ATTACHMENT A: Project Modification Request (PMR) FORM

The purpose of this PMR form is to initiate the Project modification process and provide the District with information necessary to evaluate the Project modification request.

Regional Program	☑Infrastructure Program Project ☐Scientific Studies Program ☐Technical Resources Program
Project/Study Name	Arroyo Seco - San Rafael Treatment Wetlands
Project/Study Lead	City of Pasadena Department of Public Works
Watershed Area(s)	Upper Los Angeles River
Current Project Phase	Design
Approved Stormwater Investment Plan Fiscal Year	FY 2020-21
Transfer Agreement ID (e.g., 2020RPULAR52)	2021RPULAR11

Has Transfer Agreement or most recent Addendum been executed (i.e., signed by the project lead and the District)? ☑ Yes ☐ No

What type(s) of modification request?

☐ like-for-like modifications

☑ functionally equivalent BMP modifications

☐ modifications to Project or Study components that were not material to the WASC, ROC, or Board's decision to include the Project or Study in the SIP

☐ minor modifications to the budget or schedule of intermediate tasks where the total Funded Activity amount and Funded Activity completion date is unchanged

☐ change in primary or secondary objective

☐ change in Project benefits

☐ change in methodology (e.g., infiltration instead of diversion to sanitary sewer)

☐ decrease in BMP capacity

☑ change in Project or Study location

☐ change in capture area where benefits claimed are diminished or where there is a change in the municipalities that are receiving benefits

☐ updated engineering analysis resulting in a reduction of benefits claimed

☑ increase in Construction Cost or Life Cycle Cost greater than 10%

☐ increase or reallocation of annual funding distribution

☑ change in Funded Activity completion date

☐ other, please describe:

Impact on scope or benefits?

- ☑ Improved
- ☐ Diminished
- ☐ Neither
- ☐ Not Sure

Description of the proposed modification(s) and the reason(s) why the modification(s) is/are being proposed.

The proposed project modifications are summarized and discussed in detail in the enclosed Attachment B, "Supplemental to Attachment A".

If applicable, list previously approved funding allocations/disbursements and revised funding request:

Note, if some or all of a previously Funded Activity cannot be completed as a result of the proposed modification, please include a description and indicate the amount of unused funds. Any unused funds should be reallocated and accounted for in your revised funding request.

Fiscal Year	Approved Funding Allocations	Revised Funding Request	Description/Phase *If applicable, include description of unused funds*
FY 21-22	$1,194,953		Design
FY 22-23	$1,205,468		Construction, Year 1 Funding
FY 23-24	$1,185,468		Construction, Year 2 Funding
FY 24-25	$1,185,468	$2,279,222	Construction, Year 3 Funding
FY 25-26		$2,279,221	Construction, Year 4 Funding
Future Funding			
TOTAL	$4,771,357	$4,558,443	

A: SCWP Approved Total Funding Allocations	$4,771,357
B: Revised SCWP Anticipated Total Funding Request	$9,329,800
C: Difference between B and A	$4,558,443

If applicable, description of difference in SCWP Anticipated Total Funding Request. As a reminder, annual funding is at the discretion of the WASC, ROC, and ultimately the Board of Supervisors.

Since the original cost estimate was developed in October 2020, the design has been modified to include a larger pump station at the San Pascual site, more landscaped areas for the San Rafael site, the re-location of the stormwater harvesting system to the Arroyo Seco Golf Course, and a temporary construction bridge over the Arroyo Seco Channel for the San Rafael site. Additionally, construction costs have significantly escalated due to inflation and supply shortages. See Attachment C for detailed cost estimates.

Brief description of Supporting Documentation provided.

Attachment B - Project Benefit Comparison which documents the changes
Attachment C - Construction Cost Estimate Tables

I certify the information and supporting documentation provided is accurate and true.	☑ YES
I understand this is a request and it is under the WASC's discretion to consider requested modifications.	☑ YES

Name Christina Monde, P.E., Project Manager

Organization City of Pasadena Public Works

Signature [signature]

Date 11/30/2023

FOR DISTRICT USE ONLY

Proposed Modifications to Projects or Studies:

	Status	Date
Modified Project or Study is **consistent** with the Project or Study included in the current fiscal year's SIP and proposed modifications were **approved** by the District.	☐ YES	
Modified Project or Study is **NOT consistent** with the Project or Study included in the current fiscal year's SIP. **If yes, select all that apply**:	☑ YES	12/13/23
PMR was received **after** October 31 of a fiscal year and the PMR will be considered for approval during the preparation of **subsequent** SIP for the fiscal year after the next	☐ YES	-
For Infrastructure Program Projects, modified Project was sent to **Scoring Committee**. If yes, revised score:	☐ YES	
Project or Study **abandoned** the proposed modifications	☐ YES	
Projector or Study was **withdrawn** from consideration by the WASC and shall issue repayment of unspent funds	☐ YES	
Proposed modifications were **recommended for approval** in the SIP	☐ YES ☐ NO	

Proposed Modifications to Project Concepts:

	Status	Date
Proposed modifications were deemed **consistent** with the Project concept that was approved by the WASC, ROC and Board for inclusion in the SIP and can be addressed within the existing budget. District will proceed to incorporate the proposed modification into the Feasibility Study immediately.	☐ YES	
Proposed modifications were deemed significant enough to result in a **significantly different** Project concept from the one approved by the WASC, ROC and Board for inclusion in the SIP. **If yes, select one:**	☐ YES	
District to **discontinue** work on the Feasibility Study, return unused funds to be programmed in the SIP for the next fiscal year, and advise the proponent to submit the modified Project concept during the Call for Projects for a future fiscal year.	☐ YES	-
District to **abandon** the proposed modifications and proceed with the Project concept included in the SIP.	☐ YES	-

Attachment B
Project Modification Request Form, Supplemental Information

This document is provided as a supplemental narrative to Attachment A: Project Modification Request Form.

Project Overview

The City of Pasadena (Lead Agency) and South Pasadena have collaborated to address water quality regulations in the Arroyo Seco Channel. The approach to address these regulations, particularly a high priority outfall for bacteria compliance, was through an innovative use of natural treatment wetlands at two sites along the Arroyo Seco Channel: the San Rafael site and the San Pascual site.

The San Rafael site is located at the confluence of the San Rafael Creek and the Arroyo Seco in Pasadena. The proposed facility will intercept dry and wet weather flows from the San Rafael Creek that will be directed to a naturalized stream constructed above the concrete channel. The stream will convey flows to the settling basin and wetland basins which are configured to create a more natural landscape while accommodating existing native trees.

The San Pascual site is located along the Arroyo Seco, south of San Pascual Ave in South Pasadena. A channel diversion will convey flows from the Arroyo Seco, filtered, and pumped to surface wetlands and infiltration basins. Water stored in the wetlands will be conveyed to a stormwater harvesting facility and used as source water for the Arroyo Seco Golf Course.

Project Modifications Requested

The following describes the **types of modification requests** identified in Attachment A.

1. Functionally Equivalent BMP modifications

- Project Type – **NO CHANGE.** The original project was reclassified by the scoring committee as a **DRY Weather** project due to the combined drainage area of 5,447 acres.

- Drainage Area – **MINIMAL CHANGE**. The drainage areas were updated slightly as follows.
    - San Rafael Site. 441 acres to 442 acres
    - San Pascual Site. 5,081 acres to 5,005 acres

- Drainage Area Imperviousness – **MODERATE DECREASE**. The original analysis utilized WMMS 1.0 to characterize imperviousness within the project drainage area. In accordance with the guidelines, the model that was selected for the revised analysis, WMMS 2.0 was used to characterize land use and imperviousness in the revised project drainage area.
    - San Rafael Site. The WMMS 2.0 imperviousness value for this site was updated from 21% to 12%.
    - San Pascual Site. The WMMS 2.0 imperviousness value was updated from 24% to 17.2%

- 85^{th} Percentile Storm Volume – **MODERATE DECREASE**. Due to changes in drainage area and imperviousness, the WMMS 2.0 85^{th} percentile capture volume during the design storm will decrease as follows.
    - San Rafael Site. The 85^{th} percentile flow was updated from 22 cfs to 6.3 cfs and 18 AF to 3.4 AF.
    - San Pascual Site. The 85^{th} percentile flow was updated from 305 cfs to 85.9 cfs and 232 AF to 58 AF.

2. Change in Project or Study Location

Project Location – **MINOR CHANGE.**

- San Rafael Site. During the progress of the design, the project location for the San Rafael site, was moved from the east side of San Rafael Creek to the west side of San Rafael Creek. This change is within the City of Pasadena's 1.8-acre area adjacent to the Arroyo Seco.

  The original project location was selected during project concept phase due to its proximity to the San Rafael Creek and for its ease of access for both construction and visitors upon completion. As basin sizing began, the basin could not be properly sized within the east side of San Rafael Creek without the introduction of retaining walls and basin edge depths exceeding four feet. From a public safety perspective, edge depths exceeding four feet would require fencing or safety barriers of some kind, neither of which would fit the necessary aesthetic for the Arroyo Seco and surrounding areas. It became apparent that there was not enough room on the east side of the creek. The area on the west side of the creek is much larger, 1.4 acres versus 0.4 acres on the east side, and allows for a more natural design aesthetic. Three shallower basins are proposed instead of one deep basin and allows for greater passive recreational opportunities as well by providing new trails around the treatment wetlands, expanded habitat and reestablishment of natural plant communities, and increased public access to open space areas all while still meeting program goals and objectives. The scope of work has essentially not changed, just the site location has been moved from one side of the channel to another.

- San Pascual Site. During the progress of the design, the proposed stormwater harvesting facility was relocated from the San Pascual Basin area to the Arroyo Seco Golf Course, where the stormwater will be conveyed, reused, operated, and maintained. Since the original objective was to provide stormwater for irrigation use at the Arroyo Seco Golf Course, the scope of work has not changed, only the location of the stormwater harvesting building structure location.

3. Increase in Construction Cost or Life Cycle Cost greater than 10%

Reason: Since the original cost estimate was developed in October 2020, the design has been modified to include a larger pump station at the San Pascual site, more landscaped areas for the San Rafael Site, and the re-location of the stormwater harvesting facility to the Arroyo Seco Golf Course, and a temporary bridge over the Arroyo Seco to support construction for the San Rafael site. Additionally, construction costs have significantly escalated due to inflation and supply shortages.

Table 1. Updated Project Cost Table

Phase	Activity	2020 Cost Estimate	Updated Costs 2023
Design	*Professional Design Services (30/60/90/100)*	*$ 949,964*	*$ 999,322*
Design	*Environmental Planning and Permitting*	*$ 126,662*	*$ 126,662*
Design	*Community Outreach*	*$ 50,000*	*$ 42,102*
Design	*Agency Management (Design)*	*$ 68,327*	*$ 68,327*
Construction	*Construction Administration*	*$ 653,309*	*$ 851,508*
Construction	*Agency Management (Construction)*	*$ 90,000*	*$ 90,000*
Construction	*Construction Contract**	*$ 6,333,095*	*$ 11,258,230*
	Total	***$ 8,271,357***	***$ 13,436,151***

***Note: See Attachment C for Detailed Cost Estimates**

Change in Funded Activity Completion Date

Additional survey and geotechnical investigations needed to be performed as well as updating other studies that had been completed. The new location required design updates which also required adjustments to the IS/MND that was currently being prepared. The project completion dates have been modified as follows.

Phase	Activity	Start Date	Finish Date
Design	Professional Design Services (30/60/90/100)	4/4/22	6/28/24
Design	Environmental Planning and Permitting	09/30/22	09/30/24
Design	Community Outreach	05/26/22	03/29/24
Construction	Construction Administration	9/30/24	9/30/26
Construction	Construction Contract	9/30/24	9/30/26
Design and Construction	Agency Project Management	4/4/22	12/30/26

Attachment C
ARROYO SECO SAN RAFAEL/SAN PASCUAL SW PROJECTS
Construction Cost Estimate TABLES

Table C-1. Construction Cost Change Comparison Table

San Pascual Site					
Version	90%	100%	Increase	% Inc.	Note
Miscellaneous	$ 216,372	$ 378,332	$ 161,960	75%	↑ Mob costs - Added Tribal Monitor
Channel diversion, pretreatment, and pump station	$ 1,120,000	$ 1,589,839	$ 469,839	42%	↑ Construct Costs - + Temp Diversion & Shoring
Site preparation and demolition - existing area	$ 257,582	$ 257,582	$ -	0%	
Treatment basin	$ 812,489	$ 1,175,813	$ 363,324	45%	↑ Excav/Haul Costs & Quantities - + Finish Grading
Electrical service, controls, instrumentation	$ 664,279	$ 880,349	$ 216,070	33%	↑ Material Costs - + SCADA
Landscape and irrigation modifications	$ 229,000	$ 402,804	$ 173,804	76%	↑ Tree Replacement Required - + Irrigation
Site amenities and improvements	$ 376,758	$ 523,653	$ 146,895	39%	↑ DG/DG Edge/Concrete Costs - + Stairs, Benches
Stormwater Harvesting	$ -	$ 886,000	$ 886,000		+ Stormwater Harvesting System
Erosion Control	$ 40,000	$ 72,764	$ 32,764	82%	↑ SWPPP Costs - Removed From Start Up Costs
Start-up, Testing, etc.	$ 60,000	$ 60,000	$ -	0%	Removed SWPPP
Subtotal	**$ 3,776,480**	**$ 6,227,136**	**$ 2,450,656**	**65%**	
15% Contingency	**$ 566,472**	**$ 934,070**	**$ 367,598**		
4% Escalation per Year to 2025		**$ 249,085**			
Grand Total	**$ 4,342,952**	**$ 7,410,292**	**$ 3,067,340**	**71%**	

San Rafael Site					
Version	90%	100%	Increase	% Inc.	Note
Miscellaneous	$ 117,842	$ 243,374	$ 125,532	107%	↑ Mob costs - Added Tribal Monitor
Channel diversion, pretreatment	$ 282,864	$ 365,194	$ 82,330	29%	↑ Construct Costs - + Excavation & Backfill
Site preparation and demolition - existing area	$ 83,520	$ 87,300	$ 3,780	5%	↑ Clear and Grub Costs
Infiltration basin	$ 127,600	$ 193,362	$ 65,762	52%	↑ Excav/Haul Costs - + Finish Grading
Outlet line to channel	$ 435,242	$ 500,750	$ 65,508	15%	↑ Material Costs - + Backfill & Compaction
Electrical service, controls, instrumentation	$ 478,608	$ 588,502	$ 109,894	23%	↑ Material Costs - + SCADA
Landscape and irrigation modifications	$ 105,805	$ 273,475	$ 167,670	158%	↑ Tree Replacement Required/Irrigation Costs
Site amenities and improvements	$ 337,940	$ 881,590	$ 543,650	161%	↑ DG/DG Edge/Concrete Costs - Reinforce (E) Concrete Bridge - + Temporary Construct Bridge
Erosion Control	$ 30,000	$ 50,014	$ 20,014	67%	↑ SWPPP Costs - Removed From Start Up Costs
Start-up, Testing, etc.	$ 50,000	$ 50,000	$ -	-	Removed SWPPP
Subtotal	**$ 2,049,421**	**$ 3,233,561**	**$ 1,184,140**	**58%**	
15% Contingency	**$ 307,413**	**$ 485,034**	**$ 177,621**		
4% Escalation per Year to 2025		**$ 129,342**			
Grand Total	**$ 2,356,834**	**$ 3,847,938**	**$ 1,491,103**	**63%**	

ENGINEER'S OPINION OF PROBABLE CONSTRUCTION COSTS

Client: **City of Pasadena/City of South Pasadena** Prepared by: **YW**
Project: **Arroyo Seco-San Pascual Treatment Wetlands** Checked by: **CS**
Status: **100% Cost Estimate - Draft** Date **11/29/2023**

Description	Qty	Unit	Unit Price	Total
Miscellaneous				**$378,332**
Mobilization / Demobilization (5% of Costs)	1	LS	$298,332.00	$298,332
Tribal Monitor	1	LS	$80,000.00	$80,000
Channel Diversion, Pretreatment, and Pump Station				**$1,589,839**
Modify Existing Diversion	1	EA	$50,000.00	$50,000
Actuated Valve and Vault (Includes excavation, hauling, shoring, and backfill)	1	EA	$109,700.00	$109,700
Pretreatment Device (15 CFS) (Includes excavation & shoring)	1	EA	$162,000.00	$162,000
Manhole (Includes excavation & shoring)	2	EA	$29,500.00	$59,000
Total Piping Costs (Refer to Mechanical Cost Estimates)	1	LS	$100,000.00	$100,000
15 cfs Pump Station (Wet Well, Pumps, 5 Access Hatches, Excavation, etc)	1	LS	$735,000.00	$735,000
Shoring for Pretreatment Device	1,888	SF	$81.00	$152,928
Shoring for Wet Well and Valve Vault	2,731	SF	$81.00	$221,211
Site Preparation and Demolition - Existing Area				**$257,582**
Clear and Grub	96,280	SF	$0.65	$62,582
Tree Removal	130	EA	$1,500.00	$195,000
Treatment Basin				**$1,175,813**
Excavation	3,800	CY	$50.00	$190,000
Backfill and Compaction	2,300	CY	$50.00	$115,000
Hauling	1,500	CY	$30.00	$45,000
Finish Grading	80,654	SF	$0.53	$42,747
Equalization Pipe (18" RCP)	64	LF	$240.00	$15,360
Rip Rap	203	CY	$75.00	$15,258
Concrete Liner (swale)	1,800	SF	$10.00	$18,000
Geomembrane Pond Liner	11,146	SF	$1.20	$13,375
Treatment Filter Unit (7.8 cfs)	1	EA	$439,296.00	$439,296
Structural Concrete, Headwall and Wingwall Structures	43	CY	$1,000.00	$42,667
Bar Reinforcing Steel, Headwall and Wingwall Structures	10,400	LB	$12.00	$124,800
Water Level Control Structure	1	EA	$7,000.00	$7,000
Flow meter	2	EA	$38,400.00	$76,800
Outfall Overflow Structure	1	EA	$12,000.00	$12,000
RCP Wye (Includes excavation & shoring)	1	EA	$1,000.00	$1,000
Piping (18" RCP) to Outfall (Includes excavation & shoring)	85	LF	$206.00	$17,510
Electrical Service, Controls, Instrumentation				**$880,349**
Incoming Service Summary	1	LS	$119,264.00	$119,264
Switchboard Enclosure Summary	1	LS	$234,350.00	$234,350
Conduit and Wires Summary	1	LS	$349,406.00	$349,406
Trenching and Backfill Summary	1	LS	$102,329.00	$102,329
Mobilization	1	LS	$25,000.00	$25,000
SCADA	1	LS	$50,000.00	$50,000
Landscape and Irrigation Modifications				**$402,804**
36" Box Tree	132	EA	$1,000.00	$132,000
Shrubs, Perennials, and Grasses	1	LS	$100,000.00	$100,000
Stones and Boulders	1	LS	$85,000.00	$85,000
Irrigation for Plant Establishment	35,402	SF	$2.00	$70,804
90-Day Plant Establishment Period (Irrigation and Maintenance)	1	LS	$15,000.00	$15,000

ENGINEER'S OPINION OF PROBABLE CONSTRUCTION COSTS

Client: **City of Pasadena/City of South Pasadena**
Project: **Arroyo Seco-San Pascual Treatment Wetlands**
Status: **100% Cost Estimate - Draft**

Prepared by: **YW**
Checked by: **CS**
Date **11/29/2023**

Description	Qty	Unit	Unit Price	Total
Site Amenities and Improvements				**$523,653**
Decomposed Granite Path (Pedestrian Only)	7,025	SF	$8.50	$59,713
Decomposed Granite Path (Vehicular)	6,050	SF	$12.00	$72,600
Metal Edge at DG	3,306	LF	$15.00	$49,590
Structural Concrete, Stairs	3	CY	$1,600.00	$4,800
Concrete Pavement (Vehicular)	600	SF	$25.00	$15,000
Lodgepole Fencing	2,238	LF	$125.00	$279,750
Educational Sign	4	EA	$1,800.00	$7,200
Concrete Seatwall with stone façade	40	CY	$400.00	$16,000
10' Wide Vehicular Gate	1	EA	$5,000.00	$5,000
Bollards	4	EA	$500.00	$2,000
Log Bench	16	EA	$750.00	$12,000
Stormwater Harvesting				**$886,000**
Stormwater Harvesting Equipment	1	LS	$620,000.00	$620,000
Stormwater Harvesting Building	1	LS	$100,000.00	$100,000
Reservoir Cleanout	1	LS	$80,000.00	$80,000
Concrete Pad	1	LS	$6,000.00	$6,000
Piping and Connections	1	LS	$30,000.00	$30,000
Reservoir Retrofit	1	LS	$50,000.00	$50,000
Erosion Control				**$72,764**
Construction Fence and Wind Screen	1,574	LF	$3.00	$4,722
Silt Fence	804	LF	$18.10	$14,552
Fiber Rolls	80	LF	$1.50	$120
Sand Bags	737	LF	$10.00	$7,370
Stabilized Construction Entrance/Exit	2	EA	$8,000.00	$16,000
Dewatering	30	DAY	$1,000.00	$30,000
Start-up, Testing, Prepare Operations & Maintenance Manuals				**$60,000**
Start-up and Testing	1	LS	$60,000.00	$60,000
SUBTOTAL				**$6,227,136**
			4% Escalation Per Year to 2025	$249,086
			15% Contingency	$934,071
			Total Construction Costs	**$7,410,293**
	GRAND TOTAL			**$7,410,293**

Client:	**City of Pasadena/City of South Pasadena**	Prepared by:	**YW**
Project:	**Arroyo Seco-San Pascual Treatment Wetlands**	Checked by:	**CS**
Status:	**100% Cost Estimate - Draft**	Date	**11/29/2023**

Description	Qty	Unit	Unit Price	Total

Assumptions and Exclusions

1 This is a rough order of magnitude preliminary opinion of probable construction costs only. Actual costs may vary.
2 The unit cost data is derived from inhouse sources, recent bids on similar construction, and RSMeans current construction cost data.
3 This opinion of cost is based on the project program and plans made available at the time of preparation.
4 Material prices are based on current quotations and do not include escalation.
5 This opinion of cost assumes that all improvements will be constructed at one time.
6 Quantity take offs were performed when possible and parametric estimates and allowances are used for items that cannot be quantified at this stage of the design.
7 This opinion has been based on a competitive open bid situation with a recommended 5 - 7 bonafide reputable bids from general contractors and a minimum of 3 bidders for all items of subcontracted work.
8 All unit costs take into account sales tax, general conditions, bonding and insurance, and subcontractor and general contractor overhead and profit.
9 Where applicable, unit costs include the cost of freight.

The following are excluded:

1 Environmental clearances and permits
2 Hazardous spoil disposal, if encountered
3 Property and Right of Way acquisition or easements
4 Legal and accounting fees
5 Plan check, building permit fees
6 Utility Connection Fees
7 Testing and inspection
8 Fire and all risk insurance
9 Removal of unforeseen underground obstructions
10 Relocation of unforeseen subsurface utilities
11 Signage and wayfinding
12 Additional fill or import
13 Loose furniture and equipment
14 Utility connection fees
15 Tel/data system
16 Construction contingency
17 Work done after business hours
18 Design, engineering and consulting fees other than those specifically listed in the above estimate

Items that may affect the cost estimate:

1 Modifications to the scope of work included in this estimate
2 Unforeseen sub-surface conditions
3 Restrictive technical specifications or excessive contract conditions
4 Any other non-competitive bid situations
5 Bids delayed beyond the projected schedule

ENGINEER'S OPINION OF PROBABLE CONSTRUCTION COSTS

Client: **City of Pasadena**
Project: **Arroyo Seco-San Rafael Biofiltration Basin**
Status: **100% Cost Estimate - Draft**

Prepared by: **YW**
Checked by: **CS**
Date **11/29/2023**

Description	Qty	Unit	Unit Price	Total
Miscellaneous				**$243,374**
Mobilization / Demobilization (5% of Costs)	1	LS	$179,374.00	$179,374
Tribal Monitor	1	LS	$64,000.00	$64,000
Channel Diversion and Pretreatment				**$365,194**
Temporary Diversion	1	EA	$20,000.00	$20,000
Drop Inlet w/ Grate (Diversion Structure)	1	EA	$85,000.00	$85,000
Manhole (Incl. excavation, shoring, bedding, backfill)	1	EA	$29,500.00	$29,500
Actuated Valve and Vault	1	EA	$75,700.00	$75,700
Flow Meter and Structure	1	EA	$30,400.00	$30,400
Headwall and Wingwall Structures	3	EA	$15,000.00	$45,000
Rock Lined Stream	115	LF	$500.00	$57,500
Sediment Forebay Excavation	220	CY	$50.00	$11,000
Rip Rap Weir Berm	1	LS	$1,000.00	$1,000
Piping (18" RCP) to Wetland (Incl. excavation, shoring, bedding, backfill)	49	LF	$206.00	$10,094
Site Preparation and Demolition - Existing Area				**$87,300**
Clear and Grub	63,000	SF	$0.60	$37,800
Tree Protection Fencing	1,200	LF	$35.00	$42,000
Tree Removal	5	EA	$1,500.00	$7,500
Infiltration Basin (0.43 AF)				**$193,362**
Excavation	2,000	CY	$50.00	$100,000
Backfill and Compaction	400	CY	$50.00	$20,000
Hauling	1,600	CY	$30.00	$48,000
Finish Grading	47,853	SF	$0.53	$25,362
Outlet Line to Channel				**$500,750**
Water Level Sensor and Structure	1	EA	$30,000.00	$30,000
Orifice Overflow Structure	1	EA	$17,000.00	$17,000
Connection to Channel	1	EA	$10,000.00	$10,000
Treatment Filter Unit (2.88 cfs)	1	EA	$300,000.00	$300,000
Flow Meter and Structure	1	EA	$38,400.00	$38,400
Manhole (Incl. excavation, shoring, bedding, backfill)	2	EA	$29,500.00	$59,000
Piping (18" RCP) to Outfall (Includes excavation & shoring)	225	LF	$206.00	$46,350
Electrical Service, Controls, Instrumentation				**$588,502**
Incoming Service Summary	1	LS	$207,847.00	$207,847
Switchboard Enclosure Summary	1	LS	$234,350.00	$234,350
Conduit and Wires Summary	1	LS	$53,705.00	$53,705
Trenching and Backfill Summary	1	LS	$17,600.00	$17,600
Mobilization	1	LS	$25,000.00	$25,000
SCADA Accessories	1	LS	$50,000.00	$50,000
Landscape and Irrigation Modifications				**$273,475**
Soil Preparation	31,500	SF	$0.65	$20,475
36" Box Tree	75	EA	$1,000.00	$75,000
Shrubs, Perennials, and Grasses	1	LS	$100,000.00	$100,000
90-Day Plant Establishment Period	1	LS	$15,000.00	$15,000
Irrigation for Plant Establishment	31,500	SF	$2.00	$63,000

ENGINEER'S OPINION OF PROBABLE CONSTRUCTION COSTS

Client: **City of Pasadena**
Project: **Arroyo Seco-San Rafael Biofiltration Basin**
Status: **100% Cost Estimate - Draft**

Prepared by: **YW**
Checked by: **CS**
Date **11/29/2023**

Description	Qty	Unit	Unit Price	Total
Site Amenities and Improvements				**$881,590**
Decomposed Granite Path (for pedestrians only)	13,360	SF	$9.00	$120,240
Decomposed Granite Path (for vehicles)	2,415	SF	$12.00	$28,980
Metal Edge at DG	2,600	LF	$15.00	$39,000
Post and Rail Fencing	124	SF	$35.00	$4,340
Cobblestone 1" - 3"	1,100	SF	$6.00	$6,600
Large Boulder, 4'-5' x 3'	35	EA	$500.00	$17,500
Medium Boulder, 3'-4' x 2'-3'	62	EA	$420.00	$26,040
Small Boulder, 3' x 1.5'	18	EA	$300.00	$5,400
Log Bench	11	EA	$750.00	$8,250
Educational Sign	3	EA	$1,800.00	$5,400
24" Cast-in-Drilled Hole Concrete Piling	90	LF	$580.00	$52,200
Structural Concrete, Bridge	22	CY	$2,300.00	$50,600
Bar Reinforcing Steel, Bridge	3,800	LB	$5.80	$22,040
Temporary Bridge	1	LS	$495,000.00	$495,000
Erosion Control				**$50,014**
Construction Fence and Wind Screen	916	LF	$3.00	$2,748
Silt Fence	1,370	LF	$18.10	$24,797
Fiber Rolls	446	LF	$1.50	$669
Sand Bags	1,380	LF	$10.00	$13,800
Stabilized Construction Entrance/Exit	1	EA	$8,000.00	$8,000
Start-up, Testing, Prepare Operations & Maintenance Manuals				**$50,000**
Start-up and Testing	1	LS	$50,000.00	$50,000
SUBTOTAL				**$3,233,561**
			4% Escalation Per Year to 2025	$129,343
			15% Contingency	$485,035
			Total Construction Costs	**$3,847,939**
	GRAND TOTAL			**$3,847,939**

craft water engineering, inc.

ENGINEER'S OPINION OF PROBABLE CONSTRUCTION COSTS

Client: **City of Pasadena**
Project: **Arroyo Seco-San Rafael Biofiltration Basin**
Status: **100% Cost Estimate - Draft**

Prepared by: **YW**
Checked by: **CS**
Date **11/29/2023**

Description	Qty	Unit	Unit Price	Total

Assumptions and Exclusions

1 This is a rough order of magnitude preliminary opinion of probable construction costs only. Actual costs may vary.
2 The unit cost data is derived from inhouse sources, recent bids on similar construction, and RSMeans current construction cost data.
3 This opinion of cost is based on the project program and plans made available at the time of preparation.
4 Material prices are based on current quotations and do not include escalation.
5 This opinion of cost assumes that all improvements will be constructed at one time.
6 Quantity take offs were performed when possible and parametric estimates and allowances are used for items that cannot be quantified at this stage of the design.
7 This opinion has been based on a competitive open bid situation with a recommended 5 - 7 bonafide reputable bids from general contractors and a minimum of 3 bidders for all items of subcontracted work.
8 All unit costs take into account sales tax, general conditions, bonding and insurance, and subcontractor and general contractor overhead and profit.
9 Where applicable, unit costs include the cost of freight.

The following are excluded:

1 Environmental clearances and permits
2 Hazardous spoil disposal, if encountered
3 Property and Right of Way acquisition or easements
4 Legal and accounting fees
5 Plan check, building permit fees
6 Utility Connection Fees
7 Testing and inspection
8 Fire and all risk insurance
9 Removal of unforeseen underground obstructions
10 Relocation of unforeseen subsurface utilities
11 Signage and wayfinding
12 Additional fill or import
13 Loose furniture and equipment
14 Utility connection fees
15 Tel/data system
16 Construction contingency
17 Work done after business hours
18 Design, engineering and consulting fees other than those specifically listed in the above estimate

Items that may affect the cost estimate:

1 Modifications to the scope of work included in this estimate
2 Unforeseen sub-surface conditions
3 Restrictive technical specifications or excessive contract conditions
4 Any other non-competitive bid situations
5 Bids delayed beyond the projected schedule

ATTACHMENT A: Project Modification Request (PMR) FORM

The purpose of this PMR form is to initiate the Project modification process and provide the District with information necessary to evaluate the Project modification request.

Regional Program	☒ Infrastructure Program Project ☐ Scientific Studies Program ☐ Technical Resources Program
Project/Study Name	Metro Orange Line Water Infiltration and Quality Project
Project/Study Lead	Los Angeles County Metropolitan Transportation Authority
Watershed Area(s)	Upper Los Angeles River
Current Project Phase	Design
Approved Stormwater Investment Plan Fiscal Year	FY22-23
Transfer Agreement ID (e.g., 2020RPULAR52)	2021RPULAR10

Has Transfer Agreement or most recent Addendum been executed (i.e., signed by the project lead and the District)? ☒ Yes ☐ No

What type(s) of modification request?

☐ like-for-like modifications
☐ functionally equivalent BMP modifications
☐ modifications to Project or Study components that were not material to the WASC, ROC, or Board's decision to include the Project or Study in the SIP
☐ minor modifications to the budget or schedule of intermediate tasks where the total Funded Activity amount and Funded Activity completion date is unchanged
☐ change in primary or secondary objective
☒ change in Project benefits
☐ change in methodology (e.g., infiltration instead of diversion to sanitary sewer)
☒ decrease in BMP capacity
☐ change in Project or Study location
☒ change in capture area where benefits claimed are diminished or where there is a change in the municipalities that are receiving benefits
☒ updated engineering analysis resulting in a reduction of benefits claimed
☒ increase in Construction Cost or Life Cycle Cost greater than 10%
☐ increase or reallocation of annual funding distribution
☐ change in Funded Activity completion date
☐ other, please describe:

Impact on scope or benefits?

☐ Improved
☒ Diminished
☐ Neither
☐ Not Sure

Description of the proposed modification(s) and the reason(s) why the modification(s) is/are being proposed.

LA Metro completed the 60% design and cost estimate in September 2023. The latest construction cost estimate is more than 100% higher than the construction funding allocated to the Project. LA Metro is proposing to reduce the project scope by eliminating a subset of the drywell locations. Please see the supporting documentation for details.

If applicable, list previously approved funding allocations/disbursements and revised funding request:

Note, if some or all of a previously Funded Activity cannot be completed as a result of the proposed modification, please include a description and indicate the amount of unused funds. Any unused funds should be reallocated and accounted for in your revised funding request.

Fiscal Year	Approved Funding Allocations	Revised Funding Request	Description/Phase *If applicable, include description of unused funds*
20-21	$1,600,000	$1,600,000	Project planning, CEQA
21-22	$5,070,400	$5,070,400	Design-build phase 1
22-23	$6,000,000	$6,000,000	Design-build phase 2
23-24	$7,288,000	$6,596,800	Design-build phase 2
24-25	$823,200	$132,000	Operation and maintenance
Future Funding	$13,733,858	$7,230,856	Operation and maintenance
TOTAL	$34,515,458	$26,630,056	

A: SCWP Approved Total Funding Allocations	$34,515,458
B: Revised SCWP Anticipated Total Funding Request	$26,630,056
C: Difference between B and A	$7,885,402

If applicable, description of difference in SCWP Anticipated Total Funding Request. As a reminder, annual funding is at the discretion of the WASC, ROC, and ultimately the Board of Supervisors.

The difference is due to the reduced O&M funding request.

Brief description of Supporting Documentation provided.

Details of the proposed scope change is provided

I certify the information and supporting documentation provided is accurate and true.	☑ YES
I understand this is a request and it is under the WASC's discretion to consider requested modifications.	☑ YES

Name Tom Kefalas Organization LA Metro

Signature *Tom Kefalas* Date 11/30/23

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Proposed Modifications to Projects or Studies:

	Status	Date
Modified Project or Study is **consistent** with the Project or Study included in the current fiscal year's SIP and proposed modifications were **approved** by the District.	☐ YES	
Modified Project or Study is **NOT consistent** with the Project or Study included in the current fiscal year's SIP. **If yes, select all that apply**:	☑ YES	12/13/23
PMR was received **after** October 31 of a fiscal year and the PMR will be considered for approval during the preparation of **subsequent** SIP for the fiscal year <u>after</u> the next	☐ YES	-
For Infrastructure Program Projects, modified Project was sent to **Scoring Committee**. If yes, revised score:	☐ YES	
Project or Study **abandoned** the proposed modifications	☐ YES	
Projector or Study was **withdrawn** from consideration by the WASC and shall issue repayment of unspent funds	☐ YES	
Proposed modifications were **recommended for approval** in the SIP	☐ YES ☐ NO	

Proposed Modifications to Project Concepts:

	Status	Date
Proposed modifications were deemed **consistent** with the Project concept that was approved by the WASC, ROC and Board for inclusion in the SIP and can be addressed within the existing budget. District will proceed to incorporate the proposed modification into the Feasibility Study immediately.	☐ YES	
Proposed modifications were deemed significant enough to result in a **significantly different** Project concept from the one approved by the WASC, ROC and Board for inclusion in the SIP. **If yes, select one:**	☐ YES	
District to **discontinue** work on the Feasibility Study, return unused funds to be programmed in the SIP for the next fiscal year, and advise the proponent to submit the modified Project concept during the Call for Projects for a future fiscal year.	☐ YES	-
District to **abandon** the proposed modifications and proceed with the Project concept included in the SIP.	☐ YES	-

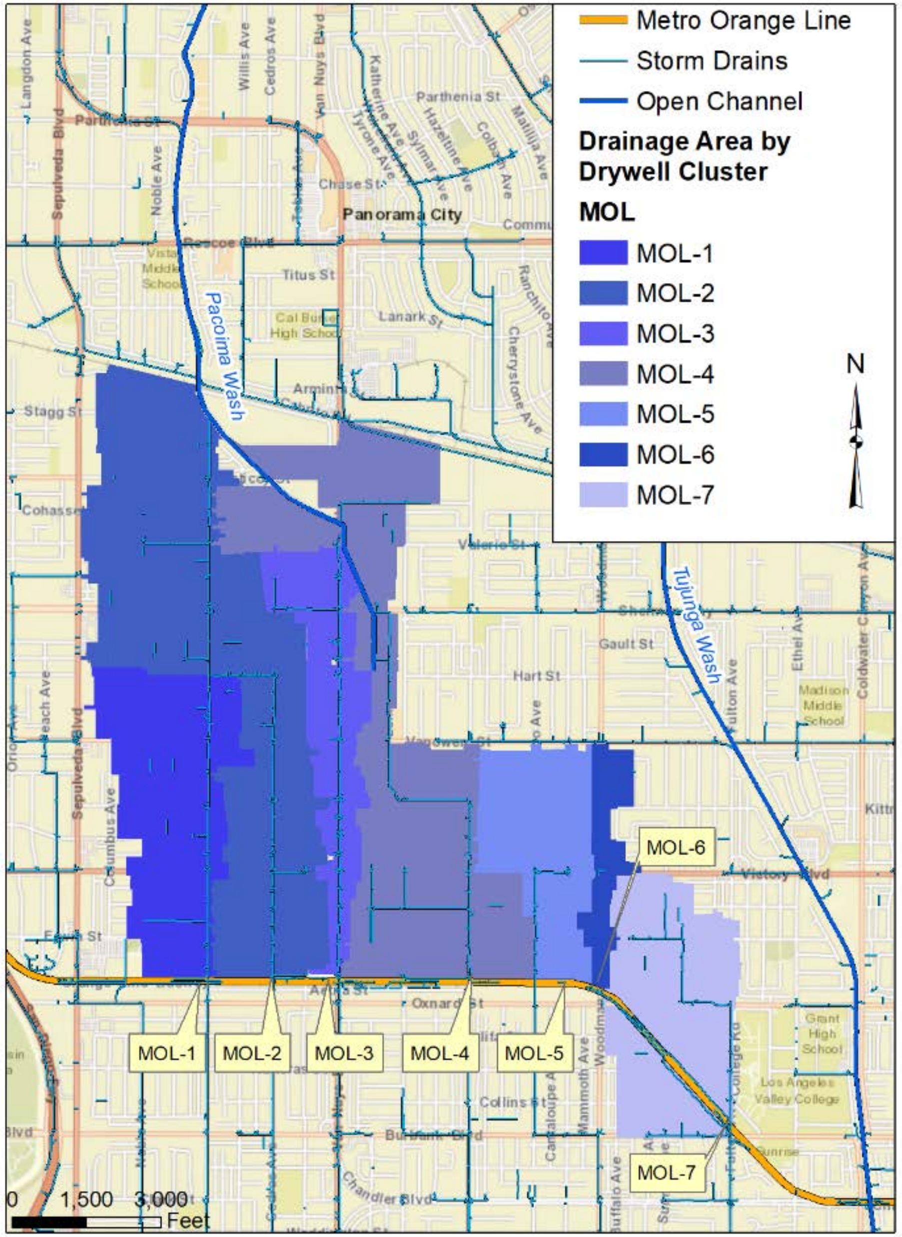
Metro Orange Line Water Infiltration and Quality Project

PMR Supporting Documentation

Original Project Scope

- 168 drywells
- Capture and recharge 890 acre-feet of stormwater and non-stormwater runoff per year

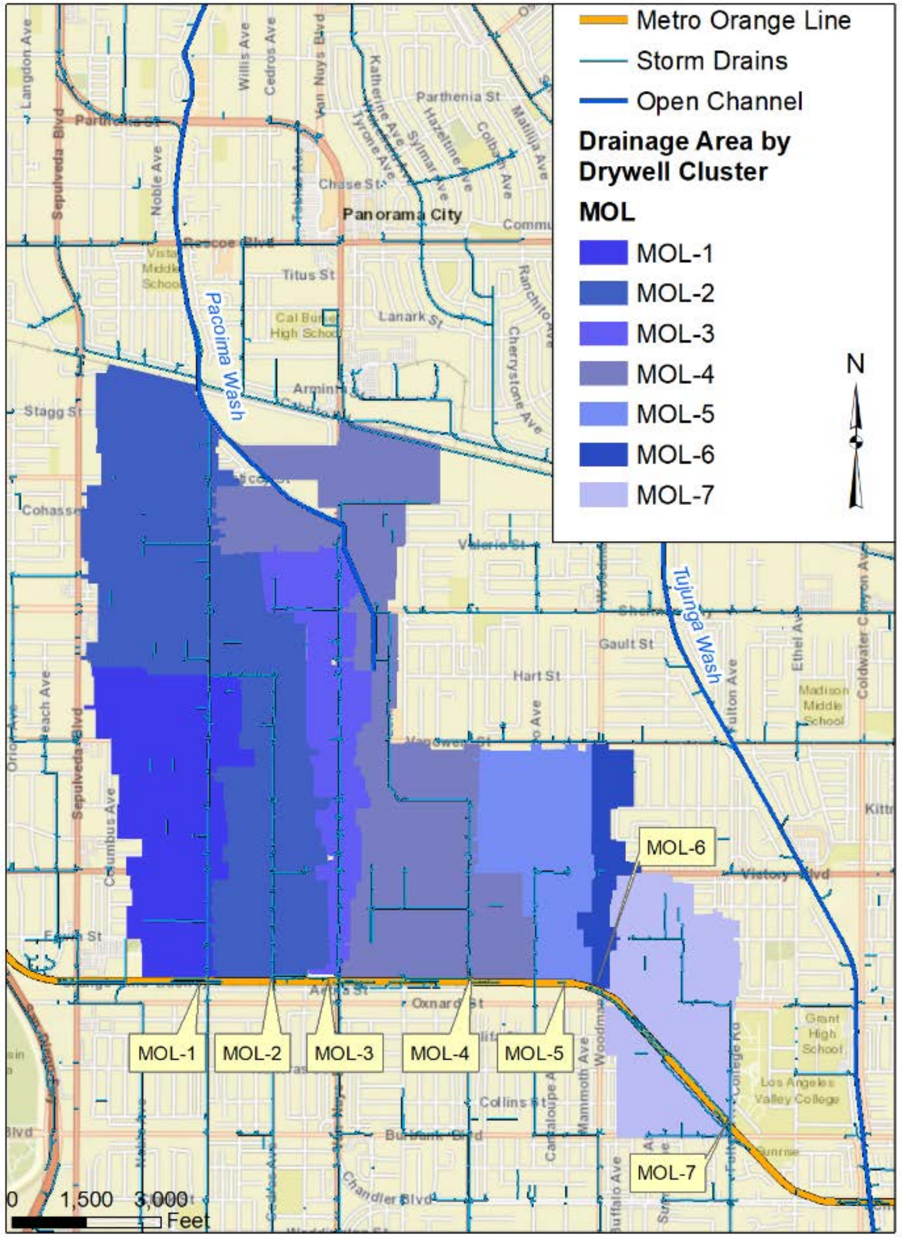
Drywell Cluster ID	Drainage Area (ac)	Number of Drywells Proposed	Estimated Annual Capture (AFY)*
MOL-1	308	24	120
~~MOL-2~~	~~683~~	~~40~~	~~250~~
~~MOL-3~~	~~197~~	~~14~~	~~85~~
~~MOL-4~~	~~579~~	~~39~~	~~220~~
~~MOL-5~~	~~193~~	~~13~~	~~65~~
~~MOL-6~~	~~67~~	~~10~~	~~35~~
~~MOL-7~~	~~292~~	~~28~~	~~115~~
Total	2,319	168	890



Proposed New Project Scope

- 24 drywells
- Capture and recharge 120 acre-feet of stormwater and non-stormwater runoff per year

Drywell Cluster ID	Drainage Area (ac)	Number of Drywells Proposed	Estimated Annual Capture (AFY)*
MOL-1	308	24	120
~~MOL-2~~	~~683~~	~~40~~	~~250~~
~~MOL-3~~	~~197~~	~~14~~	~~85~~
~~MOL-4~~	~~579~~	~~39~~	~~220~~
~~MOL-5~~	~~193~~	~~13~~	~~65~~
~~MOL-6~~	~~67~~	~~10~~	~~35~~
~~MOL-7~~	~~292~~	~~28~~	~~115~~
Total	~~2,319~~ 308	~~168~~ 24	~~890~~ 120



ATTACHMENT A: Project Modification Request (PMR) FORM

The purpose of this PMR form is to initiate the Project modification process and provide the District with information necessary to evaluate the Project modification request.

Regional Program	☑Infrastructure Program Project ☐Scientific Studies Program ☐Technical Resources Program
Project/Study Name	David M. Gonzales Recreation Center Stormwater Capture Project
Project/Study Lead	Los Angeles Department of Water and Power
Watershed Area(s)	Upper Los Angeles River
Current Project Phase	Right-of-Way Approvals
Approved Stormwater Investment Plan Fiscal Year	FY21-22
Transfer Agreement ID (e.g., 2020RPULAR52)	2021RPULAR08

Has Transfer Agreement or most recent Addendum been executed (i.e., signed by the project lead and the District)? ☑ Yes ☐ No

What type(s) of modification request?

☐ like-for-like modifications
☐ functionally equivalent BMP modifications
☐ modifications to Project or Study components that were not material to the WASC, ROC, or Board's decision to include the Project or Study in the SIP
☐ minor modifications to the budget or schedule of intermediate tasks where the total Funded Activity amount and Funded Activity completion date is unchanged
☐ change in primary or secondary objective
☐ change in Project benefits
☐ change in methodology (e.g., infiltration instead of diversion to sanitary sewer)
☐ decrease in BMP capacity
☐ change in Project or Study location
☐ change in capture area where benefits claimed are diminished or where there is a change in the municipalities that are receiving benefits
☐ updated engineering analysis resulting in a reduction of benefits claimed
☑ increase in Construction Cost or Life Cycle Cost greater than 10%
☐ increase or reallocation of annual funding distribution
☐ change in Funded Activity completion date
☐ other, please describe:

Impact on scope or benefits?

- ☐ Improved
- ☐ Diminished
- ☑ Neither
- ☐ Not Sure

Description of the proposed modification(s) and the reason(s) why the modification(s) is/are being proposed.

Updated project cost to reflect inflationary adjustments. Due to construction cost inflation and market conditions, project costs have escalated significantly.

If applicable, list previously approved funding allocations/disbursements and revised funding request:

Note, if some or all of a previously Funded Activity cannot be completed as a result of the proposed modification, please include a description and indicate the amount of unused funds. Any unused funds should be reallocated and accounted for in your revised funding request.

Fiscal Year	Approved Funding Allocations	Revised Funding Request	Description/Phase *If applicable, include description of unused funds*
21-22	$388,000	$388,000	Design
22-23	$581,000	$581,000	Design
23-24	$1,550,000	$1,550,000	Design/Bid-Award/Construction
24-25	$2,130,000	$6,799,238	Bid-Award/Construction
25-26	$3,099,000	$7,768,238	Construction
Future Funding	$11,615,000	$25,622,714	Bid-Award/Construction
TOTAL	$19,363,000	$42,709,190	Design/B&A/Construction

A: SCWP Approved Total Funding Allocations	$19,363,000
B: Revised SCWP Anticipated Total Funding Request	$42,709,190
C: Difference between B and A	$23,346,190

If applicable, description of difference in SCWP Anticipated Total Funding Request. As a reminder, annual funding is at the discretion of the WASC, ROC, and ultimately the Board of Supervisors.

The difference is to cover additional costs related to large cost increases involving significant inflation from the application period to present day. Due to the project's SCWP application being earlier in the project's schedule, costs are now more certain since the project is close to construction start. In addition, the revised total request includes full funding to complete the project.

Brief description of Supporting Documentation provided.

The supporting documentation includes a memorandum issued by the Los Angeles Department of Public Works, Bureau of Engineering regarding escalation associated with past, present, and future inflation.

I certify the information and supporting documentation provided is accurate and true.	☑ YES
I understand this is a request and it is under the WASC's discretion to consider requested modifications.	☑ YES

Name Peter N. Tonthat

Organization Los Angeles Department of Water and Power

Signature Peter Tonthat Digitally signed by Peter Tonthat Date: 2023.11.28 15:00:20 -08'00'

Date November 28, 2023

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Proposed Modifications to Projects or Studies:

	Status	Date
Modified Project or Study is **consistent** with the Project or Study included in the current fiscal year's SIP and proposed modifications were **approved** by the District.	☐ YES	
Modified Project or Study is **NOT consistent** with the Project or Study included in the current fiscal year's SIP. **If yes, select all that apply**:	☑ YES	12/11/2023
PMR was received **after** October 31 of a fiscal year and the PMR will be considered for approval during the preparation of **subsequent** SIP for the fiscal year after the next	☐ YES	-
For Infrastructure Program Projects, modified Project was sent to **Scoring Committee**. If yes, revised score:	☐ YES	
Project or Study **abandoned** the proposed modifications	☐ YES	
Projector or Study was **withdrawn** from consideration by the WASC and shall issue repayment of unspent funds	☐ YES	
Proposed modifications were **recommended for approval** in the SIP	☐ YES ☐ NO	

Proposed Modifications to Project Concepts:

	Status	Date
Proposed modifications were deemed **consistent** with the Project concept that was approved by the WASC, ROC and Board for inclusion in the SIP and can be addressed within the existing budget. District will proceed to incorporate the proposed modification into the Feasibility Study immediately.	☐ YES	
Proposed modifications were deemed significant enough to result in a **significantly different** Project concept from the one approved by the WASC, ROC and Board for inclusion in the SIP. **If yes, select one:**	☐ YES	
District to **discontinue** work on the Feasibility Study, return unused funds to be programmed in the SIP for the next fiscal year, and advise the proponent to submit the modified Project concept during the Call for Projects for a future fiscal year.	☐ YES	-
District to **abandon** the proposed modifications and proceed with the Project concept included in the SIP.	☐ YES	-

ATTACHMENT A: Project Modification Request (PMR) FORM

The purpose of this PMR form is to initiate the Project modification process and provide the District with information necessary to evaluate the Project modification request.

Regional Program	☑Infrastructure Program Project ☐Scientific Studies Program ☐Technical Resources Program
Project/Study Name	Fernangeles Park Stormwater Capture Project
Project/Study Lead	Los Angeles Department of Water and Power
Watershed Area(s)	Upper Los Angeles River
Current Project Phase	Right-of-Way Approvals
Approved Stormwater Investment Plan Fiscal Year	FY20-21
Transfer Agreement ID (e.g., 2020RPULAR52)	2020RPULAR04

Has Transfer Agreement or most recent Addendum been executed (i.e., signed by the project lead and the District)? ☑ Yes ☐ No

What type(s) of modification request?

☐ like-for-like modifications
☐ functionally equivalent BMP modifications
☐ modifications to Project or Study components that were not material to the WASC, ROC, or Board's decision to include the Project or Study in the SIP
☐ minor modifications to the budget or schedule of intermediate tasks where the total Funded Activity amount and Funded Activity completion date is unchanged
☐ change in primary or secondary objective
☐ change in Project benefits
☐ change in methodology (e.g., infiltration instead of diversion to sanitary sewer)
☐ decrease in BMP capacity
☐ change in Project or Study location
☐ change in capture area where benefits claimed are diminished or where there is a change in the municipalities that are receiving benefits
☐ updated engineering analysis resulting in a reduction of benefits claimed
☑ increase in Construction Cost or Life Cycle Cost greater than 10%
☐ increase or reallocation of annual funding distribution
☐ change in Funded Activity completion date
☐ other, please describe:

Impact on scope or benefits?

☐ Improved
☐ Diminished
☑ Neither
☐ Not Sure

Description of the proposed modification(s) and the reason(s) why the modification(s) is/are being proposed.

Updated project cost to reflect inflationary adjustments. Due to construction cost inflation and market conditions, project costs have escalated significantly.

If applicable, list previously approved funding allocations/disbursements and revised funding request:

Note, if some or all of a previously Funded Activity cannot be completed as a result of the proposed modification, please include a description and indicate the amount of unused funds. Any unused funds should be reallocated and accounted for in your revised funding request.

Fiscal Year	Approved Funding Allocations	Revised Funding Request	Description/Phase *If applicable, include description of unused funds*
20-21	$2,926,261.89	$2,926,261.89	Planning/Design/Construction
21-22	$3,344,299.31	$3,344,299.31	Planning/Design/Construction
22-23	$1,254,112.24	$1,254,112.24	Planning/Design/Construction
23-24	$836,074.83	$836,074.83	Planning/Design/Construction
24-25	$0	$0	
Future Funding	$0	$28,467,066	Bid-Award/Construction
TOTAL	$8,360,748.27	$36,827,814.27	Planning/Design/B&A/Construction

A: SCWP Approved Total Funding Allocations	$8,360,748
B: Revised SCWP Anticipated Total Funding Request	$36,827,814
C: Difference between B and A	$28,467,066

If applicable, description of difference in SCWP Anticipated Total Funding Request. As a reminder, annual funding is at the discretion of the WASC, ROC, and ultimately the Board of Supervisors.

The difference is to cover additional costs related to large cost increases involving significant inflation from the application period to present day. Due to the project's SCWP application being earlier in the project's schedule, costs are now more certain since the project is close to construction start. In addition, the revised total request includes full funding to complete the project.

Brief description of Supporting Documentation provided.

The supporting documentation includes a memorandum issued by the Los Angeles Department of Public Works, Bureau of Engineering regarding escalation associated with past, present, and future inflation.

I certify the information and supporting documentation provided is accurate and true.	☑ YES
I understand this is a request and it is under the WASC's discretion to consider requested modifications.	☑ YES

Name Peter N. Tonthat

Organization Los Angeles Department of Water and Power

Signature Peter Tonthat Digitally signed by Peter Tonthat Date: 2023.11.28 15:03:07 -08'00'

Date November 28. 2023

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Proposed Modifications to Projects or Studies:

	Status	Date
Modified Project or Study is **consistent** with the Project or Study included in the current fiscal year's SIP and proposed modifications were **approved** by the District.	☐ YES	
Modified Project or Study is **NOT consistent** with the Project or Study included in the current fiscal year's SIP. **If yes, select all that apply**:	☑ YES	12/11/23
PMR was received **after** October 31 of a fiscal year and the PMR will be considered for approval during the preparation of **subsequent** SIP for the fiscal year after the next	☐ YES	-
For Infrastructure Program Projects, modified Project was sent to **Scoring Committee**. If yes, revised score:	☐ YES	
Project or Study **abandoned** the proposed modifications	☐ YES	
Projector or Study was **withdrawn** from consideration by the WASC and shall issue repayment of unspent funds	☐ YES	
Proposed modifications were **recommended for approval** in the SIP	☐ YES ☐ NO	

Proposed Modifications to Project Concepts:

	Status	Date
Proposed modifications were deemed **consistent** with the Project concept that was approved by the WASC, ROC and Board for inclusion in the SIP and can be addressed within the existing budget. District will proceed to incorporate the proposed modification into the Feasibility Study immediately.	☐ YES	
Proposed modifications were deemed significant enough to result in a **significantly different** Project concept from the one approved by the WASC, ROC and Board for inclusion in the SIP. **If yes, select one:**	☐ YES	
District to **discontinue** work on the Feasibility Study, return unused funds to be programmed in the SIP for the next fiscal year, and advise the proponent to submit the modified Project concept during the Call for Projects for a future fiscal year.	☐ YES	-
District to **abandon** the proposed modifications and proceed with the Project concept included in the SIP.	☐ YES	-

ATTACHMENT A: Project Modification Request (PMR) FORM

The purpose of this PMR form is to initiate the Project modification process and provide the District with information necessary to evaluate the Project modification request.

Regional Program	☑Infrastructure Program Project ☐Scientific Studies Program ☐Technical Resources Program
Project/Study Name	Strathern Park North Stormwater Capture Project
Project/Study Lead	Los Angeles Department of Water and Power
Watershed Area(s)	Upper Los Angeles River
Current Project Phase	Right-of-Way Approvals
Approved Stormwater Investment Plan Fiscal Year	FY20-21
Transfer Agreement ID (e.g., 2020RPULAR52)	2020RPULAR09

Has Transfer Agreement or most recent Addendum been executed (i.e., signed by the project lead and the District)? ☑ Yes ☐ No

What type(s) of modification request?

☐ like-for-like modifications

☐ functionally equivalent BMP modifications

☐ modifications to Project or Study components that were not material to the WASC, ROC, or Board's decision to include the Project or Study in the SIP

☐ minor modifications to the budget or schedule of intermediate tasks where the total Funded Activity amount and Funded Activity completion date is unchanged

☐ change in primary or secondary objective

☐ change in Project benefits

☐ change in methodology (e.g., infiltration instead of diversion to sanitary sewer)

☐ decrease in BMP capacity

☐ change in Project or Study location

☐ change in capture area where benefits claimed are diminished or where there is a change in the municipalities that are receiving benefits

☐ updated engineering analysis resulting in a reduction of benefits claimed

☑ increase in Construction Cost or Life Cycle Cost greater than 10%

☐ increase or reallocation of annual funding distribution

☐ change in Funded Activity completion date

☐ other, please describe:

Impact on scope or benefits?

☐ Improved
☐ Diminished
☑ Neither
☐ Not Sure

Description of the proposed modification(s) and the reason(s) why the modification(s) is/are being proposed.

Updated project cost to reflect inflationary adjustments. Due to construction cost inflation and market conditions, project costs have escalated significantly.

If applicable, list previously approved funding allocations/disbursements and revised funding request:

Note, if some or all of a previously Funded Activity cannot be completed as a result of the proposed modification, please include a description and indicate the amount of unused funds. Any unused funds should be reallocated and accounted for in your revised funding request.

Fiscal Year	Approved Funding Allocations	Revised Funding Request	Description/Phase *If applicable, include description of unused funds*
20-21	$3,247,511.94	$3,247,511.94	Planning/Design/Construction
21-22	$3,711,442.21	$3,711,442.21	Planning/Design/Construction
22-23	$1,391,790.83	$1,391,790.83	Planning/Design/Construction
23-24	$927,860.55	$927,860.55	Planning/Design/Construction
24-25	$0	$0	
Future Funding	$0	$23,842,098	Bid-Award/Construction
TOTAL	$9,278,605.53	$33,120,703.53	Planning/Design/B&A/Construction

A: SCWP Approved Total Funding Allocations	$9,278,605.53
B: Revised SCWP Anticipated Total Funding Request	$33,120,703.53
C: Difference between B and A	$23,842,098

If applicable, description of difference in SCWP Anticipated Total Funding Request. As a reminder, annual funding is at the discretion of the WASC, ROC, and ultimately the Board of Supervisors.

The difference is to cover additional costs related to large cost increases involving significant inflation from the application period to present day. Due to the project's SCWP application being earlier in the project's schedule, costs are now more certain since the project is close to construction start. In addition, the revised total request includes full funding to complete the project.

Brief description of Supporting Documentation provided.

The supporting documentation includes a memorandum issued by the Los Angeles Department of Public Works, Bureau of Engineering regarding escalation associated with past, present, and future inflation.

I certify the information and supporting documentation provided is accurate and true.	☑ YES
I understand this is a request and it is under the WASC's discretion to consider requested modifications.	☑ YES

Name Peter N. Tonthat

Organization Los Angeles Department of Water and Power

Signature Peter Tonthat Digitally signed by Peter Tonthat Date: 2023.11.28 15:04:21 -08'00'

Date November 28, 2023

FOR DISTRICT USE ONLY

Proposed Modifications to Projects or Studies:

	Status	Date
Modified Project or Study is **consistent** with the Project or Study included in the current fiscal year's SIP and proposed modifications were **approved** by the District.	☐ YES	
Modified Project or Study is **NOT consistent** with the Project or Study included in the current fiscal year's SIP. **If yes, select all that apply**:	☑ YES	12/11/23
PMR was received **after** October 31 of a fiscal year and the PMR will be considered for approval during the preparation of **subsequent** SIP for the fiscal year after the next	☐ YES	-
For Infrastructure Program Projects, modified Project was sent to **Scoring Committee**. If yes, revised score:	☐ YES	
Project or Study **abandoned** the proposed modifications	☐ YES	
Projector or Study was **withdrawn** from consideration by the WASC and shall issue repayment of unspent funds	☐ YES	
Proposed modifications were **recommended for approval** in the SIP	☐ YES ☐ NO	

Proposed Modifications to Project Concepts:

	Status	Date
Proposed modifications were deemed **consistent** with the Project concept that was approved by the WASC, ROC and Board for inclusion in the SIP and can be addressed within the existing budget. District will proceed to incorporate the proposed modification into the Feasibility Study immediately.	☐ YES	
Proposed modifications were deemed significant enough to result in a **significantly different** Project concept from the one approved by the WASC, ROC and Board for inclusion in the SIP. **If yes, select one:**	☐ YES	
District to **discontinue** work on the Feasibility Study, return unused funds to be programmed in the SIP for the next fiscal year, and advise the proponent to submit the modified Project concept during the Call for Projects for a future fiscal year.	☐ YES	-
District to **abandon** the proposed modifications and proceed with the Project concept included in the SIP.	☐ YES	-

ATTACHMENT A: Project Modification Request (PMR) FORM

The purpose of this PMR form is to initiate the Project modification process and provide the District with information necessary to evaluate the Project modification request.

Regional Program	☑Infrastructure Program Project ☐Scientific Studies Program ☐Technical Resources Program
Project/Study Name	Valley Plaza Park Stormwater Capture Project
Project/Study Lead	Los Angeles Department of Water and Power
Watershed Area(s)	Upper Los Angeles River
Current Project Phase	Design
Approved Stormwater Investment Plan Fiscal Year	FY21-22
Transfer Agreement ID (e.g., 2020RPULAR52)	2021RPULAR09

Has Transfer Agreement or most recent Addendum been executed (i.e., signed by the project lead and the District)? ☑ Yes ☐ No

What type(s) of modification request?

☐ like-for-like modifications

☐ functionally equivalent BMP modifications

☐ modifications to Project or Study components that were not material to the WASC, ROC, or Board's decision to include the Project or Study in the SIP

☐ minor modifications to the budget or schedule of intermediate tasks where the total Funded Activity amount and Funded Activity completion date is unchanged

☐ change in primary or secondary objective

☐ change in Project benefits

☐ change in methodology (e.g., infiltration instead of diversion to sanitary sewer)

☐ decrease in BMP capacity

☐ change in Project or Study location

☐ change in capture area where benefits claimed are diminished or where there is a change in the municipalities that are receiving benefits

☐ updated engineering analysis resulting in a reduction of benefits claimed

☑ increase in Construction Cost or Life Cycle Cost greater than 10%

☐ increase or reallocation of annual funding distribution

☐ change in Funded Activity completion date

☐ other, please describe:

Impact on scope or benefits?

☐ Improved
☐ Diminished
☑ Neither
☐ Not Sure

Description of the proposed modification(s) and the reason(s) why the modification(s) is/are being proposed.

Due to supply chain challenges, scarcity of skilled labor forces, recent construction cost inflations, and market conditions, the total project cost has increased significantly. Additionally, DWP has agreed to redistribute FY23-24 funding request to FY26-27, which was approved by the ULAR WASC in February 2023. The budget plan has also been updated to match the latest SIP.

If applicable, list previously approved funding allocations/disbursements and revised funding request:

Note, if some or all of a previously Funded Activity cannot be completed as a result of the proposed modification, please include a description and indicate the amount of unused funds. Any unused funds should be reallocated and accounted for in your revised funding request.

Fiscal Year	Approved Funding Allocations	Revised Funding Request	Description/Phase *If applicable, include description of unused funds*
21-22	$529,000.00	$529,000.00	Planning/Design
22-23	$794,000.00	$794,000.00	Planning/Design
23-24	$0	$0	
24-25	$2,910,000.00	$2,910,000.00	Construction
25-26	$4,232,000.00	$12,854,253.00	Construction
Future Funding	$17,982,000.00	$43,848,760.00	Bid-Award/Construction
TOTAL	$26,447,000.00	$60,936,013.00	Planning/Design/B&A/Construction

A: SCWP Approved Total Funding Allocations	$26,447,000.00
B: Revised SCWP Anticipated Total Funding Request	$60,936,013.00
C: Difference between B and A	$34,489,013.00

If applicable, description of difference in SCWP Anticipated Total Funding Request. As a reminder, annual funding is at the discretion of the WASC, ROC, and ultimately the Board of Supervisors.

The difference is to cover additional costs related to large cost increases involving significant inflation from the application period to present day. Due to the project's SCWP application being earlier in the project's schedule, costs are now more certain since the project is close to construction start. In addition, the revised total request includes full funding to complete the project.

Brief description of Supporting Documentation provided.

The supporting documentation includes a memorandum issued by the Los Angeles Department of Public Works, Bureau of Engineering regarding escalation associated with past, present, and future inflation.

I certify the information and supporting documentation provided is accurate and true.	☑ YES
I understand this is a request and it is under the WASC's discretion to consider requested modifications.	☑ YES

Name Peter N. Tonthat

Organization Los Angeles Department of Water and Power

Signature Peter Tonthat Digitally signed by Peter Tonthat Date: 2023.11.28 15:05:43 -08'00'

Date November 28, 2023

FOR DISTRICT USE ONLY

Proposed Modifications to Projects or Studies:

	Status	Date
Modified Project or Study is **consistent** with the Project or Study included in the current fiscal year's SIP and proposed modifications were **approved** by the District.	☐ YES	
Modified Project or Study is **NOT consistent** with the Project or Study included in the current fiscal year's SIP. **If yes, select all that apply**:	☑ YES	12/11/23
PMR was received **after** October 31 of a fiscal year and the PMR will be considered for approval during the preparation of **subsequent** SIP for the fiscal year after the next	☐ YES	-
For Infrastructure Program Projects, modified Project was sent to **Scoring Committee**. If yes, revised score:	☐ YES	
Project or Study **abandoned** the proposed modifications	☐ YES	
Projector or Study was **withdrawn** from consideration by the WASC and shall issue repayment of unspent funds	☐ YES	
Proposed modifications were **recommended for approval** in the SIP	☐ YES ☐ NO	

Proposed Modifications to Project Concepts:

	Status	Date
Proposed modifications were deemed **consistent** with the Project concept that was approved by the WASC, ROC and Board for inclusion in the SIP and can be addressed within the existing budget. District will proceed to incorporate the proposed modification into the Feasibility Study immediately.	☐ YES	
Proposed modifications were deemed significant enough to result in a **significantly different** Project concept from the one approved by the WASC, ROC and Board for inclusion in the SIP. **If yes, select one:**	☐ YES	
District to **discontinue** work on the Feasibility Study, return unused funds to be programmed in the SIP for the next fiscal year, and advise the proponent to submit the modified Project concept during the Call for Projects for a future fiscal year.	☐ YES	-
District to **abandon** the proposed modifications and proceed with the Project concept included in the SIP.	☐ YES	-

ATTACHMENT A: Project Modification Request (PMR) FORM

The purpose of this PMR form is to initiate the Project modification process and provide the District with information necessary to evaluate the Project modification request.

Regional Program	☑Infrastructure Program Project ☐Scientific Studies Program ☐Technical Resources Program
Project/Study Name	Whitsett Fields Park North Stormwater Capture Project
Project/Study Lead	Los Angeles Department of Water and Power
Watershed Area(s)	Upper Los Angeles River
Current Project Phase	Right-of-Way Approvals
Approved Stormwater Investment Plan Fiscal Year	FY22-23
Transfer Agreement ID (e.g., 2020RPULAR52)	2022RPULAR04

Has Transfer Agreement or most recent Addendum been executed (i.e., signed by the project lead and the District)? ☑ Yes ☐ No

What type(s) of modification request?

☐ like-for-like modifications

☐ functionally equivalent BMP modifications

☐ modifications to Project or Study components that were not material to the WASC, ROC, or Board's decision to include the Project or Study in the SIP

☐ minor modifications to the budget or schedule of intermediate tasks where the total Funded Activity amount and Funded Activity completion date is unchanged

☐ change in primary or secondary objective

☐ change in Project benefits

☐ change in methodology (e.g., infiltration instead of diversion to sanitary sewer)

☐ decrease in BMP capacity

☐ change in Project or Study location

☐ change in capture area where benefits claimed are diminished or where there is a change in the municipalities that are receiving benefits

☐ updated engineering analysis resulting in a reduction of benefits claimed

☑ increase in Construction Cost or Life Cycle Cost greater than 10%

☐ increase or reallocation of annual funding distribution

☑ change in Funded Activity completion date

☐ other, please describe:

Impact on scope or benefits?

- ☐ Improved
- ☐ Diminished
- ☑ Neither
- ☐ Not Sure

Description of the proposed modification(s) and the reason(s) why the modification(s) is/are being proposed.

Delayed schedule due to securing project's O&M, and working on Implementation MOA for the project to move to construction (bid-award, construction, post-construction). Updating project cost to reflect inflationary adjustments. Due to inflation, project costs have escalated significantly. Project also secured $1 million from California Prop 1 Integrated Regional Water Management Grant Program. Updating project schedule to reflect delays in right-of-way phase due to acquiring permits and agreements.

If applicable, list previously approved funding allocations/disbursements and revised funding request:

Note, if some or all of a previously Funded Activity cannot be completed as a result of the proposed modification, please include a description and indicate the amount of unused funds. Any unused funds should be reallocated and accounted for in your revised funding request.

Fiscal Year	Approved Funding Allocations	Revised Funding Request	Description/Phase *If applicable, include description of unused funds*
22-23	$840,000.00	$840,000.00	Planning/Design
23-24	$1,679,000.00	$1,679,000.00	Planning/Design
24-25	$1,679,000.00	$1,679,000.00	Planning/Design
25-26	$1,679,000.00	$6,181,466.00	Bid-Award/Construction
26-27	$2,516,000.00	$7,018,466.00	Bid-Award/Construction
Future Funding	$0	$9,004,932.00	Bid-Award/Construction
TOTAL	$8,393,000.00	$26,402,864.00	Planning/Design/B&A/Construction

A: SCWP Approved Total Funding Allocations	$8,393,000.00
B: Revised SCWP Anticipated Total Funding Request	$26,402,864.00
C: Difference between B and A	$18,009,864.00

If applicable, description of difference in SCWP Anticipated Total Funding Request. As a reminder, annual funding is at the discretion of the WASC, ROC, and ultimately the Board of Supervisors.

The difference is to cover additional costs related to large cost increases involving significant inflation from the application period to present day. Due to the project's SCWP application being earlier in the project's schedule, costs are now more certain since the project is close to construction start. In addition, the revised total request includes full funding to complete the project.

Brief description of Supporting Documentation provided.

The supporting documentation includes a memorandum issued by the Los Angeles Department of Public Works, Bureau of Engineering regarding escalation associated with past, present, and future inflation.

I certify the information and supporting documentation provided is accurate and true.	☑ YES
I understand this is a request and it is under the WASC's discretion to consider requested modifications.	☑ YES

Name Peter N. Tonthat

Organization Los Angeles Department of Water and Power

Signature Peter Tonthat Digitally signed by Peter Tonthat Date: 2023.11.28 15:08:30 -08'00'

Date November 28, 2023

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Proposed Modifications to Projects or Studies:

	Status	Date
Modified Project or Study is **consistent** with the Project or Study included in the current fiscal year's SIP and proposed modifications were **approved** by the District.	☐ YES	
Modified Project or Study is **NOT consistent** with the Project or Study included in the current fiscal year's SIP. **If yes, select all that apply**:	☑ YES	12/11/23
PMR was received **after** October 31 of a fiscal year and the PMR will be considered for approval during the preparation of **subsequent** SIP for the fiscal year after the next	☐ YES	-
For Infrastructure Program Projects, modified Project was sent to **Scoring Committee**. If yes, revised score:	☐ YES	
Project or Study **abandoned** the proposed modifications	☐ YES	
Projector or Study was **withdrawn** from consideration by the WASC and shall issue repayment of unspent funds	☐ YES	
Proposed modifications were **recommended for approval** in the SIP	☐ YES ☐ NO	

Proposed Modifications to Project Concepts:

	Status	Date
Proposed modifications were deemed **consistent** with the Project concept that was approved by the WASC, ROC and Board for inclusion in the SIP and can be addressed within the existing budget. District will proceed to incorporate the proposed modification into the Feasibility Study immediately.	☐ YES	
Proposed modifications were deemed significant enough to result in a **significantly different** Project concept from the one approved by the WASC, ROC and Board for inclusion in the SIP. **If yes, select one:**	☐ YES	
District to **discontinue** work on the Feasibility Study, return unused funds to be programmed in the SIP for the next fiscal year, and advise the proponent to submit the modified Project concept during the Call for Projects for a future fiscal year.	☐ YES	-
District to **abandon** the proposed modifications and proceed with the Project concept included in the SIP.	☐ YES	-

ATTACHMENT A: Project Modification Request (PMR) FORM

The purpose of this PMR form is to initiate the Project modification process and provide the District with information necessary to evaluate the Project modification request.

