth Treated [Line 17 + Line 18]	45	inches

Note: Line 7 is used to estimate the amount of volume retained by the BMP. Update assumed surface area in Line 7 until its equivalent to the required biofiltration footprint (either Line 21 or Line 23)

Worksheet B.5-1: Simple Sizing Method for Biofiltration BMPs (continued)

Simple Sizing Method for Biofiltration BMPs		Worksheet B.5-1 (Page 2 of 2)	
Option 1 – Biofilter 1.5 times the DCV			
20	Required biofiltered volume [1.5 x Line 10]	8,280	cubic-feet
21	Required Footprint [Line 20/ Line 19] x 12	2,208	sq-ft
Option 2 - Store 0.75 of remaining DCV in pores and ponding			
22	Required Storage (surface + pores) Volume [0.75 x Line 10]	4,140	cubic-feet
23	Required Footprint [Line 22/ Line 18] x 12	3,312	sq-ft
Footprint of the BMP			
24	Area draining to the BMP	483,250	sq-ft
25	Adjusted Runoff Factor for drainage area (Refer to Appendix B.1 and B.2)	0.40	
26	BMP Footprint Sizing Factor (Default 0.03 or an alternative minimum footprint sizing factor from Worksheet B.5-2, Line 11)	0.03	
27	Minimum BMP Footprint [Line 24 x Line 25 x Line 26]	5,783	sq-ft
28	Footprint of the BMP = Maximum(Minimum(Line 21, Line 23), Line 27)	5,783	sq-ft
Check for Volume Reduction [Not applicable for No Infiltration Condition]			
29	Calculate the fraction of DCV retained in the BMP [Line 9/Line 1]	0.375	unitless
30	Minimum required fraction of DCV retained for partial infiltration condition	0.375	unitless
31	Is the retained DCV ≥ 0.375? If the answer is no increase the footprint sizing factor in Line 26 until the answer is yes for this criterion.	☑ Yes	☐ No

Note:

1. Line 7 is used to estimate the amount of volume retained by the BMP. Update assumed surface area in Line 7 until its equivalent to the required biofiltration footprint (either Line 21 or Line 23)
2. The DCV fraction of 0.375 is based on a 40% average annual percent capture and a 36-hour drawdown time.
3. The increase in footprint for volume reduction can be optimized using the approach presented in Appendix B.5.2. The optimized footprint cannot be smaller than the alternative minimum footprint sizing factor from Worksheet B.5-2.
4. If the proposed biofiltration BMP footprint is smaller than the alternative minimum footprint sizing factor from Worksheet B.5-2, but satisfies Option 1 or Option 2 sizing, it is considered a compact biofiltration BMP and may be allowed at the discretion of the City Engineer, if it meets the requirements in Appendix F.

ATTACHMENT 2
BACKUP FOR PDP HYDROMODIFICATION CONTROL MEASURES

This is the cover sheet for Attachment 2.

☑ Mark this box if this attachment is empty because the project is exempt from PDP hydromodification management requirements.

ATTACHMENT 3
STRUCTURAL BMP MAINTENANCE INFORMATION

This is the cover sheet for Attachment 3.

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Indicate which Items are Included:

Attachment Sequence	Contents	Checklist
Attachment 3a	Structural BMP Maintenance Thresholds and Actions (Required)	☒ Included See Structural BMP Maintenance Information Checklist.
Attachment 3b	Maintenance Agreement (Form DS-3247) (when applicable)	○ Included ◉ Not Applicable

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Use this checklist to ensure the required information has been included in the Structural BMP Maintenance Information Attachment:

Preliminary Design / Planning / CEQA level submittal:

- Attachment 3a must identify:
  - ☒ Typical maintenance indicators and actions for proposed structural BMP(s) based on Section 7.7 of the BMP Design Manual
- Attachment 3b is not required for preliminary design / planning / CEQA level submittal.

<u>Final Design level submittal:</u>

Attachment 3a must identify:

- ☐ Specific maintenance indicators and actions for proposed structural BMP(s). This shall be based on Section 7.7 of the BMP Design Manual and enhanced to reflect actual proposed components of the structural BMP(s)
- ☐ How to access the structural BMP(s) to inspect and perform maintenance
- ☐ Features that are provided to facilitate inspection (e.g., observation ports, cleanouts, silt posts, or other features that allow the inspector to view necessary components of the structural BMP and compare to maintenance thresholds)
- ☐ Manufacturer and part number for proprietary parts of structural BMP(s) when applicable
- ☐ Maintenance thresholds specific to the structural BMP(s), with a location-specific frame of reference (e.g., level of accumulated materials that triggers removal of the materials, to be identified based on viewing marks on silt posts or measured with a survey rod with respect to a fixed benchmark within the BMP)
- ☐ When applicable, frequency of bioretention soil media replacement.
- ☐ Recommended equipment to perform maintenance
- ☐ When applicable, necessary special training or certification requirements for inspection and maintenance personnel such as confined space entry or hazardous waste management

Attachment 3b: For private entity operation and maintenance, Attachment 3b must include a Storm Water Management and Discharge Control Maintenance Agreement (Form DS-3247). The following information must be included in the exhibits attached to the maintenance agreement:

- ☐ Vicinity map
- ☐ Site design BMPs for which DCV reduction is claimed for meeting the pollutant control obligations.
- ☐ BMP and HMP location and dimensions
- ☐ BMP and HMP specifications/cross section/model
- ☐ Maintenance recommendations and frequency
- ☐ LID features such as (permeable paver and LS location, dim, SF).

Table 7-1. Schedule for Developing O&M Plan and Agreement

Item	Description	Time Frame
1	Determine structural BMP ownership, party responsible for permanent O&M, and maintenance funding mechanism	Prior to first submittal of a project application – discuss with staff at pre-application meeting
2	Identify expected maintenance actions	First submittal of a project application – identify in SWQMP
3	Develop detailed O&M Plan	As required by City Engineer, prior to issuance of construction, grading, building, site development, or other applicable permits
4	Update/finalize O&M Plan to reflect constructed structural BMPs with as-built plans and baseline photos	As required by City Engineer, upon completion of construction of structural BMPs
5	[For private maintenance] Prepare draft O&M Agreement (legal agreement to be recorded against the property by the County Assessor)	As required by City Engineer
6	[For private maintenance] Execute and record O&M Agreement	As required by City Engineer

7.3. Maintenance Responsibility

Who is responsible for the maintenance of the permanent structural BMPs into perpetuity?

Depending on if the project is public or private, the responsible party and maintenance requirements may vary. Public projects shall consult the City's internal requirements to determine the responsible party and maintenance requirements.

For private projects, the property owner is responsible to ensure inspection, operation and maintenance of permanent structural BMPs on their property unless responsibility has been formally transferred to an agency, community facilities district, homeowners association, property owners association, or other special district. When property ownership changes (i.e., the property is sold or otherwise transferred to a new owner), maintenance responsibility also transfers to the new owner, typically by transfer of a maintenance agreement recorded against the property by the County Assessor. For structural BMPs that will be transferred to an agency, community facilities district, homeowners association, property owners association, or other special district, there may be an interim period during which the property owner is responsible until maintenance responsibility is formally transferred.

For public improvements, the project applicant shall submit plans, a description of required maintenance, and estimates of both annual and long-term maintenance costs, for routing by Development Services to the City department responsible for maintenance of the structural BMPs for review. For CIP projects, the routing shall be done by the Project Manager.

7.4. Long-Term Maintenance Documentation

As part of on-going structural BMP maintenance into perpetuity, property owners are required to provide documentation of maintenance for the structural BMPs on their property to support the City's reporting requirements to the SDRWQCB.

The MS4 Permit requires the City to verify that structural BMPs on each PDP "are adequately maintained, and continue to operate effectively to remove pollutants in storm water to the MEP through inspections, self-certifications, surveys, or other equally effective approaches." The City must also identify the party responsible for structural BMP maintenance for the PDP and report the dates and findings of structural BMP maintenance verifications, and corrective actions and/or resolutions when applicable, in their PDP inventory. The PDP inventory and findings of maintenance verifications must be reported to the SDRWQCB annually. Based on these MS4 Permit requirements, the City Engineer will require property owners to provide annual self-certification that inspection and maintenance has been performed, provide details of the inspection results and maintenance activities, and confirm or update the contact information for the party responsible to ensure inspection and maintenance is performed.

7.5. Inspection and Maintenance Frequency

How often is a property owner required to inspect and maintain permanent structural BMPs on their property?

The minimum inspection and maintenance frequency is annual and must be reported annually. However, actual maintenance needs are site specific, and maintenance may be needed more frequently than annually. The need for maintenance depends on the amount and quality of runoff delivered to the structural BMP. Maintenance must be performed whenever needed, based on maintenance indicators presented in Section 7.7. The optimum maintenance frequency is each time the maintenance threshold for removal of materials (sediment, trash, debris or overgrown vegetation) is met. If this maintenance threshold has been exceeded by the time the structural BMP is inspected, the BMP has been operating at reduced capacity. This would mean it is necessary to inspect and maintain the structural BMP more frequently. Routine maintenance will also help avoid more costly rehabilitative maintenance to repair damages that may occur when BMPs have not been adequately maintained on a routine basis.

During the first year of normal operation of a structural BMP (i.e. when the project is fully built out and occupied), inspection by the property owner's representative is recommended at least once prior to August 31 and then monthly from September through May. Inspection during a storm event is also recommended. It is during and after a rain event when one can determine if the components of the BMP are functioning properly. After the initial period of frequent inspections, the minimum inspection and maintenance frequency can be determined based on the results of the first year inspections.

7.6. Measures to Control Maintenance Costs

Because structural BMPs must be maintained into perpetuity, it is essential to include measures to control maintenance costs.

The most effective way to reduce maintenance of structural BMPs is to prevent or reduce pollutants generated onsite and delivered to the structural BMP by implementation of source control and site design BMPs onsite, as required and described in Chapter 4 of this manual. Second, vegetated BMPs should be placed properly to reduce the potential to come under the jurisdiction of one or more resource agencies that could require permits and costly mitigation to perform maintenance of the structural BMP. Third, the structural BMP should include design features to facilitate maintenance, as listed below.

Considerations for placement of vegetated BMPs:

- Locate structural BMPs outside of floodway, floodplain, and other jurisdictional areas.
- Avoid direct connection to a natural surface water body.
- Discuss the location of the structural BMP with a wetland biologist to avoid placing a structural BMP in a location where it could become jurisdictional or be connected to a jurisdictional area.

Measures to facilitate collection of the trapped pollutants:

- Design a forebay to trap gross pollutants in a contained area that is readily accessible for maintenance. A forebay may be a dedicated area at the inlet entrance to an infiltration BMP, biofiltration BMP, or detention basin, or may be a gross pollutant separator installed in the storm drain system that drains to the primary structural BMP.

Measures to access the structural BMP:

- The BMP must be accessible to equipment needed for maintenance. Access requirements for maintenance will vary with the type of facility selected.

- Infiltration BMPs, biofiltration BMPs and most above-ground detention basins and sand filters will typically require routine landscape maintenance using the same equipment that is used for general landscape maintenance. At times these BMPs may require excavation of clogged media (e.g. bioretention soil media, or sand for the sand filter), and should be accessible to appropriate equipment for excavation and removal/replacement of media.

- Above-ground detention basins should include access ramps for trucks to enter the basin to bring equipment and to remove materials.

- Underground BMPs such as detention vaults, media filters, or gross pollutant separators used as forebays to other BMPs, typically require access for a vactor truck to remove materials. Proprietary BMPs such as media filters or gross pollutant separators may require access by a forklift or other truck for delivery and removal of media cartridges or other internal components. Access requirements must be verified with the manufacturer of proprietary BMPs.

- Vactor trucks are large, heavy, and difficult to maneuver. Structural BMPs that are maintained by vactor truck must include a level pad adjacent to the structural BMP, preferably with no vegetation or irrigation system (otherwise vegetation or irrigation system may be destroyed by the vactor truck). Signage for vactor truck schedule must be placed in areas where maintenance is scheduled.

- The sump area of a structural BMP should not exceed 20 feet in depth due to the loss of efficiency of a vactor truck. The water removal rate is three to four times longer when the depth is greater than 20 feet. Deep structures may require additional equipment (stronger vactor trucks, ladders, more vactor pipe segments).
- All manhole access points to underground structural BMPs must include a ladder or steps.

Measures to facilitate inspection of the structural BMP:

- Structural BMPs shall include inspection ports for observing all underground components that require inspection and maintenance.
- Silt level posts or other markings shall be included in all BMP components that will trap and store sediment, trash, and/or debris, so that the inspector may determine how full the BMP is, and the maintenance personnel may determine where the bottom of the BMP is. Posts or other markings shall be indicated and described on structural BMP plans.
- Vegetation requirements including plant type, coverage, and minimum height when applicable shall be provided on the structural BMP and/or landscaping plans as appropriate or as required by the City Engineer.
- Signage indicating the location and boundary of the structural BMP is recommended.

When designing a structural BMP, the engineer should review the typical structural BMP maintenance actions listed in Section 7.7 to determine the potential maintenance equipment and access needs.

When selecting permanent structural BMPs for a project, the engineer and project owner should consider the long term cost of maintenance and what type of maintenance contracts a future property owner, homeowners association or property owners association will need to manage. The types of materials used (e.g. proprietary vs. non-proprietary parts), equipment used (e.g. landscape equipment vs. vactor truck), actions/labor expected in the maintenance process and required qualifications of maintenance personnel (e.g. confined space entry) affect the cost of long term O&M of the structural BMPs presented in the manual.

7.7. Maintenance Indicators and Actions for Structural BMPs

This Section presents typical maintenance indicators and expected maintenance actions (routine and corrective) for typical structural BMPs.

There are many different variations of structural BMPs, and structural BMPs may include multiple components. For the purpose of maintenance, the structural BMPs have been grouped into four categories based on common maintenance requirements:

- Vegetated infiltration or filtration BMPs
- Non-vegetated infiltration BMPs
- Non-vegetated filtration BMPs
- Detention BMPs

For structural BMPs that use bioretention soil mix (BSM), the frequency of maintenance is based on the BSM specification used. When the City maintains these BMPs, it does so in compliance with all local, state, and federal laws governing the handling, transport, and disposal of hazardous waste.

Additionally, private BMPs are typically maintained by property owners that are subject to state and federal regulations governing the handling, transport, and disposal of hazardous waste.

The project civil engineer is responsible for determining which categories are applicable based on the components of the structural BMP, and identifying the applicable maintenance indicators from within the category. Maintenance indicators and actions shall be shown on the construction plans and in the project-specific O&M Plan.

During inspection, the inspector checks the maintenance indicators. If one or more thresholds are met or exceeded, maintenance must be performed to ensure the structural BMP will function as designed during the next storm event.

7.7.1 Maintenance of Vegetated Infiltration or Filtration BMPs

"Vegetated infiltration or filtration BMPs" are BMPs that include vegetation as a component of the BMP. Applicable Fact Sheets may include INF-2 (bioretention), PR-1 (biofiltration with partial retention), BF-1 (biofiltration) or FT-1 (vegetated swale). The vegetated BMP may or may not include amended soils, subsurface gravel layer, underdrain, and/or impermeable liner. The project civil engineer is responsible for determining which maintenance indicators and actions shown below are applicable based on the components of the structural BMP.

7.7.2 Maintenance of Non-Vegetated Infiltration BMPs

"Non-vegetated infiltration BMPs" are BMPs that store storm water runoff until it infiltrates into the ground, and do not include vegetation as a component of the BMP (refer to the "vegetated BMPs" category for infiltration BMPs that include vegetation). Non-vegetated infiltration BMPs generally include non-vegetated infiltration trenches and infiltration basins, dry wells, underground infiltration galleries, and permeable pavement with underground infiltration gallery. Applicable Fact Sheets may include INF-1 (infiltration basin) or INF-3 (permeable pavement). The non-vegetated infiltration BMP may or may not include a pre-treatment device, and may or may not include above-ground storage of runoff. The project civil engineer is responsible for determining which maintenance indicators and actions shown below are applicable based on the components of the structural BMP.

Table 7-2. Maintenance Indicators and Actions for Vegetated BMPs

Typical Maintenance Indicator(s) for Vegetated BMPs	Maintenance Actions
Accumulation of sediment, litter, or debris	Remove and properly dispose of accumulated materials, without damage to the vegetation.
Poor vegetation establishment	Re-seed, re-plant, or re-establish vegetation per original plans.
Overgrown vegetation	Mow or trim as appropriate, but not less than the design height of the vegetation per original plans when applicable (e.g. a vegetated swale may require a minimum vegetation height).
Erosion due to concentrated irrigation flow	Repair/re-seed/re-plant eroded areas and adjust the irrigation system.
Erosion due to concentrated storm water runoff flow	Repair/re-seed/re-plant eroded areas, and make appropriate corrective measures such as adding erosion control blankets, adding stone at flow entry points, or minor re-grading to restore proper drainage according to the original plan. If the issue is not corrected by restoring the BMP to the original plan and grade, the City Engineer shall be contacted prior to any additional repairs or reconstruction.
Standing water in vegetated swales	Make appropriate corrective measures such as adjusting irrigation system, removing obstructions of debris or invasive vegetation, loosening or replacing top soil to allow for better infiltration, or minor re-grading for proper drainage. If the issue is not corrected by restoring the BMP to the original plan and grade, the City Engineer shall be contacted prior to any additional repairs or reconstruction.
Standing water in bioretention, biofiltration with partial retention, or biofiltration areas, or flow-through planter boxes for longer than 96 hours following a storm event*	Make appropriate corrective measures such as adjusting irrigation system, removing obstructions of debris or invasive vegetation, clearing underdrains (where applicable), or repairing/replacing clogged or compacted soils.
Obstructed inlet or outlet structure	Clear obstructions.
Damage to structural components such as weirs, inlet or outlet structures	Repair or replace as applicable.
*These BMPs typically include a surface ponding layer as part of their function which may take 96 hours to drain following a storm event.	

Table 7-3. Maintenance Indicators and Actions for Non-Vegetated Infiltration BMPs

Typical Maintenance Indicator(s) for Non-Vegetated Infiltration BMPs	Maintenance Actions
Accumulation of sediment, litter, or debris in infiltration basin, pre-treatment device, or on permeable pavement surface	Remove and properly dispose accumulated materials.
Standing water in infiltration basin without subsurface infiltration gallery for longer than 96 hours following a storm event	Remove and replace clogged surface soils.
Standing water in subsurface infiltration gallery for longer than 96 hours following a storm event	This condition requires investigation of why infiltration is not occurring. If feasible, corrective action shall be taken to restore infiltration (e.g. flush fine sediment or remove and replace clogged soils). BMP may require retrofit if infiltration cannot be restored. If retrofit is necessary, the City Engineer shall be contacted prior to any repairs or reconstruction.
Standing water in permeable paving area	Flush fine sediment from paving and subsurface gravel. Provide routine vacuuming of permeable paving areas to prevent clogging.
Damage to permeable paving surface	Repair or replace damaged surface as appropriate.
Note: When inspection or maintenance indicates sediment is accumulating in an infiltration BMP, the DMA draining to the infiltration BMP should be examined to determine the source of the sediment, and corrective measures should be made as applicable to minimize the sediment supply.	

7.7.3 Maintenance of Non-Vegetated Filtration BMPs

"Non-vegetated filtration BMPs" include media filters (FT-2) and sand filters (FT-3). These BMPs function by passing runoff through the media to remove pollutants. The project civil engineer is responsible for determining which maintenance indicators and actions shown below are applicable based on the components of the structural BMP.

Table 7-4. Maintenance Indicators and Actions for Filtration BMPs

Typical Maintenance Indicator(s) for Filtration BMPs	Maintenance Actions
Accumulation of sediment, litter, or debris	Remove and properly dispose accumulated materials.
Obstructed inlet or outlet structure	Clear obstructions.
Clogged filter media	Remove and properly dispose filter media, and replace with fresh media.
Damage to components of the filtration system	Repair or replace as applicable.
Note: For proprietary media filters, refer to the manufacturer's maintenance guide.	

7.7.4 Maintenance of Detention BMPs

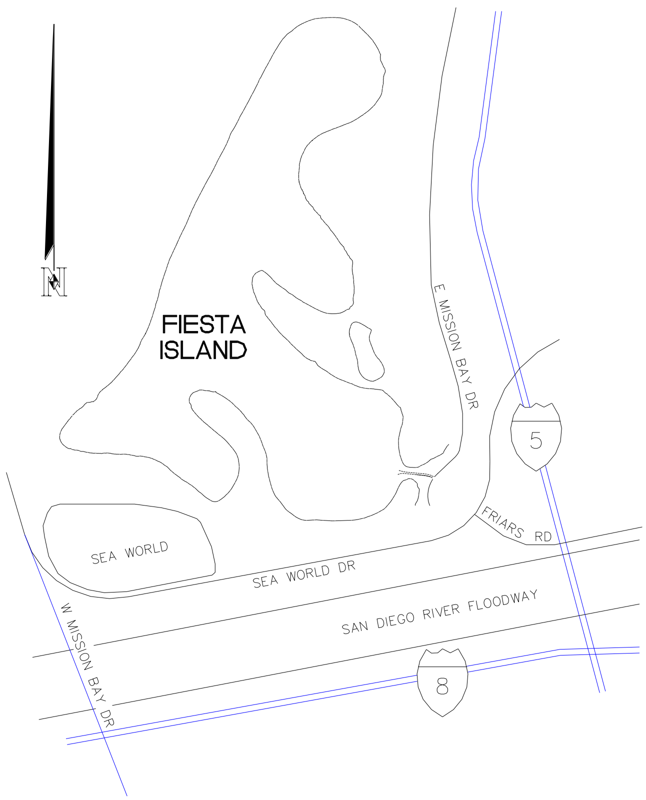
"Detention BMPs" includes basins, cisterns, vaults, and underground galleries that are primarily designed to store runoff for controlled release to downstream systems. For the purpose of the maintenance discussion, this category does not include an infiltration component (refer to "vegetated infiltration or filtration BMPs" or "non-vegetated infiltration BMPs" above). Applicable Fact Sheets may include HU-1 (cistern) or FT-4 (extended detention basin). There are many possible configurations of above ground and underground detention BMPs, including both proprietary and non-proprietary systems. The project civil engineer is responsible for determining which maintenance indicators and actions shown below are applicable based on the components of the structural BMP.

ATTACHMENT 5
DRAINAGE REPORT

Attach project's drainage report. Refer to Drainage Design Manual to determine the reporting requirements.

Project Drainage Report

VICINITY MAP:



INTRODUCTION:

The following Hydrology Report has been prepared to accompany the Fiesta Island – Mission Bay Park Master Plan Amendment. This Hydrology Study investigates the storm water runoff characteristic of the existing and proposed conditions.

PROJECT DESCRIPTION:

Fiesta Island is located within the Mission Bay Park Master Plan area. The island was created through the dredging operations five decades ago that made Mission Bay Park the outstanding water park that it is today. The island currently functions as a multi-purpose recreation area with a portion of the island allocated to habitat preservation. The existing island is approximately 485 acres and is relatively flat with grades ranging from sea level to 15 to 20 feet above sea level. Only the shoreline is readily visible to the general public. Most of the island's acreage is hidden by the containment sand berms that were used to help create it more than five decades ago. Because of the topography, and the fact that most of the island consists of sandy material, much of the runoff does not drain directly into the bay. Runoff from a portion of the interior of the site ponds during a rain event and eventually storm water percolates into the soil or evaporates. However, the access road that runs along the perimeter of the island does drain into the bay as does much of the westerly beach area of the Island.

The only existing storm drainage system on Fiesta Island includes a series of culverts that convey runoff from the interior of the island within the dog park on the southwestern portion of the island. The remaining portions of the Island ponds during rain events, eventually percolating into the soil or evaporating or drains directly to Mission Bay.

The proposed project will include improvements of certain portions of Fiesta Island consistent with the Mission Bay Park Master Plan's intent. The majority of the work to be done will be located in the central and southern portions of the island. The improvements are to include grading to create flat and mounded areas, park and habitat areas, access road extensions, parking lots, walking trails, camping areas, restroom facilities, bridge structures, and the improvement of the entry road. Proposed storm drain infrastructure will utilize the existing storm drain piping, create new infiltration basins for the dissipation storm drainage and install overflow infrastructure for peak storms.

FIDO Option

The Fido Option will include revisions to the improvements to the Southwest portion of the Island. The Fido Option includes additional improvements in basins PR-3A and PR-3B including a parking lot and the removal of the improvements and parking lot in basin PR-3C. The storm runoff from the proposed improvements will also be mitigated by the use of percolation into the soil.