Regional Program	☑Infrastructure Program Project ☐Scientific Studies Program ☐Technical Resources Program
Project/Study Name	Valley Village Park Stormwater Capture Project
Project/Study Lead	Los Angeles Department of Water and Power
Watershed Area(s)	Upper Los Angeles River
Current Project Phase	Right-of-Way Approvals
Approved Stormwater Investment Plan Fiscal Year	FY20-21
Transfer Agreement ID (e.g., 2020RPULAR52)	2020RPULAR11

Has Transfer Agreement or most recent Addendum been executed (i.e., signed by the project lead and the District)? ☑ Yes ☐ No

What type(s) of modification request?

☐ like-for-like modifications

☐ functionally equivalent BMP modifications

☐ modifications to Project or Study components that were not material to the WASC, ROC, or Board's decision to include the Project or Study in the SIP

☐ minor modifications to the budget or schedule of intermediate tasks where the total Funded Activity amount and Funded Activity completion date is unchanged

☐ change in primary or secondary objective

☐ change in Project benefits

☐ change in methodology (e.g., infiltration instead of diversion to sanitary sewer)

☐ decrease in BMP capacity

☐ change in Project or Study location

☐ change in capture area where benefits claimed are diminished or where there is a change in the municipalities that are receiving benefits

☐ updated engineering analysis resulting in a reduction of benefits claimed

☑ increase in Construction Cost or Life Cycle Cost greater than 10%

☐ increase or reallocation of annual funding distribution

☑ change in Funded Activity completion date

☐ other, please describe:

Impact on scope or benefits?

- ☐ Improved
- ☐ Diminished
- ☑ Neither
- ☐ Not Sure

Description of the proposed modification(s) and the reason(s) why the modification(s) is/are being proposed.

Delayed schedule due to securing project's O&M, and working on Implementation MOA for the project to move to construction (bid-award, construction, post-construction). Updated project cost to reflect inflationary adjustments. Due to inflation, project costs have escalated significantly. In addition, also secured $3 million from California Prop 1 Storm Water Grant Program.

If applicable, list previously approved funding allocations/disbursements and revised funding request:

Note, if some or all of a previously Funded Activity cannot be completed as a result of the proposed modification, please include a description and indicate the amount of unused funds. Any unused funds should be reallocated and accounted for in your revised funding request.

Fiscal Year	Approved Funding Allocations	Revised Funding Request	Description/Phase *If applicable, include description of unused funds*
20-21	$1,112,070.49	$1,112,070.49	Planning/Design/Construction
21-22	$1,270,937.69	$1,270,937.69	Planning/Design/Construction
22-23	$476,601.63	$476,601.63	Planning/Design/Construction
23-24	$317,734.42	$317,734.42	Planning/Design/Construction
24-25	$0	$0	
Future Funding	$0	$12,941,066.00	Bid-Award/Construction
TOTAL	$3,177,344.23	$16,118,410.23	Planning/Design/B&A/Construction

A: SCWP Approved Total Funding Allocations	$3,177,344.23
B: Revised SCWP Anticipated Total Funding Request	$16,118,410.23
C: Difference between B and A	$12,941,066.00

If applicable, description of difference in SCWP Anticipated Total Funding Request. As a reminder, annual funding is at the discretion of the WASC, ROC, and ultimately the Board of Supervisors.

The difference is to cover additional costs related to large cost increases involving significant inflation from the application period to present day. Due to the project's SCWP application being earlier in the project's schedule, costs are now more certain since the project is close to construction start. In addition, the revised total request includes full funding to complete the project.

Brief description of Supporting Documentation provided.

The supporting documentation includes a memorandum issued by the Los Angeles Department of Public Works, Bureau of Engineering regarding escalation associated with past, present, and future inflation.

I certify the information and supporting documentation provided is accurate and true.	☑ YES
I understand this is a request and it is under the WASC's discretion to consider requested modifications.	☑ YES

Name Peter N. Tonthat

Organization Los Angeles Department of Water and Power

Signature Peter Tonthat Digitally signed by Peter Tonthat Date: 2023.11.28 15:07:17 -08'00'

Date November 28, 2023

FOR DISTRICT USE ONLY

Proposed Modifications to Projects or Studies:

	Status	Date
Modified Project or Study is **consistent** with the Project or Study included in the current fiscal year's SIP and proposed modifications were **approved** by the District.	☐ YES	
Modified Project or Study is **NOT consistent** with the Project or Study included in the current fiscal year's SIP. **If yes, select all that apply**:	☑ YES	12/11/23
PMR was received **after** October 31 of a fiscal year and the PMR will be considered for approval during the preparation of **subsequent** SIP for the fiscal year after the next	☐ YES	-
For Infrastructure Program Projects, modified Project was sent to **Scoring Committee**. If yes, revised score:	☐ YES	
Project or Study **abandoned** the proposed modifications	☐ YES	
Projector or Study was **withdrawn** from consideration by the WASC and shall issue repayment of unspent funds	☐ YES	
Proposed modifications were **recommended for approval** in the SIP	☐ YES ☐ NO	

Proposed Modifications to Project Concepts:

	Status	Date
Proposed modifications were deemed **consistent** with the Project concept that was approved by the WASC, ROC and Board for inclusion in the SIP and can be addressed within the existing budget. District will proceed to incorporate the proposed modification into the Feasibility Study immediately.	☐ YES	
Proposed modifications were deemed significant enough to result in a **significantly different** Project concept from the one approved by the WASC, ROC and Board for inclusion in the SIP. **If yes, select one:**	☐ YES	
District to **discontinue** work on the Feasibility Study, return unused funds to be programmed in the SIP for the next fiscal year, and advise the proponent to submit the modified Project concept during the Call for Projects for a future fiscal year.	☐ YES	-
District to **abandon** the proposed modifications and proceed with the Project concept included in the SIP.	☐ YES	-

November 29, 2023

Mr. Mark Pestrella
Director of Public Works
Los Angeles County Public Works
900 S. Fremont Avenue
Alhambra, California 91803

Dear Mr. Pestrella:

Subject: Submittal of Project Modification Request Forms for the Safe, Clean Water Program Regional Program Projects

As noted in the Safe, Clean Water (SCW) Program Project Modification Request (PMR) Guidelines, project recipient that proposes modifications to the schedule, scope, benefits, or funding amounts shall submit a PMR form. On November 28, 2023, the Los Angeles Department of Water and Power (LADWP) submitted the following six (6) PMR forms to the Los Angeles County Flood Control District (District) as required by the PMR Guidelines, and for the District's consideration for additional funding under the Regional Program for the following LADWP projects:

1. Fernangeles Park Stormwater Capture Project
2. Strathern Park North Stormwater Capture Project
3. Valley Village Park Stormwater Capture Project
4. David M. Gonzales Recreation Center Stormwater Capture Project
5. Valley Plaza Park Stormwater Capture Project
6. Whitsett Fields Park North Stormwater Capture Project

LADWP is committed to providing matching funds up to 50 percent of the original project costs. The projects have completed final designs, environmental review, and are expected to be advertised for bid in early 2024 and are therefore shovel ready. The proposed project benefits are aligned with the SCW Program goals by addressing increased water supply, improved water quality, and providing for community investment benefits in Disadvantaged Communities. As such, these projects received the highest scores from the SCW Program Scoring Matrix and validated by the Scoring Committee. Additionally, LADWP was awarded $4,786,626 total in Proposition 1 grant funding and is actively pursuing state and federal grants as well as external partnerships to assist in mitigating the cost increases.

We hope the District and the SCW Program recognizes the importance and benefits of LADWP's projects to the region and can assist in mitigating industry-wide cost escalations.

If you have questions, or require additional information, please contact me at (213) 367-1022, or have your staff contact Mr. David R. Pettijohn, Director of Water Resources Division, at (213) 367-0899 or by email at David.Pettijohn@ladwp.com.

Sincerely,

Anselmo G. Collins
Senior Assistant General Manager – Water System

AC:lj

CITY OF LOS ANGELES
INTER-DEPARTMENTAL CORRESPONDENCE

DATE: November 16, 2023

TO: Measure W: Safe, Clean Water Program Administrative Oversight Committee
Matthew Szabo, City Administrative Officer
Sharon Tso, Chief Legislative Analyst
Ryan Jackson, Office of the Mayor

FROM: David R. Pettijohn, Director
Water Resources Division
Los Angeles Department of Water and Power

SUBJECT: SUBMITTAL OF PROJECT MODIFICATION REQUESTS SEEKING ADDITIONAL FUNDING FOR THE LOS ANGELES DEPARTMENT OF WATER AND POWER REGIONAL PROJECTS IN THE SAFE, CLEAN WATER PROGRAM

SUMMARY

1. The Los Angeles Department of Water and Power (LADWP) intends to submit six (6) Project Modification Requests (PMRs) to the Los Angeles County Flood Control District (District), requesting additional Safe, Clean Water (SCW) Regional funding as listed in Table 1.

2. LADWP intends to accept future SCW Program funds, conduct negotiations, provide additional information, and submit all documents, including, but not limited to project reports, updated Scope of Work (SOW) documents, agreements, amendments, subject to the approval of the City Attorney as to form, that are necessary to secure funding with respect to the administrative actions required as part of the PMR approval process.

BACKGROUND

Previously, any anticipated or proposed changes to scope, budget and schedule in SCW Program projects were reported by project proponents through the quarterly reporting process, which were in turn evaluated by the District and the Watershed Area Steering Committee (WASC) to help inform future Stormwater Investment Plan (SIP) recommendations. The District has recently implemented a new process to better address modifications proposed during the upcoming SIP preparation.

Utilizing the new PMR form and process will facilitate a more timely and transparent resolution of proposed modifications. It will also allow for more streamlined quarterly reports since PMRs can simply be referenced in the applicable sections of the quarterly reports that are submitted and reviewed at distinct points in the process.

LADWP intends to submit a PMR Form for each of its Round 1, 2 and 3 Projects that are included in the SCW Program's fiscal year (FY) 23/24 SIP. LADWP's Rounds 1, 2 and 3 Projects, which were prepared in FY 19/20 - 21/22, have experienced budget increases as a result of unprecedented inflation, supply chain challenges, scarcity of skilled labor forces, and market conditions. These factors have resulted in cost increases beyond what was awarded. The PMR process allows project applicants to request additional regional funding for projects which are experiencing projected shortfalls.

The additional funding request to the Regional Program will be considered by the Upper Los Angeles River (ULAR) WASC during the Round 5 SIP deliberations and for inclusion into the FY 24/25 SIPs.

CONSIDERATIONS AND RECOMMENDATIONS

This will be the first time that the District implements the PMR process and the first time that the ULAR WASC is considering additional funding for approved projects. LADWP requests priority consideration for the Stormwater Capture Parks projects for the following reasons:

1. LADWP has committed to providing matching funds up to 50 percent of the original total project costs.
2. Projects have completed 100 percent designs, received California Environmental Quality Act determination, and are ready to proceed to Bid & Award starting in early 2024.
3. Projects received the highest scores from the Scoring Committee
4. Projects meet the goals of the Measure W SCW Program by addressing increased water supply, improved water quality, and providing for community investment benefits in Disadvantaged Communities

Due to the limited funding available for programming by the ULAR WASC, funding requests have been spread into multiple years starting FY25/26 with special consideration to the David M. Gonzales Recreation Center Stormwater Capture Project to request FY24/25 SCWP funds.

Table 1 provides a summary of the projected funding shortfalls for the projects seeking additional funding from the Regional Program. Attachment 1 provides a breakdown by FY of funds requested from the Regional Program.

Table 1: Additional Funding Requests for LADWP's Regional Round 1, 2 and 3 Projects

Project Name	SIP Round	Project Modification Requests for Additional Funding
Fernangeles Park Stormwater Capture (CD 6)	1	$28.5M
Strathern Park North Stormwater Capture (CD 2)	1	$23.8M
Valley Village Park Stormwater Capture (CD 2)	1	$12.9M
David M. Gonzales Recreation Center Stormwater Capture (CD 7)	2	$23.3M
Valley Plaza Park Stormwater Capture (CD 2)	2	$34.5M
Whitsett Fields Park North Stormwater Capture (CD 2)	3	$18.0M

After a thorough review of the projected funding shortfalls, project delivery schedules, and available funding, LADWP recommends the Safe, Clean Water Program Administrative Oversight Committee (AOC) support its submission of additional funding requests, as summarized in Table 1 and Attachment 1 through the submission of PMR forms.

If you have any questions or need additional information, please contact my staff, Mr. Art Castro, at (213) 367-2966 or via email at Art.Castro@ladwp.com.

PT:lj
Attachment

cc: Delon Kwan
Sabrina Y. Tsui
Art Castro
Peter Tonthat

ATTACHMENT 1: Regional Funding By Fiscal Year

Upper Los Angeles River

Project Name	CD	Start of Construction	DAC Benefit	Project Shortfall	Cash Flow	FY 20/21	FY 21/22	FY 22/23	FY23/24	FY 24/25	FY 25/26	FY26/27	FY27/28	FY28/29	Total
Fernangeles Park Stormwater Capture (Rd 1)	6	Nov-24	Yes	$28.5M	Approved	$ 2,926,262	$ 3,344,299	$ 1,254,112	$ 836,075	$ -	$ -	$ -	$ -	$ -	$ 8,360,748
					Additional Request	$ -	$ -	$ -	$ -	$ -	$ 14,233,533	$ 14,233,533	$ -	$ -	$ 28,467,066
					PMR	*$ 2,926,262*	*$ 3,344,299*	*$ 1,254,112*	*$ 836,075*	*$ -*	*$ 14,233,533*	*$ 14,233,533*	*$ -*	*$ -*	*$ 36,827,814*
Strathern Park North Stormwater Capture (Rd 1)	2	Jan-25	Yes	$23.8M	Approved	$ 3,247,512	$ 3,711,442	$ 1,391,791	$ 927,861	$ -	$ -	$ -	$ -	$ -	$ 9,278,606
					Additional Request	$ -	$ -	$ -	$ -	$ -	$ 11,921,049	$ 11,921,049	$ -	$ -	$ 23,842,098
					PMR	*$ 3,247,512*	*$ 3,711,442*	*$ 1,391,791*	*$ 927,861*	*$ -*	*$ 11,921,049*	*$ 11,921,049*	*$ -*	*$ -*	*$ 33,120,704*
Valley Village Park Stormwater Capture (Rd 1)	2	Jul-24	Yes	$12.9M	Approved	$ 1,112,070	$ 1,270,938	$ 476,602	$ 317,734	$ -	$ -	$ -	$ -	$ -	$ 3,177,344
					Additional Request	$ -	$ -	$ -	$ -	$ -	$ 6,470,533	$ 6,470,533	$ -	$ -	$ 12,941,066
					PMR	*$ 1,112,070*	*$ 1,270,938*	*$ 476,602*	*$ 317,734*	*$ -*	*$ 6,470,533*	*$ 6,470,533*	*$ -*	*$ -*	*$ 16,118,410*
David M. Gonzales Recreation Center Stormwater Capture (Rd 2)	7	Sep-24	Yes	$23.3M	Approved	$ -	$ 388,000	$ 581,000	$ 1,550,000	$ 2,130,000	$ 3,099,000	$ 4,067,000	$ 3,873,000	$ 3,675,000	$ 19,363,000
					Additional Request	$ -	$ -	$ -	$ -	$ 4,669,238	$ 4,669,238	$ 4,669,238	$ 4,669,238	$ 4,669,238	$ 23,346,191
					PMR	*$ -*	*$ 388,000*	*$ 581,000*	*$ 1,550,000*	*$ 6,799,238*	*$ 7,768,238*	*$ 8,736,238*	*$ 8,542,238*	*$ 8,344,238*	*$ 42,709,191*
Valley Plaza Park Stormwater Capture (Rd 2)	2	Jan-26	Yes	$34.5M	Approved	$ -	$ 529,000	$ 794,000	$ -	$ 2,910,000	$ 4,232,000	$ 7,670,000	$ 5,290,000	$ 5,022,000	$ 26,447,000
					Additional Request	$ -	$ -	$ -	$ -	$ -	$ 8,622,253	$ 8,622,253	$ 8,622,253	$ 8,622,253	$ 34,489,013
					PMR	*$ -*	*$ 529,000*	*$ 794,000*	*$ -*	*$ 2,910,000*	*$ 12,854,253*	*$ 16,292,253*	*$ 13,912,253*	*$ 13,644,253*	*$ 60,936,013*
Whitsett Fields Park North Stormwater Capture (Rd 3)	2	Mar-26	Yes	$18.0M	Approved	$ -	$ -	$ 840,000	$ 1,679,000	$ 1,679,000	$ 1,679,000	$ 2,516,000	$ -	$ -	$ 8,393,000
					Additional Request	$ -	$ -	$ -	$ -	$ -	$ 4,502,466	$ 4,502,466	$ 4,502,466	$ 4,502,466	$ 18,009,864
					PMR	*$ -*	*$ -*	*$ 840,000*	*$ 1,679,000*	*$ 1,679,000*	*$ 6,181,466*	*$ 7,018,466*	*$ 4,502,466*	*$ 4,502,466*	*$ 26,402,864*

ATTACHMENT A: Project Modification Request (PMR) FORM

The purpose of this PMR form is to initiate the Project modification process and provide the District with information necessary to evaluate the Project modification request.

Regional Program	☑Infrastructure Program Project ☐Scientific Studies Program ☐Technical Resources Program
Project/Study Name	Broadway-Manchester Multi-Modal Green Streets Project
Project/Study Lead	City of Los Angeles Bureau of Street Services (StreetsLA)
Watershed Area(s)	Upper Los Angeles River
Current Project Phase	Environmental Documentation, Design
Approved Stormwater Investment Plan Fiscal Year	2021-2022
Transfer Agreement ID (e.g., 2020RPULAR52)	2021RPULAR05

Has Transfer Agreement or most recent Addendum been executed (i.e., signed by the project lead and the District)? ☐ Yes ☑ No

What type(s) of modification request?

☐ like-for-like modifications

☑ functionally equivalent BMP modifications

☐ modifications to Project or Study components that were not material to the WASC, ROC, or Board's decision to include the Project or Study in the SIP

☐ minor modifications to the budget or schedule of intermediate tasks where the total Funded Activity amount and Funded Activity completion date is unchanged

☐ change in primary or secondary objective

☐ change in Project benefits

☐ change in methodology (e.g., infiltration instead of diversion to sanitary sewer)

☑ decrease in BMP capacity

☐ change in Project or Study location

☐ change in capture area where benefits claimed are diminished or where there is a change in the municipalities that are receiving benefits

☑ updated engineering analysis resulting in a reduction of benefits claimed

☑ increase in Construction Cost or Life Cycle Cost greater than 10%

☑ increase or reallocation of annual funding distribution

☑ change in Funded Activity completion date

☑ other, please describe:

Increased project cost sharing

Impact on scope or benefits?

- ☐ Improved
- ☑ Diminished
- ☐ Neither
- ☐ Not Sure

Description of the proposed modification(s) and the reason(s) why the modification(s) is/are being proposed.

The feasibility study included in the grant application proposed a parallel storm water collection system connected to a series of 50-foot deep vertical cisterns along Broadway and Manchester Avenue to provide the water supply benefits for the project. After the grant was awarded, an updated engineering analysis resulted in a reduction of the water supply benefits claimed in the grant application. It was also determined that the system under Manchester Avenue could not feasibly be constructed due to existing utility constraints, traffic impacts, maintenance requirements, and existing trees which must remain. The team did further analysis and determined that while the removal of the system along Manchester results in a decreased BMP capacity, the system still maintains many of the project benefits that were in the original grant application.

Additionally, the project construction cost has increased greater than 10% based on more detailed and accurate bid item pricing, inflation, and escalation. This has resulted in the project water quality cost effectiveness decreasing. However, the City has been active in searching for alternate funding sources, and has been successful in securing a funding match commitment from Caltrans. As a result, the project cost share benefit is increased.

If applicable, list previously approved funding allocations/disbursements and revised funding request:

Note, if some or all of a previously Funded Activity cannot be completed as a result of the proposed modification, please include a description and indicate the amount of unused funds. Any unused funds should be reallocated and accounted for in your revised funding request.

Fiscal Year	Approved Funding Allocations	Revised Funding Request	Description/Phase *If applicable, include description of unused funds*
21-22	886,000	886,000	Current Approved Funding Design
22-23	4,000,000	4,000,000	Current Approved Funding Design & Construction
23-24			
24-25	4,000,000	4,626,116	Revised Funding Design & Construction
25-26	2,833,000	2,833,000	Current Approved Funding Construction
Future Funding			
TOTAL	11,719,000	12,345,116	

A: SCWP Approved Total Funding Allocations	11,719,000
B: Revised SCWP Anticipated Total Funding Request	12,345,116
C: Difference between B and A	626,116

If applicable, description of difference in SCWP Anticipated Total Funding Request. As a reminder, annual funding is at the discretion of the WASC, ROC, and ultimately the Board of Supervisors.

The City's Rounds 1 and 2 Projects, which were prepared in FY 19/20-20/21, have experienced budget increases as a result of unprecedented inflation, which has been further compounded due to project delays from the Covid-19 pandemic and the extended length of time to receive funding disbursements. These factors have resulted in cost increases beyond what was awarded. In addition to reporting changes in project scopes and schedules, the PMR process also allows project applicants to request additional regional funding for projects which are experiencing projected shortfalls.

The City has been successful in securing an additional funding match to supplement most of the project cost increase, and only requests $626,116 from SCW, from the $12.5M additional funding the project has identified as being needed.

Brief description of Supporting Documentation provided.

Broadway-Manchester Multi-Modal Green Streets Project - Technical Memorandum documents the modeling and analysis completed after funding was awarded.
Preferred Alternative Selection Addendum Memo - Documents the selection of the preferred alternative based on the technical memo analysis and agency meetings and requirements.
SCW Scoring Criteria Comparison - Compares the project benefits between the originally awarded grant application, and the Preferred Alternative.
FY22-23 Q1 and Q4 Modification Letters

I certify the information and supporting documentation provided is accurate and true.	☑ YES
I understand this is a request and it is under the WASC's discretion to consider requested modifications.	☑ YES

Name Gina Liang

Organization City of Los Angeles BSS

Signature DocuSigned by: Gina Liang EE95852F91514A5...

Date 11/30/2023

FOR DISTRICT USE ONLY

Proposed Modifications to Projects or Studies:

	Status	Date
Modified Project or Study is **consistent** with the Project or Study included in the current fiscal year's SIP and proposed modifications were **approved** by the District.	☐ YES	
Modified Project or Study is **NOT consistent** with the Project or Study included in the current fiscal year's SIP. **If yes, select all that apply**:	☑ YES	12/13/23
PMR was received **after** October 31 of a fiscal year and the PMR will be considered for approval during the preparation of **subsequent** SIP for the fiscal year after the next	☐ YES	-
For Infrastructure Program Projects, modified Project was sent to **Scoring Committee**. If yes, revised score:	☐ YES	
Project or Study **abandoned** the proposed modifications	☐ YES	
Projector or Study was **withdrawn** from consideration by the WASC and shall issue repayment of unspent funds	☐ YES	
Proposed modifications were **recommended for approval** in the SIP	☐ YES ☐ NO	

Proposed Modifications to Project Concepts:

	Status	Date
Proposed modifications were deemed **consistent** with the Project concept that was approved by the WASC, ROC and Board for inclusion in the SIP and can be addressed within the existing budget. District will proceed to incorporate the proposed modification into the Feasibility Study immediately.	☐ YES	
Proposed modifications were deemed significant enough to result in a **significantly different** Project concept from the one approved by the WASC, ROC and Board for inclusion in the SIP. **If yes, select one:**	☐ YES	
District to **discontinue** work on the Feasibility Study, return unused funds to be programmed in the SIP for the next fiscal year, and advise the proponent to submit the modified Project concept during the Call for Projects for a future fiscal year.	☐ YES	-
District to **abandon** the proposed modifications and proceed with the Project concept included in the SIP.	☐ YES	-

BROADWAY-MANCHESTER MULTI-MODAL GREEN STREETS PROJECT

To:	Mara Luevano, P.E. City of Los Angeles – StreetsLA
From:	Bob Blume, P.E. Nicole Dias, P.E. Janessa Mendoza Kimley-Horn and Associates, Inc
Date:	August 26, 2022; ***Revised: January 14, 2023***
Subject:	Broadway-Manchester Multi-Modal Green Streets Project - Technical Memorandum

INTRODUCTION

This technical memorandum summarizes the revised approach and analyses completed for the Broadway-Manchester Multi-Modal Green Streets Project (Project).

BACKGROUND

The Project is in South Los Angeles along a 2.8 mile stretch of Manchester Avenue (from Vermont Avenue to S Broadway) and S Broadway (from Manchester Avenue to Imperial Highway). The City of Los Angeles (City) was able to secure funding through the Measure W Safe Clean Water (SCW) Program to provide stormwater treatment, capture, reuse, and discharge infrastructure throughout the Project limits. The Measure W improvements will be implemented in conjunction with the Broadway-Manchester Active Transportation Program (ATP) Equity Project which strives to promote connectivity, mobility, and safety along the corridors. Together these improvements will provide sustainable infrastructure for the future while benefiting the community. See **Attachment A** for a location map of the Project.

In October 2020, the *Broadway-Manchester Multi-Modal Green Street Project Feasibility Study* (Feasibility Study) was finalized. The objectives identified in the study are as follows:

1. Meet the Total Maximum Daily Load (TMDL) water quality limits for the Upper Los Angeles River watershed and current NPDES permit by capturing the 85th percentile storm compliance volume.
2. Maximize the project social and environmental water supply benefits for the local community by utilizing the captured stormwater for project landscape irrigation.
3. Maximize the project sustainability by utilizing natural systems for water treatment.
4. Enhance the environmental, public health and community benefits by creating green infrastructure.
5. Maximize the project economic, educational and community investment benefits.

To meet these goals, the Feasibility Study created a hydrologic model to study the drainage area - approximately 205 acres encompassing an area greater than the ATP project tributary area. A parallel storm drain system with new inlets upstream of existing inlets were proposed throughout the entire project to collect the 85th percentile storm. Approximately 120 vertical cisterns (50' depth) were proposed as the stormwater storage option. The cisterns were sized to capture 100% of the 85th percentile/24-hour stormwater runoff in the drainage area and identified a capture volume of 100 acre-feet of stormwater annually. 29 acre-feet/year was assumed to be used for irrigation of the Project site. The proposed treatment of the stormwater consisted of a cartridge media filter and ultraviolet (UV) disinfection. The remaining 71 acre-feet/year of captured stormwater was proposed to be discharged as drawdown to the sanitary sewer system for recycled water production at the LA County Joint Water Pollution Control Plant

(JWPCP). It is important to note that infiltration was assumed to be infeasible and was not included in the Feasibility Study hydrologic model.

Ultimately, StreetsLA and the City of LA Bureau of Sanitation (LASAN) decided to assess alternative systems for several reasons:

1. Construction Impacts: The number of cisterns and the parallel system proposed would require reconstruction of significant portions of the roadway and could require relocation of many existing utilities throughout the entire Project limits. In addition, there are many existing trees throughout the medians that the City would like to protect, that would be impacted by the Feasibility Study concept.
2. One Centralized Collection System: The Feasibility Study proposed a single collection and irrigation model that would require a significant system to collect and treat stormwater, and then distribute irrigation throughout the project area. This centralized system would require irrigation distribution and stormwater collection systems with significantly more piping due to increased conveyance. Larger pipes and pumps would be needed to operate and distribute water to the entire corridor. This leads to increased cost, construction impacts, and maintenance.
3. Maintenance: The 50' deep cisterns would be difficult to maintain. A 25' maximum depth is preferred by LASAN.
4. Infiltration: Infiltration was not considered. An investigation to determine if infiltration could be incorporated was important for the City to assess if infiltration was feasible. If feasible, including infiltration would help optimize the storage footprint needed to meet the grant requirements.

ALTERNATIVES ANALYSIS

To explore different options to meet the project goals set forth by the SCW Program, the following alternatives were studied:

1. 85^{th} Percentile Storage Volume: In line with the approach in the Feasibility Study, this alternative prioritizes capturing the 85^{th} percentile/24-hour storm volume. The storage galleries are sized to capture the 85^{th} percentile volume, the stored runoff will be reused for irrigation, and the remaining stormwater runoff will be discharged to the City and County sewer systems. This results in the minimum storage volume.
2. Irrigation Demand Storage Volume: On the opposite end of the spectrum, this alternative provides storage galleries sized to meet the irrigation demand for the project year round, while maximizing pollutant reduction. Any additional runoff overflows into infiltration galleries. This results in the maximum storage volume.

PROJECT APPROACH

To reduce the piping and conveyance needed with a centralized collection system for the entire Project, the corridor is proposed to be split into four distinct irrigation areas. See **Table 1** for the limits of each irrigation area.

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Table 1: Irrigation Area Definition

Irrigation Area No.	Irrigation Area Limits
IA-1	Manchester Ave: Vermont Ave to Broadway
IA-2	Broadway: Manchester Ave to Colden Ave
IA-3	Broadway: Colden Ave to 106th St
IA-4	Broadway: 106th St to Imperial Hwy

Each irrigation area will have its own stormwater storage gallery, irrigation system, and sewer drawdown connection where feasible. The system, as shown in **Attachment B1 and B2**, will divert stormwater from the City storm drain system through a hydrodynamic separator (HDS) and into a storage gallery. A portion of the captured stormwater will be pumped to a separate irrigation reservoir that will be filtered for irrigation reuse within each irrigation area. These components will be discussed in more detail in the System Components section of this memorandum.

LONG-TERM SYSTEM MODELING

Long-term modeling was completed for the Project to predict performance of the stormwater collection and treatment system and provide the Best Management Practice (BMP) sizing. Modeling was performed using a combination of the following softwares: HydroCalc, System for Urban Stormwater Treatment and Analysis Integration (SUSTAIN), and Watershed Management Modeling System 2.0 (WMMS 2.0) software.

HydroCalc was used to calculate peak flow and runoff volumes for the 85th percentile/24-hour storm for each irrigation area (see **Table 2**).

Table 2: Alt 1 and 2 85th Percentile Peak Flow and Volumes

Irrigation Area	Area (ac)	85th Percentile Peak Flow (cfs)	85th Percentile Runoff Volume (ac-ft)
IA-1	45.05	5.07	2.38
IA-2	95.95	8.61	4.37
IA-3	30.83	3.12	1.43
IA-4	25.91	2.78	1.19
Total	197.74	19.58	9.37

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Table 3 provides the storage and infiltration gallery volumes required for Alternative 1 and 2 with an assumption of a 15 foot depth. The sizing of both the storage and infiltration galleries for Alternative 2 were optimized using the SUSTAIN program. Sizing for Alternative 1 is equivalent to the 85th percentile volume. For more detailed information on Alternative 1 and 2 sizing, see **Attachment C1 - Water Quality and Hydrology**.

Table 3: Alt 1 and 2 Storage and Infiltration Gallery Sizes Based on Optimization

Irrigation Area No.	Alt 1 Sizing (ac-ft)		Alt 2 Sizing (ac-ft)	
	Storage Gallery	Infiltration Gallery	Storage Gallery	Infiltration Gallery
IA-1	2.38	-	3.23	2.04
IA-2	4.37	-	5.72	4.51
IA-3	1.43	-	5.00	0.91
IA-4	1.19	-	7.32	-
Total	9.37	0	21.27	7.46

Using WMMS 2.0, a long-term pollutant reduction analysis was conducted to gauge water quality improvements over a period of ten years. The model consisted of running a ten year continuous time series model using rainfall data from 2008 to 2018. The Feasibility Study identified zinc as the primary pollutant and bacteria as the secondary pollutant and showed a 100% reduction for both. For these alternatives, the primary pollutant is zinc and the secondary pollutant is trash. The goal is to reduce pollutants by at least 80%.

COST-BENEFIT ANALYSIS

Alternatives 1 minimizes the storage required since the storage galleries are sized to capture only the 85th percentile/24-hour storm volume. While this minimizes the proposed improvements' footprint and cost, this alternative does not provide continuous water for irrigation reuse. While a portion of the runoff will be reused for irrigation, the remaining volume will be discharged to the sewer as drawdown to meet the 100 ac-ft/yr capture volume. This alternative also assumes surface BMPs in the form of bioretention with underdrains.

On the other hand, Alternative 2 captures, reuses, and/or infiltrates the entire 100 ac-ft/yr volume. This increases the 40% irrigation offset assumed in the Feasibility Study to 100% irrigation reuse. The irrigation demand of approximately 40 ac-ft/yr will be met by the Alternative 2 system, with the remaining runoff volume overflowing to the infiltration galleries where feasible. Due to the larger storage gallery volume, these galleries cannot fit within the median limits and extend into the roadway. This impacts construction costs, staging, and traffic control.

As updated information was received, it was determined that Alternative 1 and 2 were infeasible due to the following reasons:

1. Alternative 1 was developed before sewer capacity results were provided by LASAN and Los Angeles County Sanitation District (LACSD). Once the sewer capacity results were incorporated into the model, it was determined that the desired sewer drawdown volume of 68.4 AFY is not possible. Therefore, this alternative was deemed infeasible.
2. Alternative 2 focused on infiltration instead of sewer drawdown. After further research, it was determined that infiltration is infeasible due to the inability to prove that the Project will increase local groundwater supplies. This is a requirement per the SCW Interim Guidance which states that, "if a project proponent provides written concurrence from the agency managing the groundwater basin that the project is believed to increase local groundwater supplies, then the project's full calculated capacity to infiltrated water will be considered by the Scoring Committee and WASCs as a benefit to locally available water supply." For this Project, the Central Basin Watermaster was contacted, and it was determined that the Project's location is truly prohibitive from reaching the aquifer.

A few parameters were considered in developing the preferred alternative. Since modeling was not conducted during the feasibility study, it was determined that it is infeasible to propose the same system and achieve the same results. Matching the Feasibility Study metrics as closely as possible was important to maintain an Equivalent Project per the SCW Program. The alternative also needs to balance the sizing with its impacts on trees, utilities, and stage construction/traffic control. **Attachment H – Alternatives Analysis** provides a summary of the iterations analyzed before a preferred alternative was selected.

The preferred alternative will be addressed in this memo as Alternative 3. Like Alternative 1, this alternative focuses on capturing the 85th percentile/24-hour storm volume matching the 9.4 ac-ft storage volume approved in the grant application. However, instead of having four identical systems in each of the irrigation areas, Alternative 3 prioritizes matching the tributary areas to the selected storm drain diversions. Four City-owned storm drain lines were chosen because their collective tributary area (204 acres) is closest to the Feasibility Study (205 acres), therefore producing a similar 85th percentile/24-hour storm volume of 9.4 acre-feet. **Table 4** summarizes the selected storm drains and their hydrologic information.

Table 4: Alternative 3 Drainage Areas and Hydrology Information

Location	Pipe	Area (ac)	85th Percentile Peak Flow (cfs)	85th Percentile Runoff Volume (ac-ft) and Storage Gallery Sizing
Manchester Ave at Vermont Ave	42" RCP	18.0	1.97	1.01
Broadway at 98th St	36" RCP	49.8	4.14	2.38
Broadway at 102nd St	36" RCP	48.5	3.22	2.11
Broadway at 106th St	30" RCP	87.7	6.15	3.93
Total		204.00	15.48	9.43

Alternative 3 is an Equivalent Project to the Feasibility Study in its tributary area, capture volume, community benefits, and reuse options (sewer drawdown and irrigation), but its outputs are different due to the sewer capacity results and long-term modeling results. Although the 85th percentile volume is the same, the total yearly capture volume and sewer drawdown differs. **Table 5** provides a comparison of the Feasibility Study and Alternative 3. See **Attachment D – Order of Magnitude Cost Estimate** for a breakdown of costs per the major system components.

Table 5: Alternative Comparison

System Components	Feasibility Study	Alternative 3
Total Storage Gallery Volume (ac-ft)	9.4	9.4
Total Infiltration Gallery Volume (ac-ft)	-	-
Total Project Capture Volume (ac-ft/yr)	100	59.7
Bioretention Volume (ac-ft/yr)	-	0.1
Irrigation Reuse Volume (ac-ft/yr)	28.8	-
Infiltration Volume (ac-ft/yr)	-	-
Sewer Drawdown Volume (ac-ft/yr)	71.3	59.6
Order of Magnitude Cost Range ($M)	$14.76	$19.0-$23.3

As shown in **Table 5**, the modeling results for Alternative 3 prioritize sewer drawdown over irrigation reuse to maximize the total project capture volume. The rate of sewer drawdown is greater than the rate of irrigation, so by prioritizing sewer drawdown, the storage galleries have more capacity to be refilled when the next rain event occurs, allowing the total capture volume to be maximized. As the irrigation reuse is increased, more water must be stored to meet that demand, thus reducing the available capacity in the storage galleries when the next rain event occurs, in turn reducing the total capture volume.

When adjusting the model and how the system operates, there are many variables that can be changed or held. One option could be to hold the tributary area at 204 acres and the storage volume at the 85th percentile of 9.4 ac-ft. The irrigation reuse can then be increased, thus decreasing the sewer drawdown, and in turn reducing the total project capture volume. In the SCW scoring criteria, Alternative 3 falls under the Water Supply Benefit range of 25 ac-ft/yr to 100 ac-ft/yr. With this option the system could still prioritize irrigation reuse, while not allowing the total capture volume to fall below 25 ac-ft/yr, thus allowing the SCW score to remain the same.

The general assumption for capturing the 85th-percentile is assuming 10 rainfall events throughout the year, with a small amount of dry weather flow. 9.4 ac-ft of storage, multiplied by the 10 rainfall events, plus a small amount of dry weather flow is how the 100 ac-ft/yr value is reached. However, because of drought and lack of rainfall in recent history, when modeling the 85h-percentile system using 10-year, or even 20-year, rainfall data, there is simply not enough historic rainfall to reach the 100 ac-ft/yr volume. Therefore, our limiting factor in meeting the 100 ac-ft/yr total capture volume is the rainfall received.

To increase our total capture volume to achieve the 100 ac-ft/yr, or closer to it, we would need to increase the tributary area and the 85th-percentile capture volume. This would allow the system to capture a larger volume of water, and in turn, increase our total capture volume. With this option, we could continue to balance between prioritizing irrigation reuse and sewer drawdown. However, it should be noted that with this option the storage gallery sizes would need to increase, increasing the Project footprint and cost.

The first option, to maintain the 204-acre tributary area and 9.4 ac-ft storage gallery sizing, is recommended. This would be an Equivalent Project to the one approved by the SCW Program, with the exception that upon receipt of additional data, and after further analysis, it was determined that the performance metrics presented in the grant application cannot be met.

SYSTEM COMPONENTS

Each system component identified in the Project Approach is comprised of many sub-parts which are discussed in this section. See **Attachment B1-B4** for the concept strip maps and conceptual site details depicting the proposed alternatives.

DIVERSION SYSTEM

An intercept diversion system is proposed to divert stormwater from City of LA storm drain lines. A direct connection via a manhole, or diversion structure, will be constructed at the point of connection. This lateral pipe will divert flow into a HDS before runoff flows into the storage gallery.

During the Value Analysis session held on June 21, 2022, it was suggested that a direct connection to the Los Angeles Flood Control District (LACFCD) system be considered to capture dry weather flows from a larger tributary area. LASAN does not have any existing dry weather monitoring in the Project area. There is also concern over the long lead times currently experienced with LACFCD's review and permit process. Previous projects completed by the City have successfully connected to LACFCD lines by receiving approval of their flood construction permit during construction. Because City storm drain lines are available for connection in each of the alternatives, a direct connection to the LACFCD system is not recommended at this time.

TREATMENT ALTERNATIVES

An analysis of various treatment alternatives for the Project was completed. The three options considered for the pre-treatment are summarized below.

1. Engineered filter media (Xylem): Low tech/low cost. Anthracite-engineered media with the lowest uniformity coefficient provides superior filtration qualities, increased filter run volumes, and less water to thoroughly backwash.
2. CDSTM Continuous Deflective Separation Treatment Method (CDS): Relatively easy to maintain with medium cost. A combination of swirl concentration and indirect screening to filter, separate, and trap debris, sediment, and hydrocarbons from stormwater runoff).
3. Gravity Media Filtration (Xylem): Highest Cost. Gravity filters are ideal for treating larger volumes than pressure filters can economically handle.

LASAN provided feedback that engineered filter media and gravity media filtration are not acceptable options due to increased mechanical maintenance and changing of consumable. Therefore, a HDS system (like the CDS) is the preferred option.

LASAN has implemented CDS units in previous projects and has experience maintaining the units. LASAN's preference is a conical bottom modified CDS unit that includes an outlet screen to prevent trash bypass. To isolate the HDS/CDS unit, a gate vault is included in the diversion system upstream and a shut off-valve is downstream.

If a baffle box is needed due to depth constraints, a Nutrient Separating Baffle Box (NSBB), or equivalent, will be used per LASAN's guidance. The baffle box should provide access into the structure and should avoid use of concrete partitions. Open hatches from above should provide clear overhead access to the baffle box for cleaning.

To prevent stormwater from going septic in the storage galleries, a recirculation pump is proposed.

Disinfection of stormwater prior to irrigation was also studied. UV light, ozone, and chlorination were among the options considered. However, according to the LA County Department of Public Health's *Guidelines for Alternate Water Sources: Indoor and Outdoor Non-Potable Uses*, the Project will not be required to disinfect the water being reused for irrigation because a subsurface drip irrigation system is proposed. Instead, a filtration unit is proposed to filter out any debris, grease, salt, or oil before entering the irrigation reservoir. For more information on the irrigation filtration unit, see the Irrigation System section below. See **Attachment C3 – Treatment Alternatives Memorandum** for a comparison of the studied options.

STORMWATER STORAGE GALLERY

Storage galleries can vary in materials and dimensions, ranging from concrete vaults to underground chambers and large diameter pipes. The stormwater galleries proposed must avoid existing utilities, existing trees, and maintain sufficient roadway width during construction. Pre-cast modular systems are commonly used for projects with spatial constraints. To prevent vectors from entering the galleries, a sealed storage gallery is recommended. Routine maintenance will also be required to ensure vector control.

Figure 1: Pre-Cast Storage Gallery Schematic

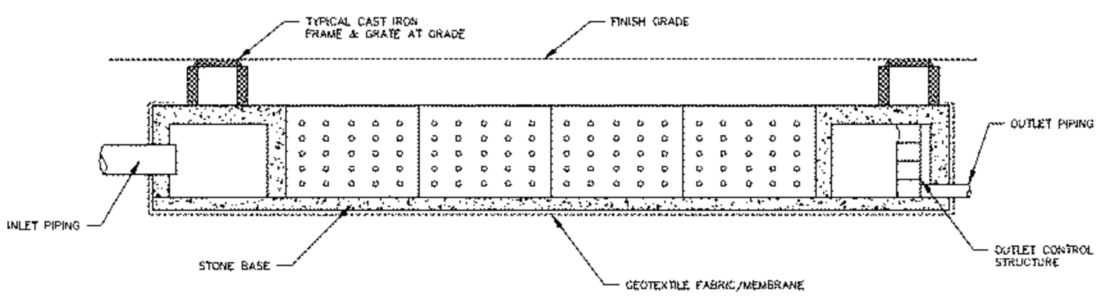

Figure 1 illustrates a typical pre-cast storage gallery. The galleries are usually gravity systems with a raised storm drain overflow. Stormwater galleries with a depth of 15 feet were modeled. A freeboard of 2 feet is assumed which includes an 18-inch overflow pipe and at least 6 inches to the top of the storage gallery. See **Attachment C2 – Storage Alternatives Memorandum**.

The proposed layouts (**Attachment B1-B3**) include storage galleries under medians and the roadway. On Broadway, the galleries have been kept within the median limits where possible to minimize construction impacts and help with maintenance access. Keeping the galleries within the median limits reduces traffic impacts and lane closures when maintenance is required. Maintenance vehicle pullouts (MVPs) are also proposed on the medians adjacent to the galleries and vaults to allow for ease of access and maintenance without traffic impacts. Because there are no larger medians on Manchester, the two storage galleries are placed within the roadway. Traffic control will be required to maintain the system on Manchester.

IRRIGATION SYSTEM

A portion of the captured stormwater will be used for subsurface drip irrigation throughout the Project. The Project includes landscaping and planting funded through the Active Transportation Program (ATP), Infrastructure for Rebuilding America (INFRA), Measure W, and Urban Greening grant programs. The City is also continuing to apply for grant funding to provide median activation improvements which would include additional planting, a continuous pedestrian path, and community gathering spaces. All landscaping will be drought tolerant and from the city approved plant palette. The irrigation design will be compliant with the State of California Model Water Efficient Landscape Ordinance requirements (MWELO). The irrigation demand for all phases of the project, including an assumption for future improvements, were calculated for all four irrigation areas and used in the hydrologic model. See **Attachment E** for the irrigation demand calculations.

The stormwater from the storage gallery will be pumped into an automatic flushing filtration unit (120 mesh filter) to remove any particles which would potentially clog the drip emitters before being stored in an irrigation reservoir. The irrigation reservoir will contain approximately two days' worth of irrigation water. Captured treated stormwater will serve as the primary source of water for the irrigation systems. A secondary domestic water supply source will supplement the irrigation reservoir in the event when captured storm water is not available. Master control valves, one for each water supply, will control the level and type of water entering the irrigation reservoir. Within the irrigation reservoir, a submersible booster pump will provide the required amount of pressure within the irrigation system to operate the drip systems efficiently. Other components within the irrigation reservoir include float switches which control the function of the corresponding master control valves. The irrigation reservoir will also have an overflow pipe discharging to the sewer to prevent overfilling of the reservoir. The filtration unit's overflow must discharge into the sanitary sewer due to the contaminants in the unit. The system will also consist of a wet well with pump and a check valve vault. All the components of the irrigation system are shown in **Attachment B4 – Conceptual Site Details**.

INFILTRATION

The Feasibility Study assumed that infiltration was not feasible. To investigate whether infiltration was feasible for the Project in an effort to maximize the Project's benefits, infiltration testing was completed to support the revised approach (see **Attachment F – Geotechnical Infiltration Report**). 11 boring locations evenly distributed throughout all four irrigation areas, except for the segments of irrigation areas 1 and 2 that fall within the liquefaction zone, were identified for field testing. Along with conducting in-hole permeability testing for each boring, an assessment of the groundwater levels and existing soil conditions was completed.

The *LA County Guidelines for Geotechnical Investigation and Reporting – Low Impact Development Stormwater Infiltration* requires a reduction factor be applied to the unfactored infiltration rates to represent long-term performance of the proposed infiltration devices. Based on these guidelines, a reduction factor of 3 is recommended for the Project.

The *City of LA Low Impact Development (LID) Manual* states that factored infiltration rates must be greater than 0.5 in/hr and the depth to groundwater be at least 10 feet from the BMP for infiltration to be feasible.

Table 6 summarizes the data provided in the infiltration report and shows the design infiltration rates used for the Project. Green shows areas where infiltration rates are favorable and red where unfavorable. For more information, see **Attachment F – Geotechnical Infiltration Report**.

Table 6: Infiltration Testing Results

Boring Location	Irrigation Area	Well Depth (ft)	Groundwater (ft)	Layer Depth (ft)	Unfactored Infiltration Rate (in/hr)	LA County Reduction Factor	Design Infiltration Rate
1	1	50	NE	10 - 25	2.5	3	0.83
				25 - 50	0.3	3	0.10
2	1	50	NE	10 - 30	2.5	3	0.83
				30 - 40	0.3	3	0.10
3	1	50	NE	10 - 40	2.5	3	0.83
				40 - 50	1	3	0.33
4	2	50	NE	10 - 25	2	3	0.67
				25 - 40	0.3	3	0.10
5	3	50	NE	10 - 45	0.3	3	0.10
6	3	50	NE	10 - 40	0.5	3	0.17
				40 - 45	0.1	3	0.03
7	3	50	36.2	10 - 25	2.5	3	0.83
				25 - 30	0.5	3	0.17
8	3	50	NE	10 - 28	2	3	0.67
9	4	50	NE	10 - 40	0.3	3	0.10
10	4	50	NE	10 - 30	0.5	3	0.17
				30 - 35	0.1	3	0.03
11	4	50	NE	10 - 40	0.5	3	0.17

NE = Not Encountered

Based on the infiltration rates, and LA County and City of LA LID criteria, infiltration was proposed for Alternative 2 in portions of irrigation areas 1, 2, and 3. Infiltration is infeasible in irrigation area 4 due to insufficient infiltration rates. Portions of irrigation area 1 and 2 fall within the liquefaction zone where infiltration is not permitted.

Stormwater will enter the infiltration gallery from the storage gallery where it will be stored temporarily as it infiltrates. When the water level reaches a certain height, there will be an overflow pipe to the storm drain system to avoid backflow in the system.

The infiltration devices considered for the Project are underground infiltration galleries and drywells. Infiltration galleries are subsurface vaults with void spaces and can take the form of pipes, plastic tanks, or concrete vaults. Drywells are vertical shafts that are greater in height than width. Due to the large capture volume, it was determined that drywells would be inefficient and would not store the volume required. It is recommended that underground infiltration galleries be used for the Project. See **Attachment C2 – Storage Alternatives Memorandum** for a more detailed comparison of the two infiltration BMPs.

Infiltration galleries must be serviceable without a crane and provide a minimum of two access points. The access points should include one on the entry side and one on the exit side and both should have ramps that provide sufficient room for necessary equipment.

As discussed in the Cost-Benefit Analysis section earlier, infiltration was deemed infeasible by the Central Basin Watermaster.

SANITARY SEWER DRAWDOWN

The capture volume remaining after irrigation and/or infiltration may be diverted to either the City or LACSD sanitary sewer system for recycle and reuse at the Joint Water Pollution Control Plant (JWPCP). The team submitted a Sewer Capacity Request to LACSD and a Wastewater Service Information (WWSI) Request to LASAN to determine how much discharge will be allowed into their sewer systems. LACSD and LASAN have provided the following sewer capacity availabilities. LACSD's availability is preliminary, and they are still working on the off-peak analysis to evaluate if there is additional capacity overnight. See **Table 7** below for a summary of the sewer capacity provided thus far.

Table 7: LASAN and LACSD Sewer Capacity

Irrigation Area No.	LASAN Sewer Capacity (cfs)	LACSD Sewer Capacity (cfs)
IA-1	0.5	0
IA-2	0.5	0.5-0.8 (combined DA-2 & 3)
IA-3	0	0.5-0.8 (combined DA-2 & 3)
IA-4	0	0

LASAN does not allow discharge during a storm and up to 48 hours after. There is also no discharge allowed when a 0.1-inch rain event is forecasted. LACSD typically does not allow flow to the sewer during a storm event for 24 hours after rainfall has ended.

A request for off-peak sewer capacity has been submitted to LACSD. If the off-peak capacity is favorable, the total capture volume of the Project could increase.

A LACSD JWPCP discharge permit and LASAN industrial wastewater permit application will need to be submitted and approved by the appropriate agencies before discharging to sewer systems.

The sewer drawdown system is depicted in the conceptual site details sheet (see **Attachment B**). From the storage gallery, stormwater will flow into a pump well where the discharge amount can be controlled. There will also be a sampling vault and a gas trap manhole before the connection and discharge to the sanitary sewer.

BIORETENTION

BMPs in the parkways along the existing sidewalk and in the curb extensions were also considered for the Project. In Alternatives 1 and 2, longitudinal gutters were proposed to increase the drainage area tributary to the proposed curb extension BMP. After further consideration, BMPs in the curb extensions have been removed due to cost and tree impacts. The longitudinal gutters were removed alongside the curb extension BMPs.

Bioinfiltration was considered in Alternative 2 where infiltration rates allowed and bioretention with underdrains was proposed in all other locations where infiltration is not feasible. All bioinfiltration has now been removed due to the infeasibility of infiltration for the Project.

In Alternative 3, there are six bioretention BMPs proposed, totaling in approximately 695 square feet along Broadway. A greater BMP area was initially considered to maximize the project sustainability via natural systems for water treatment. However, due to existing utilities, trees, and space constraints along the corridor, some BMP locations were removed.

For the bioretention BMP, stormwater enters the BMP through curb cuts. Once the stormwater filters through the bioretention BMP, it is piped back to the existing storm drain system. Curb cuts will be proposed at the downstream end of all BMPs to allow for overflow to the existing curb and gutter.

PERFORMANCE SPECIFICATIONS OUTLINE

BMP performance specifications will be provided as part of the Measure W plans, specifications, and estimate (PS&E) submittals to the city. BMP performance specification guidelines will be prepared for submittal with the 65% plans and estimate based upon the agreed upon system. A draft set of BMP performance specifications will be provided with the 65% PS&E, draft final with the 90% PS&E, and final with the 100% PS&E.

Some items anticipated to have performance specifications are:

- Irrigation Pumps
- Recirculation Pumps
- Filtration Unit

- Hydrodynamic Separator
- Storage Galleries
- Infiltration Galleries
- Irrigation Reservoir tank
- Wet Well Vault
- Flow Meter Vault
- I&C/LAWINS Integration (Instrumentation & Control/Los Angeles Wastewater Integrated Network Systems)
- Supervisory Control and Data Acquisition (SCADA) System

Because there is federal funding for the ATP portion of the Project, the Buy America requirements must also be met. The Build America, Buy America Act states that all infrastructure projects receiving federal funding must source all of iron, steel, manufactured products, and construction materials from the Unites States. The performance specifications will directly address these requirements to ensure compliance.

PILOT PROGRAM

The City is interested in trial testing up to three different systems to evaluate for consideration in future projects. The following systems are recommended for the pilot program but are still being discussed and locations finalized with the City.

1. Permeable Concrete Panels: Permeable concrete panels for the width of the cycle track are recommended for one block along the S Broadway corridor. These permeable panels will allow for stormwater infiltration within the cycle track but will also be designed for ease of maintenance where individual large panels can be removed to access utilities or replaced if damaged.
2. Silva Cells (or approved equivalent): These are a modular suspended pavement system that allow larger trees to be planted in smaller areas by using soil volume under sidewalks and other infrastructure to support large tree root growth. They can also support stormwater management through bioretention. Silva Cells, or approved equivalent, could allow for planting of trees in smaller spaces than currently required by Urban Forestry Division (UFD).
3. Tree Well Biofiltration: A tree well stormwater capture device system to capture stormwater runoff in tree wells instead of stormwater flowing into the storm drain system. There are various proprietary systems in the market such as Filterra, Hydro Stormscape, StormVault Biofiltration, etc.

OPERATIONS AND MAINTENANCE (O&M)

The awarded grant for the Project does not include O&M costs, but the City plans to apply for future O&M funding. The Measure W SCW grant program has allocated a portion of the funds to be used for O&M. O&M is covered under Measure W for 50 years after implementation, thus coordination between the StreetsLA, UFD, and LASAN O&M teams is vital to the success of the Project. An O&M Plan and Monitoring Plan will be developed with StreetsLA, UFD, and LASAN. See **Attachment G** for a draft matrix of possible O&M items that must be reviewed and agreed upon by all parties.

A Memorandum of Agreement (MOA) that identifies which department will maintain each item must be agreed upon by all parties.

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SCADA SYSTEM

A SCADA system will monitor and control the entire stormwater system. The SCADA system will read stormwater levels to trigger actions and controls to decide when to switch over to potable water, or to control the sewer drawdown within the requirements provided by LASAN and LACSD to operate the system efficiently and effectively.

LASAN and LACSD may have differing SCADA systems that need to be included. Dual systems may need to be implemented depending on which agency storm drain and sewer facility are being connected to in each area. The SCADA systems must be compatible with existing LASAN SCADA and should be able to communicate with the Venice Pump Plant. The SCADA system components will be documented in the O&M Manual as the design progresses.

While the initial installation of the SCADA system will be constructed with current funds, maintenance will be an O&M cost paid for by the next phase of Measure W funding. Further coordination with LASAN and LACSD will determine the exact cost over 50 years for the SCADA systems.

QUALITY ASSURANCE (QA)/QUALITY CONTROL (QC) PLAN

A QA/QC plan will be executed for the technical assessments, modeling, conceptual and final engineering for the Project. This will be developed in partnership with StreetsLA, LASAN, and other reviewing agencies.

The QC Plan will be based on the following principals that are described in the Kimley-Horn Quality Control/Quality Assurance Manual:

- Quality is achieved by adequate planning, coordination, supervision, and technical direction; proper definition of job requirements and procedures; understanding the scope of services; the use of appropriately skilled personnel and by individuals performing work functions carefully.
- Quality is assured through detail checking, reviewing and backchecking by individuals who are not directly responsible for performing the initial effort.
- Quality is controlled by assigning a senior person (QC/QA Manager) who is responsible for the overall project quality and the enforcement of the QA program.
- Quality is verified through independent technical reviews (ITR) by qualified staff that are familiar with the technical procedures, processes, standards, and guidelines associated with the deliverables set forth in the scope of services.

This QC Plan will establish the quality goals, requirements and expectations for the major deliverables associated with the Project. The plan will also identify the key individuals who are responsible for producing each deliverable and deliverable review. Key team members are also identified by their role and responsibilities.
Procedures for submittal reviews, ITRs, detailed checks and project coordination are to be described and appropriate forms are included in the QC plan appendices.

Lastly, Quality Assurance (QA) is defined, and the requirements are outlined. Generally, QA is the effort associated with documenting and verifying that QC measures are being implemented and their implementation is consistent with the guidelines set forth in this QC plan.

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ATTACHMENTS

Attachment A – Location Map

Attachment B1 – Alternative 1 Concept Strip Map

Attachment B2 – Alternative 2 Concept Strip Map

Attachment B3 – Alternative 3 Concept Strip Map

Attachment B4 – Conceptual Site Details

Attachment C1 – Water Quality and Hydrology

Attachment C2 – Storage Alternatives Memorandum

Attachment C3 – Treatment Alternatives Memorandum

Attachment C4 – Stormwater Capture Memo

Attachment D – Order of Magnitude Cost Estimate

Attachment E – Irrigation Demand Calculations

Attachment F – Geotechnical Infiltration Report

Attachment G – Draft O&M Matrix

Attachment H – Alternatives Analysis

ATTACHMENT A

Location Map

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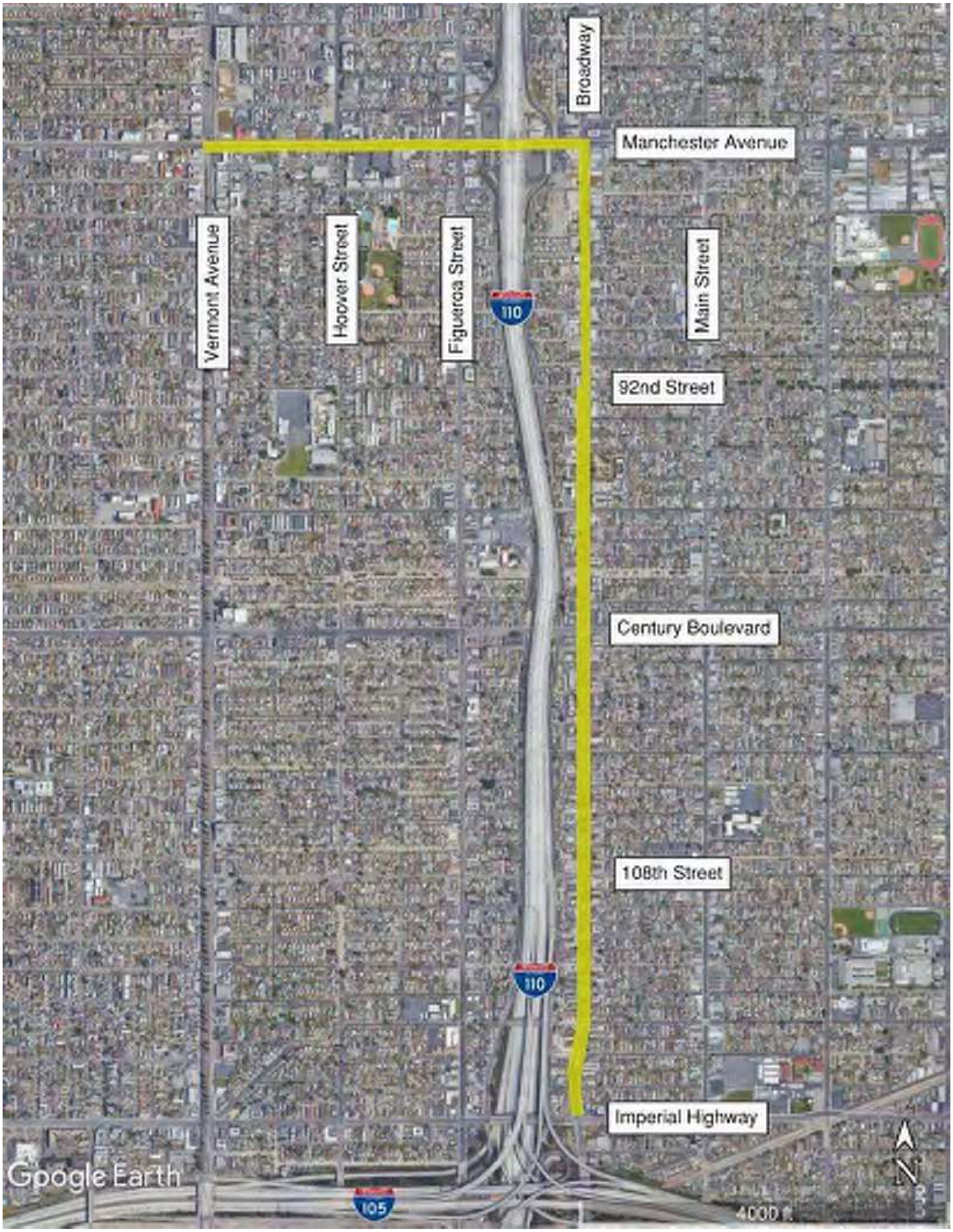

Broadway
Manchester Avenue
Vermont Avenue
Hoover Street
Figueroa Street
110
Main Street
92nd Street
Century Boulevard
108th Street
110
Imperial Highway
Google Earth
105
N

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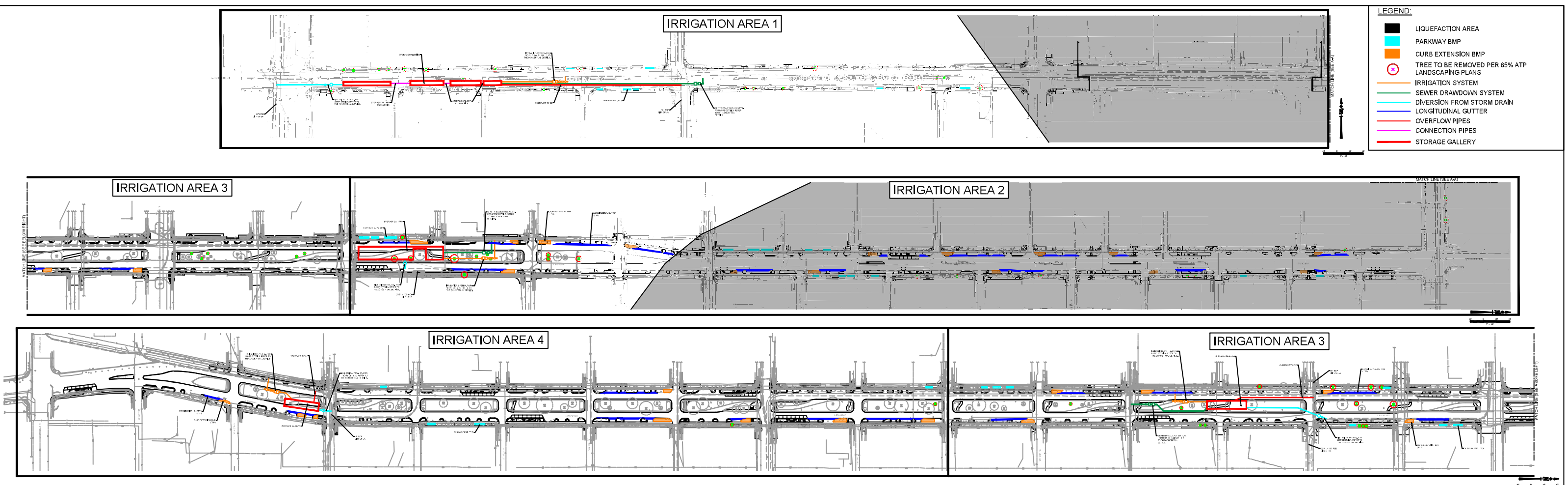
ATTACHMENT B1

Concept Strip Map – Alternative 1



COUNCIL DISTRICT 8

BROADWAY-MANCHESTER ATP EQUITY PROJECT

MEASURE W CONCEPTUAL STRIP MAP - ALTERNATIVE 1

1/3/2023

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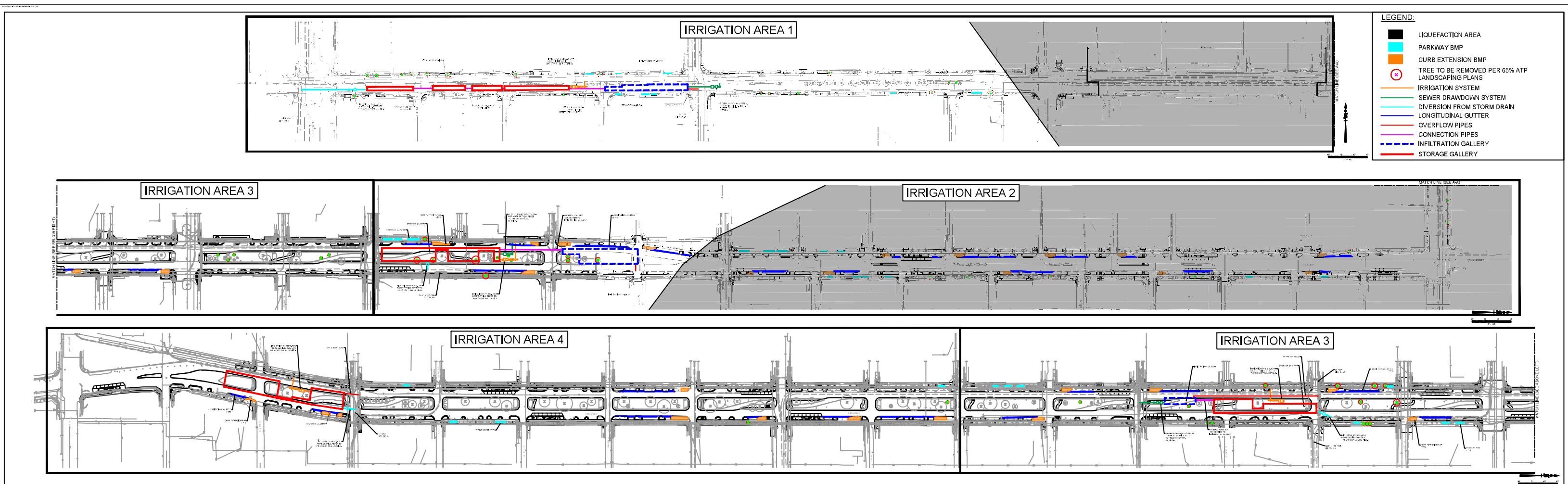
ATTACHMENT B2

Concept Strip Map – Alternative 2



COUNCIL DISTRICT 8

BROADWAY-MANCHESTER ATP EQUITY PROJECT

MEASURE W CONCEPTUAL STRIP MAP – ALTERNATIVE 2

1/13/2023

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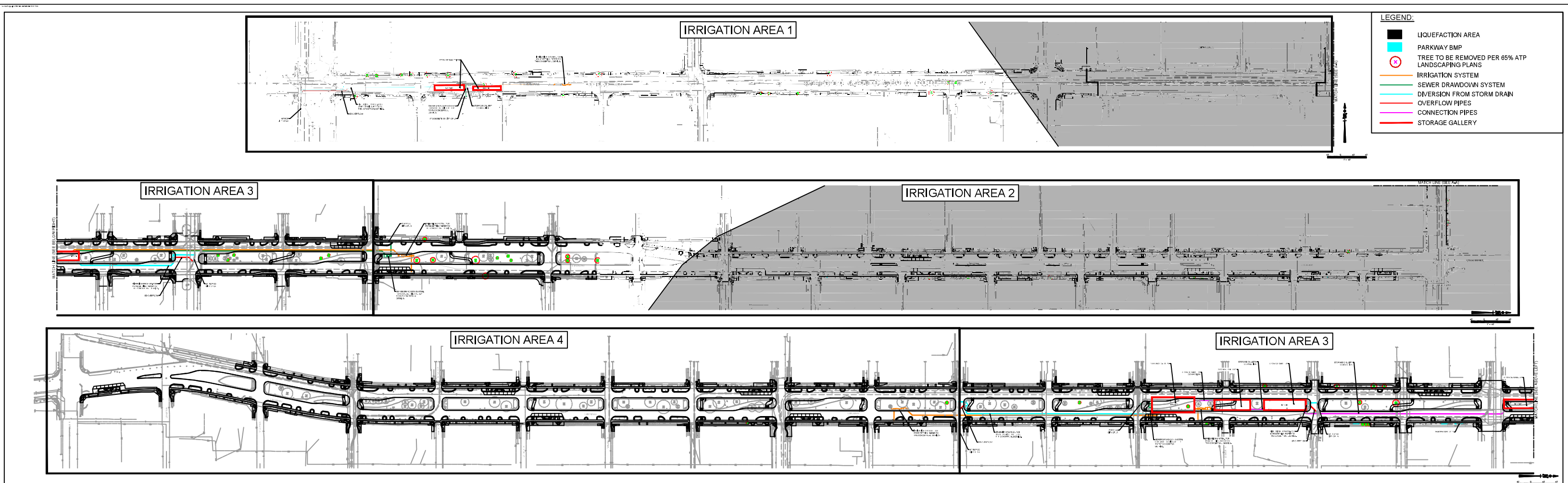
ATTACHMENT B3

Concept Strip Map – Alternative 3



COUNCIL DISTRICT 8

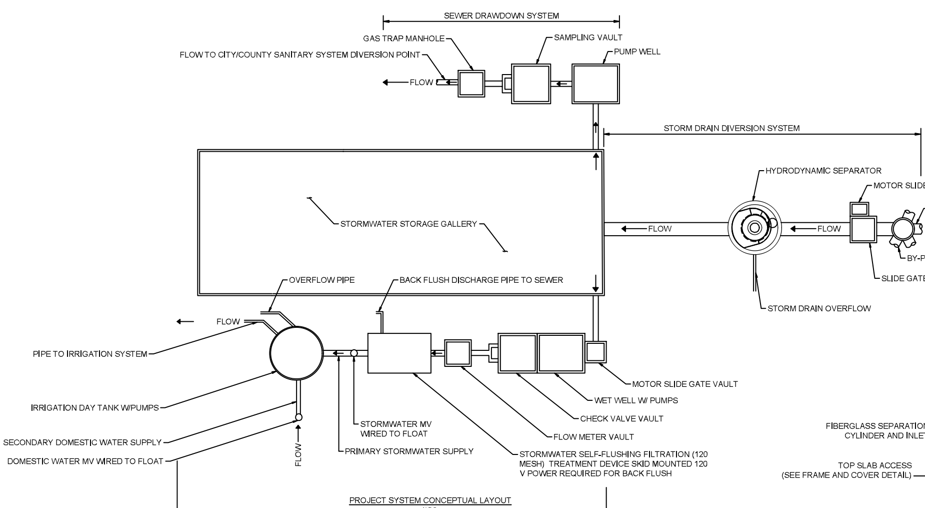
BROADWAY-MANCHESTER ATP EQUITY PROJECT

MEASURE W CONCEPTUAL STRIP MAP - PROPOSED ALTERNATIVE 3

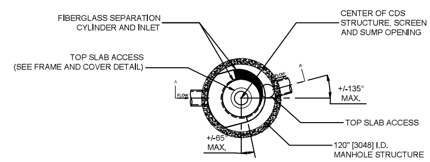
1/13/2023

ATTACHMENT B4

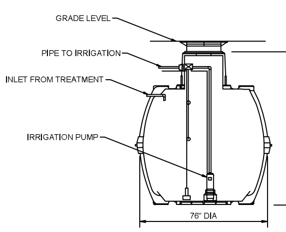
Conceptual Site Details



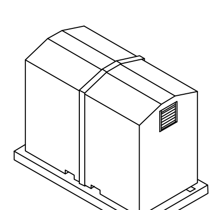
PROJECT SYSTEM CONCEPTUAL LAYOUT
N.T.S.



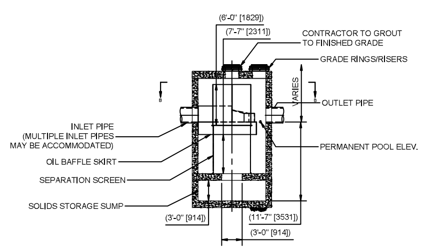
PLAN VIEW B-B
N.T.S.



1,700 GAL IRRIGATION DAY TANK
FINAL SIZE TBD BASED ON CALCULATIONS



STORMWATER SELF FLUSHING FILTRATION TREATMENT DEVICE (120 MESH) MOUNTED ON SKIDS
120 V POWER REQUIRED FOR BACK FLUSH CONTROLLER



ELEVATION A-A
N.T.S.

HYDRODYNAMIC SEPARATOR

TRACT, PARCEL MAP, VAC., ZA/CPC, R3, GEN. IMP.

PLANS PREPARED BY:
Kimley»Horn
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660 SOUTH FIGUEROA STREET, SUITE 2050
LOS ANGELES, CA 90017

CITY OF LOS ANGELES DEPARTMENT OF PUBLIC WORKS
STREETSLA

SHEET TITLE: DRAINAGE DETAILS
PROJECT: BROADWAY-MANCHESTER MEASURE W
ADDRESS: LOS ANGELES, CA

ENGINEER: NICOLE DIAS
DESIGNED BY: JANESSA MENDOZA
DRAWN BY: ALYSSA LAM
CHECKED BY: JUSTIN GATZA
APPROVED BY: NICOLE DIAS

BUREAU OF ENGINEERING APPROVAL
INDEX NO.
BRXXXXXX

DRAWING NO.
CU-16
SHEET 29 OF 28 SHEETS

Kimley»Horn

ATTACHMENT C1

Water Quality and Hydrology

Watearth™

Water Quality and Hydrology

City of LA Broadway and Manchester

Project:	City of LA Broadway and Manchester Active Transportation Equity Project (ATP Cycle 4)
Watearth #:	21-260.0
Subject:	Water Quality and Hydrology
Date:	August 25, 2022
Prepared By:	Jennifer J. Walker, PE, DWRE, ENV SP, CFM, QSD Sinem Gokgoz-Kilic, PhD Farhana Akhter

Draft

DRAFT MEMORANDUM RELEASED UNDER THE AUTHORITY OF **JENNIFER J. WALKER PE (C77079), DWRE, CFM** ON 2022-08-25 AND SHOULD NOT BE USED FOR DESIGN OR CONSTRUCTION.

Introduction

This memorandum describes the modeling approach to the hydrology and water quality analysis for the City of Los Angeles Broadway Manchester Active Transportation Equity Project (ATP Cycle 4). This project will increase stormwater and urban runoff capture and reduce stormwater runoff pollution by diverting wet weather flow from City of Los Angeles storm drain systems and pre-treating it prior to diversion to underground infiltration galleries.

The proposed stormwater infiltration galleries will be located underneath roadway or medians along the 2.8-mile linear project area along Manchester and Broadway Avenues. The captured stormwater will be used for on-site irrigation and a portion will be sent to either Los Angeles County Sanitation District (LACSD) or Los Angeles Bureau of Sanitation (LABOS) to be recycled and reused within the City of Los Angeles.

Watearth, together with Kimley-Horn, is working with both LACSD and LABOS on their available capacities to receive captured stormwater into their treatment systems as part of this project. Both agencies stated that they will not allow discharge into sanitary sewer during rain events or "immediately" (up to 48 hours) after a rain event. "Dry days" are assumed to have less than 0.1 inches of precipitation and will not face discharge timing restrictions. The project details will be further revised as these discussions with the sanitary agencies continue. Dry weather flow might be considered based on monitoring and discussion with Los Angeles City and County.

The first section of this memorandum describes the components of the stormwater capture facilities, the diversion and treatment systems. The second section of this memorandum explains the determination of event-based hydrologic analyses for 85th percentile, 50-year, 25-year, and 10-year 24-hour design storm event flow rates using the Modified Rational (MODRAT) Method. The third section explains the long-term (10-year) continuous simulation water quality modeling. Long-term hydrology analysis is used for estimating the pollutant loading and pollutant reduction through the underground stormwater capture facility proposed to be built along the 2.8-mile linear project area.

In the last section of this memorandum, both the hydrology and water quality analysis results are evaluated to determine sizing of the underground storage facilities using Watershed Modeling Management Software (WMMS) version 2.0. The underground treatment, storage, and infiltration facilities are the recommended Best Management Practices (BMP) to achieve the goal of reducing stormwater runoff and pollutant loading.

Stormwater Capture Project Layout

The project area is divided into four separate drainage areas: one along Manchester Avenue, and three along Broadway Avenue (**Exhibit 1**). The total drainage area of all four drainage areas is 197.8 acres (ac). Each drainage area will have its own separate stormwater capture system, which will divert captured stormwater runoff into a storage gallery. Through a series of valves and controllers the captured water will flow from the storage gallery into an infiltration gallery, onsite irrigation system, and into existing city/county sanitary sewer for further treatment at the wastewater treatment plant. These devices will be located underground in the medians or roadways in each drainage area. There will not be any infiltration in the known liquefaction zones, but storage galleries can be implemented to capture stormwater runoff. Other existing utilities will remain in their current location.

Stormwater will be diverted from both City of Los Angeles and Los Angeles County storm drain systems to a pretreatment device which will remove debris, grease, and oil. If diverted from City of Los Angeles, a diversion structure will be built. It the flow is diverted from Los Angeles County, the diversion will be through upstream catch basins and a parallel system. Flows then will be captured in the underground storage gallery. A portion of the captured water will be filtered and used for on-site irrigation within the drainage area and another portion of the captured water will be filtered and transferred to an underground gallery for infiltration. Any remaining portion of captured water will be diverted to either LACSD or LABOS for processing into recycled water (**Appendix A**).

The underground storage units are commonly constructed using modular precast concrete and are equipped with surface access for operation & maintenance (O&M). They provide detention to temporarily store stormwater runoff in large underground chambers which is later released at a controlled rate.

Infiltration galleries are engineered, subsurface void spaces consisting of one or more holding structures, such as pipes, plastic tanks, or concrete vaults. Stormwater runoff enters the gallery through a surface inlet or low flow diversion structure and is temporarily stored, allowing fine sediment and particles remaining after pretreatment to settle. Infiltration of captured stormwater has additional benefits beyond removal from the stormwater system such as removal of pollutants through filtration, groundwater recharge as infiltrated stormwater flows into the aquifer, and reduction of peak flow during rain events. If the water level reaches a certain height in the infiltration galleries, it will be discharged as overflow back to the City or County's storm drain system. For the layout and connections, please refer to Conceptual Site Detail drawing in **Appendix A**.

A geotechnical field investigation and site assessment was performed for the ATP Equity Grant portion of this project, which classified the subsurface soils, soil infiltration rates, and identified the depth to groundwater for the design of the infiltration facilities (**Appendix B**). Based on this report, infiltration is feasible along the 2.8-mile project area.

Based on the geotechnical report, an infiltration rate of 0.83 in/hr. is used for drainage area 1; 0.67 in/hr. for drainage area 2; 0.44 in/hr. for drainage area 3; and 0.14 in/hr. for drainage area 4. An average of the unfactored infiltration rate of the first layer depth of the boring were estimated to determine the infiltration rate of the drainage area. Then, a safety factor of 3 is used to calculate the design infiltration rates following the guidance in the geotechnical report (**Appendix B**).

Event-Based Hydrology Analysis

Hydrologic modeling was performed following the *Los Angeles County Hydrology Manual (LACHM)* published in January 2006. MODRAT, the standard method for hydrologic studies within Los Angeles County, is used in the determination of peak flowrates for each drainage area. MODRAT applies a time of concentration for each designed storm events to determine rainfall intensity. HydroCalc software was used to estimate runoff volume and peak flowrate for 10 - year, 25-year, and 50-year 24-hour storm events. Runoff volume of 85th percentile storm event is calculated using LA County's Watershed Management Modeling System 2.0 (WMMS 2.0). Based on the irrigation demand, the contributing drainage area was divided into 4 smaller drainage areas as shown in **Exhibit 1.**

Hydrologic Parameters

All hydrologic parameters including rainfall data, elevation data, land cover data, soil data, longest flow path, and slope were incorporated into the drainage areas to perform hydrologic modeling as explained in detail below.

Drainage Area

The Broadway Manchester project contains four drainage areas that are 197.8 acres total (**Exhibit 1**). Drainage Area 1 (DA-1) is 45 acres and located along Manchester Ave, just west of I-110 in the northern part of the project area. Drainage Area 2 (DA-2) is 95 acres and is in the northern part of the project area along Broadway. DA-2 is just west of I-110 and intersects with Manchester Ave near its northernmost point. Drainage Area -3 (DA-3) is 31 acres and is just west of I-110 and along the central section of Broadway. W Century Blvd runs through the central part of DA-3. Drainage Area-4 (DA-4) is the smallest drainage area at 26 acres and in the southern part of the project area. The southernmost boundary intersects with Imperial Highway, less than a half mile from the junction of I-110 (running north and south) and I-105 (running east and west).

Topography

A digital elevation model (DEM) from United States Geological Survey (USGS) 3D Elevation Program was used for the Broadway and Manchester water demand and supply project. The DEM elevation across the 4 drainage areas varies from approximately 135 feet to 153 feet above mean sea level. The elevation is generally decreasing to the east and remains between approximately 130 and 150 feet across the drainage areas. The project area elevation is consistently between 120 and 140 feet in elevation except for the western end near the intersection of Manchester Ave and Vermont Ave and the southern end of S Broadway. The elevation in these locations gradually increases and is between 140 and 160 feet. All this data is shown in **Exhibit 2**. The flow paths were drawn based on flow direction, slope, and elevation to flow downstream. Sheet flow/overland flow was determined by evaluating flow in impervious areas of the project Area (Broadway and Manchester Ave) and by using the slopes.

Rainfall

Rainfall data from Los Angeles County shows rainfall for both the 85th percentile storm event for the county and the 50-year 24-hour rainfall event (**Exhibit 3**). The nearest rainfall data was used for MODRAT analysis. The nearest 85th percentile rainfall hyetograph is in the northwestern part of the project area in DA-1 approximately 0.5 miles west of I-110. The nearest 85th percentile hyetograph shows 1.0 inch of rain for this storm event. The nearest 50-yr rainfall hyetograph contour is 5.4 inches and runs through DA-2 near I-110.

Impervious Cover

Impervious cover was determined using aerial imagery and digitization of impervious and pervious features within ArcGIS. Pervious land in the study area is any land that stormwater can infiltrate such as grassy open space, wooded open space, dirt, residential yards, etc. Impervious land in the study area is any land that stormwater cannot infiltrate such as sidewalks, roads, buildings, etc. These urban areas range from residential neighborhoods and apartment complexes to commercial development and schools. The entire watershed contains 197.8 ac. The watershed has 79% impervious cover as shown in **Exhibit 4**.

Land Use

Land use was determined using City of Los Angeles GIS database (**Exhibit 5**). The project area and drainage areas contain 44% residential land use and 33% commercial land use. Transportation land use is less at 16%, and there is a small amount of institutional land use (3%) and vacant land (1%).

Soils

Soil data from Los Angeles County was collected for the Broadway and Manchester water demand and supply drainage areas. There are three soil types within the drainage areas that include Hanford Fine Sandy Loam, Chino Silt Loam, and Ramona Loam. Both DA-1 and DA-2 contain Hanford Fine Sandy Loam and Chino Silt Loam. DA-3 contains only Hanford Fine Sandy Loam and DA-4 contains Hanford Fine Sandy Loam and Ramona Loam. MODRAT requires assignment of a single soil type for each drainage area modeled. If a drainage area contains more than one soil type, the predominant soil type in the drainage area is used. The drainage area and LA County soil types are shown in **Exhibit 6**.

The hydrologic parameters of each drainage area are summarized in **Table 1**.

Table 1: Hydrologic Parameters

Drainage Area	Area (ac)	Soil Type	Impervious Cover (%)	50-yr Rainfall Depth (in)	Flow Path Slope (ft/ft)	Flow Path Length (ft)
DA-1	45.05	03	83.12	5.4	0.00392	3,061
DA-2	95.95	03	75.94	5.4	0.00440	4,773
DA-3	30.83	06	79.48	5.4	0.00301	3,321
DA-4	25.91	13	81.24	5.4	0.00396	3,281
Total	197.74		78.82			

After performing the MODRAT analysis for all 4 drainage areas, the peak flow rate and the runoff volume for the 50-year, 25-year and 10-year, 24-hour events are summarized in **Appendix C**. Resulting hydrographs are also located in **Appendix C**.

Hydrology and Water Quality Analysis

85th percentile 24-hr storm event and a long-term hydrologic analysis of the drainage areas were performed using LA County's Watershed Management Modeling System 2.0 (WMMS 2.0) which includes Loading Simulation Program C++ (LSPC) as the baseline hydrology and water quality model. LSPC was used to simulate the runoff volume, flow rate, and pollutant loading for long-term analysis. WMMS 2.0 subbasins 6045, 6050, 5052, 6056, 6057 and 6061 were revised to be consistent with the project drainage area. Ten-year, continuous time series data (from year 2008 to year 2018) was used for the long-term analysis.

The land use information was obtained from WMMS 2.0 (**Exhibit 7**) and is summarized in **Table 2** below, using the model's own naming convention. Pollutants behave differently over different land use areas, that is why land use information is important in water quality analysis. LSPC model provides the capability to simulate pollutant transport that varies across different HRUs represented in the model. Previous monitoring and modeling studies performed in California have investigated water quality associated with stormwater runoff from individual land use categories (WMMS manual).

Table 2. Land use/Land Cover Characteristics for Drainage Areas

Hydrologic Response Unit (HRU) ID	HRU Name	DA 1 (Ac)	DA 2 (Ac)	DA 3 (Ac)	DA 4 (Ac)
1000	Road_Freeway-All-All-All	0.05	0.65	-	-
2000	Road_Primary-All-All-All	5.66	6.28	4.62	4.08
3000	Road_Minor-All-All-All	1.63	7.16	1.76	1.75
4000	Dev_ResHigh-All-All-All	0.96	3.43	1.21	1.26
5000	Dev_ResLow-All-All-All	6.45	12.90	4.41	3.93
6000	Dev_Com-All-All-All	4.16	6.00	1.62	0.81
7000	Dev_Ind-All-All-All	0.07	0.29	-	0.05
8000	Dev_Inst-All-All-All	3.63	1.78	0.75	0.49
9000	Dev_Roof-All-All-All	5.46	13.10	3.06	2.21
10000	Dev_Overspray-All-All-All	0.29	0.55	0.19	0.18
11311	Dev_Irrigated-C-Low-Confined	2.21	1.72	1.96	1.66
11411	Dev_Irrigated-D-Low-Confined	0.77	6.73	-	-

Hydrologic Response Unit (HRU) ID	HRU Name	DA 1 (Ac)	DA 2 (Ac)	DA 3 (Ac)	DA 4 (Ac)
12311	Dev_Pervious-C-Low-Confined	5.94	4.67	5.63	4.46
12411	Dev_Pervious-D-Low-Confined	1.96	17.98	-	-
14321	Veg_Low-C-Med-Confined	3.38	2.39	4.21	3.94
14421	Veg_Low-D-Med-Confined	1.05	6.55	-	-
15321	Veg_High-C-Med-Confined	0.97	1.27	1.36	1.05
15421	Veg_High-D-Med-Confined	0.43	2.37	-	-
	Total	**45.07**	**95.83**	**30.78**	**25.87**

85th percentile runoff, annual runoff volume and annual pollutant loadings are summarized in **Table 3** for each drainage area. Runoff hydrographs for long-term are presented in **Appendix D** for the four drainage areas.

Pollutants behave differently over different land use areas, that is why land use information is important in water quality analysis.

Table 3. Annual Average Pollutant Loadings for Each Drainage Area

Drainage Area	Total Area	85th Runoff (ac-ft)	Runoff (ac-ft/yr)	TSS[1] loading (lbs/yr)	TN[2] loading (lbs/yr)	TP[3] loading (lbs/yr)	Cd[4] loading (lbs/yr)	Cu[5] loading (lbs/yr)	Pb[6] loading (lbs/yr)	Zn[7] loading (lbs/yr)
DA1	45.07	2.38	24.69	10952.40	126.37	24.42	0.06	6.24	1.60	24.31
DA 2	95.83	4.37	47.85	18449.58	245.86	44.59	0.10	10.00	2.53	39.36
DA 3	30.78	1.43	15.29	6871.77	76.14	15.98	0.04	3.80	0.95	15.42
DA-4	25.87	1.19	12.81	5844.05	63.23	13.55	0.03	3.17	0.79	13.09

Notes: [1]Total suspended solids; [2]Total nitrogen; [3]Total Phosphorous; [4]Cadmium; [5]Copper; [6]Lead; and [7]Zinc

BMP Size Optimization

The System for Urban Stormwater Treatment and Analysis (SUSTAIN) program is a decision support system that assists with developing and implementing plans for flow and pollution control measures to project source waters and meet water quality goals. Watearth performed BMP optimization modeling for this project using SUSTAIN. The conceptual project layout is used to capture long-term stormwater into a storage unit which is connected to another filtration basin. From the storage unit, captured stormwater is used for irrigating each drainage area along the project area. The size for storage and infiltration units in each drainage area is optimized based on the availability of space, pollutant reduction, and captured stormwater volume available to meet the irrigation demand. The input and output files of SUSTAIN are presented in **Appendix E**. The results for the volume needed for storage and infiltration units in each drainage area are listed in **Table 4** below:

Table 4: Storage and Infiltration Gallery Sizes Based on Optimization

Drainage Area	BMP Size (ac-ft)	
	Underground Storage	Infiltration Gallery
Drainage Area 1	3.23	2.04
Drainage Area 2	5.72	4.51
Drainage Area 3	5.00	0.91
Drainage Area 4	7.32	-

SUSTAIN model results indicate that there is no need for an additional infiltration basin in drainage area 4. The storage unit would collect sufficient stormwater to supply the irrigation demand in this zone. Long-term pollutant loading results obtained from the SUSTAIN model are used to calculate the pollutant reductions with the addition of BMPs. The amount of pollutant reductions achieved through the stormwater capture and infiltration units are summarized in **Table 5** on the following page.

Table 5: Percentage of pollutant reduction for long-term simulation

Pollutant	Percentage of Reduction (%)			
	Drainage area 1	Drainage area 2	Drainage Area 3	Drainage Area 4
Total Suspended Solids (TSS)	88.67	88.77	99.68	100
Total Nitrogen (TN)	91.41	91.31	99.79	100
Total Phosphorous (TP)	89.03	89.50	99.81	100
Cadmium (Cd)	88.64	89.13	99.82	100
Copper (Cu)	88.67	89.16	99.80	100
Lead (Pb)	89.06	89.70	99.89	100
Zinc (Zn)	88.57	88.92	99.73	100

Conclusions and Recommendations

Watearth concluded the following based on hydrology and water quality modeling and has the following recommendations for the sizing storage and infiltration units.

1. **Peak flow**: Watearth has performed a hydrologic analysis for each drainage area to determine peak flow and runoff volume. The lowest peak flow rate is 2.8 cfs for irrigation for zone 4 for the 85^{th} percentile storm event, while the highest peak flow rate is 8.6 cfs for drainage area 2 for 85^{th} percentile storm event. Watearth concludes that this project will capture the 85^{th} percentile to be infiltrated and used on-site. Peak flows for other design storm events were also analyzed as part of this memorandum.
2. **Stormwater capture**: Watearth has located one possible storage area in each drainage area to capture and infiltrate stormwater in the project area.
3. **Pollutant reduction**: Long-term continuous simulation results were analyzed to determine the pollutant reduction capacity of the recommended BMP size. Long-term analysis shows more than 88% average pollutant reduction for the recommended BMP configuration.
4. **BMP optimization results**: Watearth has determined the optimal size of both the underground storage unit and the size of the infiltration gallery in each drainage area based on irrigation demand, available area, and pollutant reduction using SUSTAIN. Watearth recommends using 3.23 Ac-ft, 5.72 ac-ft, 5.00 ac-ft, and 7.32 ac-ft for drainage areas 1 through 4 respectively. Watearth also recommend using 2.04 ac-ft, 4.51 ac-ft, and 0.91 ac-ft of Infiltration Gallery for drainage areas 1 to 3, respectively.
5. **Discharge to Sanitary Sewer**: Watearth recommends revision of the models when maximum capacity information is received from LACSD and/or LABOS. The results presented in this memorandum are preliminary and will be updated as more information is received.

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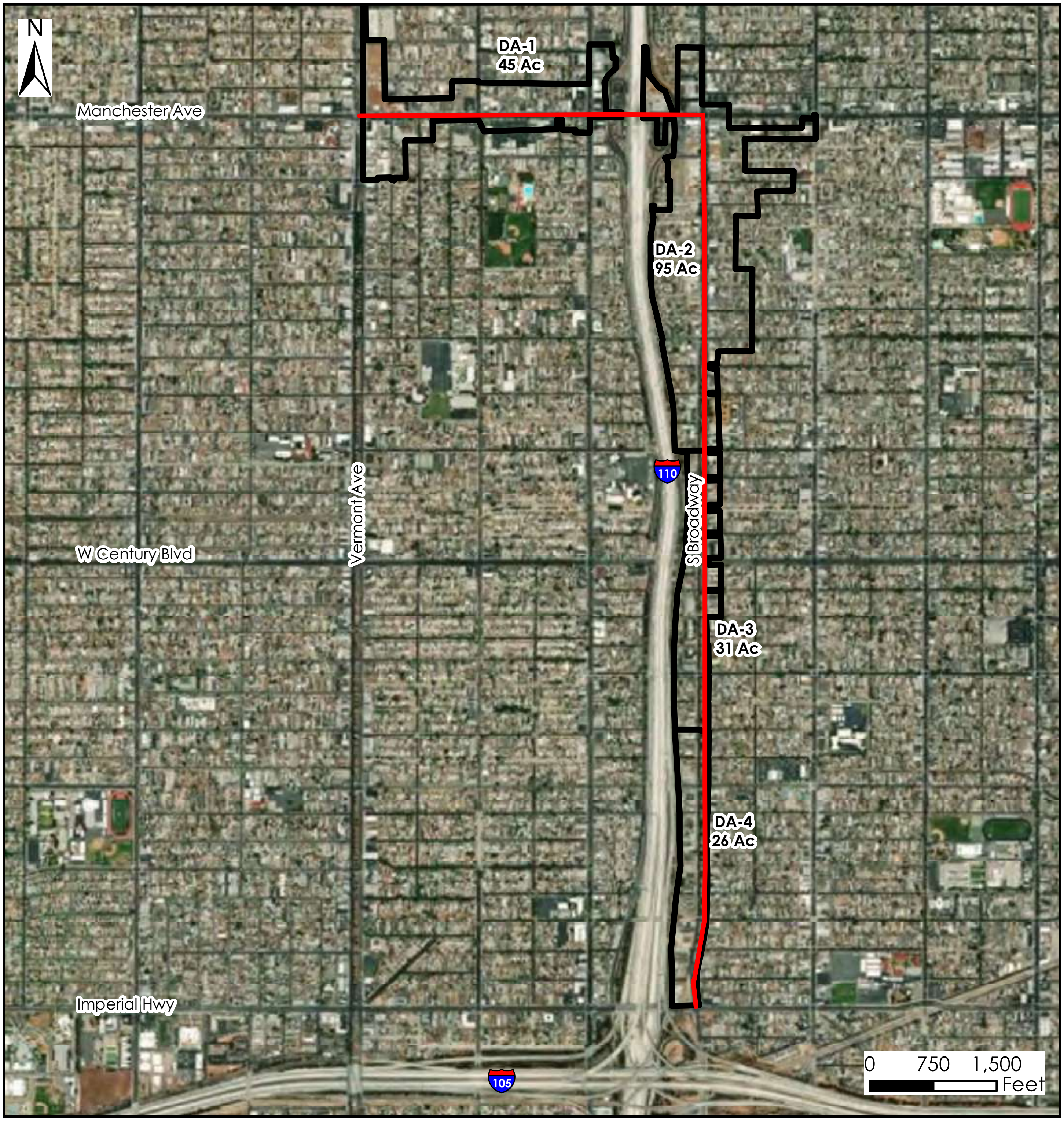
United States Geological Survey, The National Map, https://apps.nationalmap.gov/downloader/#/, Accessed 8-18-2021

WMMS 2.0 Manual – Phase I Report Baseline Hydrology and Water Quality. May 2020

Exhibits

Appendices

Exhibits



City of Los Angeles Broadway and Manchester Water Demand and Supply Task Order

Exhibit 1 - Drainage Area Map

Watearth

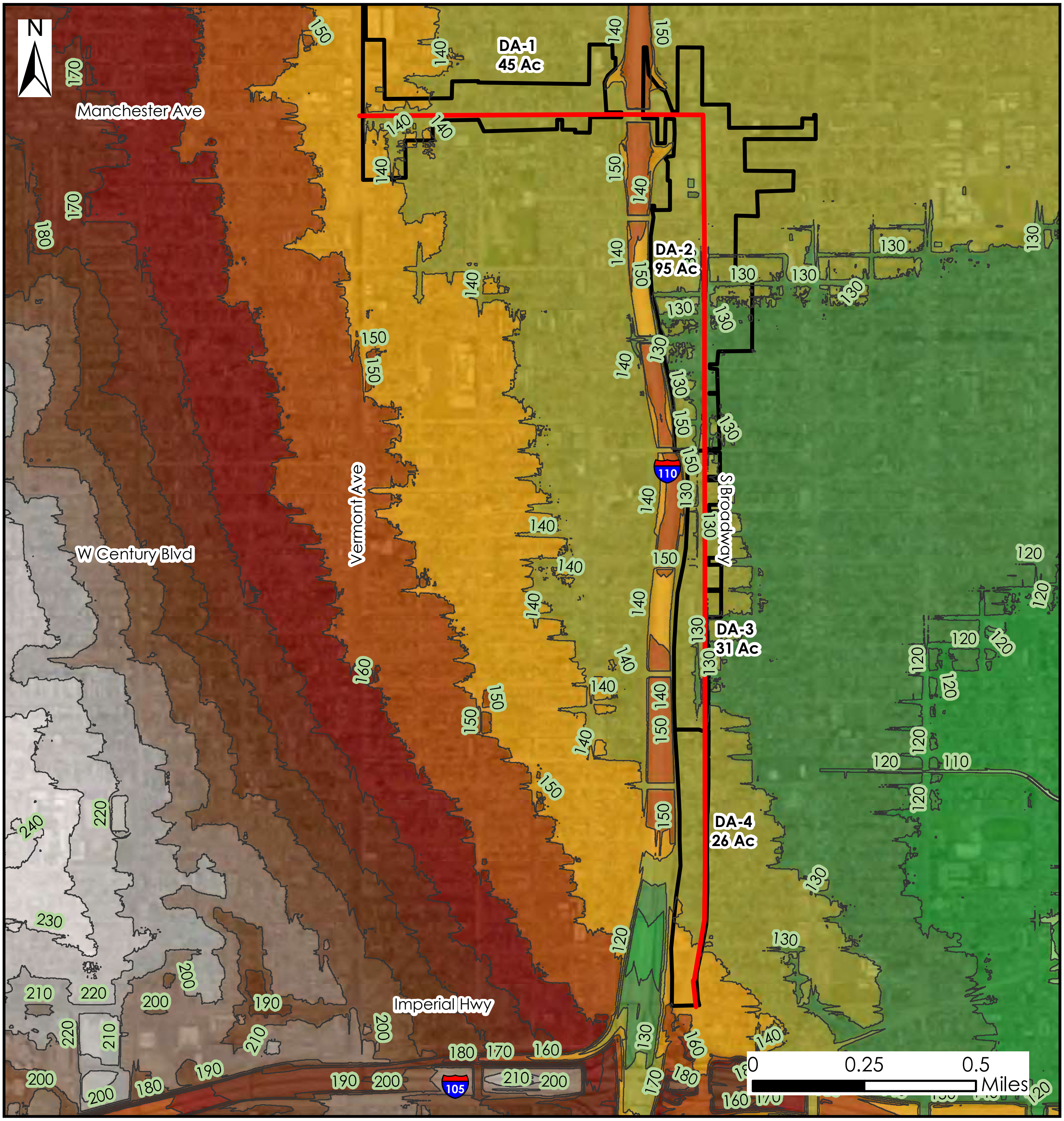
Legend

Project Area

Drainage Area

21-260.0
A. LePera - July 14, 2022

Datum: NAD83, Units: US Feet
Sources: Google Earth, LA County



City of Los Angeles Broadway and Manchester Water Demand and Supply Task Order

Exhibit 2 - Topographic Map

Watearth

Legend

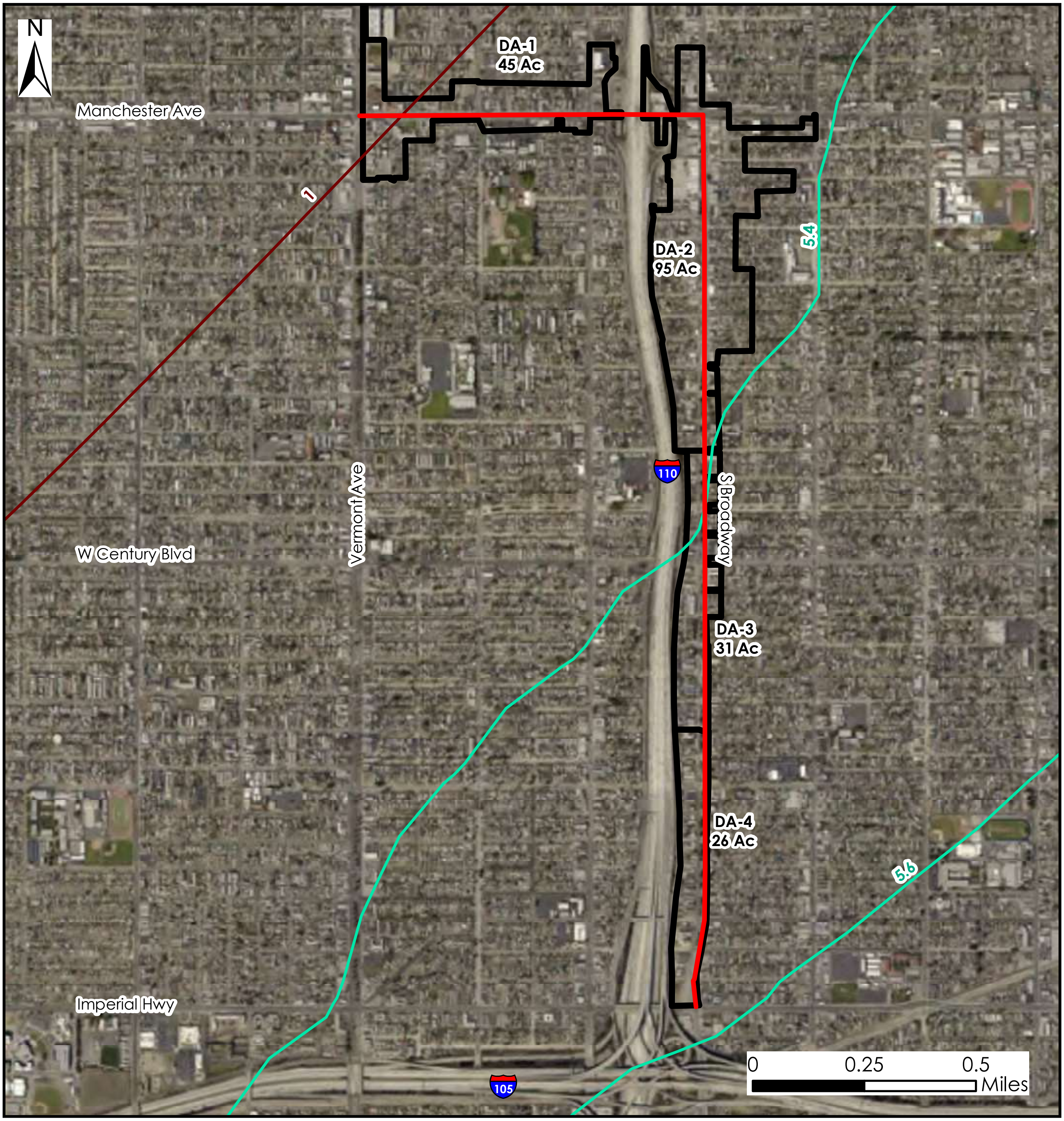
- Project Area
- 10-Foot Contour Line
- Drainage Area

Elevation (Feet)

70 - 80	120 - 130	170 - 180	220 - 230
80 - 90	130 - 140	180 - 190	230 - 240
90 - 100	140 - 150	190 - 200	
100 - 110	150 - 160	200 - 210	
110 - 120	160 - 170	210 - 220	

21-260.0
A. LePera - July 14, 2022

Datum: NAD83, Units: US Feet
Sources: Google Earth, LA County



City of Los Angeles Broadway and Manchester Water Demand and Supply Task Order

Exhibit 3 - Rainfall Map

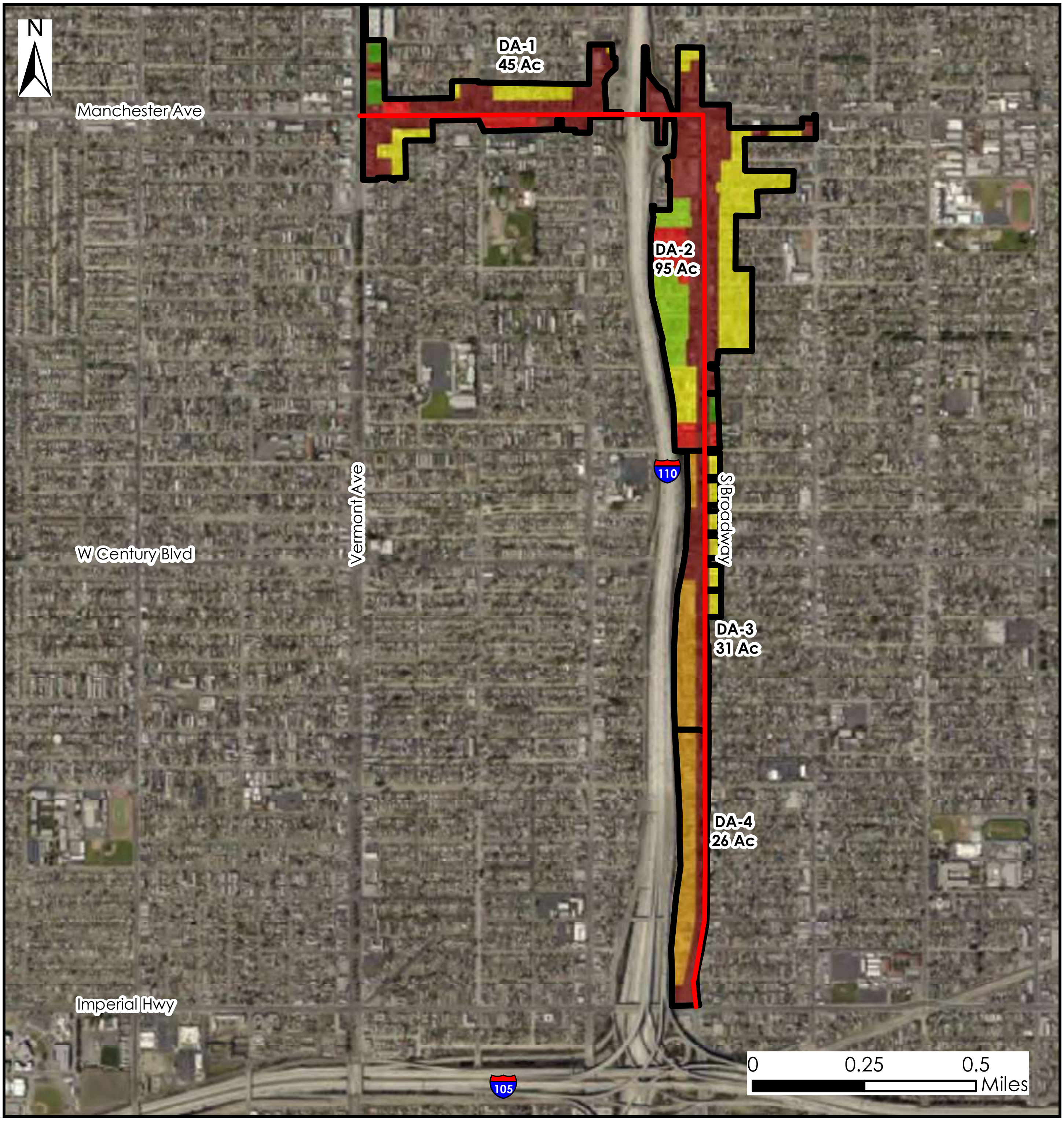
Watearth

Legend

- Project Area
- 85th-Percentile Rainfall
- 50-year 24-hour Rainfall
- Drainage Area

21-260.0
A. LePera - July 14, 2022

Datum: NAD83, Units: US Feet
Sources: Google Earth, LA County



City of Los Angeles Broadway and Manchester Water Demand and Supply Task Order

Exhibit 4 - Impervious Cover Map

Watearth

Legend

Project Area

Drainage Area

Impervious Cover

< 10%

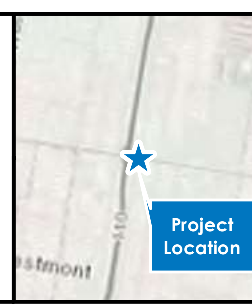
40 - 50%

50 - 60%

70 - 80%

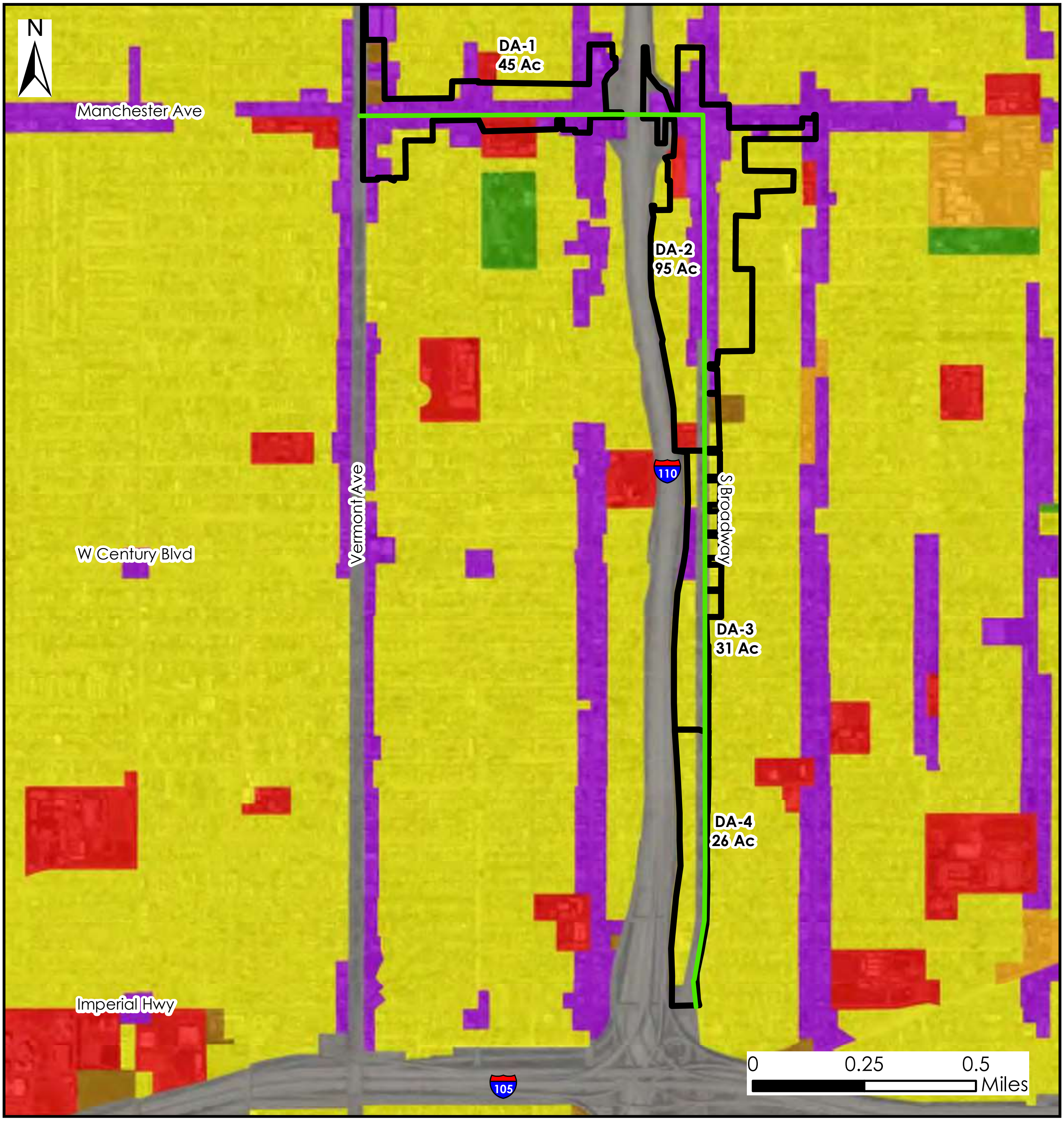
80 - 90%

> 90%



21-260.0
A. LePera - July 14, 2022

Datum: NAD83, Units: US Feet
Sources: Google Earth, LA County



City of Los Angeles Broadway and Manchester Water Demand and Supply Task Order

Exhibit 5 - Land Use Map

Watearth

Legend

Project Area

Drainage Area

LA County Land Use

Commercial

Institutional

Parks and Open Space

Residential

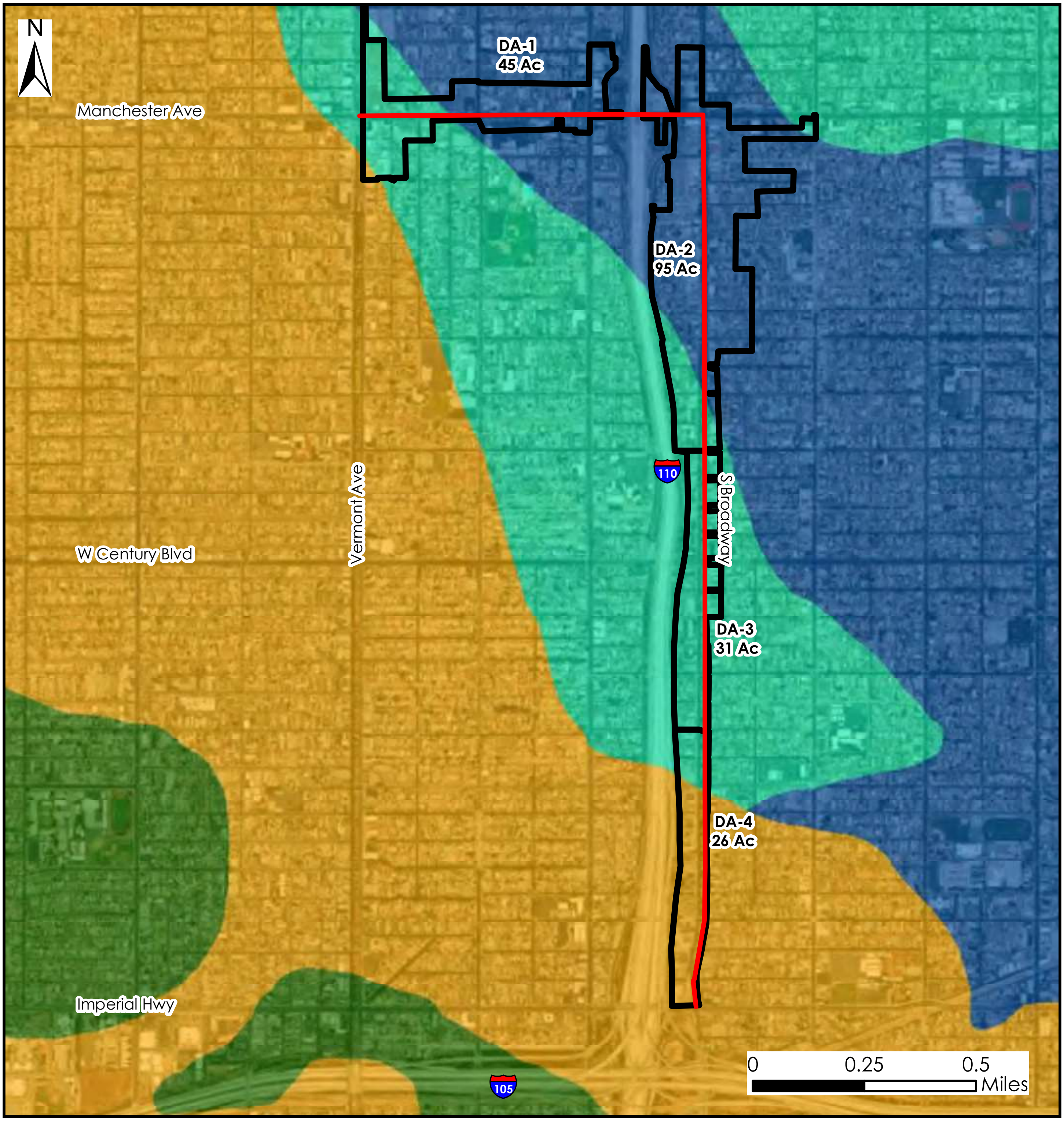
Industrial

Vacant

Transportation

21-260.0
A. LePera - July 13, 2022

Datum: NAD83, Units: US Feet
Sources: Google Earth, LA County



City of Los Angeles Broadway and Manchester Water Demand and Supply Task Order

Exhibit 6 - LA County Soil Group Map

Watearth

Legend

Project Area

Drainage Area

LA County Soil

003 - Chino Silt Loam

006 - Hanford Fine Sandy Loam

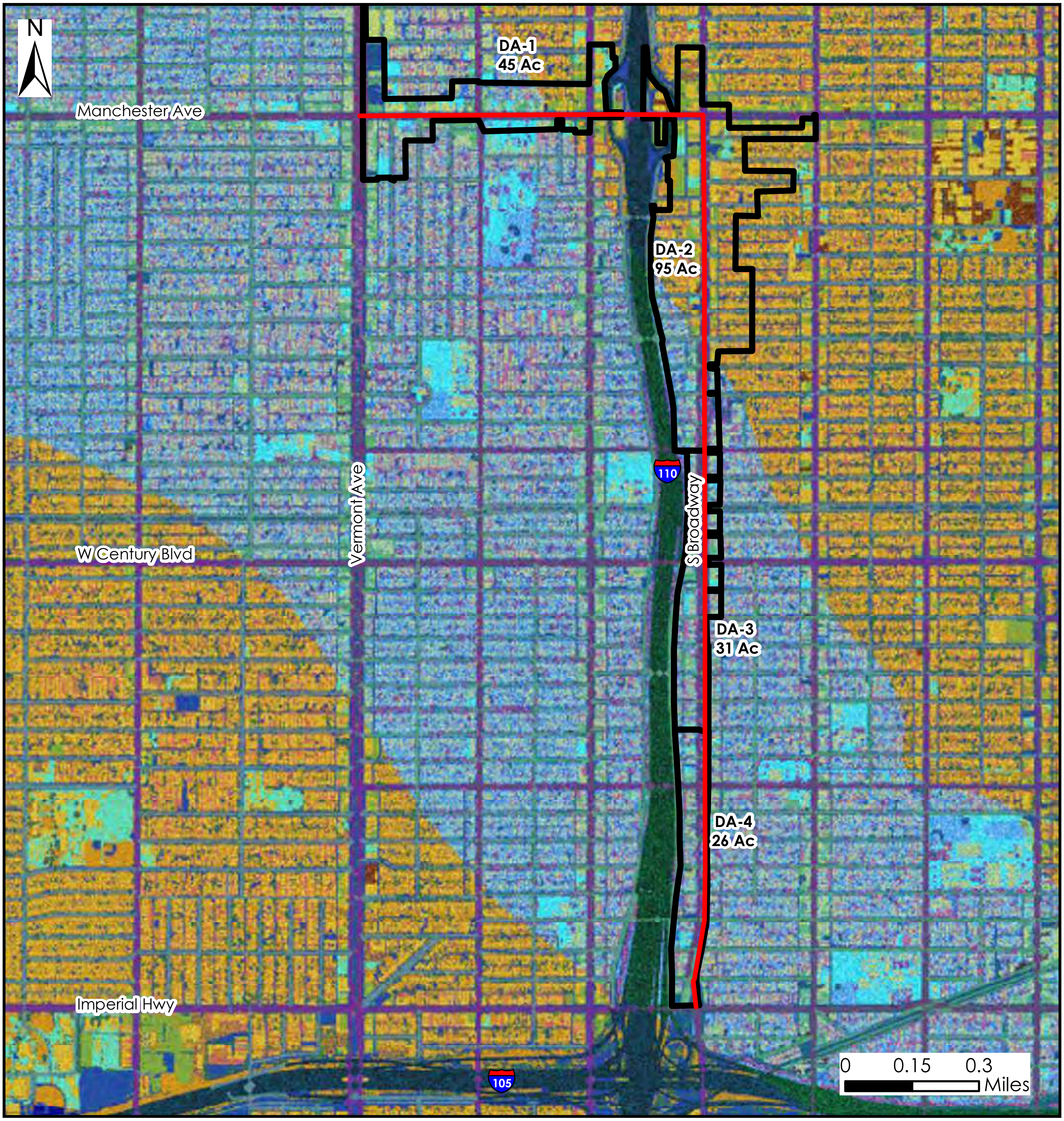
009 - Montezuma Clay Adobe

013 - Ramona Loam

Project Location

21-260.0
A. LePera - July 13, 2022

Datum: NAD83, Units: US Feet
Sources: Google Earth, LA County



City of Los Angeles Broadway and Manchester Water Demand and Supply Task Order

Exhibit 7 - Complete WMMS2 Hydrologic Response Unit Map

Watearth

Legend

Project Area
Drainage Area

Hydrologic Response Unit

1,000
2,000
3,000
4,000
5,000
6,000
7,000
8,000
9,000
10,000
11,311
11,411
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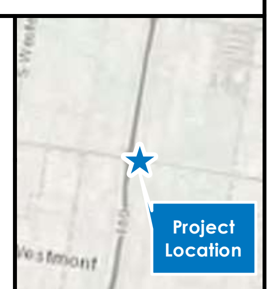
14,421
15,321
15,421

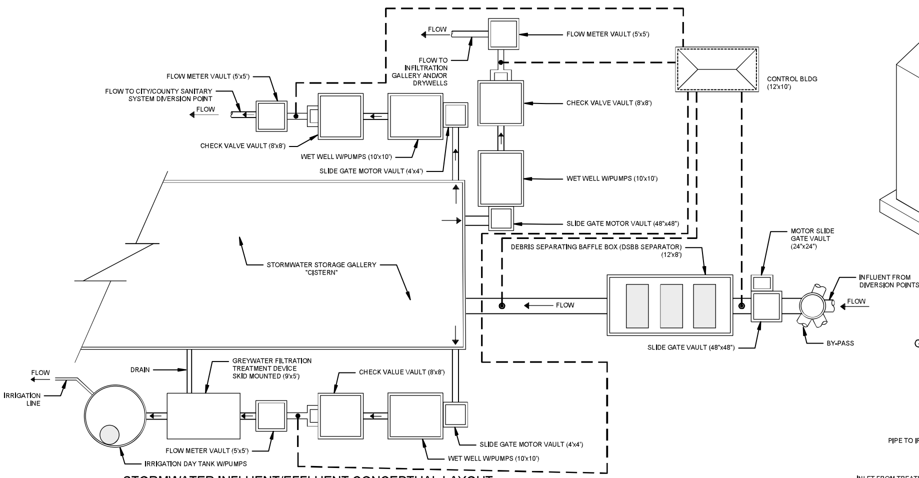


21-260.0
A. LePera - August 24, 2022

Datum: NAD83, Units: US Feet
Sources: Google Earth, LA County

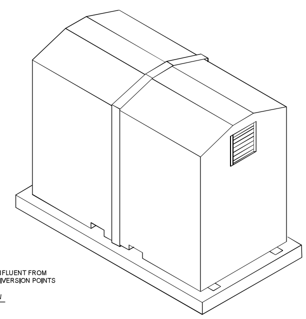
Appendix A

Conceptual Site Details

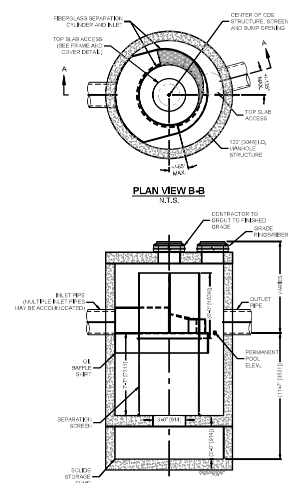


STORMWATER INFLUENT/EFFLUENT CONCEPTUAL LAYOUT

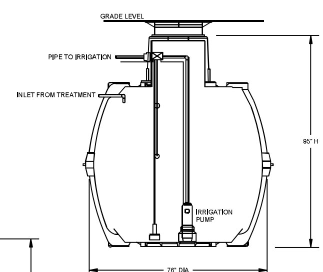
SCHEMATIC AND DETAILS SUBJECT TO CHANGE AS DESIGN PROGRESS



GREYWATER FILTRATION TREATMENT DEVICE MOUNTED ON SKIDS



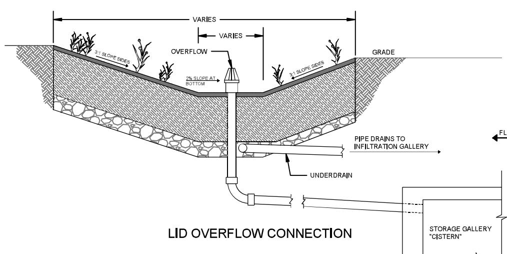
CDS SEPARATOR



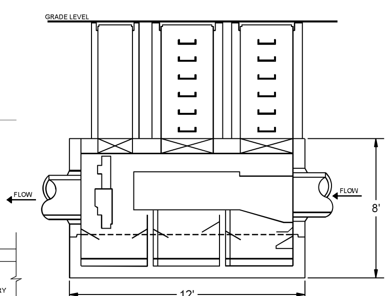
1,700 GAL IRRIGATION DAY TANK

FINAL SIZE TBD BASED ON CALCULATIONS

IRRIGATION DAY TANK SIZES		
TANK CAPACITY	DIAMETER	HEIGHT
1,700 GAL	76 IN	95 IN
2,000 GAL	90 IN	93 IN
5,000 GAL	102 IN	152 IN
10,000 GAL	142 IN	165 IN
15,500 GAL	141 IN	244 IN



LID OVERFLOW CONNECTION



DEBRIS SEPARATING BAFFLE BOX (DSBB SEPARATOR)

TBD IN FINAL DESIGN

COUNCIL DISTRICT 8
SERVING THE SOUTH LA COMMUNITY

STREETS LA

Watearth

3371 GLENDALE BLVD, STE 101
LOS ANGELES, CA, 90039
213.465.8350
WATEARTH @ WATEARTH.COM

NO.	REVISION	REVISED BY	APPROVED BY	DATE

PRELIMINARY
NOT FOR CONSTRUCTION, BIDDING, OR PERMITTING.
FOR REVIEW ONLY
JENNIFER J. WALKER
PE C77079
WATEARTH, INC.
JULY 22, 2022

CITY OF LOS ANGELES
BROADWAY - MANCHESTER
EQUITY PROJECT

CONCEPTUAL SITE DETAILS

DWG SW-1
SHEET 1 OF 1

Appendix B

Geotechnical Report

Earth Mechanics, Inc.

Geotechnical & Earthquake Engineering

GEOTECHNICAL DATA REPORT FOR BEST MANAGEMENT PRACTICE DEVICES BROADWAY-MANCHESTER ATP EQUITY PROJECT CITY OF LOS ANGELES, LOS ANGELES COUNTY, CALIFORNIA

Prepared for:
Kimley-Horn & Associates, Inc.
660 S. Figueroa Street, Suite 2050
Los Angeles, CA 90017

Prepared by:

Earth Mechanics, Inc.
17800 Newhope Street, Suite B
Fountain Valley, California 92708

EMI Project Number: 21-169

May 27, 2022

May 27, 2022

EMI Project No. 21-169

Kimley-Horn & Associates, Inc.
660 S. Figueroa Street, Suite 2050
Los Angeles, CA 90017

Attention: Mr. Robert Blume, P.E.

Subject: ***Geotechnical Data Report for Best Management Practice (BMP) Devices***
Broadway-Manchester ATP Equity Project
City of Los Angeles, California

Dear Mr. Blume,

Attached is our Geotechnical Data Report for the subject project in the City of Los Angeles documenting our field testing and soil infiltration data evaluation and recommendations to assist in selection and design of the proposed BMP devices.

We appreciate the opportunity to provide geotechnical services for the project. If you have any questions, please call this office.

Sincerely,
EARTH MECHANICS, INC.

REGISTERED PROFESSIONAL ENGINEER
DANE NICKLAUS
NO. C84266
EXP. 9-30-2023
CIVIL
STATE OF CALIFORNIA

Dane Nicklaus, PE
Project Engineer

REGISTERED PROFESSIONAL ENGINEER
MIKE KAPUSKAR
No. GE2564
Expires 12-31-22
GEOTECHNICAL
STATE OF CALIFORNIA

Mike Kapuskar, PE, GE
Project Manager

DN:mk

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TABLES

FIGURES

APPENDICES

1.0 INTRODUCTION

1.1 Purpose and Scope of Work

This Data Report documents the findings of our geotechnical field investigation and site assessment performed for the Broadway-Manchester ATP Equity Project. The project includes numerous improvements along S. Broadway and Manchester Avenue, which include 11 proposed drywell locations. The project alignment is in the City of Los Angeles, California (see Figure 1). The purpose of the field investigation was to classify the subsurface soils, determine the soil infiltration rates, and identify the depth to groundwater for design of the proposed infiltration devices.

EMI's scope of work consisted of the following tasks:

- Performing a geotechnical field exploration consisting of excavating 11 exploratory borings and installing 11 temporary wells to conduct field infiltration tests (Small Diameter Boring for Deep Infiltration Test),
- Observing groundwater depths to determine groundwater levels and assess BMP device-to-groundwater separation (performed during the geotechnical field investigation),
- Evaluating soil conditions and conducting engineering analysis to estimate soil infiltration rates, and
- Preparing this report, which presents our findings, conclusions, and recommendations.

This work was conducted in general conformance with the practices for BMP evaluation outlined in the Los Angeles County Guidelines for Geotechnical Investigation and Reporting - Low Impact Development Stormwater Infiltration (2021).

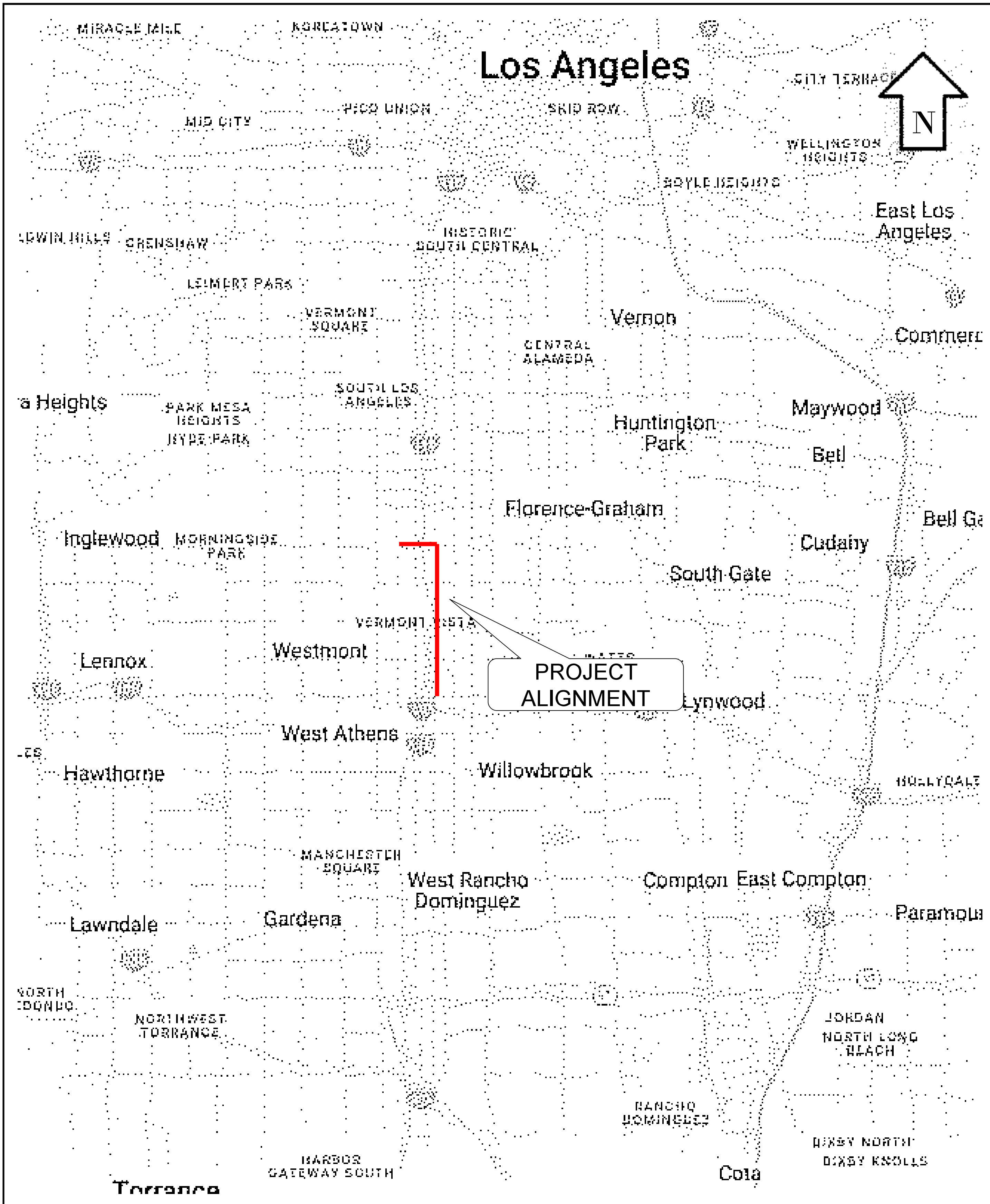
1.2 Site Description and Proposed Development

Based on the project information provided by Kimley-Horn & Associates, Inc. (KHA), improvements are proposed along S. Broadway between Imperial Highway and Manchester Avenue and along Manchester Avenue from Vermont Avenue to Figueroa Street. The proposed improvements consist of numerous general improvements and installing several drywells along S. Broadway and Manchester Avenue to improving drainage along the corridor. KHA has selected 11 BMP sites where infiltration devices are proposed. The BMP site information is provided in Table 1.

Table 1. BMP Site Description

BMP Site #	***Latitude (deg)***	***Longitude (deg)***	***Elevation (ft)***	***Site Location***	***Area Description***	***Ground Cover***	***Device Type***
1	33.96003	-118.29063	136	Manchester Ave. – Near S. Menlo Ave.	Near median area of existing roadway	Paved Road Surface	Drywell
2	33.96004	-118.28752	132	Manchester Ave. – Between Orchard Ave. and Hoover St.		Paved Road Surface	
3	33.96005	-118.28468	131	Manchester Ave. – About 150 ft west of Denver Ave.		Paved Road Surface	
4	33.95170	-118.27828	125	S. Broadway – Between W. 93^{rd} St. and W. 94^{th} St.	Partially Landscaped area within existing median turnout	Unpaved	
5	33.94861	-118.27831	130	S. Broadway – Between W. Colden Ave. and W. 97^{th} St.		Unpaved	
6	33.94615	-118.27826	130	S. Broadway – Between W. 99^{th} St. and W. Century Blvd.		Unpaved	
7	33.94473	-118.27828	131	S. Broadway – Between W. Century Blvd. and W. 101^{st} St.		Unpaved	
8	33.94129	-118.27828	128	S. Broadway – Between W. 104^{th} St. and W. 105^{th} St.		Unpaved	
9	33.93881	-118.27824	131	S. Broadway – Between W. 107^{th} St. and W. 108^{th} St.		Unpaved	
10	33.93577	-118.27826	133	S. Broadway – Between W. 109^{th} St. and W. 109^{th} Pl.		Unpaved	
11	33.93334	-118.27838	135	S. Broadway – Between W. 111^{th} Pl. and W. 112^{th} St.		Unpaved	

Note: Latitude, longitude, and elevations are approximate.



Broadway-Manchester ATP Equity Project	SITE LOCATION MAP
Earth Mechanics, Inc. Geotechnical and Earthquake Engineering	Figure 1
	Project No. 21-169 | Date: May 2022

Broadway – Manchester ATP Equity Project	BORING AND INFILTRATION TEST LOCATIONS	
Earth Mechanics, Inc. Geotechnical and Earthquake Engineering	Figure 2	
	Project No. 21-169	Date: May 2022

Legend

Geotechnical Boring And Infiltration Test Well — A-22-001

Broadway – Manchester ATP Equity Project	BORING AND INFILTRATION TEST LOCATIONS	
Earth Mechanics, Inc. Geotechnical and Earthquake Engineering		Figure 3
	Project No. 21-169	Date: May 2022

Legend

Geotechnical Boring And Infiltration Test Well — A-22-001

Broadway – Manchester ATP Equity Project	**BORING AND INFILTRATION TEST LOCATIONS**
Earth Mechanics, Inc. Geotechnical and Earthquake Engineering	Figure 4
	Project No. 21-169 / Date: May 2022

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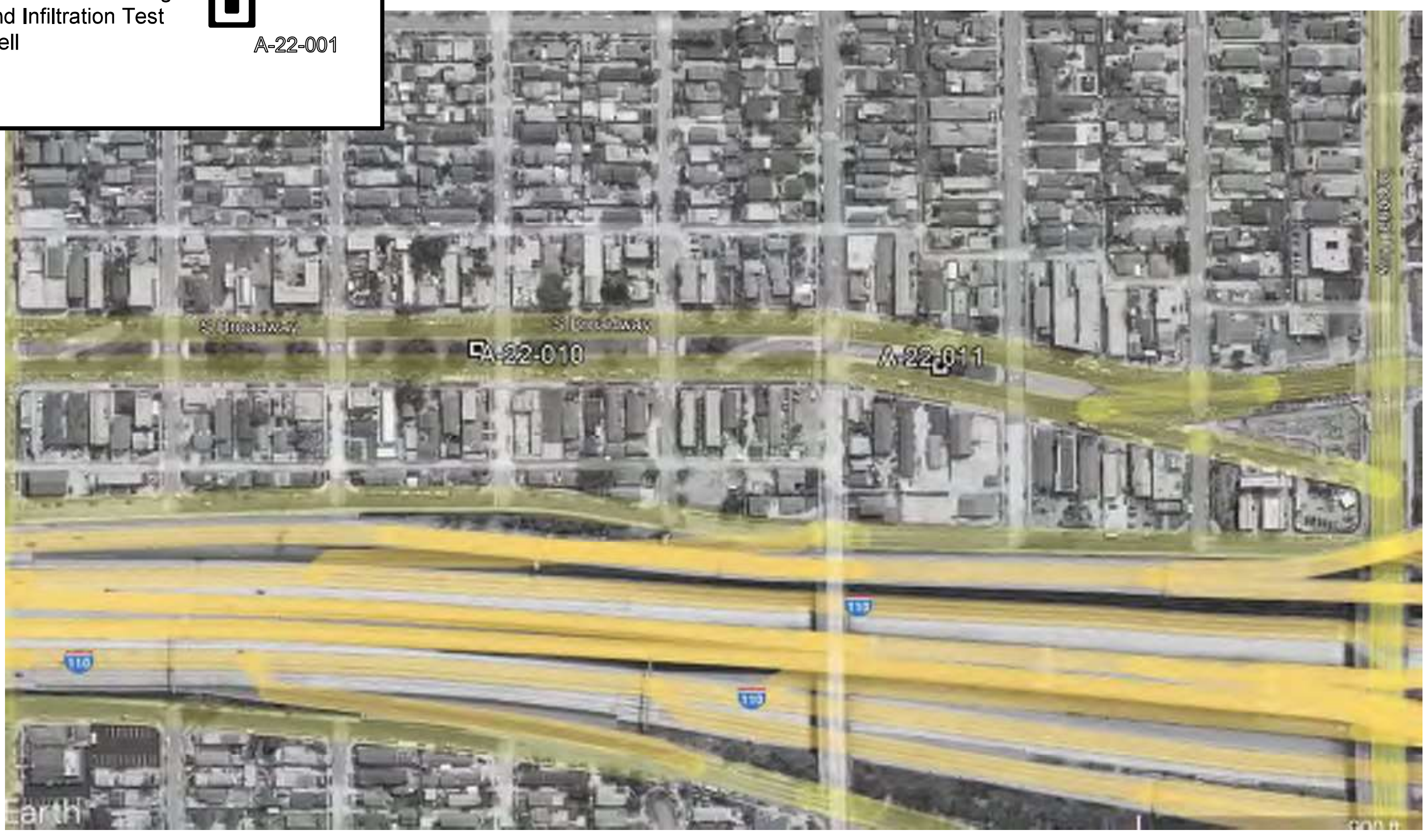
Legend

Geotechnical Boring And Infiltration Test Well — A-22-001



Broadway – Manchester ATP Equity Project	**BORING AND INFILTRATION TEST LOCATIONS**	
Earth Mechanics, Inc. Geotechnical and Earthquake Engineering		Figure 5
	Project No. 21-169	Date: May 2022

2.0 FIELD EXPLORATION AND INFILTRATION TESTING

For the proposed drywells, a geotechnical investigation was performed under the supervision of EMI between April 4 and 22, 2022. The field investigation included excavating and logging eleven geotechnical borings (A-22-001 to 011) and installing eleven temporary wells for conducting in-hole infiltration tests. The approximate locations of the borings and test wells are shown on Figure 2 through Figure 5.

The geotechnical borings were drilled to obtain information on subsurface earth materials and conditions for the proposed improvements. The borings were excavated to a depth of 50 feet below ground surface and the top of boring elevations ranged from 125 feet and 136 feet. Groundwater was encountered in one of the geotechnical borings, A-22-007, at a depth of about 36 feet below ground surface. Groundwater was not encountered within the other ten geotechnical borings excavated for the project. Appendix B can be referred to for the geotechnical boring logs.

Hollow-stem auger borings were drilled using truck-mounted drill rigs (CME 75) equipped with 8" diameter hollow-stem augers. The hand auger borings were drilled using a 3" diameter stainless steel hand auger. Subsurface soils and conditions were logged, and samples of soils were collected for laboratory testing. Soil samples were collected from borings generally at 5-ft intervals alternatively using the Standard Penetration Test (SPT) sampler and the Modified California Drive (MCD) sampler. The SPT sampler is unlined and has an inside diameter of 1.4" and the MCD sampler is lined with a series of 1" tall brass rings with an inside diameter of 2.4". Blowcounts from the SPT and MCD samplers were recorded during the exploration. The samplers were driven into the soil using a 140-lb hammer falling 30" down a total depth of 18" or until refusal. The drill rigs were equipped with an automatic trip safety hammer. The blowcounts for the last 12" or less of penetration and hammer efficiencies are shown on the boring logs in Appendix B. After completion, the borings were backfilled with neat cement slurry and the ground surface was restored.

To estimate the soil infiltration rate for the proposed drywells, test wells were installed near the proposed locations provided by KHA. The test wells were installed within the boreholes that were excavated to collect subsurface soil samples. Test wells were installed to a depth of about 50 feet below existing grade. The test wells were constructed using 40-feet long 2-inch diameter Schedule 40 PVC screen (0.020' slot size) with blank PVC casing extending to the ground surface. The bottom 40 feet of the test wells were backfilled with 3/8-inch pea gravel as the filter medium.