HYDROLOGY METHODOLOGY/DESIGN CRITERIA:

Runoff is calculated by utilizing methods outlined in the City of San Diego Drainage Design Manual. Topographical information has been obtained from Nasland Engineering. Hydrologic basin boundaries, landscape areas, and flow path characteristics such as change in elevation and length of flow are obtained from the Existing and Proposed Conditions Maps which are drafted in AutoCAD Civil 3D 2013 software. This information is utilized to determine the basin area, runoff coefficient and inlet time for each basin.

Calculations have been performed per Rational Method guidelines set forth in Appendix I of the City of San Diego Drainage Design Manual.

- Runoff Coefficients have been calculated per Table 2 of the Drainage Design Manual.
- Land Use type was used per Table 2 of the Drainage Design Manual. The existing condition was considered Rural (Lots greater than ½ acre) and therefore the coefficient used was 0.45. The proposed condition is also considered Rural and the coefficient is 0.45, however a tabulated C value was used for the proposed conditions due to the difference in impervious areas.
- Stormwater runoff is considered to be in an Overland Flow condition. Time of concentration for Urban Area Overland Flow is determined per the equation published on the "Urban Areas Overland Time of Flow Curves" located on page 86 of the City of San Diego Drainage Design Manual
- The intensity (I) is calculated as a function of time of concentration and can be determined by using the Intensity Duration Design Curves page 83.
- The runoff discharge (Q) is calculated using the Modified Rational Method

$$Q=CIA$$

Q= year storm discharge (cfs)
C= the runoff coefficient
I= the intensity
A= the area in acres

CALCULATIONS:

Fiesta Island - Existing & Proposed Time of Concentrations

Existing Site Conditions							
Basin	Runoff	Urban Area Overland Flow Tc					
		High Point	Low Point	ΔE	Length	Avg Slope	$T_{overland}$
	(C)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(min)
North Island							
1A	0.45	17.4	12.8	4.6	730	0.006	36.8
1B	0.45	23.3	14.7	8.6	361.0	0.024	16.7
1C	0.45	19.6	11.3	8.3	817	0.010	33.3
1D	0.45	19.4	13.7	5.7	545	0.010	26.9
1E	0.45	18.2	8.9	9.3	38	0.245	2.5
1F	0.45	23.6	12.0	11.6	87.0	0.133	4.6
1G	0.45	21.2	13.5	7.7	251	0.031	12.8
1H	0.45	21.2	8.2	13.0	606	0.021	22.4
1I	0.45	21.2	7.3	13.9	163	0.085	7.4
Central Island							
2A	0.45	26.4	11.8	14.6	318.0	0.046	12.6
2B	0.45	26.4	12.2	14.2	461.0	0.031	17.3
2C	0.45	23.3	9.8	13.5	119.0	0.113	5.7
2D	0.45	24.0	10.8	13.2	1078.0	0.012	35.9
2E	0.45	23.5	12.9	10.6	121.0	0.088	6.3
2F	0.45	23.6	11.8	11.8	486.0	0.024	19.2
2G	0.45	24.8	11.7	13.1	1418.0	0.009	45.2
2H	0.45	21.0	10.9	10.1	685.0	0.015	26.9
2I	0.45	26.6	12.9	13.7	1346.0	0.010	42.7
2J	0.45	23.7	12.3	11.4	52.0	0.219	3.0
2K	0.45	32.0	18.8	13.2	573.0	0.023	21.3
2L	0.45	30.5	20.5	10.0	40.0	0.250	2.6
2M	0.45	18.0	12.8	5.2	887.0	0.006	41.6
Southwest Island							
3A	0.45	21.3	11.9	9.4	160.0	0.059	8.3
3B	0.45	19.3	11.1	8.2	721.0	0.011	30.1
3C	0.45	18.8	13.2	5.6	500.0	0.011	25.2
Southeast Island							
4A	0.45	32.0	14.2	17.8	627.0	0.028	20.8
4B	0.45	22.6	9.3	13.3	63.0	0.211	3.4
4C	0.45	23.5	12.8	10.7	43.0	0.249	2.7
4D	0.45	32.5	14.5	18.0	938.0	0.019	28.9
4E	0.45	32.7	16.8	15.9	531.0	0.030	18.8
4F	0.45	23.2	12.5	10.7	70.0	0.153	4.0
4G	0.45	25.1	13.9	11.2	68.0	0.165	3.8

Proposed Site Conditions							
Basin	Runoff Coefficient	Urban Area Overland Flow Tc					
		High Point	Low Point	ΔE	Length	Avg Slope	$T_{overland}$
	(C)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(min)
North Island							
1A	0.45	17.4	12.8	4.6	730	0.006	36.8
1B	0.45	23.3	14.7	8.6	361.0	0.024	16.7
1C	0.45	19.6	11.3	8.3	817	0.010	33.3
1D	0.45	19.4	13.7	5.7	545	0.010	26.9
1E	0.45	18.2	8.9	9.3	38	0.245	2.5
1F	0.45	23.6	12.0	11.6	87.0	0.133	4.6
1G	0.45	21.2	13.5	7.7	251	0.031	12.8
1H	0.45	21.2	8.2	13.0	606	0.021	22.4
1I	0.45	21.2	7.3	13.9	163	0.085	7.4
Central Island							
2A	0.45	26.4	11.8	14.6	318.0	0.046	12.6
2B	0.45	26.4	12.2	14.2	461.0	0.031	17.3
2C	0.45	23.3	9.8	13.5	119.0	0.113	5.7
2D	0.45	24.0	10.8	13.2	1078.0	0.012	35.9
2E	0.45	23.5	12.9	10.6	121.0	0.088	6.3
2F	0.45	23.6	11.8	11.8	486.0	0.024	19.2
2G	0.45	24.8	11.7	13.1	1418.0	0.009	45.2
2H	0.45	21.0	10.9	10.1	685.0	0.015	26.9
2I	0.45	26.6	12.9	13.7	1346.0	0.010	42.7
2J	0.45	23.7	12.3	11.4	52.0	0.219	3.0
2K	0.45	32.0	18.8	13.2	573.0	0.023	21.3
Southwest Island							
3A	0.45	21.3	11.9	9.4	160.0	0.059	8.3
3B	0.45	19.3	11.1	8.2	721.0	0.011	30.1
3C	0.45	18.8	13.2	5.6	500.0	0.011	25.2
Southeast Island							
4A	0.45	32.0	14.2	17.8	627.0	0.028	20.8
4B	0.45	22.6	9.3	13.3	63.0	0.211	3.4
4C	0.45	23.5	12.8	10.7	43.0	0.249	2.7
4D	0.45	32.5	14.5	18.0	938.0	0.019	28.9
4E	0.45	32.7	16.8	15.9	531.0	0.030	18.8
4F	0.45	23.2	12.5	10.7	70.0	0.153	4.0
4G	0.45	25.1	13.9	11.2	68.0	0.165	3.8

Fiesta Island - Existing & Proposed Surface Runoff

Existing Site Conditions

Basin	Basin Area	Basin Acreage (A)	Impervious Area	Pervious Area	% Pervious	% Impervious	[1]Runoff Coefficient	[2]Tc	P62	[3]Intensity 2-year	Q_2	P610	[3]Intensity 10-year	Q_{10}	P650	[3]Intensity 50-year	Q_{50}	P6100	[3]Intensity 100-year	Q_{100}
	(sf)	(ac)	(sf)	(sf)	%	%	(C)	(min)		(in/hr)	(cfs)		(in/hr)	(cfs)		(in/hr)	(cfs)		(in/hr)	(cfs)
North Island																				
EX-1A	343,178	7.88	17.4	343,161	100%	0%	0.50	36.8	1.0	0.73	2.86	1.5	1.09	4.30	1.9	1.38	5.44	2.2	1.60	6.30
EX-1B	452,030	10.38	0	452,030	100%	0%	0.50	16.7	1.0	1.21	6.28	1.5	1.82	9.42	1.9	2.30	11.94	2.2	2.66	13.82
EX-1C	700,592	16.08	0	700,592	100%	0%	0.50	33.3	1.0	0.78	6.24	1.5	1.16	9.36	1.9	1.47	11.86	2.2	1.71	13.73
EX-1D	220,191	5.05	0	220,191	100%	0%	0.50	26.9	1.0	0.89	2.25	1.5	1.33	3.37	1.9	1.69	4.27	2.2	1.96	4.95
EX-1E	103,996	2.39	35,797	68,199	66%	34%	0.62	2.5	1.0	4.11	6.09	1.5	6.16	9.13	1.9	7.81	11.56	2.2	9.04	13.39
EX-1F	124,855	2.87	18,857	105,998	85%	15%	0.55	4.6	1.0	2.76	4.38	1.5	4.15	6.57	1.9	5.25	8.32	2.2	6.08	9.64
EX-1G	67,619	1.55	0	67,619	100%	0%	0.50	12.8	1.0	1.44	1.11	1.5	2.15	1.67	1.9	2.73	2.12	2.2	3.16	2.45
EX-1H	197,700	4.54	0	197,700	100%	0%	0.50	22.4	1.0	1.00	2.27	1.5	1.50	3.41	1.9	1.90	4.32	2.2	2.20	5.00
EX-1I	73,517	1.69	12,245	61,272	83%	17%	0.56	7.4	1.0	2.05	1.93	1.5	3.08	2.90	1.9	3.90	3.67	2.2	4.52	4.25
																			Total=	73.53
Central Island																				
EX-2A	55,862	1.28	12,960	42,902	77%	23%	0.58	12.6	1.0	1.45	1.08	1.5	2.18	1.62	1.9	2.76	2.05	2.2	3.19	2.38
EX-2B	133,255	3.06	0	133,255	100%	0%	0.50	17.3	1.0	1.18	1.81	1.5	1.77	2.71	1.9	2.25	3.43	2.2	2.60	3.98
EX-2C	60,113	1.38	21,033	39,080	65%	35%	0.62	5.7	1.0	2.41	2.07	1.5	3.62	3.11	1.9	4.59	3.94	2.2	5.31	4.56
EX-2D	1,718,830	39.46	0	1,718,830	100%	0%	0.50	35.9	1.0	0.74	14.57	1.5	1.11	21.85	1.9	1.40	27.68	2.2	1.62	32.05
EX-2E	184,625	4.24	20,145	164,480	89%	11%	0.54	6.3	1.0	2.27	5.18	1.5	3.41	7.78	1.9	4.32	9.85	2.2	5.00	11.40
EX-2F	74,330	1.71	19,411	54,919	74%	26%	0.59	19.2	1.0	1.10	1.11	1.5	1.66	1.67	1.9	2.10	2.12	2.2	2.43	2.45
EX-2G	1,513,360	34.74	15,496	1,497,864	99%	1%	0.50	45.2	1.0	0.64	11.14	1.5	0.95	16.71	1.9	1.21	21.16	2.2	1.40	24.50
EX-2H	147,193	3.38	35,481	111,712	76%	24%	0.58	26.9	1.0	0.89	1.76	1.5	1.33	2.63	1.9	1.69	3.34	2.2	1.96	3.86
EX-2I	997,320	22.90	96,800	900,520	90%	10%	0.53	42.7	1.0	0.66	8.08	1.5	0.99	12.12	1.9	1.26	15.35	2.2	1.45	17.77
EX-2J	38,645	0.89	11,756	26,889	70%	30%	0.61	3.0	1.0	3.63	1.95	1.5	5.44	2.93	1.9	6.89	3.71	2.2	7.98	4.29
EX-2K	222,505	5.11	0	222,505	100%	0%	0.50	21.3	1.0	1.04	2.65	1.5	1.55	3.97	1.9	1.97	5.03	2.2	2.28	5.82
EX-2L	45,225	1.04	18,700	26,525	59%	41%	0.64	2.6	1.0	4.06	2.72	1.5	6.09	4.08	1.9	7.71	5.16	2.2	8.93	5.98
EX-2M	77,120	1.77	16,290	60,830	79%	21%	0.57	41.6	1.0	0.67	0.68	1.5	1.01	1.02	1.9	1.28	1.30	2.2	1.48	1.50
																			Total=	120.56
Southwest Island																				
EX-3A	665,495	15.28	115,000	550,495	83%	17%	0.56	8.3	1.0	1.91	16.33	1.5	2.86	24.50	1.9	3.62	31.03	2.2	4.20	35.93
EX-3B	2,176,075	49.96	0	2,176,075	100%	0%	0.50	30.1	1.0	0.83	20.67	1.5	1.24	31.01	1.9	1.57	39.27	2.2	1.82	45.48
EX-3C	676,647	15.53	100,920	575,727	85%	15%	0.55	25.2	1.0	0.93	7.96	1.5	1.39	11.94	1.9	1.76	15.13	2.2	2.04	17.52
																			Total=	98.92
Southeast Island																				
EX-4A	938,790	21.55	0	938,790	100%	0%	0.50	20.8	1.0	1.05	11.33	1.5	1.58	17.00	1.9	2.00	21.53	2.2	2.31	24.93
EX-4B	95,590	2.19	23,480	72,110	75%	25%	0.59	3.4	1.0	3.38	4.35	1.5	5.07	6.52	1.9	6.43	8.26	2.2	7.44	9.57
EX-4C	155,765	3.58	44,612	111,153	71%	29%	0.60	2.7	1.0	3.96	8.50	1.5	5.94	12.76	1.9	7.53	16.16	2.2	8.72	18.71
EX-4D	2,416,120	55.47	0	2,416,120	100%	0%	0.50	28.9	1.0	0.85	23.57	1.5	1.27	35.35	1.9	1.61	44.78	2.2	1.87	51.85
EX-4E	1,006,760	23.11	34,207	972,553	97%	3%	0.51	18.8	1.0	1.12	13.28	1.5	1.68	19.92	1.9	2.13	25.23	2.2	2.47	29.21
EX-4F	111,140	2.55	23,555	87,585	79%	21%	0.57	4.0	1.0	3.05	4.47	1.5	4.58	6.71	1.9	5.80	8.50	2.2	6.72	9.84
EX-4G	95,270	2.19	27,493	67,777	71%	29%	0.60	3.8	1.0	3.13	4.11	1.5	4.70	6.17	1.9	5.95	7.82	2.2	6.89	9.05
																			Total=	153.16

***See Existing Hydrology Maps (Attachment 2) for basin locations.**

Proposed Site Conditions																				
Basin	Basin Area	Basin Acreage (A)	Impervious Area	Pervious Area	% Pervious	% Impervious	[1]Runoff Coefficient	[2]Tc	P62	[3]Intensity 2-year	Q_2	P610	[3]Intensity 10-year	Q_{10}	P650	[3]Intensity 50-year	Q_{50}	P6100	[3]Intensity 100-year	Q_{100}
	(sf)	(ac)	(sf)	(sf)	%	%	(C)	(min)		(in/hr)	(cfs)		(in/hr)	(cfs)		(in/hr)	(cfs)		(in/hr)	(cfs)
North Island																				
PR-1A	343,178	7.88	0	343,178	100%	0%	0.50	36.8	1.0	0.73	2.86	1.5	1.09	4.30	1.9	1.38	5.44	2.2	1.60	6.30
PR-1B	452,030	10.38	0	452,030	100%	0%	0.50	16.7	1.0	1.21	6.28	1.5	1.82	9.42	1.9	2.30	11.94	2.2	2.66	13.82
PR-1C	700,592	16.08	0	700,592	100%	0%	0.50	33.3	1.0	0.78	6.24	1.5	1.16	9.36	1.9	1.47	11.86	2.2	1.71	13.73
PR-1D	220,191	5.05	0	220,191	100%	0%	0.50	26.9	1.0	0.89	2.25	1.5	1.33	3.37	1.9	1.69	4.27	2.2	1.96	4.95
PR-1E	103,996	2.39	46,525	57,471	55%	45%	0.66	2.5	1.0	4.11	6.44	1.5	6.16	9.66	1.9	7.81	12.24	2.2	9.04	14.17
PR-1F	124,855	2.87	27,343	97,512	78%	22%	0.58	4.6	1.0	2.76	4.57	1.5	4.15	6.85	1.9	5.25	8.68	2.2	6.08	10.05
PR-1G	67,619	1.55	0	67,619	100%	0%	0.50	12.8	1.0	1.44	1.11	1.5	2.15	1.67	1.9	2.73	2.12	2.2	3.16	2.45
PR-1H	197,700	4.54	3,407	194,293	98%	2%	0.51	22.4	1.0	1.00	2.30	1.5	1.50	3.45	1.9	1.90	4.37	2.2	2.20	5.06
PR-1I	73,517	1.69	19,362	54,155	74%	26%	0.59	7.4	1.0	2.05	2.05	1.5	3.08	3.08	1.9	3.90	3.90	2.2	4.52	4.51
																			Total=	75.04
Central Island																				
PR-2A	55,862	1.28	7,675	48,187	86%	14%	0.55	12.6	1.0	1.45	1.02	1.5	2.18	1.53	1.9	2.76	1.94	2.2	3.19	2.24
PR-2B	133,255	3.06	32,260	100,995	76%	24%	0.58	17.3	1.0	1.18	2.11	1.5	1.77	3.17	1.9	2.25	4.02	2.2	2.60	4.65
PR-2C	60,113	1.38	23,973	36,140	60%	40%	0.64	5.7	1.0	2.41	2.13	1.5	3.62	3.20	1.9	4.59	4.05	2.2	5.31	4.69
PR-2D	1,718,830	39.46	0	1,718,830	100%	0%	0.50	35.9	1.0	0.74	14.57	1.5	1.11	21.85	1.9	1.40	27.68	2.2	1.62	32.05
PR-2E	184,625	4.24	24,845	159,780	87%	13%	0.55	6.3	1.0	2.27	5.27	1.5	3.41	7.90	1.9	4.32	10.01	2.2	5.00	11.59
PR-2F	74,330	1.71	27,845	46,485	63%	37%	0.63	19.2	1.0	1.10	1.19	1.5	1.66	1.78	1.9	2.10	2.26	2.2	2.43	2.62
PR-2G	1,513,360	34.74	31,600	1,481,760	98%	2%	0.51	45.2	1.0	0.64	11.22	1.5	0.95	16.83	1.9	1.21	21.32	2.2	1.40	24.68
PR-2H	147,193	3.38	50,130	97,063	66%	34%	0.62	26.9	1.0	0.89	1.86	1.5	1.33	2.79	1.9	1.69	3.53	2.2	1.96	4.09
PR-2I	997,320	22.90	96,800	900,520	90%	10%	0.53	42.7	1.0	0.66	8.08	1.5	0.99	12.12	1.9	1.26	15.35	2.2	1.45	17.77
PR-2J	38,645	0.89	13,055	25,590	66%	34%	0.62	3.0	1.0	3.63	1.99	1.5	5.44	2.98	1.9	6.89	3.78	2.2	7.98	4.38
PR-2K	222,505	5.11	92,652	129,853	58%	42%	0.65	21.3	1.0	1.04	3.42	1.5	1.55	5.12	1.9	1.97	6.49	2.2	2.28	7.52
PR-2L	45,225	1.04	18,700	26,525	59%	41%	0.64	2.6	1.0	4.06	2.72	1.5	6.09	4.08	1.9	7.71	5.16	2.2	8.93	5.98
PR-2M	77,120	1.77	20,752	56,368	73%	27%	0.59	41.6	1.0	0.67	0.71	1.5	1.01	1.06	1.9	1.28	1.34	2.2	1.48	1.56
																			Total=	123.82
Southwest Island																				
PR-3A	665,495	15.28	115,000	550,495	83%	17%	0.56	8.3	1.0	1.91	16.33	1.5	2.86	24.50	1.9	3.62	31.03	2.2	4.20	35.93
PR-3B	2,176,075	49.96	0	2,176,075	100%	0%	0.50	30.1	1.0	0.83	20.67	1.5	1.24	31.01	1.9	1.57	39.27	2.2	1.82	45.48
PR-3C	676,647	15.53	100,920	575,727	85%	15%	0.55	25.2	1.0	0.93	7.96	1.5	1.39	11.94	1.9	1.76	15.13	2.2	2.04	17.52
																			Total=	98.92
FIDO OPTION - Southwest Island																				
PR-3A	665,495	15.28	114,980	550,515	83%	17%	0.56	8.3	1.0	1.91	16.33	1.5	2.86	24.50	1.9	3.62	31.03	2.2	4.20	35.93
PR-3B	2,176,075	49.96	10,455	2,165,620	100%	0%	0.50	30.1	1.0	0.83	20.74	1.5	1.24	31.11	1.9	1.57	39.41	2.2	1.82	45.63
PR-3C	676,647	15.53	0	676,647	100%	0%	0.50	25.2	1.0	0.93	7.21	1.5	1.39	10.81	1.9	1.76	13.70	2.2	2.04	15.86
																			Total=	97.42
PR-4A	938,790	21.55	107,905	830,885	89%	11%	0.54	20.8	1.0	1.05	12.25	1.5	1.58	18.37	1.9	2.00	23.27	2.2	2.31	26.94
PR-4B	95,590	2.19	35,330	60,260	63%	37%	0.63	3.4	1.0	3.38	4.67	1.5	5.07	7.01	1.9	6.43	8.88	2.2	7.44	10.28
PR-4C	155,765	3.58	51,570	104,195	67%	33%	0.62	2.7	1.0	3.96	8.73	1.5	5.94	13.09	1.9	7.53	16.58	2.2	8.72	19.20
PR-4D	2,416,120	55.47	6,150	2,409,970	100%	0%	0.50	28.9	1.0	0.85	23.61	1.5	1.27	35.41	1.9	1.61	44.86	2.2	1.87	51.94
PR-4E	1,006,760	23.11	258,000	748,760	74%	26%	0.59	18.8	1.0	1.12	15.30	1.5	1.68	22.94	1.9	2.13	29.06	2.2	2.47	33.65
PR-4F	111,140	2.55	17,500	93,640	84%	16%	0.56	4.0	1.0	3.05	4.32	1.5	4.58	6.48	1.9	5.80	8.21	2.2	6.72	9.51
PR-4G	95,270	2.19	28,950	66,320	70%	30%	0.61	3.8	1.0	3.13	4.15	1.5	4.70	6.23	1.9	5.95	7.89	2.2	6.89	9.13
																			Total=	160.65

***See Proposed Hydrology Maps (Attachment 3) for basin locations.**

SUMMARY:

The project is subdivided into four areas:

North Island
Central Island
Southwest Island
Southeast Island

Existing and proposed stormwater basins in each portion of the Island are indicated for a total of 32 separate basins. The tables of the existing and proposed surface runoff determine the existing and proposed 100 year runoff flows for each basin. Due to the proposed increase in impervious surfaces with the proposed project, some of the basins result in an increasing in 100 year runoff with a maximum of 5%:

	Existing 100yr Q	Proposed 100yr Q	Percent Increase
North Island	73.53 cfs	75.04 cfs	2%
Central Island	120.56 cfs	123.82 cfs	3%
Southwest Island	98.92 cfs	98.92 cfs	0%
Southeast Island	153.16 cfs	160.65 cfs	5%

However, these increases in 100 year runoff will be mitigated with the installation of infiltration basins which would also serve as retention basins to mimic the pre-project runoff and would not adversely affect the project area or downstream areas associated with substantial erosion, siltation, or flooding.

ATTACHMENT 1

Tables, Charts and Isopluvial Maps

TABLE 2

RUNOFF COEFFICIENTS (RATIONAL METHOD)

DEVELOPED AREAS (URBAN)

Land Use	Coefficient, C Soil Type (1)
Residential:	D
Single Family	.55
Multi-Units	.70
Mobile Homes	.65
Rural (lots greater than 1/2 acre)	.45
Commercial (2) 80% Impervious	.85
Industrial (2) 90% Impervious	.95

NOTES:

(1) Type D soil to be used for all areas.