Constant- and falling-head in-hole permeability tests were conducted in general accordance with the Los Angeles County Guidelines for Geotechnical Investigation and Reporting - Low Impact Development Stormwater Infiltration (2021). Water for the infiltration tests was supplied from a 2,000-gallon water truck. The water supply line was connected from the truck to an electronic flow totalizer and then to a ball valve and ¾-inch PVC downtube assembly at the top of the test well. The ball valve was used to adjust flow and maintain the water level at 10 ft below the ground surface. An electronic water-level meter was used to measure the water level within the test well during the test. The flow quantities and water level within the test well were monitored and recorded for a minimum of 3 hours. After completion of the tests, the PVC pipe was removed, the test wells were backfilled with neat cement slurry, and the ground surface was restored.

Soil infiltration rates from the test wells were evaluated using methods described in the Los Angeles County Guidelines for Geotechnical Investigation and Reporting - Low Impact Development Stormwater Infiltration (2021).

A summary of the key test data is shown in Table 2 and Table 3. The infiltration test data is attached in Appendix A. The infiltration test locations are shown on Figure 2 through Figure 5. The locations shown are approximated based on physical measurements from identifiable features. Approximate existing ground surface elevations were obtained from Google Earth Pro (2022).

Table 2. Field Exploration Information

BMP Site #	*Test Location ID*	*Approx. Ground Surface Elevation (ft)*	*Borehole*	*Borehole Depth (ft)*	*Test Well Depth Interval (ft)*	*Groundwater Depth (ft)*	*Depth to Impermeable Layer / Slow Infiltration (ft)*
1	I-1	136	A-22-001	50	10 to 50	>50	>50
2	I-2	134	A-22-002	50	10 to 50	>50	40
3	I-3	130	A-22-003	50	10 to 50	>50	>50
4	I-4	125	A-22-004	50	10 to 50	>50	40
5	I-5	128	A-22-005	50	10 to 50	>50	45
6	I-6	130	A-22-006	50	10 to 50	>50	45
7	I-7	130	A-22-007	50	10 to 50	36.2	30
8	I-8	128	A-22-008	50	10 to 50	>50	28
9	I-9	132	A-22-009	50	10 to 50	>50	40
10	I-10	136	A-22-010	50	10 to 50	>50	35
11	I-11	136	A-22-011	50	10 to 50	>50	40

3.0 SUBSURFACE CONDITIONS

3.1 Soil Types

Earth materials encountered during the field investigation consisted of alluvial soils. Soil types were determined by visual inspection of samples during drilling and are summarized in Table 3 using the Uniform Soil Classification System (USCS) and Hydrologic Soil Group (HSG) Type. Additional information on soil types can be found in Section 4.1.

3.2 Present and Historical Groundwater

During the geotechnical field investigation by EMI for the project, groundwater was encountered at Borehole A-22-007 at an elevation of about 94 feet, or at a depth of about 36 feet below ground surface. The maximum depth of exploration reached to about elevation 50 feet. Groundwater was not encountered within any other the other boreholes excavated during the field investigation.

Regional well records from the Department of Water Resources Water Data Library (2022) were reviewed for groundwater measurements. Based on a single well found within a 2-mile radius from the project alignment, data shows one groundwater level measurement made in 1995. The well data shows that the historical groundwater level was more than 100 ft below ground surface.

Several boring logs and monitoring well logs are available on the Geotracker website (2022) from nearby environmental sites. Monitoring well logs from a site near the intersection of S. Broadway and Manchester Ave., near the northern project limit, show groundwater being deeper than 90 ft below ground surface. Borings excavated near W. Century Blvd. and S. Broadway show that groundwater is about 75 ft below ground surface. Near Imperial Hwy and S. Broadway, near the southern project limit, data shows that groundwater is deeper than 80 ft below ground surface.

Per California Geological Survey (CGS, 2006) map for the Inglewood Quadrangle, the depth to historical groundwater at the project site is from 10 ft to 50 ft below ground surface.

Based on available information and information collected during the recent field investigation, groundwater is generally deeper than 50 feet below ground surface at the site. However, groundwater was encountered at a depth of 36 feet below ground surface at Borehole A-22-007, indicating that groundwater can vary within the project alignment.

It should be noted, though, that soil moisture content and groundwater elevation can fluctuate due to variations in seasonal rainfall, nearby irrigation, changes to or addition of flood control improvements, groundwater injection or extraction activities, construction activities, or numerous other man-made or natural conditions.

3.3 Potential for Hydroconsolidation

Hydroconsolidation occurs when soil layers collapse (settle) when water is added under loads. Natural deposits susceptible to hydroconsolidation are typically aeolian, alluvial, or colluvial materials with high apparent dry strength.

Standard Penetration Test (SPT) blowcounts recorded in the existing alluvium during the geotechnical field investigation show generally medium dense to dense granular soils and medium stiff to stiff silts and clays. Hydroconsolidation is not anticipated to impact the proposed infiltration devices or nearby existing structures.

4.0 BMP SITE EVALUATION

4.1 Soil Infiltration Rates

Soil infiltration rates from the well infiltration tests were evaluated using the method described in the Guidelines for Geotechnical Investigation and Reporting - Low Impact Development Stormwater Infiltration (LA County, 2021). The measured infiltration rates are provided in Table 3. It should be noted that the presented design infiltration rates are unfactored.

Table 3. BMP Site Evaluation Summary

BMP Site #	*Location*	*Approx. GSE (ft)*	*Approx. GWD below FG (ft)*	*Controlling Soil Types*			*Design Infiltration Rates*	
				USCS	*HSG*	*Unit*	*Test Depth below FG (ft)*	*Averaged Rate (in/hr)*
1	Manchester Ave. – Near S. Menlo Ave.	136	>50	SM	A	Alluvium	10 - 25	2.5
				CL	B	Alluvium	25 - 50	0.3
2	Manchester Ave. – Between Orchard Ave. and Hoover St.	134	>50	SM	A	Alluvium	10 - 30	2.5
				ML	B	Alluvium	30 - 40	0.3
3	Manchester Ave. – About 150 ft west of Denver Ave.	130	>50	SM/ SP-SM	A	Alluvium	10 - 40	2.5
				SM/ ML	A	Alluvium	40 - 50	1.0
4	S. Broadway – Between W. 93rd St. and W. 94th St.	125	>50	SC/SM	A	Alluvium	10 - 25	2.0
				CL/ML	B	Alluvium	25 - 40	0.3
5	S. Broadway – Between W. Colden Ave. and W. 97th St.	128	>50	SM/ML	B	Alluvium	10 - 45	0.3
6	S. Broadway – Between W. 99th St. and W. Century Blvd.	130	>50	SP-SM/ SM	A	Alluvium	10 - 40	0.5
				CL	C	Alluvium	40 - 45	0.1
7	S. Broadway – Between W. Century Blvd. and W. 101st St.	130	36.2	SP-SM	A	Alluvium	10 - 25	2.5
				CL/ML	A	Alluvium	25 - 30	0.5
8	S. Broadway – Between W. 104th St. and W. 105th St.	128	>50	SP-SM	A	Alluvium	10 - 28	2.0
9	S. Broadway – Between W. 107th St. and W. 108th St.	132	>50	CL/ML	B	Alluvium	10 - 40	0.3
10	S. Broadway – Between W. 109th St. and W. 109th Pl.	136	>50	SP-SM/ SM	A	Alluvium	10 - 30	0.5
				CL	C	Alluvium	30 - 35	0.1
11	S. Broadway – Between W. 111th Pl. and W. 112th St.	136	>50	CL/ML/ SM	A	Alluvium	10 - 40	0.5

Notes:
GSE is an approximate existing ground surface elevation at BMP site and boreholes based on available data.
GWD is the highest groundwater depth below GSE of BMP site based on available groundwater data.
Soil types are predominant soil classifications within the depth explored.
HSG = Hydrologic Soil Group; USCS = Unified Soil Classification System.

Based on observations from the field investigation, the subsurface profile along Manchester Avenue is predominantly coarse-grained material, e.g., silty sand, clayey sand, and poorly graded sand, that has thinly interbedded layers of clay and silt within the upper 30 to 35 feet below ground surface. Below about 35 feet, fine-grained materials became more predominant within the soil borings.

The soils encountered along South Broadway during the geotechnical field investigation were observed to be predominantly coarse-grained material with clay and silt interbeds of varying thickness within the upper 35 to 40 feet below ground surface. Below a depth of about 40 feet, the soils become predominantly fine-grained.

4.2 Groundwater Separation and BMP Feasibility

Groundwater was encountered at a depth of about 36 feet below ground surface at one borehole, A-22-007, during EMI's field investigation. Groundwater was not encountered within any of the other ten boreholes drilled. Historic groundwater levels range from about 10 to 50 feet below ground surface.

Per the Los Angeles County Guidelines for Geotechnical Investigation and Reporting - Low Impact Development Stormwater Infiltration (2021), there is a 10-ft minimum vertical separation requirement between the base of the BMP device and highest seasonal groundwater level.

4.3 Reduction Factors

A reduction factor (RF) should be applied to the unfactored infiltration rates provided in Table 3. The reduction factor is intended to reduce the design values to represent long-term performance of the proposed infiltration devices. The total reduction factor is given based on the values provided in Table 4 and the LA County guidelines (2021). An RF = 3 is recommended based on information collected during the site-specific geotechnical investigation and assuming satisfactory long-term device maintenance. The RF assumes $RF_t = 1$, $RF_v = 1$, and $RF_s = 1$.

Table 4. Reduction Factors

Type of Factor	*Range of Values*
Small Diameter Boring	$RF_t = 1$ to 3
Site Variability, number of tests, and thoroughness of subsurface investigation	$RF_v = 1$ to 3
Long-term siltation, plugging, and maintenance	$RF_s = 1$ to 3

Total Reduction Factor, $RF = RF_t + RF_v + RF_s$
Design Infiltration Rate = Unfactored Infiltration Rate / RF

5.0 CONCLUSIONS AND RECOMMENDATIONS

This report presents the results of an evaluation of the soil and groundwater conditions at the Broadway-Manchester ATP Equity Project in the City of Los Angeles based on a geotechnical field investigation with in-hole permeability testing. The purpose of the evaluation was to assist KHA in assessing the feasibility of the site for BMP devices that are proposed as part of the project improvements.

The soil types encountered and observed infiltration rates are presented in Table 3. Appendix A presents the infiltration test data and analysis results for the project site. Based on observations from the field investigation, the subsurface profile along Manchester Avenue is predominantly coarse-grained material, e.g. silty sand, clayey sand, and poorly graded sand, that has thinly interbedded layers of clay and silt within the upper 30 to 35 feet below ground surface. Below about 35 feet, fine-grained materials became more predominant within the soil borings. The soils encountered along South Broadway during the geotechnical field investigation were observed to be predominantly coarse-grained material with clay and silt interbeds of varying thickness within the upper 35 to 40 feet below ground surface. Below a depth of about 40 feet, the soils become predominantly fine-grained.

Groundwater was encountered at borehole A-22-007 at a depth of about 36 feet below ground surface, however, groundwater was not encountered at any of the other exploratory locations during the geotechnical field investigation for the BMP devices. For details of stratigraphy at each borehole, refer to the boring logs provided in Appendix B.

Based on the test results, the range of calculated infiltration rates was <0.1 in/hr to 2.5 in/hr. At all locations, the average infiltration rate was greater than 0.3 in/hr in the soil layers where infiltration occurred.

A minimum Reduction Factor (RF) equal to 3 should be applied to the unfactored design infiltration rates. The RF assumes $RF_t = 1$, $RF_v = 1$, and $RF_s = 1$.

Per the Los Angeles County Guidelines for Geotechnical Investigation and Reporting - Low Impact Development Stormwater Infiltration (2021), the average design infiltration rates for the alluvium soils meet or exceed the minimum design infiltration rate criteria of 0.3 in/hr at all eleven sites. Refer to Table 2 and Table 3 for infiltration test information, unfactored soil infiltration rates, and depth to groundwater or impervious soil layers.

6.0 LIMITATIONS

This report is intended for use by KHA and the City of Los Angeles for the proposed drainage site evaluations for the Broadway-Manchester ATP Equity Project in the City of Los Angeles, California. This report is based on the project as described herein and the information obtained from the exploratory borings at the approximate locations as described on the boring logs. The findings and recommendations contained in this report are based on the results of the field investigation, literature review, and engineering analyses. Also, soils and subsurface conditions encountered in the exploratory borings are presumed to be representative of the project site; however, subsurface conditions and characteristics of soils between exploratory borings can vary. The findings reflect an interpretation of the direct evidence obtained. Recommendations presented herein assume that an appropriate level of quality control and quality assurance (inspections and tests) will be provided during construction. EMI should be notified of any pertinent changes in the project plans or if subsurface conditions are found to vary from those described herein. Modifications to the project plans or variations in subsurface conditions may require re-evaluation of the recommendations contained in this report.

The data, opinions, and recommendations contained herein are applicable to the specific design elements and locations which are the subject of this report. Data, opinions, and recommendations herein have no applicability to any other design elements or to any other locations, and any and all subsequent users accept any and all liability resulting from any use or reuse of the data, opinions, and recommendations without the prior written consent of EMI.

EMI is not responsible for construction means, methods, techniques, sequences, or procedures, or for safety precautions or programs in connection with the construction, for the acts or omissions of the Contractor, or any other person performing any of the construction, or for the failure of any worker to carry out the construction in accordance with the final construction drawings and specifications.

Services performed by EMI were conducted in a manner consistent with that level of care and skill ordinarily exercised by members of the profession currently practicing in the same locality under similar conditions. No other representation, expressed or implied, and no warranty or guarantee is included or intended.

7.0 REFERENCES

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APPENDIX A

INFILTRATION TEST DATA AND CALCULATIONS

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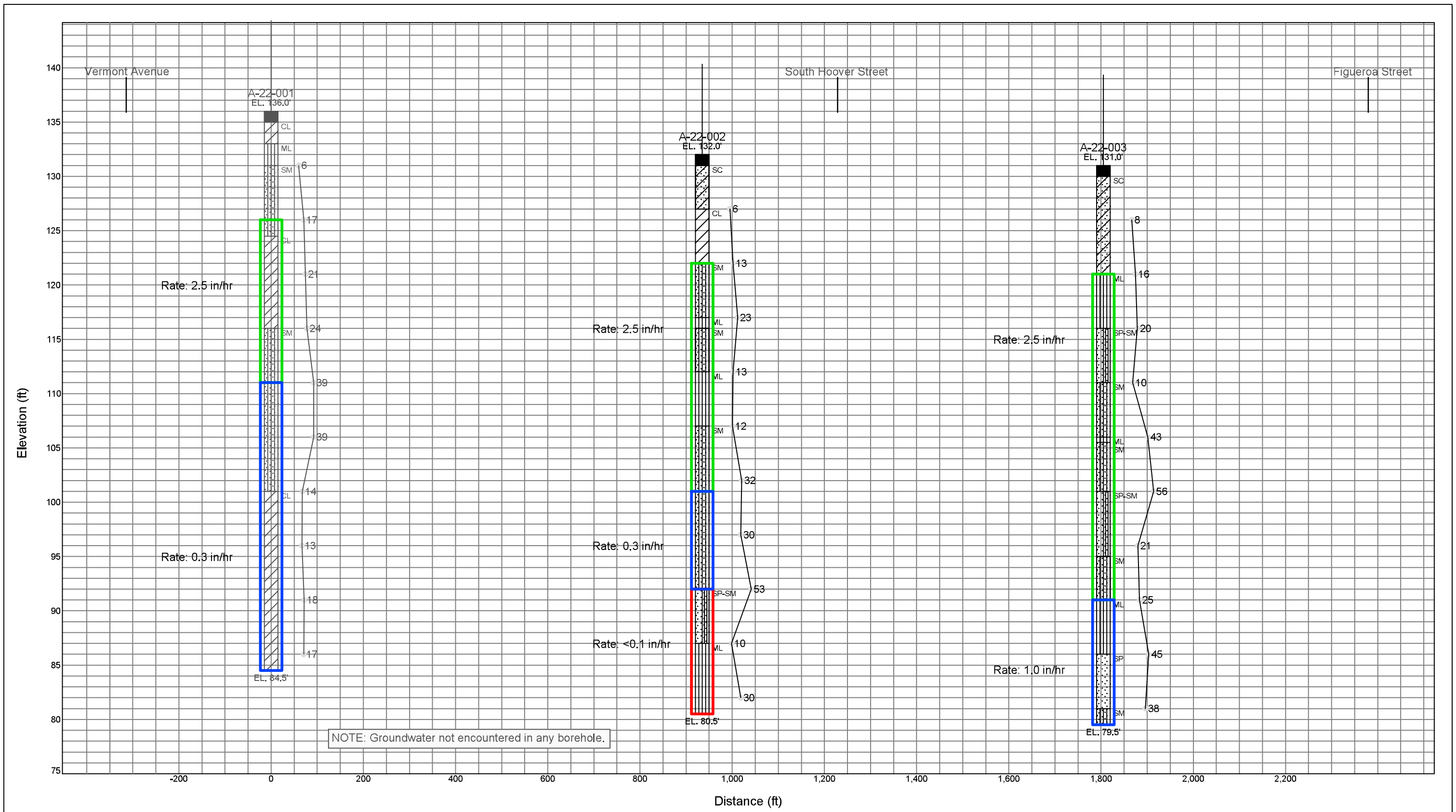
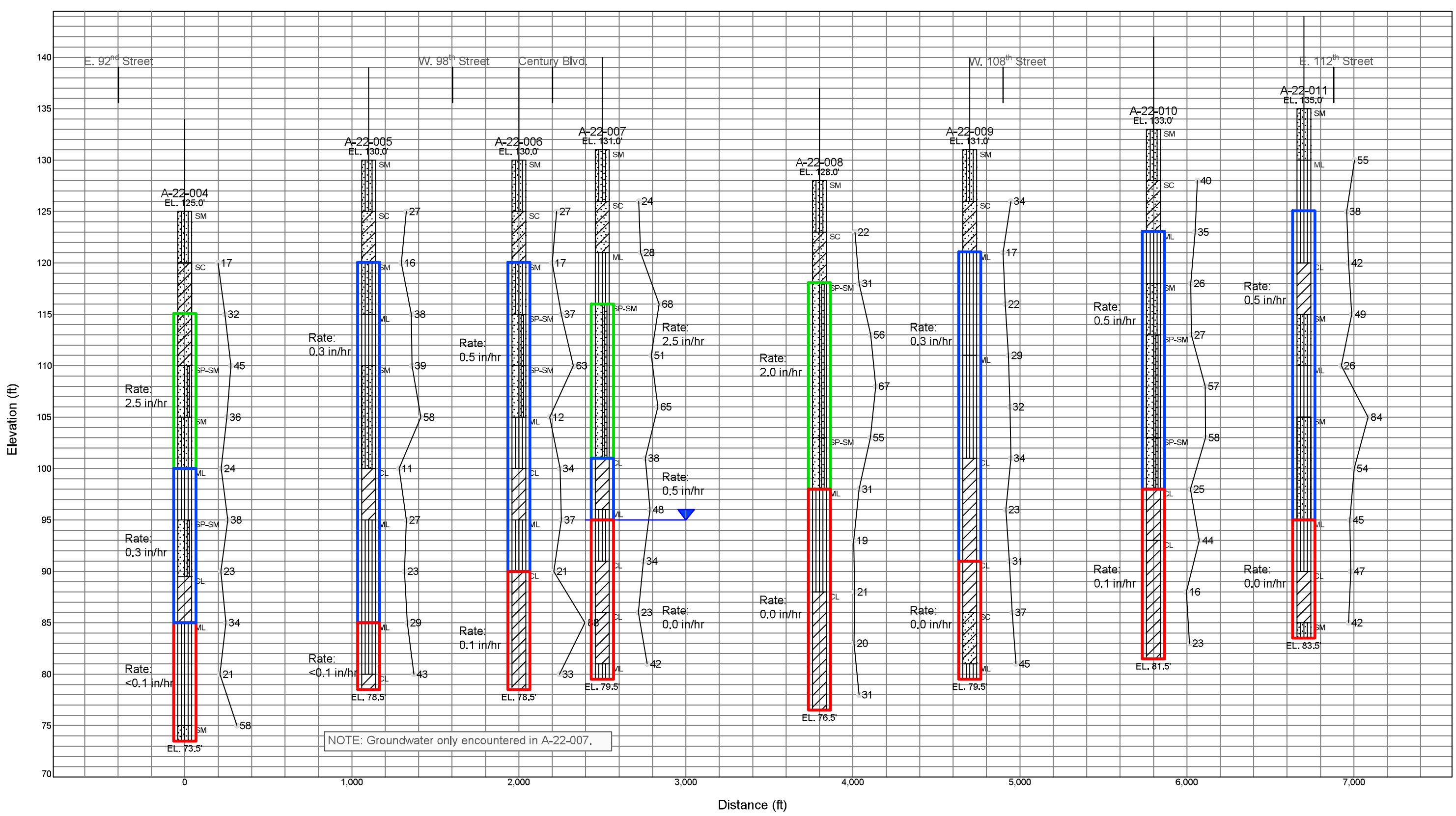


Earth Mechanics, Inc. Geotechnical and Earthquake Engineering	KHA, Broadway- Manchester ATP Dry Wells		Manchester Avenue Unfactored Infiltration Rate Profile
	Project No.: 21-169	DATE: May 2022	



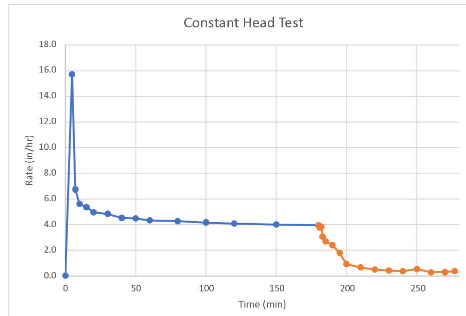
Earth Mechanics, Inc. Geotechnical and Earthquake Engineering	KHA, Broadway- Manchester ATP Dry Wells	South Broadway Unfactored Infiltration Rate Profile
	Project No.: 21-169 / DATE: May 2022	

Location	Well Depth ft	Groundwater ft	Depth to GW or Impervious Layer ft	Layer Depth ft	Unfactored Infiltration Rate in/hr
I-1	50	NE	50	10 - 25 25 - 50	2.5 0.3
I-2	50	NE	40	10 - 30 30 - 40	2.5 0.3
I-3	50	NE	50	10 - 40 40 - 50	2.5 1.0
I-4	50	NE	40	10 - 25 25 - 40	2.0 0.3
I-5	50	NE	45	10 - 45	0.3
I-6	50	NE	45	10 - 40 40 - 45	0.5 0.1
I-7	50	36.2	30	10 - 25 25 - 30	2.5 0.5
I-8	50	NE	28	10 - 28	2.0
I-9	50	NE	40	10 - 40	0.3
I-10	50	NE	35	10 - 30 30 - 35	0.5 0.1
I-11	50	NE	40	10 - 40	0.5

I-1 **Field Infiltration Test Data** Project: **Broaday/Manchester ATP Equity Project**

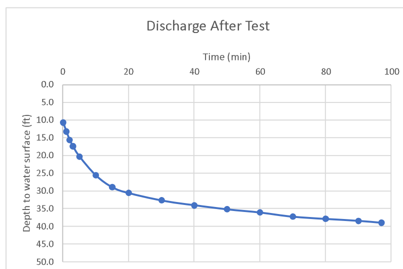
Depth to GW or Impermeable Layer 50
Diameter 8.0 in
Perimeter 2.09 ft

Diameter in	ft	Area ft2	Time	Depth ft	Volume L	Volume gal	Delta min	Time hr	Cumulative Time mim	hr	Delta Vol	Flow gpm	Boring Area	Calc Flow	Infiltration Rate
8	0.67	0.35	9:28	-	0	0	0	0	0	0.00	0	-	-	-	0.0
8	0.67	0.35	9:32	11.0	240	63.4	5	0.08	5	0.08	63.4	13.3	81.7	107.1	15.7
8	0.67	0.35	9:35	10.8	289	76.3	2	0.04	7	0.12	12.9	5.8	82.1	46.1	6.7
8	0.67	0.35	9:38	11.0	343	90.6	3	0.05	10	0.17	14.3	4.8	81.7	38.1	5.6
8	0.67	0.35	9:43	10.9	429	113.3	5	0.08	15	0.25	22.7	4.5	81.9	36.4	5.3
8	0.67	0.35	9:48	10.9	509	134.5	5	0.08	20	0.33	21.1	4.2	81.9	33.9	5.0
8	0.67	0.35	9:58	10.8	665	175.7	10	0.17	30	0.50	41.2	4.1	82.1	33.1	4.8
8	0.67	0.35	10:08	10.8	811	214.2	10	0.17	40	0.67	38.6	3.9	82.1	30.9	4.5
8	0.67	0.35	10:18	10.7	956	252.5	10	0.17	50	0.83	38.3	3.8	82.3	30.7	4.5
8	0.67	0.35	10:28	11.0	1095	289.3	10	0.17	60	1.00	36.7	3.7	81.7	29.5	4.3
8	0.67	0.35	10:48	10.7	1371	362.2	20	0.33	80	1.33	72.9	3.6	82.3	29.2	4.3
8	0.67	0.35	11:08	10.9	1639	433.0	20	0.33	100	1.67	70.8	3.5	81.9	28.4	4.2
8	0.67	0.35	11:28	10.7	1903	502.7	20	0.33	120	2.00	69.7	3.5	82.3	28.0	4.1
8	0.67	0.35	11:58	10.8	2291	605.2	30	0.50	150	2.50	102.5	3.4	82.1	27.4	4.0
8	0.67	0.35	12:28	10.7	2673	706.1	30	0.50	180	3.00	100.9	3.4	82.3	27.0	3.9



Drainage After Testing

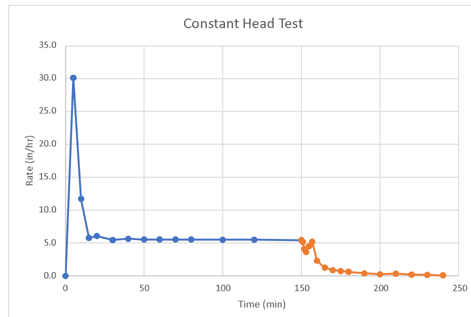
Time	Depth	Volume	Delta T	Delta V	Area	Flow GPM	Flow ft3/hr	Rate
12:30	10.7	47.2	0	0	0.0	0.0	0.0	3.9
12:31	13.2	44.2	1	3.0	77.1	3.0	24.1	3.7
12:32	15.6	41.3	1	2.9	72.0	2.9	23.1	3.8
12:33	17.4	39.1	1	2.2	68.3	2.2	17.3	3.0
12:35	20.3	35.6	2	3.5	62.2	1.7	14.0	2.7
12:40	25.6	29.3	5	6.4	51.1	1.3	10.2	2.4
12:45	29.0	25.2	5	4.1	44.0	0.8	6.5	1.8
12:50	30.6	23.3	5	1.9	40.6	0.4	3.1	0.9
13:00	32.7	20.8	10	2.5	36.2	0.3	2.0	0.7
13:10	34.1	19.1	10	1.7	33.3	0.2	1.3	0.5
13:20	35.2	17.8	10	1.3	31.0	0.1	1.1	0.4
13:30	36.1	16.7	10	1.1	29.1	0.1	0.9	0.4
13:40	37.3	15.2	10	1.4	26.6	0.1	1.2	0.5
13:50	37.9	14.5	10	0.7	25.3	0.1	0.6	0.3
14:00	38.5	13.8	10	0.7	24.1	0.1	0.6	0.3
14:07	39.0	13.2	7	0.6	23.0	0.1	0.7	0.4
Gal/ft	1.2							



I-2 **Field Infiltration Test Data** Project: **Broaday/Manchester ATP Equity Project**

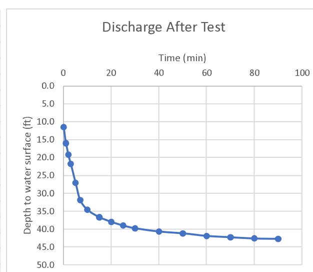
Depth to GW or Impermeable Layer	50	
Diameter	8.0	in
Perimeter	2.09	ft

Diameter in	ft	Area ft2	Time	Depth ft	Volume L	Volume gal	Delta min	Time hr	Cumulative Time mim	hr	Delta Vol	Flow gpm	Boring Area	Calc Flow	Infiltration Rate
8	0.67	0.35	9:55	-	0	0	0	0	0	0.00	0	-	-	-	0.0
8	0.67	0.35	10:00	28.0	273	72.1	5	0.08	5	0.08	72.1	14.4	46.1	115.7	30.1
8	0.67	0.35	10:05	11.6	458	121.0	5	0.08	10	0.17	48.9	9.8	80.4	78.4	11.7
8	0.67	0.35	10:10	11.5	549	145.0	5	0.08	15	0.25	24.0	4.8	80.6	38.6	5.7
8	0.67	0.35	10:15	11.5	645	170.4	5	0.08	20	0.33	25.4	5.1	80.6	40.7	6.1
8	0.67	0.35	10:25	11.4	819	216.4	10	0.17	30	0.50	46.0	4.6	80.8	36.9	5.5
8	0.67	0.35	10:35	11.5	998	263.6	10	0.17	40	0.67	47.3	4.7	80.6	37.9	5.6
8	0.67	0.35	10:45	11.5	1174	310.1	10	0.17	50	0.83	46.5	4.6	80.6	37.3	5.5
8	0.67	0.35	10:55	11.5	1350	356.6	10	0.17	60	1.00	46.5	4.6	80.6	37.3	5.5
8	0.67	0.35	11:05	11.5	1525	402.9	10	0.17	70	1.17	46.2	4.6	80.6	37.1	5.5
8	0.67	0.35	11:15	11.5	1700	449.1	10	0.17	80	1.33	46.2	4.6	80.6	37.1	5.5
8	0.67	0.35	11:35	11.5	2049	541.3	20	0.33	100	1.67	92.2	4.6	80.6	37.0	5.5
8	0.67	0.35	11:55	11.5	2397	633.2	20	0.33	120	2.00	91.9	4.6	80.6	36.9	5.5
8	0.67	0.35	12:25	11.5	2913	769.5	30	0.50	150	2.50	136.3	4.5	80.6	36.4	5.4



Drainage After Testing

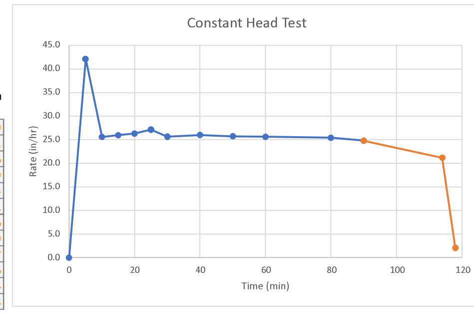
Time	Depth	Volume	Delta T	Delta V	Area	Flow GPM	Flow ft3/hr	Rate
12:27	11.5	32.7	0	0	0.0	0.0	0.0	5.4
12:28	16.0	28.9	1	3.8	71.2	3.8	30.7	5.2
12:29	19.2	26.2	1	2.7	64.5	2.7	21.8	4.1
12:30	21.8	24.0	1	2.2	59.1	2.2	17.7	3.6
12:32	27.1	19.5	2	4.5	48.0	2.3	18.1	4.5
12:34	31.9	15.4	2	4.1	37.9	2.0	16.4	5.2
12:37	34.6	13.1	3	2.3	32.3	0.8	6.1	2.3
12:42	36.7	11.3	5	1.8	27.9	0.4	2.9	1.2
12:47	38.0	10.2	5	1.1	25.1	0.2	1.8	0.8
12:52	39.0	9.4	5	0.9	23.0	0.2	1.4	0.7
12:57	39.8	8.7	5	0.7	21.4	0.1	1.1	0.6
13:07	40.7	7.9	10	0.8	19.5	0.1	0.6	0.4
13:17	41.2	7.5	10	0.4	18.4	0.0	0.3	0.2
13:27	41.9	6.9	10	0.6	17.0	0.1	0.5	0.3
13:37	42.3	6.5	10	0.3	16.1	0.0	0.3	0.2
13:47	42.6	6.3	10	0.3	15.5	0.0	0.2	0.2
13:57	42.8	6.2	10	0.1	15.2	0.0	0.1	0.1
Gal/ft	0.9							



I-3 **Field Infiltration Test Data** Project: **Broaday/Manchester ATP Equity Project**

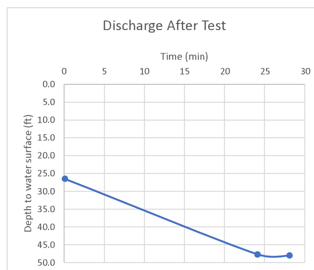
Depth to GW or Impermeable Layer	50	
Diameter	8.0	in
Perimeter	2.09	ft

Diameter in	ft	Area ft2	Time	Depth ft	Volume L	Volume gal	Delta min	Time hr	Cumulative Time mim	hr	Delta Vol	Flow gpm	Boring Area	Calc Flow	Infiltration Rate
8	0.67	0.35	9:22	-	0	0	0	0	0	0.00	0	-	-	-	0.0
8	0.67	0.35	9:27	36.0	243	64.2	5	0.08	5	0.08	64.2	12.8	29.3	103.0	42.1
8	0.67	0.35	9:32	28.0	475	125.5	5	0.08	10	0.17	61.3	12.3	46.1	98.3	25.6
8	0.67	0.35	9:37	27.0	721	190.5	5	0.08	15	0.25	65.0	13.0	48.2	104.2	26.0
8	0.67	0.35	9:42	27.0	970	256.2	5	0.08	20	0.33	65.8	13.2	48.2	105.5	26.3
8	0.67	0.35	9:47	27.0	1227	324.1	5	0.08	25	0.42	67.9	13.6	48.2	108.9	27.1
8	0.67	0.35	9:52	26.8	1472	388.9	5	0.08	30	0.50	64.7	12.9	48.6	103.8	25.6
8	0.67	0.35	10:02	26.7	1971	520.7	10	0.17	40	0.67	131.8	13.2	48.8	105.7	26.0
8	0.67	0.35	10:12	26.6	2467	651.7	10	0.17	50	0.83	131.0	13.1	49.0	105.1	25.7
8	0.67	0.35	10:22	26.6	2961	782.2	10	0.17	60	1.00	130.5	13.1	49.0	104.7	25.6
8	0.67	0.35	10:42	26.5	3946	1042.4	20	0.33	80	1.33	260.2	13.0	49.2	104.4	25.4
8	0.67	0.35	10:52	26.5	4426	1169.2	10	0.17	90	1.50	126.8	12.7	49.2	101.7	24.8



Drainage After Testing

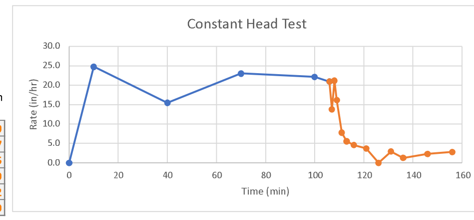
Time	Depth	Volume	Delta T	Delta V		Area	Flow GPM	Flow ft3/hı	Rate		
10:52	26.5	28.2	0	0		0.0	0.0	0.0	24.8	0.1	90
11:16	47.7	2.8	24	25.4		4.8	1.1	8.5	21.2	24	114
11:20	48.0	2.4	4	0.4		4.2	0.1	0.7	2.1	28	118
Gal/ft	1.2										



I-3 **Field Infiltration Test Data** Project: **Broaday/Manchester ATP Equity Project**

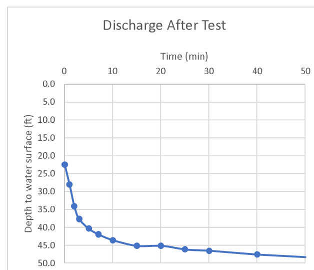
Depth to GW or Impermeable Layer	50	
Diameter	8.0	in
Perimeter	2.09	ft

Diameter		Area	Time	Depth	Volume	Volume	Delta	Time	Cumulative Time		Delta	Flow	Boring	Calc	Infiltration
in	ft	ft2		ft	L	gal	min	hr	mim	hr	Vol	gpm	Area	Flow	Rate
8	0.67	0.35	11:20	-	0	0	0	0	0	0.00	0	-	-	-	0.0
8	0.67	0.35	11:30	24.0	530	140.0	10	0.17	10	0.17	140.0	14.0	54.5	112.3	24.7
8	0.67	0.35	12:00	23.2	1554	410.5	30	0.50	40	0.67	270.5	9.0	56.1	72.3	15.5
8	0.67	0.35	12:30	23.2	3080	813.6	30	0.50	70	1.17	403.1	13.4	56.1	107.8	23.0
8	0.67	0.35	13:00	22.8	4569	1207.0	30	0.50	100	1.67	393.4	13.1	57.0	105.2	22.2
8	0.67	0.35	13:06	22.5	4854	1282.3	6	0.10	106	1.77	75.3	12.5	57.6	100.6	21.0



Drainage After Testing

Time	Depth	Volume	Delta T	Delta V	Area	Flow GPM	Flow ft3/hr	Rate		
13:06	22.5	33.0	0	0	0.0	0.0	0.0	21.0	0.1	106
13:07	28.0	26.4	1	6.6	46.1	6.6	52.9	13.8	1	107
13:08	34.1	19.1	1	7.3	33.3	7.3	58.7	21.2	2	108
13:09	37.7	14.8	1	4.3	25.8	4.3	34.6	16.1	3	109
13:11	40.4	11.5	2	3.2	20.1	1.6	13.0	7.8	5	111
13:13	42.0	9.6	2	1.9	16.8	1.0	7.7	5.5	7	113
13:16	43.6	7.7	3	1.9	13.4	0.6	5.1	4.6	10	116
13:21	45.2	5.8	5	1.9	10.1	0.4	3.1	3.7	15	121
13:26	45.2	5.8	5	0.0	10.1	0.0	0.0	0.0	20	126
13:31	46.2	4.6	5	1.2	8.0	0.2	1.9	2.9	25	131
13:36	46.6	4.1	5	0.5	7.1	0.1	0.8	1.3	30	136
13:46	47.6	2.9	10	1.2	5.0	0.1	1.0	2.3	40	146
13:56	48.4	1.9	10	1.0	3.4	0.1	0.8	2.8	50	156
Gal/ft	1.2									



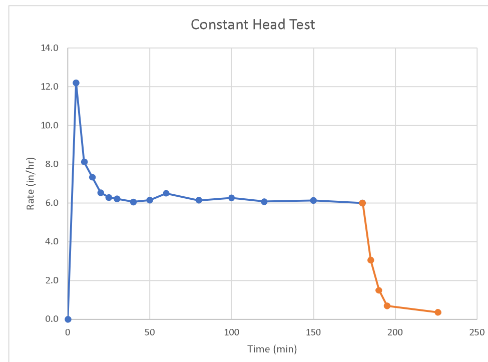
I-4 **Field Infiltration Test Data** Project: **Broaday/Manchester ATP Equity Project**

Depth to GW or Impermeable Layer 50

Diameter 8.0 in

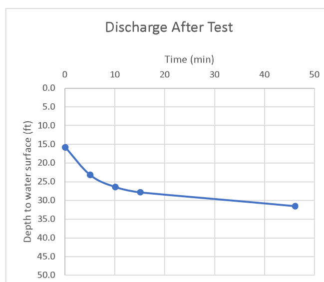
Perimeter 2.09 ft

Diameter in	ft	Area ft2	Time	Depth ft	Volume gal	Delta min	Time hr	Cumulative Time mim	hr	Delta Vol	Flow gpm	Boring Area	Calc Flow	Infiltration Rate
8	0.67	0.35	11:45	-	0	0	0	0	0.00	0	-	-	-	0.0
8	0.67	0.35	11:50	35.0	19.9	5	0.08	5	0.08	19.9	4.0	31.4	32.0	12.2
8	0.67	0.35	11:55	25.0	42.0	5	0.08	10	0.17	22.1	4.4	52.4	35.4	8.1
8	0.67	0.35	12:00	21.5	64.7	5	0.08	15	0.25	22.7	4.5	59.7	36.4	7.3
8	0.67	0.35	12:05	17.3	88.0	5	0.08	20	0.33	23.2	4.6	68.5	37.3	6.5
8	0.67	0.35	12:10	16.4	111.0	5	0.08	25	0.42	23.0	4.6	70.4	36.9	6.3
8	0.67	0.35	12:15	16.4	133.7	5	0.08	30	0.50	22.7	4.5	70.4	36.4	6.2
8	0.67	0.35	12:25	16.1	178.3	10	0.17	40	0.67	44.6	4.5	71.0	35.8	6.1
8	0.67	0.35	12:35	16.0	223.8	10	0.17	50	0.83	45.4	4.5	71.2	36.4	6.1
8	0.67	0.35	12:45	16.0	271.8	10	0.17	60	1.00	48.1	4.8	71.2	38.6	6.5
8	0.67	0.35	13:05	15.8	363.2	20	0.33	80	1.33	91.4	4.6	71.6	36.7	6.1
8	0.67	0.35	13:25	15.8	456.5	20	0.33	100	1.67	93.3	4.7	71.6	37.4	6.3
8	0.67	0.35	13:45	15.8	546.8	20	0.33	120	2.00	90.3	4.5	71.6	36.2	6.1
8	0.67	0.35	14:15	15.8	683.7	30	0.50	150	2.50	136.8	4.6	71.6	36.6	6.1
8	0.67	0.35	14:45	15.8	817.6	30	0.50	180	3.00	133.9	4.5	71.6	35.8	6.0



Drainage After Testing

Time	Depth	Volume	Delta T	Delta V	Area	Flow GPM	Flow ft3/hr	Rate
14:45	15.8	41.0	0	0	0	0	0	6.0
14:50	23.2	32.2	5	8.9	56.1	1.776	14.24	3.0
14:55	26.4	28.3	5	3.8	49.4	0.768	6.16	1.5
15:00	27.8	26.6	5	1.7	46.5	0.336	2.69	0.7
15:31	31.5	22.2	31	4.4	38.7	0.143226	1.15	0.4
Gal/ft	1.2							



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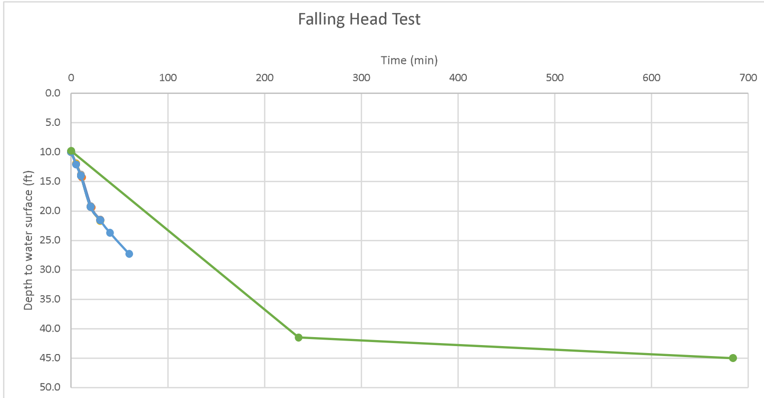
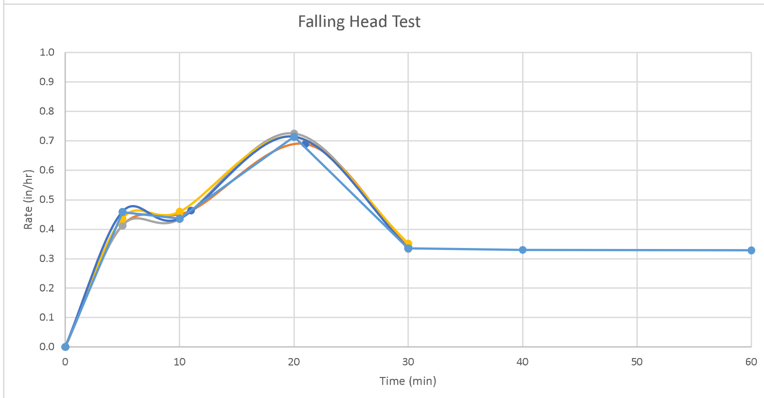
I-5 **Field Infiltration Test Data** Project: **Broaday/Manchester ATP Equity Project**

Depth to GW or Impermeable Layer		50	
Diameter	8.0	in	
Perimeter	2.09	ft	

Time	Depth	Volume	Delta T	Delta V	Area	Flow GPM	Flow ft3/hr	Rate
Falling Head Test #1								
8:32	10.0	36.0	0	0	0.0	0.0	0.0	-
8:37	11.9	34.3	5	1.7	79.8	0.3	2.7	0.4
8:43	14.3	32.1	6	2.2	74.8	0.4	2.9	0.5
8:53	19.4	27.5	10	4.6	64.1	0.5	3.7	0.7
9:02	21.5	25.7	9	1.9	59.7	0.2	1.7	0.3
Falling Head Test #2								
9:03	10.0	36.0	0	0.0	0.0	0.0	0.0	-
9:08	11.9	34.3	5	1.7	79.8	0.3	2.7	0.4
9:13	13.8	32.6	5	1.7	75.8	0.3	2.7	0.4
9:23	19.2	27.7	10	4.9	64.5	0.5	3.9	0.7
9:33	21.5	25.7	10	2.1	59.7	0.2	1.7	0.3
Falling Head Test #3								
9:33	10.0	36.0	0	0	0.0	0.0	0.0	-
9:38	12.0	34.2	5	1.8	79.6	0.4	2.9	0.4
9:43	14.0	32.4	5	1.8	75.4	0.4	2.9	0.5
9:53	19.3	27.6	10	4.8	64.3	0.5	3.8	0.7
10:03	21.7	25.5	10	2.2	59.3	0.2	1.7	0.4
Falling Head Test #4								
10:05	10.0	36.0	0	0	0.0	0.0	0.0	-
10:10	12.1	34.1	5	1.9	79.4	0.4	3.0	0.5
10:15	14.0	32.4	5	1.7	75.4	0.3	2.7	0.4
10:25	19.3	27.6	10	4.8	64.3	0.5	3.8	0.7
10:35	21.6	25.6	10	2.1	59.5	0.2	1.7	0.3
Falling Head Test #5								
10:37	10.0	36.0	0	0	0.0	0.0	0.0	-
10:42	12.1	34.1	5	1.9	79.4	0.4	3.0	0.5
10:47	14.0	32.4	5	1.7	75.4	0.3	2.7	0.4
10:57	19.3	27.6	10	4.8	64.3	0.5	3.8	0.7
11:07	21.6	25.6	10	2.1	59.5	0.2	1.7	0.3
11:17	23.7	23.7	10	1.9	55.1	0.2	1.5	0.3
11:37	27.3	20.4	20	3.2	47.5	0.2	1.3	0.3
Falling Head Test #6								
8:18	9.8	36.2	0	0	0.0	0.0	0.0	-
12:13	41.5	7.7	235	28.5	17.8	0.1	1.0	0.7
15:47	45.0	4.5	449	31.7	10.5	0.1	0.6	0.6





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I-6 **Field Infiltration Test Data** Project: **Broaday/Manchester ATP Equity Project**

Depth to GW or Impermeable Layer	45	
Diameter	8.0	in
Perimeter	2.09	ft

Falling Head Test #1

Time	Depth	Volume	Delta T	Delta V	Area	Flow GPM	Flow ft3/hı	Rate
12:27	10.0	38.5	0	0	0.0	0.0	0.0	-
12:32	13.0	35.2	5	3.3	67.0	0.7	5.3	0.9
12:38	15.5	32.5	6	2.8	61.8	0.5	3.7	0.7
12:47	19.3	28.3	9	4.2	53.8	0.5	3.7	0.8
12:57	22.0	25.3	10	3.0	48.2	0.3	2.4	0.6

Falling Head Test #2

Time	Depth	Volume	Delta T	Delta V	Area	Flow GPM	Flow ft3/hı	Rate
13:00	10.0	38.5	0	0.0	0.0	0.0	0.0	-
13:05	12.6	35.6	5	2.9	67.9	0.6	4.6	0.8
13:10	16.2	31.7	5	4.0	60.3	0.8	6.4	1.3
13:20	20.3	27.2	10	4.5	51.7	0.5	3.6	0.8
13:30	23.3	23.9	10	3.3	45.4	0.3	2.6	0.7

Falling Head Test #3

Time	Depth	Volume	Delta T	Delta V	Area	Flow GPM	Flow ft3/hı	Rate
13:31	10.0	38.5	0	0	0.0	0.0	0.0	-
13:36	12.5	35.8	5	2.8	68.1	0.6	4.4	0.8
13:41	15.2	32.8	5	3.0	62.4	0.6	4.8	0.9
13:51	20.0	27.5	10	5.3	52.4	0.5	4.2	1.0
14:01	22.7	24.5	10	3.0	46.7	0.3	2.4	0.6

Falling Head Test #4

Time	Depth	Volume	Delta T	Delta V	Area	Flow GPM	Flow ft3/hı	Rate
14:02	10.0	38.5	0	0	0.0	0.0	0.0	-
14:07	12.7	35.5	5	3.0	67.6	0.6	4.8	0.8
14:12	15.2	32.8	5	2.8	62.4	0.6	4.4	0.8
14:22	20.0	27.5	10	5.3	52.4	0.5	4.2	1.0
14:32	22.8	24.4	10	3.1	46.5	0.3	2.5	0.6

Falling Head Test #5

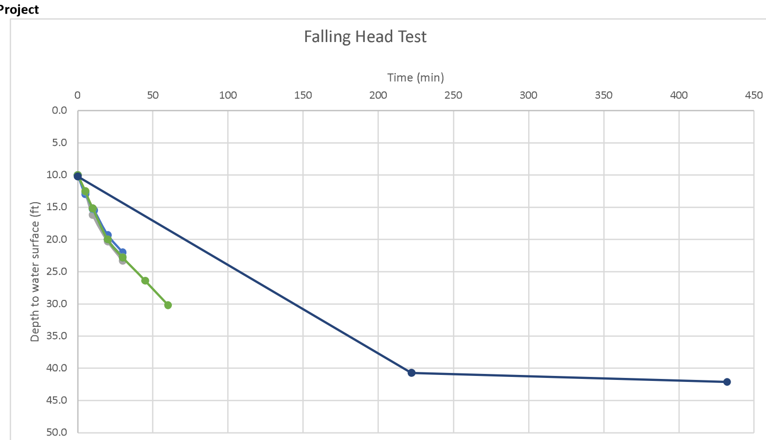
Time	Depth	Volume	Delta T	Delta V	Area	Flow GPM	Flow ft3/hı	Rate
14:33	10.0	38.5	0	0	0.0	0.0	0.0	-
14:38	12.6	35.6	5	2.9	67.9	0.6	4.6	0.8
14:43	15.3	32.7	5	3.0	62.2	0.6	4.8	0.9
14:53	20.0	27.5	10	5.2	52.4	0.5	4.1	1.0
15:03	22.7	24.5	10	3.0	46.7	0.3	2.4	0.6

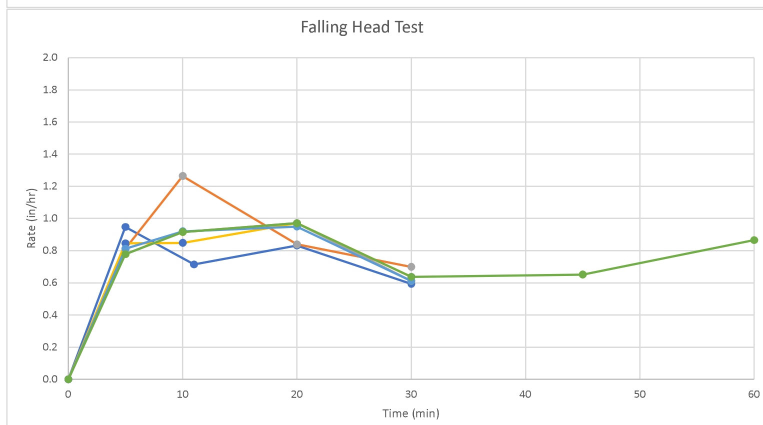
Falling Head Test #6

Time	Depth	Volume	Delta T	Delta V	Area	Flow GPM	Flow ft3/hı	Rate
15:04	10.0	38.5	0	0	0.0	0.0	0.0	-
15:09	12.5	35.8	5	2.8	68.1	0.6	4.4	0.8
15:14	15.2	32.8	5	3.0	62.4	0.6	4.8	0.9
15:24	20.0	27.5	10	5.3	52.4	0.5	4.2	1.0
15:34	22.8	24.4	10	3.1	46.5	0.3	2.5	0.6
15:49	26.4	20.5	15	4.0	39.0	0.3	2.1	0.7
16:04	30.2	16.3	15	4.2	31.0	0.3	2.2	0.9

Falling Head Test #7

Time	Depth	Volume	Delta T	Delta V	Area	Flow GPM	Flow ft3/hı	Rate
8:33	10.2	38.3	0	0	0.0	0.0	0.0	-
12:15	40.7	4.7	222	33.6	9.0	0.2	1.2	1.6
15:45	42.1	3.2	210	1.5	6.1	0.0	0.1	0.1





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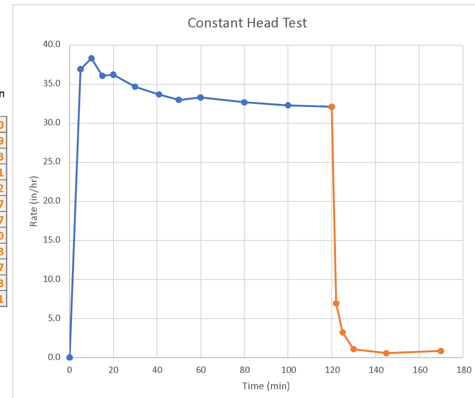
I-7 **Field Infiltration Test Data** Project: **Broaday/Manchester ATP Equity Project**

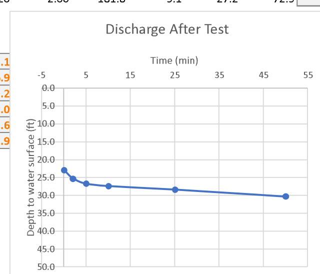
Depth to GW or Impermeable Layer	36	
Diameter	8.0	in
Perimeter	2.09	ft

Diameter in	ft	Area ft2	Time	Depth ft	Volume L	Volume gal	Delta min	Time hr	Cumulative Time mim	hr	Delta Vol	Flow gpm	Boring Area	Calc Flow	Infiltration Rate
8	0.67	0.35	9:00	-	0	0	0	0	0	0.00	0	-	-	-	0.0
8	0.67	0.35	9:05	23.9	184	48.6	5	0.08	5	0.08	48.6	9.7	25.3	78.0	36.9
8	0.67	0.35	9:10	23.9	375	99.1	5	0.08	10	0.17	50.5	10.1	25.3	80.9	38.3
8	0.67	0.35	9:15	23.9	555	146.6	5	0.08	15	0.25	47.6	9.5	25.3	76.3	36.1
8	0.67	0.35	9:20	23.6	740	195.5	5	0.08	20	0.33	48.9	9.8	26.0	78.4	36.2
8	0.67	0.35	9:30	23.3	1103	291.4	10	0.17	30	0.50	95.9	9.6	26.6	76.9	34.7
8	0.67	0.35	9:41	23.0	1500	396.3	11	0.18	41	0.68	104.9	9.5	27.2	76.5	33.7
8	0.67	0.35	9:50	23.0	1818	480.3	9	0.15	50	0.83	84.0	9.3	27.2	74.9	33.0
8	0.67	0.35	10:00	23.0	2175	574.6	10	0.17	60	1.00	94.3	9.4	27.2	75.6	33.3
8	0.67	0.35	10:20	23.0	2875	759.5	20	0.33	80	1.33	184.9	9.2	27.2	74.2	32.7
8	0.67	0.35	10:40	23.0	3567	942.3	20	0.33	100	1.67	182.8	9.1	27.2	73.3	32.3
8	0.67	0.35	11:00	23.0	4255	1124.1	20	0.33	120	2.00	181.8	9.1	27.2	72.9	32.1



Drainage After Testing

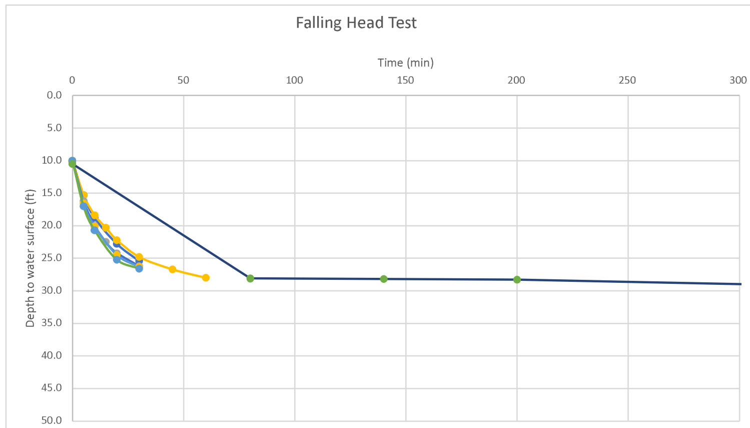
Time	Depth	Volume	Delta T	Delta V	Area	Flow GPM	Flow ft3/h	Rate
11:00	23.0	18.2	0	0	0.0	0.0	0.0	32.1
11:02	25.3	15.0	2	3.2	22.4	1.6	12.9	6.9
11:05	26.7	13.0	3	2.0	19.5	0.7	5.2	3.2
11:10	27.4	12.0	5	1.0	18.0	0.2	1.6	1.0
11:25	28.4	10.6	15	1.4	15.9	0.1	0.7	0.6
11:50	30.3	8.0	25	2.7	11.9	0.1	0.9	0.9

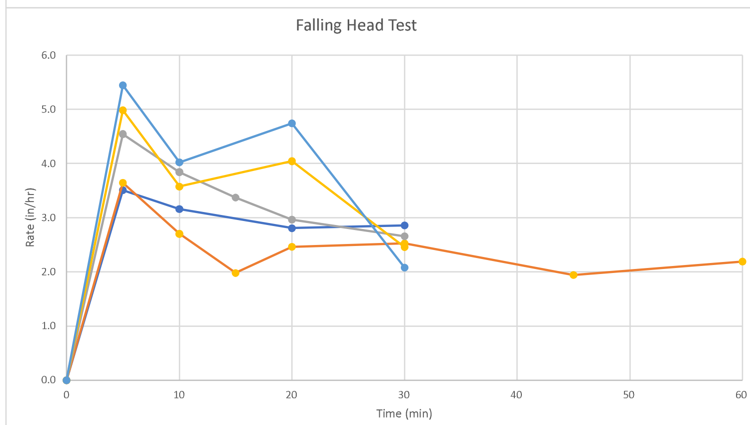


I-8 **Field Infiltration Test Data** Project: **Broaday/Manchester ATP Equity Project**

Depth to GW or Impermeable Layer	30	
Diameter	8.0	in
Perimeter	2.09	ft

Time	Depth	Volume	Delta T	Delta V	Area	Flow GPM	Flow ft3/hr	Rate
Falling Head Test #1								
8:55	10.2	21.8	0	0	0.0	0.0	0.0	-
9:00	15.3	16.2	5	5.6	30.8	1.1	9.0	3.5
9:05	18.8	12.3	5	3.9	23.5	0.8	6.2	3.2
9:15	22.8	7.9	10	4.4	15.1	0.4	3.5	2.8
9:25	25.4	5.1	10	2.9	9.6	0.3	2.3	2.9
Falling Head Test #2								
9:30	10.0	22.0	0	0.0	0.0	0.0	0.0	-
9:35	15.3	16.2	5	5.8	30.8	1.2	9.4	3.6
9:40	18.4	12.8	5	3.4	24.3	0.7	5.5	2.7
9:45	20.3	10.7	5	2.1	20.3	0.4	3.4	2.0
9:50	22.2	8.6	5	2.1	16.3	0.4	3.4	2.5
10:00	24.8	5.7	10	2.9	10.9	0.3	2.3	2.5
10:15	26.7	3.6	15	2.1	6.9	0.1	1.1	1.9
10:30	28.0	2.2	15	1.4	4.2	0.1	0.8	2.2
Falling Head Test #3								
10:33	10.0	22.0	0	0	0.0	0.0	0.0	-
10:38	16.2	15.2	5	6.8	28.9	1.4	10.9	4.5
10:43	20.0	11.0	5	4.2	20.9	0.8	6.7	3.8
10:48	22.5	8.3	5	2.8	15.7	0.6	4.4	3.4
10:53	24.2	6.4	5	1.9	12.1	0.4	3.0	3.0
11:03	26.2	4.2	10	2.2	8.0	0.2	1.8	2.7
Falling Head Test #4								
11:06	10.0	22.0	0	0	0.0	0.0	0.0	-
11:11	16.6	14.7	5	7.3	28.1	1.5	11.6	5.0
11:16	20.1	10.9	5	3.9	20.7	0.8	6.2	3.6
11:26	24.5	6.1	10	4.8	11.5	0.5	3.9	4.0
11:36	26.3	4.1	10	2.0	7.7	0.2	1.6	2.5
Falling Head Test #5								
11:38	10.0	22.0	0	0	0.0	0.0	0.0	-
11:43	17.0	14.3	5	7.7	27.2	1.5	12.4	5.4
11:48	20.7	10.2	5	4.1	19.5	0.8	6.5	4.0
11:58	25.2	5.3	10	5.0	10.1	0.5	4.0	4.7
12:08	26.6	3.7	10	1.5	7.1	0.2	1.2	2.1
Falling Head Test #6								
12:10	10.5	21.5	0	0	0.0	0.0	0.0	-
13:30	28.1	2.1	80	19.4	4.0	0.2	1.9	5.9
14:30	28.2	2.0	60	0.1	3.8	0.0	0.0	0.0
15:30	28.3	1.9	60	0.1	3.6	0.0	0.0	0.0
4/7/2022								
8:53	34.1	-4.5	1043	6.4	-8.6	0.0	0.0	-0.1
15:39	36.1	-6.7	1449	2.2	-12.8	0.0	0.0	0.0

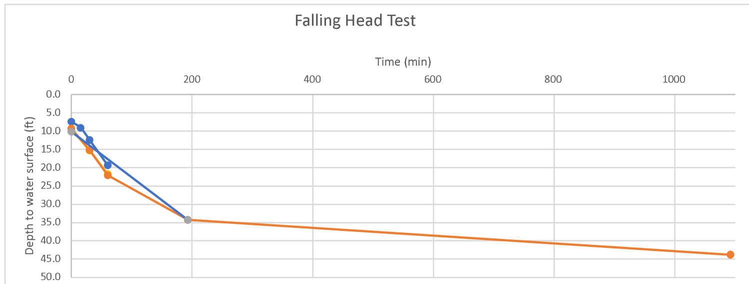


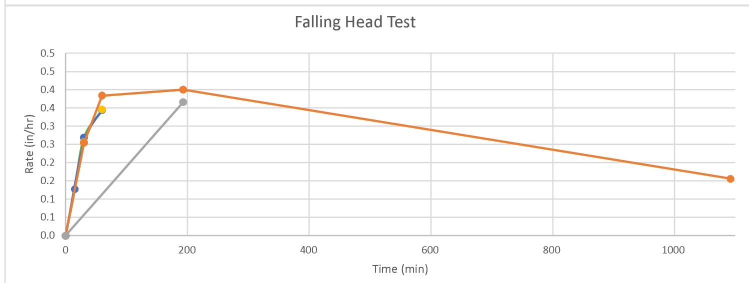


I-9 **Field Infiltration Test Data** Project: **Broaday/Manchester ATP Equity Project**

Depth to GW or Impermeable Layer	50	
Diameter	8.0	in
Perimeter	2.09	ft

Time	Depth	Volume	Delta T	Delta V	Area	Flow GPM	Flow ft3/hr	Rate
Falling Head Test #1								
12:45	7.4	42.6	0	0	0.0	0.0	0.0	-
13:00	9.1	40.9	15	1.7	85.7	0.1	0.9	0.1
13:15	12.4	37.6	15	3.3	78.7	0.2	1.8	0.3
13:45	19.3	30.7	30	6.9	64.3	0.2	1.8	0.3
Falling Head Test #2								
13:46	9.5	40.5	0	0.0	0.0	0.0	0.0	-
14:16	15.3	34.7	30	5.8	72.7	0.2	1.6	0.3
14:46	21.7	28.3	30	6.4	59.3	0.2	1.7	0.3
Falling Head Test #3								
14:48	9.3	40.7	0	0	0.0	0.0	0.0	-
15:18	15.1	34.9	30	5.8	73.1	0.2	1.6	0.3
15:48	22.1	27.9	30	7.0	58.4	0.2	1.9	0.4
	34.3	15.7						0.4
9:00	43.8	6.2	1032	21.7	13.0	0.0	0.2	0.2
Falling Head Test #4								
9:09	10.2	39.8	0	0	0.0	0.0	0.0	-
12:22	34.3	15.7	193	24.1	32.9	0.1	1.0	0.4

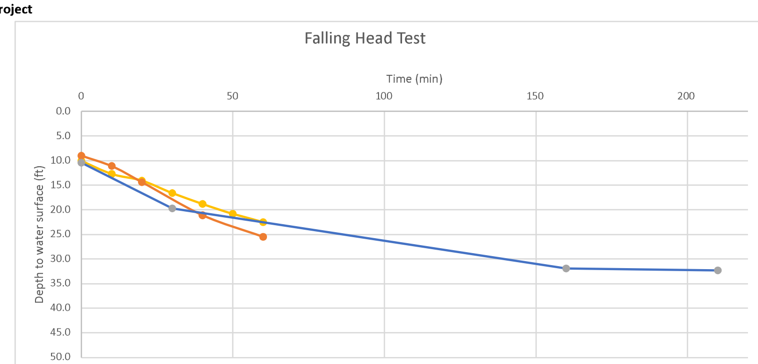


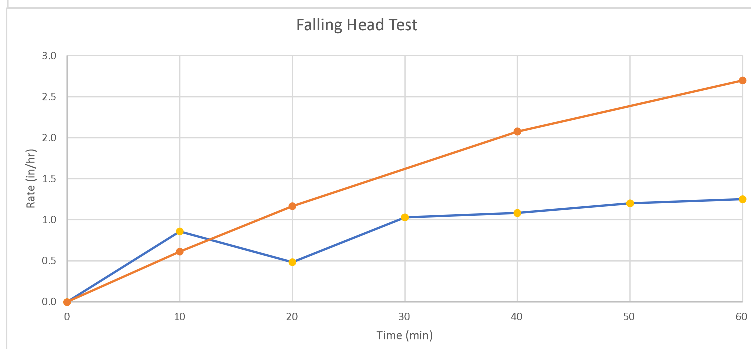


I-10 Field Infiltration Test Data Project: **Broaday/Manchester ATP Equity Project**

Depth to GW or Impermeable Layer: 30
Diameter: 8.0 in
Perimeter: 2.09 ft

Time	Depth	Volume	Delta T	Delta V	Area	Flow GPM	Flow ft3/hr	Rate
Falling Head Test #1								
9:50	10.0	24.0	0	0.0	0.0	0.0	0.0	-
10:00	12.7	20.8	10	3.2	36.2	0.3	2.6	0.9
10:10	14.1	19.1	10	1.7	33.3	0.2	1.3	0.5
10:20	16.6	16.1	10	3.0	28.1	0.3	2.4	1.0
10:30	18.8	13.4	10	2.6	23.5	0.3	2.1	1.1
10:40	20.8	11.0	10	2.4	19.3	0.2	1.9	1.2
10:50	22.5	9.0	10	2.0	15.7	0.2	1.6	1.3
Falling Head Test #2								
10:57	9.0	25.2	0	0	0.0	0.0	0.0	-
11:07	11.1	22.7	10	2.5	39.6	0.3	2.0	0.6
11:17	14.4	18.7	10	4.0	32.7	0.4	3.2	1.2
11:37	21.1	10.7	20	8.0	18.6	0.4	3.2	2.1
11:57	25.5	5.4	20	5.3	9.4	0.3	2.1	2.7
Falling Head Test #3								
12:00	10.4	23.5	0	0	0.0	0.0	0.0	-
12:30	19.7	12.4	30	11.2	21.6	0.4	3.0	1.7
14:40	31.9	-2.3	130	14.6	-4.0	0.1	0.9	-2.7
15:30	32.3	-2.8	50	0.5	-4.8	0.0	0.1	-0.2

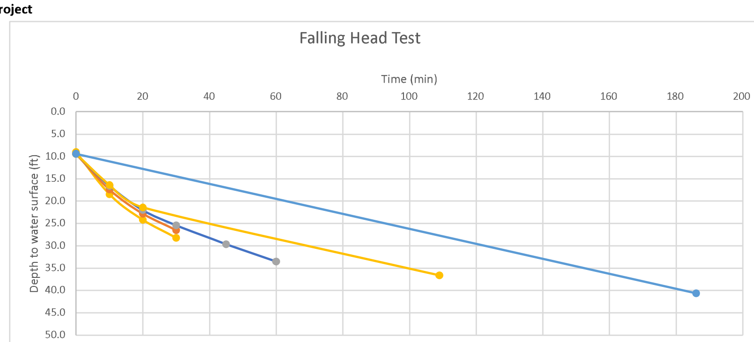


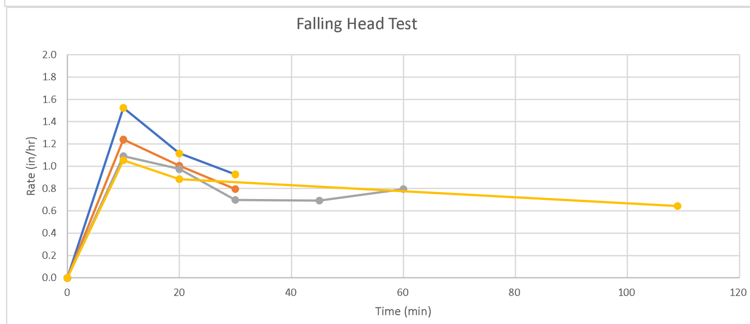


I-11 **Field Infiltration Test Data** Project: **Broaday/Manchester ATP Equity Project**

Depth to GW or Impermeable Layer	50	
Diameter	8.0	in
Perimeter	2.09	ft

Time	Depth	Volume	Delta T	Delta V	Area	Flow GPM	Flow ft3/hr	Rate
Falling Head Test #1								
13:00	9.0	45.1	0	0	0.0	0.0	0.0	-
13:10	18.5	34.7	10	10.5	66.0	1.0	8.4	1.5
13:20	24.2	28.4	10	6.3	54.0	0.6	5.0	1.1
13:30	28.2	24.0	10	4.4	45.7	0.4	3.5	0.9
Falling Head Test #2								
13:30	9.4	44.7	0	0.0	0.0	0.0	0.0	-
13:40	17.4	35.9	10	8.8	68.3	0.9	7.1	1.2
13:50	22.8	29.9	10	5.9	57.0	0.6	4.8	1.0
14:00	26.5	25.9	10	4.1	49.2	0.4	3.3	0.8
Falling Head Test #3								
14:05	9.4	44.7	0	0	0.0	0.0	0.0	-
14:15	16.6	36.7	10	7.9	70.0	0.8	6.4	1.1
14:25	22.0	30.8	10	5.9	58.6	0.6	4.8	1.0
14:35	25.4	27.1	10	3.7	51.5	0.4	3.0	0.7
14:50	29.6	22.4	15	4.6	42.7	0.3	2.5	0.7
15:05	33.5	18.2	15	4.3	34.6	0.3	2.3	0.8
Falling Head Test #4								
15:06	9.4	44.7	0	0	0.0	0.0	0.0	-
15:16	16.4	37.0	10	7.7	70.4	0.8	6.2	1.1
15:26	21.4	31.5	10	5.5	59.9	0.6	4.4	0.9
16:55	36.6	14.7	89	16.7	28.1	0.2	1.5	0.6
Falling Head Test #5								
8:08	9.4	44.7	0	0	0.0	0.0	0.0	-
11:14	40.6	10.3	186	34.3	19.7	0.2	1.5	0.9





APPENDIX B

GEOTECHNICAL BORING LOGS

LOG OF BORING NO. A-22-001

Grade Elevation:	136.0 ft			
Boring Depth:	51.5 ft	Driller:	ABC Liovin Drilling	SHEET 1 of 2
Borehole Diameter:	8"	Type of Rig:		Comments:
Date Drilled:	4-18-22	Hammer Data:	Automatic Hammer, 140 lbs/ 30 in drop	
Logged By:	DN	Groundwater Reading:		

Depth (ft)	Sample Type	Sample	Blows/foot	Graphic Log	GEOTECHNICAL DESCRIPTION	Moisture (%)	Dry Density (pcf)	Test/ Results
0					ASPHALT Asphalt~ 8 inches/ Concrete~ 4 inches.			
					Lean CLAY (CL); reddish brown; moist; few fine SAND; mostly medium plasticity fines.			
					SILT with SAND (ML); reddish brown; moist; little fine SAND; mostly nonplastic fines.			
5	X	S-1	6		SILTY SAND (SM); loose; dark brown; moist; mostly fine SAND; some nonplastic to low plasticity fines; some CLAY; to CLAYEY SAND.			
10	X	S-2	17		Medium dense; brown; medium to fine SAND; little nonplastic fines.			
					Lean CLAY (CL); very stiff; dark brown; moist; few fine SAND; mostly medium plasticity fines.			
15	X	S-3	21		Olive brown.			
20	X	S-4	24		SILTY SAND (SM); medium dense; brown; moist; trace fine GRAVEL; mostly medium to fine SAND; some nonplastic to low plasticity fines.			
25								