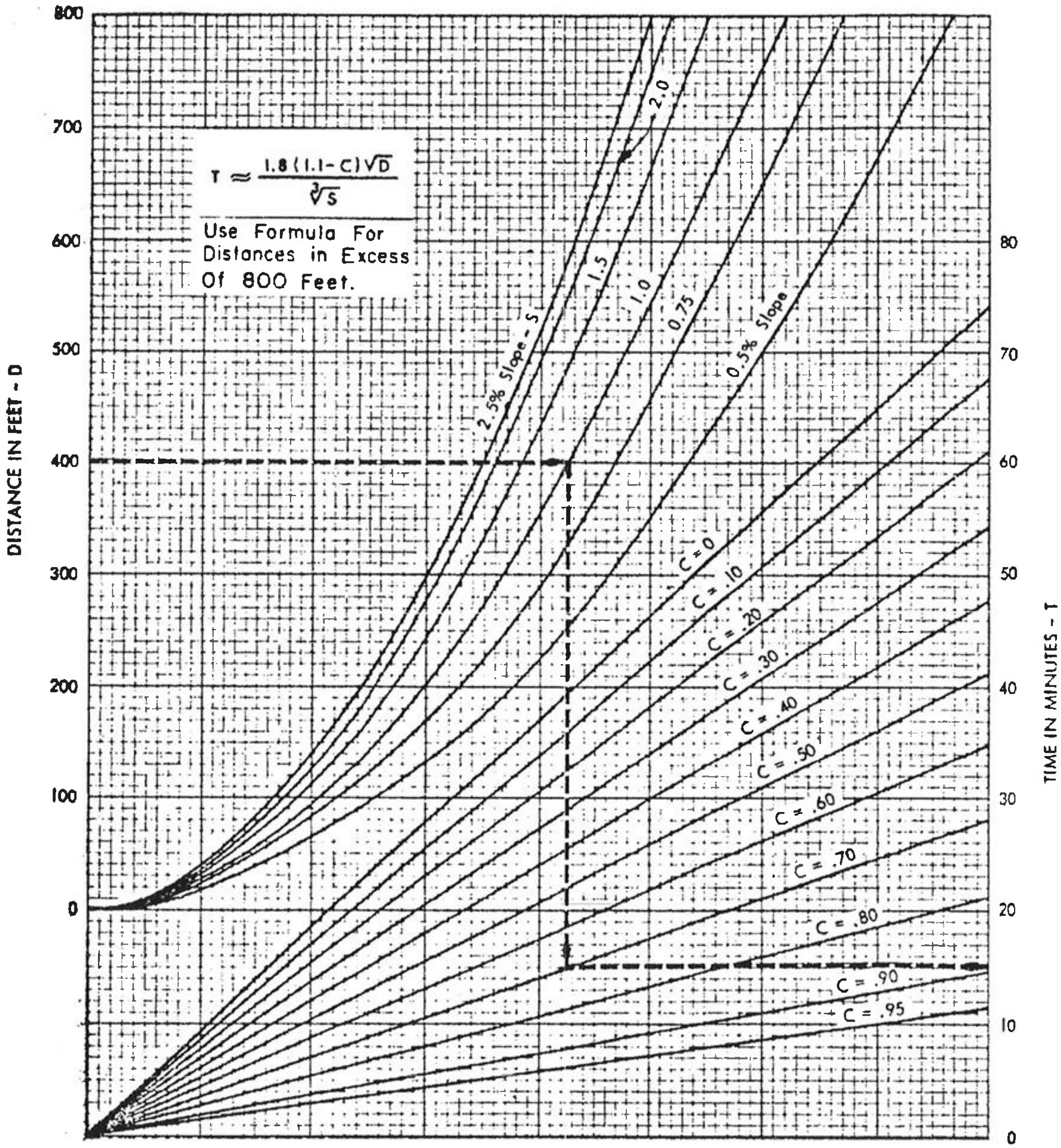
(2) Where actual conditions deviate significantly from the tabulated imperviousness values of 80% or 90%, the values given for coefficient C, may be revised by multiplying 80% or 90% by the ratio of actual imperviousness to the tabulated imperviousness. However, in no case shall the final coefficient be less than 0.50. For example: Consider commercial property on D soil.

Actual imperviousness = 50%

Tabulated imperviousness = 80%

$$\text{Revised C} = \frac{50}{80} \times 0.85 = 0.53$$

URBAN AREAS OVERLAND TIME OF FLOW CURVES

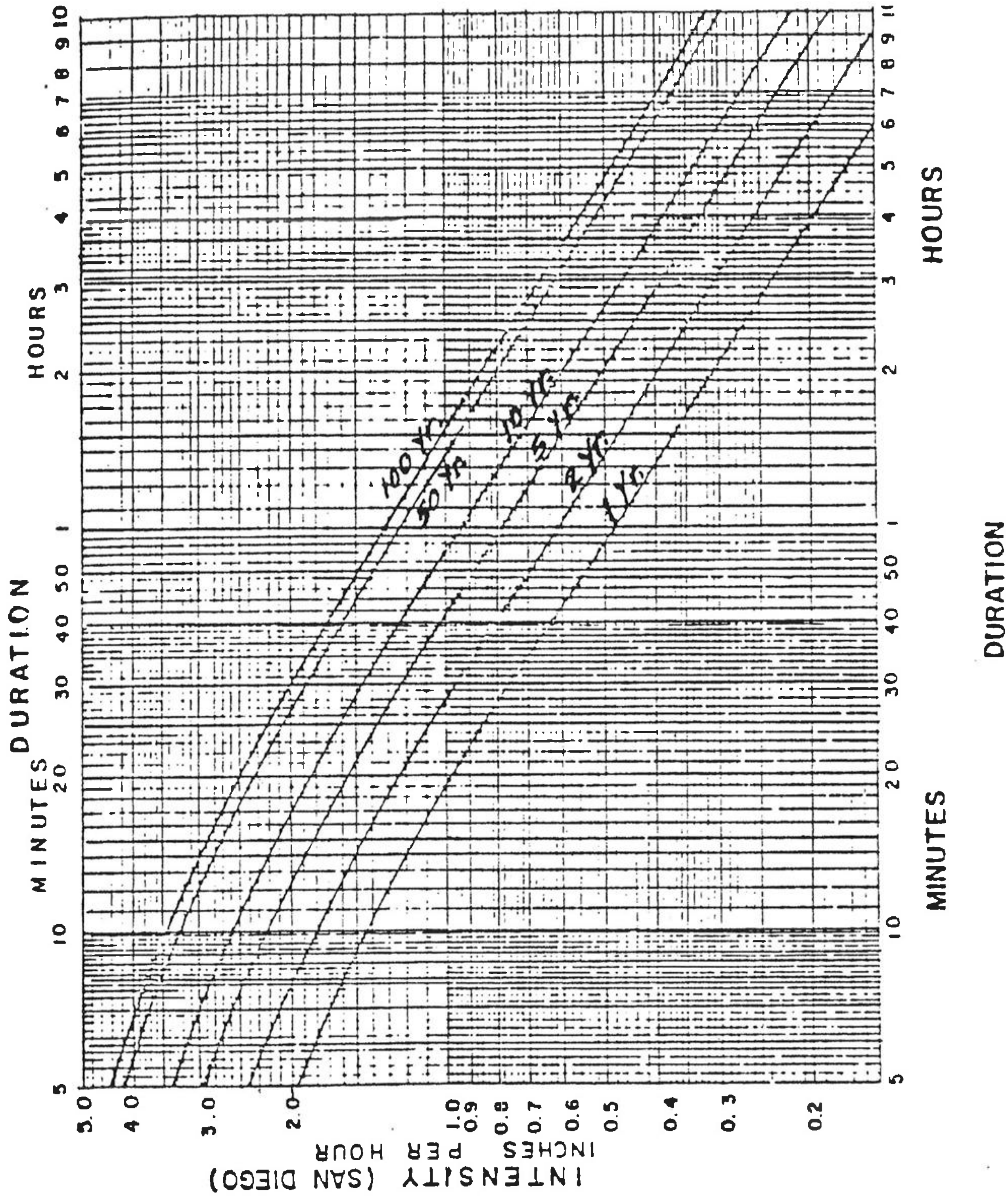


Surface Flow Time Curves

EXAMPLE:

GIVEN: LENGTH OF FLOW = 400 FT.
SLOPE = 1.0 %
COEFFICIENT OF RUNOFF C = .70

READ: OVERLAND FLOWTIME = 15 MINUTES



ELEV.	FACTOR
0–1500	1.00
1500–3000	1.25
3000–4000	1.42
4000–5000	1.60
5000–6000	1.70
DESERT	1.25

To obtain correct intensity, multiply intensity on chart by factor for design elevation.

RAINFALL

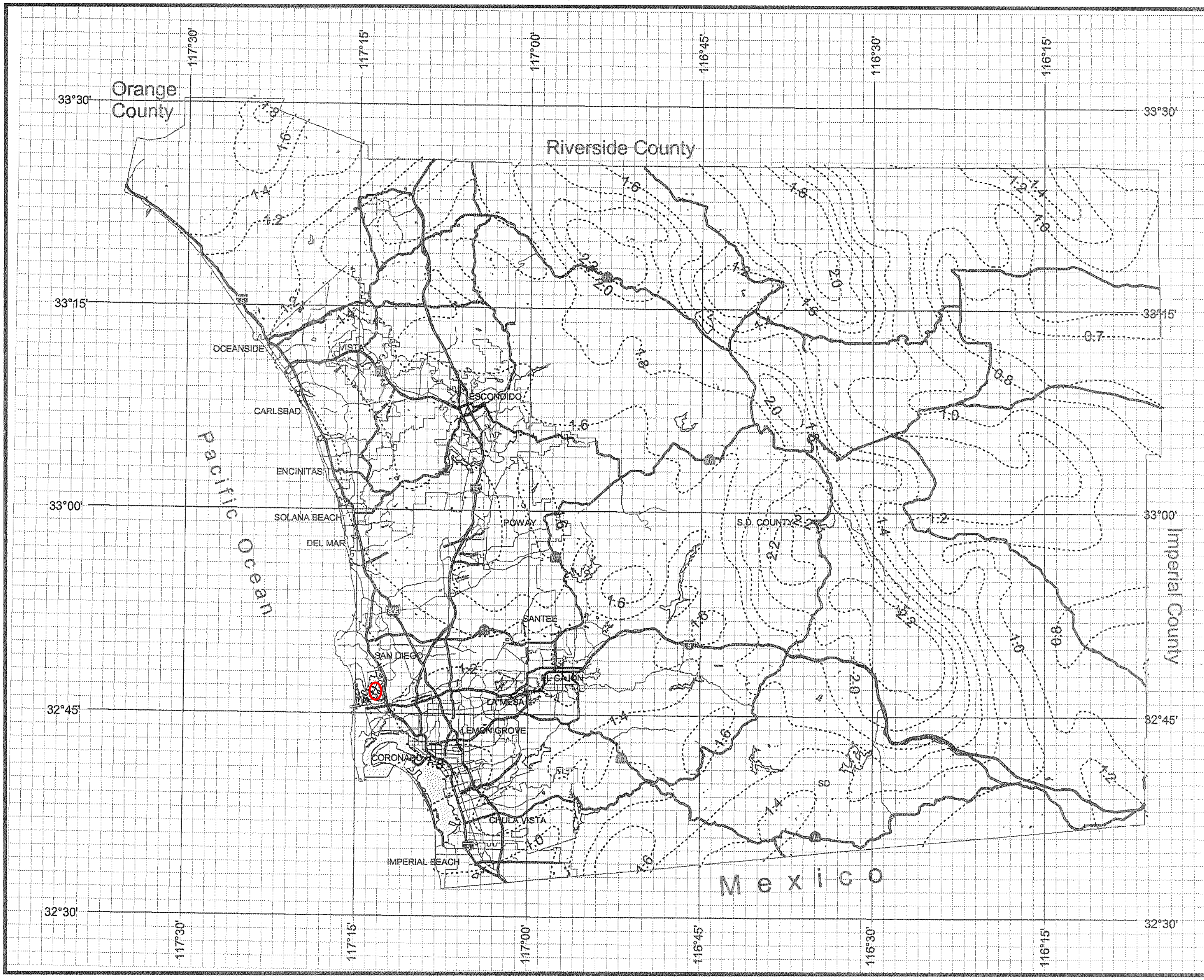
INTENSITY – DURATION – FREQUENCY

CURVES

for

COUNTY OF SAN DIEGO

APPENDIX I-1



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Rainfall Isopluvials

2 Year Rainfall Event - 6 Hours

------- Isopluvial (inches)

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Department of Public Works
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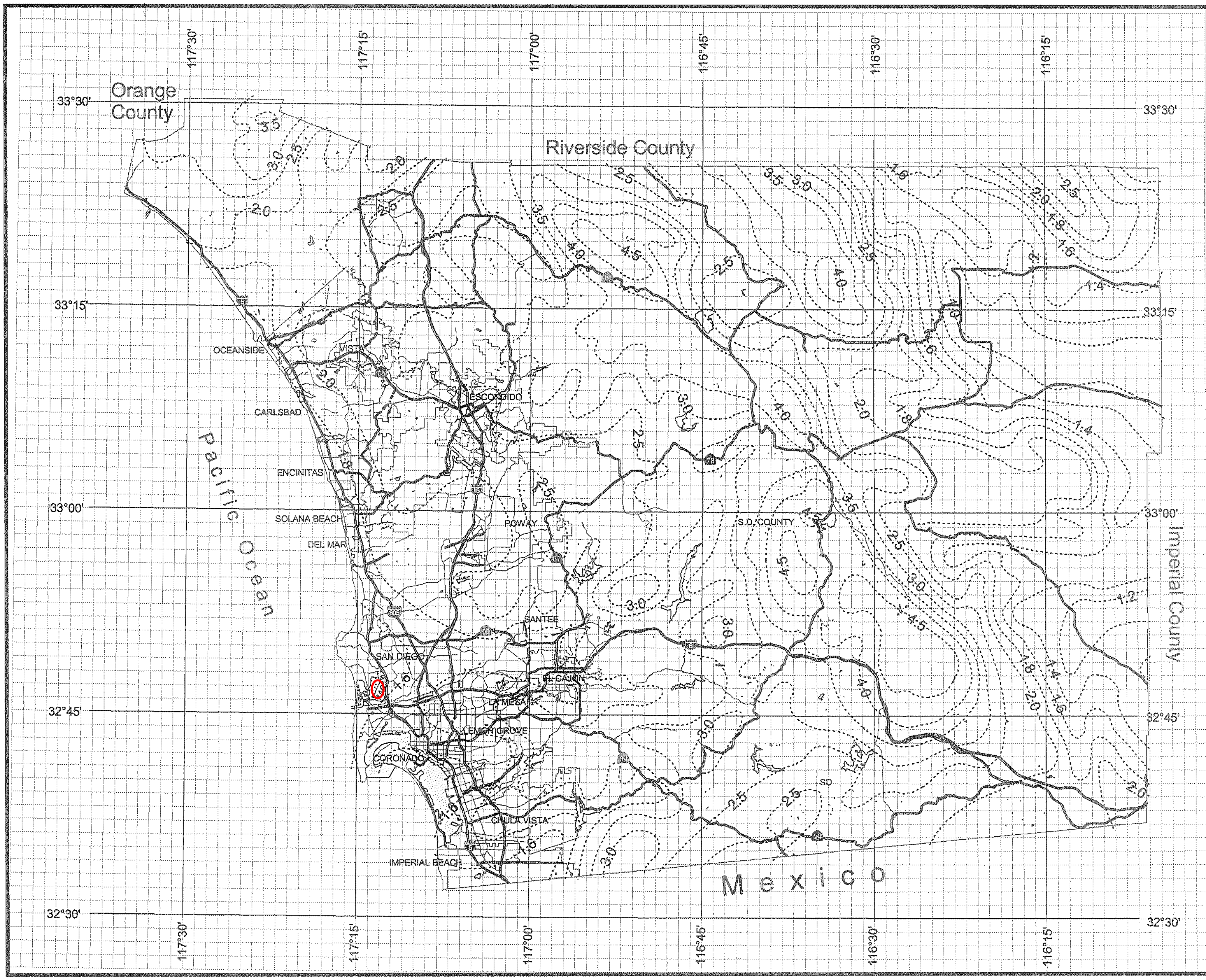
3 0 3 Miles



County of San Diego Hydrology Manual

Rainfall Isopluvials

2 Year Rainfall Event - 24 Hours

------- Isopluvial (inches)

DPW GIS
Department of Public Works
Geographic Information Services

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N
W E
S

3 0 3 Miles

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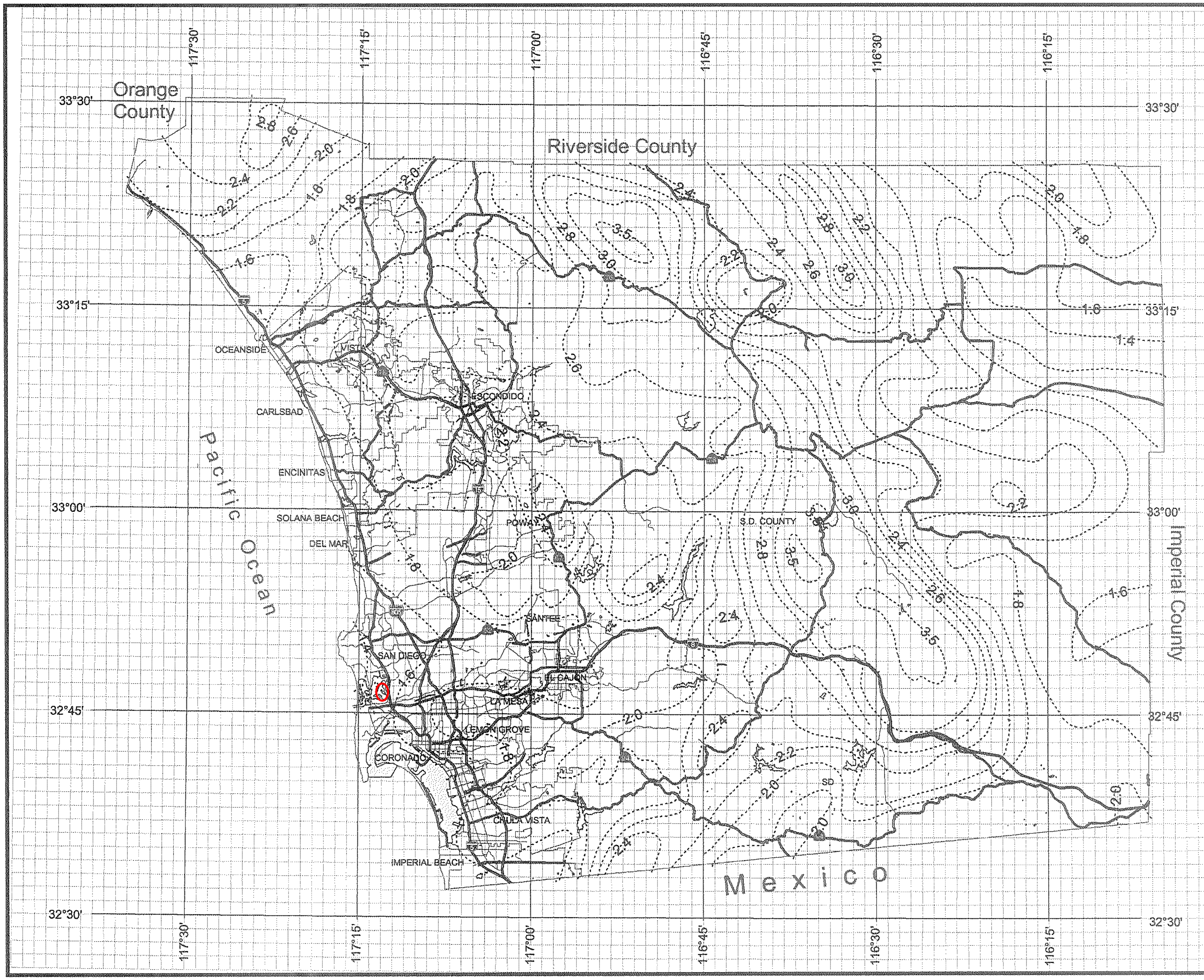
Rainfall Isopluvials

10 Year Rainfall Event - 6 Hours

Isopluvial (inches)



N
W E
S

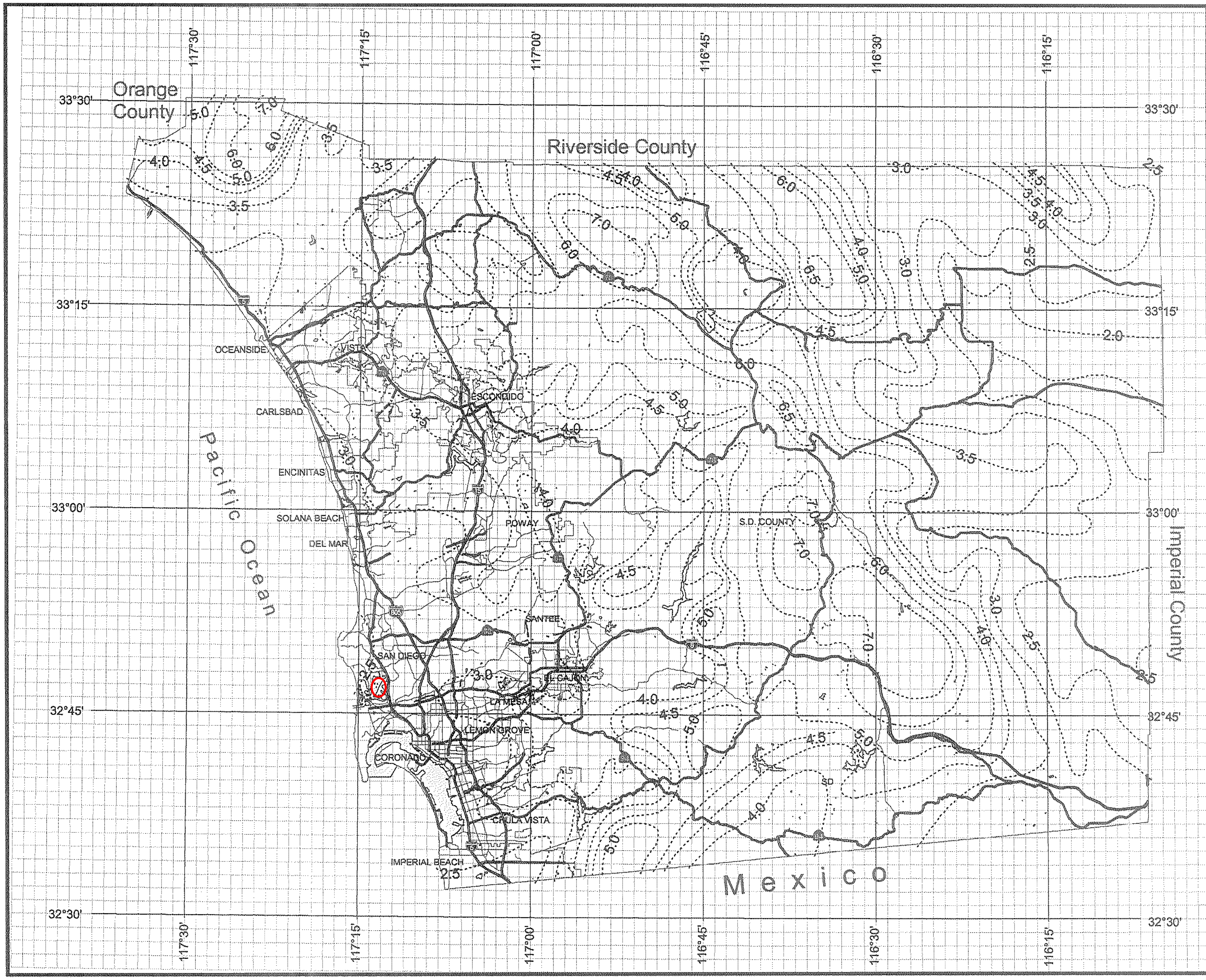
3 0 3 Miles

County of San Diego Hydrology Manual

Rainfall Isopluvials

10 Year Rainfall Event - 24 Hours

------- Isopluvial (inches)



DPW GIS

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Geographic Information Services

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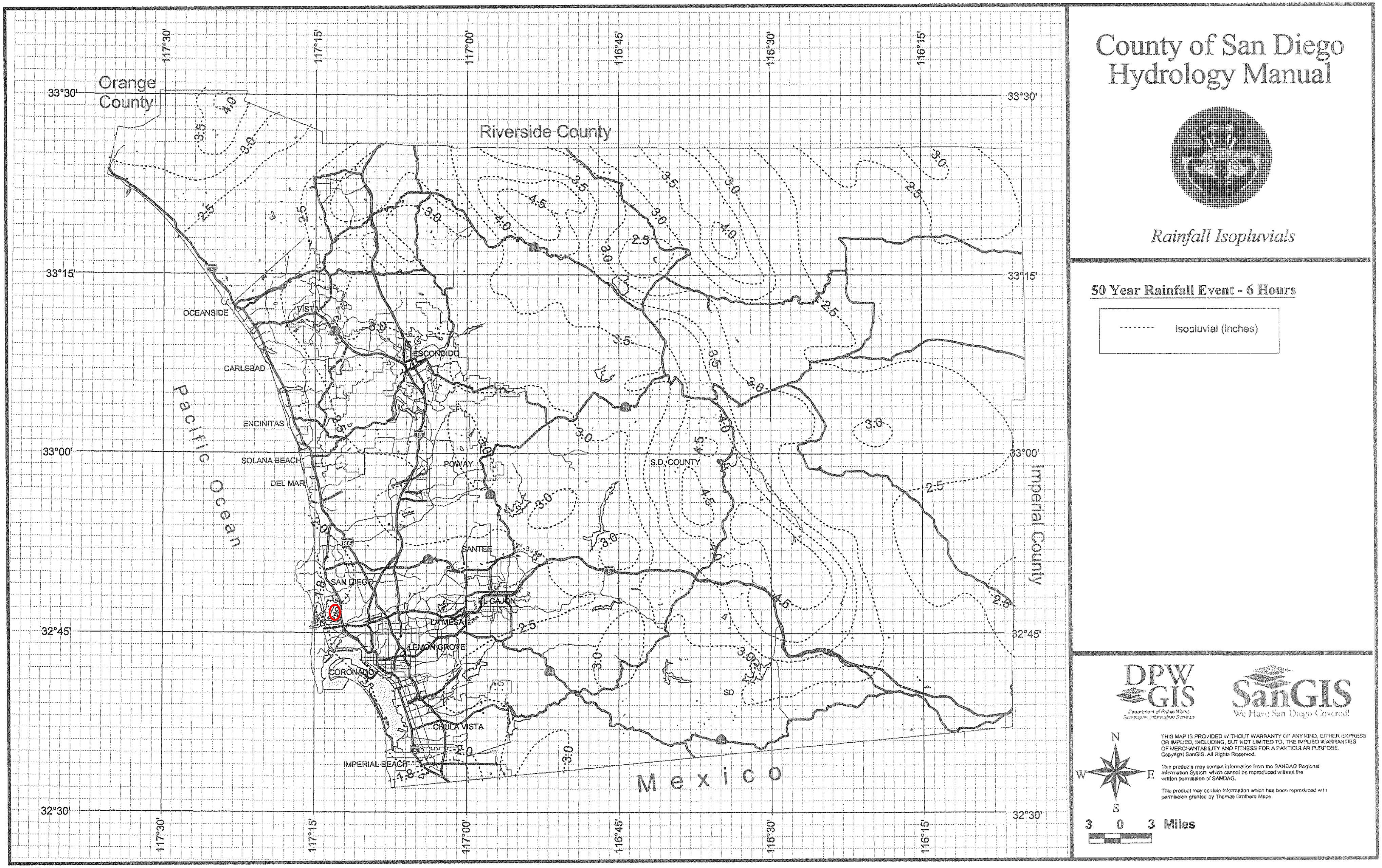
N
W E
S

3 0 3 Miles


County of San Diego
Hydrology Manual
Rainfall Isopluvials
50 Year Rainfall Event - 6 Hours
Isopluvial (inches)
Orange County
Riverside County
Imperial County
Mexico
Pacific Ocean
OCEANSIDE
VISTA
CARLSBAD
ESCONDIDO
ENCINITAS
SOLANA BEACH
DEL MAR
POWAY
S.D. COUNTY
SANTEE
SAN DIEGO
EL CAJON
LA MESA
LEMON GROVE
CORONADO
CHULA VISTA
IMPERIAL BEACH
33°30'
33°15'
33°00'
32°45'
32°30'
117°30'
117°15'
117°00'
116°45'
116°30'
116°15'
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N
S
E
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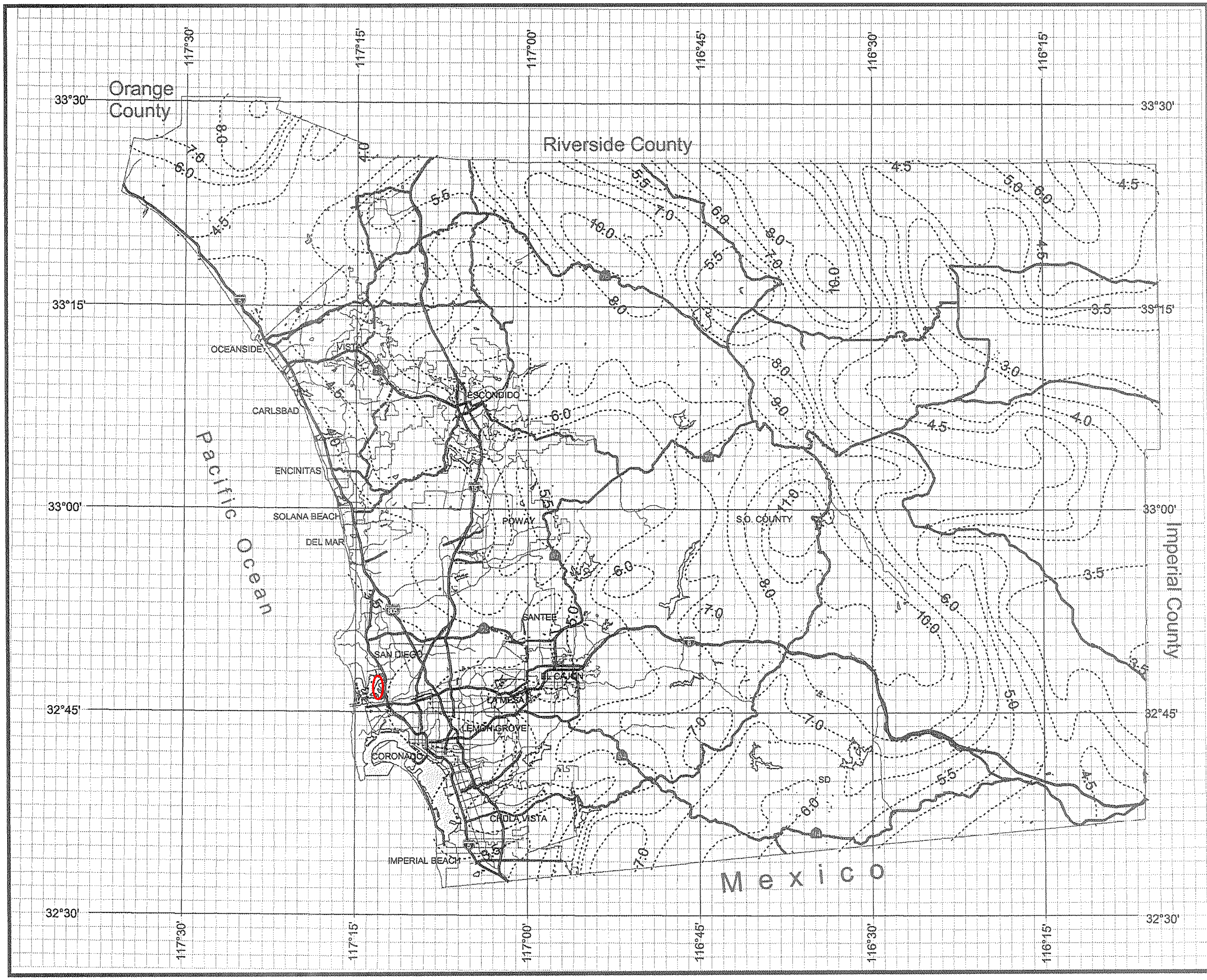
3 0 3 Miles



County of San Diego Hydrology Manual

Rainfall Isopluvials

50 Year Rainfall Event - 24 Hours

Isopluvial (inches)

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N W E S

3 0 3 Miles

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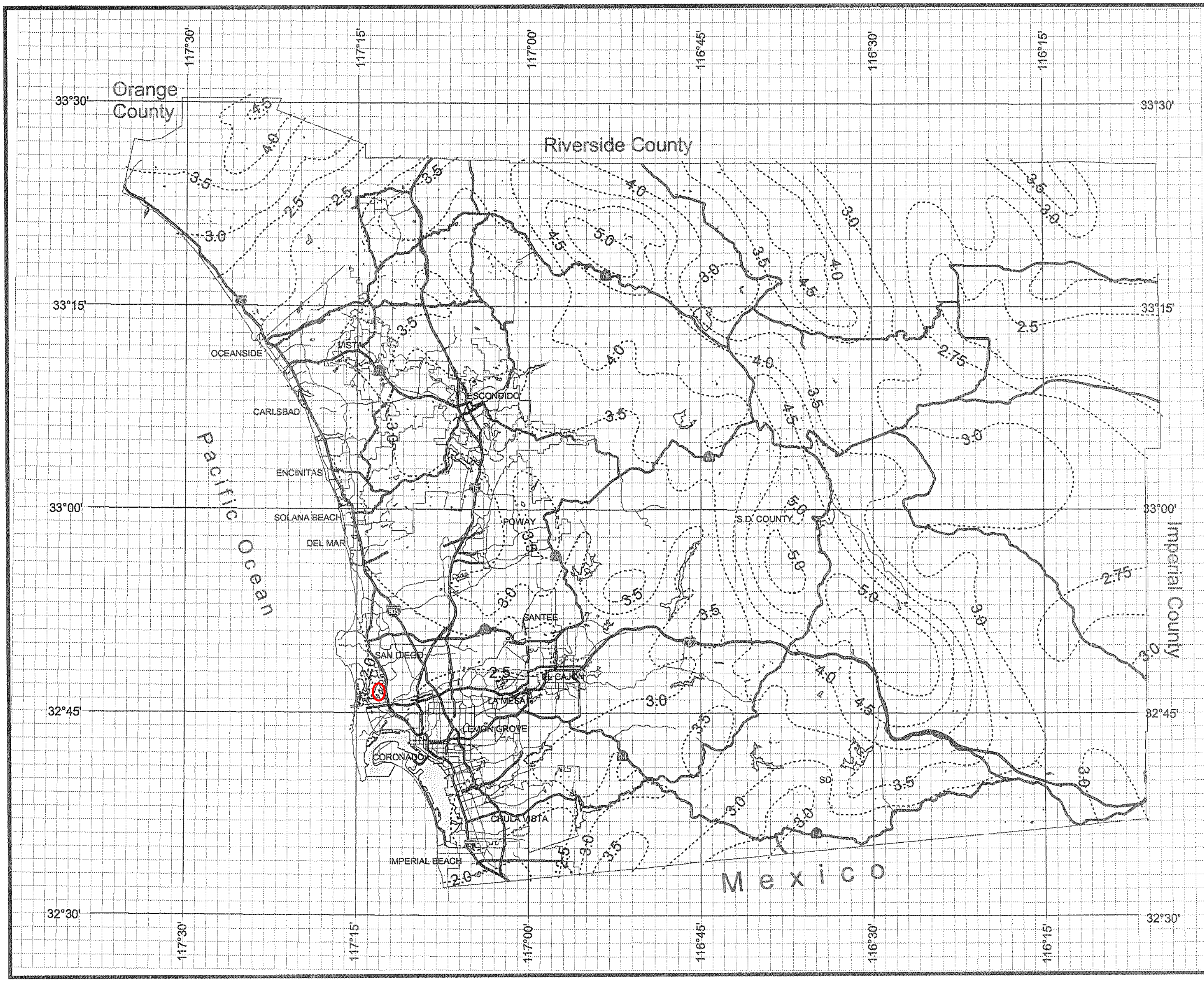
Rainfall Isopluvials



100 Year Rainfall Event - 6 Hours

------- Isopluvial (inches)

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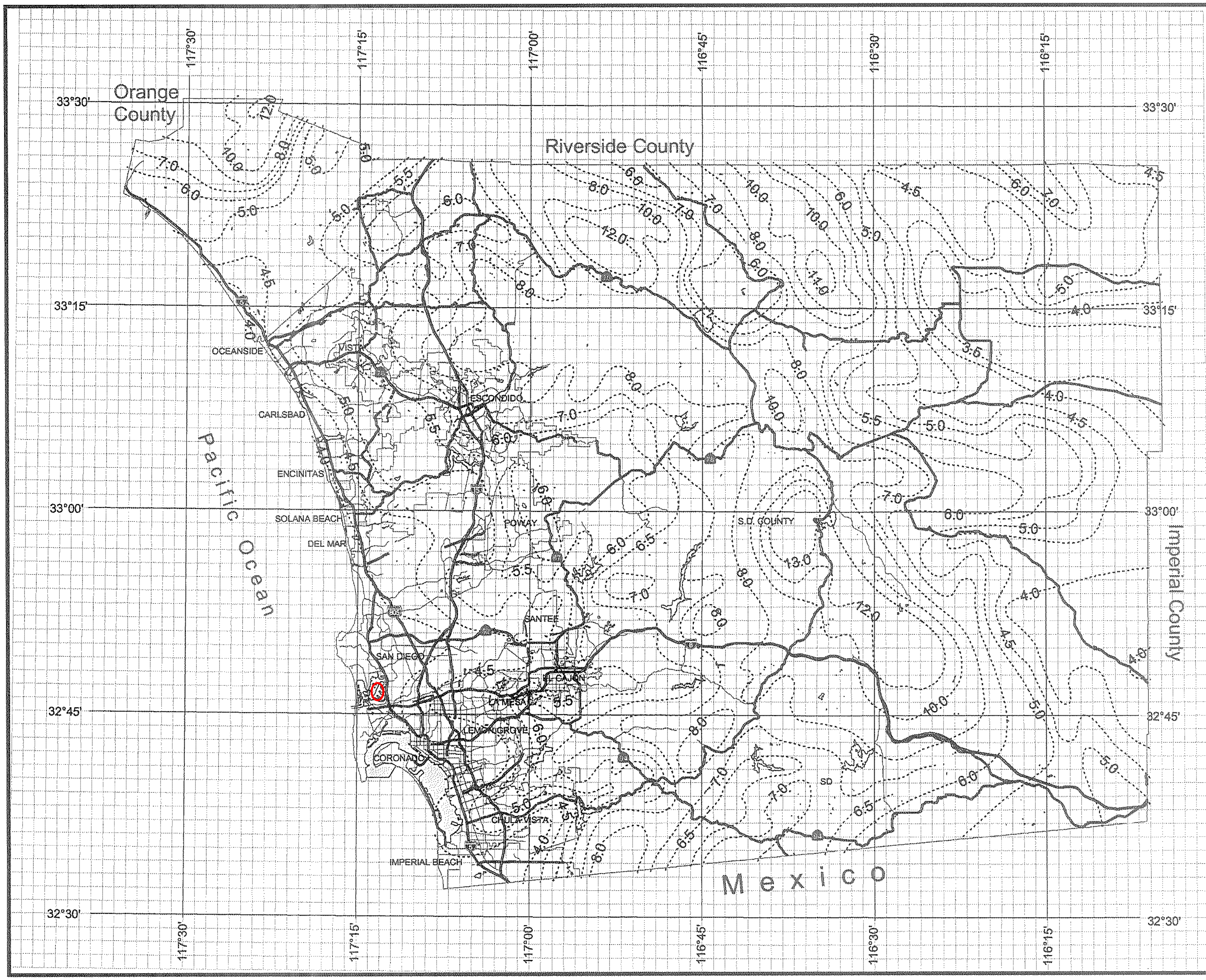
N
W E
S

3 0 3 Miles



County of San Diego Hydrology Manual

Rainfall Isopluvials

100 Year Rainfall Event - 24 Hours

------- Isopluvial (inches)

DPW GIS

Department of Public Works Geographic Information Services

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N
W E
S

3 0 3 Miles

ATTACHMENT 2
Existing Hydrology Maps

EXISTING HYDROLOGY - NORTH ISLAND

1" = 300'

LEGEND:

BASIN NAME WITH IMPERVIOUS AREA/TOTAL AREA . . . . . EX-1A 15,865 SF IMP 49,637 SF TOT

BOUNDARY OF BASIN . . . .

EXISTING IMPERVIOUS SURFACE . . . .

N

0 300 600

SCALE 1" = 300'

NE JOB NO. 115-138.1

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Surveying
Land Planning
T (858) 292-7770
4740 Ruffner Street
San Diego, CA 92111
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PROPOSED HYDROLOGY - CENTRAL ISLAND

1" = 400'

LEGEND:

BASIN NAME WITH IMPERVIOUS AREA/TOTAL AREA . . . . . (PR-1A 15,865 SF IMP 49,637 SF TOT)

BOUNDARY OF BASIN . . . .

PROPOSED IMPERVIOUS SURFACE . . . .

N

0 300 600

SCALE 1" = 300'

NE JOB NO. 115-138.1

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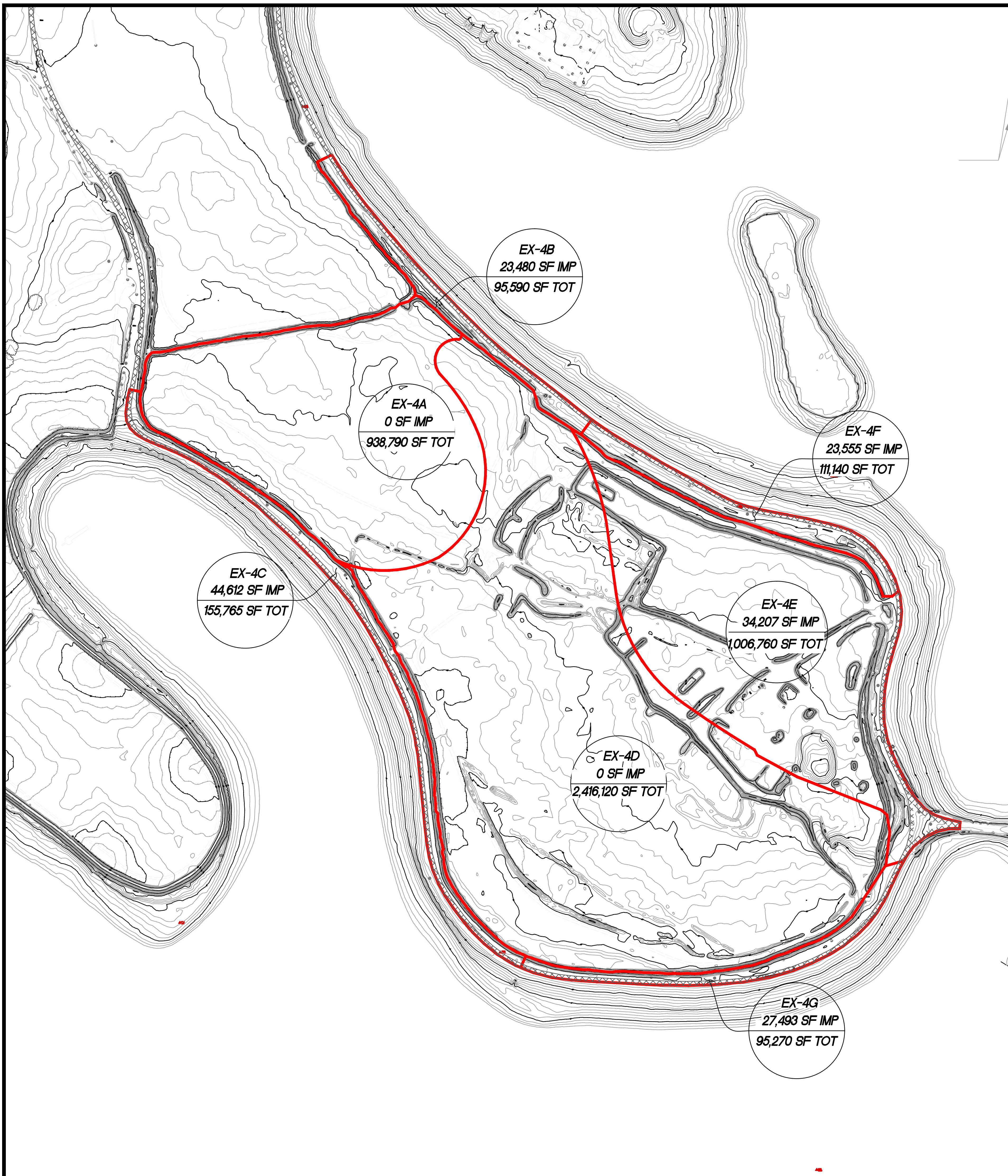

EXISTING HYDROLOGY - SOUTHEAST ISLAND

1" = 400'

LEGEND:

BASIN NAME WITH IMPERVIOUS AREA/TOTAL AREA	EX-1A 15,865 SF IMP / 49,637 SF TOT
BOUNDARY OF BASIN	(red line)
EXISTING IMPERVIOUS SURFACE	(crosshatch)

N

0 300 600

SCALE 1" = 300'

NE JOB NO. 115-138.1

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Land Planning

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San Diego, CA 92111
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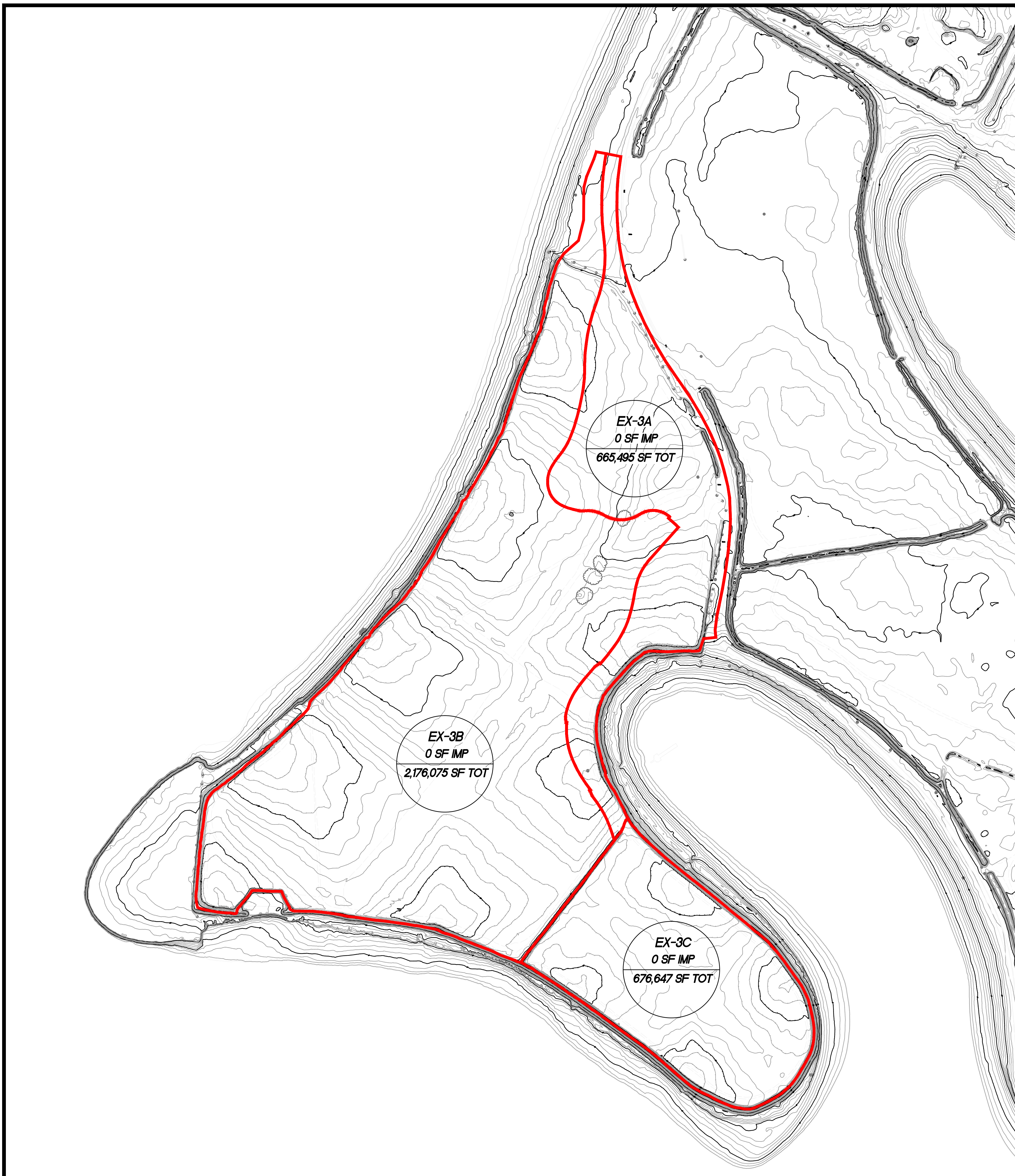

EXISTING HYDROLOGY - SOUTHWEST ISLAND

1" = 400'

LEGEND:

BASIN NAME WITH IMPERVIOUS AREA/TOTAL AREA	EX-1A 15,865 SF IMP 49,637 SF TOT
BOUNDARY OF BASIN	(red line)
EXISTING IMPERVIOUS SURFACE	(crosshatch)

0 300 600

SCALE 1" = 300'

N

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ATTACHMENT 3

Proposed Hydrology Maps

PROPOSED HYDROLOGY - NORTH ISLAND

1" = 300'

LEGEND:

BASIN NAME WITH IMPERVIOUS AREA/TOTAL AREA	PRO-1A 15,865 SF IMP 49,637 SF TOT
BOUNDARY OF BASIN	(red line)
PROPOSED IMPERVIOUS SURFACE	(cross-hatch)

N

0 300 600

SCALE 1" = 300'