(continued)

Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

KHA, Broadway- Manchester STP Dry Wells

Project Number: 21-169 | Date: 4-29-22

(CONTINUED) LOG OF BORING NO. A-22-001

Date Drilled:	4-18-22	Comments:	SHEET 2 of 2
Logged By:	DN		

Depth (ft)	Sample Type	Sample	Blows/foot	Graphic Log	GEOTECHNICAL DESCRIPTION	Moisture (%)	Dry Density (pcf)	Test/ Results
25	X	S-5	39		Dense; light brown; fine SAND; little nonplastic fines. SILTY SAND (SM) *(continued)*.			
30	X	S-6	39		Medium to fine SAND.			
35	X	S-7	14		Lean CLAY (CL); stiff; olive brown; moist; few coarse to fine SAND; mostly medium plasticity fines; lensed SILTY SAND.			
40	X	S-8	13		Fine SAND.			
45	X	S-9	18		Very stiff; brown to olive brown; lensed SILTY SAND.			
50	X	S-10	17		Trace coarse to fine GRAVEL; few SAND.			
					Bottom of borehole at 51.5 ft bgs			

Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

KHA, Broadway- Manchester STP Dry Wells

Project Number: 21-169 | Date: 4-29-22

LOG OF BORING NO. A-22-002

Grade Elevation:	**132.0 ft**			
Boring Depth:	**51.5 ft**	Driller:	**ABC Liovin Drilling**	SHEET **1 of 2**
Borehole Diameter:	**8"**	Type of Rig:		Comments:
Date Drilled:	**4-19-22**	Hammer Data:	**Automatic Hammer, 140 lbs/ 30 in drop**	
Logged By:	**DV**	Groundwater Reading:		

Depth (ft)	Sample Type	Sample	Blows/foot	Graphic Log	GEOTECHNICAL DESCRIPTION	Moisture (%)	Dry Density (pcf)	Test/ Results
0					ASPHALT Asphalt~8 inches/ Concrete~4 inches.			
					CLAYEY SAND (SC); brown; moist; few fine GRAVEL; mostly coarse to fine SAND; some low to medium plasticity fines; GRAVEL is angular to subangular; rock fragments and debris (asphalt and concrete).			
5	X	S-1	6		SANDY lean CLAY (CL); stiff; olive brown; moist; few fine GRAVEL; little coarse to fine SAND; mostly medium plasticity fines; GRAVEL is angular to subangular; lensed SILT.			
10	X	S-2	13		SILTY SAND (SM); medium dense; olive brown; moist; trace fine GRAVEL; mostly medium to fine SAND; some nonplastic to low plasticity fines; GRAVEL is angular to subangular; lensed fine SAND and lensed Lean CLAY.			
15	X	S-3	23		SANDY SILT (ML); medium dense; olive brown; moist; some medium to fine SAND; mostly nonplastic fines; borderline SILTY SAND.			
					SILTY SAND (SM); medium dense; olive brown; moist; mostly medium to fine SAND; little nonplastic fines; borderline Poorly Graded SAND with SILT; lensed SANDY SILT.			
20	X	S-4	13		SANDY SILT (ML); stiff; olive gray; moist; trace fine GRAVEL; some medium to fine SAND; mostly nonplastic fines; GRAVEL is angular to subangular; lensed CLAY.			
25								

(continued)

Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

KHA, Broadway- Manchester STP Dry Wells

Project Number: 21-169 | Date: 4-28-22

(CONTINUED) LOG OF BORING NO. A-22-002

Date Drilled:	**4-19-22**	Comments:	SHEET **2 of 2**
Logged By:	**DV**		

Depth (ft)	Sample Type	Sample	Blows/foot	Graphic Log	GEOTECHNICAL DESCRIPTION	Moisture (%)	Dry Density (pcf)	Test/ Results
25	X	S-5	12		SILTY SAND (SM); medium dense; olive gray; moist; mostly medium to fine SAND; some nonplastic fines; lensed SANDY SILT- borderline.			
30	X	S-6	32		Olive brown to olive gray; little fines; lensed fine to medium SAND; lensed SANDY SILT.			
35	X	S-7	30					
40	X	S-8	53		Poorly graded SAND with SILT (SP-SM); very dense; olive gray; moist; mostly medium to fine SAND; few nonplastic fines.			
45	X	S-9	10		SANDY SILT (ML); stiff; olive gray; moist; little fine SAND; mostly nonplastic to low plasticity fines; lensed SILT- borderline SILT with SAND.			
50	X	S-10	30		Very stiff; trace fine GRAVEL; some medium to fine SAND; nonplastic fines; lensed SILT with SAND; GRAVEL is angular to subangular; some SILTY SAND.			
					Bottom of borehole at 51.5 ft bgs			

Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

KHA, Broadway- Manchester STP Dry Wells

Project Number: 21-169 | Date: 4-28-22

LOG OF BORING NO. A-22-003

Grade Elevation:	**131.0 ft**			
Boring Depth:	**51.5 ft**	Driller:	**ABC Liovin Drilling**	SHEET **1 of 2**
Borehole Diameter:	**8"**	Type of Rig:		Comments:
Date Drilled:	**4-20-22**	Hammer Data:	**Automatic Hammer, 140 lbs/ 30 in drop**	
Logged By:	**DV**	Groundwater Reading:		

Depth (ft)	Sample Type	Sample	Blows/foot	Graphic Log	GEOTECHNICAL DESCRIPTION	Moisture (%)	Dry Density (pcf)	Test/ Results
0					ASPHALT Asphalt~ 8 inches/ Concrete~ 4 inches.			
					CLAYEY SAND with GRAVEL (SC); brown to olive brown; moist; little coarse to fine GRAVEL; mostly coarse to fine SAND; some low plasticity fines; GRAVEL is angular to subangular; rock fragments and debris (asphalt and cement); lensed SILTY SAND.			
5	X	S-1	8		Loose; low to medium plasticity fines; lensed CLAY and SILTY SAND.			
10	X	S-2	16		SANDY SILT (ML); very stiff; olive brown; moist; few fine GRAVEL; some medium to fine SAND; mostly nonplastic fines; GRAVEL is angular to subangular; lensed SILTY SAND.			
15	X	S-3	20		Poorly graded SAND with SILT (SP-SM); medium dense; olive to olive brown; dry to moist; few fine GRAVEL; mostly medium to fine SAND; few nonplastic fines; GRAVEL is angular to subangular, borderline SILTY SAND.			
20	X	S-4	10		SILTY SAND (SM); loose; olive brown; dry to moist; few fine GRAVEL; mostly coarse to fine SAND; little nonplastic fines; GRAVEL is angular to subangular.			
25								

(continued)

(CONTINUED) LOG OF BORING NO. A-22-003

Date Drilled:	4-20-22	Comments:	SHEET 2 of 2
Logged By:	DV		

Depth (ft)	Sample Type	Sample	Blows/foot	Graphic Log	GEOTECHNICAL DESCRIPTION	Moisture (%)	Dry Density (pcf)	Test/ Results
25					SANDY SILT (ML); hard; olive brown; moist; some fine SAND; mostly nonplastic fines; borderline SILTY SAND.			
	X	S-5	43		SILTY SAND (SM); dense; olive brown; moist; few fine GRAVEL; mostly coarse to fine SAND; little nonplastic fines; GRAVEL is angular to subangular; borderline Poorly Graded SAND with SILT.			
30	X	S-6	56		Poorly graded SAND with SILT (SP-SM); very dense; light brown; moist; few fine GRAVEL; mostly medium to fine SAND; few nonplastic fines; GRAVEL is angular to subangular.			
35	X	S-7	21		Medium dense; olive brown; coarse to medium SAND.			
					SILTY SAND (SM); medium dense; olive brown; moist; some fine SAND; mostly nonplastic fines; borderline SANDY SILT; lensed SILT/ CLAY.			
40	X	S-8	25		SANDY SILT (ML); very stiff; olive brown to brown; moist; some medium to fine SAND; mostly low plasticity fines; borderline SANDY Lean CLAY; lensed Poorly Graded SAND; some CLAY/ SILT-mixed sample.			
45	X	S-9	45		Poorly graded SAND (SP); dense; light brown; moist; trace fine GRAVEL; mostly medium to fine SAND; trace nonplastic fines; GRAVEL is angular; lensed CLAY.			
50	X	S-10	38		SILTY SAND (SM); dense; olive brown; moist; mostly fine SAND; little nonplastic fines; borderline Poorly Graded Sand with SILT.			
					Bottom of borehole at 51.5 ft bgs			

LOG OF BORING NO. A-22-004

Grade Elevation:	**125.0 ft**				
Boring Depth:	**51.5 ft**	Driller:	**ABC Liovin Drilling**	SHEET **1 of 2**	
Borehole Diameter:	**8"**	Type of Rig:		Comments:	
Date Drilled:	**4-4-22**	Hammer Data:	**Automatic Hammer, 140 lbs/ 30 in drop**		
Logged By:	**DV**	Groundwater Reading:		Boring Backfill: grout	

Depth (ft)	Sample Type	Sample	Blows/foot	Graphic Log	GEOTECHNICAL DESCRIPTION	Moisture (%)	Dry Density (pcf)	Test/ Results
0					SILTY SAND (SM); brown; moist; few fine GRAVEL; mostly coarse to fine SAND; some nonplastic to low plasticity fines; GRAVEL is angular to subangular; some CLAY; lensed roots and grass.			
5	X	S-1	17		CLAYEY SAND (SC); medium dense; brown; moist; few fine GRAVEL; mostly coarse to fine SAND; some low plasticity fines; GRAVEL is angular to subangular; some SILT.			
10	X	S-2	32		Dense; brown to olive brown; lensed SANDY SILT.			
15	X	S-3	45		Poorly graded SAND with SILT (SP-SM); dense; olive brown; dry to moist; few fine GRAVEL; mostly medium to fine SAND; few nonplastic fines; GRAVEL is angular to subangular; borderline SILTY SAND.			
20	X	S-4	36		SILTY SAND (SM); dense; olive brown; moist; trace fine GRAVEL; mostly coarse to fine SAND; little nonplastic fines; GRAVEL is angular to subangular; borderline Poorly Graded SAND with SILT.			
25								

(continued)

(CONTINUED) LOG OF BORING NO. A-22-004

Date Drilled:	4-4-22	Comments:	SHEET 2 of 2
Logged By:	DV	Boring Backfill: grout	

Depth (ft)	Sample Type	Sample	Blows/foot	Graphic Log	GEOTECHNICAL DESCRIPTION	Moisture (%)	Dry Density (pcf)	Test/ Results
25		S-5	24		SANDY SILT (ML); very stiff; olive brown; moist; little fine SAND; mostly nonplastic to low plasticity fines; lensed SILT to SILT with SAND; lensed CLAY.			
30		S-6	38		Poorly graded SAND with SILT (SP-SM); dense; olive brown; moist; few fine GRAVEL; mostly medium to fine SAND; few nonplastic fines; GRAVEL is angular to subangular; lensed SILT/ CLAY.			
35		S-7	23		Lean CLAY with GRAVEL (CL); very stiff; olive gray; moist; little fine GRAVEL; few fine SAND; mostly low to medium plasticity fines; GRAVEL is angular to subangular- cementation; lensed SILT- borderline CL/ML.			
40		S-8	34		SANDY SILT (ML); hard; olive gray; moist; few fine GRAVEL; some fine SAND; mostly nonplastic to low plasticity fines; GRAVEL is angular to subangular- cementation; lensed SILT/ CLAY.			
45		S-9	21		Very stiff; medium to fine SAND; nonplastic fines; lensed SILT; borderline SILTY SAND.			
50		S-10	58		SILTY SAND (SM); very dense; olive gray; moist; mostly medium to fine SAND; some nonplastic fines; borderline SANDY SILT; increase in SAND.			
					Bottom of borehole at 51.5 ft bgs			

Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

KHA, Broadway- Manchester STP Dry Wells

Project Number: 21-169 | Date: 4-28-22

LOG OF BORING NO. A-22-005

Grade Elevation:	**130.0 ft**				
Boring Depth:	**51.5 ft**	Driller:	**ABC Liovin Drilling**		SHEET **1 of 2**
Borehole Diameter:	**8"**	Type of Rig:		Comments:	
Date Drilled:	**4-4-22**	Hammer Data:	**Automatic Hammer, 140 lbs/ 30 in drop**		
Logged By:	**DV**	Groundwater Reading:			

Depth (ft)	Sample Type	Sample	Blows/foot	Graphic Log	GEOTECHNICAL DESCRIPTION	Moisture (%)	Dry Density (pcf)	Test/ Results
0					SILTY SAND (SM); brown; moist; few fine GRAVEL; mostly coarse to fine SAND; some nonplastic fines; GRAVEL is angular to subangular.			
5		S-1	27		CLAYEY SAND (SC); medium dense; olive brown; moist; few fine GRAVEL; mostly coarse to fine SAND; some low plasticity fines; GRAVEL is angular to subangular; some SILT/ CLAY.			
10		S-2	16		SILTY SAND (SM); medium dense; olive brown; moist; few fine GRAVEL; mostly medium to fine SAND; some nonplastic fines; GRAVEL is angular to subangular; lensed SANDY SILT.			
15		S-3	38		SANDY SILT (ML); hard; olive brown; moist; trace fine GRAVEL; some medium to fine SAND; mostly nonplastic fines; GRAVEL is angular to subangular; borderline SILTY SAND.			
20		S-4	39		SILTY SAND (SM); dense; olive brown; moist; few fine GRAVEL; mostly medium to fine SAND; some nonplastic fines; GRAVEL is angular to subangular.			
25								

(continued)

Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

KHA, Broadway- Manchester STP Dry Wells

Project Number: 21-169 | Date: 4-28-22

(CONTINUED) LOG OF BORING NO. A-22-005

Date Drilled:	4-4-22	Comments:	SHEET 2 of 2
Logged By:	DV		

Depth (ft)	Sample Type	Sample	Blows/foot	Graphic Log	GEOTECHNICAL DESCRIPTION	Moisture (%)	Dry Density (pcf)	Test/ Results
25	X	S-5	58		Very dense; trace GRAVEL; fine SAND; lensed SANDY SILT- borderline. SILTY SAND (SM) *(continued)*.			
30	X	S-6	11		SANDY lean CLAY with GRAVEL (CL); stiff; olive gray; moist; little fine GRAVEL; some fine SAND; mostly low to medium plasticity fines; GRAVEL is angular to subangular- cementation; lensed SILT.			
35	X	S-7	27		SANDY SILT with GRAVEL (ML); very stiff; olive gray; moist; little fine GRAVEL; some fine SAND; mostly low plasticity fines; GRAVEL is angular to subangular- cementation; lensed SILT/ CLAY; borderline SILTY SAND.			
40	X	S-8	23					
45	X	S-9	29		SANDY SILT (ML); very stiff; olive gray; moist; trace fine GRAVEL; some fine SAND; mostly nonplastic to low plasticity fines; GRAVEL is angular to subangular; lensed SILT.			
50	X	S-10	43		Lean CLAY with SAND (CL); hard; olive gray; moist; few fine SAND; mostly medium plasticity fines; lensed Lean CLAY; lensed CLAYEY SAND.			
					Bottom of borehole at 51.5 ft bgs			

EMI BORING LOG 21-169.GPJ EMI CALTRANS 2013 V2.0.GLB 5/27/22

Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

KHA, Broadway- Manchester STP Dry Wells

Project Number: 21-169 | Date: 4-28-22

LOG OF BORING NO. A-22-006

Grade Elevation:	**130.0 ft**				
Boring Depth:	**51.5 ft**	Driller:	**ABC Liovin Drilling**	SHEET **1 of 2**	
Borehole Diameter:	**8"**	Type of Rig:		Comments:	
Date Drilled:	**4-5-22**	Hammer Data:	**Automatic Hammer, 140 lbs/ 30 in drop**		
Logged By:	**DV**	Groundwater Reading:			

Depth (ft)	Sample Type	Sample	Blows/foot	Graphic Log	GEOTECHNICAL DESCRIPTION	Moisture (%)	Dry Density (pcf)	Test/ Results
0					SILTY SAND with GRAVEL (SM); brown; moist; little fine GRAVEL; mostly coarse to fine SAND; little nonplastic to low plasticity fines; GRAVEL is angular to subangular; lensed CLAY; some rock fragments.			
5	X	S-1	27		CLAYEY SAND (SC); medium dense; brown; moist; few fine GRAVEL; mostly coarse to fine SAND; some low plasticity fines; GRAVEL is angular to subangular.			
10	X	S-2	17		SILTY SAND (SM); medium dense; brown to olive brown; moist; trace fine GRAVEL; mostly medium to fine SAND; little nonplastic fines; GRAVEL is angular to subangular; increase in SAND; borderline Poorly Graded SAND with SILT.			
15	X	S-3	37		Poorly graded SAND with SILT (SP-SM); dense; olive brown; moist; trace fine GRAVEL; mostly medium to fine SAND; few nonplastic fines; GRAVEL is angular to subangular; borderline SILTY SAND.			
20	X	S-4	63		Poorly graded SAND with SILT and GRAVEL (SP-SM); very dense; olive brown; moist; little fine GRAVEL; mostly coarse to medium SAND; few nonplastic fines; GRAVEL is angular to subangular.			
25								

(continued)

(CONTINUED) LOG OF BORING NO. A-22-006

Date Drilled:	4-5-22	Comments:	SHEET 2 of 2
Logged By:	DV		

Depth (ft)	Sample Type	Sample	Blows/foot	Graphic Log	GEOTECHNICAL DESCRIPTION	Moisture (%)	Dry Density (pcf)	Test/ Results
25		S-5	12		SANDY SILT with GRAVEL (ML); stiff; olive gray; moist; little fine GRAVEL; some medium to fine SAND; mostly low to medium plasticity fines; GRAVEL is angular to subangular- cementation; lensed CLAY and SILT.			
30		S-6	34		SANDY lean CLAY with GRAVEL (CL); hard; olive gray; moist; little fine GRAVEL; some medium to fine SAND; mostly low to medium plasticity fines; GRAVEL is angular to subangular; lensed SILT/ CLAY.			
35		S-7	37		SANDY SILT with GRAVEL (ML); hard; olive gray; moist; little fine GRAVEL; some medium to fine SAND; mostly nonplastic to low plasticity fines; GRAVEL is angular to subangular- cementation; lensed CLAY; borderline SILTY SAND.			
40		S-8	21		Lean CLAY with SAND (CL); very stiff; olive gray; moist; few fine GRAVEL; few fine SAND; mostly medium plasticity fines; GRAVEL is angular to subangular- cementation; lensed CLAY/ SILT.			
45		S-9	88		Hard.			
50		S-10	33					
					Bottom of borehole at 51.5 ft bgs			

EMI BORING LOG 21-169.GPJ EMI CALTRANS 2013 V2.0.GLB 5/27/22

Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

KHA, Broadway- Manchester STP Dry Wells

Project Number: 21-169 | Date: 4-28-22

LOG OF BORING NO. A-22-007

Grade Elevation:	131.0 ft			
Boring Depth:	51.5 ft	Driller:	ABC Liovin Drilling	SHEET 1 of 2
Borehole Diameter:	8"	Type of Rig:		Comments:
Date Drilled:	4-7-22	Hammer Data:	Automatic Hammer, 140 lbs/ 30 in drop	
Logged By:	DV	Groundwater Reading:		

Depth (ft)	Sample Type	Sample	Blows/foot	Graphic Log	GEOTECHNICAL DESCRIPTION	Moisture (%)	Dry Density (pcf)	Test/ Results
0					SILTY SAND with GRAVEL (SM); brown; moist; little fine GRAVEL; mostly coarse to fine SAND; some low plasticity fines; GRAVEL is angular to subangular; lensed CLAY.			
5	X	S-1	24		CLAYEY SAND with GRAVEL (SC); medium dense; brown; moist; little fine GRAVEL; mostly coarse to fine SAND; some low to medium plasticity fines; GRAVEL is angular to subangular; lensed SILT to SANDY SILT.			
10	X	S-2	28		SANDY SILT with GRAVEL (ML); very stiff; brown to olive brown; moist; little fine GRAVEL; some coarse to fine SAND; mostly low plasticity fines; GRAVEL is angular to subangular; lensed CLAY to CLAYEY SAND.			
15	X	S-3	68		Poorly graded SAND with SILT and GRAVEL (SP-SM); very dense; olive brown; moist; little fine GRAVEL; mostly medium to fine SAND; few nonplastic fines; GRAVEL is angular to subangular; lensed SILTY SAND- borderline.			
20	X	S-5	51		Coarse to medium SAND.			
25								

(continued)

(CONTINUED) LOG OF BORING NO. A-22-007

Date Drilled:	4-7-22	Comments:	SHEET 2 of 2
Logged By:	DV		

Depth (ft)	Sample Type	Sample	Blows/foot	Graphic Log	GEOTECHNICAL DESCRIPTION	Moisture (%)	Dry Density (pcf)	Test/ Results
25		S-5	65		Poorly graded SAND with SILT and GRAVEL (SP-SM) *(continued)*.			
30		S-6	38		SANDY lean CLAY (CL); hard; olive gray; moist; few fine GRAVEL; some medium to fine SAND; mostly low to medium plasticity fines; GRAVEL is angular to subangular; lensed SAND; some CLAY/ SILT.			
35		S-7	48		SANDY SILT (ML); hard; grayish brown; moist; some fine SAND; mostly nonplastic fines; lensed CLAY.			
40		S-8	34		SANDY lean CLAY (CL); hard; olive gray; moist; trace fine GRAVEL; little fine SAND; mostly low to medium plasticity fines; Lensed CLAY; GRAVEL is angular to subangular.			
45		S-9	23		Lean CLAY with GRAVEL (CL); very stiff; olive gray; moist; little fine GRAVEL; few fine SAND; mostly medium plasticity fines; GRAVEL is angular to subangular- cementation; lensed SILT.			
50		S-10	42		SANDY SILT (ML); hard; olive gray; moist; few fine GRAVEL; some fine SAND; mostly low plasticity fines; GRAVEL is angular to subangular- cementation; lensed CLAY.			
					Bottom of borehole at 51.5 ft bgs			

EMI BORING LOG 21-169.GPJ EMI CALTRANS 2013 V2.0.GLB 5/27/22

Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

KHA, Broadway- Manchester STP Dry Wells

Project Number: 21-169 | Date: 4-28-22

LOG OF BORING NO. A-22-008

Grade Elevation:	128.0 ft				
Boring Depth:	51.5 ft	Driller:	ABC Liovin Drilling	SHEET 1 of 2	
Borehole Diameter:	8"	Type of Rig:		Comments:	
Date Drilled:	4-5-22	Hammer Data:	Automatic Hammer, 140 lbs/ 30 in drop		
Logged By:	DV	Groundwater Reading:			

Depth (ft)	Sample Type	Sample	Blows/foot	Graphic Log	GEOTECHNICAL DESCRIPTION	Moisture (%)	Dry Density (pcf)	Test/ Results
0					SILTY SAND with GRAVEL (SM); brown; moist; little coarse to fine GRAVEL; mostly coarse to fine SAND; little nonplastic to low plasticity fines; GRAVEL is angular to subangualr; rock fragments; lensed CLAY.			
5	X	S-1	22		CLAYEY SAND with GRAVEL (SC); medium dense; brown; moist; little fine GRAVEL; mostly coarse to fine SAND; some low to medium plasticity fines; GRAVEL is angular to subangular; lensed SILT; borderline SANDY Lean CLAY.			
10	X	S-2	31		Poorly graded SAND with SILT (SP-SM); dense; olive brown; moist; few fine GRAVEL; mostly medium to fine SAND; few nonplastic fines; GRAVEL is angular to subangular.			
15	X	S-3	56		Very dense.			
20	X	S-4	67					
25								

(continued)

(CONTINUED) LOG OF BORING NO. A-22-008

Date Drilled:	4-5-22	Comments:	SHEET 2 of 2
Logged By:	DV		

Depth (ft)	Sample Type	Sample	Blows/foot	Graphic Log	GEOTECHNICAL DESCRIPTION	Moisture (%)	Dry Density (pcf)	Test/ Results
25		S-5	55		Poorly graded SAND with SILT and GRAVEL (SP-SM); very dense; olive gray; dry to moist; little fine GRAVEL; mostly coarse to medium SAND; few nonplastic fines; GRAVEL is angular to subangular; borderline SILTY SAND.			
30		S-6	31		SANDY SILT (ML); hard; olive gray; moist; few fine GRAVEL; some medium to fine SAND; mostly low to medium plasticity fines; GRAVEL is angular to subangular- cementation; lensed SILT/ CLAY.			
35		S-7	19		Very stiff; fine SAND; nonplastic to low plasticity fines; lensed CLAY.			
40		S-8	21		SANDY lean CLAY with GRAVEL (CL); very stiff; olive gray; moist; little fine GRAVEL; little fine SAND; mostly low to medium plasticity fines; GRAVEL is angular to subangular- cementation; lensed CLAY/ SILT.			
45		S-8	20					
50		S-10	31		Hard.			
					Bottom of borehole at 51.5 ft bgs			

EMI BORING LOG 21-169.GPJ EMI CALTRANS 2013 V2.0.GLB 5/27/22

Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

KHA, Broadway- Manchester STP Dry Wells

Project Number: 21-169 | Date: 4-28-22

LOG OF BORING NO. A-22-009

Grade Elevation:	**131.0 ft**				
Boring Depth:	**51.5 ft**	Driller:	**ABC Liovin Drilling**	SHEET **1 of 2**	
Borehole Diameter:	**8"**	Type of Rig:		Comments:	
Date Drilled:	**4-6-22**	Hammer Data:	**Automatic Hammer, 140 lbs/ 30 in drop**		
Logged By:	**DV**	Groundwater Reading:			

Depth (ft)	Sample Type	Sample	Blows/foot	Graphic Log	GEOTECHNICAL DESCRIPTION	Moisture (%)	Dry Density (pcf)	Test/ Results
0					SILTY SAND (SM); brown; moist; few coarse to fine GRAVEL; mostly coarse to fine SAND; some low plasticity fines; GRAVEL is angular to subangular; some CLAY; lensed roots and grass.			
5	X	S-1	34		CLAYEY SAND (SC); dense; brown; moist; few fine GRAVEL; mostly coarse to fine SAND; some low to medium plasticity fines; GRAVEL is angular to subangular.			
10	X	S-2	17		SANDY SILT (ML); very stiff; olive brown; moist; few fine GRAVEL; some medium to fine SAND; mostly low plasticity fines; GRAVEL is angular to subangular; lensed CLAYEY SAND and CLAY.			
15	X	S-3	22		Olive brown to olive gray; little fine GRAVEL; fine SAND; lensed CLAY.			
20	X	S-4	29		SILT with SAND (ML); very stiff; olive gray; few fine GRAVEL; few fine SAND; mostly low to medium plasticity fines; GRAVEL is angular to subangular- cementation; lensed SILT/ CLAY.			
25								

(continued)

(CONTINUED) LOG OF BORING NO. A-22-009

Date Drilled:	4-6-22	Comments:	SHEET 2 of 2
Logged By:	DV		

Depth (ft)	Sample Type	Sample	Blows/foot	Graphic Log	GEOTECHNICAL DESCRIPTION	Moisture (%)	Dry Density (pcf)	Test/ Results
25	X	S-5	32		Hard; trace GRAVEL; low plasticity fines; lensed roots; some CLAY to CLAYEY SILT. SILT with SAND (ML) *(continued)*.			
30	X	S-6	34		Lean CLAY with SAND (CL); hard; olive gray; moist; few fine GRAVEL; few fine SAND; mostly low to medium plasticity fines; GRAVEL is angular to subangular- cementation; lensed SILT and CLAY.			
35	X	S-7	23		Very stiff; trace GRAVEL; medium plasticity fines.			
40	X	S-8	31		SANDY lean CLAY with GRAVEL (CL); hard; brown; moist; little fine GRAVEL; some coarse to fine SAND; mostly low to medium plasticity fines; GRAVEL is angular to subangular; lensed SANDY Lean CLAY.			
45	X	S-9	37		CLAYEY SAND (SC); dense; brown; moist; few fine GRAVEL; mostly coarse to medium SAND; little low plasticity fines; GRAVEL is angular to subangular; lensed SANDY Lean CLAY.			
50	X	S-10	45		SANDY SILT (ML); hard; brown to olive brown; moist; few fine GRAVEL; little medium to fine SAND; mostly low plasticity fines; lensed SILT with SAND and SILTY SAND; GRAVEL is angular to subangular- cementation; some CLAY.			
					Bottom of borehole at 51.5 ft bgs			

LOG OF BORING NO. A-22-010

Grade Elevation:	**133.0 ft**				
Boring Depth:	**51.5 ft**	Driller:	**ABC Liovin Drilling**		SHEET **1 of 2**
Borehole Diameter:	**8"**	Type of Rig:		Comments:	
Date Drilled:	**4-6-22**	Hammer Data:	**Automatic Hammer, 140 lbs/ 30 in drop**		
Logged By:	**DV**	Groundwater Reading:			

Depth (ft)	Sample Type	Sample	Blows/foot	Graphic Log	GEOTECHNICAL DESCRIPTION	Moisture (%)	Dry Density (pcf)	Test/ Results
0					SILTY SAND (SM); brown; moist; few fine GRAVEL; mostly coarse to fine SAND; some low plasticity fines; GRAVEL is angular to subangular; some CLAY.			
5	X	S-1	40		CLAYEY SAND (SC); dense; brown; moist; few fine GRAVEL; mostly coarse to fine SAND; some low to medium plasticity fines; GRAVEL is angular to subangular; lensed SILT.			
10	X	S-2	35		SANDY SILT (ML); hard; olive brown; moist; few fine GRAVEL; some medium to fine SAND; mostly nonplastic to low plasticity fines; GRAVEL is angular to subangular; lensed CLAY.			
15	X	S-3	26		SILTY SAND (SM); medium dense; olive brown; moist; mostly medium to fine SAND; some nonplastic to low plasticity fines; lensed SAND and SILT; borderline SANDY SILT.			
20	X	S-4	27		Poorly graded SAND with SILT (SP-SM); medium dense; olive brown; moist; few fine GRAVEL; mostly medium to fine SAND; few nonplastic fines; GRAVEL is angular to subangular; lensed SILT/ CLAY.			
25								

(continued)

(CONTINUED) LOG OF BORING NO. A-22-010

Date Drilled:	4-6-22	Comments:	SHEET 2 of 2
Logged By:	DV		

Depth (ft)	Sample Type	Sample	Blows/foot	Graphic Log	GEOTECHNICAL DESCRIPTION	Moisture (%)	Dry Density (pcf)	Test/ Results
25	X	S-5	57		Very dense; lensed SILTY SAND. Poorly graded SAND with SILT (SP-SM) *(continued)*.			
30	X	S-6	58		Poorly graded SAND with SILT and GRAVEL (SP-SM); very dense; light brown; moist; little fine GRAVEL; mostly coarse to medium SAND; few nonplastic fines; GRAVEL is angular to subangular; lensed SILT/ CLAY.			
35	X	S-7	25		SANDY lean CLAY (CL); very stiff; olive gray; moist; few fine GRAVEL; little fine SAND; mostly medium plasticity fines; GRAVEL is angular to subangular; lensed SILT/ CLAY.			
40	X	S-8	44		Lean CLAY with SAND (CL); hard; olive gray; moist; trace fine GRAVEL; few fine SAND; mostly medium plasticity fines; GRAVEL is angular to subangular; lensed SILT/ CLAY.			
45	X	S-9	16		Very stiff; cementation; lensed SILT.			
50	X	S-10	23		Lensed SILT/ CLAY- some SANDY SILT.			
					Bottom of borehole at 51.5 ft bgs			

EMI BORING LOG 21-169.GPJ EMI CALTRANS 2013 V2.0.GLB 5/27/22

Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

KHA, Broadway- Manchester STP Dry Wells

Project Number: 21-169 | Date: 4-28-22

LOG OF BORING NO. A-22-011

Grade Elevation:	135.0 ft				
Boring Depth:	51.5 ft	Driller:	ABC Liovin Drilling	SHEET 1 of 2	
Borehole Diameter:	8"	Type of Rig:		Comments:	
Date Drilled:	4-7-22	Hammer Data:	Automatic Hammer, 140 lbs/ 30 in drop		
Logged By:	DV	Groundwater Reading:			

Depth (ft)	Sample Type	Sample	Blows/foot	Graphic Log	GEOTECHNICAL DESCRIPTION	Moisture (%)	Dry Density (pcf)	Test/ Results
0					SILTY SAND with GRAVEL (SM); brown; moist; little fine GRAVEL; mostly coarse to fine SAND; little low plasticity fines; GRAVEL is angular to subangular; some CLAY.			
5		S-1	55		SANDY SILT with GRAVEL (ML); hard; olive brown; dry to moist; little fine GRAVEL; some medium to fine SAND; mostly low plasticity fines; GRAVEL is angular to subangular; lensed CLAY; some cementation.			
10		S-2	38		Low to medium plasticity fines.			
15		S-3	42		SANDY lean CLAY with GRAVEL (CL); hard; brown; moist; little fine GRAVEL; some coarse to fine SAND; mostly medium plasticity fines; GRAVEL is angular to subangular- cementation; lensed SILT.			
20		S-4	49		SILTY SAND (SM); dense; brown; moist; few fine GRAVEL; mostly medium to fine SAND; some nonplastic to low plasticity fines; GRAVEL is angular to subangular; lensed SILT/ CLAY.			
25								

(continued)

(CONTINUED) LOG OF BORING NO. A-22-011

Date Drilled:	4-7-22	Comments:	SHEET 2 of 2
Logged By:	DV		

Depth (ft)	Sample Type	Sample	Blows/foot	Graphic Log	GEOTECHNICAL DESCRIPTION	Moisture (%)	Dry Density (pcf)	Test/ Results
25	X	S-5	26		SANDY SILT (ML); very stiff; olive brown; moist; trace fine GRAVEL; some fine SAND; mostly nonplastic to low plasticity fines; GRAVEL is angular to subangular; lensed SILT/ CLAY- borderline SILTY SAND.			
30	X	S-6	84		SILTY SAND (SM); very dense; olive brown; moist; trace fine GRAVEL; mostly medium to fine SAND; some nonplastic fines; GRAVEL is angular to subangular; lensed SANDY SILT.			
35	X	S-7	54					
40	X	S-8	45		SANDY SILT (ML); hard; brown; moist; few fine GRAVEL; some medium to fine SAND; mostly low plasticity fines; GRAVEL is angular to subangular- cementation; lensed CLAY.			
45	X	S-9	47		Lean CLAY with SAND (CL); hard; olive brown; moist; few fine SAND; mostly medium plasticity fines; lensed SILT and SAND.			
50	X	S-10	42		SILTY SAND (SM); hard; brown; moist; mostly fine SAND; some nonplastic fines; lensed SANDY SIT; some CLAY.			
					Bottom of borehole at 51.5 ft bgs			

EMI BORING LOG 21-169.GPJ EMI CALTRANS 2013 V2.0.GLB 5/27/22

Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

KHA, Broadway- Manchester STP Dry Wells

Project Number: 21-169 | Date: 4-28-22

Appendix C

Hydrographs

The peak flow rate and the runoff volume for the 50-year, 25-year and 10-year, 24-hour events are summarized in **Table 1**

Table 1: Drainage Area Peak Flow

Drainage Area	Area (ac)	10-year Peak Flow (cfs)	25-year Peak Flow (cfs)	50-year Peak Flow (cfs)
DA-1	45.05	34.33	42.69	48.99
DA-2	95.95	67.99	85.04	97.98
DA-3	30.83	25.46	31.65	36.32
DA-4	25.91	20.95	26.41	30.62
Total	197.74	148.73	185.79	213.91

The runoff volumes for the 85^{th} percentile storm, 50-year, 25-year and 10-year storm events are summarized in **Table 2**

Table 2: Drainage Area Runoff Volume

Drainage Area	Area (ac)	10-year Runoff Volume (ac-ft)	25-year Runoff Volume (ac-ft)	50-year Runoff Volume (ac-ft)
DA-1	45.05	10.97	13.51	15.40
DA-2	95.95	21.66	26.68	30.43
DA-3	30.83	7.33	9.06	10.36
DA-4	25.91	6.23	7.70	8.80
Total	197.74	46.19	56.95	64.99

Peak Flow Hydrologic Analysis

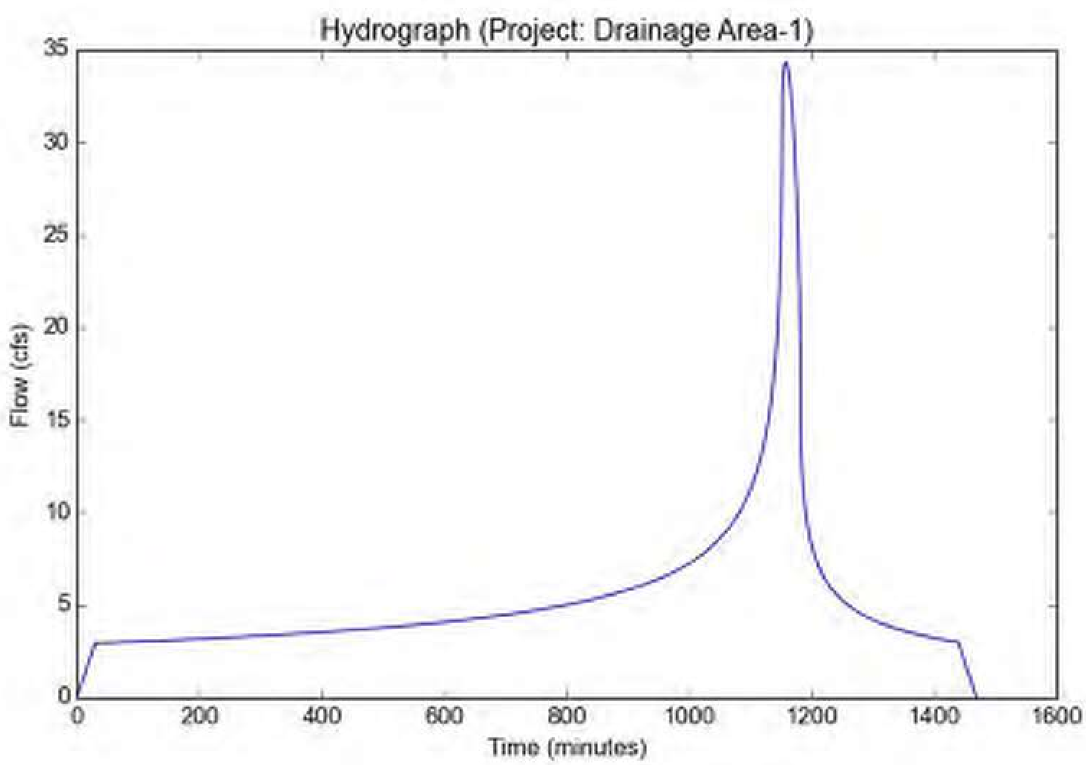
File location: D:/Task/Manchester2/HydroCalc results/Drainage Area 1/Project - Drainage Area-1-10yr.pdf
Version: HydroCalc 1.0.3

Input Parameters

Project Name	Project
Subarea ID	Drainage Area-1
Area (ac)	45.05
Flow Path Length (ft)	3061.0
Flow Path Slope (vft/hft)	0.00392
50-yr Rainfall Depth (in)	5.4
Percent Impervious	0.83
Soil Type	3
Design Storm Frequency	10-yr
Fire Factor	0
LID	False

Output Results

Modeled (10-yr) Rainfall Depth (in)	3.8556
Peak Intensity (in/hr)	0.991
Undeveloped Runoff Coefficient (Cu)	0.1293
Developed Runoff Coefficient (Cd)	0.769
Time of Concentration (min)	30.0
Clear Peak Flow Rate (cfs)	34.3304
Burned Peak Flow Rate (cfs)	34.3304
24-Hr Clear Runoff Volume (ac-ft)	10.9718
24-Hr Clear Runoff Volume (cu-ft)	477929.9118



Peak Flow Hydrologic Analysis

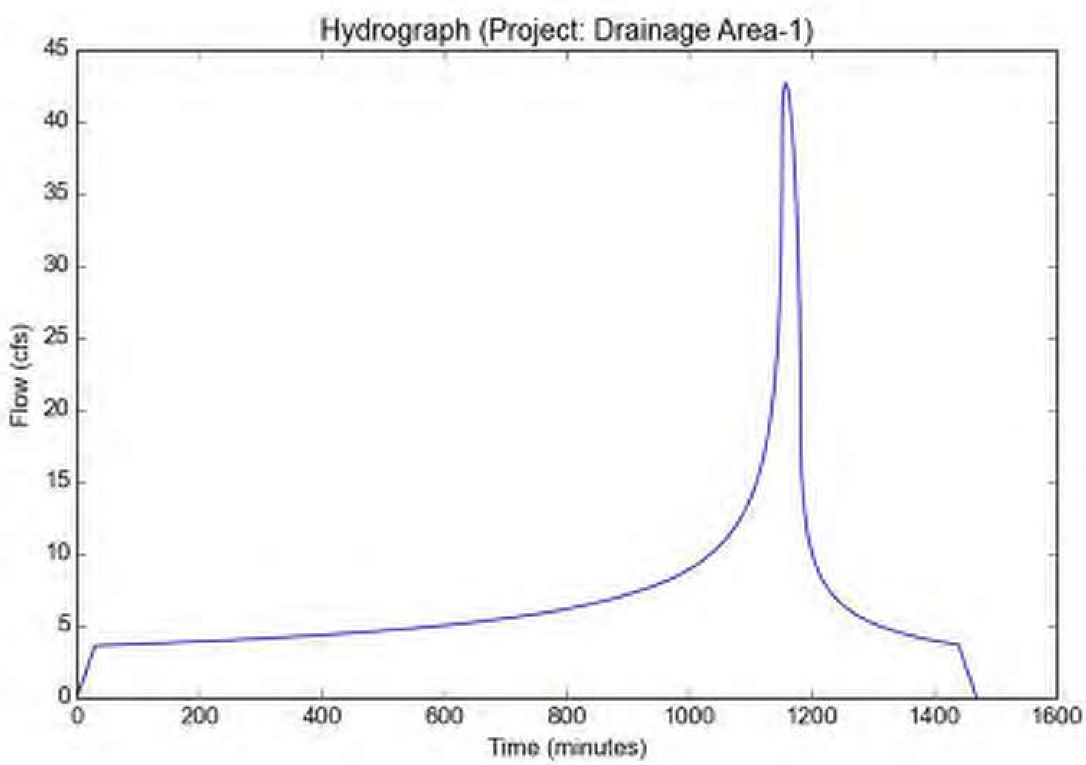
File location: D:/Task/Manchester2/HydroCalc results/Drainage Area 1/Project - Drainage Area-1-25yr.pdf
Version: HydroCalc 1.0.3

Input Parameters

Project Name	Project
Subarea ID	Drainage Area-1
Area (ac)	45.05
Flow Path Length (ft)	3061.0
Flow Path Slope (vft/hft)	0.00392
50-yr Rainfall Depth (in)	5.4
Percent Impervious	0.83
Soil Type	3
Design Storm Frequency	25-yr
Fire Factor	0
LID	False

Output Results

Modeled (25-yr) Rainfall Depth (in)	4.7412
Peak Intensity (in/hr)	1.2186
Undeveloped Runoff Coefficient (Cu)	0.1803
Developed Runoff Coefficient (Cd)	0.7777
Time of Concentration (min)	30.0
Clear Peak Flow Rate (cfs)	42.6918
Burned Peak Flow Rate (cfs)	42.6918
24-Hr Clear Runoff Volume (ac-ft)	13.5066
24-Hr Clear Runoff Volume (cu-ft)	588347.025



Peak Flow Hydrologic Analysis

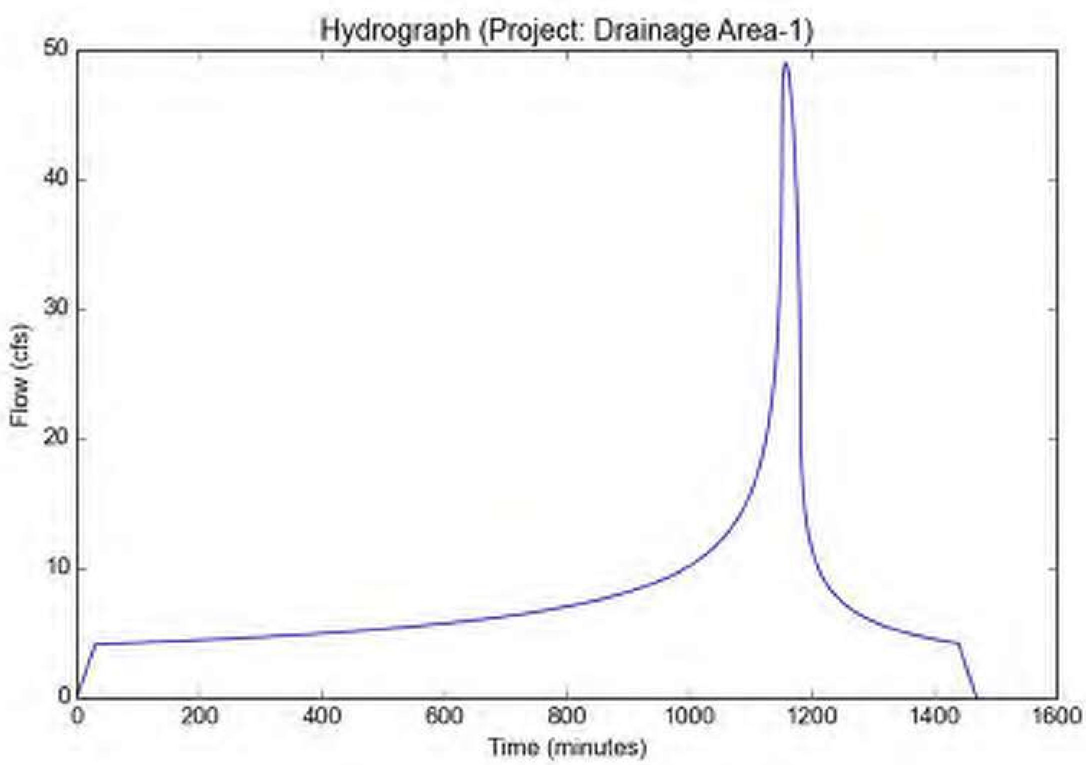
File location: D:/Task/Manchester2/HydroCalc results/Drainage Area 1/Project - Drainage Area-1-50yr.pdf
Version: HydroCalc 1.0.3

Input Parameters

Project Name	Project
Subarea ID	Drainage Area-1
Area (ac)	45.05
Flow Path Length (ft)	3061.0
Flow Path Slope (vft/hft)	0.00392
50-yr Rainfall Depth (in)	5.4
Percent Impervious	0.83
Soil Type	3
Design Storm Frequency	50-yr
Fire Factor	0
LID	False

Output Results

Modeled (50-yr) Rainfall Depth (in)	5.4
Peak Intensity (in/hr)	1.3879
Undeveloped Runoff Coefficient (Cu)	0.2157
Developed Runoff Coefficient (Cd)	0.7837
Time of Concentration (min)	30.0
Clear Peak Flow Rate (cfs)	48.9994
Burned Peak Flow Rate (cfs)	48.9994
24-Hr Clear Runoff Volume (ac-ft)	15.3973
24-Hr Clear Runoff Volume (cu-ft)	670705.262



Peak Flow Hydrologic Analysis

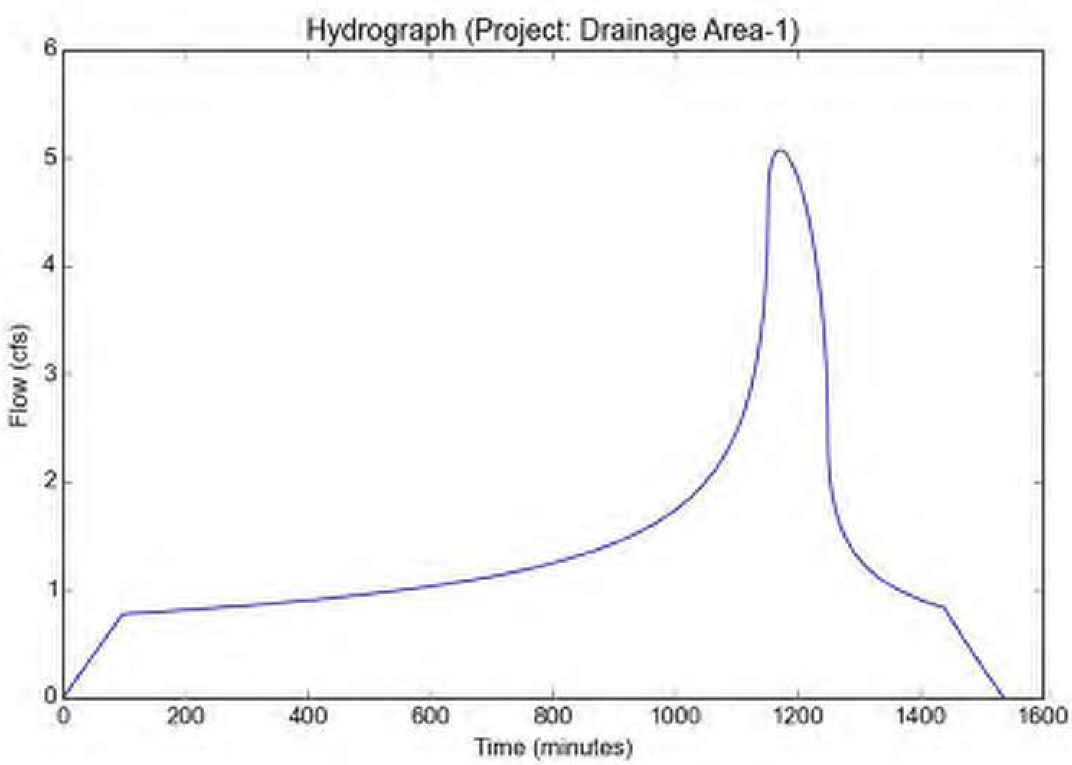
File location: D:/Task/Manchester2/HydroCalc results/Drainage Area 1/Project - Drainage Area-1-85th percentile.pdf
Version: HydroCalc 1.0.3

Input Parameters

Project Name	Project
Subarea ID	Drainage Area-1
Area (ac)	45.05
Flow Path Length (ft)	3061.0
Flow Path Slope (vft/hft)	0.00392
85th Percentile Rainfall Depth (in)	1.0
Percent Impervious	0.83
Soil Type	3
Design Storm Frequency	85th percentile storm
Fire Factor	0
LID	True

Output Results

Modeled (85th percentile storm) Rainfall Depth (in)	1.0
Peak Intensity (in/hr)	0.1473
Undeveloped Runoff Coefficient (Cu)	0.1
Developed Runoff Coefficient (Cd)	0.764
Time of Concentration (min)	98.0
Clear Peak Flow Rate (cfs)	5.0714
Burned Peak Flow Rate (cfs)	5.0714
24-Hr Clear Runoff Volume (ac-ft)	2.8448
24-Hr Clear Runoff Volume (cu-ft)	123921.4047



Peak Flow Hydrologic Analysis

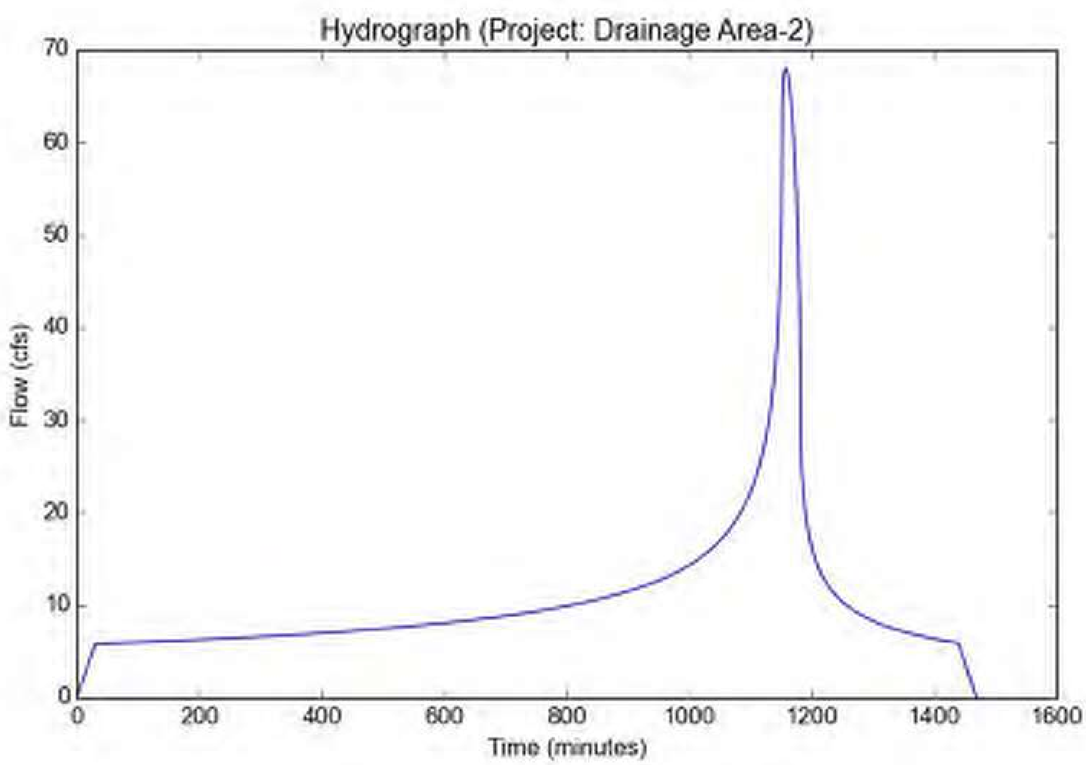
File location: D:/Task/Manchester2/HydroCalc results/Drainage Area 2/Project - Drainage Area-2-10yr.pdf
Version: HydroCalc 1.0.3

Input Parameters

Project Name	Project
Subarea ID	Drainage Area-2
Area (ac)	95.95
Flow Path Length (ft)	4773.0
Flow Path Slope (vft/hft)	0.0044
50-yr Rainfall Depth (in)	5.4
Percent Impervious	0.76
Soil Type	3
Design Storm Frequency	10-yr
Fire Factor	0
LID	False

Output Results

Modeled (10-yr) Rainfall Depth (in)	3.8556
Peak Intensity (in/hr)	0.991
Undeveloped Runoff Coefficient (Cu)	0.1293
Developed Runoff Coefficient (Cd)	0.715
Time of Concentration (min)	30.0
Clear Peak Flow Rate (cfs)	67.9894
Burned Peak Flow Rate (cfs)	67.9894
24-Hr Clear Runoff Volume (ac-ft)	21.66
24-Hr Clear Runoff Volume (cu-ft)	943510.4268



Peak Flow Hydrologic Analysis

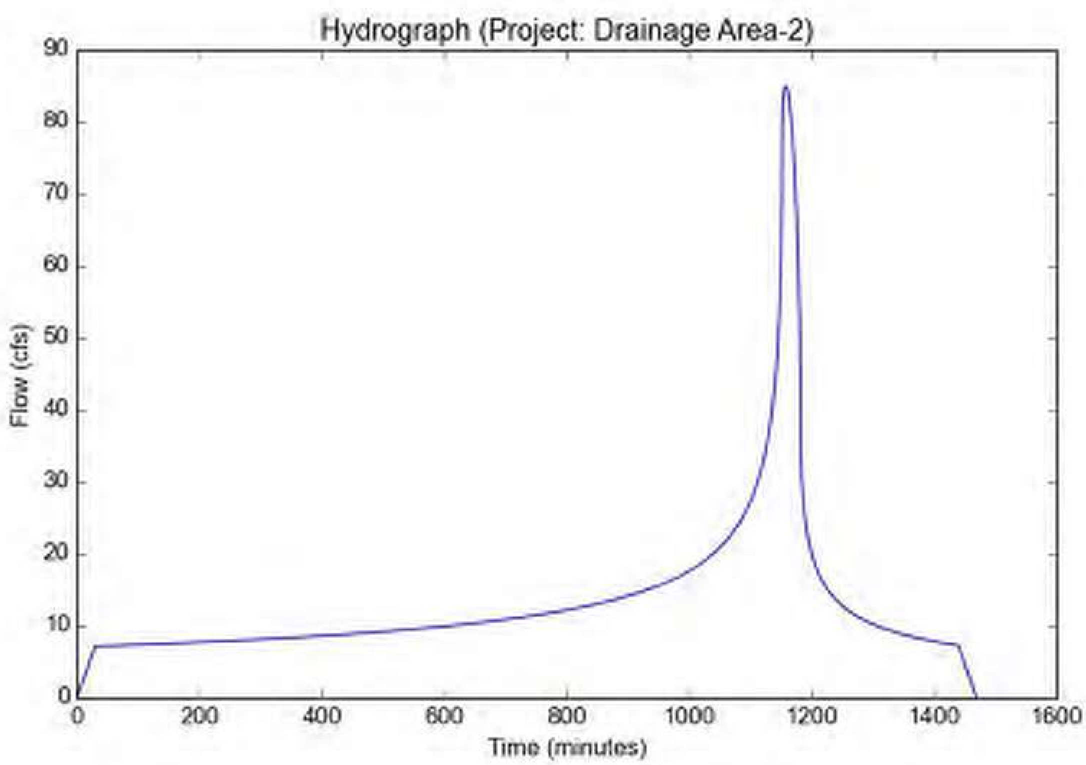
File location: D:/Task/Manchester2/HydroCalc results/Drainage Area 2/Project - Drainage Area-2-25yr.pdf
Version: HydroCalc 1.0.3

Input Parameters

Project Name	Project
Subarea ID	Drainage Area-2
Area (ac)	95.95
Flow Path Length (ft)	4773.0
Flow Path Slope (vft/hft)	0.0044
50-yr Rainfall Depth (in)	5.4
Percent Impervious	0.76
Soil Type	3
Design Storm Frequency	25-yr
Fire Factor	0
LID	False

Output Results

Modeled (25-yr) Rainfall Depth (in)	4.7412
Peak Intensity (in/hr)	1.2186
Undeveloped Runoff Coefficient (Cu)	0.1803
Developed Runoff Coefficient (Cd)	0.7273
Time of Concentration (min)	30.0
Clear Peak Flow Rate (cfs)	85.0372
Burned Peak Flow Rate (cfs)	85.0372
24-Hr Clear Runoff Volume (ac-ft)	26.6794
24-Hr Clear Runoff Volume (cu-ft)	1162152.9824



Peak Flow Hydrologic Analysis

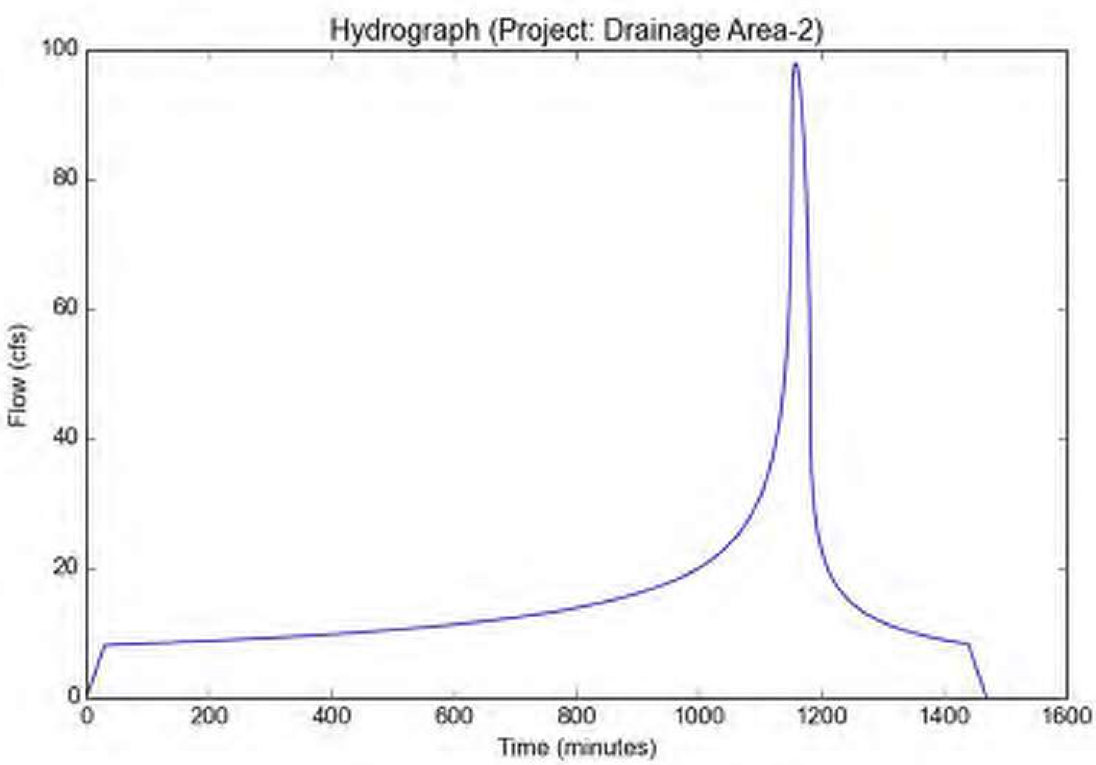
File location: D:/Task/Manchester2/HydroCalc results/Drainage Area 2/Project - Drainage Area-2-50yr.pdf
Version: HydroCalc 1.0.3

Input Parameters

Project Name	Project
Subarea ID	Drainage Area-2
Area (ac)	95.95
Flow Path Length (ft)	4773.0
Flow Path Slope (vft/hft)	0.0044
50-yr Rainfall Depth (in)	5.4
Percent Impervious	0.76
Soil Type	3
Design Storm Frequency	50-yr
Fire Factor	0
LID	False

Output Results

Modeled (50-yr) Rainfall Depth (in)	5.4
Peak Intensity (in/hr)	1.3879
Undeveloped Runoff Coefficient (Cu)	0.2157
Developed Runoff Coefficient (Cd)	0.7358
Time of Concentration (min)	30.0
Clear Peak Flow Rate (cfs)	97.9824
Burned Peak Flow Rate (cfs)	97.9824
24-Hr Clear Runoff Volume (ac-ft)	30.4284
24-Hr Clear Runoff Volume (cu-ft)	1325459.2437



Peak Flow Hydrologic Analysis

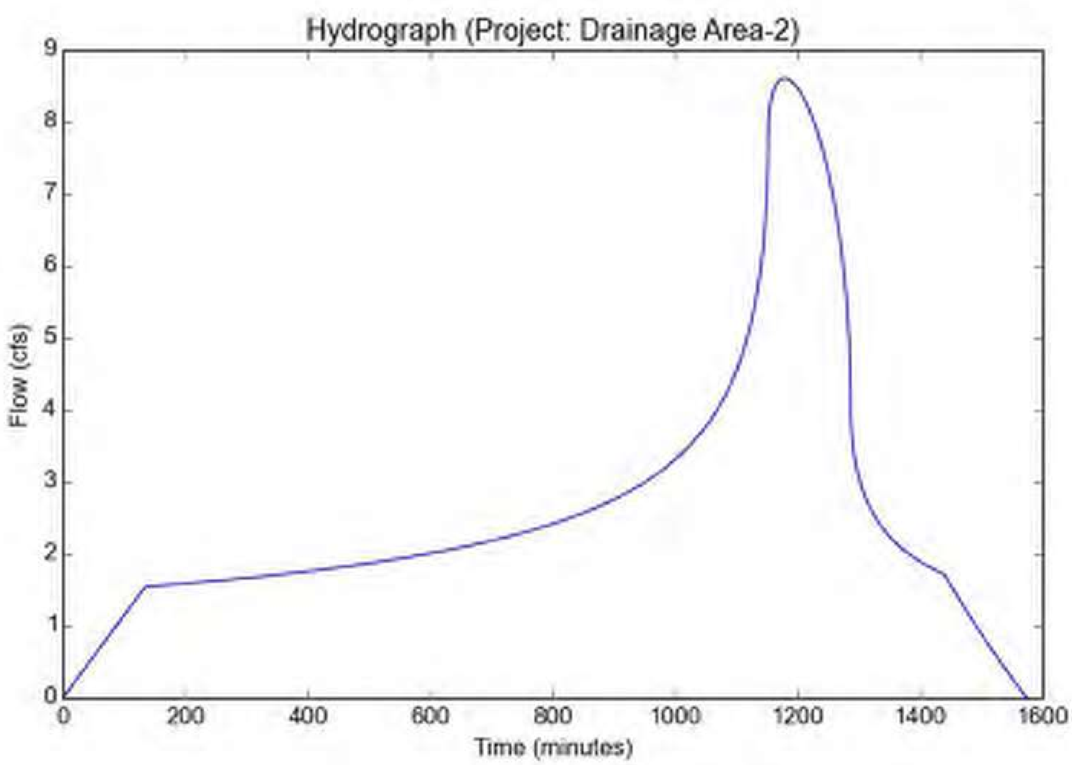
File location: D:/Task/Manchester2/HydroCalc results/Drainage Area 2/Project - Drainage Area-2-85th percentile.pdf
Version: HydroCalc 1.0.3

Input Parameters

Project Name	Project
Subarea ID	Drainage Area-2
Area (ac)	95.95
Flow Path Length (ft)	4773.0
Flow Path Slope (vft/hft)	0.0044
85th Percentile Rainfall Depth (in)	1.0
Percent Impervious	0.76
Soil Type	3
Design Storm Frequency	85th percentile storm
Fire Factor	0
LID	True

Output Results

Modeled (85th percentile storm) Rainfall Depth (in)	1.0
Peak Intensity (in/hr)	0.1268
Undeveloped Runoff Coefficient (Cu)	0.1
Developed Runoff Coefficient (Cd)	0.708
Time of Concentration (min)	135.0
Clear Peak Flow Rate (cfs)	8.6107
Burned Peak Flow Rate (cfs)	8.6107
24-Hr Clear Runoff Volume (ac-ft)	5.6157
24-Hr Clear Runoff Volume (cu-ft)	244618.3957



Peak Flow Hydrologic Analysis

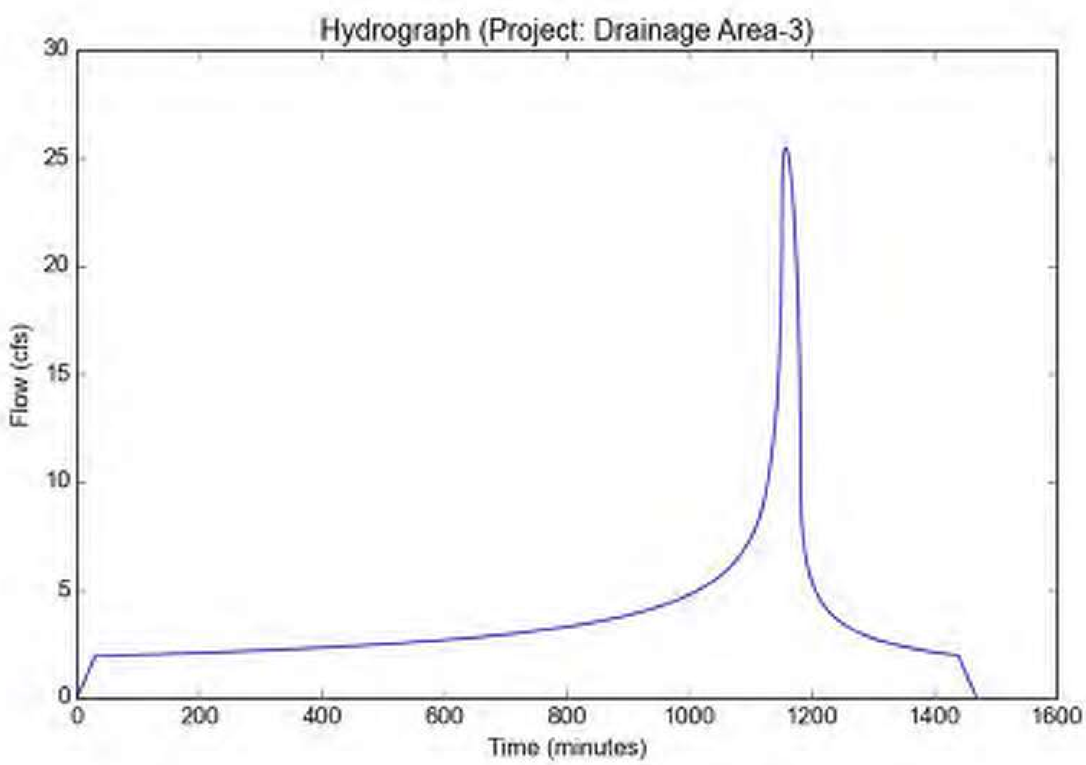
File location: D:/Task/Manchester2/HydroCalc results/Drainage Area 3/Project - Drainage Area-10yr.pdf
Version: HydroCalc 1.0.3

Input Parameters

Project Name	Project
Subarea ID	Drainage Area-3
Area (ac)	30.83
Flow Path Length (ft)	3321.0
Flow Path Slope (vft/hft)	0.00301
50-yr Rainfall Depth (in)	5.4
Percent Impervious	0.79
Soil Type	6
Design Storm Frequency	10-yr
Fire Factor	0
LID	False

Output Results

Modeled (10-yr) Rainfall Depth (in)	3.8556
Peak Intensity (in/hr)	0.991
Undeveloped Runoff Coefficient (Cu)	0.5821
Developed Runoff Coefficient (Cd)	0.8332
Time of Concentration (min)	30.0
Clear Peak Flow Rate (cfs)	25.4572
Burned Peak Flow Rate (cfs)	25.4572
24-Hr Clear Runoff Volume (ac-ft)	7.3294
24-Hr Clear Runoff Volume (cu-ft)	319267.3755



Peak Flow Hydrologic Analysis

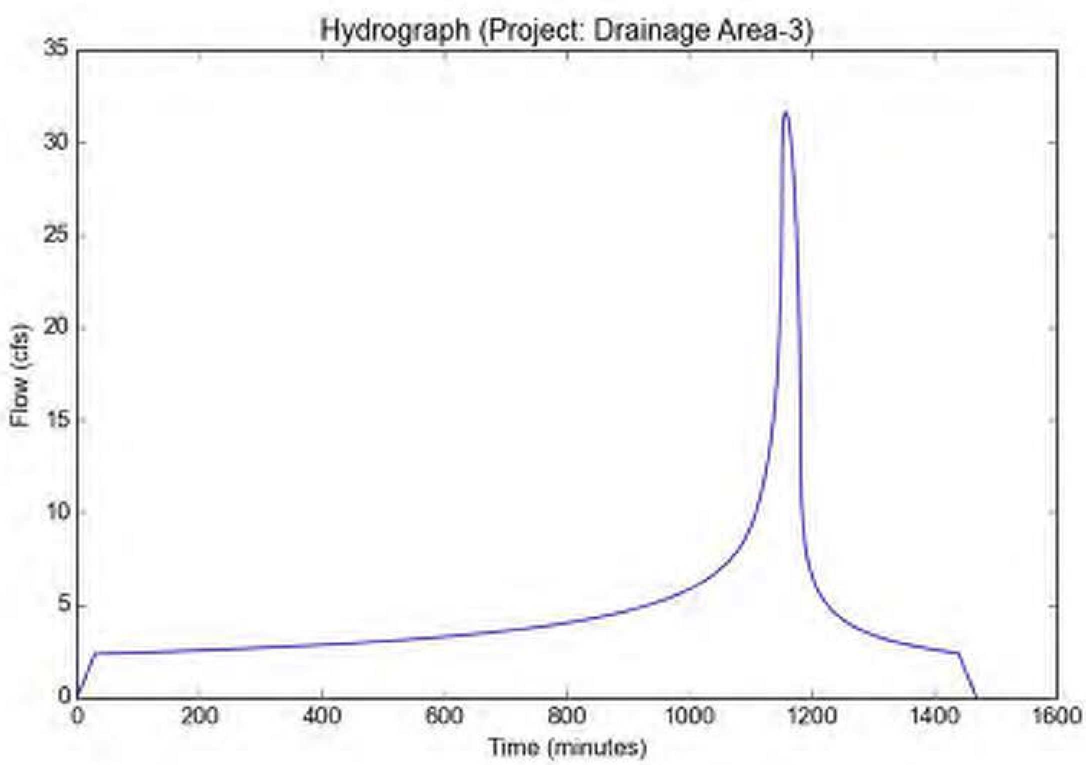
File location: D:/Task/Manchester2/HydroCalc results/Drainage Area 3/Project - Drainage Area-25yr.pdf
Version: HydroCalc 1.0.3

Input Parameters

Project Name	Project
Subarea ID	Drainage Area-3
Area (ac)	30.83
Flow Path Length (ft)	3321.0
Flow Path Slope (vft/hft)	0.00301
50-yr Rainfall Depth (in)	5.4
Percent Impervious	0.79
Soil Type	6
Design Storm Frequency	25-yr
Fire Factor	0
LID	False

Output Results

Modeled (25-yr) Rainfall Depth (in)	4.7412
Peak Intensity (in/hr)	1.2186
Undeveloped Runoff Coefficient (Cu)	0.6255
Developed Runoff Coefficient (Cd)	0.8424
Time of Concentration (min)	30.0
Clear Peak Flow Rate (cfs)	31.6469
Burned Peak Flow Rate (cfs)	31.6469
24-Hr Clear Runoff Volume (ac-ft)	9.0596
24-Hr Clear Runoff Volume (cu-ft)	394638.0605



Peak Flow Hydrologic Analysis

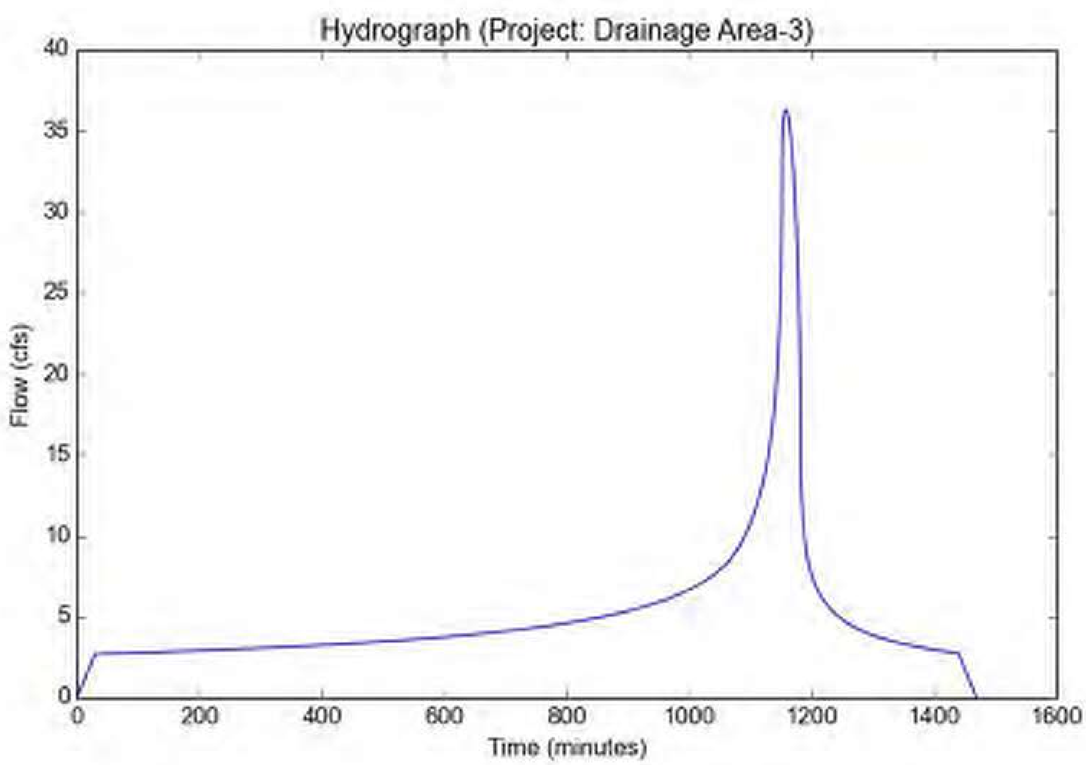
File location: D:/Task/Manchester2/HydroCalc results/Drainage Area 3/Project - Drainage Area-50yr.pdf
Version: HydroCalc 1.0.3

Input Parameters

Project Name	Project
Subarea ID	Drainage Area-3
Area (ac)	30.83
Flow Path Length (ft)	3321.0
Flow Path Slope (vft/hft)	0.00301
50-yr Rainfall Depth (in)	5.4
Percent Impervious	0.79
Soil Type	6
Design Storm Frequency	50-yr
Fire Factor	0
LID	False

Output Results

Modeled (50-yr) Rainfall Depth (in)	5.4
Peak Intensity (in/hr)	1.3879
Undeveloped Runoff Coefficient (Cu)	0.6567
Developed Runoff Coefficient (Cd)	0.8489
Time of Concentration (min)	30.0
Clear Peak Flow Rate (cfs)	36.3249
Burned Peak Flow Rate (cfs)	36.3249
24-Hr Clear Runoff Volume (ac-ft)	10.3592
24-Hr Clear Runoff Volume (cu-ft)	451248.7252



Peak Flow Hydrologic Analysis

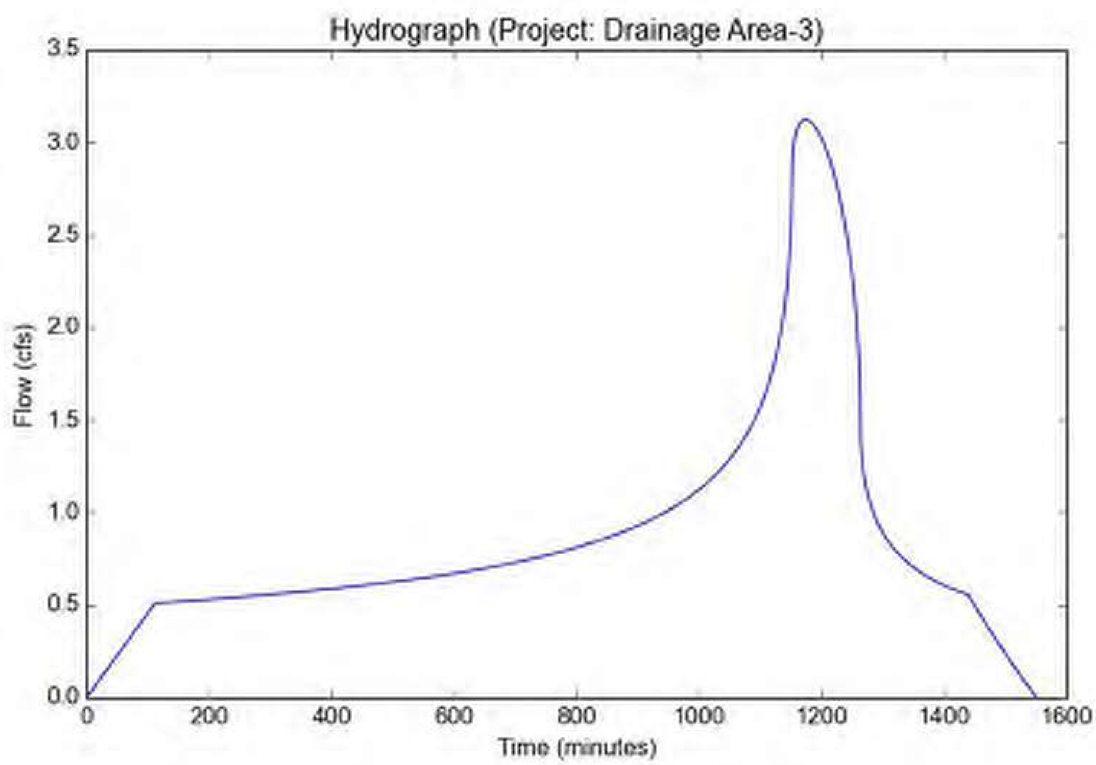
File location: D:/Task/Manchester2/HydroCalc results/Drainage Area 3/Project - Drainage Area-3-85th percentile.pdf
Version: HydroCalc 1.0.3

Input Parameters

Project Name	Project
Subarea ID	Drainage Area-3
Area (ac)	30.83
Flow Path Length (ft)	3321.0
Flow Path Slope (vft/hft)	0.00301
85th Percentile Rainfall Depth (in)	1.0
Percent Impervious	0.79
Soil Type	6
Design Storm Frequency	85th percentile storm
Fire Factor	0
LID	True

Output Results

Modeled (85th percentile storm) Rainfall Depth (in)	1.0
Peak Intensity (in/hr)	0.1384
Undeveloped Runoff Coefficient (Cu)	0.1
Developed Runoff Coefficient (Cd)	0.732
Time of Concentration (min)	112.0
Clear Peak Flow Rate (cfs)	3.123
Burned Peak Flow Rate (cfs)	3.123
24-Hr Clear Runoff Volume (ac-ft)	1.8654
24-Hr Clear Runoff Volume (cu-ft)	81256.9509



Peak Flow Hydrologic Analysis

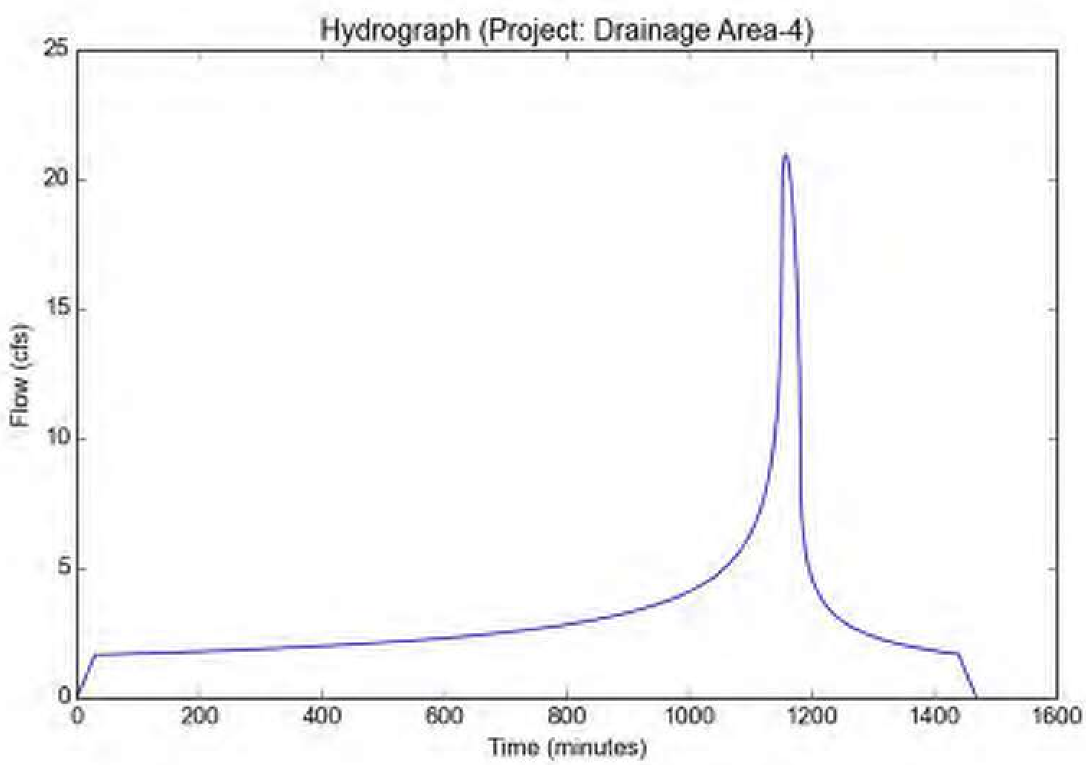
File location: D:/Task/Manchester2/HydroCalc results/Drainage Area 4/Project - Drainage Area-4-10yr.pdf
Version: HydroCalc 1.0.3

Input Parameters

Project Name	Project
Subarea ID	Drainage Area-4
Area (ac)	25.91
Flow Path Length (ft)	3281.0
Flow Path Slope (vft/hft)	0.00396
50-yr Rainfall Depth (in)	5.4
Percent Impervious	0.81
Soil Type	13
Design Storm Frequency	10-yr
Fire Factor	0
LID	False

Output Results

Modeled (10-yr) Rainfall Depth (in)	3.8556
Peak Intensity (in/hr)	0.991
Undeveloped Runoff Coefficient (Cu)	0.4574
Developed Runoff Coefficient (Cd)	0.8159
Time of Concentration (min)	30.0
Clear Peak Flow Rate (cfs)	20.9496
Burned Peak Flow Rate (cfs)	20.9496
24-Hr Clear Runoff Volume (ac-ft)	6.2333
24-Hr Clear Runoff Volume (cu-ft)	271521.1015



Peak Flow Hydrologic Analysis

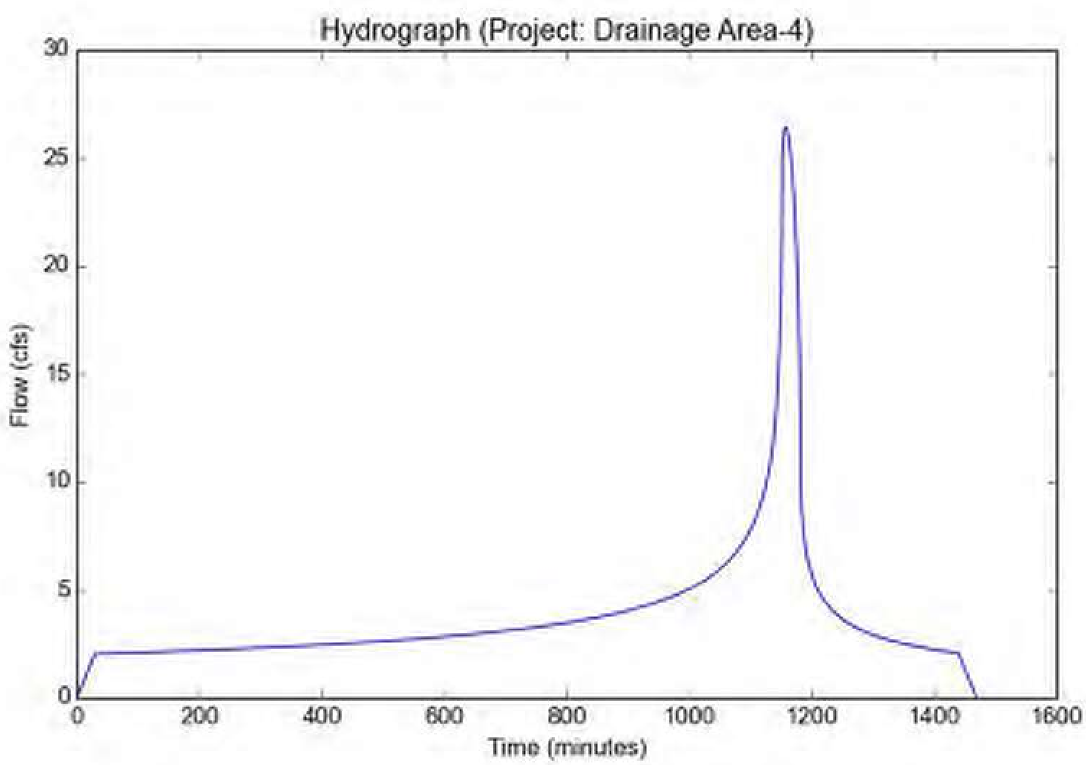
File location: D:/Task/Manchester2/HydroCalc results/Drainage Area 4/Project - Drainage Area-4-25yr.pdf
Version: HydroCalc 1.0.3

Input Parameters

Project Name	Project
Subarea ID	Drainage Area-4
Area (ac)	25.91
Flow Path Length (ft)	3281.0
Flow Path Slope (vft/hft)	0.00396
50-yr Rainfall Depth (in)	5.4
Percent Impervious	0.81
Soil Type	13
Design Storm Frequency	25-yr
Fire Factor	0
LID	False

Output Results

Modeled (25-yr) Rainfall Depth (in)	4.7412
Peak Intensity (in/hr)	1.2186
Undeveloped Runoff Coefficient (Cu)	0.5656
Developed Runoff Coefficient (Cd)	0.8365
Time of Concentration (min)	30.0
Clear Peak Flow Rate (cfs)	26.4102
Burned Peak Flow Rate (cfs)	26.4102
24-Hr Clear Runoff Volume (ac-ft)	7.6986
24-Hr Clear Runoff Volume (cu-ft)	335352.4378



Peak Flow Hydrologic Analysis

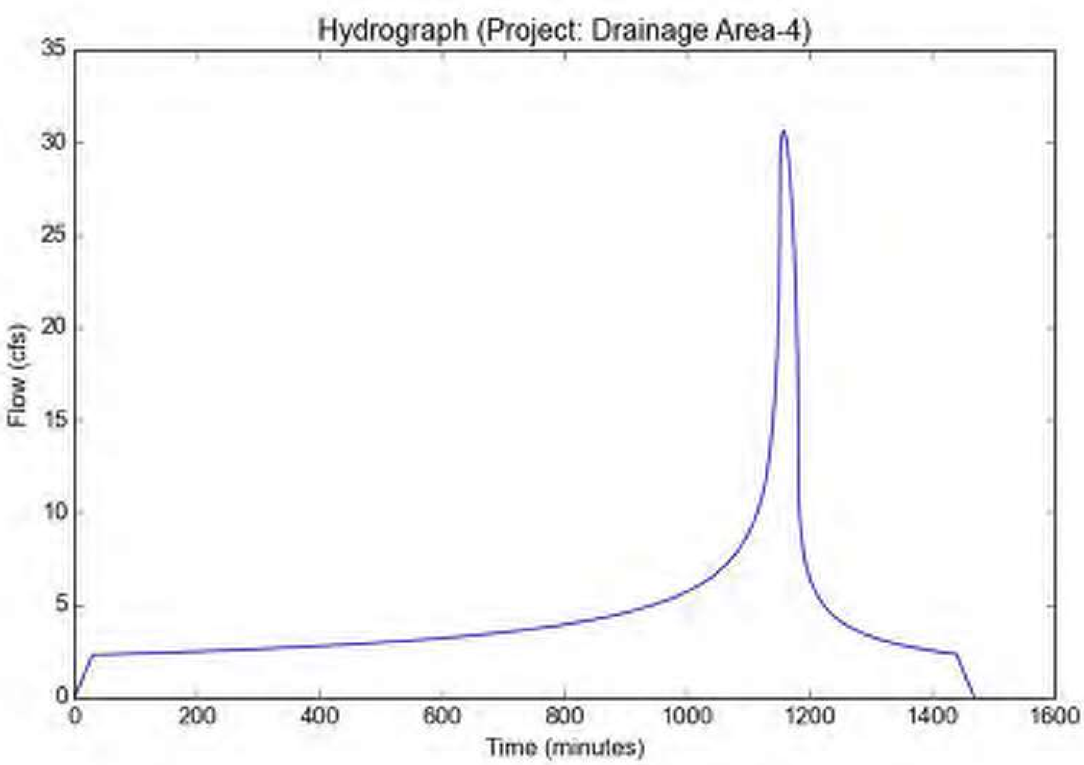
File location: D:/Task/Manchester2/HydroCalc results/Drainage Area 4/Project - Drainage Area-4-50yr.pdf
Version: HydroCalc 1.0.3

Input Parameters

Project Name	Project
Subarea ID	Drainage Area-4
Area (ac)	25.91
Flow Path Length (ft)	3281.0
Flow Path Slope (vft/hft)	0.00396
50-yr Rainfall Depth (in)	5.4
Percent Impervious	0.81
Soil Type	13
Design Storm Frequency	50-yr
Fire Factor	0
LID	False

Output Results

Modeled (50-yr) Rainfall Depth (in)	5.4
Peak Intensity (in/hr)	1.3879
Undeveloped Runoff Coefficient (Cu)	0.6453
Developed Runoff Coefficient (Cd)	0.8516
Time of Concentration (min)	30.0
Clear Peak Flow Rate (cfs)	30.6244
Burned Peak Flow Rate (cfs)	30.6244
24-Hr Clear Runoff Volume (ac-ft)	8.7973
24-Hr Clear Runoff Volume (cu-ft)	383212.536



Peak Flow Hydrologic Analysis

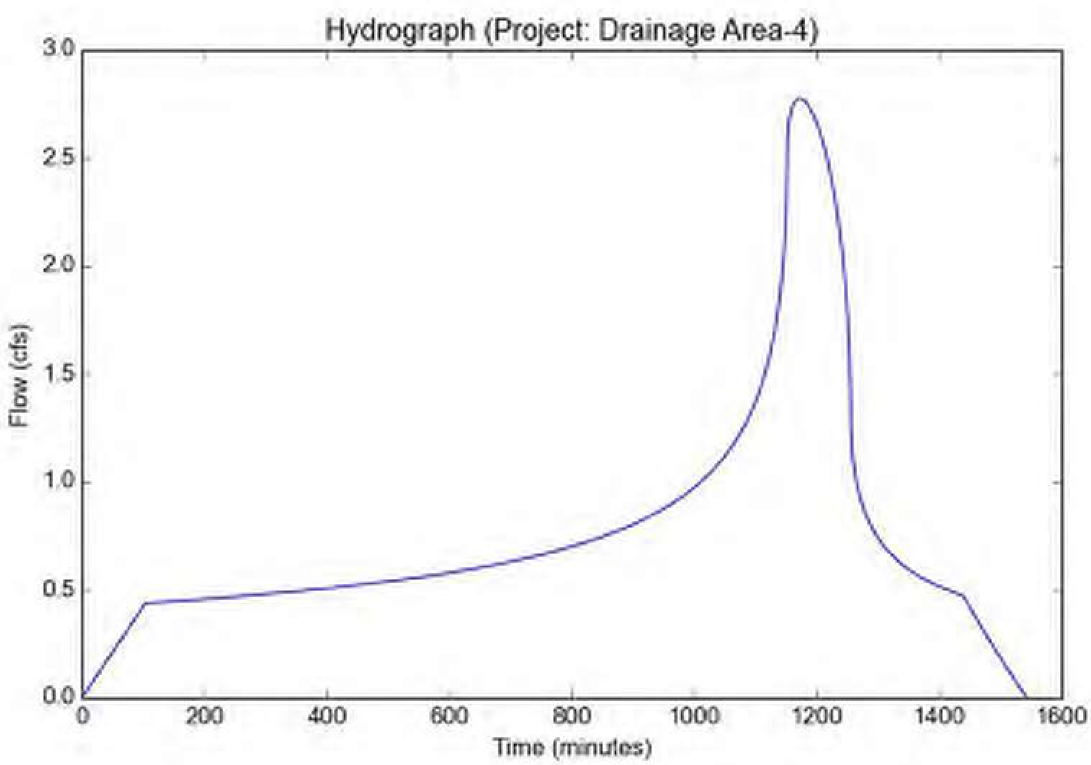
File location: D:/Task/Manchester2/HydroCalc results/Drainage Area 4/Project - Drainage Area-4-85th percentile.pdf
Version: HydroCalc 1.0.3

Input Parameters

Project Name	Project
Subarea ID	Drainage Area-4
Area (ac)	25.91
Flow Path Length (ft)	3281.0
Flow Path Slope (vft/hft)	0.00396
85th Percentile Rainfall Depth (in)	1.0
Percent Impervious	0.81
Soil Type	13
Design Storm Frequency	85th percentile storm
Fire Factor	0
LID	True

Output Results

Modeled (85th percentile storm) Rainfall Depth (in)	1.0
Peak Intensity (in/hr)	0.1433
Undeveloped Runoff Coefficient (Cu)	0.1
Developed Runoff Coefficient (Cd)	0.748
Time of Concentration (min)	104.0
Clear Peak Flow Rate (cfs)	2.777
Burned Peak Flow Rate (cfs)	2.777
24-Hr Clear Runoff Volume (ac-ft)	1.6019
24-Hr Clear Runoff Volume (cu-ft)	69780.5627



Appendix D

Long Term Runoff Hydrographs from WMMS 2

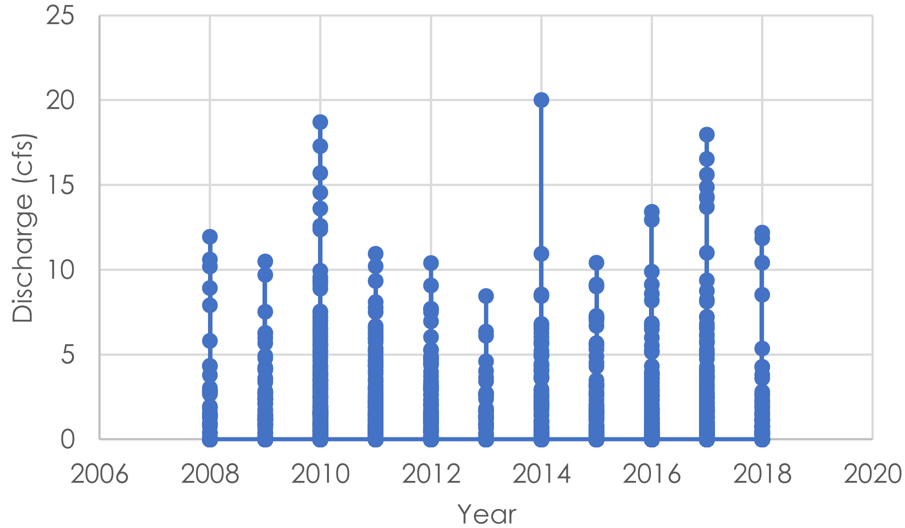


***Figure 1**: Runoff Hydrograph for Drainage Area 1- Long-term event*

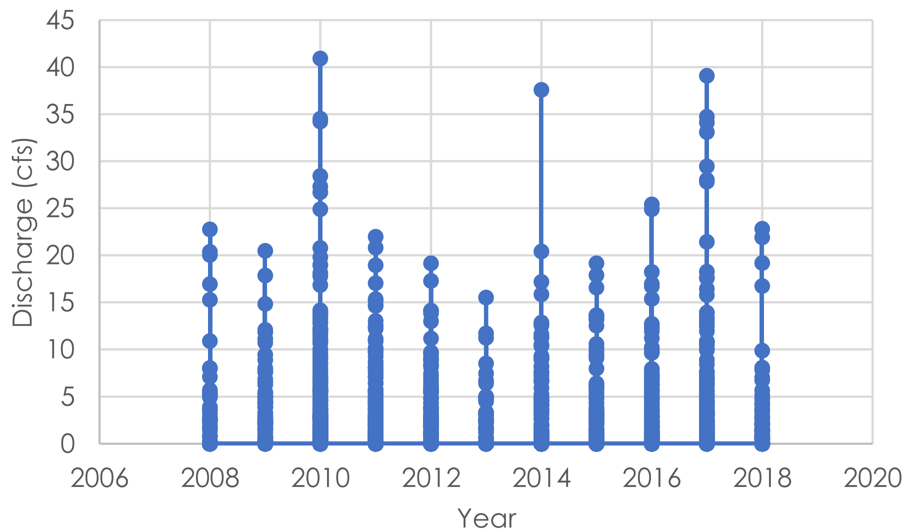


Figure 2: Runoff Hydrograph for Drainage Area 2- Long-term event

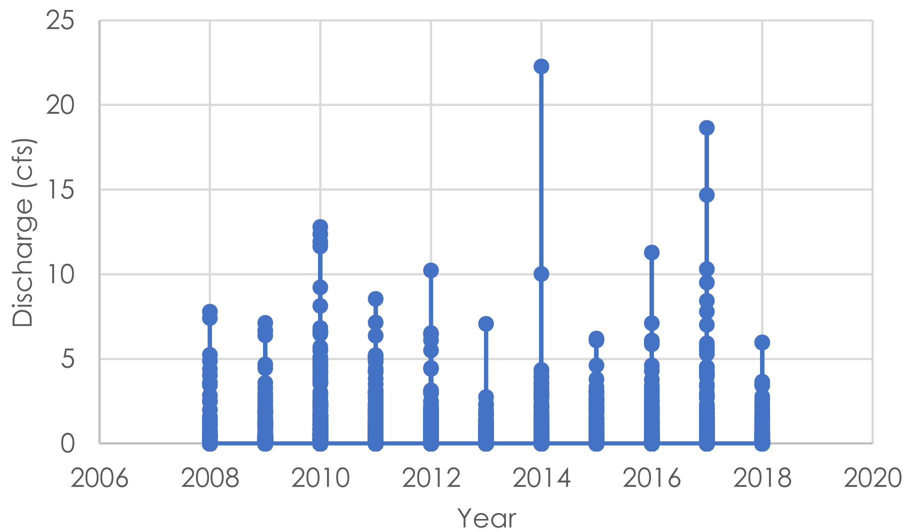


Figure 3: *Runoff Hydrograph for Drainage Area 3- Long-term event*

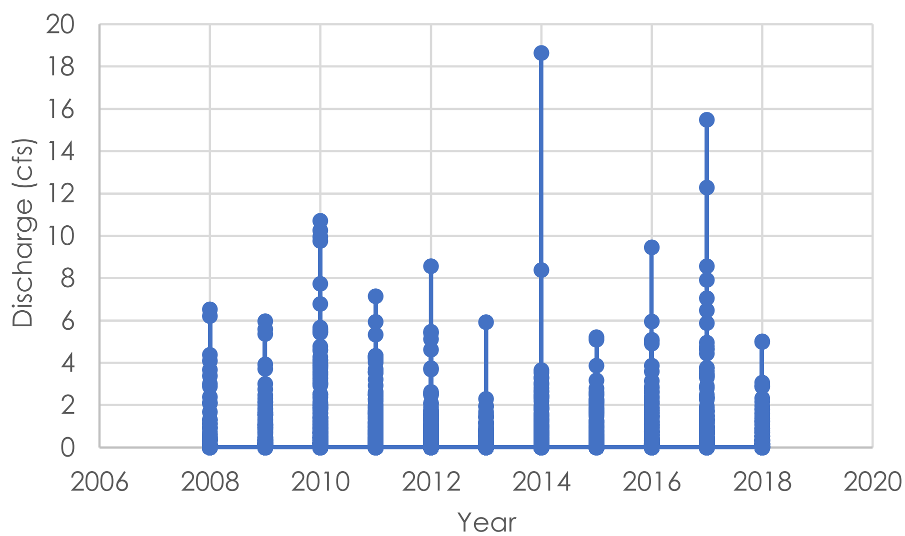


Figure 4: *Runoff Hydrograph for Drainage Area 4- Long-term event*

Appendix E

Sustain Model Input and Output Files

c---

c700 Model Controls

c

c LINE1 = Land simulation control (0-external),

c Land output directory path (containing unit-area land output timeseries)

c Note: external land timeseries data must be in this order;

c flow(in./ timestep),

c groundwater recharge(in./ timestep),

c pollutant 1(lb / acre / timestep),

c pollutant2, ...

c LINE2 = Start date of simulation (Year Month Day)

c LINE3 = End date of simulation (Year Month Day)

c LINE4 = Land Timeseries timestep (Min),

c BMP simulation timestep (Min),

c CRRAT = The ratio of max velocity to mean velocity under typical flow conditions (value of 1.0 or greater)

c Model output control (0-the same timestep as land time series; 1-hourly),

c Model output directory

c LINE5 = PET Flag(0 - constant monthly PET, 1 - PET from the timeseries (in/ timestep as land time series),

c PET time series file path(required if PET flag is 1)

c LINE6 = Monthly PET rate (in/day) if PET flag is 0 OR

c Monthly PET coefficient (multiplier to PET value) if PET flag is 1

c LINE7 = dummy integer value such as 0 (not used)

c exceeding days flag time series file path (optional) file format - month/day/year, flag for flow (1 for retain), flag for pollutant 1 (1 for exceeding), ..., flag for pollutant n (1 for exceeding)

c

0 C:\MyFiles\WMMS\SUSTAIN\Current_Input\LSPCData\WSTNUM-652

2008 10 1

2018 10 1

60 5 1.5 1 C:\MyFiles\WMMS\SUSTAIN\Current\Files_Output\605049

1 C:\MyFiles\WMMS\SUSTAIN\Current_Input\LSPCData\WSTNUM-652\PEVT.txt

0 0 0 0 0 0 0 0 0 0 0 0

c---

c705 Pollutant Definition

c

c POLLUT_ID = Unique pollutant identifier (Sequence number same as in land output time series)

c POLLUT_NAME = Unique pollutant name

c MULTIPLIER = Multiplying factor used to convert the pollutant load to lbs (external control)

c SED_FLAG = The sediment flag (0-not sediment,1-sand,2-silt,3-clay,4-total sediment)

c if = 4 SEDIMENT will be splitted into sand, silt,and clay based on the fractions defined in card 710.

c SED_QUAL = The sediment-associated pollutant flag (0-no, 1-yes)

c if = 1 then SEDIMENT is required in the pollutant list

c SAND_QFRAC = The sediment-associated qual-fraction on sand (0-1), only required if SED_QUAL = 1

c SILT_QFRAC = The sediment-associated qual-fraction on silt (0-1), only required if SED_QUAL = 1

c CLAY_QFRAC = The sediment-associated qual-fraction on clay (0-1), only required if SED_QUAL = 1

c

c POLLUT_ID POLLUT_NAME MULTIPLIER SED_FLAG SED_QUAL SAND_QFRAC SILT_QFRAC CLAY_QFRAC

1	TSS	2240	0	0	0	0	0
2	TN	1	0	0	0	0	0
3	TP	1	0	0	0	0	0
4	TCD	1	0	0	0	0	0
5	TCU	1	0	0	0	0	0
6	TPB	1	0	0	0	0	0
7	TZN	1	0	0	0	0	0

c---

c710 LAND USE DEFINITION (required if land simulation control is external)

c

c LANDTYPE = Unique land use definition identifier

c LANDNAME = land use name

c IMPERVIOUS = Distinguishes pervious/impervious land unit (0-pervious; 1-impervious)

c TIMESERIESFILE = File name containing input timeseries

c SAND_FRAC = The fraction of total sediment from the land which is sand (0-1)

c SILT_FRAC = The fraction of total sediment from the land which is silt (0-1)

c CLAY_FRAC = The fraction of total sediment from the land which is clay (0-1)

c

c LANDTYPE LANDNAME IMPERVIOUS TIMESERIESFILE SAND_FRAC SILT_FRAC CLAY_FRAC

1 Road_Freeway-All-All-All 1 1000_Road_Freeway-All-All-All.txt 0 0.55 0.4

2 Road_Primary-All-All-All1 2000_Road_Primary-All-All-All.txt 0 0.55 0.4

3 Road_Minor-All-All-All 1 3000_Road_Minor-All-All-All.txt0 0.55 0.4

4 Dev_ResHigh-All-All-All 1 4000_Dev_ResHigh-All-All-All.txt 0 0.55 0.4

5 Dev_ResLow-All-All-All 1 5000_Dev_ResLow-All-All-All.txt0 0.55 0.4

6 Dev_Com-All-All-All 1 6000_Dev_Com-All-All-All.txt 0 0.55 0.4

7 Dev_Ind-All-All-All 1 7000_Dev_Ind-All-All-All.txt 0 0.55 0.4

8 Dev_Inst-All-All-All 1 8000_Dev_Inst-All-All-All.txt 0 0.55 0.4

9 Dev_Roof-All-All-All 1 9000_Dev_Roof-All-All-All.txt 0 0.55 0.4

10 Dev_Overspray-All-All-All 1 10000_Dev_Overspray-All-All-All.txt 0 0.55 0.4

11 Dev_Irrigated-A-Low-Confined 0 11111_Dev_Irrigated-A-Low-Confined.txt 0 0.55 0.4

12 Dev_Irrigated-A-Low-Unconfined 0 11112_Dev_Irrigated-A-Low-Unconfined.txt 0 0.55 0.4

13 Dev_Irrigated-A-Med-Confined 0 11121_Dev_Irrigated-A-Med-Confined.txt 0 0.55 0.4

14 Dev_Irrigated-A-Med-Unconfined 0 11122_Dev_Irrigated-A-Med-Unconfined.txt 0 0.55 0.4

15 Dev_Irrigated-B-Low-Confined 0 11211_Dev_Irrigated-B-Low-Confined.txt 0 0.55 0.4

16 Dev_Irrigated-B-Low-Unconfined 0 11212_Dev_Irrigated-B-Low-Unconfined.txt 0 0.55 0.4

17 Dev_Irrigated-B-Med-Confined 0 11221_Dev_Irrigated-B-Med-Confined.txt 0 0.55 0.4

18 Dev_Irrigated-B-Med-Unconfined 0 11222_Dev_Irrigated-B-Med-Unconfined.txt 0 0.55 0.4

19 Dev_Irrigated-C-Low-Confined 0 11311_Dev_Irrigated-C-Low-Confined.txt 0 0.55 0.4

20 Dev_Irrigated-C-Low-Unconfined 0 11312_Dev_Irrigated-C-Low-Unconfined.txt 0 0.55 0.4

21 Dev_Irrigated-C-Med-Confined 0 11321_Dev_Irrigated-C-Med-Confined.txt 0 0.55 0.4

22 Dev_Irrigated-C-Med-Unconfined 0 11322_Dev_Irrigated-C-Med-Unconfined.txt 0 0.55 0.4

23 Dev_Irrigated-D-Low-Confined 0 11411_Dev_Irrigated-D-Low-Confined.txt 0 0.55 0.4

24 Dev_Irrigated-D-Low-Unconfined 0 11412_Dev_Irrigated-D-Low-Unconfined.txt 0 0.55 0.4

25 Dev_Irrigated-D-Med-Confined 0 11421_Dev_Irrigated-D-Med-Confined.txt 0 0.55 0.4

26 Dev_Irrigated-D-Med-Unconfined 0 11422_Dev_Irrigated-D-Med-Unconfined.txt 0 0.55 0.4

27 Dev_Pervious-A-Low-Confined 0 12111_Dev_Pervious-A-Low-Confined.txt 0 0.55 0.4

28 Dev_Pervious-A-Low-Unconfined 0 12112_Dev_Pervious-A-Low-Unconfined.txt 0 0.55 0.4

29 Dev_Pervious-A-Med-Confined 0 12121_Dev_Pervious-A-Med-Confined.txt 0 0.55 0.4

30 Dev_Pervious-A-Med-Unconfined 0 12122_Dev_Pervious-A-Med-Unconfined.txt 0 0.55 0.4

31 Dev_Pervious-B-Low-Confined 0 12211_Dev_Pervious-B-Low-Confined.txt 0 0.55 0.4

32 Dev_Pervious-B-Low-Unconfined 0 12212_Dev_Pervious-B-Low-Unconfined.txt 0 0.55 0.4

33 Dev_Pervious-B-Med-Confined 0 12221_Dev_Pervious-B-Med-Confined.txt 0 0.55 0.4

34 Dev_Pervious-B-Med-Unconfined 0 12222_Dev_Pervious-B-Med-Unconfined.txt 0 0.55 0.4

35 Dev_Pervious-C-Low-Confined 0 12311_Dev_Pervious-C-Low-Confined.txt 0 0.55 0.4

36 Dev_Pervious-C-Low-Unconfined 0 12312_Dev_Pervious-C-Low-Unconfined.txt 0 0.55 0.4

37 Dev_Pervious-C-Med-Confined 0 12321_Dev_Pervious-C-Med-Confined.txt 0 0.55 0.4

38 Dev_Pervious-C-Med-Unconfined 0 12322_Dev_Pervious-C-Med-Unconfined.txt 0 0.55 0.4

39 Dev_Pervious-D-Low-Confined 0 12411_Dev_Pervious-D-Low-Confined.txt 0 0.55 0.4

40 Dev_Pervious-D-Low-Unconfined 0 12412_Dev_Pervious-D-Low-Unconfined.txt 0 0.55 0.4

41 Dev_Pervious-D-Med-Confined 0 12421_Dev_Pervious-D-Med-Confined.txt 0 0.55 0.4

42 Dev_Pervious-D-Med-Unconfined 0 12422_Dev_Pervious-D-Med-Unconfined.txt 0 0.55 0.4

43 Agriculture-A-Low-Confined 0 13111_Agriculture-A-Low-Confined.txt 0 0.55 0.4

44 Agriculture-A-Low-Unconfined 0 13112_Agriculture-A-Low-Unconfined.txt 0 0.55 0.4

45 Agriculture-A-Med-Confined 0 13121_Agriculture-A-Med-Confined.txt 0 0.55 0.4

46 Agriculture-A-Med-Unconfined 0 13122_Agriculture-A-Med-Unconfined.txt 0 0.55 0.4

47 Agriculture-B-Low-Confined 0 13211_Agriculture-B-Low-Confined.txt 0 0.55 0.4

48 Agriculture-B-Low-Unconfined 0 13212_Agriculture-B-Low-Unconfined.txt 0 0.55 0.4

49	Agriculture-B-Med-Confined	0	13221_Agriculture-B-Med-Confined.txt	0	0.55	0.4
50	Agriculture-B-Med-Unconfined	0	13222_Agriculture-B-Med-Unconfined.txt	0	0.55	0.4
51	Agriculture-B-High-Confined	0	13231_Agriculture-B-High-Confined.txt	0	0.55	0.4
52	Agriculture-B-High-Unconfined	0	13232_Agriculture-B-High-Unconfined.txt	0	0.55	0.4
53	Agriculture-C-Low-Confined	0	13311_Agriculture-C-Low-Confined.txt	0	0.55	0.4
54	Agriculture-C-Low-Unconfined	0	13312_Agriculture-C-Low-Unconfined.txt	0	0.55	0.4
55	Agriculture-C-Med-Confined	0	13321_Agriculture-C-Med-Confined.txt	0	0.55	0.4
56	Agriculture-C-Med-Unconfined	0	13322_Agriculture-C-Med-Unconfined.txt	0	0.55	0.4
57	Agriculture-C-High-Confined	0	13331_Agriculture-C-High-Confined.txt	0	0.55	0.4
58	Agriculture-D-Low-Confined	0	13411_Agriculture-D-Low-Confined.txt	0	0.55	0.4
59	Agriculture-D-Low-Unconfined	0	13412_Agriculture-D-Low-Unconfined.txt	0	0.55	0.4
60	Agriculture-D-Med-Confined	0	13421_Agriculture-D-Med-Confined.txt	0	0.55	0.4
61	Agriculture-D-Med-Unconfined	0	13422_Agriculture-D-Med-Unconfined.txt	0	0.55	0.4
62	Agriculture-D-High-Confined	0	13431_Agriculture-D-High-Confined.txt	0	0.55	0.4
63	Agriculture-D-High-Unconfined	0	13432_Agriculture-D-High-Unconfined.txt	0	0.55	0.4
64	Veg_Low-A-Med-Confined	0	14121_Veg_Low-A-Med-Confined.txt	0	0.55	0.4
65	Veg_Low-A-Med-Unconfined	0	14122_Veg_Low-A-Med-Unconfined.txt	0	0.55	0.4

66	Veg_Low-A-High-Confined	0	14131_Veg_Low-A-High-Confined.txt	0	0.55	0.4
67	Veg_Low-A-High-Unconfined	0	14132_Veg_Low-A-High-Unconfined.txt	0	0.55	0.4
68	Veg_Low-B-Med-Confined	0	14221_Veg_Low-B-Med-Confined.txt	0	0.55	0.4
69	Veg_Low-B-Med-Unconfined	0	14222_Veg_Low-B-Med-Unconfined.txt	0	0.55	0.4
70	Veg_Low-B-High-Confined	0	14231_Veg_Low-B-High-Confined.txt	0	0.55	0.4
71	Veg_Low-B-High-Unconfined	0	14232_Veg_Low-B-High-Unconfined.txt	0	0.55	0.4
72	Veg_Low-C-Med-Confined	0	14321_Veg_Low-C-Med-Confined.txt	0	0.55	0.4
73	Veg_Low-C-Med-Unconfined	0	14322_Veg_Low-C-Med-Unconfined.txt	0	0.55	0.4
74	Veg_Low-C-High-Confined	0	14331_Veg_Low-C-High-Confined.txt	0	0.55	0.4
75	Veg_Low-C-High-Unconfined	0	14332_Veg_Low-C-High-Unconfined.txt	0	0.55	0.4
76	Veg_Low-D-Med-Confined	0	14421_Veg_Low-D-Med-Confined.txt	0	0.55	0.4
77	Veg_Low-D-Med-Unconfined	0	14422_Veg_Low-D-Med-Unconfined.txt	0	0.55	0.4
78	Veg_Low-D-High-Confined	0	14431_Veg_Low-D-High-Confined.txt	0	0.55	0.4
79	Veg_Low-D-High-Unconfined	0	14432_Veg_Low-D-High-Unconfined.txt	0	0.55	0.4
80	Veg_High-A-Med-Confined	0	15121_Veg_High-A-Med-Confined.txt	0	0.55	0.4
81	Veg_High-A-Med-Unconfined	0	15122_Veg_High-A-Med-Unconfined.txt	0	0.55	0.4
82	Veg_High-A-High-Confined	0	15131_Veg_High-A-High-Confined.txt	0	0.55	0.4

83 Veg_High-A-High-Unconfined 0 15132_Veg_High-A-High-Unconfined.txt0 0.55 0.4

84 Veg_High-B-Med-Confined 0 15221_Veg_High-B-Med-Confined.txt 0 0.55 0.4

85 Veg_High-B-Med-Unconfined 0 15222_Veg_High-B-Med-Unconfined.txt0 0.55 0.4

86 Veg_High-B-High-Confined 0 15231_Veg_High-B-High-Confined.txt 0 0.55 0.4

87 Veg_High-B-High-Unconfined 0 15232_Veg_High-B-High-Unconfined.txt0 0.55 0.4

88 Veg_High-C-Med-Confined 0 15321_Veg_High-C-Med-Confined.txt 0 0.55 0.4

89 Veg_High-C-Med-Unconfined 0 15322_Veg_High-C-Med-Unconfined.txt0 0.55 0.4

90 Veg_High-C-High-Confined 0 15331_Veg_High-C-High-Confined.txt 0 0.55 0.4

91 Veg_High-C-High-Unconfined 0 15332_Veg_High-C-High-Unconfined.txt0 0.55 0.4

92 Veg_High-D-Med-Confined 0 15421_Veg_High-D-Med-Confined.txt 0 0.55 0.4

93 Veg_High-D-Med-Unconfined 0 15422_Veg_High-D-Med-Unconfined.txt 0 0.55 0.4

94 Veg_High-D-High-Confined 0 15431_Veg_High-D-High-Confined.txt 0 0.55 0.4

95 Veg_High-D-High-Unconfined 0 15432_Veg_High-D-High-Unconfined.txt 0 0.55 0.4

96 Water-All-All-All 0 16000_Water-All-All-All.txt 0 0.55 0.4

c---

c712 Aquifer INFORMATION

c

c AquiferID = Unique Aquifer identifier

c AquiferNAME = Aquifer name

c Initial Storage = Initial Storage (ac-ft)

c RecessionCoef = Recession Coefficient (1/hr)

c SeepageCoef = Seepage Coefficient (1/hr)

c

c AquiferID AquiferNAME InitialStorage RecessionCoef SeepageCoef

c--

c713 Aquifer Pollutant Background Concentration

c

c AquiferID = Unique Aquifer identifier as in c712

c Ci = Background concentration for pollutant i (mg/l)

c Where i = 1 to N (N = Number of QUAL from card 705)

c

c AQUIFER_ID QUALC1 QUALC2 ... QUALCN

c--

c715 BMP SITE INFORMATION

c

c BMPSITE = Unique BMP site identifier

c BMPNAME = BMP template name or site name

c BMPTYPE = Unique BMP Types (must use the exact same keyword)

c
(BIORETENTION,WETPOND,CISTERN,DRYPOND,INFILTRATIONTRENCH,GREENROOF,POROUSPAVEMENT,RAINBARREL,REGULATOR,SWALE,CONDUIT,BUFFERSTRIP,AREABMP)

c DArea = Total Drainage Area in acre

c NUMUNIT = Number of BMP structures

c DDAREA = Design drainage area of the BMP structure (acre)

c PreLUType = Predevelopment land use type (for external land simulation option)

c AquiferID = Unique Aquifer ID, 0 --- no aquifer (for external land simulation option)

c FtableFLG = Ftable flag, 0 = no, 1 = yes (for BMP Class A, B, and C)

c FTABLE_ID = Unique Ftable identifier (continuous string) as in card 714

c DA2FP_RATIO = BMP drainage area to footprint ratio (ac/ac)

c GID = BMPSITE Group Identifier (non-zero integer, 0 = not a group)

c NOTE: if multiple BMPSITE for the same GID then optimizer will choose only one for a solution

c the user must specify the nested routing for the BMPs in a group and drainage area should be assigned to the most upstream BMPSITE.

c land swap controls (card 711) and structural controls (card 715) will be grouped together if they are assigned the same GID. To keep them separate use the different GID in card 711 and 715.

c RtableFLG = Rtable flag, 0 = no, 1 = yes (for JUNCTION only)

c RTABLE_ID = Unique REDUCTION-table identifier (continuous string) as in card 707

c

c BMPSITE BMPNAME BMPTYPE DArea NUMUNIT DDAREA PreLUType AquiferID FtableFLG FTABLE_ID DA2FP_RATIO GID RtableFLG RTABLE_ID

out SubwatershedOutlet JUNCTION 0 1 0 1 0 0 No 0 0 0

ut UntreatedFlow JUNCTION 0 1 0 1 0 0 No 0 0 0

TBDBMP BioretentionType1 BIORETENTION 0 1 0 1 0 0 No 0 0 0

REG1 BioretentionType1 RAINBARREL 25.86695140 1 0 1 0 0 No 0 0 0

LID7 BioretentionType1 INFILTRATIONTRENCH 0 1 0 1 0 0 No 0 0 0

sewer Sewer JUNCTION 0 1 0 1 0 0 0 0 0 0

c---

c721 Tier-1 Watershed Outlets Definition

c

c BMPSITE = BMP site(watershed outlet) identifier in card 715

c NUMBREAKS = Number of break points on the cost-effectiveness curve

c CECurveFile = CECurve_Solutions file for the project cost(sorted cost value) of each break point

c

c BMPSITE NUMBREAKS CECurveFile

c---

c722 Tier-1 Watershed Timeseries Definition

c

c BMPSITE = BMP site(watershed outlet) identifier in card 721

c BREAKPOINTID = Unique break point id on cost-effectiveness curve

c(0 for initial, -1 for PreDev, and - 2 for PostDev condition)

c MULTIPLIER = Multiplier applied to the timeseries file

c TIMESERIESFILE = Timeseries output file corresponding to the breakpoint id

c

c BMPSITE BREAKPOINTID MULTIPLIER TIMESERIESFILE

c---

c723 Pump Curve (applies if PUMP_FLG is ON in card 725)

c

c PUMP_CURVE = The unique name of pump curve (continuous string without space)

c NUM_RECORD = Number of points on the curve

c

c DEPTH = Depth (ft)

c FLOW = Pumping flow rate (cfs)

c

c PUMP_CURVE NUM_RECORD

c DEPTH FLOW

c---

c725 CLASS-A BMP Site Parameters (required if BMPSITE is CLASS-A in card 715)

c

c BMPSITE = Class A BMP dimension group identifier in card 715

c WIDTH = Basin bottom width (ft)

c LENGTH = Basin bottom length (ft) / diameter (ft) for rain barrel or cistern

c OHEIGHT = Orifice Height (ft)

c DIAM = Orifice Diameter (in)

c CCOEF = Contraction Coefficient, user-specified value between 0 and 1 (e.g., Rounded = 1.0, Short Tube = 0.8, Sharp-edged = 0.61, Borda = 0.5)

c RELTP = Release Type (1-Cistern, 2-Rain barrel, 3-others)

c PEOPLE = Number of persons (Cistern Option)

c DDAYS = Number of dry days (Rain Barrel Option)

c WEIRTP = Weir Type (1-Rectangular,2-Triangular)

c WEIRH = Weir Height (ft)

c WEIRW = (weir type 1) Weir width (ft)

c THETA = (weir type 2) Weir angle (degrees)

c ET_MULT = multiplier to PET

c PUMP_FLG = pump option (0-OFF, 1-ON)

c DEPTH_ON = water Depth (ft) at which the pump is started

c DEPTH_OFF = water Depth (ft) at which the pump is stopped

c PUMP_CURVE = The unique name of pump curve (continuous string without space)

c BYPASS_FRAC = Fraction of inflow that bypasses the BMP when full (0.0-1.0)

c DIV_RATE = Maximum flow diversion rate into BMP (cfs)

c BMP_GID = BMP group ID, activate only one BMP within a group (default = 0 [not a group], non-zero positive integer value as group ID)

c The user must specify the nested routing for the BMPs in a group and drainage area should be specified only for the most upstream BMP.

c

c BMPSITE WIDTH LENGTH OHEIGHT DIAM EXITYPE RELEASETYPE PEOPLE DDAYS WEIRTYPE WEIRH WEIRW THETA ET_MULT PUMP_FLG DEPTH_ON DEPTH_OFF PUMP_CURVE BYPASS_FRAC DIV_RATE BMP_GID

TBDBMP 0 0 0 0 0.61 3 0 0 1 0.5 10000 0 0 0 0 0 none 0 -1

REG1 166 128 0 0.6 0.61 4 0 0 1 14 10000 0 0 0 0 0 none 0 -1

LID7 151 1 0 0.01 0.61 4 0 0 1 14 10000 0 0 0 0 0 none 0 -1

c---

c730 Cistern Control Water Release Curve (applies if release type is cistern in card 725)

c

c BMPSITE = Class A BMP dimension group identifier in card 715

c Flow = Hourly water release per capita from the Cistern Control (ft3/hr/capita)

c

c BMPSITE FLOW

TBDBMP 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0
0

REG1 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0

LID7 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0

c--

c735 CLASS B BMP Site DIMENSION GROUPS

c

c BMPSITE = BMP Site identifier in card 715

c WIDTH = basin bottom width (ft)

c LENGTH = basin bottom Length (ft)

c MAXDEPTH = Maximum depth of channel (ft)

c SLOPE1 = Side slope 1 (ft/ft)

c SLOPE2 = Side slope 2 (ft/ft) (1-4)

c SLOPE3 = Side slope 3 (ft/ft)

c MANN_N = Manning 's roughness coefficient

c ET_MULT = multiplier to PET

c

c BMPSITE WIDTH LENGTH MAXDEPTH SLOPE1 SLOPE2 SLOPE3 MANN_N
ET_MULT

c--

c740 BMP Site BOTTOM SOIL/VEGITATION CHARACTERISTICS

c

c BMPSITE = BMPSITE identifier in c715

c INFILTM = Infiltration Method (0-Green Ampt, 1-Horton, 2-Holtan)

c POLROTM = Pollutant Routing Method (1-Completely mixed, >1-number of CSTRs in series)

c POLREMM = Pollutant Removal Method (0-1st order decay, 1-kadlec and knight method, 2-user defined concentration)

c SDEPTH = Soil Depth (ft)

c POROSITY = Soil Porosity (0-1)

c FCAPACITY = Soil Field Capacity (ft/ft)

c WPOINT = Soil Wilting Point (ft/ft)

c AVEG = Vegetative Parameter A (0.1-1.0) (Empirical), only required for Holtan infiltration method

c FINFILT = Soil layer infiltration rate (in/hr)

c UNDSWITCH = Underdrain option (0-No underdrain, 1-underdrain with percent removal rate, 2-underdrain with constant effluent conc.)

c UNDDEPTH = Depth of storage media below underdrain (ft)

c UNDVOID = Fraction of underdrain storage depth that is void space (0-1)

c UNDINFILT = Background infiltration rate, below underdrain (in/hr)

c SUCTION = Average value of soil capillary suction along the wetting front, value must be greater than zero (in), only required for Green-Ampt infiltration method

c IMDMAX = Difference between soil porosity and initial moisture content, value must be greater than or equal to zero (a fraction), only required for Green-Ampt infiltration method

c MAXINFILT = Maximum rate on the Horton infiltration curve (in/hr), only required for Horton infiltration method

c DECAYCONS = Decay constant for the Horton infiltration curve (1/hr), only required for Horton infiltration method

c DRYTIME = Time for a fully staurated soil to completely dry (day), only required for Horton infiltration method

c MAXVOLUME = Maximum infiltration volume possible (in), only required for Horton infiltration method

c

c BMPSITE INFILTM POLROTM POLREMM SDEPTH POROSITY FCAPACITY WPOINT AVEG FINFILT UNDSWITCH UNDDEPTH UNDVOID UNDINFILT SUCTION IMDMAX MAXINFILT DECAYCONS DRYTIME MAXVOLUME

TBDBMP 2 1 0 2 0.35 0.3 0.15 0.6 1 0 1.5
0.4 1 0 0 3 4 7 0

REG1 2 1 0 0.1 0.4 0.3 0.15 0 0 0 1 0.4
0.01 0 0 3 4 7 0

LID7 2 1 0 0 0.45 0.3 0.15 0 0.14 0 1 0.4
1.5 0 0 3 4 7 0

c---

c745 BMP Site HOLTAN GROWTH INDEX

c

c HOLTAN EQUATION: F = GI * AVEG * (Computed Available Soil Storage)^ 1.4 + FINFILT

c

c BMPSITE = BMPSITE identifier in card 715

c GIi = 12 monthly values for GI in HOLTAN equation

c Where i = jan, feb, mar...dec

c

c BMPSITE jan feb mar apr may jun jul aug sep oct nov dec

TBDBMP 0 0 0 0 0 0 0 0 0 0 0
0

REG1 0 0 0 0 0 0 0 0 0 0 0 0

LID7 0 0 0 0 0 0 0 0 0 0 0 0

c---

c747 BMP Site Initial Moisture Content

c

c BMPSITE = BMP Site identifier in card 715

c WATDEP_i = initial surface water depth (ft)

c THETA_i = initial soil moisture (ft/ft)

c

c BMPSITE WATDEP_i THETA_i

TBDBMP 0 0.15

REG1 0 0.15

LID7 0 0.15

c---

c750 Class-C Conduit Parameters (required if BMPSITE is CLASS-C in card 715)

c

c BMPSITE = BMP site identifier in card 715

c INLET_NODE = BMP Id at the entrance of the conduit

c OUTLET_NODE = BMP Id at the exit of the conduit

c LENGTH = Conduit length (ft)

c MANNING_N = Manning's roughness coefficient

c INLET_IEL = Invert Elevation at the entrance of the conduit (ft)

c OUTLET_IEL = Invert Elevation at the exit of the conduit (ft)

c INIT_FLOW = Initial flow in the conduit (cfs)

c INLET_HL = Head loss coefficient at the entrance of the conduit

c OUTLET_HL = Head loss coefficient at the exit of the conduit

c AVERAGE_HL = Head loss coefficient along the length of the conduit

c

c BMPSITE INLET_NODE OUTLET_NODE LENGTH MANNING_N INLET_IEL OUTLET_IEL INIT_FLOW INLET_HL OUTLET_HL AVERAGE_HL

c---

c755 Class C Conduit Cross Sections

c

c LINK = BMP site identifier in card 715

c TYPE = Conduit Type (rectangular, circular...)

c GEOM1 = Geometric cross-sectional property of the conduit

c GEOM2 = Geometric cross-sectional property of the conduit

c GEOM3 = Geometric cross-sectional property of the conduit

c GEOM4 = Geometric cross-sectional property of the conduit

c BARRELS = Number of Barrels in the conduit

c

c LINK TYPE GEOM1 GEOM2 GEOM3 GEOM4 BARRELS

c---

c760 Irregular Cross Sections

c

c Format of transect data follows:

c NC nLeft nRight nChannel

c X1 name nSta xLeftBank xRightBank 0 0 0 xFactor yFactor

c GR Elevation Station ...

c--

c761 BufferStrip BMP Parameters (required if BMPTYPE is BUFFERSTRIP in card 715)

c

c BMPSITE = BMP site identifier in card 715

c Width = BMP width (ft)

c FLength = Flow length (ft)

c DStorage = Surface depression storage (in)

c SLOPE = Overland slope (ft / ft)

c MANNING_N = Overland Manning's roughness coefficient

c POLREMM = Pollutant Removal Method (0-1st order decay, 1-kadlec and knight method)

c ET_MULT = Multiplier to PET

c

c--

c762 Area BMP Parameters (required if BMPTYPE is AREABMP in card 715)

c

c BMPSITE = BMP site identifier in card 715

c Area = BMP area (ft2)

c FLength = flow length (ft) note: area width = area / flow length

c DStorage = Surface depression storage (in)

c SLOPE = Overland slope (ft / ft)

c MANNING_N = Overland Manning's roughness coefficient

c SAT_INFILT = Saturated infiltration rate (in/hr)

c POLREMM = Pollutant Removal Method (0-1st order decay, 1-kadlec and knight method)

c DCIA = Percentage of Directly Connected Impervious Area (0-100)

c TOTAL_IMP_DA = Total Impervious Drainage Area (acre)

c

c BMPSITE Area FLengthDStorage SLOPE MANNING_N SAT_INFILT POLREMM DCIA TOTAL_IMP_DA

c---

c---

c765 BMP SITE Pollutant Decay / Loss rates

c

c BMPSITE = BMP site identifier in card 715information

c QUALDECAYi = First - order decay rate for pollutant i (hr ^ -1)

c Where i = 1 to N(N = Number of QUAL from TIMESERIES FILES)

c

c BMPSITE QUALDECAY1 QUALDECAY2...QUALDECAYN

TBDBMP 0.008333333 0.008333333 0.008333333 0.008333333 0.008333333 0.008333333 0.008333333

REG1 0.008333333 0.008333333 0.008333333 0.008333333 0.008333333 0.008333333 0.008333333

LID7 0.008333333 0.008333333 0.008333333 0.008333333 0.008333333 0.008333333 0.008333333

c---

c766 Pollutant K' values (applies when pollutant removal method is kadlec and knight method in card 740)

c

c BMPSITE = BMP site identifier in card 715

C QUALK'i = Constant rate for pollutant i (ft/yr)

c Where i = 1 to N (N = Number of QUAL from card 705)

c

c BMPSITE QUALK'1 QUALK'2 ... QUALK'N

c---

c767 Pollutant C* values (applies when pollutant removal method is kadlec and knight method in card 740)

c

c BMPSITE = BMP site identifier in card 715

c QUALC*i = Background concentration for pollutant i (mg/l)

c Where i = 1 to N (N = Number of QUAL from card 705)

c

c BMPSITE QUALC*1 QUALC*2 ... QUALC*N

c---

c768 Pollutant C values (applies when surface release type is 4 in card 725)

c

c BMPSITE = BMP site identifier in card 715

c QUALCi = Constant surface release concentration for pollutant i (mg/l)

c Where i = 1 to N (N = Number of QUAL from card 705)

c

c BMPSITE QUALC1 QUALC2 ... QUALCN

TBDBMP 0 0 0 0 0 0 0

REG1 0 0 0 0 0 0 0

LID7 0 0 0 0 0 0 0

c---

c770 BMP Underdrain Pollutant Percent Removal(applies when underdrain is on in card 740)

c

c BMPSITE = BMPSITE identifier in card 715

c QUALPCTREMi = Perecent Removal for pollutant i through underdrain(0 - 1)

c Where i = 1 to N(N = Number of QUAL from TIMESERIES FILES)

c

c BMPSITE QUALPCTREM1 QUALPCTREM2...QUALPCTREMN

TBDBMP 0 0 0 0 0 0 0

REG1 0 0 0 0 0 0 0

LID7 0 0 0 0 0 0 0

c--

c771 BMP Underdrain Pollutant Effluent Concentration (applies when underdrain option is '2' in card 740)

c

c BMPSITE = BMPSITE identifier in card 715

c QUALEFFCi = Underdrain effluent concentration for pollutant i (mg / l)

c Where i = 1 to N(N = Number of QUAL from TIMESERIES FILES)

c

c BMPSITE QUALEFFC1 QUALEFFC2...QUALEFFCN

TBDBMP 0 0 0 0 0 0 0

REG1 0 0 0 0 0 0 0

LID7 0 0 0 0 0 0 0

c--

c775 Sediment General Parameters (required if pollutant type is sediment in card 705)

c

c BMPSITE = BMP site identifier in card 715

c BEDWID = Bed width (ft) - this is constant for the entire simulation period

c BEDDEP = Initial bed depth (ft)

c BEDPOR = Bed sediment porosity

c

c BMPSITE BEDWID BEDDEPBEDPOR

c--

c780 Sand Transport Parameters (required if pollutant type is sediment in card 705)

c

c BMPSITE = BMP site identifier in card 715

c D = Effective diameter of the transported sand particles (in)

```
c W       = The corresponding fall velocity in still water (in/sec)
c RHO     = The density of the sand particles (lb/ft3)
c KSAND   = The coefficient in the sandload power function formula
c EXPSND  = The exponent in the sandload power function formula
c
c BMPSITE         D          W          RHO      KSAND  EXPSND
c-----------------------------------------------------------------------------------------------------------------------
c785 Silt Transport Parameters (required if pollutant type is sediment in card 705)
c
c BMPSITE = BMP site identifier in card 715
c D       = Effective diameter of the transported silt particles (in)
c W       = The corresponding fall velocity in still water (in/sec)
c RHO     = The density of the silt particles (lb/ft3)
c TAUCD   = The critical bed shear stress for deposition (lb/ft2)
c TAUCS   = The critical bed shear stress for scour (lb/ft2)
c M       = The erodibility coefficient of the silt particles (lb/ft2/day)
c
c BMPSITE         D          W          RHO      TAUCD  TAUCS   M
c-----------------------------------------------------------------------------------------------------------------------
c786 Clay Transport Parameters (required if pollutant type is sediment in card 705)
c
c BMPSITE = BMP site identifier in card 715
c D       = Effective diameter of the transported clay particles (in)
c W       = The corresponding fall velocity in still water (in/sec)
c RHO     = The density of the silt/clay particles (lb/ft3)
c TAUCD   = The critical bed shear stress for deposition (lb/ft2)
c TAUCS   = The critical bed shear stress for scour (lb/ft2)
c M       = The erodibility coefficient of the clay particles (lb/ft2/day)
c
```

c BMPSITE D W RHO TAUCD TAUCS M

c---

c790 LAND TO BMP ROUTING NETWORK(required for external land simulation control in card 700)

c

c UniqueID = Identifies an instance of LANDTYPE in SCHEMATIC

c LANDTYPE = Corresponds to LANDTYPE in c710

c AREA = Area of LANDTYPE in ACRES

c DS = UNIQUE ID of DS BMP(0 - no BMP, add to end)

c GID = Group Identifier in card 711 (0 - no change)

c

c UniqueID LANDTYPE AREA DS LCGID

1	2	4.08316302	REG1	0
2	3	1.7524686600000001	REG1	0
3	4	1.2602355	REG1	0
4	5	3.92600424	REG1	0
5	6	0.80852756	REG1	0
6	7	0.04843258	REG1	0
7	8	0.49223316	REG1	0
8	9	2.2081302800000002	REG1	0
9	10	0.17791560000000003	REG1	0
10	19	1.65659192	REG1	0
11	35	4.46469314	REG1	0
12	72	3.9418189600000004	REG1	0
13	88	1.0467367800000003	REG1	0

c---

c795 BMP Site ROUTING NETWORK

c

c BMPSITE = BMPSITE identifier in card 715 c OUTLET_TYPE = Outlet type(1 - total, 2 - weir, 3 - orifice or channel, 4 - underdrain, 5-untreated or bypass)

c DS = Downstrem BMP site identifier in card 715(0 - no BMP, add to end)

c

c BMPSITE OUTLET_TYPE DS

```
ut      1       out
out     1       0
TBDBMP          1       out
REG1    2       LID7
REG1    3       sewer
REG1    4       LID7
REG1    5       LID7
LID7    2       out
LID7    3       sewer
LID7    4       out
LID7    5       out
```

c--

c800 Optimization Controls

c

c Technique --Optimization Techniques

c 0 = no optimization

c 1 = Scatter Search

c 2 = NSGAII

c Option --Optimization options

c 0 = no optimization

c 1 = specific control target and minimize cost

c 2 = generate cost effectiveness curve

c StopDelta-- Criteria for stopping the optimization iteration

c in dollars($), meaning if the cost not improved by this criteria, stop the search(for Option 1) c MaxRuns --Maximum number of iterations

c NumBest-- Number of best solutions for output(for Option 1)

c

c Technique Option StopDelta MaxRuns NumBest

0 2 0 10000 1

c--

c805 BMP Cost Functions

c Cost($) = ((LinearCost)Length ^ (LengthExp) + (AreaCost)Area ^ (AreaExp) + (TotalVolumeCost)TotalVolume ^ (TotalVolExp)

c + (MediaVolumeCost)SoilMediaVolume ^ (MediaVolExp) + (UnderDrainVolumeCost)UnderDrainVolume ^ (UDVolExp)

c + (Unitcost) + (ConstantCost)) * (1 + PercentCost / 100)

c

c BMPSITE = BMP site identifier in card 715

c LinearCost = Cost per unit length of the BMP structure($/ ft)

c AreaCost = Cost per unit area of the BMP structure($/ ft ^ 2)

c TotalVolumeCost = Cost per unit total volume of the BMP structure($/ ft ^ 3)

c MediaVolumeCost = Cost per unit volume of the soil media($/ ft ^ 3)

c UnderDrainVolumeCost = Cost per unit volume of the under drain structure($/ ft ^ 3)

c ConstantCost = Constant cost($)

c PercentCost = Cost in percentage of all other cost(%)

c LengthExp = Exponent for linear unit

c AreaExp = Exponent for area unit

c TotalVolExp = Exponent for total volume unit

c MediaVolExp = Exponent for soil media volume unit

c UDVolExp = Exponent for underdrain volume unit

c

c BMPSITE LinearCost AreaCost TotalVolumeCost MediaVolumeCost UnderDrainVolumeCost ConstantCost PercentCost LengthExp AreaExp TotalVolExp MediaVolExp UDVolExp

```
TBDBMP    0    0    0    0    0    0    0    1    1    1    1
     1
REG1    0    0    12.6    0    0    120000 0    1    1    1    1    1
LID7    0    0    5.9848  0    0    0    0    1    1    1    1    1
c-----------------------------------------------------------------------------------------------------------
c806 Diversion Structure Cost Function
c Cost ($) = ((DiversionCost)*DIV_RATE^(DiversionExp) + (ConstantCost)) * (1+PercentCost/100)
c
c BMPSITE          = BMP site identifier in card 715
c DiversionCost    = Cost per unit diversion rate ($/cfs)
c DiversionExp     = Exponent for diversion rate
c ConstantCost     = Constant cost ($)
c PercentCost      = Cost in percentage of all other cost (%)
c
c BMPSITE    DiversionCost    DiversionExp    ConstantCost    PercentCost
TBDBMP    0    1    0    0
REG1    25400    1    0    0
LID7    0    1    0    0
c-----------------------------------------------------------------------------------------------------------
c810 BMP SITE Adjustable Parameters
c BMPSITE = BMP site identifier in card 715
c VARIABLE = Variable name
c       LENGTH = BMP length,
c       NUMUNIT = number of units,
c       WEIRH = weir height,
c       SDEPTH = soil media depth,
c       DCIA = directly connected impervious area,
c       MAXDEPTH = BMP maximum depth,
c       CECURVE = cost - effectiveness curve for Tier - 1 solution
```

c DIV_RATE --- maximum flow diversion rate into BMP

c FROM = From value in the range

c TO = To value in the range

c STEP = Increment step

c BMPSITE VARIABLE FROM TO STEP

TBDBMP LENGTH 0 0 0

REG1 LENGTH 0 175.19417798545703 0.8759708899272851

LID7 LENGTH 0 63.245553203367585 0.31622776601683794

c---

c814 Predeveloped Timeseries at Assessment Point for Flow Duration Curve

c

c BMPSITE = BMP site identifier in card 715 if it is an assessment point

c NumBins = Number of bins for flow duration curve

c PreDevFlag = Pre-developed timeseries option (1-internal,2-external)

c PreDevFile = Pre-developed timeseries file path for external option

c The timeseries file format (AssessmentPoint_IDYear Month Day Hour Minute Flow_cfs)

c The first line is skipped (comment line) and data start from the second line in the required format.