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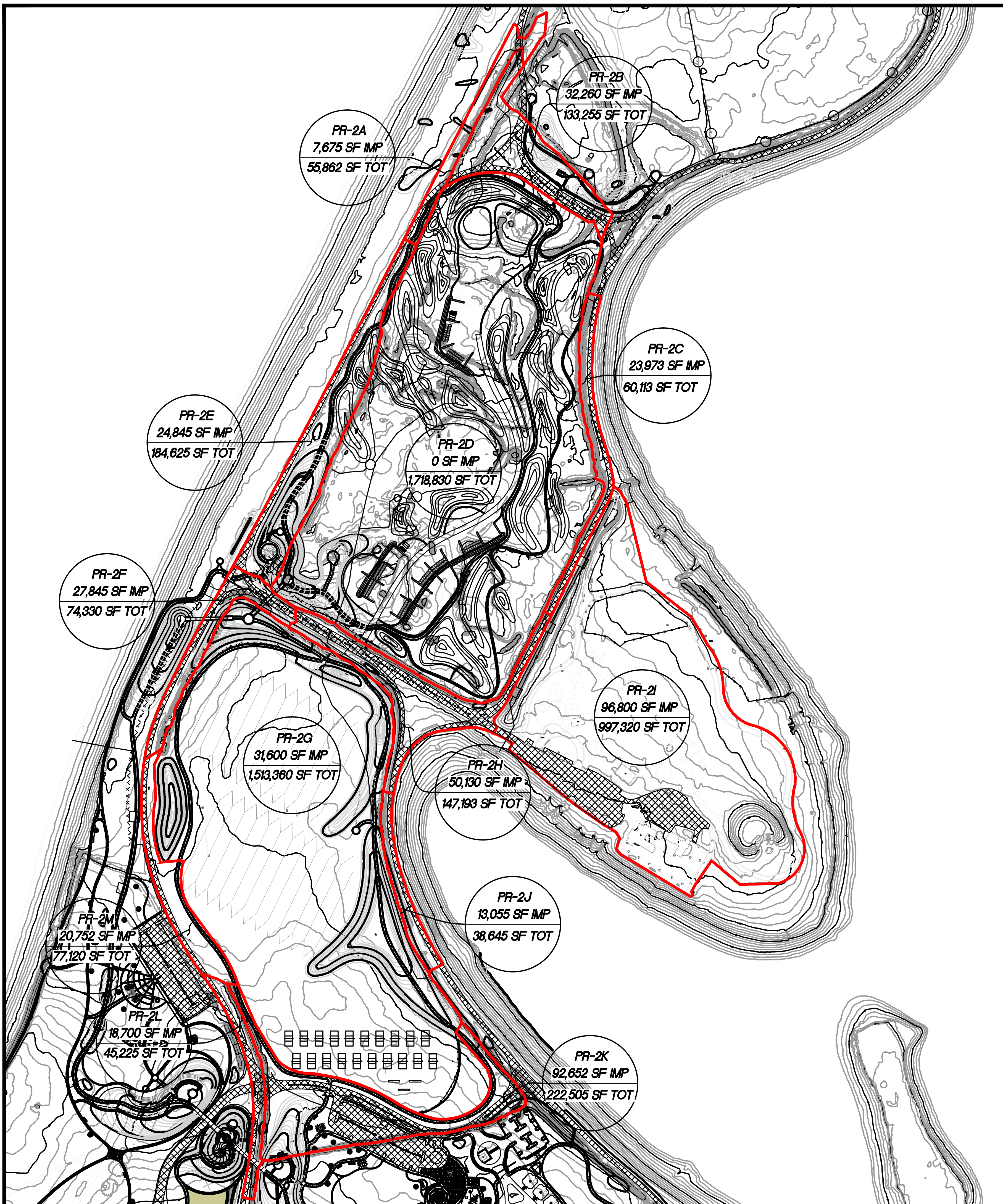

PROPOSED HYDROLOGY - CENTRAL ISLAND

1" = 400'

LEGEND:

PR-1A
15,865 SF IMP
49,637 SF TOT

BASIN NAME WITH IMPERVIOUS AREA/TOTAL AREA . . . . .

BOUNDARY OF BASIN . . . .

PROPOSED IMPERVIOUS SURFACE . . . .

N

0 300 600

SCALE 1" = 300'

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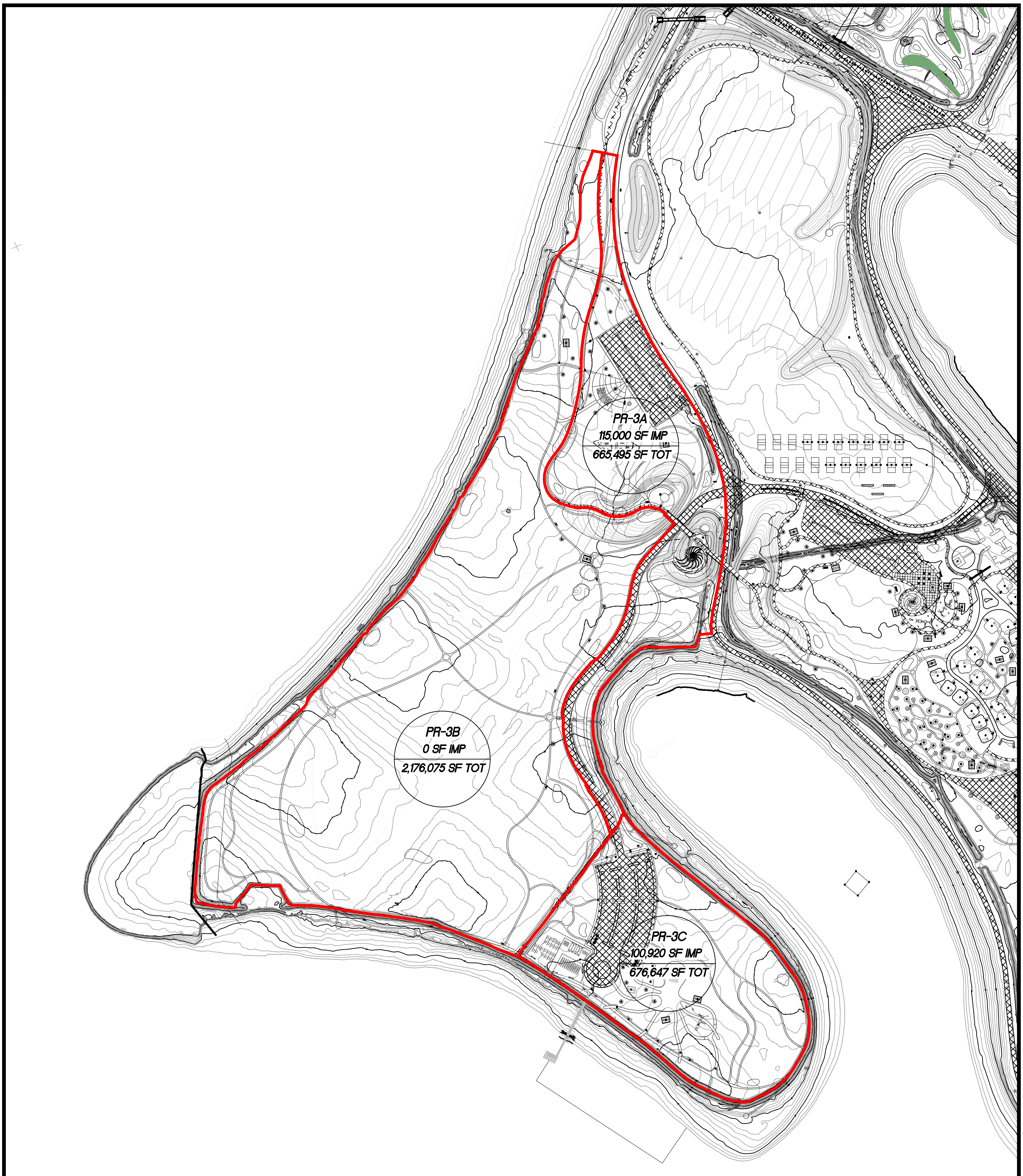

PROPOSED HYDROLOGY - SOUTHWEST ISLAND

1" = 400'

LEGEND:

PR-1A
15,865 SF IMP
49,637 SF TOT

BASIN NAME WITH IMPERVIOUS AREA/TOTAL AREA . . . . .

BOUNDARY OF BASIN . . . .

PROPOSED IMPERVIOUS SURFACE . . . .

N

0 300 600

SCALE 1" = 300'

NE JOB NO. 115-138.1

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PROPOSED HYDROLOGY - SOUTHEAST ISLAND

1" = 400'

LEGEND:

BASIN NAME WITH IMPERVIOUS AREA/TOTAL AREA . . . . . (PR-1A 15,865 SF IMP 49,637 SF TOT)

BOUNDARY OF BASIN . . . .

PROPOSED IMPERVIOUS SURFACE . . . .

N

0 300 600

SCALE 1" = 300'

NE JOB NO. 115-138.1

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ATTACHMENT 6
GEOTECHNICAL AND GROUNDWATER INVESTIGATION REPORT

Attach project's geotechnical and groundwater investigation report. Refer to Appendix C.4 to determine the reporting requirements.

GEOTECHNICAL SUMMARY REPORT
FIESTA ISLAND, MISSION BAY
SAN DIEGO, CALIFORNIA

Prepared for
KTU+A
San Diego, California

Prepared by
TERRACOSTA CONSULTING GROUP, INC.
San Diego, California

Project No. 2390
February 2, 2007

TerraCosta Consulting Group
Geotechnical Engineering
Coastal Engineering
Maritime Engineering

Project No. 2390
February 2, 2007

Mr. Michael Singleton
KTU+A
3916 Normal Street
San Diego, California 92103

GEOTECHNICAL SUMMARY REPORT
FIESTA ISLAND, MISSION BAY
SAN DIEGO, CALIFORNIA

Dear Mr. Singleton:

In accordance with your request, and our subconsultant agreement, dated January 10, 2006, we have performed a document review, a site-area geotechnical field reconnaissance, limited subsurface exploratory work, and prepared this report addressing geotechnical and coastal engineering issues pertinent to our currently active team effort to update the General Development Plan for Fiesta Island. The objective of our work is to obtain approval by the Mission Bay Park Committee, the Park and Recreation Design Subcommittee, and the Park and Recreation Board; the final goal of the process being adoption by the City Council of the General Development Plan as a guiding document for future Fiesta Island development under the Mission Bay Master Plan.

The accompanying report presents the results of our document review, site-area geotechnical field reconnaissance, subsurface exploratory work, and our conclusions and recommendations in cooperation with team specialists in related disciplines.

We appreciate the opportunity to be of service and trust this information meets your needs. If you have any questions or require additional information, please give us a call.

Very truly yours,
TERRACOSTA CONSULTING GROUP, INC.

Walter F. Crampton, Principal Engineer
R.C.E. 23792, R.G.E. 245

Braven R. Smillie, Principal Geologist
C.E.G. 207, R.G. 402

WFC/BRS/sd
Attachments

(1) Addressee
(1) Keith Merkel, Merkel & Associates
(1) Larry Thornburgh, Nasland Engineering

TABLE OF CONTENTS

GEOTECHNICAL SUMMARY REPORT
FIESTA ISLAND, MISSION BAY
SAN DIEGO, CALIFORNIA

1 INTRODUCTION

The Mission Bay Park Master Plan envisions a relatively low level of open landscape development for the 442-acre Fiesta Island, which currently includes park land, a youth and primitive camping area, an upland preserve and salt-pan habitat, open beaches, and with a few "hard" structures such as the Aquatic Center buildings and restrooms, a two-lane access roadway, and limited parking in various areas. We understand that individual projects under consideration for the island include possible upgrading of the island-access causeway; dedication of a Least Tern nesting area at the north end of the island, to be separated from areas of more intensive use by an open (or partially open) channel, and served by an access/connector causeway or low-water crossing; construction of minor lightly loaded structures such as restrooms, equipment storage buildings, etc.; and regrading of selected individual areas to mitigate ongoing erosion.

2 PROJECT DESCRIPTION

The purpose of this report is to provide background planning information on the geotechnical characterization, coastal processes, and long-term stability of future improvements within generalized areas of the island. The City of San Diego and other agencies (such as the California Coastal Commission) with jurisdiction over grading and construction improvements on Fiesta Island will, of course, require site-specific geotechnical reports for each individual project.

3 SUBCONSULTANT TEAMWORK

We have reviewed available geologic, geotechnical, and coastal documents, including historic (predevelopment) stereopair aerial photographs, from various on-line sources, and from our office files. We have discussed project geotechnical issues with you and your subconsultants in periodic meetings since early January 2006, and participated in a team field reconnaissance of Fiesta Island on Tuesday, January 10, 2006.

Finally, as an aid to our evaluations of geotechnical and coastal processes, we have reviewed specific project issues with both Keith Merkel of Merkel & Associates and Larry Thornburgh of Nasland Engineering in order to enhance understanding in those areas where our disciplines are interdependent.

4 SCOPE OF WORK

As required for updated input to the General Development Plan, our document review, site reconnaissance, evaluation, and report preparation were focused on:

- The geologic setting of Fiesta island;
- Topographic and subsurface conditions;
- Geologic hazards;
- Geotechnical issues, including foundation support for buildings, alternatives for both the island-access causeway and the Least Tern area access/connector;
- The existing coastal processes environment; and
- Shoreline stability and erosion.

We understand that water quality issues are being addressed by Mr. Keith Merkel of Merkel & Associates. Regarding issues relating to soil-support for building foundations and/or structural fills (such as the island-access and Least Tern area access/connector), we are consulting with Mr. Larry Thornburgh of Nasland Engineering.

5 GEOLOGIC SETTING

5.1 Geologic and Recent History

Mission Bay covers most of the former delta of the San Diego River. Historic records indicate that major storm events have periodically diverted the flow of the San Diego River alternatively to the north or south of the Loma Portal rise between the San Diego Embayment and Mission Bay (previously known as "False Bay").

By the early 1950s, the river levees and the Mission Bay jetties were completed, confining San Diego River flows to a new man-made river channel that discharges into the ocean only during peak flooding periods.

Mission Bay was dredged during the 1950s, approximately to its current configuration in that part of the former river delta north of the existing man-made river channel. Topography within Mission Bay consists of low-lying dredged islands and channels bounded on the south by the Ocean Beach/Sunset Cliffs rise; on the east by the very steep westerly slopes of the Lindavista Terrace; and on the north by Pacific Beach and the La Jolla Terrace. Crown Point, an extension of the La Jolla Terrace, protrudes into the north-central third of Mission Bay. To the west, Mission Bay is bounded by the Mission Beach sand bar, a narrow sand strip extending south from Pacific Beach to the Mission Bay entrance channel.

Surface exposures in the Mission Bay area include late Quaternary-age (geologically recent) fluvial, beach and embayment deposits, most of which have been transported and placed at least once during several phases of hydraulic dredging. These unconsolidated silts, sands, and clays technically are classified and mapped as artificial fill material. However, fluvial tidal storm wave and wind erosion (natural processes) are constantly re-depositing the dredged soils as "natural" sediments.

Like all of the major coastal drainage areas in the region, Mission Bay was incised rapidly during mid to late Quaternary periods of glacial advance when sea level was 300 to 400 feet below present-day levels; and then, during the past 18,000± years, a geologically rapid eustatic rise in sea level caused large volumes of alluvial sediment to fill the coastal drainages to depths on the order of 70 to 120 feet. Figure 1, adapted from Abbott (1999), provides generalized plan and cross-sectional views of the Mission

Bay area. Figure 2 (taken from U.S.D.A. Photo No. AXN-4M-91, flown March 31, 1953) shows the Fiesta Island site-area as a characteristic "tidal flat" prior to the dredging and grading of the 1950s which essentially completed the configuration of Mission Bay. Figure 3, flown February 2, 1988, shows the extent to which rectangular sludge-drying ponds (reportedly since abandoned, regraded, and the dried sludge hauled off-site) covered the southwesterly part of the island. Figure 4 (NOAA) shows currently available bathymetric data for the Fiesta Island area with depths recorded in fathoms and feet (subtext).

5.2 Geologic Structure and Stratigraphy

Figure 1 (Abbott, 1999) presents a generalized geologic map and cross-section to illustrate the structural and stratigraphic setting of the Mission Bay area westerly of the Rose Canyon fault zone, currently classified as "active" by the California Geologic Survey. Section 6.4 of this report, "Geologic Hazards," presents a brief summary of potential project-area geologic hazards related to faulting and seismicity.

Our document review indicates that Fiesta Island is underlain by from 10 to 30 feet of hydraulic fill soils, in turn underlain by an estimated 70 to 80 feet of Holocene-age deltaic fluvial and estuarine deposits, and, at approximately 80 to 110 feet of depth, underlain by Quaternary- and Tertiary-age formational units, shown on the Figure 1 cross section as a down-warped syncline in the Mission Bay area, between the Mount Soledad and Point Loma structural highs.

5.3 Island Construction

The dredging and development of Mission Bay spanned a total of 16 years, with the City's first dredging operation commencing in early 1946. Between 1946 and 1956, the City completed dredging in the west bay, west of Ingram Street, at the same time creating some new land areas with dredged material. In addition, a narrow channel was dredged in the east bay to DeAnza Cove, with DeAnza Point created by this dredged material. In 1956-57, the City Engineering and Planning Department prepared preliminary drawings of a master plan for the area, which included a series of wash borings taken throughout the area to be dredged, the results of which indicated considerable variability throughout the bay, with soils ranging from relatively clean sands to highly compressible silts and clays. These soft silts and clays were predominantly found in the more northern parts of the East Basin where the finer fraction of the alluvial outwash during flood flows from the San Diego River and Tecolote Creek would eventually settle out in these more quiescent waters.

The initial plan as part of the 1956-57 City studies was to dispose of several million cubic yards of compressible silts and clays in the ocean. However, vigorous public opposition to offshore disposal encouraged the City to add an additional island in the bay (Fiesta Island) and make this a disposal area. The island would have, as margins, 200-foot-wide sand levees and be covered with a minimum of 3 feet of sand.

Considerable difficulty was experienced in forming the dikes on the north side of Fiesta Island. Since this area was known to contain the poorest material in the bay, a silty clay, trouble had been expected. The sand settled into the silty clay as much as 6 to 8 feet, causing a mud wave on the outboard side of the dike. The width of the dike in this area was increased and the excess yardage caused by the mud wave was ultimately removed. Between 1959 and 1961, Mission Bay was dredged to its current configuration, with virtually all of the silts and clays pumped into the bottom of Fiesta Island. Subsequent improvements to DeAnza Point in 1963-64 resulted in some additional dredging along the western shores of Fiesta Island, encroaching into the original 200-foot-wide sand dike to provide additional granular fill for DeAnza Point (San Diego Historical Society, 2002).

Given the preceding, and recognizing that the dike disposal areas were compartmentalized to facilitate the dredge disposal, the current composition of Fiesta Island is highly variable with the potential for subsurface clean sands (a containment dike) immediately adjacent to highly compressible silty clays. This condition can be encountered across any proposed building foundation and site-specific geotechnical investigative work will be required to determine any specific geotechnical foundation requirements.

5.4 Causeway Construction Concerns

All of the Fiesta Island General Development Plan alternatives consider improvements to the main entry causeway, with several of the alternatives, including Alternative 4, considering a sheet-pile bulkhead along both sides of the causeway. The presence of any large rock or debris along the proposed bulkhead alignments would result in a substantially increased construction cost. Thus, as part of this project, it was considered important to address these concerns with a subsurface exploratory program to confirm the presence or absence of any debris along the proposed bulkhead alignments. In response to this concern, we performed a field investigation to determine the subsurface conditions in the area of the causeway. That work consisted of jet probing at 22 locations along both sides of the causeway to depths up to 15 feet (see Figure 5). The probe points were advanced by pumping water through a 3/4-inch pipe to remove fines ahead of the pipe as it was advanced. Soil conditions were determined by both feel of the pipe as it was advanced and by observation of the cuttings that were returned to the surface. The results of the jet probing are summarized in Table 1.

Our field work indicated that the causeway was originally constructed by placing an estimated 3- to 5-foot-thick cobble and gravel fill in the area of the roadway to bridge the soft bay sediments and provide support for the roadway. Observations also indicate that additional fill soils were placed along the sides of the roadway, apparently in an attempt to repair and control erosion of the causeway. These secondary fills consist of loose, and likely dumped clayey sand fill with sandstone boulders (Figure 6). Underlying the roadway fills are estuarine deposits consisting of interbedded sands, silts, and clays with occasional gravels, provisionally deposited by the San Diego River and Tecolote Creek.

In summary, although the surface sandstone boulders will require removal, there is no large rock or debris along the proposed bulkhead alignment below the surface boulders that would preclude the installation of sheet-pile bulkheads, when using conventional vibratory pile driving equipment.

6 TOPOGRAPHIC AND SUBSURFACE CONDITIONS

6.1 Topography

Published topographic maps indicate that surface elevations across Fiesta Island generally range from 10 to 25 feet (MSLD), with the higher elevations generally concentrated along the northwest-southeast "leg" of the island, which is connected by the access causeway to the mainland. Ten- to 15-foot-high impoundment berms or dikes, originally constructed to contain discharge from the hydraulic dredges, are still a prominent feature around the perimeter of the island, and also across the island in areas where smaller settlement basins were apparently needed. Figure 7 (an aerial-oblique photo taken in 2005) shows the present-day extent of these impoundment-dike systems.

6.2 Soil and Geologic Units

Appendix A presents a site plan and logs from Test Boring Nos. 15, 16, 17, 19, and 20, drilled as part of the geotechnical investigation for the "Mission Bay Park Resort" (also called "Ramada Renaissance, Mission Bay"), and reported September 27, 1983, by Woodward-Clyde Consultants, Inc. The approximate locations of these test borings have also been superimposed on Figure 2 of the main report and reproduced again in Appendix A. Giving due consideration to the discussion in Island Construction in Section 5.3, we believe the geotechnical characteristics and consistencies reported on the logs are likely to be generally representative of the subsurface soils below the containment dikes and compressible bay muds described in Section 5.3. These soil units are described below.

Hydraulic Fill: As indicated in Section 5.3, Fiesta Island was created entirely by the placement of hydraulically-dredged bay deposits, which were then pumped into a series of containment dikes, decanted, and then capped with a minimum of 3 feet of sand. These near-surface, hydraulically placed fills are estimated to be 10 to 30 feet in total thickness and consist of materials ranging from gray to brown, silty fine to coarse sands and fine sandy silts to soft silty clays. Most of the hydraulic fill soils also contain abundant shell fragments. The consistency of these materials, as characterized by blow count, ranges from very loose/soft to medium dense.

Holocene Alluvium: Loose to medium dense, saturated, gray interbeds of silty fine sands and firm to stiff clays (micaceous with shell fragments) characterize, in general, the Holocene fluvial and estuarine alluvial deposits, which underlie the hydraulic fill, and range in thickness from an estimated 70 to 80 feet.

Quaternary and Tertiary Formational Soils: At depths on the order of 70 to 110± feet, the above-described alluvial sediments are underlain by very dense, saturated, brown, medium to coarse silty to clayey sands, with gravels and cobbles. These very competent formational soils are characteristics of San Diego-area, Quaternary- Tertiary-age sediments.

6.3 Groundwater

The groundwater table was encountered in the test borings at approximately Mean Sea Level, corresponding to, or within a few feet of, the bottom of the hydraulic fill material. Moreover, throughout the island, it should be anticipated that the groundwater will fluctuate with the tide with increased attenuation as a function of distance from the bay.

6.4 Geologic Hazards (Faulting, Seismicity/Liquefaction Potential)

The loose, and loose to medium dense cohesionless soils (sands and silts), which make up a significant part of the 70 to 80 feet of Holocene sediments below the water table are susceptible to a temporary, but essentially total, loss of shear strength due to reversing cyclic shear stresses caused by moderately strong seismic ground shaking. Analyses based on the results of penetration resistance tests in these deposits indicate that they could lose their strength if peak ground surface accelerations were to exceed about 0.15 to 0.2g. In their geotechnical report dated September 27, 1983, Woodward-Clyde Consultants estimated an average recurrence interval of about 100 years peak ground acceleration of 0.15g at the then-proposed Ramada Renaissance Hotel site on the southeast side of Sea World Drive (at Friars Road), approximately ½ mile west of the active Rose Canyon fault zone, and immediately southeast of Fiesta Island.

The Woodward-Clyde report also describes the likely manifestations of seismically-inducted liquefaction at the site, such as the expulsion of sand and water from sand boils, ground cracking, vertical settlement, and lateral displacement, generally toward the shoreline.