c

c BMPSITE NumBins PreDevFlag PreDevFile

c815 Assessment Point and Evaluation Factor

c

c BMPSITE -- BMP site identifier in card 715 if it is an assessment point

c FactorGroup -- Flow or pollutant related evaluation factor group

c -1 = flow related evaluation factor

c # = pollutant ID in card 705

c FactorType -- Evaluation Factor Type (negative number for flow related and positive number for pollutant related)

c -1 = AAFV Annual Average Flow Volume (ft3/yr) c -2 = PDF Peak Discharge Flow (cfs)

c -3 = FEF Flow Exceeding frequency (#times/year)

c -4 = FDC Flow Duration Curve (sum of sorted flow difference with pre-developed condition, cfs)

c -5 = RAAFV Retain Annual Average Flow Volume (ft3/yr), it requires retain daily flag (value = 1) timeseries in card 700

c 1 = AAL Annual Average Load (lb/yr)

c 2 = AAC Annual Average Concentration (mg/L)

c 3 = MAC Maximum #days Average Concentraion (mg/L)

c 4 = CEF Conc Exceeding frequency (#times/year)

c FactorVal1 -- if FactorType = 3 (MAC): Maximum #Days;

c -- if FactorType = -3 (FEF): Flow Threshold (cfs)

c -- if FactorType = -4 (FDC): Low flow limit (cfs)

c -- if FactorType = 4 (CEF): Conc Threshold (mg/l)

c -- all other FactorType : -99

c FactorVal2 -- if FactorType = -3 (FEF): Minimum inter-exceedance time (hr)

c if = 0 then daily running average flow exceeding frequency

c if = -1 then daily average flow exceeding frequency

c otherwise minimum inter-exceedance time for simulation interval

c -- if FactorType = -4 (FDC): High flow limit (cfs)

c -- if FactorType = 4 (CEF): Flow weighted average conc Options

c if = 0 then daily running average conc exceeding frequency

c if = -1 then daily average conc exceeding frequency

c otherwise conc exceeding frequency at land simulation interval

c -- all other FactorType : -99

c CalcMode -- Evaluation Factor Calculation Mode

c -99 for Option 0 (card 800): no optimizaiton

c 1 = % percent of value under existing condition (0-100)

c 2 = S scale between pre-develop and existing condition (0-1)

c 3 = V absolute value in the unit as shown in FactorType (third block in this card) c TargetVal1 -- Target value for evaluation factor calculation mode

c -99 for Option 0 (card 800): no optimizaiton

c Target value for minimize cost Option 1 (card 800)

c Lower limit of target value for cost-effective curve Option 2 (card 800)

c TargetVal2 -- Target value for evaluation factor calculation mode

c -99 for Option 0 (card 800): no optimizaiton

c -99 for Option 1 (card 800): minimize cost

c Upper limit of target value for cost-effective curve Option 2 (card 800)

c Factor_Name -- Evaluation factor name (user specified without any space), e.g. FlowVolume or SEDIMENT

out	1	1	-99	-99	-99	-99	100	PLS_TSS
out	2	1	-99	-99	-99	-99	100	PLS_TN
out	3	1	-99	-99	-99	-99	100	PLS_TP
out	4	1	-99	-99	-99	-99	100	PLS_TCD
out	5	1	-99	-99	-99	-99	100	PLS_TCU
out	6	1	-99	-99	-99	-99	100	PLS_TPB
out	7	1	-99	-99	-99	-99	100	PLS_TZN
out	-1	-1	-99	-99	-99	-99	100	AAFV
out	-1	-2	-99	-99	-99	-99	100	Qpk
REG1	1	1	-99	-99	-99	-99	100	PLS_TSS
REG1	2	1	-99	-99	-99	-99	100	PLS_TN
REG1	3	1	-99	-99	-99	-99	100	PLS_TP
REG1	4	1	-99	-99	-99	-99	100	PLS_TCD
REG1	5	1	-99	-99	-99	-99	100	PLS_TCU
REG1	6	1	-99	-99	-99	-99	100	PLS_TPB
REG1	7	1	-99	-99	-99	-99	100	PLS_TZN
REG1	-1	-1	-99	-99	-99	-99	100	AAFV
REG1	-1	-2	-99	-99	-99	-99	100	Qpk
LID7	1	1	-99	-99	-99	-99	100	PLS_TSS

LID7	2	1	-99	-99	-99	-99	100	PLS_TN
LID7	3	1	-99	-99	-99	-99	100	PLS_TP
LID7	4	1	-99	-99	-99	-99	100	PLS_TCD
LID7	5	1	-99	-99	-99	-99	100	PLS_TCU
LID7	6	1	-99	-99	-99	-99	100	PLS_TPB
LID7	7	1	-99	-99	-99	-99	100	PLS_TZN
LID7	-1	-1	-99	-99	-99	-99	100	AAFV
LID7	-1	-2	-99	-99	-99	-99	100	Qpk

c---

c700 Model Controls

c

c LINE1 = Land simulation control (0-external),

c Land output directory path (containing unit-area land output timeseries)

c Note: external land timeseries data must be in this order;

c flow(in./ timestep),

c groundwater recharge(in./ timestep),

c pollutant 1(lb / acre / timestep),

c pollutant2, ...

c LINE2 = Start date of simulation (Year Month Day)

c LINE3 = End date of simulation (Year Month Day)

c LINE4 = Land Timeseries timestep (Min),

c BMP simulation timestep (Min),

c CRRAT = The ratio of max velocity to mean velocity under typical flow conditions (value of 1.0 or greater)

c Model output control (0-the same timestep as land time series; 1-hourly),

c Model output directory

c LINE5 = PET Flag(0 - constant monthly PET, 1 - PET from the timeseries (in/ timestep as land time series),

c PET time series file path(required if PET flag is 1)

c LINE6 = Monthly PET rate (in/day) if PET flag is 0 OR

c Monthly PET coefficient (multiplier to PET value) if PET flag is 1

c LINE7 = dummy integer value such as 0 (not used)

c exceeding days flag time series file path (optional) file format - month/day/year, flag for flow (1 for retain), flag for pollutant 1 (1 for exceeding), ..., flag for pollutant n (1 for exceeding)

c

0 C:\MyFiles\WMMS\SUSTAIN\Current_Input\LSPCData\WSTNUM-652

2008 10 1

2018 10 1

60 5 1.5 1 C:\MyFiles\WMMS\SUSTAIN\Current\Files_Output\605049

1 C:\MyFiles\WMMS\SUSTAIN\Current_Input\LSPCData\WSTNUM-652\PEVT.txt

0 0 0 0 0 0 0 0 0 0 0 0

c--

c705 Pollutant Definition

c

c POLLUT_ID = Unique pollutant identifier (Sequence number same as in land output time series)

c POLLUT_NAME = Unique pollutant name

c MULTIPLIER = Multiplying factor used to convert the pollutant load to lbs (external control)

c SED_FLAG = The sediment flag (0-not sediment,1-sand,2-silt,3-clay,4-total sediment)

c if = 4 SEDIMENT will be splitted into sand, silt,and clay based on the fractions defined in card 710.

c SED_QUAL = The sediment-associated pollutant flag (0-no, 1-yes)

c if = 1 then SEDIMENT is required in the pollutant list

c SAND_QFRAC = The sediment-associated qual-fraction on sand (0-1), only required if SED_QUAL = 1

c SILT_QFRAC = The sediment-associated qual-fraction on silt (0-1), only required if SED_QUAL = 1

c CLAY_QFRAC = The sediment-associated qual-fraction on clay (0-1), only required if SED_QUAL = 1

c

c POLLUT_ID POLLUT_NAME MULTIPLIER SED_FLAG SED_QUAL SAND_QFRAC SILT_QFRAC CLAY_QFRAC

1 TSS 2240 0 0 0 0 0

2 TN 1 0 0 0 0 0

3 TP 1 0 0 0 0 0

4 TCD 1 0 0 0 0 0

5 TCU 1 0 0 0 0 0

6 TPB 1 0 0 0 0 0

7 TZN 1 0 0 0 0 0

c--

c710 LAND USE DEFINITION (required if land simulation control is external)

c

c LANDTYPE = Unique land use definition identifier

c LANDNAME = land use name

c IMPERVIOUS = Distinguishes pervious/impervious land unit (0-pervious; 1-impervious)

c TIMESERIESFILE = File name containing input timeseries

c SAND_FRAC = The fraction of total sediment from the land which is sand (0-1)

c SILT_FRAC = The fraction of total sediment from the land which is silt (0-1)

c CLAY_FRAC = The fraction of total sediment from the land which is clay (0-1)

c

c LANDTYPE	LANDNAME	IMPERVIOUS	TIMESERIESFILE	SAND_FRAC	SILT_FRAC	CLAY_FRAC
1	Road_Freeway-All-All-All	1	1000_Road_Freeway-All-All-All.txt	0	0.55	0.4
2	Road_Primary-All-All-All	1	2000_Road_Primary-All-All-All.txt	0	0.55	0.4
3	Road_Minor-All-All-All	1	3000_Road_Minor-All-All-All.txt	0	0.55	0.4
4	Dev_ResHigh-All-All-All	1	4000_Dev_ResHigh-All-All-All.txt	0	0.55	0.4
5	Dev_ResLow-All-All-All	1	5000_Dev_ResLow-All-All-All.txt	0	0.55	0.4
6	Dev_Com-All-All-All	1	6000_Dev_Com-All-All-All.txt	0	0.55	0.4
7	Dev_Ind-All-All-All	1	7000_Dev_Ind-All-All-All.txt	0	0.55	0.4
8	Dev_Inst-All-All-All	1	8000_Dev_Inst-All-All-All.txt	0	0.55	0.4
9	Dev_Roof-All-All-All	1	9000_Dev_Roof-All-All-All.txt	0	0.55	0.4
10	Dev_Overspray-All-All-All	1	10000_Dev_Overspray-All-All-All.txt	0	0.55	0.4
11	Dev_Irrigated-A-Low-Confined	0	11111_Dev_Irrigated-A-Low-Confined.txt	0	0.55	0.4
12	Dev_Irrigated-A-Low-Unconfined	0	11112_Dev_Irrigated-A-Low-Unconfined.txt	0	0.55	0.4
13	Dev_Irrigated-A-Med-Confined	0	11121_Dev_Irrigated-A-Med-Confined.txt	0	0.55	0.4
14	Dev_Irrigated-A-Med-Unconfined	0	11122_Dev_Irrigated-A-Med-Unconfined.txt	0	0.55	0.4

15 Dev_Irrigated-B-Low-Confined 0 11211_Dev_Irrigated-B-Low-Confined.txt 0 0.55 0.4

16 Dev_Irrigated-B-Low-Unconfined 0 11212_Dev_Irrigated-B-Low-Unconfined.txt 0 0.55 0.4

17 Dev_Irrigated-B-Med-Confined 0 11221_Dev_Irrigated-B-Med-Confined.txt 0 0.55 0.4

18 Dev_Irrigated-B-Med-Unconfined 0 11222_Dev_Irrigated-B-Med-Unconfined.txt 0 0.55 0.4

19 Dev_Irrigated-C-Low-Confined 0 11311_Dev_Irrigated-C-Low-Confined.txt 0 0.55 0.4

20 Dev_Irrigated-C-Low-Unconfined 0 11312_Dev_Irrigated-C-Low-Unconfined.txt 0 0.55 0.4

21 Dev_Irrigated-C-Med-Confined 0 11321_Dev_Irrigated-C-Med-Confined.txt 0 0.55 0.4

22 Dev_Irrigated-C-Med-Unconfined 0 11322_Dev_Irrigated-C-Med-Unconfined.txt 0 0.55 0.4

23 Dev_Irrigated-D-Low-Confined 0 11411_Dev_Irrigated-D-Low-Confined.txt 0 0.55 0.4

24 Dev_Irrigated-D-Low-Unconfined 0 11412_Dev_Irrigated-D-Low-Unconfined.txt 0 0.55 0.4

25 Dev_Irrigated-D-Med-Confined 0 11421_Dev_Irrigated-D-Med-Confined.txt 0 0.55 0.4

26 Dev_Irrigated-D-Med-Unconfined 0 11422_Dev_Irrigated-D-Med-Unconfined.txt 0 0.55 0.4

27 Dev_Pervious-A-Low-Confined 0 12111_Dev_Pervious-A-Low-Confined.txt 0 0.55 0.4

28 Dev_Pervious-A-Low-Unconfined 0 12112_Dev_Pervious-A-Low-Unconfined.txt 0 0.55 0.4

29 Dev_Pervious-A-Med-Confined 0 12121_Dev_Pervious-A-Med-Confined.txt 0 0.55 0.4

30 Dev_Pervious-A-Med-Unconfined 0 12122_Dev_Pervious-A-Med-Unconfined.txt 0 0.55 0.4

31 Dev_Pervious-B-Low-Confined 0 12211_Dev_Pervious-B-Low-Confined.txt 0 0.55 0.4

32	Dev_Pervious-B-Low-Unconfined	0	12212_Dev_Pervious-B-Low-Unconfined.txt	0	0.55	0.4
33	Dev_Pervious-B-Med-Confined	0	12221_Dev_Pervious-B-Med-Confined.txt	0	0.55	0.4
34	Dev_Pervious-B-Med-Unconfined	0	12222_Dev_Pervious-B-Med-Unconfined.txt	0	0.55	0.4
35	Dev_Pervious-C-Low-Confined	0	12311_Dev_Pervious-C-Low-Confined.txt	0	0.55	0.4
36	Dev_Pervious-C-Low-Unconfined	0	12312_Dev_Pervious-C-Low-Unconfined.txt	0	0.55	0.4
37	Dev_Pervious-C-Med-Confined	0	12321_Dev_Pervious-C-Med-Confined.txt	0	0.55	0.4
38	Dev_Pervious-C-Med-Unconfined	0	12322_Dev_Pervious-C-Med-Unconfined.txt	0	0.55	0.4
39	Dev_Pervious-D-Low-Confined	0	12411_Dev_Pervious-D-Low-Confined.txt	0	0.55	0.4
40	Dev_Pervious-D-Low-Unconfined	0	12412_Dev_Pervious-D-Low-Unconfined.txt	0	0.55	0.4
41	Dev_Pervious-D-Med-Confined	0	12421_Dev_Pervious-D-Med-Confined.txt	0	0.55	0.4
42	Dev_Pervious-D-Med-Unconfined	0	12422_Dev_Pervious-D-Med-Unconfined.txt	0	0.55	0.4
43	Agriculture-A-Low-Confined	0	13111_Agriculture-A-Low-Confined.txt	0	0.55	0.4
44	Agriculture-A-Low-Unconfined	0	13112_Agriculture-A-Low-Unconfined.txt	0	0.55	0.4
45	Agriculture-A-Med-Confined	0	13121_Agriculture-A-Med-Confined.txt	0	0.55	0.4
46	Agriculture-A-Med-Unconfined	0	13122_Agriculture-A-Med-Unconfined.txt	0	0.55	0.4
47	Agriculture-B-Low-Confined	0	13211_Agriculture-B-Low-Confined.txt	0	0.55	0.4
48	Agriculture-B-Low-Unconfined	0	13212_Agriculture-B-Low-Unconfined.txt	0	0.55	0.4

49	Agriculture-B-Med-Confined	0	13221_Agriculture-B-Med-Confined.txt	0	0.55	0.4
50	Agriculture-B-Med-Unconfined	0	13222_Agriculture-B-Med-Unconfined.txt	0	0.55	0.4
51	Agriculture-B-High-Confined	0	13231_Agriculture-B-High-Confined.txt	0	0.55	0.4
52	Agriculture-B-High-Unconfined	0	13232_Agriculture-B-High-Unconfined.txt	0	0.55	0.4
53	Agriculture-C-Low-Confined	0	13311_Agriculture-C-Low-Confined.txt	0	0.55	0.4
54	Agriculture-C-Low-Unconfined	0	13312_Agriculture-C-Low-Unconfined.txt	0	0.55	0.4
55	Agriculture-C-Med-Confined	0	13321_Agriculture-C-Med-Confined.txt	0	0.55	0.4
56	Agriculture-C-Med-Unconfined	0	13322_Agriculture-C-Med-Unconfined.txt	0	0.55	0.4
57	Agriculture-C-High-Confined	0	13331_Agriculture-C-High-Confined.txt	0	0.55	0.4
58	Agriculture-D-Low-Confined	0	13411_Agriculture-D-Low-Confined.txt	0	0.55	0.4
59	Agriculture-D-Low-Unconfined	0	13412_Agriculture-D-Low-Unconfined.txt	0	0.55	0.4
60	Agriculture-D-Med-Confined	0	13421_Agriculture-D-Med-Confined.txt	0	0.55	0.4
61	Agriculture-D-Med-Unconfined	0	13422_Agriculture-D-Med-Unconfined.txt	0	0.55	0.4
62	Agriculture-D-High-Confined	0	13431_Agriculture-D-High-Confined.txt	0	0.55	0.4
63	Agriculture-D-High-Unconfined	0	13432_Agriculture-D-High-Unconfined.txt	0	0.55	0.4
64	Veg_Low-A-Med-Confined	0	14121_Veg_Low-A-Med-Confined.txt	0	0.55	0.4
65	Veg_Low-A-Med-Unconfined	0	14122_Veg_Low-A-Med-Unconfined.txt	0	0.55	0.4

66 Veg_Low-A-High-Confined 0 14131_Veg_Low-A-High-Confined.txt 0 0.55
0.4

67 Veg_Low-A-High-Unconfined 0 14132_Veg_Low-A-High-Unconfined.txt 0 0.55
0.4

68 Veg_Low-B-Med-Confined 0 14221_Veg_Low-B-Med-Confined.txt 0 0.55
0.4

69 Veg_Low-B-Med-Unconfined 0 14222_Veg_Low-B-Med-Unconfined.txt 0 0.55
0.4

70 Veg_Low-B-High-Confined 0 14231_Veg_Low-B-High-Confined.txt 0 0.55
0.4

71 Veg_Low-B-High-Unconfined 0 14232_Veg_Low-B-High-Unconfined.txt 0 0.55
0.4

72 Veg_Low-C-Med-Confined 0 14321_Veg_Low-C-Med-Confined.txt 0 0.55
0.4

73 Veg_Low-C-Med-Unconfined 0 14322_Veg_Low-C-Med-Unconfined.txt 0 0.55
0.4

74 Veg_Low-C-High-Confined 0 14331_Veg_Low-C-High-Confined.txt 0 0.55
0.4

75 Veg_Low-C-High-Unconfined 0 14332_Veg_Low-C-High-Unconfined.txt 0 0.55
0.4

76 Veg_Low-D-Med-Confined 0 14421_Veg_Low-D-Med-Confined.txt 0 0.55
0.4

77 Veg_Low-D-Med-Unconfined 0 14422_Veg_Low-D-Med-Unconfined.txt 0 0.55
0.4

78 Veg_Low-D-High-Confined 0 14431_Veg_Low-D-High-Confined.txt 0 0.55
0.4

79 Veg_Low-D-High-Unconfined 0 14432_Veg_Low-D-High-Unconfined.txt 0 0.55
0.4

80 Veg_High-A-Med-Confined 0 15121_Veg_High-A-Med-Confined.txt 0 0.55
0.4

81 Veg_High-A-Med-Unconfined 0 15122_Veg_High-A-Med-Unconfined.txt 0
0.55 0.4

82 Veg_High-A-High-Confined 0 15131_Veg_High-A-High-Confined.txt 0 0.55
0.4

83 Veg_High-A-High-Unconfined 0 15132_Veg_High-A-High-Unconfined.txt0 0.55 0.4

84 Veg_High-B-Med-Confined 0 15221_Veg_High-B-Med-Confined.txt 0 0.55 0.4

85 Veg_High-B-Med-Unconfined 0 15222_Veg_High-B-Med-Unconfined.txt0 0.55 0.4

86 Veg_High-B-High-Confined 0 15231_Veg_High-B-High-Confined.txt 0 0.55 0.4

87 Veg_High-B-High-Unconfined 0 15232_Veg_High-B-High-Unconfined.txt0 0.55 0.4

88 Veg_High-C-Med-Confined 0 15321_Veg_High-C-Med-Confined.txt 0 0.55 0.4

89 Veg_High-C-Med-Unconfined 0 15322_Veg_High-C-Med-Unconfined.txt0 0.55 0.4

90 Veg_High-C-High-Confined 0 15331_Veg_High-C-High-Confined.txt 0 0.55 0.4

91 Veg_High-C-High-Unconfined 0 15332_Veg_High-C-High-Unconfined.txt0 0.55 0.4

92 Veg_High-D-Med-Confined 0 15421_Veg_High-D-Med-Confined.txt 0 0.55 0.4

93 Veg_High-D-Med-Unconfined 0 15422_Veg_High-D-Med-Unconfined.txt 0 0.55 0.4

94 Veg_High-D-High-Confined 0 15431_Veg_High-D-High-Confined.txt 0 0.55 0.4

95 Veg_High-D-High-Unconfined 0 15432_Veg_High-D-High-Unconfined.txt 0 0.55 0.4

96 Water-All-All-All 0 16000_Water-All-All-All.txt 0 0.55 0.4

c---

c712 Aquifer INFORMATION

c

c AquiferID = Unique Aquifer identifier

c AquiferNAME = Aquifer name

c Initial Storage = Initial Storage (ac-ft)

c RecessionCoef = Recession Coefficient (1/hr)

c SeepageCoef = Seepage Coefficient (1/hr)

c

c AquiferID AquiferNAME InitialStorage RecessionCoef SeepageCoef

c---

c713 Aquifer Pollutant Background Concentration

c

c AquiferID = Unique Aquifer identifier as in c712

c Ci = Background concentration for pollutant i (mg/l)

c Where i = 1 to N (N = Number of QUAL from card 705)

c

c AQUIFER_ID QUALC1 QUALC2 ... QUALCN

c---

c715 BMP SITE INFORMATION

c

c BMPSITE = Unique BMP site identifier

c BMPNAME = BMP template name or site name

c BMPTYPE = Unique BMP Types (must use the exact same keyword)

c
(BIORETENTION,WETPOND,CISTERN,DRYPOND,INFILTRATIONTRENCH,GREENROOF,POROUSPAVEMENT,
RAINBARREL,REGULATOR,SWALE,CONDUIT,BUFFERSTRIP,AREABMP)

c DArea = Total Drainage Area in acre

c NUMUNIT = Number of BMP structures

c DDAREA = Design drainage area of the BMP structure (acre)

c PreLUType = Predevelopment land use type (for external land simulation option)

c AquiferID = Unique Aquifer ID, 0 --- no aquifer (for external land simulation option)

c FtableFLG = Ftable flag, 0 = no, 1 = yes (for BMP Class A, B, and C)

c FTABLE_ID = Unique Ftable identifier (continuous string) as in card 714

c DA2FP_RATIO = BMP drainage area to footprint ratio (ac/ac)

c GID = BMPSITE Group Identifier (non-zero integer, 0 = not a group)

c NOTE: if multiple BMPSITE for the same GID then optimizer will choose only one for a solution

c the user must specify the nested routing for the BMPs in a group and drainage area should be assigned to the most upstream BMPSITE.

c land swap controls (card 711) and structural controls (card 715) will be grouped together if they are assigned the same GID. To keep them separate use the different GID in card 711 and 715.

c RtableFLG = Rtable flag, 0 = no, 1 = yes (for JUNCTION only)

c RTABLE_ID = Unique REDUCTION-table identifier (continuous string) as in card 707

c

c BMPSITE BMPNAME BMPTYPE DArea NUMUNIT DDAREA PreLUType AquiferID FtableFLG FTABLE_ID DA2FP_RATIO GID RtableFLG RTABLE_ID

out SubwatershedOutlet JUNCTION 0 1 0 1 0 0 No 0 0 0

ut UntreatedFlow JUNCTION 0 1 0 1 0 0 No 0 0 0

TBDBMP BioretentionType1 BIORETENTION 0 1 0 1 0 0 No 0 0 0

REG1 BioretentionType1 RAINBARREL 30.77742196 1 0 1 0 0 No 0 0 0

LID7 BioretentionType1 INFILTRATIONTRENCH 0 1 0 1 0 0 No 0 0 0

sewer Sewer JUNCTION 0 1 0 1 0 0 0 0 0 0

c--

c721 Tier-1 Watershed Outlets Definition

c

c BMPSITE = BMP site(watershed outlet) identifier in card 715

c NUMBREAKS = Number of break points on the cost-effectiveness curve

c CECurveFile = CECurve_Solutions file for the project cost(sorted cost value) of each break point

c

c BMPSITE NUMBREAKS CECurveFile

c---

c722 Tier-1 Watershed Timeseries Definition

c

c BMPSITE = BMP site(watershed outlet) identifier in card 721

c BREAKPOINTID = Unique break point id on cost-effectiveness curve

c(0 for initial, -1 for PreDev, and - 2 for PostDev condition)

c MULTIPLIER = Multiplier applied to the timeseries file

c TIMESERIESFILE = Timeseries output file corresponding to the breakpoint id

c

c BMPSITE   BREAKPOINTID MULTIPLIER TIMESERIESFILE

c---

c723 Pump Curve (applies if PUMP_FLG is ON in card 725)

c

c PUMP_CURVE = The unique name of pump curve (continuous string without space)

c NUM_RECORD = Number of points on the curve

c

c DEPTH   = Depth (ft)

c FLOW   = Pumping flow rate (cfs)

c

c PUMP_CURVE NUM_RECORD

c DEPTH   FLOW

c---

c725 CLASS-A BMP Site Parameters (required if BMPSITE is CLASS-A in card 715)

c

c BMPSITE = Class A BMP dimension group identifier in card 715

c WIDTH   = Basin bottom width (ft)

c LENGTH = Basin bottom length (ft) / diameter (ft) for rain barrel or cistern

c OHEIGHT = Orifice Height (ft)

c DIAM   = Orifice Diameter (in)

c CCOEF = Contraction Coefficient, user-specified value between 0 and 1 (e.g., Rounded = 1.0, Short Tube = 0.8, Sharp-edged = 0.61, Borda = 0.5)

c RELTP = Release Type (1-Cistern, 2-Rain barrel, 3-others)

c PEOPLE = Number of persons (Cistern Option)

c DDAYS = Number of dry days (Rain Barrel Option)

c WEIRTP = Weir Type (1-Rectangular,2-Triangular)

c WEIRH = Weir Height (ft)

c WEIRW = (weir type 1) Weir width (ft)

c THETA = (weir type 2) Weir angle (degrees)

c ET_MULT = multiplier to PET

c PUMP_FLG = pump option (0-OFF, 1-ON)

c DEPTH_ON = water Depth (ft) at which the pump is started

c DEPTH_OFF = water Depth (ft) at which the pump is stopped

c PUMP_CURVE = The unique name of pump curve (continuous string without space)

c BYPASS_FRAC = Fraction of inflow that bypasses the BMP when full (0.0-1.0)

c DIV_RATE = Maximum flow diversion rate into BMP (cfs)

c BMP_GID = BMP group ID, activate only one BMP within a group (default = 0 [not a group], non-zero positive integer value as group ID)

c The user must specify the nested routing for the BMPs in a group and drainage area should be specified only for the most upstream BMP.

c

c BMPSITE WIDTH LENGTH OHEIGHT DIAM EXITYPE RELEASETYPE PEOPLE DDAYS WEIRTYPE WEIRH WEIRW THETA ET_MULT PUMP_FLG DEPTH_ON DEPTH_OFF PUMP_CURVE BYPASS_FRAC DIV_RATE BMP_GID

TBDBMP 0 0 0 0 0.61 3 0 0 1 0.5 10000 0 0 0 0 0 none 0 -1

REG1 132 110 0 0.6 0.61 4 0 0 1 14 10000 0 0 0 0 0 none 0 -1

LID7 132 20 0 0.01 0.61 4 0 0 1 14 10000 0 0 0 0 0 none 0 -1

c---

c730 Cistern Control Water Release Curve (applies if release type is cistern in card 725)

c

c BMPSITE = Class A BMP dimension group identifier in card 715

c Flow = Hourly water release per capita from the Cistern Control (ft3/hr/capita)

c

c BMPSITE FLOW

TBDBMP 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0
0

REG1 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0

LID7 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0

c---

c735 CLASS B BMP Site DIMENSION GROUPS

c

c BMPSITE = BMP Site identifier in card 715

c WIDTH = basin bottom width (ft)

c LENGTH = basin bottom Length (ft)

c MAXDEPTH = Maximum depth of channel (ft)

c SLOPE1 = Side slope 1 (ft/ft)

c SLOPE2 = Side slope 2 (ft/ft) (1-4)

c SLOPE3 = Side slope 3 (ft/ft)

c MANN_N = Manning 's roughness coefficient

c ET_MULT = multiplier to PET

c

c BMPSITE WIDTH LENGTH MAXDEPTH SLOPE1 SLOPE2 SLOPE3 MANN_N
ET_MULT

c---

c740 BMP Site BOTTOM SOIL/VEGITATION CHARACTERISTICS

c

c BMPSITE = BMPSITE identifier in c715

c INFILTM = Infiltration Method (0-Green Ampt, 1-Horton, 2-Holtan)

c POLROTM = Pollutant Routing Method (1-Completely mixed, >1-number of CSTRs in series)

c POLREMM = Pollutant Removal Method (0-1st order decay, 1-kadlec and knight method, 2-user defined concentration)

c SDEPTH = Soil Depth (ft)

c POROSITY = Soil Porosity (0-1)

c FCAPACITY = Soil Field Capacity (ft/ft)

c WPOINT = Soil Wilting Point (ft/ft)

c AVEG = Vegetative Parameter A (0.1-1.0) (Empirical), only required for Holtan infiltration method

c FINFILT = Soil layer infiltration rate (in/hr)

c UNDSWITCH = Underdrain option (0-No underdrain, 1-underdrain with percent removal rate, 2-underdrain with constant effluent conc.)

c UNDDEPTH = Depth of storage media below underdrain (ft)

c UNDVOID = Fraction of underdrain storage depth that is void space (0-1)

c UNDINFILT = Background infiltration rate, below underdrain (in/hr)

c SUCTION = Average value of soil capillary suction along the wetting front, value must be greater than zero (in), only required for Green-Ampt infiltration method

c IMDMAX = Difference between soil porosity and initial moisture content, value must be greater than or equal to zero (a fraction), only required for Green-Ampt infiltration method

c MAXINFILT = Maximum rate on the Horton infiltration curve (in/hr), only required for Horton infiltration method

c DECAYCONS = Decay constant for the Horton infiltration curve (1/hr), only required for Horton infiltration method

c DRYTIME = Time for a fully staurated soil to completely dry (day), only required for Horton infiltration method

c MAXVOLUME = Maximum infiltration volume possible (in), only required for Horton infiltration method

c

c BMPSITE INFILTM POLROTM POLREMM SDEPTH POROSITY FCAPACITY WPOINT AVEG FINFILT UNDSWITCH UNDDEPTH UNDVOID UNDINFILT SUCTION IMDMAX MAXINFILT DECAYCONS DRYTIME MAXVOLUME

TBDBMP 2 1 0 2 0.35 0.3 0.15 0.6 1 0 1.5
0.4 1 0 0 3 4 7 0

REG1 2 1 0 0.1 0.4 0.3 0.15 0 0 0 1 0.4
0.01 0 0 3 4 7 0

LID7 2 1 0 0 0.45 0.3 0.15 0 0.44 0 1 0.4
1.5 0 0 3 4 7 0

c---

c745 BMP Site HOLTAN GROWTH INDEX

c

c HOLTAN EQUATION: F = GI * AVEG * (Computed Available Soil Storage)^ 1.4 + FINFILT

c

c BMPSITE = BMPSITE identifier in card 715

c GIi = 12 monthly values for GI in HOLTAN equation

c Where i = jan, feb, mar...dec

c

c BMPSITE jan feb mar apr may jun jul aug sep oct nov dec

TBDBMP 0 0 0 0 0 0 0 0 0 0 0
0

REG1 0 0 0 0 0 0 0 0 0 0 0 0

LID7 0 0 0 0 0 0 0 0 0 0 0 0

c---

c747 BMP Site Initial Moisture Content

c

c BMPSITE = BMP Site identifier in card 715

c WATDEP_i = initial surface water depth (ft)

c THETA_i = initial soil moisture (ft/ft)

c

c BMPSITE WATDEP_i THETA_i

TBDBMP 0 0.15

REG1 0 0.15

LID7 0 0.15

c---

c750 Class-C Conduit Parameters (required if BMPSITE is CLASS-C in card 715)

c

c BMPSITE = BMP site identifier in card 715

c INLET_NODE = BMP Id at the entrance of the conduit

c OUTLET_NODE = BMP Id at the exit of the conduit

c LENGTH = Conduit length (ft)

c MANNING_N = Manning's roughness coefficient

c INLET_IEL = Invert Elevation at the entrance of the conduit (ft)

c OUTLET_IEL = Invert Elevation at the exit of the conduit (ft)

c INIT_FLOW = Initial flow in the conduit (cfs)

c INLET_HL = Head loss coefficient at the entrance of the conduit

c OUTLET_HL = Head loss coefficient at the exit of the conduit

c AVERAGE_HL = Head loss coefficient along the length of the conduit

c

c BMPSITE INLET_NODE OUTLET_NODE LENGTH MANNING_N INLET_IEL OUTLET_IEL INIT_FLOW INLET_HL OUTLET_HL AVERAGE_HL

c---

c755 Class C Conduit Cross Sections

c

c LINK = BMP site identifier in card 715

c TYPE = Conduit Type (rectangular, circular...)

c GEOM1 = Geometric cross-sectional property of the conduit

c GEOM2 = Geometric cross-sectional property of the conduit

c GEOM3 = Geometric cross-sectional property of the conduit

c GEOM4 = Geometric cross-sectional property of the conduit

c BARRELS = Number of Barrels in the conduit

c

```
c LINK   TYPE     GEOM1 GEOM2 GEOM3 GEOM4 BARRELS
c---------------------------------------------------------------------------------------------------------------------
c760 Irregular Cross Sections
c
c Format of transect data follows:
c NC     nLeft    nRight   nChannel
c X1     name    nSta     xLeftBank       xRightBank       0        0        0        xFactor yFactor
c GR     Elevation          Station  ...
c------------------------------------------------------------------------------------------
c761 BufferStrip BMP Parameters (required if BMPTYPE is BUFFERSTRIP in card 715)
c
c BMPSITE   = BMP site identifier in card 715
c Width     = BMP width (ft)
c FLength   = Flow length (ft)
c DStorage  = Surface depression storage (in)
c SLOPE     = Overland slope (ft / ft)
c MANNING_N = Overland Manning's roughness coefficient
c POLREMM   = Pollutant Removal Method (0-1st order decay, 1-kadlec and knight method)
c ET_MULT   = Multiplier to PET
c
c------------------------------------------------------------------------------------------
c762 Area BMP Parameters (required if BMPTYPE is AREABMP in card 715)
c
c BMPSITE     = BMP site identifier in card 715
c Area        = BMP area (ft2)
c FLength     = flow length (ft) note: area width = area / flow length
c DStorage    = Surface depression storage (in)
c SLOPE       = Overland slope (ft / ft)
c MANNING_N   = Overland Manning's roughness coefficient
```

c SAT_INFILT = Saturated infiltration rate (in/hr)

c POLREMM = Pollutant Removal Method (0-1st order decay, 1-kadlec and knight method)

c DCIA = Percentage of Directly Connected Impervious Area (0-100)

c TOTAL_IMP_DA = Total Impervious Drainage Area (acre)

c

c BMPSITE Area FLengthDStorage SLOPE MANNING_N SAT_INFILT POLREMM DCIA TOTAL_IMP_DA

c---

c---

c765 BMP SITE Pollutant Decay / Loss rates

c

c BMPSITE = BMP site identifier in card 715information

c QUALDECAYi = First - order decay rate for pollutant i (hr ^ -1)

c Where i = 1 to N(N = Number of QUAL from TIMESERIES FILES)

c

c BMPSITE QUALDECAY1 QUALDECAY2...QUALDECAYN

TBDBMP 0.008333333 0.008333333 0.008333333 0.008333333 0.008333333 0.008333333 0.008333333

REG1 0.008333333 0.008333333 0.008333333 0.008333333 0.008333333 0.008333333 0.008333333

LID7 0.008333333 0.008333333 0.008333333 0.008333333 0.008333333 0.008333333 0.008333333

c---

c766 Pollutant K' values (applies when pollutant removal method is kadlec and knight method in card 740)

c

c BMPSITE = BMP site identifier in card 715

C QUALK'i = Constant rate for pollutant i (ft/yr)

c Where i = 1 to N (N = Number of QUAL from card 705)

c

c BMPSITE QUALK'1 QUALK'2 ... QUALK'N

c---

c767 Pollutant C* values (applies when pollutant removal method is kadlec and knight method in card 740)

c

c BMPSITE = BMP site identifier in card 715

c QUALC*i = Background concentration for pollutant i (mg/l)

c Where i = 1 to N (N = Number of QUAL from card 705)

c

c BMPSITE QUALC*1 QUALC*2 ... QUALC*N

c---

c768 Pollutant C values (applies when surface release type is 4 in card 725)

c

c BMPSITE = BMP site identifier in card 715

c QUALCi = Constant surface release concentration for pollutant i (mg/l)

c Where i = 1 to N (N = Number of QUAL from card 705)

c

c BMPSITE QUALC1 QUALC2 ... QUALCN

TBDBMP 0 0 0 0 0 0 0

REG1 0 0 0 0 0 0 0

LID7 0 0 0 0 0 0 0

c---

c770 BMP Underdrain Pollutant Percent Removal(applies when underdrain is on in card 740)

c

c BMPSITE = BMPSITE identifier in card 715

c QUALPCTREMi = Perecent Removal for pollutant i through underdrain(0 - 1)

c Where i = 1 to N(N = Number of QUAL from TIMESERIES FILES)

c

c BMPSITE QUALPCTREM1 QUALPCTREM2...QUALPCTREMN

TBDBMP 0 0 0 0 0 0 0

REG1 0 0 0 0 0 0 0

LID7 0 0 0 0 0 0 0

c--

c771 BMP Underdrain Pollutant Effluent Concentration (applies when underdrain option is '2' in card 740)

c

c BMPSITE = BMPSITE identifier in card 715

c QUALEFFCi = Underdrain effluent concentration for pollutant i (mg / l)

c Where i = 1 to N(N = Number of QUAL from TIMESERIES FILES)

c

c BMPSITE QUALEFFC1 QUALEFFC2...QUALEFFCN

TBDBMP 0 0 0 0 0 0 0

REG1 0 0 0 0 0 0 0

LID7 0 0 0 0 0 0 0

c--

c775 Sediment General Parameters (required if pollutant type is sediment in card 705)

c

c BMPSITE = BMP site identifier in card 715

c BEDWID = Bed width (ft) - this is constant for the entire simulation period

c BEDDEP = Initial bed depth (ft)

c BEDPOR = Bed sediment porosity

c

c BMPSITE BEDWID BEDDEPBEDPOR

c--

c780 Sand Transport Parameters (required if pollutant type is sediment in card 705)

c

c BMPSITE = BMP site identifier in card 715

c D = Effective diameter of the transported sand particles (in)

c W = The corresponding fall velocity in still water (in/sec)

c RHO = The density of the sand particles (lb/ft3)

c KSAND = The coefficient in the sandload power function formula

c EXPSND = The exponent in the sandload power function formula

c

c BMPSITE D W RHO KSAND EXPSND

c--

c785 Silt Transport Parameters (required if pollutant type is sediment in card 705)

c

c BMPSITE = BMP site identifier in card 715

c D = Effective diameter of the transported silt particles (in)

c W = The corresponding fall velocity in still water (in/sec)

c RHO = The density of the silt particles (lb/ft3)

c TAUCD = The critical bed shear stress for deposition (lb/ft2)

c TAUCS = The critical bed shear stress for scour (lb/ft2)

c M = The erodibility coefficient of the silt particles (lb/ft2/day)

c

c BMPSITE D W RHO TAUCD TAUCS M

c--

c786 Clay Transport Parameters (required if pollutant type is sediment in card 705)

c

c BMPSITE = BMP site identifier in card 715

c D = Effective diameter of the transported clay particles (in)

c W = The corresponding fall velocity in still water (in/sec)

c RHO = The density of the silt/clay particles (lb/ft3)

c TAUCD = The critical bed shear stress for deposition (lb/ft2)

c TAUCS = The critical bed shear stress for scour (lb/ft2)

c M = The erodibility coefficient of the clay particles (lb/ft2/day)

c

c BMPSITE D W RHO TAUCD TAUCS M

c---

c790 LAND TO BMP ROUTING NETWORK(required for external land simulation control in card 700)

c

c UniqueID = Identifies an instance of LANDTYPE in SCHEMATIC

c LANDTYPE = Corresponds to LANDTYPE in c710

c AREA = Area of LANDTYPE in ACRES

c DS = UNIQUE ID of DS BMP(0 - no BMP, add to end)

c GID = Group Identifier in card 711 (0 - no change)

c

c UniqueID LANDTYPE AREA DS LCGID

1 2 4.617898240000001 REG1 0

2 3 1.7613644400000001 REG1 0

3 4 1.21180292 REG1 0

4 5 4.41428372 REG1 0

5 6 1.62397406 REG1 0

6 8 0.75317604 REG1 0

7 9 3.05520622 REG1 0

8 10 0.19175348 REG1 0

9 19 1.9600368600000002 REG1 0

10 35 5.62509822 REG1 0

11 72 4.20770394 REG1 0

12 88 1.35512382 REG1 0

c---

c795 BMP Site ROUTING NETWORK

c

c BMPSITE = BMPSITE identifier in card 715

c OUTLET_TYPE = Outlet type(1 - total, 2 - weir, 3 - orifice or channel, 4 - underdrain, 5-untreated or bypass)

```
c DS = Downstrem BMP site identifier in card 715(0 - no BMP, add to end)
c
c BMPSITE OUTLET_TYPE DS
ut      1       out
out     1       0
TBDBMP          1       out
REG1    2       LID7
REG1    3       sewer
REG1    4       LID7
REG1    5       LID7
LID7    2       out
LID7    3       sewer
LID7    4       out
LID7    5       out
c--------------------------------------------------------------------------------------------------------------------
c800 Optimization Controls
c
c Technique --Optimization Techniques
c     0 = no optimization
c     1 = Scatter Search
c 2 = NSGAII
c Option --Optimization options
c     0 = no optimization
c     1 = specific control target and minimize cost
c     2 = generate cost effectiveness curve
c StopDelta-- Criteria for stopping the optimization iteration
c           in dollars($), meaning if the cost not improved by this criteria, stop the search(for Option 1)
c MaxRuns --Maximum number of iterations
c NumBest-- Number of best solutions for output(for Option 1)
```

c

c Technique Option StopDelta MaxRuns NumBest

0 2 0 10000 1

c---

c805 BMP Cost Functions

c Cost($) = ((LinearCost)Length ^ (LengthExp) + (AreaCost)Area ^ (AreaExp) + (TotalVolumeCost)TotalVolume ^ (TotalVolExp)

c + (MediaVolumeCost)SoilMediaVolume ^ (MediaVolExp) + (UnderDrainVolumeCost)UnderDrainVolume ^ (UDVolExp)

c + (Unitcost) + (ConstantCost)) * (1 + PercentCost / 100)

c

c BMPSITE = BMP site identifier in card 715

c LinearCost = Cost per unit length of the BMP structure($/ ft)

c AreaCost = Cost per unit area of the BMP structure($/ ft ^ 2)

c TotalVolumeCost = Cost per unit total volume of the BMP structure($/ ft ^ 3)

c MediaVolumeCost = Cost per unit volume of the soil media($/ ft ^ 3)

c UnderDrainVolumeCost = Cost per unit volume of the under drain structure($/ ft ^ 3)

c ConstantCost = Constant cost($)

c PercentCost = Cost in percentage of all other cost(%)

c LengthExp = Exponent for linear unit

c AreaExp = Exponent for area unit

c TotalVolExp = Exponent for total volume unit

c MediaVolExp = Exponent for soil media volume unit

c UDVolExp = Exponent for underdrain volume unit

c

c BMPSITE LinearCost AreaCost TotalVolumeCost MediaVolumeCost UnderDrainVolumeCost ConstantCost PercentCost LengthExp AreaExp TotalVolExp MediaVolExp UDVolExp

TBDBMP 0 0 0 0 0 0 0 1 1 1 1 1

REG1 0 0 12.6 0 0 120000 0 1 1 1 1 1

LID7 0 0 5.9848 0 0 0 0 1 1 1 1 1

c--

c806 Diversion Structure Cost Function

c Cost ($) = ((DiversionCost)*DIV_RATE^(DiversionExp) + (ConstantCost)) * (1+PercentCost/100)

c

c BMPSITE = BMP site identifier in card 715

c DiversionCost = Cost per unit diversion rate ($/cfs)

c DiversionExp = Exponent for diversion rate

c ConstantCost = Constant cost ($)

c PercentCost = Cost in percentage of all other cost (%)

c

c BMPSITE DiversionCost DiversionExp ConstantCost PercentCost

TBDBMP 0 1 0 0

REG1 25400 1 0 0

LID7 0 1 0 0

c--

c810 BMP SITE Adjustable Parameters

c BMPSITE = BMP site identifier in card 715

c VARIABLE = Variable name

c LENGTH = BMP length,

c NUMUNIT = number of units,

c WEIRH = weir height,

c SDEPTH = soil media depth,

c DCIA = directly connected impervious area,

c MAXDEPTH = BMP maximum depth,

c CECURVE = cost - effectiveness curve for Tier - 1 solution

c DIV_RATE --- maximum flow diversion rate into BMP

c FROM = From value in the range

c TO = To value in the range

c STEP = Increment step

c BMPSITE VARIABLE FROM TO STEP

TBDBMP LENGTH 0 0 0

REG1 LENGTH 0 175.19417798545703 0.8759708899272851

LID7 LENGTH 0 63.245553203367585 0.31622776601683794

c---

c814 Predeveloped Timeseries at Assessment Point for Flow Duration Curve

c

c BMPSITE = BMP site identifier in card 715 if it is an assessment point

c NumBins = Number of bins for flow duration curve

c PreDevFlag = Pre-developed timeseries option (1-internal,2-external)

c PreDevFile = Pre-developed timeseries file path for external option

c The timeseries file format (AssessmentPoint_ID Year Month Day Hour Minute Flow_cfs)

c The first line is skipped (comment line) and data start from the second line in the required format.

c

c BMPSITE NumBins PreDevFlag PreDevFile

c815 Assessment Point and Evaluation Factor

c

c BMPSITE -- BMP site identifier in card 715 if it is an assessment point

c FactorGroup -- Flow or pollutant related evaluation factor group

c -1 = flow related evaluation factor

c # = pollutant ID in card 705

c FactorType -- Evaluation Factor Type (negative number for flow related and positive number for pollutant related)

c -1 = AAFV Annual Average Flow Volume (ft3/yr)

c -2 = PDF Peak Discharge Flow (cfs)

c -3 = FEF Flow Exceeding frequency (#times/year)

c -4 = FDC Flow Duration Curve (sum of sorted flow difference with pre-developed condition, cfs) c -5 = RAAFV Retain Annual Average Flow Volume (ft3/yr), it requires retain daily flag (value = 1) timeseries in card 700

c 1 = AAL Annual Average Load (lb/yr)

c 2 = AAC Annual Average Concentration (mg/L)

c 3 = MAC Maximum #days Average Concentraion (mg/L)

c 4 = CEF Conc Exceeding frequency (#times/year)

c FactorVal1 -- if FactorType = 3 (MAC): Maximum #Days;

c -- if FactorType = -3 (FEF): Flow Threshold (cfs)

c -- if FactorType = -4 (FDC): Low flow limit (cfs)

c -- if FactorType = 4 (CEF): Conc Threshold (mg/l)

c -- all other FactorType : -99

c FactorVal2 -- if FactorType = -3 (FEF): Minimum inter-exceedance time (hr)

c if = 0 then daily running average flow exceeding frequency

c if = -1 then daily average flow exceeding frequency

c otherwise minimum inter-exceedance time for simulation interval

c -- if FactorType = -4 (FDC): High flow limit (cfs)

c -- if FactorType = 4 (CEF): Flow weighted average conc Options

c if = 0 then daily running average conc exceeding frequency

c if = -1 then daily average conc exceeding frequency

c otherwise conc exceeding frequency at land simulation interval

c -- all other FactorType : -99

c CalcMode -- Evaluation Factor Calculation Mode

c -99 for Option 0 (card 800): no optimizaiton

c 1 = % percent of value under existing condition (0-100)

c 2 = S scale between pre-develop and existing condition (0-1)

c 3 = V absolute value in the unit as shown in FactorType (third block in this card)

c TargetVal1 -- Target value for evaluation factor calculation mode

c -99 for Option 0 (card 800): no optimizaiton

c Target value for minimize cost Option 1 (card 800) c   Lower limit of target value for cost-effective curve Option 2 (card 800)

c TargetVal2 -- Target value for evaluation factor calculation mode

c   -99 for Option 0 (card 800): no optimizaiton

c   -99 for Option 1 (card 800): minimize cost

c   Upper limit of target value for cost-effective curve Option 2 (card 800)

c Factor_Name -- Evaluation factor name (user specified without any space), e.g. FlowVolume or SEDIMENT

out	1	1	-99	-99	-99	-99	100	PLS_TSS
out	2	1	-99	-99	-99	-99	100	PLS_TN
out	3	1	-99	-99	-99	-99	100	PLS_TP
out	4	1	-99	-99	-99	-99	100	PLS_TCD
out	5	1	-99	-99	-99	-99	100	PLS_TCU
out	6	1	-99	-99	-99	-99	100	PLS_TPB
out	7	1	-99	-99	-99	-99	100	PLS_TZN
out	-1	-1	-99	-99	-99	-99	100	AAFV
out	-1	-2	-99	-99	-99	-99	100	Qpk
REG1	1	1	-99	-99	-99	-99	100	PLS_TSS
REG1	2	1	-99	-99	-99	-99	100	PLS_TN
REG1	3	1	-99	-99	-99	-99	100	PLS_TP
REG1	4	1	-99	-99	-99	-99	100	PLS_TCD
REG1	5	1	-99	-99	-99	-99	100	PLS_TCU
REG1	6	1	-99	-99	-99	-99	100	PLS_TPB
REG1	7	1	-99	-99	-99	-99	100	PLS_TZN
REG1	-1	-1	-99	-99	-99	-99	100	AAFV
REG1	-1	-2	-99	-99	-99	-99	100	Qpk
LID7	1	1	-99	-99	-99	-99	100	PLS_TSS
LID7	2	1	-99	-99	-99	-99	100	PLS_TN
LID7	3	1	-99	-99	-99	-99	100	PLS_TP
LID7	4	1	-99	-99	-99	-99	100	PLS_TCD

LID7	5	1	-99	-99	-99	-99	100	PLS_TCU
LID7	6	1	-99	-99	-99	-99	100	PLS_TPB
LID7	7	1	-99	-99	-99	-99	100	PLS_TZN
LID7	-1	-1	-99	-99	-99	-99	100	AAFV
LID7	-1	-2	-99	-99	-99	-99	100	Qpk

```
c-----------------------------------------------------------------------------------------------------------------------
c700 Model Controls
c
c LINE1 = Land simulation control (0-external),
c       Land output directory path (containing unit-area land output timeseries)
c       Note: external land timeseries data must be in this order;
c               flow(in./ timestep),
c               groundwater recharge(in./ timestep),
c               pollutant 1(lb / acre / timestep),
c               pollutant2, ...
c LINE2 = Start date of simulation (Year Month Day)
c LINE3 = End date of simulation (Year Month Day)
c LINE4 = Land Timeseries timestep (Min),
c       BMP simulation timestep (Min),
c       CRRAT = The ratio of max velocity to mean velocity under typical flow conditions (value of 1.0 or greater)
c       Model output control (0-the same timestep as land time series; 1-hourly),
c       Model output directory
c LINE5 = PET Flag(0 - constant monthly PET, 1 - PET from the timeseries (in/ timestep as land time series),
c       PET time series file path(required if PET flag is 1)
c LINE6 = Monthly PET rate (in/day) if PET flag is 0   OR
c       Monthly PET coefficient (multiplier to PET value) if PET flag is 1
c LINE7 = dummy integer value such as 0 (not used)
c       exceeding days flag time series file path (optional) file format - month/day/year, flag for flow (1 for retain), flag for pollutant 1 (1 for exceeding), ..., flag for pollutant n (1 for exceeding)
c
0       C:\MyFiles\WMMS\SUSTAIN\Current\_Input\LSPCData\WSTNUM-029
2008    10      1
2018    10      1
```

60 5 1.5 1 C:\MyFiles\WMMS\SUSTAIN\Current\Files_Output\605749

1 C:\MyFiles\WMMS\SUSTAIN\Current_Input\LSPCData\WSTNUM-029\PEVT.txt

0 0 0 0 0 0 0 0 0 0 0 0

c---

c705 Pollutant Definition

c

c POLLUT_ID = Unique pollutant identifier (Sequence number same as in land output time series)

c POLLUT_NAME = Unique pollutant name

c MULTIPLIER = Multiplying factor used to convert the pollutant load to lbs (external control)

c SED_FLAG = The sediment flag (0-not sediment,1-sand,2-silt,3-clay,4-total sediment)

c if = 4 SEDIMENT will be splitted into sand, silt,and clay based on the fractions defined in card 710.

c SED_QUAL = The sediment-associated pollutant flag (0-no, 1-yes)

c if = 1 then SEDIMENT is required in the pollutant list

c SAND_QFRAC = The sediment-associated qual-fraction on sand (0-1), only required if SED_QUAL = 1

c SILT_QFRAC = The sediment-associated qual-fraction on silt (0-1), only required if SED_QUAL = 1

c CLAY_QFRAC = The sediment-associated qual-fraction on clay (0-1), only required if SED_QUAL = 1

c

c POLLUT_ID POLLUT_NAME MULTIPLIER SED_FLAG SED_QUAL SAND_QFRAC SILT_QFRAC CLAY_QFRAC

1 TSS 2240 0 0 0 0 0

2 TN 1 0 0 0 0 0

3 TP 1 0 0 0 0 0

4 TCD 1 0 0 0 0 0

5 TCU 1 0 0 0 0 0

6 TPB 1 0 0 0 0 0

7 TZN 1 0 0 0 0 0

c---

c710 LAND USE DEFINITION (required if land simulation control is external)

c

c LANDTYPE = Unique land use definition identifier

c LANDNAME = land use name

c IMPERVIOUS = Distinguishes pervious/impervious land unit (0-pervious; 1-impervious)

c TIMESERIESFILE = File name containing input timeseries

c SAND_FRAC = The fraction of total sediment from the land which is sand (0-1)

c SILT_FRAC = The fraction of total sediment from the land which is silt (0-1)

c CLAY_FRAC = The fraction of total sediment from the land which is clay (0-1)

c

c LANDTYPE	LANDNAME	IMPERVIOUS	TIMESERIESFILE	SAND_FRAC	SILT_FRAC	CLAY_FRAC
1	Road_Freeway-All-All-All	1	1000_Road_Freeway-All-All-All.txt	0	0.55	0.4
2	Road_Primary-All-All-All	1	2000_Road_Primary-All-All-All.txt	0	0.55	0.4
3	Road_Minor-All-All-All	1	3000_Road_Minor-All-All-All.txt	0	0.55	0.4
4	Dev_ResHigh-All-All-All	1	4000_Dev_ResHigh-All-All-All.txt	0	0.55	0.4
5	Dev_ResLow-All-All-All	1	5000_Dev_ResLow-All-All-All.txt	0	0.55	0.4
6	Dev_Com-All-All-All	1	6000_Dev_Com-All-All-All.txt	0	0.55	0.4
7	Dev_Ind-All-All-All	1	7000_Dev_Ind-All-All-All.txt	0	0.55	0.4
8	Dev_Inst-All-All-All	1	8000_Dev_Inst-All-All-All.txt	0	0.55	0.4
9	Dev_Roof-All-All-All	1	9000_Dev_Roof-All-All-All.txt	0	0.55	0.4
10	Dev_Overspray-All-All-All	1	10000_Dev_Overspray-All-All-All.txt	0	0.55	0.4
11	Dev_Irrigated-A-Low-Confined	0	11111_Dev_Irrigated-A-Low-Confined.txt	0	0.55	0.4
12	Dev_Irrigated-A-Low-Unconfined	0	11112_Dev_Irrigated-A-Low-Unconfined.txt	0	0.55	0.4
13	Dev_Irrigated-A-Med-Confined	0	11121_Dev_Irrigated-A-Med-Confined.txt	0	0.55	0.4
14	Dev_Irrigated-A-Med-Unconfined	0	11122_Dev_Irrigated-A-Med-Unconfined.txt	0	0.55	0.4

15	Dev_Irrigated-B-Low-Confined	0	11211_Dev_Irrigated-B-Low-Confined.txt	0	0.55	0.4
16	Dev_Irrigated-B-Low-Unconfined	0	11212_Dev_Irrigated-B-Low-Unconfined.txt	0	0.55	0.4
17	Dev_Irrigated-B-Med-Confined	0	11221_Dev_Irrigated-B-Med-Confined.txt	0	0.55	0.4
18	Dev_Irrigated-B-Med-Unconfined	0	11222_Dev_Irrigated-B-Med-Unconfined.txt	0	0.55	0.4
19	Dev_Irrigated-C-Low-Confined	0	11311_Dev_Irrigated-C-Low-Confined.txt	0	0.55	0.4
20	Dev_Irrigated-C-Low-Unconfined	0	11312_Dev_Irrigated-C-Low-Unconfined.txt	0	0.55	0.4
21	Dev_Irrigated-C-Med-Confined	0	11321_Dev_Irrigated-C-Med-Confined.txt	0	0.55	0.4
22	Dev_Irrigated-C-Med-Unconfined	0	11322_Dev_Irrigated-C-Med-Unconfined.txt	0	0.55	0.4
23	Dev_Irrigated-D-Low-Confined	0	11411_Dev_Irrigated-D-Low-Confined.txt	0	0.55	0.4
24	Dev_Irrigated-D-Low-Unconfined	0	11412_Dev_Irrigated-D-Low-Unconfined.txt	0	0.55	0.4
25	Dev_Irrigated-D-Med-Confined	0	11421_Dev_Irrigated-D-Med-Confined.txt	0	0.55	0.4
26	Dev_Irrigated-D-Med-Unconfined	0	11422_Dev_Irrigated-D-Med-Unconfined.txt	0	0.55	0.4
27	Dev_Pervious-A-Low-Confined	0	12111_Dev_Pervious-A-Low-Confined.txt	0	0.55	0.4
28	Dev_Pervious-A-Low-Unconfined	0	12112_Dev_Pervious-A-Low-Unconfined.txt	0	0.55	0.4
29	Dev_Pervious-A-Med-Confined	0	12121_Dev_Pervious-A-Med-Confined.txt	0	0.55	0.4
30	Dev_Pervious-A-Med-Unconfined	0	12122_Dev_Pervious-A-Med-Unconfined.txt	0	0.55	0.4
31	Dev_Pervious-B-Low-Confined	0	12211_Dev_Pervious-B-Low-Confined.txt	0	0.55	0.4

32	Dev_Pervious-B-Low-Unconfined	0	12212_Dev_Pervious-B-Low-Unconfined.txt	0	0.55	0.4
33	Dev_Pervious-B-Med-Confined	0	12221_Dev_Pervious-B-Med-Confined.txt	0	0.55	0.4
34	Dev_Pervious-B-Med-Unconfined	0	12222_Dev_Pervious-B-Med-Unconfined.txt	0	0.55	0.4
35	Dev_Pervious-C-Low-Confined	0	12311_Dev_Pervious-C-Low-Confined.txt	0	0.55	0.4
36	Dev_Pervious-C-Low-Unconfined	0	12312_Dev_Pervious-C-Low-Unconfined.txt	0	0.55	0.4
37	Dev_Pervious-C-Med-Confined	0	12321_Dev_Pervious-C-Med-Confined.txt	0	0.55	0.4
38	Dev_Pervious-C-Med-Unconfined	0	12322_Dev_Pervious-C-Med-Unconfined.txt	0	0.55	0.4
39	Dev_Pervious-D-Low-Confined	0	12411_Dev_Pervious-D-Low-Confined.txt	0	0.55	0.4
40	Dev_Pervious-D-Low-Unconfined	0	12412_Dev_Pervious-D-Low-Unconfined.txt	0	0.55	0.4
41	Dev_Pervious-D-Med-Confined	0	12421_Dev_Pervious-D-Med-Confined.txt	0	0.55	0.4
42	Dev_Pervious-D-Med-Unconfined	0	12422_Dev_Pervious-D-Med-Unconfined.txt	0	0.55	0.4
43	Agriculture-A-Low-Confined	0	13111_Agriculture-A-Low-Confined.txt	0	0.55	0.4
44	Agriculture-A-Low-Unconfined	0	13112_Agriculture-A-Low-Unconfined.txt	0	0.55	0.4
45	Agriculture-A-Med-Confined	0	13121_Agriculture-A-Med-Confined.txt	0	0.55	0.4
46	Agriculture-A-Med-Unconfined	0	13122_Agriculture-A-Med-Unconfined.txt	0	0.55	0.4
47	Agriculture-B-Low-Confined	0	13211_Agriculture-B-Low-Confined.txt	0	0.55	0.4
48	Agriculture-B-Low-Unconfined	0	13212_Agriculture-B-Low-Unconfined.txt	0	0.55	0.4

49	Agriculture-B-Med-Confined	0	13221_Agriculture-B-Med-Confined.txt	0	0.55	0.4
50	Agriculture-B-Med-Unconfined	0	13222_Agriculture-B-Med-Unconfined.txt	0	0.55	0.4
51	Agriculture-B-High-Confined	0	13231_Agriculture-B-High-Confined.txt	0	0.55	0.4
52	Agriculture-B-High-Unconfined	0	13232_Agriculture-B-High-Unconfined.txt	0	0.55	0.4
53	Agriculture-C-Low-Confined	0	13311_Agriculture-C-Low-Confined.txt	0	0.55	0.4
54	Agriculture-C-Low-Unconfined	0	13312_Agriculture-C-Low-Unconfined.txt	0	0.55	0.4
55	Agriculture-C-Med-Confined	0	13321_Agriculture-C-Med-Confined.txt	0	0.55	0.4
56	Agriculture-C-Med-Unconfined	0	13322_Agriculture-C-Med-Unconfined.txt	0	0.55	0.4
57	Agriculture-C-High-Confined	0	13331_Agriculture-C-High-Confined.txt	0	0.55	0.4
58	Agriculture-D-Low-Confined	0	13411_Agriculture-D-Low-Confined.txt	0	0.55	0.4
59	Agriculture-D-Low-Unconfined	0	13412_Agriculture-D-Low-Unconfined.txt	0	0.55	0.4
60	Agriculture-D-Med-Confined	0	13421_Agriculture-D-Med-Confined.txt	0	0.55	0.4
61	Agriculture-D-Med-Unconfined	0	13422_Agriculture-D-Med-Unconfined.txt	0	0.55	0.4
62	Agriculture-D-High-Confined	0	13431_Agriculture-D-High-Confined.txt	0	0.55	0.4
63	Agriculture-D-High-Unconfined	0	13432_Agriculture-D-High-Unconfined.txt	0	0.55	0.4
64	Veg_Low-A-Med-Confined	0	14121_Veg_Low-A-Med-Confined.txt	0	0.55	0.4
65	Veg_Low-A-Med-Unconfined	0	14122_Veg_Low-A-Med-Unconfined.txt	0	0.55	0.4

66	Veg_Low-A-High-Confined	0	14131_Veg_Low-A-High-Confined.txt	0	0.55	0.4
67	Veg_Low-A-High-Unconfined	0	14132_Veg_Low-A-High-Unconfined.txt	0	0.55	0.4
68	Veg_Low-B-Med-Confined	0	14221_Veg_Low-B-Med-Confined.txt	0	0.55	0.4
69	Veg_Low-B-Med-Unconfined	0	14222_Veg_Low-B-Med-Unconfined.txt	0	0.55	0.4
70	Veg_Low-B-High-Confined	0	14231_Veg_Low-B-High-Confined.txt	0	0.55	0.4
71	Veg_Low-B-High-Unconfined	0	14232_Veg_Low-B-High-Unconfined.txt	0	0.55	0.4
72	Veg_Low-C-Med-Confined	0	14321_Veg_Low-C-Med-Confined.txt	0	0.55	0.4
73	Veg_Low-C-Med-Unconfined	0	14322_Veg_Low-C-Med-Unconfined.txt	0	0.55	0.4
74	Veg_Low-C-High-Confined	0	14331_Veg_Low-C-High-Confined.txt	0	0.55	0.4
75	Veg_Low-C-High-Unconfined	0	14332_Veg_Low-C-High-Unconfined.txt	0	0.55	0.4
76	Veg_Low-D-Med-Confined	0	14421_Veg_Low-D-Med-Confined.txt	0	0.55	0.4
77	Veg_Low-D-Med-Unconfined	0	14422_Veg_Low-D-Med-Unconfined.txt	0	0.55	0.4
78	Veg_Low-D-High-Confined	0	14431_Veg_Low-D-High-Confined.txt	0	0.55	0.4
79	Veg_Low-D-High-Unconfined	0	14432_Veg_Low-D-High-Unconfined.txt	0	0.55	0.4
80	Veg_High-A-Med-Confined	0	15121_Veg_High-A-Med-Confined.txt	0	0.55	0.4
81	Veg_High-A-Med-Unconfined	0	15122_Veg_High-A-Med-Unconfined.txt	0	0.55	0.4
82	Veg_High-A-High-Confined	0	15131_Veg_High-A-High-Confined.txt	0	0.55	0.4

83 Veg_High-A-High-Unconfined 0 15132_Veg_High-A-High-Unconfined.txt0 0.55 0.4

84 Veg_High-B-Med-Confined 0 15221_Veg_High-B-Med-Confined.txt 0 0.55 0.4

85 Veg_High-B-Med-Unconfined 0 15222_Veg_High-B-Med-Unconfined.txt0 0.55 0.4

86 Veg_High-B-High-Confined 0 15231_Veg_High-B-High-Confined.txt 0 0.55 0.4

87 Veg_High-B-High-Unconfined 0 15232_Veg_High-B-High-Unconfined.txt0 0.55 0.4

88 Veg_High-C-Med-Confined 0 15321_Veg_High-C-Med-Confined.txt 0 0.55 0.4

89 Veg_High-C-Med-Unconfined 0 15322_Veg_High-C-Med-Unconfined.txt0 0.55 0.4

90 Veg_High-C-High-Confined 0 15331_Veg_High-C-High-Confined.txt 0 0.55 0.4

91 Veg_High-C-High-Unconfined 0 15332_Veg_High-C-High-Unconfined.txt0 0.55 0.4

92 Veg_High-D-Med-Confined 0 15421_Veg_High-D-Med-Confined.txt 0 0.55 0.4

93 Veg_High-D-Med-Unconfined 0 15422_Veg_High-D-Med-Unconfined.txt 0 0.55 0.4

94 Veg_High-D-High-Confined 0 15431_Veg_High-D-High-Confined.txt 0 0.55 0.4

95 Veg_High-D-High-Unconfined 0 15432_Veg_High-D-High-Unconfined.txt 0 0.55 0.4

96 Water-All-All-All 0 16000_Water-All-All-All.txt 0 0.55 0.4

c---

c712 Aquifer INFORMATION

c

c AquiferID = Unique Aquifer identifier

c AquiferNAME = Aquifer name

c Initial Storage = Initial Storage (ac-ft)

c RecessionCoef = Recession Coefficient (1/hr)

c SeepageCoef = Seepage Coefficient (1/hr)

c

c AquiferID AquiferNAME InitialStorage RecessionCoef SeepageCoef

c---

c713 Aquifer Pollutant Background Concentration

c

c AquiferID = Unique Aquifer identifier as in c712

c Ci = Background concentration for pollutant i (mg/l)

c Where i = 1 to N (N = Number of QUAL from card 705)

c

c AQUIFER_ID QUALC1 QUALC2 ... QUALCN

c---

c715 BMP SITE INFORMATION

c

c BMPSITE = Unique BMP site identifier

c BMPNAME = BMP template name or site name

c BMPTYPE = Unique BMP Types (must use the exact same keyword)

c
(BIORETENTION,WETPOND,CISTERN,DRYPOND,INFILTRATIONTRENCH,GREENROOF,POROUSPAVEMENT,
RAINBARREL,REGULATOR,SWALE,CONDUIT,BUFFERSTRIP,AREABMP)

c DArea = Total Drainage Area in acre

c NUMUNIT = Number of BMP structures

c DDAREA = Design drainage area of the BMP structure (acre)

c PreLUType = Predevelopment land use type (for external land simulation option)

c AquiferID = Unique Aquifer ID, 0 --- no aquifer (for external land simulation option)

c FtableFLG = Ftable flag, 0 = no, 1 = yes (for BMP Class A, B, and C)

c FTABLE_ID = Unique Ftable identifier (continuous string) as in card 714

c DA2FP_RATIO = BMP drainage area to footprint ratio (ac/ac)

c GID = BMPSITE Group Identifier (non-zero integer, 0 = not a group)

c NOTE: if multiple BMPSITE for the same GID then optimizer will choose only one for a solution

c the user must specify the nested routing for the BMPs in a group and drainage area should be assigned to the most upstream BMPSITE.

c land swap controls (card 711) and structural controls (card 715) will be grouped together if they are assigned the same GID. To keep them separate use the different GID in card 711 and 715.

c RtableFLG = Rtable flag, 0 = no, 1 = yes (for JUNCTION only)

c RTABLE_ID = Unique REDUCTION-table identifier (continuous string) as in card 707

c

c BMPSITE BMPNAME BMPTYPE DArea NUMUNIT DDAREA PreLUType AquiferID FtableFLG FTABLE_ID DA2FP_RATIO GID RtableFLG RTABLE_ID

out SubwatershedOutlet JUNCTION 0 1 0 1 0 0 No 0 0 0

ut UntreatedFlow JUNCTION 0 1 0 1 0 0 No 0 0 0

TBDBMP BioretentionType1 BIORETENTION 0 1 0 1 0 0 No 0 0 0

REG1 BioretentionType1 RAINBARREL 95.82929584000001 1 0 1 0 0 No 0 0 0

LID7 BioretentionType1 INFILTRATIONTRENCH 0 1 0 1 0 0 No 0 0 0

sewer Sewer JUNCTION 0 1 0 1 0 0 0 0 0 0

c--

c721 Tier-1 Watershed Outlets Definition

c

c BMPSITE = BMP site(watershed outlet) identifier in card 715

c NUMBREAKS = Number of break points on the cost-effectiveness curve

c CECurveFile = CECurve_Solutions file for the project cost(sorted cost value) of each break point

c

c BMPSITE NUMBREAKS CECurveFile

c--

c722 Tier-1 Watershed Timeseries Definition

c

c BMPSITE = BMP site(watershed outlet) identifier in card 721

c BREAKPOINTID = Unique break point id on cost-effectiveness curve

c(0 for initial, -1 for PreDev, and - 2 for PostDev condition)

c MULTIPLIER = Multiplier applied to the timeseries file

c TIMESERIESFILE = Timeseries output file corresponding to the breakpoint id

c

c BMPSITE BREAKPOINTID MULTIPLIER TIMESERIESFILE

c--

c723 Pump Curve (applies if PUMP_FLG is ON in card 725)

c

c PUMP_CURVE = The unique name of pump curve (continuous string without space)

c NUM_RECORD = Number of points on the curve

c

c DEPTH = Depth (ft)

c FLOW = Pumping flow rate (cfs)

c

c PUMP_CURVE NUM_RECORD

c DEPTH FLOW

c--

c725 CLASS-A BMP Site Parameters (required if BMPSITE is CLASS-A in card 715)

c

c BMPSITE = Class A BMP dimension group identifier in card 715

c WIDTH = Basin bottom width (ft)

c LENGTH = Basin bottom length (ft) / diameter (ft) for rain barrel or cistern

c OHEIGHT = Orifice Height (ft)

c DIAM = Orifice Diameter (in)

c CCOEF = Contraction Coefficient, user-specified value between 0 and 1 (e.g., Rounded = 1.0, Short Tube = 0.8, Sharp-edged = 0.61, Borda = 0.5)

c RELTP = Release Type (1-Cistern, 2-Rain barrel, 3-others)

c PEOPLE = Number of persons (Cistern Option)

c DDAYS = Number of dry days (Rain Barrel Option)

c WEIRTP = Weir Type (1-Rectangular,2-Triangular)

c WEIRH = Weir Height (ft)

c WEIRW = (weir type 1) Weir width (ft)

c THETA = (weir type 2) Weir angle (degrees)

c ET_MULT = multiplier to PET

c PUMP_FLG = pump option (0-OFF, 1-ON)

c DEPTH_ON = water Depth (ft) at which the pump is started

c DEPTH_OFF = water Depth (ft) at which the pump is stopped

c PUMP_CURVE = The unique name of pump curve (continuous string without space)

c BYPASS_FRAC = Fraction of inflow that bypasses the BMP when full (0.0-1.0)

c DIV_RATE = Maximum flow diversion rate into BMP (cfs)

c BMP_GID = BMP group ID, activate only one BMP within a group (default = 0 [not a group], non-zero positive integer value as group ID)

c The user must specify the nested routing for the BMPs in a group and drainage area should be specified only for the most upstream BMP.

c

c BMPSITE WIDTH LENGTH OHEIGHT DIAM EXITYPE RELEASETYPE PEOPLE DDAYS WEIRTYPE WEIRH WEIRW THETA ET_MULT PUMP_FLG DEPTH_ON DEPTH_OFF PUMP_CURVE BYPASS_FRAC DIV_RATE BMP_GID