7 GEOTECHNICAL DISCUSSION AND CONCLUSIONS

7.1 Foundation Support for Buildings, Walls, and Minor Ancillary Structures

The hydraulic fill soils within the upper 10 to 30 feet of depth on Fiesta Island are known to be prone to wide variations in settlement potential, both vertically and laterally. This variability is, at least in part, due to the fact that coarser materials (sand and shells) tend to settle out of suspension relatively near the end of the hydraulic dredge discharge pipe, whereas finer materials (silts and clays) tend to settle out of suspension farther away. Also adding to the potential for differential settlement is the fact that there have been generations of grading and regrading to construct and remove various dikes, pits, ponds, stockpiles, and access trails without benefit of any systematic soil compaction, compaction (compliance) testing, and site-specific mapping typically required for engineered cut and fill grading operations.

In order to mitigate, or reduce, the potential for differential settlement of planned small (lightly loaded) buildings and ancillary structures, future site-specific geotechnical investigation reports may recommend the construction of a uniformly compacted soil mat, by removal and recompaction of the foundation soils to a depth suitable for the proposed building loads (to be determined by the design geotechnical engineer). A structural mat foundation may also be used to structurally accommodate differential soil settlements, thereby eliminating, or at least reducing, the amount of required overexcavation and recompaction. The potential for differential settlement of any walls can be mitigated to some extent by expansion joints, the location and spacing of which should be determined by consultation between the design geotechnical and structural engineers.

Any large or settlement-sensitive building loads can also be supported on deep foundations consisting of either piles or drilled piers.

7.2 Roadway Considerations

Although the subsurface soils comprising Fiesta Island are variable in nature, the near-surface soils generally consist of relatively coarse sands, which should provide excellent subgrade support. Although we have not performed any R-value tests of the on-site soils, we anticipate that the near-surface sandy soils may exhibit R-values approaching 50. Assuming a design traffic index (TI) of 4.5 for typical passenger car traffic, a typical pavement section would consist of 3 inches of asphalt concrete on 4 inches of Class II aggregate base. Please note, however, that at least portions, if not all, of the island's roads are occasionally trafficked by the City's heavily-loaded sand maintenance vehicles, and these roadway surfaces will require a substantially thicker design pavement section.

7.3 Island-Access Causeway - Construction Alternatives

The existing island access causeway is currently proposed to be widened to a total width of 48 feet, with two vertical bulkheads supporting the new causeway. Hydraulic jetting along both proposed bulkhead alignments did not encounter refusal on any buried obstructions, and although large sandstone boulders exist along the southerly side of the existing causeway, we anticipate no construction difficulties in installing these vertical sheet-pile bulkheads. Although insufficient information was obtained for a formal bulkhead design, we anticipate that the bulkheads would be vibrated into place and restrained near their tops with a series of tierods spanning between the two bulkheads.

7.4 Least Tern Area Access/Connector - Construction Alternatives

The northerly least tern causeway also includes several alternative designs, including an elevated bridge, a vertical sheet-pile bulkhead, and an earthen embankment, the latter of which would likely include at least limited slope protection to protect the pavement section. As indicated in Section 5.3, we anticipate that as the eelgrass/lagoon and low salt marsh areas are excavated adjacent the causeway, soft silts and clays will be encountered and may require limited overexcavation beyond the plan dredge depths and recapping with more granular soils, depending upon the marine habitat requirements. Even with these anticipated near-surface soft silts and clays, the geotechnical requirements for any of the causeway alternatives are relatively straightforward and should not create any constraints to the currently proposed northerly causeway alternatives.

7.5 Surface Infiltration

As indicated previously, while virtually the entire surface of Fiesta Island is covered with relatively permeable sandy soils, the underlying soils are variable in nature and at times are relatively impermeable This said, however, we anticipate that sufficient near-surface permeable soils exist throughout the majority of the island to facilitate the use of bioswales as the currently proposed method of capturing and treating runoff from pavement surfaces throughout the island. Bioswales may locally incorporate perforated underdrains with drain rock to accommodate near-surface infiltration where less permeable soils are encountered along any given bioswale alignment. Bioswales are particularly useful around parking lots and roadway surfaces where substantial automotive pollution is collected by the paving and then flushed by rain, where the vegetation treats the runoff before releasing it downstream. As all of the perimeter roadways are currently designed to slope inward away from the bay, a series of small storm drains will be incorporated into these bioswales for excess runoff exceeding the infiltration capacity of the system to discharge into the bay. It is anticipated that under these conditions, any residual automotive pollution would have been first captured and treated by the bioswale, with the excess runoff from heavy rainfall then discharging relatively clean storm waters into the bay.

Elsewhere within the interior of the island, provisions will be made to maximize infiltration with additional site-specific geotechnical exploratory work likely necessary to confirm that proposed infiltration areas coincide with subsurface soils with higher permeabilities. It may also be locally necessary to add seepage pits in areas where more pervasive fine-grained dredge spoils exist to penetrate beneath these more impermeable dredge spoils and reacquire more permeable soils at depth.

8 SHORELINE STABILITY

8.1 Existing Coastal Processes Environment

Tides are caused by the gravitational pull of astronomical bodies; primarily the moon, sun, and planets. Tides along the San Diego coast have a semi-diurnal inequality. On an annual average basis, the lowest tide is about -1.6 feet (MLLW datum) and the highest tide is about 7.1 feet, MLLW datum.

The National Oceanic and Atmospheric Administration (NOAA) collected 18 years of measurements at La Jolla in establishing tidal datums of the 1960 to 1978 tidal epoch (NOAA, 1978). Tidal characteristics at the La Jolla Tidal Station are shown in the following table. The highest recorded sea level at the La Jolla Pier Gauge was 7.81 feet, MLLW, on August 8, 1993.

San Diego Tidal Characteristics at La Jolla
(elevation in feet referenced to mean lower low water, MLLW)

Highest observed water level (Aug. 8, 1983)	7.81
Mean Higher High Water (MHHW)	5.37
Mean High Water (MHW)	4.62
Mean Sea Level (MSL)	2.75
Mean Tide Level (MTL)	2.77
National Geodetic Datum - 1929 (NGVD)	2.56
Mean Low Water (MLW)	0.93
Mean Lower Low Water (MLLW)	0.00
Lowest observed water level (Dec. 17, 1933)	-2.6

El Niño Events

Large-scale, Pacific Ocean-wide warming periods occur episodically and are related to the El Niño phenomenon. These meteorological anomalies are characterized by low atmospheric pressures and persistent onshore winds. During these events, average sea levels in southern California can rise up to 0.5 foot above normal. Tidal data indicates that six episodes (1914, 1930 through 1931, 1941, 1957 through 1959, and 1982 through 1983, and 1997 through 1998 - mild El Niño-type conditions were also reported in 1988 and 1992) have occurred since 1905. Further analysis suggests that these events have an average return period of 14 years, with 0.2-foot tidal departures lasting for two to three years.

The added probability of experiencing more severe winter storms during El Niño periods increases the likelihood of coincident storm waves and higher storm surge. The record water level of 8.35 feet, MLLW, observed in San Diego Bay in January 1983, includes an estimated 0.8 foot of surge and seasonal level rise (Flick and Cayan, 1984), which set the stage for the wave-induced flooding and erosion that marked that winter season.

Sea Level Rise

Continuous sea level records exist from a tide gauge in San Diego Bay beginning in 1906, and from a tide gauge in La Jolla beginning in 1924. Figure 8 shows a plot of yearly mean sea level for the tide gauge in San Diego Bay based on data published by the National Ocean Service (NOS). The straight line represents a least-squares fit of the data and indicates a mean rate of sea-level rise of 0.69 foot per century. The shaded areas above the trend line correspond to above-average sea level episodes corresponding to major El Niño events (Quinn, et al., 1978). The highest sea levels in La Jolla were observed on January 29, 1983 (7.71 feet MLLW), and August 8, 1983 (7.81 feet MLLW). These episodes were part of a run of El Niño and storm-influenced extreme events that occurred during the 1982-1983 storm season. The 8.35-foot extreme tidal level recorded in San Diego Bay during this same period is due to the tidal amplification that occurs within the sheltered bay location. In Mission Bay, during these same high tide periods, flooding was reported along the southerly terminus of West and East Briarfield Drive and Dawes Street, where these public street ends terminate into the northern edge of Sail Bay. Assuming sea level continues to rise at its current rate, within the next century, extreme tidal levels within the site vicinity could be expected to reach elevation 9.0 feet, MLLW.

Winds and Waves

The winds are primarily from the west, with wind velocities averaging 5 to 10 mph throughout the year. Statistically, extreme sustained wind speeds approaching 50 knots are expected off the Southern California coast below 35 degrees latitude once in one hundred years (NOAA, 1980). Wind roses for San Diego/Lindbergh Field are provided on Figure 9 for the periods 1984 through 1988. These data illustrate the predominant northwesterly winds and are comparable to other wind data reviewed.

Fiesta Island is exposed to wind-driven waves from the southwestern through northern quadrants, with fetches typically limited to about 1/2 mile, except from the southwest through the Mission Bay Channel, and from the north over Kendall Marsh, with both of these quadrants providing maximum fetch lengths approaching 7,500 feet. The presence of shallow water within the bay further limits the height of these fetch-limited wind waves, with wave heights on the order of 2 to 2½ feet, with corresponding wave periods on the order of 2 to 3 seconds from 50 knot sustained winds.

Offshore storm waves propagating into Mission Bay are also major contributors to shoreline erosion within the bay and responsible for the rock revetments lining the entire entrance channel extending to Vacation Isle and on to Stony Point. When coupled with westerly winds, offshore storm waves, propagated through Mission Bay Channel and on to Stony Point, can sustain 3-foot waves with significant transport capacity northerly along the western face of Fiesta Island and easterly along Pacific Passage.

8.1.1 *Tidal Currents*

Inlets backed by substantial tidal prisms generate relatively strong tidal currents capable of moving fine-grained sands. The entrance to Santa Barbara Cove, Mariner's Basin, Quivera Basin, and the North pacific Passage are typical of this condition. Main channel areas, such as Fisherman's Channel, the easterly and southerly perimeters of Vacation Isle, and the throat of the main channel extending from Ventura Point out into the ocean, also experience relatively strong tidal currents.

Fine-grained sands with an average grain size ranging from 0.1 to 0.3 millimeters have a threshold velocity on the order of 0.65 feet per second, beyond which sediment movement occurs. As part of the 1992 Mission Bay Test Sand Project, TerraCosta's predecessor firm (Group Delta Consultants-San Diego) conducted tidal current measurements in and adjacent to Fishermans Channel during a maximum spring ebb tide to measure tidal velocities along the channel edge, specifically addressing that zone of tidal currents directly above the sand beach that would contribute to sediment transport (Group Delta, 1992).

A total of four S4 Sea Data electromagnetic current meters were deployed in and adjacent to Fisherman's Channel to measure the maximum flow velocities within the channel and the variation in velocity throughout the tidal cycle. Maximum measured current velocities exceeded 40 cm per second (1.31 feet per second) in mid-channel, with current velocities approaching 0.9 foot per second along the edges of Fisherman's Channel. Site 4 in that study was located midway up the east side of Crown Point Shores, well away from the Fisherman's Channel constriction, where maximum current velocities approaching 0.25 foot per second were measured.

Based on this 1992 current measurement data, and recognizing that both the Northern Pacific Passage and the Southern Pacific Passage both north and south of Fiesta Island are less constrained than Fishermans Channel, and with less tidal prism than that feeding Fishermans Channel, one could conclude that maximum tidal currents around the north end of Fiesta Island might approach 0.6 foot per second, while the maximum tidal currents southerly of Fiesta Island might be on the order of 0.25 foot per second. Although tidal currents locally play a major role in sediment transport within Mission Bay, we doubt that tidal currents have much, if any, influence on sediment transport adjacent to Fiesta Island.

8.1.2 *Boat-Induced Waves*

Both waterskiing and speedboat races maintain a counter-clockwise traffic pattern that tend to produce unidirectional boat-induced waves along at least portions of the Mission Bay shoreline, including Fiesta Island. For small recreational power boats with modest draft and running on a plane in a counter-clockwise traffic pattern within Ski Bay, boat-induced waves along Fiesta Island are likely on the order of 0.4 to 0.6 foot, approaching from an azimuth of approximately 240 degrees true. Although less frequent, any larger draft vessels in the bay will generate correspondingly larger boat wakes. Boat-induced waves are likely a major contributor to shoreline erosion in localized areas where tidal currents and other wave sources provide limited contribution.

8.1.3 *Inland Flooding*

Inland flooding from Rose and Tecolote Creeks primarily results in sediment deposition within the North Pacific Passage and Rose Inlet. Depending upon the severity of the storm, localized channel degradation may occur near the mouths of these inlets.

8.2 **Shoreline Materials**

As part of the 1988 and 1989 geotechnical work in support of the Mission Bay Shoreline Restoration and Stabilization Master Plan, GDC performed a total of 35 shore face profiles, four of which were surveyed on Fiesta Island, along with a total of 100 sediment samples taken at or slightly above mean sea level, 22 of which were taken around the shoreline of Fiesta Island. The results are reproduced herein in Appendix B. The 100 samples were visually examined and classified with an optical comparator at a resolution of 0.02 mm.

In summary, the shore face materials along the westerly shoreline of Fiesta Island, and extending to the northeasterly point where a spit typically forms, had average grain sizes ranging from 0.2 to 0.3 mm, which corresponds to a fine sand when using the Unified Soil Classification System. Of the eight samples along the south shore of Fiesta Island immediately easterly of Stony Point, the material was noticeably finer than along the western shoreline, locally with silts encountered (less than 0.074 mm) and typically very fine sands ranging from 0.1 to 0.2 mm. The results of the six grain size curves are also included in Appendix B.

8.3 **Shoreline Erosion and Accretion Within Mission Bay**

Once sediment is placed in suspension, any longshore currents will tend to move the suspended sediment in the down-current direction, eventually building a shoal area, spit or fillet, in a more quiescent down-drift area. Longshore currents are generated by the longshore component of motion and waves that obliquely approach the shoreline. Within Mission Bay these currents are also augmented by tidal currents. Obliquely approaching waves are refracted by the rising shoreline, resulting in a breaking wave angle somewhat different than that of the originally generated deep-water wave.

The longshore component of wave energy is actually affected by both refraction and shoaling, and may be assumed to be proportional to the product $(\cos\alpha_0)^{1/4}\sin 2\alpha_0$, where α_0 is the angle between the deep-water wave crest and the shoreline. This relationship indicates that maximum wave energy available for longshore transport occurs when the incident deep-water wave approaches at an angle of 42 degrees from the shoreline, and reduces to zero (0) when the incoming wave (wind field) is parallel to the shoreline, or at right angles to the shoreline.

Wind-driven waves develop in response to sustained wind stress on the water surface, and are strongly dependent upon the length of water surface available to develop the wave form. Water depth also affects wave generation and, for a given set of wind and fetch conditions, wave heights will be smaller and wave periods shorter than in a similar deep water environment.

The U.S. Army Corps of Engineers recommends four basic methods for use in the prediction of longshore transport rate (Shore Protection Manual, COE 1984). These have been reproduced herein as follows:

1. The best way to predict longshore transport at a site is to adopt the best known rate from a nearby site, with modifications based on local conditions;

2. If rates from nearby sites are unknown, the next best way to predict transport rates at a site is to compute them from data showing historical changes in the topography of the littoral zone (charts, surveys, and dredging records are primary sources). Some indicators of the transport rate are the growth of a spit, shoaling patterns, and deposition rates at an inlet;

3. If neither Method 1 or Method 2 is practical, then it is accepted practice to use either measured or calculated wave conditions to compute a longshore component of wave energy flux, which can be simplified to deep-water wave height and angle of approach; and

4. By empirical numerical models that estimate gross longshore transport rate as a function of a particular variable, such as mean annual nearshore breaker height (Galvin, 1972).

Although only limited data has been developed in the past for numerical assessment of erosion rates, considerable experience does exist regarding both trends in shoreline erosion and actual rates of sediment transport at various locations throughout the Bay, resulting from the many years of beach maintenance activities that, at one time, included the recapture of shoaling sands at various downdrift locations. That information was, in part, used to develop the original Mission Bay Shoreline Restoration and Stabilization Master Plan (Pountney and Assoc. 1990).

At North Vacation Island, significant sediment transport has, in the past, developed a sand spit extending well out into North Cove, and past maintenance activities, which at one time included recapture of the sand and replacement on the northwest shoreline of Vacation Village, would suggest average annual sediment transport rates on the order of 800 cubic yards per year (600 m^3/yr). Likewise, at Crown Point Shores, a minor net southerly drift has been observed in the past, and occasionally regraded as necessary to dress up the small beach scarps that develop in the area. Although somewhat more difficult to predict, annual transport rates in this area are likely on the order of 200 cubic yards per year (150 m3/yr), based on the recollection of City maintenance personnel regarding past regrading in this area (Mr. Art Belenzon, pers. comm., 1992 [Group Delta, 1992]).

Although considerable effort was made to evaluate longshore transport rates at the two sand test project sites located on Crown Point Shores and the northwest corner of Vacation Isle, it would appear, at least anecdotally, that littoral transport northerly along the west face of Fiesta Island ultimately terminating in the developing shoal near the northeastern corner of Fiesta Island (Figure 3) is also likely on the order of 200 to 300 cubic yards per year, while the small shoal accumulating at the headland between Southwest Pacific Passage and Hidden Anchorage (Figure 3) is likely less than 100 cubic yards per year.

8.3.1 *Shoreline Stabilization Measures*

Shoreline erosion throughout Mission Bay has been well documented since its initial construction in the 1950s, with ongoing mechanized maintenance routinely employed to recapture sediment accreting in shoal areas and replacing it on the eroding beaches. Part of the Mission Bay Shoreline Restoration and Stabilization Master Plan was to assess ongoing erosion within the bay and to determine other ways to help stabilize the shoreline and reduce the need for continuing beach maintenance. As part of that study, and in subsequent studies, it was also noted that Fiesta Island was experiencing considerable erosion on both sides of Stony Point, with northerly drift along the west face of Fiesta Island ultimately culminating in an enlarging spit along the extreme northeast corner of Fiesta Island. Similarly, the south shore of Stony Point was experiencing ongoing erosion, with a shoal area developing near the headland formed by Hidden Anchorage and the south shoreline of Stony Point. Erosion was most pronounced immediately beyond the revetted headland in Stony Point, where considerable erosion has flanked in behind both the northerly and southerly ends of the Stony Point revetment.

One of the conclusions of the 1990 Mission Bay Shoreline Restoration and Stabilization Master Plan work was that absent a regular program of ongoing maintenance, a substantial increase in shoreline stabilization could be achieved with the use of a coarser grain size beach sand, which for Mission Bay was suggested at 1.0 to 1.2 mm in diameter. Although importation of a coarser grain size sand would enhance the stability of the sand beaches throughout Mission Bay, concern was raised over the potential impacts to shorebirds, eelgrass, fisheries, benthic infaunal communities, and human use of the beach. To determine and evaluate the impacts that may be associated with grain size modification, and to assist in determining the validity of the use of such measures for erosion control, a monitoring plan was established to study the effects of using the coarser grain size sand within Mission Bay, the results of which were reported in a March 13, 1992, report titled, "Report of Findings, Mission Bay Beach Stabilization, Sand Test Project, Mission Bay Park, San Diego, California," prepared by Group Delta in association with Pacific Southwest Biological Services and Ogden Environmental & Energy Services. This monitoring plan was also developed in part based on a study by Dr. Richard Seymour, an Oceanographer with Scripps Institution of Oceanography, the results of which were published in a report titled, "Beach Renourishment Options in Mission Bay," dated February 6, 1989.

The actual coarse grained sands used within the experimental beach sites were substantially smaller than those originally contemplated with the coarse sand $d_{50} = 0.65$ mm and the medium sand $d_{50} = 0.4$ mm. These samples were ultimately selected due to their availability and economy.

To briefly summarize the results of the 1992 study, the coarser grain sand sizes were clearly more stable than the finer grain indigenous beach sands and the use of even coarser grain size sands would further increase stability of the beach. The informal human use survey suggested that the people using the beaches in and around the test site show no apparent preference for using either the test areas of the non-test areas. More importantly, however, it should be noted that many recreational beaches throughout the world have substantially coarser grain size sands than the 0.2± mm sands typical of Mission Beach. One of the more notable beaches are the large recreational beaches in Cabo San Lucas, which have a $d_{50} = 3$ mm, along with an exposed yet stable shore face that occasionally experiences fairly strong tropical hurricanes, which commonly develop off the west coast of Mexico.

One of the undesirable findings of the study was the apparent difficulty that shorebirds had distinguishing prey items from sand grains that are similar in size. The biological monitoring addressed in some detail eelgrass, fisheries, and benthic infauna, with a lengthy discussion of the results. However, in our non-technical review of the data, the only potentially substantive adverse environmental impact was on shorebird foraging with the study results apparently similar to results from other studies.

The main conclusion that can be drawn from the 1988-92 Mission Bay Shoreline Erosion and Stabilization Studies is that erosion within Mission Bay caused by tidal currents, surge, wind fetch, and waves from boats will be a continual problem that will require occasional maintenance. The stability of the shore face can be substantially enhanced by capping the shore face with a coarse grained sand and/or by reducing the slope of the shore face.

Given the preceding, it would appear that the importation of coarse sands for the reconstruction of the beach face along the southern shoreline east of Stony Point, where a swimming and wading beach is now proposed, would help stabilize this area. A coarser grain sized sand, possibly approaching 2 mm, will substantially improve the stability of the southerly shoreline and, if considered, should extend easterly up to the primitive overnight camping area and, if possible, graded at an inclination as flat as 1:12 to 1:15.

The use of a coarse grained sand on the western shore face of Fiesta Island would also reduce longshore transport. However, absent any changes to the beach face composition, we would anticipate the gradual growth of a northerly trending spit extending into the proposed lagoon westerly of the northern turn causeway. The relatively large width of the lagoon entrance, which for Alternative 4 is approaching 600 feet, should easily accommodate a gradually accreting spit from the south encroaching into this new proposed lagoon, with relatively infrequent maintenance or, more specifically, retrieval of the accreting spit in the future.

8.3.1.1 Stony Point Revetment

The two edges of the Stony Point revetment need to be stabilized to accommodate the potentially erosive eddies that form in the lee of the two edges of the revetment. An alteration of the shore face immediately downstream of the revetment, as currently proposed, also affords one the opportunity to reduce the incident wave angle, thereby reducing the erosion potential from approaching waves. The shape of the shoreline in the lee of the revetment also affects the stability of the beach, with the most stable beach faces taking the shape of a hook-shaped bay. The importance of hook-shaped bays has been recognized for nearly a century, with numerous studies addressing the geometry of these hook-shaped bays (Everts, 2002). In a study prepared for the California Coastal Conservancy in June 2002, Everts Coastal report on the "Impact of Sand Retention Structures on Southern and Central California Beaches" provided a methodology for developing the geometry and dimensions of the required hook-shaped bay to provide a stable shoreline. As indicated in Figure 10, Everts describes the stability of hook-shaped bays along the California coast on both the regional scale and at the macro scale. Although size likely precludes the ability to develop the appropriate stable hook-shaped bay landform in the lee of Stony Point, the proposed dredge inlets on several of the alternatives, including Alternative 4, should still reduce shoreline scour in the lee of Stony Point. This said, however, in all of the proposed alternatives, the shore face adjacent the Stony Point causeway has been proposed to have a convex shape, while performance would likely improve somewhat with a concave shape more along the lines of that shown on Figure 10.

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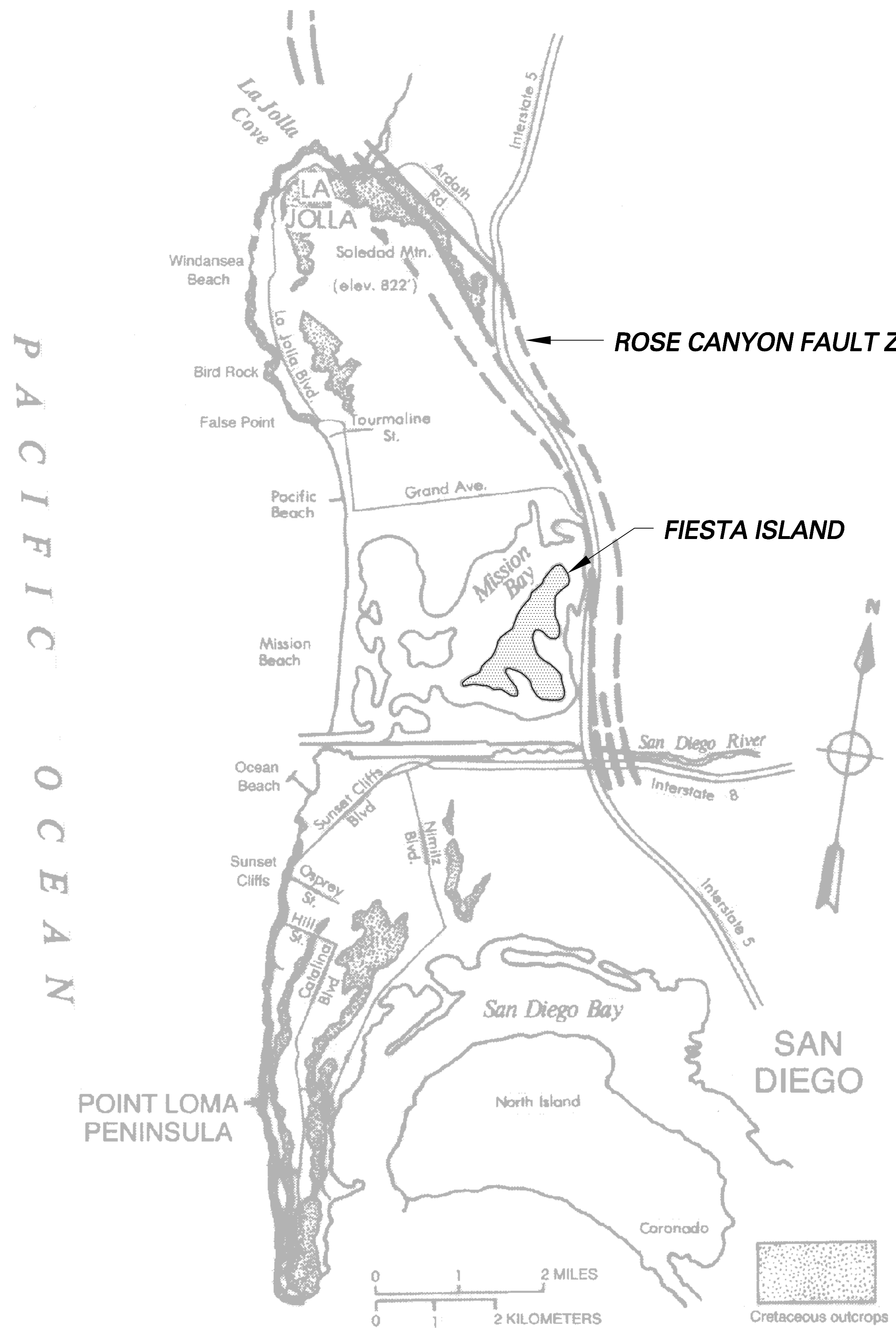
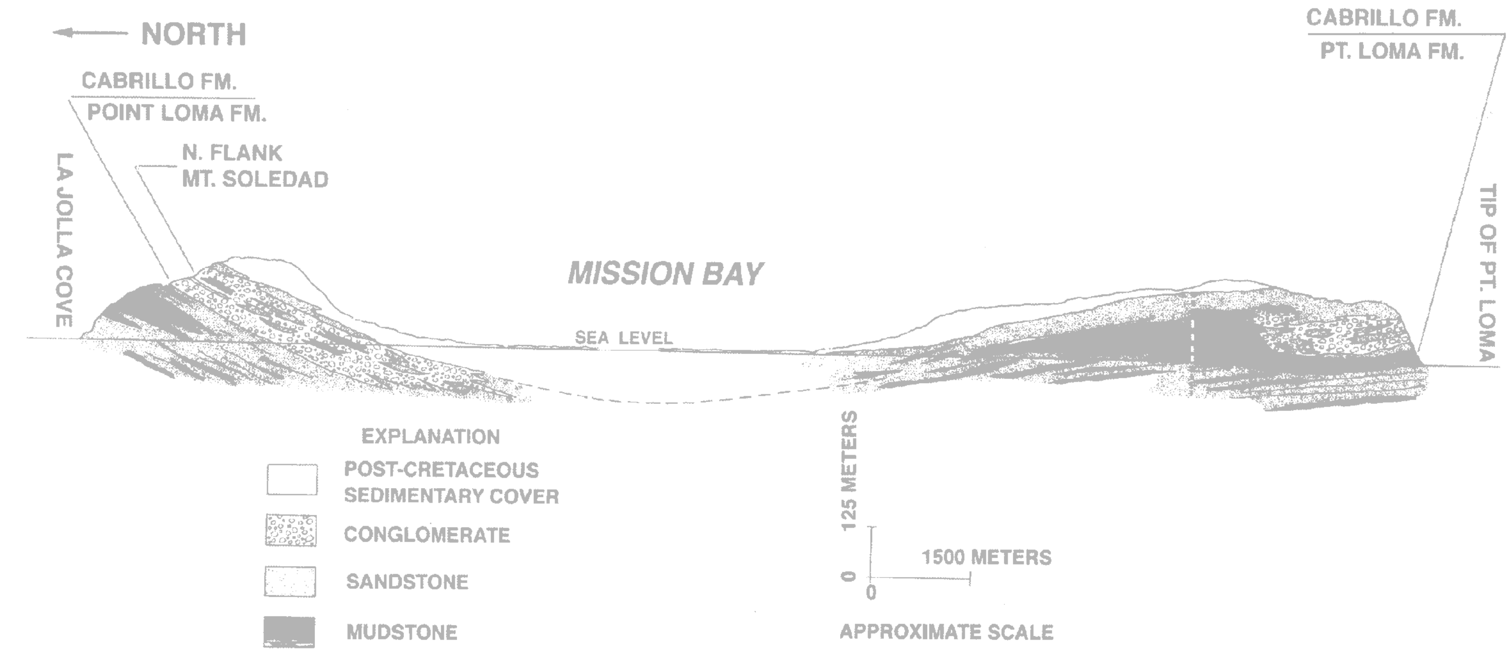
LOGS OF EXPLORATORY BORINGS

BORING NO.	DEPTH	DESCRIPTION
B-1	0 - 2’	Fill - Brown Silty Sand (SM) with boulders
	2 - 5’	Fill - Gray Clayey Gravel (GP)
	5 - 15’	Bay Deposits - Dark gray to gray, interbedded Silty to Clayey Sand (SM/SC) with occasional silt lenses
		- - - - - - - - - - - - - - - - - - - -
B-2	0 - 2’	Fill – Brown Silty Sand (SM)
	2’	Fill - Refusal on gravels and cobbles
		- - - - - - - - - - - - - - - - - - - -
B-3	0 - 15’	Bay Deposits – Dark gray to gray, interbedded Silty to Clayey Sand (SM/SC)
		- - - - - - - - - - - - - - - - - - - -
B4	0 - 9’	Bay Deposits – Dark gray to gray, interbedded Clayey Sand (SC)
	9 -12’	Bay Deposits – Dark gray Clay (CL)
	12 - 13’	Bay Deposits – Gravel lense (GP)
	13 - 15’	Bay Deposits – Gray, interbedded Silty to Clayey Sand (SC - SM)
		- - - - - - - - - - - - - - - - - - - -
B5	0 - 3’	Fill - Dark gray Sandy Gravel (GP)
	3 - 10’	Bay Deposits – Gray Silty Sand (SM)
	10 - 15’	Bay Deposits – Dark gray, interbedded Silt (ML) and Clay (CL)
		- - - - - - - - - - - - - - - - - - - -
B6	0 - 2’	Fill – Brown Silty Sand (SM) with gravel and cobble
	2 - 8’	Bay Deposits – Gray interbedded Silty Sand (SM)
	8 - 15’	Bay Deposits – Gray to dark gray Clayey Sand (SC)
		- - - - - - - - - - - - - - - - - - - -
B7	0 - 2’	Fill – Brown Silty Sand with gravel (SM)
	2 - 6’	Bay Deposits – Gray interbedded Silty Sand (SM)
	6 - 8’	Bay Deposits - Gray interbedded Silty Sand with gravel (SM)
	8 - 12’	Bay Deposits – Gray interbedded Silt to Clayey Sand (SM/SC)
	12 - 14’	Bay Deposits – Gray to dark gray Sandy Clay (CL)
	14 - 15’	Bay Deposits – Gray interbedded Silty Sand
		- - - - - - - - - - - - - - - - - - - -

BORING NO.	DEPTH	DESCRIPTION
B8	0 - 2'	Fill – Brown Clayey Sand (SC) with gravel
	2 - 5'	Bay Deposits – Gray Silty Sand (SM) with gravel
	5 - 9'	Bay Deposits – Gray interbedded Silty Sand (SM)
	9 - 15'	Bay Deposits – Gray interbedded Silty Sand (SM) and Silt (ML)
		- - - - - - - - - - - - - - - - - - - -
B9	0 - 15'	Bay Deposits – Gray to gray brown, interbedded Silty Sand (SM)
		- - - - - - - - - - - - - - - - - - - -
B10	0 - 3'	Fill – Brown Silty Sand (SM)
		- - - - - - - - - - - - - - - - - - - -
	3 - 15'	Bay Deposits – Gray interbedded Silty Sand (SM)
B11	0 - 2'	Fill – Gray-brown Silty Sand (SM) boulder @ 2'
	2 - 15'	Bay Deposits – Gray interbedded Silty Sand (SM)
		- - - - - - - - - - - - - - - - - - - -
B12	0 - 1'	Fill – Gray-brown Silty Sand (ML)
	1 - 2'	Fill – Gray-brown Silty Sand (SM) with gravel
	2 - 6'	Bay Deposits -Gray interbedded Silty Sand (SM)
	6 - 8'	Bay Deposits - Gray interbedded Silty Sand with gravel
	8 - 12'	Bay Deposits – Gray Clayey Sand (SC)
	12 - 15'	Bay Deposits – Gray Sandy Clay (CL)
		- - - - - - - - - - - - - - - - - - - -
B-13	0 - 3'	Fill – Gray-brown Silty Sand (SM) boulder @ 2'
	3 - 4'	Fill – Gray-brown Silty Sand (SM) with gravel
	4 - 9'	Bay Deposits – Gray interbedded Silty Sand (SM)
	9 - 15'	Bay Deposits – Gray interbedded Clayey Sand and Sandy Clay (SC/CL)
		- - - - - - - - - - - - - - - - - - - -
B14	0 - 5'	Fill – Gray-brown Silty Sand (SM)
	5 - 7'	Fill - Gray-brown Silty Sand with gravel
	7'	Refusal on gravel
		- - - - - - - - - - - - - - - - - - - -

BORING NO.	DEPTH	DESCRIPTION
B15	0 - 7’	Fill - Gray-brown Silty Sand (SM)
	7 - 9’	Fill – Gray-brown Silty Sand (SM) with gravel
	9 - 15’	Bay Deposits – Gray Clayey Sand (SC)
		- - - - - - - - - - - - - - - - - - - -
B16	0 - 8’	Fill – Gray-brown Silty Sand (SM)
	8 - 9’	Bay Deposits – Gray Clayey Sand (SC) with gravel
	9’	Bay Deposits – Refusal on gravel
		- - - - - - - - - - - - - - - - - - - -
B17	0 - 2’	Fill – Gray-brown Silty Sand (SM)
	2’	Refusal on gravel and cobble
		- - - - - - - - - - - - - - - - - - - -
B18	0 - 6’	Fill – Gray-brown Silty Sand (SM)
	6 - 8’	Fill - Gray-brown Silty Sand (SM) with gravel
	8 - 12’	Bay Deposits – Gray interbedded Clayey Sand (SC)
	12 - 15’	Bay Deposits – Gray interbedded Clayey Sand and Silt (SC/ML)
		- - - - - - - - - - - - - - - - - - - -
B19	0 - 3’	Fill – Gray-brown Silty Sand (SM)
	3 - 15’	Bay Deposits – Gray interbedded Clayey Sand (SC) with occasional gravel
		- - - - - - - - - - - - - - - - - - - -
B20	0 - 5’	Fill - Gray-brown Clayey Sand (SC)
	5 - 7’	Fill - Gray-brown Clayey Sand with gravel
	7’	Bay Deposits – Refusal on gravel
B21	0 - 5’	Fill - Gray-brown Silty to Clayey Sand (SM/SC)
	5 - 10’	Bay Deposits – Gray interbedded Silty Sand (SM) with gravel
	10 - 11’	Bay Deposits - Gray interbedded Silty Sand (SM)
	11’	Refusal on gravel
B22	0 - 7’	Bay Deposits – Gray interbedded Silty Sand (SM) with shell
		Bay Deposits – Refusal on gravel



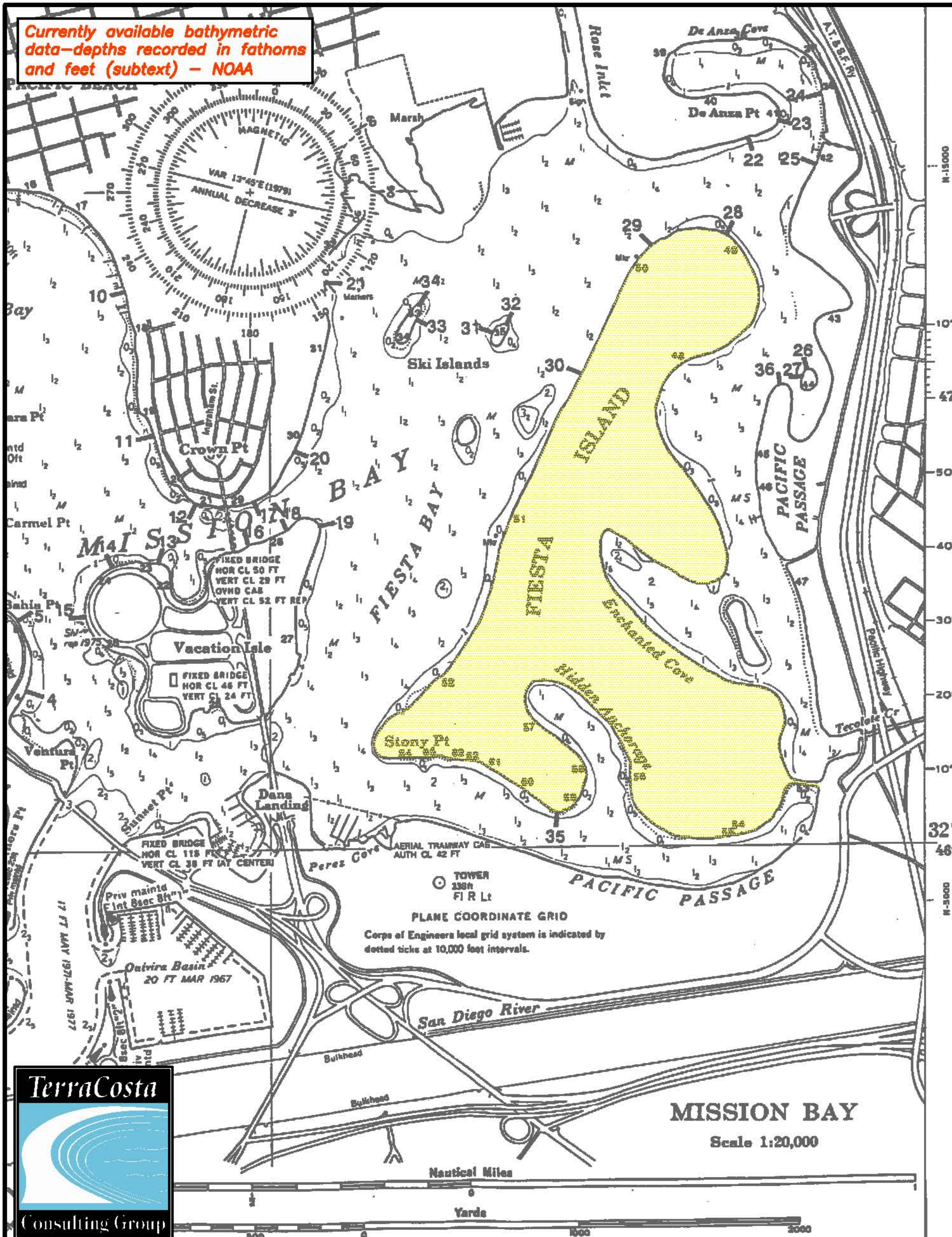


Adapted from: The Rise and Fall of San Diego, by Patrick L. Abbott, © 1999, Sunbelt Publications

TerraCosta Consulting Group	TERRACOSTA CONSULTING GROUP ENGINEERS AND GEOLOGISTS 4455 MURPHY CANYON ROAD, SUITE 100 SAN DIEGO, CA 92123 (858) 573-6900	FIGURE NUMBER 1
	PROJECT NAME FIESTA ISLAND, MISSION BAY	PROJECT NUMBER 2390
	GENERALIZED GEOLOGIC MAP AND CROSS-SECTION OF MISSION BAY	

Project Name: Fiesta Island, Mission Bay - Project No. 2390 - Figure No. 2

Project Name: Fiesta Island, Mission Bay - Project No. 2390 - Figure No. 3



Project Name: Fiesta Island, Mission Bay - Project No. 2390 - Figure No. 4

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FIGURE NUMBER 5

PROJECT NAME: FIESTA ISLAND, MISSION BAY

PROJECT NUMBER: 2390

BORING LOCATION MAP

Project Name: Fiesta Island, Mission Bay - Project No. 2390 - Figure No. 6

LEGEND

B-22 APPROXIMATE LOCATION OF SOIL BORING

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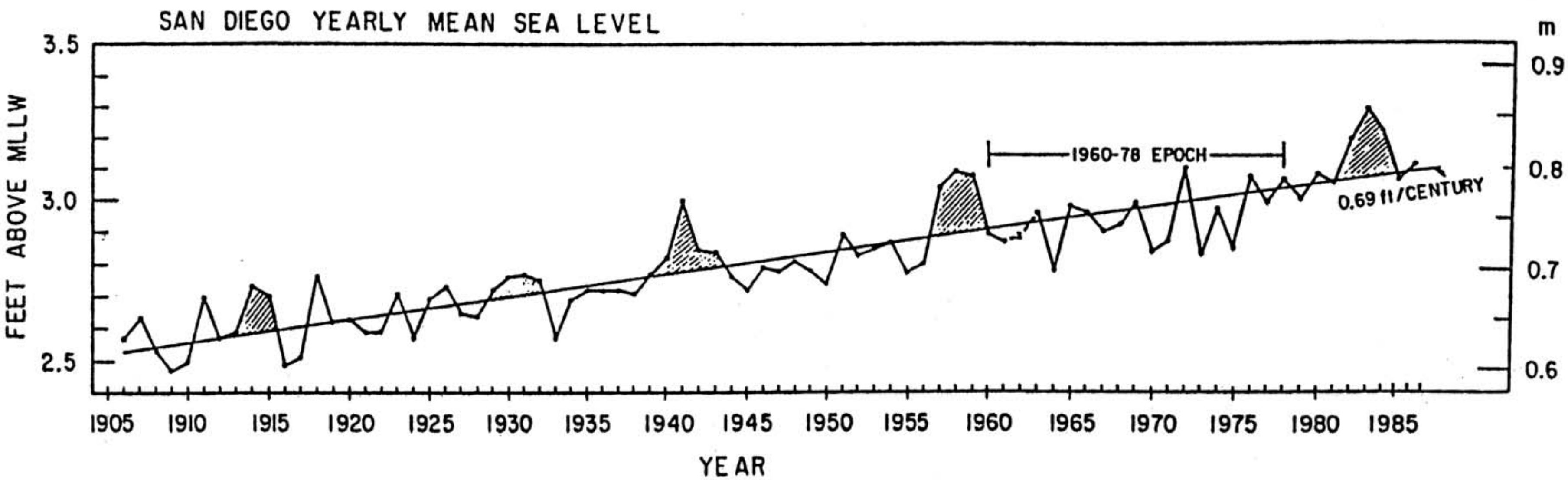
FIGURE NUMBER: 7

PROJECT NAME: **FIESTA ISLAND, MISSION BAY**

PROJECT NUMBER: **2390**

BORING LOCATION MAP

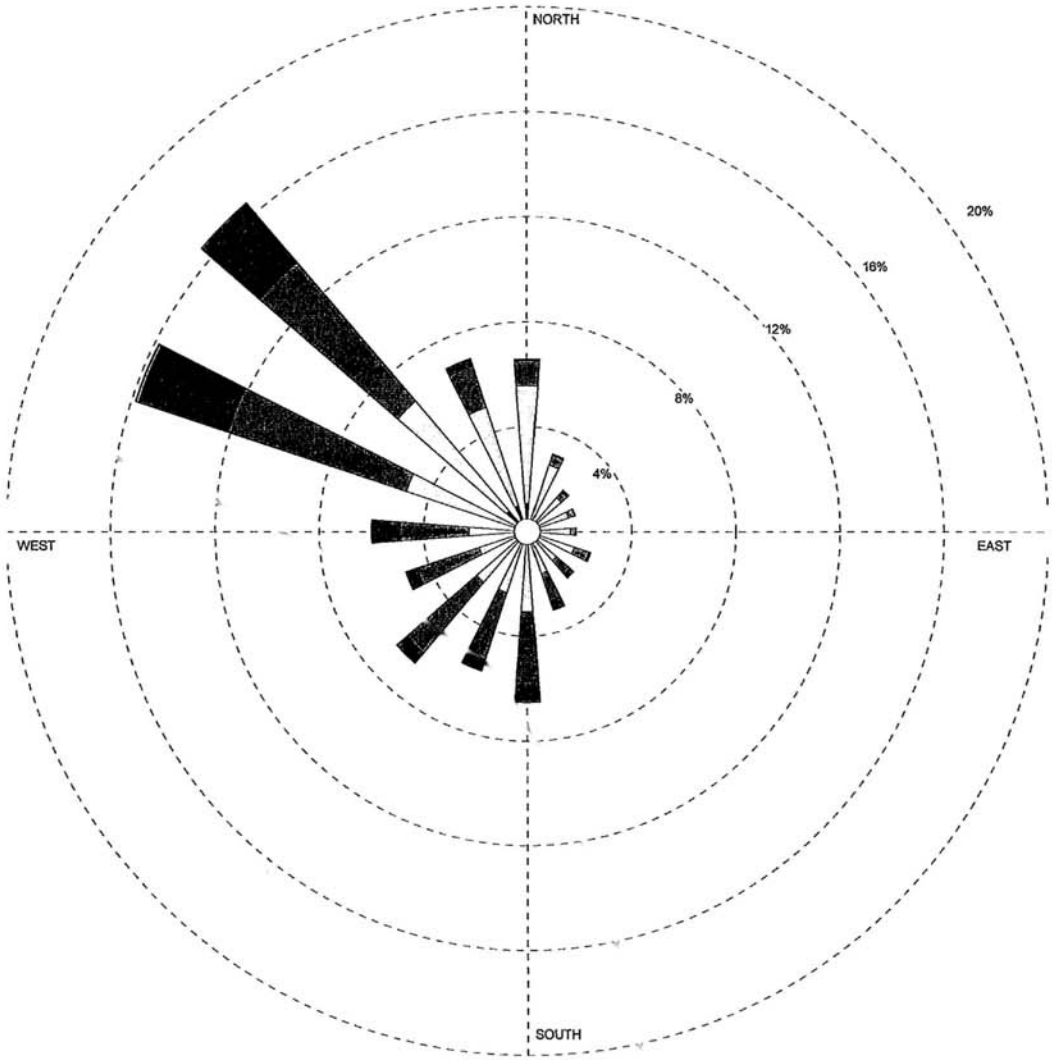


Yearly mean sea level measured in San Diego, 1906-1987. Linear trend indicates increase at the rate of about 0.7 ft/century. Shaded episodes indicate periods of moderate to severe El Nino events that raise sea level up to 0.3 ft above normal for a year or two. Data at La Jolla starting in 1925 are very similar.

TerraCosta Consulting Group	TERRACOSTA CONSULTING GROUP, INC. 4455 MURPHY CANYON ROAD, SUITE 100 SAN DIEGO, CA 92123 (858) 573-6900	FIGURE NUMBER 8
	PROJECT NAME FIESTA ISLAND, MISSION BAY	PROJECT NUMBER 2390
	YEARLY MEAN SEA LEVEL FOR SAN DIEGO BAY TIDE GAUGE	

WIND ROSE PLOT

Station #23188 - SAN DIEGO/LINDBERGH FIELD, CA 1984-1988



Wind Speed (m/s)	MODELER	DATE 5/28/2003	COMPANY NAME
> 11.06 8.49 - 11.06 5.40 - 8.49 3.34 - 5.40 1.80 - 3.34 0.51 - 1.80	DISPLAY **Wind Speed**	UNIT **m/s**	COMMENTS
	AVG. WIND SPEED **3.59 m/s**	CALM WINDS **7.25%**	
	ORIENTATION **Direction (blowing from)**	PLOT YEAR-DATE-TIME **1984 Jan 1 - Dec 31 Midnight - 11 PM**	PROJECT/PLOT NO. **1984-1988**

WRPLOT View 3.5 by Lakes Environmental Software - www.lakes-environmental.com

TerraCosta Consulting Group	TERRACOSTA CONSULTING GROUP ENGINEERS AND GEOLOGISTS 4455 MURPHY CANYON ROAD, SUITE 100 SAN DIEGO, CA 92123 (858) 573-6900	FIGURE NUMBER 9
	PROJECT NAME FIESTA ISLAND, MISSION BAY	PROJECT NUMBER 2390
	LINDBERGH FIELD WIND ROSE - 1984 TO 1988	

Benefits and Adverse Impacts

As shown in Figure 56, almost all beaches along the central California coast from Point Estero (north of Morro Bay) to Point Conception are retained within mature, natural hook-shaped bays. The same is true for most of the beaches in Malibu and many of the south-facing beaches between Point Conception and Ventura. The Silver Strand Littoral Cell in San Diego is a hook-shaped bay retained in the lee of Point Loma. Prior to the construction of a breakwater that protects Los Angeles and Long Beach Harbors, a natural hooked bay retained beaches between Point Fermin and the seacliffs at Huntington Beach. Hook-shaped bays occupy 240 km of the central and southern California coast.

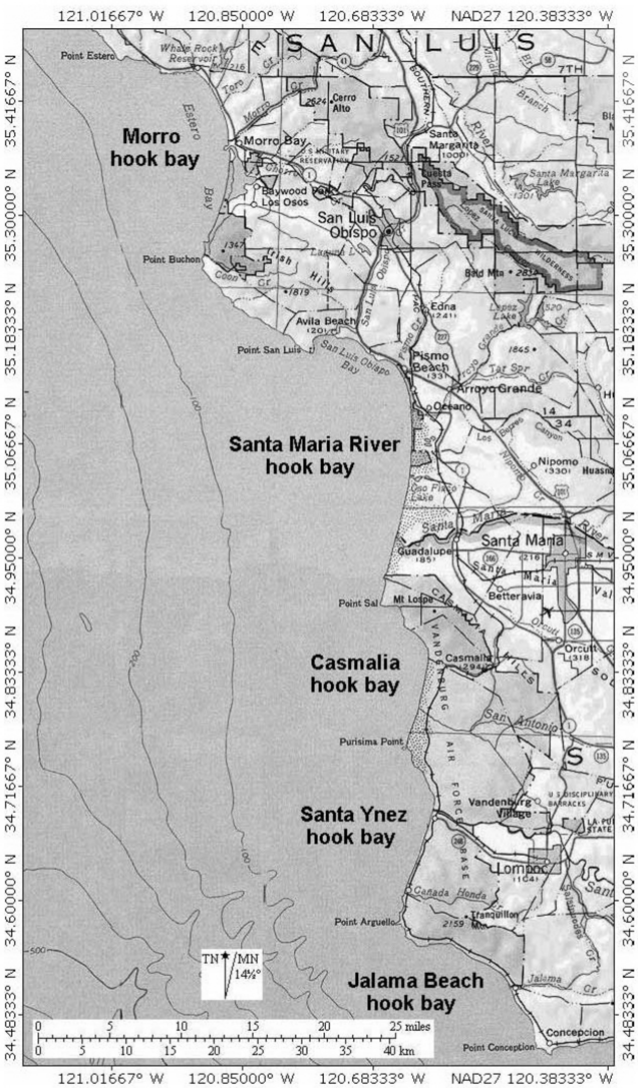


Figure 56. Hook-shaped bays north of Point Conception.

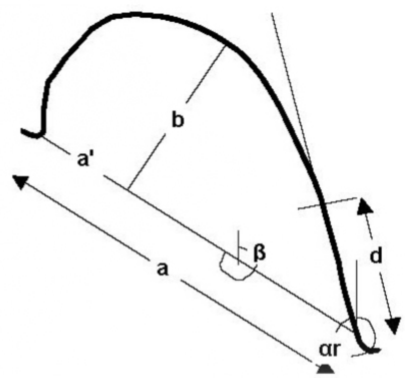


Figure 53. Definition sketch, hook-shaped bays and beaches.

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FIGURE NUMBER **10**

PROJECT NAME: **FIESTA ISLAND, MISSION BAY**

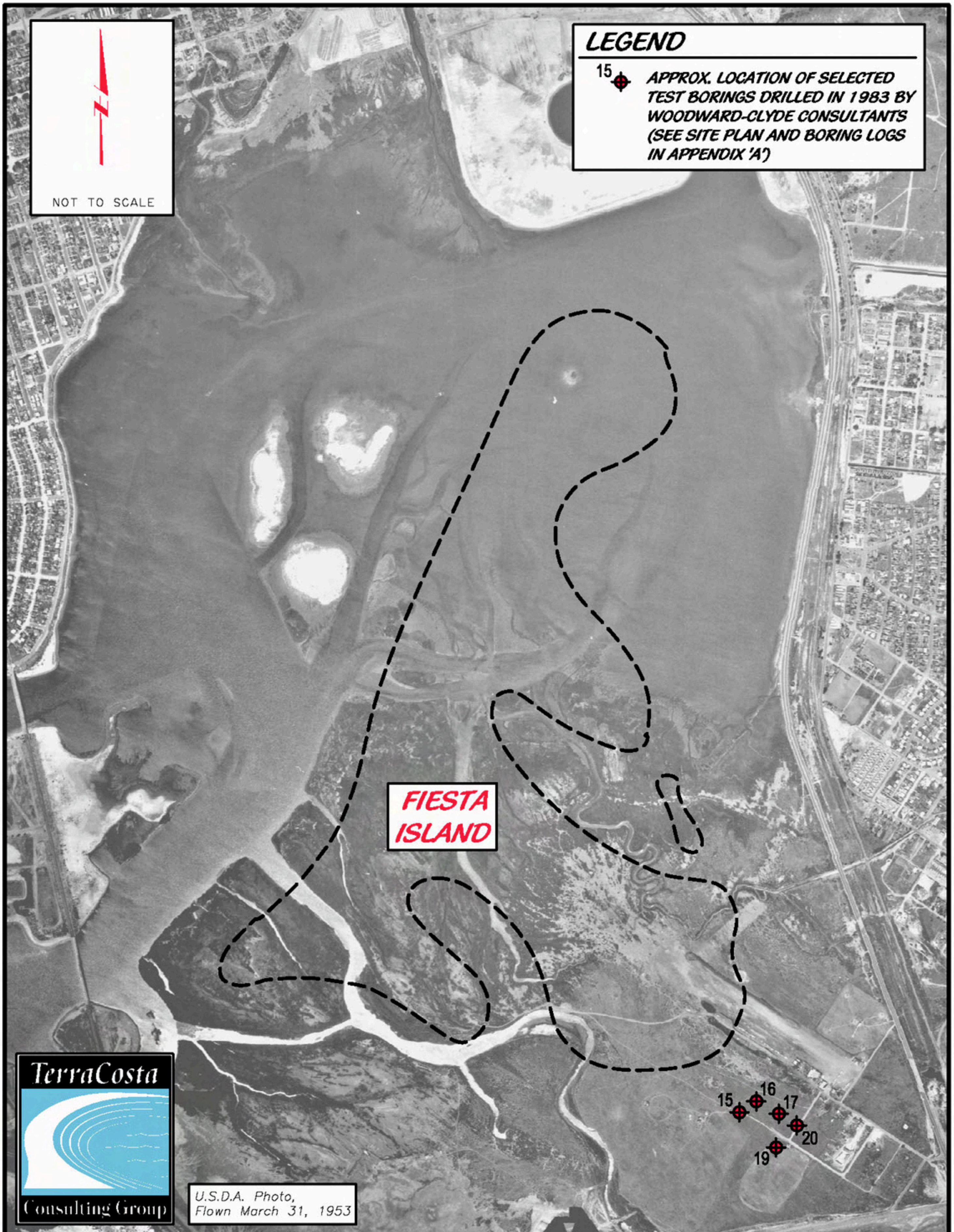
PROJECT NUMBER: **2390**

HOOK-SHAPED BAYS

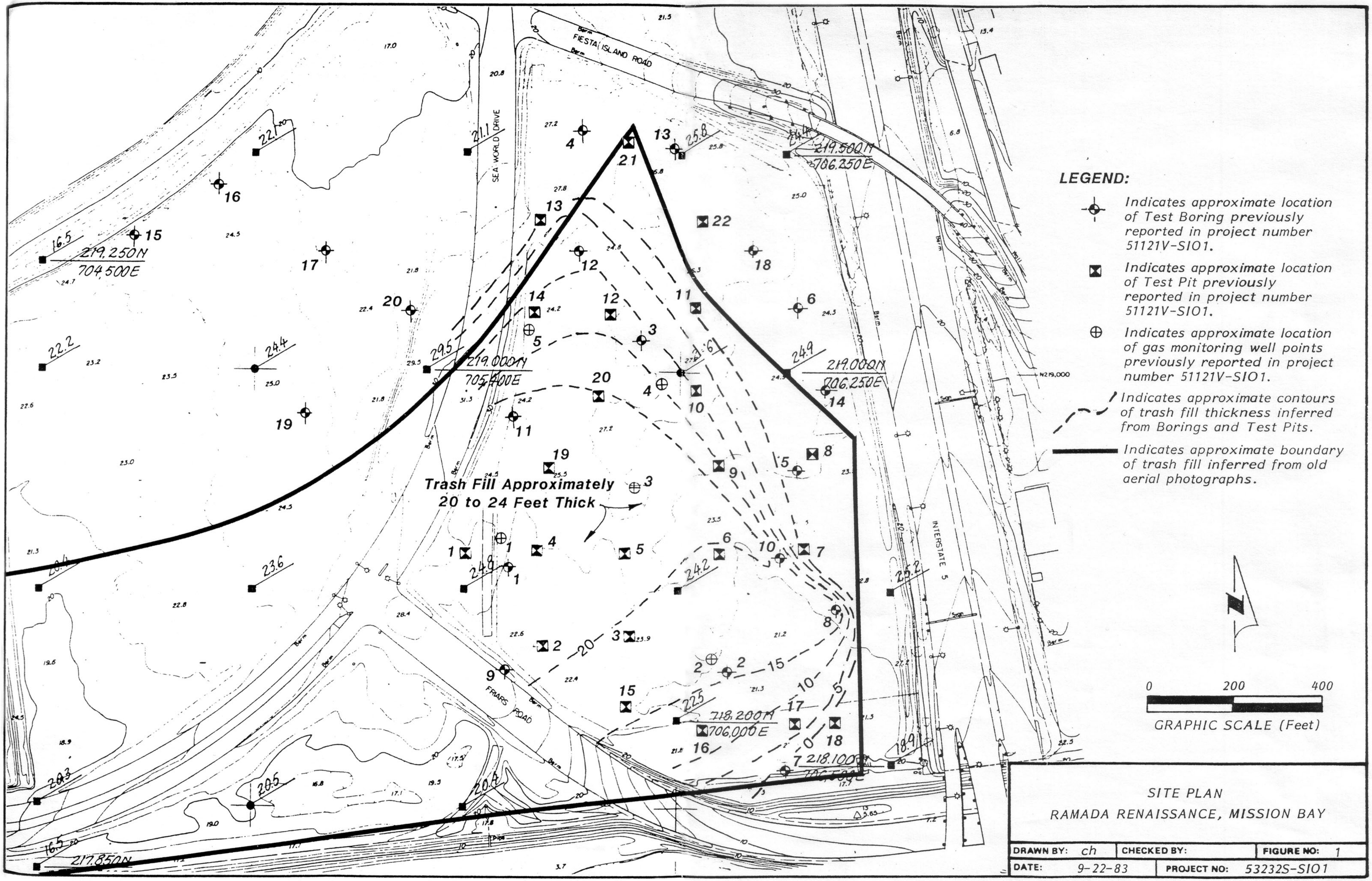
APPENDIX A

Site Plan and Logs from Test Boring
Nos. 15, 16, 17, 19, and 20, Drilled for
Proposed "Mission Bay Park Resort"
(also called "Ramada Renaissance, Mission Bay")
Reported September 27, 1983
Prepared by Woodward-Clyde Consultants, Inc.

TerraCosta Consulting Group



Project Name: Fiesta Island, Mission Bay - Project No. 2390 - Figure No. 2



WOODWARD-CLYDE CONSULTANTS

Location | Boring Number | Elevation

DEPTH IN FEET	TEST DATA *MC	*DD	*BC	*OTHER TESTS	SAMPLE NUMBER	SOIL DESCRIPTION
	12	110	65		1	Very dense, damp, brown silty sand (SM)
					2	

WATER LEVEL
At time of drilling or as indicated.

SOIL CLASSIFICATION
Soil Classifications are based on the Unified Soil Classification System and include color, moisture and consistency. Field descriptions have been modified to reflect results of laboratory analyses where appropriate.

DISTURBED SAMPLE LOCATION
Obtained by collecting the auger cuttings in a plastic or cloth bag.

DRIVE SAMPLE LOCATION
MODIFIED CALIFORNIA SAMPLER
Sample with recorded blows per foot was obtained with a Modified California drive sampler (2" inside diameter, 2.5" outside diameter) lined with sample tubes. The sampler was driven into the soil at the bottom of the hole with a 140 pound hammer falling 30 inches.

SPLIT SPOON SAMPLER
Sample with recorded blows per foot was obtained with a Split Spoon wampler (1-3/8" inside diameter. 2" outside diameter) The sampler was driven into the soil at the bottom of the hole with a 140 pound hammer falling 30".

INDICATES SAMPLE TESTED FOR OTHER PROPERTIES
- GS – Grain Size Distribution
- LC – Laboratory Compaction Test
- PI – Atterberg Limits Test
- ST – Loaded Swell Test
- CC – Confined Compression Test
- CT – Consolidation Test
- UCS – Unconfined Compression Test
- SDS – Slow Direct Shear Test
- DS – Direct Shear Test
- TX – Triaxial Compression Test
- 'R' – R-Value

NOTE: In this column the results of these tests may be recorded where applicable.

BLOW COUNT
Number of blows needed to advance sampler one foot or as indicated.

DRY DENSITY
Pounds per Cubic Foot

MOISTURE CONTENT
Percent of Dry Weight

NOTES ON FIELD INVESTIGATION

1. REFUSAL indicates the inability to extend excavation, practically, with equipment being used in the investigation.

KEY TO LOGS MISSION BAY PARK RESORT				
DRAWN BY: mrk	CHECKED BY: [illegible]	PROJECT NO: 51121V-SI01	DATE: 4-21-81	FIGURE NO: A-1

WOODWARD-CLYDE CONSULTANTS

Boring 15

Approximate El. 24'

DEPTH IN FEET	TEST DATA •MC	•DD	•BC	•OTHER TESTS	SAMPLE NUMBER	SOIL DESCRIPTION
						Loose to medium dense, moist, gray interbeds of silty fine sand and sandy silt; micaceous HYDRAULIC FILL
			10		15-1	
5						
			5		15-2	
10						
			5		15-3	
15						
			7		15-4	
20						
			13		15-5	
25						
			9		15-6	
30						Bottom of Hole
35						
40						

•For description of symbols, see Figure A-1

LOG OF TEST BORING 15
MISSION BAY PARK RESORT

DRAWN BY: mrk	CHECKED BY: [signature]	PROJECT NO: 51121V-SI01	DATE: 4-17-81	FIGURE NO: A-26

WOODWARD-CLYDE CONSULTANTS

Boring 16

Approximate El. 24'

DEPTH IN FEET	TEST DATA *MC	*DD	*BC	*OTHER TESTS	SAMPLE NUMBER	SOIL DESCRIPTION
0–2						Loose, moist, light brown silty fine sand; micaceous HYDRAULIC FILL
2–5	65		4	LL=79 PI=47	16-1	Loose, moist, dark gray, sandy silt to sandy clay; micaceous HYDRAULIC FILL
5–29			13		16-2	Loose to medium dense, light brown to gray interbeds of silty fine sand and sandy silt to clay; micaceous HYDRAULIC FILL
			9		16-3	
			19		16-4	▽
			*		16-5	*Hammer pumping water, inaccurate blow counts
29–36						Medium dense, saturated, dark gray sandy clay and silt (ML-CL); micaceous ALLUVIAL DEPOSITS
36–40	53		*	GS	16-6	Medium dense to dense, saturated, light brown to gray silty fine to coarse sand (SM-SP) with scattered gravels and pebbles ALLUVIAL DEPOSITS

Continued on Next Page

*For description of symbols, see Figure A-1

LOG OF TEST BORING 16
MISSION BAY PARK RESORT

DRAWN BY: mrk	CHECKED BY: [signature]	PROJECT NO: 51121V-SI01	DATE: 4-17-81	FIGURE NO: A-27

WOODWARD-CLYDE CONSULTANTS

DEPTH IN FEET	TEST DATA *MC	*DD	*BC	*OTHER TESTS	SAMPLE NUMBER	SOIL DESCRIPTION
						Medium dense to dense, saturated, light brown to gray silty fine to coarse sand (SM-SP) with scattered gravels and pebbles ALLUVIAL DEPOSITS
45						Becoming very dense
			50/4"		16-7	
50						Dense, saturated, dark gray, fine sandy silt (ML); micaceous ALLUVIAL DEPOSITS
55						
60						
65						
70						
75						
80						

*For description of symbols, see Figure A-1

LOG OF TEST BORING 16 (CONT'D)
MISSION BAY PARK RESORT

DRAWN BY: mrk	CHECKED BY:	PROJECT NO: 51121V-SI01	DATE: 4-17-81	FIGURE NO: A-28

WOODWARD-CLYDE CONSULTANTS

Boring 17

Approximate El. 22'

DEPTH IN FEET	TEST DATA *MC	*DD	*BC	*OTHER TESTS	SAMPLE NUMBER	SOIL DESCRIPTION
0						Loose, moist, gray, fine sandy silt and clay with some silty sand HYDRAULIC FILL
			4		17-1	
5						
			6		17-2	
10						
			5		17-3	
15						
20						
						Dense, saturated, light gray silty fine to medium sand (SM-SP) ALLUVIAL DEPOSITS
			33		17-4	
25						
30						Stiff, saturated, dark gray sandy silt and clay (ML-CL); micaceous ALLUVIAL DEPOSITS
			14		17-5	
35						
40						

Continued on Next Page

*For description of symbols, see Figure A-1

LOG OF TEST BORING 17
MISSION BAY PARK RESORT

DRAWN BY: mrk | CHECKED BY: [illegible] | PROJECT NO: 51121V-SI01 | DATE: 4-17-81 | FIGURE NO: A-29

WOODWARD-CLYDE CONSULTANTS

Boring 17 (Continued)

DEPTH IN FEET	TEST DATA *MC	*DD	*BC	*OTHER TESTS	SAMPLE NUMBER	SOIL DESCRIPTION
						Stiff, saturated, dark gray, sandy silt and clay (ML-CL); micaceous ALLUVIAL DEPOSITS
			64		17-6	
45						
50						Shell fragments
			29		17-7	
55						Bottom of Hole
60						
65						
70						
75						
80						

*For description of symbols, see Figure A-1

LOG OF TEST BORING 17 (CONT'D)
MISSION BAY PARK RESORT

DRAWN BY: mrk | CHECKED BY: [signature] | PROJECT NO: 51121V-SI01 | DATE: 4-17-81 | FIGURE NO: A-30

WOODWARD-CLYDE CONSULTANTS

Boring 19

Approximate El. 25'

DEPTH IN FEET	TEST DATA *MC	*DD	*BC	*OTHER TESTS	SAMPLE NUMBER	SOIL DESCRIPTION
					19-1	Loose, moist, light brown silty fine sand; micaceous HYDRAULIC FILL
			8		19-2	
5						Loose, moist, gray fine sandy silt and clay; micaceous HYDRAULIC FILL
			12		19-3	Medium dense, moist, light brown to gray silty fine sand; micaceous HYDRAULIC FILL
10						
15						Medium dense, damp, gray fine sandy silt and clay (ML-CL) with interbeds of silty fine sand (SM); micaceous ALLUVIAL DEPOSITS
20						
25						▽
30						Bottom of Hole
35						
40						

*For description of symbols, see Figure A-1

LOG OF TEST BORING 19
MISSION BAY PARK RESORT

DRAWN BY: mrk	CHECKED BY: [signature]	PROJECT NO: 51121V-SI01	DATE: 4-17-81	FIGURE NO: A-34

WOODWARD-CLYDE CONSULTANTS

Boring 20

Approximate El. 21'

DEPTH IN FEET	TEST DATA *MC	*DD	*BC	*OTHER TESTS	SAMPLE NUMBER	SOIL DESCRIPTION
				"R"	20-1	Loose to medium dense, moist, light brown silty fine sand with shell fragments HYDRAULIC FILL
5			18		20-2	
			6		20-3	Loose, moist, gray, fine sandy silt; micaceous HYDRAULIC FILL
10						Bottom of Hole
15						
20						
25						
30						
35						
40						

*For description of symbols, see Figure A-1

LOG OF TEST BORING 20
MISSION BAY PARK RESORT

DRAWN BY: mrk	CHECKED BY:	PROJECT NO: 51121V-SI01	DATE: 4-17-81	FIGURE NO: A-35

WOODWARD-CLYDE CONSULTANTS

APPENDIX B

SEDIMENT SAMPLES
GROUP DELTA CONSULTANTS
1998 & 1989

TerraCosta Consulting Group

LEGEND

1 APPROXIMATE LOCATION OF BEACH PROFILE

65 APPROXIMATE LOCATION OF SEDIMENT SAMPLE

VICINITY MAP

MISSION BAY SHORELINE MASTER PLAN

PLATE C-1

TABLE 1

MISSION BAY SHORELINE

Grain sizes of samples taken at elevation of MSL at each location where a cross section was made for bayfloor topography.

SECTION NUMBER	GRAIN SIZE (mm)	SECTION NUMBER	GRAIN SIZE (mm)
1	0.30 - 0.40	19	0.24 - 0.32
2	0.20 - 0.30	20	0.16 - 0.20
3	0.16 - 0.20	21	0.24 - 0.28
4	0.18 - 0.26	22	0.30 - 0.38
5	0.18 - 0.24	23	0.28 - 0.40
6	0.26 - 0.30	24	0.24 - 0.30
7	0.18 - 0.22	25	0.24 - 0.38
8	0.20 - 0.24	26	0.20 - 0.30
9	0.22 - 0.30	27	0.26 - 0.34
10	0.18 - 0.24 w/some to 0.40	28	0.24 - 0.30
11	0.24 - 0.34	29	0.28 - 0.44
12	0.22 - 0.40	30	0.26 - 0.40
12A	0.30 - 0.44	31	0.32 - 0.42
13	0.24 - 0.28	32	0.24 - 0.34
14	0.16 - 0.24	33	0.12 - 0.18
15	0.16 - 0.26	34	0.16 - 0.20
16	0.24 - 0.36	35	0.18 - 0.22
17	0.14 - 0.20	36	0.24 - 0.30
18	0.22 - 0.30		

TABLE C-1

AVERAGE PARTICLE SIZE

Sample No.	Predominant Grain Size mm.	Sample No.	Predominant Grain Size mm.
1	0.20 - 0.24	34	0.14 - 0.18
2	0.20	35	0.26 - 0.32
3	0.30 - 0.32	36	0.24 - 0.40
4	0.20 - 0.30	37	0.18 - 0.26
5	0.18 - 0.20	38	0.18 - 0.26
6	0.16 - 0.18	39	0.28 - 0.34
7	0.16 - 0.20	40	0.28 - 0.34
8	0.14 - 0.20	41	0.28 - 0.36
9	0.18 - 0.22	42	0.28 - 0.32
10	0.20	43	0.28 - 0.36
11	0.18	44	0.22 - 0.30
12	0.16 - 0.18	45	0.20 - 0.24
13	0.24 - 0.40	46	0.28 - 0.36
14	0.16 - 0.18	47	0.28 - 0.36
15	0.12 - 0.50	48	0.20 - 0.24
16	0.18 - 0.24	49	0.20 - 0.30
17	0.14 - 0.30	50	0.28 - 0.38
18	0.14 - 0.28	51	0.20 - 0.32
19	0.20 - 0.60	52	0.20 - 0.26
20	0.20 - 0.60	53	0.28 - 0.32
21	0.18 - 0.24	54	0.20 - 0.22
22	0.14 - 0.18	55	0.30 - 0.40
23	0.18 - 0.30	56	SILT
24	0.20 - 0.30	57	0.24 - 0.36
25	0.22	58	0.18 - 0.25
26	0.20	59	0.25
27	0.26 - 0.30	60	0.20 - 0.30
28	0.22 - 0.24	61	0.25
29	0.14 - 0.20	62	SILT
30	0.12 - 0.14	63	0.16 - 0.26
31	0.20 - 0.26	64	0.10 - 0.20
32	0.22 - 0.24	65	0.20
33	0.18 - 0.20		