TBDBMP 0 0 0 0 0.61 3 0 0 1 0.5 10000
0 0 0 0 0 none 0 -1

REG1 175 95 0 0.0134 0.61 4 0 0 1 14 10000 0
0 0 0 0 none 0 -1

LID7 114 115 0 0.01 0.61 4 0 0 1 14 10000 0
0 0 0 0 none 0 -1

c--

c730 Cistern Control Water Release Curve (applies if release type is cistern in card 725)

c

c BMPSITE = Class A BMP dimension group identifier in card 715

c Flow = Hourly water release per capita from the Cistern Control (ft3/hr/capita)

c

c BMPSITE FLOW

TBDBMP 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0
0

REG1 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0

LID7 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0

c---

c735 CLASS B BMP Site DIMENSION GROUPS

c

c BMPSITE = BMP Site identifier in card 715

c WIDTH = basin bottom width (ft)

c LENGTH = basin bottom Length (ft)

c MAXDEPTH = Maximum depth of channel (ft)

c SLOPE1 = Side slope 1 (ft/ft)

c SLOPE2 = Side slope 2 (ft/ft) (1-4)

c SLOPE3 = Side slope 3 (ft/ft)

c MANN_N = Manning 's roughness coefficient

c ET_MULT = multiplier to PET

c

c BMPSITE WIDTH LENGTH MAXDEPTH SLOPE1 SLOPE2 SLOPE3 MANN_N
ET_MULT

c---

c740 BMP Site BOTTOM SOIL/VEGITATION CHARACTERISTICS

c

c BMPSITE = BMPSITE identifier in c715

c INFILTM = Infiltration Method (0-Green Ampt, 1-Horton, 2-Holtan)

c POLROTM = Pollutant Routing Method (1-Completely mixed, >1-number of CSTRs in series)

c POLREMM = Pollutant Removal Method (0-1st order decay, 1-kadlec and knight method, 2-user defined concentration)

c SDEPTH = Soil Depth (ft)

c POROSITY = Soil Porosity (0-1)

c FCAPACITY = Soil Field Capacity (ft/ft)

c WPOINT = Soil Wilting Point (ft/ft)

c AVEG = Vegetative Parameter A (0.1-1.0) (Empirical), only required for Holtan infiltration method

c FINFILT = Soil layer infiltration rate (in/hr)

c UNDSWITCH = Underdrain option (0-No underdrain, 1-underdrain with percent removal rate, 2-underdrain with constant effluent conc.)

c UNDDEPTH = Depth of storage media below underdrain (ft)

c UNDVOID = Fraction of underdrain storage depth that is void space (0-1)

c UNDINFILT = Background infiltration rate, below underdrain (in/hr)

c SUCTION = Average value of soil capillary suction along the wetting front, value must be greater than zero (in), only required for Green-Ampt infiltration method

c IMDMAX = Difference between soil porosity and initial moisture content, value must be greater than or equal to zero (a fraction), only required for Green-Ampt infiltration method

c MAXINFILT = Maximum rate on the Horton infiltration curve (in/hr), only required for Horton infiltration method

c DECAYCONS = Decay constant for the Horton infiltration curve (1/hr), only required for Horton infiltration method

c DRYTIME = Time for a fully staurated soil to completely dry (day), only required for Horton infiltration method

c MAXVOLUME = Maximum infiltration volume possible (in), only required for Horton infiltration method

c

c BMPSITE INFILTM POLROTM POLREMM SDEPTH POROSITY FCAPACITY WPOINT AVEG FINFILT UNDSWITCH UNDDEPTH UNDVOID UNDINFILT SUCTION IMDMAX MAXINFILT DECAYCONS DRYTIME MAXVOLUME

TBDBMP 2 1 0 2 0.35 0.3 0.15 0.6 1 0 1.5
0.4 1 0 0 3 4 7 0

REG1 2 1 0 0.1 0.4 0.3 0.15 0 0 0 1 0.4
0.01 0 0 3 4 7 0

LID7 2 1 0 0 0.45 0.3 0.15 0 0.67 0 1 0.4
1.5 0 0 3 4 7 0

c---

c745 BMP Site HOLTAN GROWTH INDEX

c

c HOLTAN EQUATION: F = GI * AVEG * (Computed Available Soil Storage)^ 1.4 + FINFILT

c

c BMPSITE = BMPSITE identifier in card 715

c GIi = 12 monthly values for GI in HOLTAN equation

c Where i = jan, feb, mar...dec

c

c BMPSITE jan feb mar apr may jun jul aug sep oct nov dec

TBDBMP 0 0 0 0 0 0 0 0 0 0 0
0

REG1 0 0 0 0 0 0 0 0 0 0 0 0

LID7 0 0 0 0 0 0 0 0 0 0 0 0

c---

c747 BMP Site Initial Moisture Content

c

c BMPSITE = BMP Site identifier in card 715

c WATDEP_i = initial surface water depth (ft)

c THETA_i = initial soil moisture (ft/ft)

c

c BMPSITE WATDEP_i THETA_i

TBDBMP 0 0.15

REG1 0 0.15

```
LID7      0          0.15
c---------------------------------------------------------------------------------------------------------------------
c750 Class-C Conduit Parameters (required if BMPSITE is CLASS-C in card 715)
c
c BMPSITE     = BMP site identifier in card 715
c INLET_NODE  = BMP Id at the entrance of the conduit
c OUTLET_NODE = BMP Id at the exit of the conduit
c LENGTH      = Conduit length (ft)
c MANNING_N   = Manning's roughness coefficient
c INLET_IEL   = Invert Elevation at the entrance of the conduit (ft)
c OUTLET_IEL  = Invert Elevation at the exit of the conduit (ft)
c INIT_FLOW   = Initial flow in the conduit (cfs)
c INLET_HL    = Head loss coefficient at the entrance of the conduit
c OUTLET_HL   = Head loss coefficient at the exit of the conduit
c AVERAGE_HL  = Head loss coefficient along the length of the conduit
c
c BMPSITE        INLET_NODE     OUTLET_NODE  LENGTH          MANNING_N    INLET_IEL
          OUTLET_IEL      INIT_FLOW       INLET_HL         OUTLET_HL       AVERAGE_HL
c---------------------------------------------------------------------------------------------------------------------
c755 Class C Conduit Cross Sections
c
c LINK    = BMP site identifier in card 715
c TYPE    = Conduit Type (rectangular, circular...)
c GEOM1   = Geometric cross-sectional property of the conduit
c GEOM2   = Geometric cross-sectional property of the conduit
c GEOM3   = Geometric cross-sectional property of the conduit
c GEOM4   = Geometric cross-sectional property of the conduit
c BARRELS = Number of Barrels in the conduit
c
```

```
c LINK   TYPE     GEOM1 GEOM2 GEOM3 GEOM4 BARRELS
c-----------------------------------------------------------------------------------------------------------------------
c760 Irregular Cross Sections
c
c Format of transect data follows:
c NC     nLeft    nRight   nChannel
c X1     name    nSta     xLeftBank       xRightBank       0        0        0        xFactor yFactor
c GR     Elevation         Station  ...
c------------------------------------------------------------------------------------------
c761 BufferStrip BMP Parameters (required if BMPTYPE is BUFFERSTRIP in card 715)
c
c BMPSITE   = BMP site identifier in card 715
c Width     = BMP width (ft)
c FLength   = Flow length (ft)
c DStorage  = Surface depression storage (in)
c SLOPE     = Overland slope (ft / ft)
c MANNING_N = Overland Manning's roughness coefficient
c POLREMM   = Pollutant Removal Method (0-1st order decay, 1-kadlec and knight method)
c ET_MULT   = Multiplier to PET
c
c------------------------------------------------------------------------------------------
c762 Area BMP Parameters (required if BMPTYPE is AREABMP in card 715)
c
c BMPSITE     = BMP site identifier in card 715
c Area        = BMP area (ft2)
c FLength     = flow length (ft) note: area width = area / flow length
c DStorage    = Surface depression storage (in)
c SLOPE       = Overland slope (ft / ft)
c MANNING_N   = Overland Manning's roughness coefficient
```

c SAT_INFILT = Saturated infiltration rate (in/hr)

c POLREMM = Pollutant Removal Method (0-1st order decay, 1-kadlec and knight method)

c DCIA = Percentage of Directly Connected Impervious Area (0-100)

c TOTAL_IMP_DA = Total Impervious Drainage Area (acre)

c

c BMPSITE Area FLengthDStorage SLOPE MANNING_N SAT_INFILT POLREMM DCIA TOTAL_IMP_DA

c---

c---

c765 BMP SITE Pollutant Decay / Loss rates

c

c BMPSITE = BMP site identifier in card 715information

c QUALDECAYi = First - order decay rate for pollutant i (hr ^ -1)

c Where i = 1 to N(N = Number of QUAL from TIMESERIES FILES)

c

c BMPSITE QUALDECAY1 QUALDECAY2...QUALDECAYN

TBDBMP 0.008333333 0.008333333 0.008333333 0.008333333 0.008333333 0.008333333 0.008333333

REG1 0.008333333 0.008333333 0.008333333 0.008333333 0.008333333 0.008333333 0.008333333

LID7 0.008333333 0.008333333 0.008333333 0.008333333 0.008333333 0.008333333 0.008333333

c---

c766 Pollutant K' values (applies when pollutant removal method is kadlec and knight method in card 740)

c

c BMPSITE = BMP site identifier in card 715

C QUALK'i = Constant rate for pollutant i (ft/yr)

c Where i = 1 to N (N = Number of QUAL from card 705)

c

c BMPSITE QUALK'1 QUALK'2 ... QUALK'N

c---

c767 Pollutant C* values (applies when pollutant removal method is kadlec and knight method in card 740)

c

c BMPSITE = BMP site identifier in card 715

c QUALC*i = Background concentration for pollutant i (mg/l)

c Where i = 1 to N (N = Number of QUAL from card 705)

c

c BMPSITE QUALC*1 QUALC*2 ... QUALC*N

c---

c768 Pollutant C values (applies when surface release type is 4 in card 725)

c

c BMPSITE = BMP site identifier in card 715

c QUALCi = Constant surface release concentration for pollutant i (mg/l)

c Where i = 1 to N (N = Number of QUAL from card 705)

c

c BMPSITE QUALC1 QUALC2 ... QUALCN

```
TBDBMP      0     0     0     0     0     0     0
REG1   0    0     0     0     0     0     0
LID7   0    0     0     0     0     0     0
```

c---

c770 BMP Underdrain Pollutant Percent Removal(applies when underdrain is on in card 740)

c

c BMPSITE = BMPSITE identifier in card 715

c QUALPCTREMi = Perecent Removal for pollutant i through underdrain(0 - 1)

c Where i = 1 to N(N = Number of QUAL from TIMESERIES FILES)

c

c BMPSITE QUALPCTREM1 QUALPCTREM2...QUALPCTREMN

TBDBMP 0 0 0 0 0 0 0

REG1 0 0 0 0 0 0 0

LID7 0 0 0 0 0 0 0

c---

c771 BMP Underdrain Pollutant Effluent Concentration (applies when underdrain option is '2' in card 740)

c

c BMPSITE = BMPSITE identifier in card 715

c QUALEFFCi = Underdrain effluent concentration for pollutant i (mg / l)

c Where i = 1 to N(N = Number of QUAL from TIMESERIES FILES)

c

c BMPSITE QUALEFFC1 QUALEFFC2...QUALEFFCN

TBDBMP 0 0 0 0 0 0 0

REG1 0 0 0 0 0 0 0

LID7 0 0 0 0 0 0 0

c---

c775 Sediment General Parameters (required if pollutant type is sediment in card 705)

c

c BMPSITE = BMP site identifier in card 715

c BEDWID = Bed width (ft) - this is constant for the entire simulation period

c BEDDEP = Initial bed depth (ft)

c BEDPOR = Bed sediment porosity

c

c BMPSITE BEDWID BEDDEPBEDPOR

c---

c780 Sand Transport Parameters (required if pollutant type is sediment in card 705)

c

c BMPSITE = BMP site identifier in card 715

c D = Effective diameter of the transported sand particles (in)

c W = The corresponding fall velocity in still water (in/sec)

c RHO = The density of the sand particles (lb/ft3)

c KSAND = The coefficient in the sandload power function formula

c EXPSND = The exponent in the sandload power function formula

c

c BMPSITE D W RHO KSAND EXPSND

c---

c785 Silt Transport Parameters (required if pollutant type is sediment in card 705)

c

c BMPSITE = BMP site identifier in card 715

c D = Effective diameter of the transported silt particles (in)

c W = The corresponding fall velocity in still water (in/sec)

c RHO = The density of the silt particles (lb/ft3)

c TAUCD = The critical bed shear stress for deposition (lb/ft2)

c TAUCS = The critical bed shear stress for scour (lb/ft2)

c M = The erodibility coefficient of the silt particles (lb/ft2/day)

c

c BMPSITE D W RHO TAUCD TAUCS M

c---

c786 Clay Transport Parameters (required if pollutant type is sediment in card 705)

c

c BMPSITE = BMP site identifier in card 715

c D = Effective diameter of the transported clay particles (in)

c W = The corresponding fall velocity in still water (in/sec)

c RHO = The density of the silt/clay particles (lb/ft3)

c TAUCD = The critical bed shear stress for deposition (lb/ft2)

c TAUCS = The critical bed shear stress for scour (lb/ft2)

c M = The erodibility coefficient of the clay particles (lb/ft2/day)

c

c BMPSITE D W RHO TAUCD TAUCS M

c---

c790 LAND TO BMP ROUTING NETWORK(required for external land simulation control in card 700)

c

c UniqueID = Identifies an instance of LANDTYPE in SCHEMATIC

c LANDTYPE = Corresponds to LANDTYPE in c710

c AREA = Area of LANDTYPE in ACRES

c DS = UNIQUE ID of DS BMP(0 - no BMP, add to end)

c GID = Group Identifier in card 711 (0 - no change)

c

c UniqueID LANDTYPE AREA DS LCGID

1 1 0.65038036 REG1 0

2 2 6.2833859400000005 REG1 0

3 3 7.162091320000001 REG1 0

4 4 3.4347595 REG1 0

5 5 12.895915740000001 REG1 0

6 6 6.003663080000001 REG1 0

7 7 0.29454916000000003 REG1 0

8 8 1.7771791600000002 REG1 0

9 9 13.10249552 REG1 0

10 10 0.5545036200000001 REG1 0

11 19 1.7198508000000001 REG1 0

12 23 6.7261981 REG1 0

13 35 4.66731924 REG1 0

14 39 17.97837138 REG1 0

15 72 2.38604588 REG1 0

16 76 6.548282500000001 REG1 0

17 88 1.2740733800000001 REG1 0

18 92 2.3702311600000003 REG1 0

c---

c795 BMP Site ROUTING NETWORK

c

c BMPSITE = BMPSITE identifier in card 715

c OUTLET_TYPE = Outlet type(1 - total, 2 - weir, 3 - orifice or channel, 4 - underdrain, 5-untreated or bypass)

c DS = Downstrem BMP site identifier in card 715(0 - no BMP, add to end)

c

c BMPSITE OUTLET_TYPE DS

ut 1 out

out 1 0

TBDBMP 1 out

REG1 2 LID7

REG1 3 sewer

REG1 4 LID7

REG1 5 LID7

LID7 2 out

LID7 3 sewer

LID7 4 out

LID7 5 out

c---

c800 Optimization Controls

c

c Technique --Optimization Techniques

c 0 = no optimization

c 1 = Scatter Search

c 2 = NSGAII

c Option --Optimization options

c 0 = no optimization

c 1 = specific control target and minimize cost

c 2 = generate cost effectiveness curve

c StopDelta-- Criteria for stopping the optimization iteration

c in dollars($), meaning if the cost not improved by this criteria, stop the search(for Option 1)

c MaxRuns --Maximum number of iterations

c NumBest-- Number of best solutions for output(for Option 1)

c

c Technique Option StopDelta MaxRuns NumBest

0 2 0 10000 1

c---

c805 BMP Cost Functions

c Cost($) = ((LinearCost)Length ^ (LengthExp) + (AreaCost)Area ^ (AreaExp) + (TotalVolumeCost)TotalVolume ^ (TotalVolExp)

c + (MediaVolumeCost)SoilMediaVolume ^ (MediaVolExp) + (UnderDrainVolumeCost)UnderDrainVolume ^ (UDVolExp)

c + (Unitcost) + (ConstantCost)) * (1 + PercentCost / 100)

c

c BMPSITE = BMP site identifier in card 715

c LinearCost = Cost per unit length of the BMP structure($/ ft)

c AreaCost = Cost per unit area of the BMP structure($/ ft ^ 2)

c TotalVolumeCost = Cost per unit total volume of the BMP structure($/ ft ^ 3)

c MediaVolumeCost = Cost per unit volume of the soil media($/ ft ^ 3)

c UnderDrainVolumeCost = Cost per unit volume of the under drain structure($/ ft ^ 3)

c ConstantCost = Constant cost($)

c PercentCost = Cost in percentage of all other cost(%)

c LengthExp = Exponent for linear unit

c AreaExp = Exponent for area unit

c TotalVolExp = Exponent for total volume unit

c MediaVolExp = Exponent for soil media volume unit c UDVolExp = Exponent for underdrain volume unit

c

c BMPSITE LinearCost AreaCost TotalVolumeCost MediaVolumeCost UnderDrainVolumeCost ConstantCost PercentCost LengthExp AreaExp TotalVolExp MediaVolExp UDVolExp

TBDBMP 0 0 0 0 0 0 0 1 1 1 1 1

REG1 0 0 12.6 0 0 120000 0 1 1 1 1 1

LID7 0 0 5.9848 0 0 0 0 1 1 1 1 1

c---

c806 Diversion Structure Cost Function

c Cost ($) = ((DiversionCost)*DIV_RATE^(DiversionExp) + (ConstantCost)) * (1+PercentCost/100)

c

c BMPSITE = BMP site identifier in card 715

c DiversionCost = Cost per unit diversion rate ($/cfs)

c DiversionExp = Exponent for diversion rate

c ConstantCost = Constant cost ($)

c PercentCost = Cost in percentage of all other cost (%)

c

c BMPSITE DiversionCost DiversionExp ConstantCost PercentCost

TBDBMP 0 1 0 0

REG1 25400 1 0 0

LID7 0 1 0 0

c---

c810 BMP SITE Adjustable Parameters

c BMPSITE = BMP site identifier in card 715

c VARIABLE = Variable name

c LENGTH = BMP length,

c NUMUNIT = number of units,

c WEIRH = weir height,

c SDEPTH = soil media depth,

c DCIA = directly connected impervious area,

c MAXDEPTH = BMP maximum depth,

c CECURVE = cost - effectiveness curve for Tier - 1 solution

c DIV_RATE --- maximum flow diversion rate into BMP

c FROM = From value in the range

c TO = To value in the range

c STEP = Increment step

c BMPSITE VARIABLE FROM TO STEP

TBDBMP LENGTH 0 0 0

REG1 LENGTH 0 175.19417798545703 0.8759708899272851

LID7 LENGTH 0 63.245553203367585 0.31622776601683794

c---

c814 Predeveloped Timeseries at Assessment Point for Flow Duration Curve

c

c BMPSITE = BMP site identifier in card 715 if it is an assessment point

c NumBins = Number of bins for flow duration curve

c PreDevFlag = Pre-developed timeseries option (1-internal,2-external)

c PreDevFile = Pre-developed timeseries file path for external option

c The timeseries file format (AssessmentPoint_IDYear Month Day Hour Minute Flow_cfs)

c The first line is skipped (comment line) and data start from the second line in the required format.

c

c BMPSITE NumBins PreDevFlag PreDevFile

c815 Assessment Point and Evaluation Factor

c

c BMPSITE -- BMP site identifier in card 715 if it is an assessment point

c FactorGroup -- Flow or pollutant related evaluation factor group c -1 = flow related evaluation factor

c # = pollutant ID in card 705

c FactorType -- Evaluation Factor Type (negative number for flow related and positive number for pollutant related)

c -1 = AAFV Annual Average Flow Volume (ft3/yr)

c -2 = PDF Peak Discharge Flow (cfs)

c -3 = FEF Flow Exceeding frequency (#times/year)

c -4 = FDC Flow Duration Curve (sum of sorted flow difference with pre-developed condition, cfs)

c -5 = RAAFV Retain Annual Average Flow Volume (ft3/yr), it requires retain daily flag (value = 1) timeseries in card 700

c 1 = AAL Annual Average Load (lb/yr)

c 2 = AAC Annual Average Concentration (mg/L)

c 3 = MAC Maximum #days Average Concentraion (mg/L)

c 4 = CEF Conc Exceeding frequency (#times/year)

c FactorVal1 -- if FactorType = 3 (MAC): Maximum #Days;

c -- if FactorType = -3 (FEF): Flow Threshold (cfs)

c -- if FactorType = -4 (FDC): Low flow limit (cfs)

c -- if FactorType = 4 (CEF): Conc Threshold (mg/l)

c -- all other FactorType : -99

c FactorVal2 -- if FactorType = -3 (FEF): Minimum inter-exceedance time (hr)

c if = 0 then daily running average flow exceeding frequency

c if = -1 then daily average flow exceeding frequency

c otherwise minimum inter-exceedance time for simulation interval

c -- if FactorType = -4 (FDC): High flow limit (cfs)

c -- if FactorType = 4 (CEF): Flow weighted average conc Options

c if = 0 then daily running average conc exceeding frequency

c if = -1 then daily average conc exceeding frequency

c otherwise conc exceeding frequency at land simulation interval

c -- all other FactorType : -99

c CalcMode -- Evaluation Factor Calculation Mode

c -99 for Option 0 (card 800): no optimizaiton

c 1 = % percent of value under existing condition (0-100)

c 2 = S scale between pre-develop and existing condition (0-1)

c 3 = V absolute value in the unit as shown in FactorType (third block in this card)

c TargetVal1 -- Target value for evaluation factor calculation mode

c -99 for Option 0 (card 800): no optimizaiton

c Target value for minimize cost Option 1 (card 800)

c Lower limit of target value for cost-effective curve Option 2 (card 800)

c TargetVal2 -- Target value for evaluation factor calculation mode

c -99 for Option 0 (card 800): no optimizaiton

c -99 for Option 1 (card 800): minimize cost

c Upper limit of target value for cost-effective curve Option 2 (card 800)

c Factor_Name -- Evaluation factor name (user specified without any space), e.g. FlowVolume or SEDIMENT

out	1	1	-99	-99	-99	-99	100	PLS_TSS
out	2	1	-99	-99	-99	-99	100	PLS_TN
out	3	1	-99	-99	-99	-99	100	PLS_TP
out	4	1	-99	-99	-99	-99	100	PLS_TCD
out	5	1	-99	-99	-99	-99	100	PLS_TCU
out	6	1	-99	-99	-99	-99	100	PLS_TPB
out	7	1	-99	-99	-99	-99	100	PLS_TZN
out	-1	-1	-99	-99	-99	-99	100	AAFV
out	-1	-2	-99	-99	-99	-99	100	Qpk
REG1	1	1	-99	-99	-99	-99	100	PLS_TSS
REG1	2	1	-99	-99	-99	-99	100	PLS_TN
REG1	3	1	-99	-99	-99	-99	100	PLS_TP
REG1	4	1	-99	-99	-99	-99	100	PLS_TCD
REG1	5	1	-99	-99	-99	-99	100	PLS_TCU

REG1	6	1	-99	-99	-99	-99	100	PLS_TPB
REG1	7	1	-99	-99	-99	-99	100	PLS_TZN
REG1	-1	-1	-99	-99	-99	-99	100	AAFV
REG1	-1	-2	-99	-99	-99	-99	100	Qpk
LID7	1	1	-99	-99	-99	-99	100	PLS_TSS
LID7	2	1	-99	-99	-99	-99	100	PLS_TN
LID7	3	1	-99	-99	-99	-99	100	PLS_TP
LID7	4	1	-99	-99	-99	-99	100	PLS_TCD
LID7	5	1	-99	-99	-99	-99	100	PLS_TCU
LID7	6	1	-99	-99	-99	-99	100	PLS_TPB
LID7	7	1	-99	-99	-99	-99	100	PLS_TZN
LID7	-1	-1	-99	-99	-99	-99	100	AAFV
LID7	-1	-2	-99	-99	-99	-99	100	Qpk

c---

c700 Model Controls

c

c LINE1 = Land simulation control (0-external),

c Land output directory path (containing unit-area land output timeseries)

c Note: external land timeseries data must be in this order;

c flow(in./ timestep),

c groundwater recharge(in./ timestep),

c pollutant 1(lb / acre / timestep),

c pollutant2, ...

c LINE2 = Start date of simulation (Year Month Day)

c LINE3 = End date of simulation (Year Month Day)

c LINE4 = Land Timeseries timestep (Min),

c BMP simulation timestep (Min),

c CRRAT = The ratio of max velocity to mean velocity under typical flow conditions (value of 1.0 or greater)

c Model output control (0-the same timestep as land time series; 1-hourly),

c Model output directory

c LINE5 = PET Flag(0 - constant monthly PET, 1 - PET from the timeseries (in/ timestep as land time series),

c PET time series file path(required if PET flag is 1)

c LINE6 = Monthly PET rate (in/day) if PET flag is 0 OR

c Monthly PET coefficient (multiplier to PET value) if PET flag is 1

c LINE7 = dummy integer value such as 0 (not used)

c exceeding days flag time series file path (optional) file format - month/day/year, flag for flow (1 for retain), flag for pollutant 1 (1 for exceeding), ..., flag for pollutant n (1 for exceeding)

c

0 C:\MyFiles\WMMS\SUSTAIN\Current_Input\LSPCData\WSTNUM-029

2008 10 1

2018 10 1

60 5 1.5 1 C:\MyFiles\WMMS\SUSTAIN\Current\Files_Output\605749

1 C:\MyFiles\WMMS\SUSTAIN\Current_Input\LSPCData\WSTNUM-029\PEVT.txt

0 0 0 0 0 0 0 0 0 0 0 0

c---

c705 Pollutant Definition

c

c POLLUT_ID = Unique pollutant identifier (Sequence number same as in land output time series)

c POLLUT_NAME = Unique pollutant name

c MULTIPLIER = Multiplying factor used to convert the pollutant load to lbs (external control)

c SED_FLAG = The sediment flag (0-not sediment,1-sand,2-silt,3-clay,4-total sediment)

c if = 4 SEDIMENT will be splitted into sand, silt,and clay based on the fractions defined in card 710.

c SED_QUAL = The sediment-associated pollutant flag (0-no, 1-yes)

c if = 1 then SEDIMENT is required in the pollutant list

c SAND_QFRAC = The sediment-associated qual-fraction on sand (0-1), only required if SED_QUAL = 1

c SILT_QFRAC = The sediment-associated qual-fraction on silt (0-1), only required if SED_QUAL = 1

c CLAY_QFRAC = The sediment-associated qual-fraction on clay (0-1), only required if SED_QUAL = 1

c

c POLLUT_ID POLLUT_NAME MULTIPLIER SED_FLAG SED_QUAL SAND_QFRAC SILT_QFRAC CLAY_QFRAC

1 TSS 2240 0 0 0 0 0

2 TN 1 0 0 0 0 0

3 TP 1 0 0 0 0 0

4 TCD 1 0 0 0 0 0

5 TCU 1 0 0 0 0 0

6 TPB 1 0 0 0 0 0

7 TZN 1 0 0 0 0 0

c---

c710 LAND USE DEFINITION (required if land simulation control is external)

c

c LANDTYPE = Unique land use definition identifier

c LANDNAME = land use name

c IMPERVIOUS = Distinguishes pervious/impervious land unit (0-pervious; 1-impervious)

c TIMESERIESFILE = File name containing input timeseries

c SAND_FRAC = The fraction of total sediment from the land which is sand (0-1)

c SILT_FRAC = The fraction of total sediment from the land which is silt (0-1)

c CLAY_FRAC = The fraction of total sediment from the land which is clay (0-1)

c

c LANDTYPE LANDNAME IMPERVIOUS TIMESERIESFILE SAND_FRAC SILT_FRAC CLAY_FRAC

1 Road_Freeway-All-All-All 1 1000_Road_Freeway-All-All-All.txt 0 0.55 0.4

2 Road_Primary-All-All-All 1 2000_Road_Primary-All-All-All.txt 0 0.55 0.4

3 Road_Minor-All-All-All 1 3000_Road_Minor-All-All-All.txt 0 0.55 0.4

4 Dev_ResHigh-All-All-All 1 4000_Dev_ResHigh-All-All-All.txt 0 0.55 0.4

5 Dev_ResLow-All-All-All 1 5000_Dev_ResLow-All-All-All.txt 0 0.55 0.4

6 Dev_Com-All-All-All 1 6000_Dev_Com-All-All-All.txt 0 0.55 0.4

7 Dev_Ind-All-All-All 1 7000_Dev_Ind-All-All-All.txt 0 0.55 0.4

8 Dev_Inst-All-All-All 1 8000_Dev_Inst-All-All-All.txt 0 0.55 0.4

9 Dev_Roof-All-All-All 1 9000_Dev_Roof-All-All-All.txt 0 0.55 0.4

10 Dev_Overspray-All-All-All 1 10000_Dev_Overspray-All-All-All.txt 0 0.55 0.4

11 Dev_Irrigated-A-Low-Confined 0 11111_Dev_Irrigated-A-Low-Confined.txt 0 0.55 0.4

12 Dev_Irrigated-A-Low-Unconfined 0 11112_Dev_Irrigated-A-Low-Unconfined.txt 0 0.55 0.4

13 Dev_Irrigated-A-Med-Confined 0 11121_Dev_Irrigated-A-Med-Confined.txt 0 0.55 0.4

14 Dev_Irrigated-A-Med-Unconfined 0 11122_Dev_Irrigated-A-Med-Unconfined.txt 0 0.55 0.4

15	Dev_Irrigated-B-Low-Confined	0	11211_Dev_Irrigated-B-Low-Confined.txt	0	0.55	0.4
16	Dev_Irrigated-B-Low-Unconfined	0	11212_Dev_Irrigated-B-Low-Unconfined.txt	0	0.55	0.4
17	Dev_Irrigated-B-Med-Confined	0	11221_Dev_Irrigated-B-Med-Confined.txt	0	0.55	0.4
18	Dev_Irrigated-B-Med-Unconfined	0	11222_Dev_Irrigated-B-Med-Unconfined.txt	0	0.55	0.4
19	Dev_Irrigated-C-Low-Confined	0	11311_Dev_Irrigated-C-Low-Confined.txt	0	0.55	0.4
20	Dev_Irrigated-C-Low-Unconfined	0	11312_Dev_Irrigated-C-Low-Unconfined.txt	0	0.55	0.4
21	Dev_Irrigated-C-Med-Confined	0	11321_Dev_Irrigated-C-Med-Confined.txt	0	0.55	0.4
22	Dev_Irrigated-C-Med-Unconfined	0	11322_Dev_Irrigated-C-Med-Unconfined.txt	0	0.55	0.4
23	Dev_Irrigated-D-Low-Confined	0	11411_Dev_Irrigated-D-Low-Confined.txt	0	0.55	0.4
24	Dev_Irrigated-D-Low-Unconfined	0	11412_Dev_Irrigated-D-Low-Unconfined.txt	0	0.55	0.4
25	Dev_Irrigated-D-Med-Confined	0	11421_Dev_Irrigated-D-Med-Confined.txt	0	0.55	0.4
26	Dev_Irrigated-D-Med-Unconfined	0	11422_Dev_Irrigated-D-Med-Unconfined.txt	0	0.55	0.4
27	Dev_Pervious-A-Low-Confined	0	12111_Dev_Pervious-A-Low-Confined.txt	0	0.55	0.4
28	Dev_Pervious-A-Low-Unconfined	0	12112_Dev_Pervious-A-Low-Unconfined.txt	0	0.55	0.4
29	Dev_Pervious-A-Med-Confined	0	12121_Dev_Pervious-A-Med-Confined.txt	0	0.55	0.4
30	Dev_Pervious-A-Med-Unconfined	0	12122_Dev_Pervious-A-Med-Unconfined.txt	0	0.55	0.4
31	Dev_Pervious-B-Low-Confined	0	12211_Dev_Pervious-B-Low-Confined.txt	0	0.55	0.4

32 Dev_Pervious-B-Low-Unconfined 0 12212_Dev_Pervious-B-Low-Unconfined.txt 0 0.55 0.4

33 Dev_Pervious-B-Med-Confined 0 12221_Dev_Pervious-B-Med-Confined.txt 0 0.55 0.4

34 Dev_Pervious-B-Med-Unconfined 0 12222_Dev_Pervious-B-Med-Unconfined.txt 0 0.55 0.4

35 Dev_Pervious-C-Low-Confined 0 12311_Dev_Pervious-C-Low-Confined.txt 0 0.55 0.4

36 Dev_Pervious-C-Low-Unconfined 0 12312_Dev_Pervious-C-Low-Unconfined.txt 0 0.55 0.4

37 Dev_Pervious-C-Med-Confined 0 12321_Dev_Pervious-C-Med-Confined.txt 0 0.55 0.4

38 Dev_Pervious-C-Med-Unconfined 0 12322_Dev_Pervious-C-Med-Unconfined.txt 0 0.55 0.4

39 Dev_Pervious-D-Low-Confined 0 12411_Dev_Pervious-D-Low-Confined.txt 0 0.55 0.4

40 Dev_Pervious-D-Low-Unconfined 0 12412_Dev_Pervious-D-Low-Unconfined.txt 0 0.55 0.4

41 Dev_Pervious-D-Med-Confined 0 12421_Dev_Pervious-D-Med-Confined.txt 0 0.55 0.4

42 Dev_Pervious-D-Med-Unconfined 0 12422_Dev_Pervious-D-Med-Unconfined.txt 0 0.55 0.4

43 Agriculture-A-Low-Confined 0 13111_Agriculture-A-Low-Confined.txt 0 0.55 0.4

44 Agriculture-A-Low-Unconfined 0 13112_Agriculture-A-Low-Unconfined.txt 0 0.55 0.4

45 Agriculture-A-Med-Confined 0 13121_Agriculture-A-Med-Confined.txt 0 0.55 0.4

46 Agriculture-A-Med-Unconfined 0 13122_Agriculture-A-Med-Unconfined.txt 0 0.55 0.4

47 Agriculture-B-Low-Confined 0 13211_Agriculture-B-Low-Confined.txt 0 0.55 0.4

48 Agriculture-B-Low-Unconfined 0 13212_Agriculture-B-Low-Unconfined.txt 0 0.55 0.4

49	Agriculture-B-Med-Confined	0	13221_Agriculture-B-Med-Confined.txt	0	0.55	0.4
50	Agriculture-B-Med-Unconfined	0	13222_Agriculture-B-Med-Unconfined.txt	0	0.55	0.4
51	Agriculture-B-High-Confined	0	13231_Agriculture-B-High-Confined.txt	0	0.55	0.4
52	Agriculture-B-High-Unconfined	0	13232_Agriculture-B-High-Unconfined.txt	0	0.55	0.4
53	Agriculture-C-Low-Confined	0	13311_Agriculture-C-Low-Confined.txt	0	0.55	0.4
54	Agriculture-C-Low-Unconfined	0	13312_Agriculture-C-Low-Unconfined.txt	0	0.55	0.4
55	Agriculture-C-Med-Confined	0	13321_Agriculture-C-Med-Confined.txt	0	0.55	0.4
56	Agriculture-C-Med-Unconfined	0	13322_Agriculture-C-Med-Unconfined.txt	0	0.55	0.4
57	Agriculture-C-High-Confined	0	13331_Agriculture-C-High-Confined.txt	0	0.55	0.4
58	Agriculture-D-Low-Confined	0	13411_Agriculture-D-Low-Confined.txt	0	0.55	0.4
59	Agriculture-D-Low-Unconfined	0	13412_Agriculture-D-Low-Unconfined.txt	0	0.55	0.4
60	Agriculture-D-Med-Confined	0	13421_Agriculture-D-Med-Confined.txt	0	0.55	0.4
61	Agriculture-D-Med-Unconfined	0	13422_Agriculture-D-Med-Unconfined.txt	0	0.55	0.4
62	Agriculture-D-High-Confined	0	13431_Agriculture-D-High-Confined.txt	0	0.55	0.4
63	Agriculture-D-High-Unconfined	0	13432_Agriculture-D-High-Unconfined.txt	0	0.55	0.4
64	Veg_Low-A-Med-Confined	0	14121_Veg_Low-A-Med-Confined.txt	0	0.55	0.4
65	Veg_Low-A-Med-Unconfined	0	14122_Veg_Low-A-Med-Unconfined.txt	0	0.55	0.4

66	Veg_Low-A-High-Confined	0	14131_Veg_Low-A-High-Confined.txt	0	0.55	0.4
67	Veg_Low-A-High-Unconfined	0	14132_Veg_Low-A-High-Unconfined.txt	0	0.55	0.4
68	Veg_Low-B-Med-Confined	0	14221_Veg_Low-B-Med-Confined.txt	0	0.55	0.4
69	Veg_Low-B-Med-Unconfined	0	14222_Veg_Low-B-Med-Unconfined.txt	0	0.55	0.4
70	Veg_Low-B-High-Confined	0	14231_Veg_Low-B-High-Confined.txt	0	0.55	0.4
71	Veg_Low-B-High-Unconfined	0	14232_Veg_Low-B-High-Unconfined.txt	0	0.55	0.4
72	Veg_Low-C-Med-Confined	0	14321_Veg_Low-C-Med-Confined.txt	0	0.55	0.4
73	Veg_Low-C-Med-Unconfined	0	14322_Veg_Low-C-Med-Unconfined.txt	0	0.55	0.4
74	Veg_Low-C-High-Confined	0	14331_Veg_Low-C-High-Confined.txt	0	0.55	0.4
75	Veg_Low-C-High-Unconfined	0	14332_Veg_Low-C-High-Unconfined.txt	0	0.55	0.4
76	Veg_Low-D-Med-Confined	0	14421_Veg_Low-D-Med-Confined.txt	0	0.55	0.4
77	Veg_Low-D-Med-Unconfined	0	14422_Veg_Low-D-Med-Unconfined.txt	0	0.55	0.4
78	Veg_Low-D-High-Confined	0	14431_Veg_Low-D-High-Confined.txt	0	0.55	0.4
79	Veg_Low-D-High-Unconfined	0	14432_Veg_Low-D-High-Unconfined.txt	0	0.55	0.4
80	Veg_High-A-Med-Confined	0	15121_Veg_High-A-Med-Confined.txt	0	0.55	0.4
81	Veg_High-A-Med-Unconfined	0	15122_Veg_High-A-Med-Unconfined.txt	0	0.55	0.4
82	Veg_High-A-High-Confined	0	15131_Veg_High-A-High-Confined.txt	0	0.55	0.4

83 Veg_High-A-High-Unconfined 0 15132_Veg_High-A-High-Unconfined.txt0 0.55 0.4

84 Veg_High-B-Med-Confined 0 15221_Veg_High-B-Med-Confined.txt 0 0.55 0.4

85 Veg_High-B-Med-Unconfined 0 15222_Veg_High-B-Med-Unconfined.txt0 0.55 0.4

86 Veg_High-B-High-Confined 0 15231_Veg_High-B-High-Confined.txt 0 0.55 0.4

87 Veg_High-B-High-Unconfined 0 15232_Veg_High-B-High-Unconfined.txt0 0.55 0.4

88 Veg_High-C-Med-Confined 0 15321_Veg_High-C-Med-Confined.txt 0 0.55 0.4

89 Veg_High-C-Med-Unconfined 0 15322_Veg_High-C-Med-Unconfined.txt0 0.55 0.4

90 Veg_High-C-High-Confined 0 15331_Veg_High-C-High-Confined.txt 0 0.55 0.4

91 Veg_High-C-High-Unconfined 0 15332_Veg_High-C-High-Unconfined.txt0 0.55 0.4

92 Veg_High-D-Med-Confined 0 15421_Veg_High-D-Med-Confined.txt 0 0.55 0.4

93 Veg_High-D-Med-Unconfined 0 15422_Veg_High-D-Med-Unconfined.txt 0 0.55 0.4

94 Veg_High-D-High-Confined 0 15431_Veg_High-D-High-Confined.txt 0 0.55 0.4

95 Veg_High-D-High-Unconfined 0 15432_Veg_High-D-High-Unconfined.txt 0 0.55 0.4

96 Water-All-All-All 0 16000_Water-All-All-All.txt 0 0.55 0.4

c---

c712 Aquifer INFORMATION

c

c AquiferID = Unique Aquifer identifier

c AquiferNAME = Aquifer name

c Initial Storage = Initial Storage (ac-ft)

c RecessionCoef = Recession Coefficient (1/hr)

c SeepageCoef = Seepage Coefficient (1/hr)

c

c AquiferID AquiferNAME InitialStorage RecessionCoef SeepageCoef

c---

c713 Aquifer Pollutant Background Concentration

c

c AquiferID = Unique Aquifer identifier as in c712

c Ci = Background concentration for pollutant i (mg/l)

c Where i = 1 to N (N = Number of QUAL from card 705)

c

c AQUIFER_ID QUALC1 QUALC2 ... QUALCN

c---

c715 BMP SITE INFORMATION

c

c BMPSITE = Unique BMP site identifier

c BMPNAME = BMP template name or site name

c BMPTYPE = Unique BMP Types (must use the exact same keyword)

c
(BIORETENTION,WETPOND,CISTERN,DRYPOND,INFILTRATIONTRENCH,GREENROOF,POROUSPAVEMENT,
RAINBARREL,REGULATOR,SWALE,CONDUIT,BUFFERSTRIP,AREABMP)

c DArea = Total Drainage Area in acre

c NUMUNIT = Number of BMP structures

c DDAREA = Design drainage area of the BMP structure (acre)

c PreLUType = Predevelopment land use type (for external land simulation option)

c AquiferID = Unique Aquifer ID, 0 --- no aquifer (for external land simulation option)

c FtableFLG = Ftable flag, 0 = no, 1 = yes (for BMP Class A, B, and C)

c FTABLE_ID = Unique Ftable identifier (continuous string) as in card 714

c DA2FP_RATIO = BMP drainage area to footprint ratio (ac/ac)

c GID = BMPSITE Group Identifier (non-zero integer, 0 = not a group)

c NOTE: if multiple BMPSITE for the same GID then optimizer will choose only one for a solution

c the user must specify the nested routing for the BMPs in a group and drainage area should be assigned to the most upstream BMPSITE.

c land swap controls (card 711) and structural controls (card 715) will be grouped together if they are assigned the same GID. To keep them separate use the different GID in card 711 and 715.

c RtableFLG = Rtable flag, 0 = no, 1 = yes (for JUNCTION only)

c RTABLE_ID = Unique REDUCTION-table identifier (continuous string) as in card 707

c

c BMPSITE BMPNAME BMPTYPE DArea NUMUNIT DDAREA PreLUType AquiferID FtableFLG FTABLE_ID DA2FP_RATIO GID RtableFLG RTABLE_ID

out SubwatershedOutlet JUNCTION 0 1 0 1 0 0 No 0 0 0

ut UntreatedFlow JUNCTION 0 1 0 1 0 0 No 0 0 0

TBDBMP BioretentionType1 BIORETENTION 0 1 0 1 0 0 No 0 0 0

REG1 BioretentionType1 RAINBARREL 45.06799832 1 0 1 0 0 No 0 0 0

LID7 BioretentionType1 INFILTRATIONTRENCH 0 1 0 1 0 0 No 0 0 0

sewer Sewer JUNCTION 0 1 0 1 0 0 0 0 0 0

c---

c721 Tier-1 Watershed Outlets Definition

c

c BMPSITE = BMP site(watershed outlet) identifier in card 715

c NUMBREAKS = Number of break points on the cost-effectiveness curve

c CECurveFile = CECurve_Solutions file for the project cost(sorted cost value) of each break point

c

c BMPSITE NUMBREAKS CECurveFile

```
c-----------------------------------------------------------------------------------------------------------------
c722 Tier-1 Watershed Timeseries Definition
c
c BMPSITE = BMP site(watershed outlet) identifier in card 721
c BREAKPOINTID = Unique break point id on cost-effectiveness curve
c(0 for initial, -1 for PreDev, and - 2 for PostDev condition)
c MULTIPLIER = Multiplier applied to the timeseries file
c TIMESERIESFILE = Timeseries output file corresponding to the breakpoint id
c
c BMPSITE   BREAKPOINTID MULTIPLIER  TIMESERIESFILE
c-----------------------------------------------------------------------------------------------------------------
c723 Pump Curve (applies if PUMP_FLG is ON in card 725)
c
c PUMP_CURVE = The unique name of pump curve (continuous string without space)
c NUM_RECORD = Number of points on the curve
c
c DEPTH      = Depth (ft)
c FLOW       = Pumping flow rate (cfs)
c
c PUMP_CURVE NUM_RECORD
c DEPTH            FLOW
c-----------------------------------------------------------------------------------------------------------------
c725 CLASS-A BMP Site Parameters (required if BMPSITE is CLASS-A in card 715)
c
c BMPSITE = Class A BMP dimension group identifier in card 715
c WIDTH   = Basin bottom width (ft)
c LENGTH  = Basin bottom length (ft) / diameter (ft) for rain barrel or cistern
c OHEIGHT = Orifice Height (ft)
c DIAM    = Orifice Diameter (in)
```

c CCOEF = Contraction Coefficient, user-specified value between 0 and 1 (e.g., Rounded = 1.0, Short Tube = 0.8, Sharp-edged = 0.61, Borda = 0.5)

c RELTP = Release Type (1-Cistern, 2-Rain barrel, 3-others)

c PEOPLE = Number of persons (Cistern Option)

c DDAYS = Number of dry days (Rain Barrel Option)

c WEIRTP = Weir Type (1-Rectangular,2-Triangular)

c WEIRH = Weir Height (ft)

c WEIRW = (weir type 1) Weir width (ft)

c THETA = (weir type 2) Weir angle (degrees)

c ET_MULT = multiplier to PET

c PUMP_FLG = pump option (0-OFF, 1-ON)

c DEPTH_ON = water Depth (ft) at which the pump is started

c DEPTH_OFF = water Depth (ft) at which the pump is stopped

c PUMP_CURVE = The unique name of pump curve (continuous string without space)

c BYPASS_FRAC = Fraction of inflow that bypasses the BMP when full (0.0-1.0)

c DIV_RATE = Maximum flow diversion rate into BMP (cfs)

c BMP_GID = BMP group ID, activate only one BMP within a group (default = 0 [not a group], non-zero positive integer value as group ID)

c The user must specify the nested routing for the BMPs in a group and drainage area should be specified only for the most upstream BMP.

c

c BMPSITE WIDTH LENGTH OHEIGHT DIAM EXITYPE RELEASETYPE PEOPLE DDAYS WEIRTYPE WEIRH WEIRW THETA ET_MULT PUMP_FLG DEPTH_ON DEPTH_OFF PUMP_CURVE BYPASS_FRAC DIV_RATE BMP_GID

TBDBMP 0 0 0 0 0.61 3 0 0 1 0.5 10000 0 0 0 0 0 none 0 -1

REG1 134 70 0 0.0045 0.61 4 0 0 1 14 10000 0 0 0 0 0 none 0 -1

LID7 77 77 0 0.01 0.61 4 0 0 1 14 10000 0 0 0 0 0 none 0 -1

c---

c730 Cistern Control Water Release Curve (applies if release type is cistern in card 725)

c

c BMPSITE = Class A BMP dimension group identifier in card 715

c Flow = Hourly water release per capita from the Cistern Control (ft3/hr/capita)

c

c BMPSITE FLOW

TBDBMP 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0
0

REG1 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0

LID7 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0

c---

c735 CLASS B BMP Site DIMENSION GROUPS

c

c BMPSITE = BMP Site identifier in card 715

c WIDTH = basin bottom width (ft)

c LENGTH = basin bottom Length (ft)

c MAXDEPTH = Maximum depth of channel (ft)

c SLOPE1 = Side slope 1 (ft/ft)

c SLOPE2 = Side slope 2 (ft/ft) (1-4)

c SLOPE3 = Side slope 3 (ft/ft)

c MANN_N = Manning 's roughness coefficient

c ET_MULT = multiplier to PET

c

c BMPSITE WIDTH LENGTH MAXDEPTH SLOPE1 SLOPE2 SLOPE3 MANN_N
ET_MULT

c---

c740 BMP Site BOTTOM SOIL/VEGITATION CHARACTERISTICS

c

c BMPSITE = BMPSITE identifier in c715

c INFILTM = Infiltration Method (0-Green Ampt, 1-Horton, 2-Holtan)

c POLROTM = Pollutant Routing Method (1-Completely mixed, >1-number of CSTRs in series)

c POLREMM = Pollutant Removal Method (0-1st order decay, 1-kadlec and knight method, 2-user defined concentration)

c SDEPTH = Soil Depth (ft)

c POROSITY = Soil Porosity (0-1)

c FCAPACITY = Soil Field Capacity (ft/ft)

c WPOINT = Soil Wilting Point (ft/ft)

c AVEG = Vegetative Parameter A (0.1-1.0) (Empirical), only required for Holtan infiltration method

c FINFILT = Soil layer infiltration rate (in/hr)

c UNDSWITCH = Underdrain option (0-No underdrain, 1-underdrain with percent removal rate, 2-underdrain with constant effluent conc.)

c UNDDEPTH = Depth of storage media below underdrain (ft)

c UNDVOID = Fraction of underdrain storage depth that is void space (0-1)

c UNDINFILT = Background infiltration rate, below underdrain (in/hr)

c SUCTION = Average value of soil capillary suction along the wetting front, value must be greater than zero (in), only required for Green-Ampt infiltration method

c IMDMAX = Difference between soil porosity and initial moisture content, value must be greater than or equal to zero (a fraction), only required for Green-Ampt infiltration method

c MAXINFILT = Maximum rate on the Horton infiltration curve (in/hr), only required for Horton infiltration method

c DECAYCONS = Decay constant for the Horton infiltration curve (1/hr), only required for Horton infiltration method

c DRYTIME = Time for a fully staurated soil to completely dry (day), only required for Horton infiltration method

c MAXVOLUME = Maximum infiltration volume possible (in), only required for Horton infiltration method

c

c BMPSITE INFILTM POLROTM POLREMM SDEPTH POROSITY FCAPACITY WPOINT AVEG FINFILT UNDSWITCH UNDDEPTH UNDVOID UNDINFILT SUCTION IMDMAX MAXINFILT DECAYCONS DRYTIME MAXVOLUME

TBDBMP 2 1 0 2 0.35 0.3 0.15 0.6 1 0 1.5
0.4 1 0 0 3 4 7 0

REG1 2 1 0 0 0.4 0.3 0.15 0 0 0 1 0.4
0.01 0 0 3 4 7 0

LID7 2 1 0 0 0.45 0.3 0.15 0 0.833 0 1 0.4
1.5 0 0 3 4 7 0

c---

c745 BMP Site HOLTAN GROWTH INDEX

c

c HOLTAN EQUATION: F = GI * AVEG * (Computed Available Soil Storage)^ 1.4 + FINFILT

c

c BMPSITE = BMPSITE identifier in card 715

c GIi = 12 monthly values for GI in HOLTAN equation

c Where i = jan, feb, mar...dec

c

c BMPSITE jan feb mar apr may jun jul aug sep oct nov dec

TBDBMP 0 0 0 0 0 0 0 0 0 0 0
0

REG1 0 0 0 0 0 0 0 0 0 0 0 0

LID7 0 0 0 0 0 0 0 0 0 0 0 0

c---

c747 BMP Site Initial Moisture Content

c

c BMPSITE = BMP Site identifier in card 715

c WATDEP_i = initial surface water depth (ft)

c THETA_i = initial soil moisture (ft/ft)

c

c BMPSITE WATDEP_i THETA_i

TBDBMP 0 0.15

REG1 0 0.15

LID7 0 0.15

c---

c750 Class-C Conduit Parameters (required if BMPSITE is CLASS-C in card 715)

c

c BMPSITE = BMP site identifier in card 715

c INLET_NODE = BMP Id at the entrance of the conduit

c OUTLET_NODE = BMP Id at the exit of the conduit

c LENGTH = Conduit length (ft)

c MANNING_N = Manning's roughness coefficient

c INLET_IEL = Invert Elevation at the entrance of the conduit (ft)

c OUTLET_IEL = Invert Elevation at the exit of the conduit (ft)

c INIT_FLOW = Initial flow in the conduit (cfs)

c INLET_HL = Head loss coefficient at the entrance of the conduit

c OUTLET_HL = Head loss coefficient at the exit of the conduit

c AVERAGE_HL = Head loss coefficient along the length of the conduit

c

c BMPSITE INLET_NODE OUTLET_NODE LENGTH MANNING_N INLET_IEL OUTLET_IEL INIT_FLOW INLET_HL OUTLET_HL AVERAGE_HL

c---

c755 Class C Conduit Cross Sections

c

c LINK = BMP site identifier in card 715

c TYPE = Conduit Type (rectangular, circular...)

c GEOM1 = Geometric cross-sectional property of the conduit

c GEOM2 = Geometric cross-sectional property of the conduit

c GEOM3 = Geometric cross-sectional property of the conduit

c GEOM4 = Geometric cross-sectional property of the conduit

c BARRELS = Number of Barrels in the conduit

c

c LINK TYPE GEOM1 GEOM2 GEOM3 GEOM4 BARRELS

c--

c760 Irregular Cross Sections

c

c Format of transect data follows:

c NC nLeft nRight nChannel

c X1 name nSta xLeftBank xRightBank 0 0 0 xFactor yFactor

c GR Elevation Station ...

c--

c761 BufferStrip BMP Parameters (required if BMPTYPE is BUFFERSTRIP in card 715)

c

c BMPSITE = BMP site identifier in card 715

c Width = BMP width (ft)

c FLength = Flow length (ft)

c DStorage = Surface depression storage (in)

c SLOPE = Overland slope (ft / ft)

c MANNING_N = Overland Manning's roughness coefficient

c POLREMM = Pollutant Removal Method (0-1st order decay, 1-kadlec and knight method)

c ET_MULT = Multiplier to PET

c

c--

c762 Area BMP Parameters (required if BMPTYPE is AREABMP in card 715)

c

c BMPSITE = BMP site identifier in card 715

c Area = BMP area (ft2)

c FLength = flow length (ft) note: area width = area / flow length

c DStorage = Surface depression storage (in)

c SLOPE = Overland slope (ft / ft)

c MANNING_N = Overland Manning's roughness coefficient

c SAT_INFILT = Saturated infiltration rate (in/hr)

c POLREMM = Pollutant Removal Method (0-1st order decay, 1-kadlec and knight method)

c DCIA = Percentage of Directly Connected Impervious Area (0-100)

c TOTAL_IMP_DA = Total Impervious Drainage Area (acre)

c

c BMPSITE Area FLengthDStorage SLOPE MANNING_N SAT_INFILT POLREMM DCIA TOTAL_IMP_DA

c--

c---

c765 BMP SITE Pollutant Decay / Loss rates

c

c BMPSITE = BMP site identifier in card 715information

c QUALDECAYi = First - order decay rate for pollutant i (hr ^ -1)

c Where i = 1 to N(N = Number of QUAL from TIMESERIES FILES)

c

c BMPSITE QUALDECAY1 QUALDECAY2...QUALDECAYN

TBDBMP 0.008333333 0.008333333 0.008333333 0.008333333 0.008333333 0.008333333 0.008333333

REG1 0.008333333 0.008333333 0.008333333 0.008333333 0.008333333 0.008333333 0.008333333

LID7 0.008333333 0.008333333 0.008333333 0.008333333 0.008333333 0.008333333 0.008333333

c---

c766 Pollutant K' values (applies when pollutant removal method is kadlec and knight method in card 740)

c

c BMPSITE = BMP site identifier in card 715

C QUALK'i = Constant rate for pollutant i (ft/yr)

c Where i = 1 to N (N = Number of QUAL from card 705)

c

c BMPSITE QUALK'1 QUALK'2 ... QUALK'N

c---

c767 Pollutant C* values (applies when pollutant removal method is kadlec and knight method in card 740)

c

c BMPSITE = BMP site identifier in card 715

c QUALC*i = Background concentration for pollutant i (mg/l)

c Where i = 1 to N (N = Number of QUAL from card 705)

c

c BMPSITE QUALC*1 QUALC*2 ... QUALC*N

c---

c768 Pollutant C values (applies when surface release type is 4 in card 725)

c

c BMPSITE = BMP site identifier in card 715

c QUALCi = Constant surface release concentration for pollutant i (mg/l)

c Where i = 1 to N (N = Number of QUAL from card 705)

c

c BMPSITE QUALC1 QUALC2 ... QUALCN

TBDBMP 0 0 0 0 0 0 0

REG1 0 0 0 0 0 0 0

LID7 0 0 0 0 0 0 0

c---

c770 BMP Underdrain Pollutant Percent Removal(applies when underdrain is on in card 740)

c

c BMPSITE = BMPSITE identifier in card 715

c QUALPCTREMi = Perecent Removal for pollutant i through underdrain(0 - 1)

c Where i = 1 to N(N = Number of QUAL from TIMESERIES FILES)

c

c BMPSITE QUALPCTREM1 QUALPCTREM2...QUALPCTREMN

TBDBMP 0 0 0 0 0 0 0

REG1 0 0 0 0 0 0 0

LID7 0 0 0 0 0 0 0

c---

c771 BMP Underdrain Pollutant Effluent Concentration (applies when underdrain option is '2' in card 740)

c

c BMPSITE = BMPSITE identifier in card 715

c QUALEFFCi = Underdrain effluent concentration for pollutant i (mg / l)

c Where i = 1 to N(N = Number of QUAL from TIMESERIES FILES)

c

c BMPSITE QUALEFFC1 QUALEFFC2...QUALEFFCN

TBDBMP 0 0 0 0 0 0 0

REG1 0 0 0 0 0 0 0

LID7 0 0 0 0 0 0 0

c---

c775 Sediment General Parameters (required if pollutant type is sediment in card 705)

c

c BMPSITE = BMP site identifier in card 715

c BEDWID = Bed width (ft) - this is constant for the entire simulation period

c BEDDEP = Initial bed depth (ft)

c BEDPOR = Bed sediment porosity

c

c BMPSITE BEDWID BEDDEPBEDPOR

c---

c780 Sand Transport Parameters (required if pollutant type is sediment in card 705)

c

c BMPSITE = BMP site identifier in card 715

c D = Effective diameter of the transported sand particles (in)

c W = The corresponding fall velocity in still water (in/sec)

c RHO = The density of the sand particles (lb/ft3)

c KSAND = The coefficient in the sandload power function formula

c EXPSND = The exponent in the sandload power function formula

c

c BMPSITE D W RHO KSAND EXPSND

c---

c785 Silt Transport Parameters (required if pollutant type is sediment in card 705)

c

c BMPSITE = BMP site identifier in card 715

c D = Effective diameter of the transported silt particles (in)

c W = The corresponding fall velocity in still water (in/sec)

c RHO = The density of the silt particles (lb/ft3)

c TAUCD = The critical bed shear stress for deposition (lb/ft2)

c TAUCS = The critical bed shear stress for scour (lb/ft2)

c M = The erodibility coefficient of the silt particles (lb/ft2/day)

c

c BMPSITE D W RHO TAUCD TAUCS M

c---

c786 Clay Transport Parameters (required if pollutant type is sediment in card 705)

c

c BMPSITE = BMP site identifier in card 715

c D = Effective diameter of the transported clay particles (in)

c W = The corresponding fall velocity in still water (in/sec)

c RHO = The density of the silt/clay particles (lb/ft3)

c TAUCD = The critical bed shear stress for deposition (lb/ft2)

c TAUCS = The critical bed shear stress for scour (lb/ft2)

c M = The erodibility coefficient of the clay particles (lb/ft2/day)

c

c BMPSITE D W RHO TAUCD TAUCS M

c---

c790 LAND TO BMP ROUTING NETWORK(required for external land simulation control in card 700)

c

c UniqueID = Identifies an instance of LANDTYPE in SCHEMATIC

c LANDTYPE = Corresponds to LANDTYPE in c710

c AREA = Area of LANDTYPE in ACRES

c DS = UNIQUE ID of DS BMP(0 - no BMP, add to end)

c GID = Group Identifier in card 711 (0 - no change)

c

c UniqueID LANDTYPE AREA DS LCGID

1 1 0.052386260000000004 REG1 0

2 2 5.6616697600000006 REG1 0

3 3 1.6269393200000002 REG1 0

4 4 0.9577789800000001 REG1 0

5 5 6.454382600000001 REG1 0

6 6 4.1553176800000005 REG1 0

7 7 0.07215466000000001 REG1 0

8 8 3.6324435000000004 REG1 0

9 9 5.4649741800000005 REG1 0

10 10 0.2915839 REG1 0

11 19 2.21109554 REG1 0

12 23 0.7709676 REG1 0

13 35 5.93941578 REG1 0

14 39 1.96102528 REG1 0

15 72 3.3754543000000004 REG1 0

16 76 1.0477252 REG1 0

17 88 0.96568634 REG1 0

18 92 0.42699744 REG1 0

c---

c795 BMP Site ROUTING NETWORK

c

c BMPSITE = BMPSITE identifier in card 715

c OUTLET_TYPE = Outlet type(1 - total, 2 - weir, 3 - orifice or channel, 4 - underdrain, 5-untreated or bypass)

c DS = Downstrem BMP site identifier in card 715(0 - no BMP, add to end)

c

c BMPSITE OUTLET_TYPE DS

ut 1 out

out 1 0

TBDBMP 1 out

REG1 2 LID7

REG1 3 sewer

REG1 4 LID7

REG1 5 LID7

LID7 2 out

LID7 3 sewer

LID7 4 out

LID7 5 out

c---

c800 Optimization Controls

c

c Technique --Optimization Techniques

c 0 = no optimization

c 1 = Scatter Search

c 2 = NSGAII

c Option --Optimization options

c 0 = no optimization

c   1 = specific control target and minimize cost

c   2 = generate cost effectiveness curve

c StopDelta-- Criteria for stopping the optimization iteration

c   in dollars($), meaning if the cost not improved by this criteria, stop the search(for Option 1)

c MaxRuns --Maximum number of iterations

c NumBest-- Number of best solutions for output(for Option 1)

c

c Technique Option   StopDelta MaxRuns NumBest

0   2   0   10000   1

c---

c805 BMP Cost Functions

c Cost($) = ((LinearCost)Length ^ (LengthExp) + (AreaCost)Area ^ (AreaExp) + (TotalVolumeCost)TotalVolume ^ (TotalVolExp)

c + (MediaVolumeCost)SoilMediaVolume ^ (MediaVolExp) + (UnderDrainVolumeCost)UnderDrainVolume ^ (UDVolExp)

c + (Unitcost) + (ConstantCost)) * (1 + PercentCost / 100)

c

c BMPSITE = BMP site identifier in card 715

c LinearCost = Cost per unit length of the BMP structure($/ ft)

c AreaCost = Cost per unit area of the BMP structure($/ ft ^ 2)

c TotalVolumeCost = Cost per unit total volume of the BMP structure($/ ft ^ 3)

c MediaVolumeCost = Cost per unit volume of the soil media($/ ft ^ 3)

c UnderDrainVolumeCost = Cost per unit volume of the under drain structure($/ ft ^ 3)

c ConstantCost = Constant cost($)

c PercentCost = Cost in percentage of all other cost(%)

c LengthExp = Exponent for linear unit

c AreaExp = Exponent for area unit

c TotalVolExp = Exponent for total volume unit

c MediaVolExp = Exponent for soil media volume unit c UDVolExp = Exponent for underdrain volume unit

c

c BMPSITE LinearCost AreaCost TotalVolumeCost MediaVolumeCost UnderDrainVolumeCost ConstantCost PercentCost LengthExp AreaExp TotalVolExp MediaVolExp UDVolExp

TBDBMP 0 0 0 0 0 0 0 1 1 1 1 1

REG1 0 0 12.6 0 0 120000 0 1 1 1 1 1

LID7 0 0 5.9848 0 0 0 0 1 1 1 1 1

c---

c806 Diversion Structure Cost Function

c Cost ($) = ((DiversionCost)*DIV_RATE^(DiversionExp) + (ConstantCost)) * (1+PercentCost/100)

c

c BMPSITE = BMP site identifier in card 715

c DiversionCost = Cost per unit diversion rate ($/cfs)

c DiversionExp = Exponent for diversion rate

c ConstantCost = Constant cost ($)

c PercentCost = Cost in percentage of all other cost (%)

c

c BMPSITE DiversionCost DiversionExp ConstantCost PercentCost

TBDBMP 0 1 0 0

REG1 25400 1 0 0

LID7 0 1 0 0

c---

c810 BMP SITE Adjustable Parameters

c BMPSITE = BMP site identifier in card 715

c VARIABLE = Variable name

c LENGTH = BMP length,

c NUMUNIT = number of units,

c WEIRH = weir height,

c SDEPTH = soil media depth,

c DCIA = directly connected impervious area,

c MAXDEPTH = BMP maximum depth,

c CECURVE = cost - effectiveness curve for Tier - 1 solution

c DIV_RATE --- maximum flow diversion rate into BMP

c FROM = From value in the range

c TO = To value in the range

c STEP = Increment step

c BMPSITE VARIABLE FROM TO STEP

TBDBMP LENGTH 0 0 0

REG1 LENGTH 0 175.19417798545703 0.8759708899272851

LID7 LENGTH 0 63.245553203367585 0.31622776601683794

c---

c814 Predeveloped Timeseries at Assessment Point for Flow Duration Curve

c

c BMPSITE = BMP site identifier in card 715 if it is an assessment point

c NumBins = Number of bins for flow duration curve

c PreDevFlag = Pre-developed timeseries option (1-internal,2-external)

c PreDevFile = Pre-developed timeseries file path for external option

c The timeseries file format (AssessmentPoint_ID Year Month Day Hour Minute Flow_cfs)

c The first line is skipped (comment line) and data start from the second line in the required format.

c

c BMPSITE NumBins PreDevFlag PreDevFile

c815 Assessment Point and Evaluation Factor

c

c BMPSITE -- BMP site identifier in card 715 if it is an assessment point

c FactorGroup -- Flow or pollutant related evaluation factor group c -1 = flow related evaluation factor

c # = pollutant ID in card 705

c FactorType -- Evaluation Factor Type (negative number for flow related and positive number for pollutant related)

c -1 = AAFV Annual Average Flow Volume (ft3/yr)

c -2 = PDF Peak Discharge Flow (cfs)

c -3 = FEF Flow Exceeding frequency (#times/year)

c -4 = FDC Flow Duration Curve (sum of sorted flow difference with pre-developed condition, cfs)

c -5 = RAAFV Retain Annual Average Flow Volume (ft3/yr), it requires retain daily flag (value = 1) timeseries in card 700

c 1 = AAL Annual Average Load (lb/yr)

c 2 = AAC Annual Average Concentration (mg/L)

c 3 = MAC Maximum #days Average Concentraion (mg/L)

c 4 = CEF Conc Exceeding frequency (#times/year)

c FactorVal1 -- if FactorType = 3 (MAC): Maximum #Days;

c -- if FactorType = -3 (FEF): Flow Threshold (cfs)

c -- if FactorType = -4 (FDC): Low flow limit (cfs)

c -- if FactorType = 4 (CEF): Conc Threshold (mg/l)

c -- all other FactorType : -99

c FactorVal2 -- if FactorType = -3 (FEF): Minimum inter-exceedance time (hr)

c if = 0 then daily running average flow exceeding frequency

c if = -1 then daily average flow exceeding frequency

c otherwise minimum inter-exceedance time for simulation interval

c -- if FactorType = -4 (FDC): High flow limit (cfs)

c -- if FactorType = 4 (CEF): Flow weighted average conc Options

c if = 0 then daily running average conc exceeding frequency

c if = -1 then daily average conc exceeding frequency

c otherwise conc exceeding frequency at land simulation interval

c -- all other FactorType : -99

c CalcMode -- Evaluation Factor Calculation Mode

c -99 for Option 0 (card 800): no optimizaiton

c 1 = % percent of value under existing condition (0-100)

c 2 = S scale between pre-develop and existing condition (0-1)

c 3 = V absolute value in the unit as shown in FactorType (third block in this card)

c TargetVal1 -- Target value for evaluation factor calculation mode

c -99 for Option 0 (card 800): no optimizaiton

c Target value for minimize cost Option 1 (card 800)

c Lower limit of target value for cost-effective curve Option 2 (card 800)

c TargetVal2 -- Target value for evaluation factor calculation mode

c -99 for Option 0 (card 800): no optimizaiton

c -99 for Option 1 (card 800): minimize cost

c Upper limit of target value for cost-effective curve Option 2 (card 800)

c Factor_Name -- Evaluation factor name (user specified without any space), e.g. FlowVolume or SEDIMENT

out	1	1	-99	-99	-99	-99	100	PLS_TSS
out	2	1	-99	-99	-99	-99	100	PLS_TN
out	3	1	-99	-99	-99	-99	100	PLS_TP
out	4	1	-99	-99	-99	-99	100	PLS_TCD
out	5	1	-99	-99	-99	-99	100	PLS_TCU
out	6	1	-99	-99	-99	-99	100	PLS_TPB
out	7	1	-99	-99	-99	-99	100	PLS_TZN
out	-1	-1	-99	-99	-99	-99	100	AAFV
out	-1	-2	-99	-99	-99	-99	100	Qpk
REG1	1	1	-99	-99	-99	-99	100	PLS_TSS
REG1	2	1	-99	-99	-99	-99	100	PLS_TN
REG1	3	1	-99	-99	-99	-99	100	PLS_TP
REG1	4	1	-99	-99	-99	-99	100	PLS_TCD
REG1	5	1	-99	-99	-99	-99	100	PLS_TCU

REG1	6	1	-99	-99	-99	-99	100	PLS_TPB
REG1	7	1	-99	-99	-99	-99	100	PLS_TZN
REG1	-1	-1	-99	-99	-99	-99	100	AAFV
REG1	-1	-2	-99	-99	-99	-99	100	Qpk
LID7	1	1	-99	-99	-99	-99	100	PLS_TSS
LID7	2	1	-99	-99	-99	-99	100	PLS_TN
LID7	3	1	-99	-99	-99	-99	100	PLS_TP
LID7	4	1	-99	-99	-99	-99	100	PLS_TCD
LID7	5	1	-99	-99	-99	-99	100	PLS_TCU
LID7	6	1	-99	-99	-99	-99	100	PLS_TPB
LID7	7	1	-99	-99	-99	-99	100	PLS_TZN
LID7	-1	-1	-99	-99	-99	-99	100	AAFV
LID7	-1	-2	-99	-99	-99	-99	100	Qpk

```
TT--------------------------------------------------------------------------------------
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TT
TT SUSTAIN: System for Urban Stormwater Treatment and Analysis INtegration
TT
TT--------------------------------------------------------------------------------------
-------
TT BMP Site Assessment Results
TT Version 2.1 - Jan 2020
TT
TT Created through code updates by :
TT Paradigm Environmental, Inc.
TT San Diego, California, USA
TT www.paradigmh2o.com
TT
TT Based upon SUSTAIN version 1.2 (May 2013), originally developed by :
TT United States Environmental Protection Agency
TT Office of Research & Development
TT with support by Tetra Tech, Inc.
TT
https://www.epa.gov/water-research/system-urban-stormwater-treatment-and-analysis-in
tegration-sustain
TT
TT This output file was created at 02:55:09pm on 07/22/2022
TT
TT--------------------------------------------------------------------------------------
-------
TT
Assessment Point (ID)     Factor Name     Factor Value     Total Cost
REG1    PLS_TSS 18449.57971     0.00000
REG1    PLS_TN  245.85886       0.00000
REG1    PLS_TP  44.59248        0.00000
REG1    PLS_TCD 0.09946 0.00000
REG1    PLS_TCU 10.00086        0.00000
REG1    PLS_TPB 2.53486 0.00000
REG1    PLS_TZN 39.36470        0.00000
REG1    AAFV    2084141.11069   0.00000
REG1    Qpk     40.91403        0.00000
LID7    PLS_TSS 18449.57971     0.00000
LID7    PLS_TN  245.85886       0.00000
LID7    PLS_TP  44.59248        0.00000
LID7    PLS_TCD 0.09946 0.00000
LID7    PLS_TCU 10.00086        0.00000
LID7    PLS_TPB 2.53486 0.00000
LID7    PLS_TZN 39.36470        0.00000
LID7    AAFV    2084141.11069   0.00000
LID7    Qpk     40.91403        0.00000
out     PLS_TSS 18449.57971     0.00000
out     PLS_TN  245.85886       0.00000
out     PLS_TP  44.59248        0.00000
```

out	PLS_TCD	0.09946	0.00000
out	PLS_TCU	10.00086	0.00000
out	PLS_TPB	2.53486	0.00000
out	PLS_TZN	39.36470	0.00000
out	AAFV	2084141.11069	0.00000
out	Qpk	40.91403	0.00000

```
TT--------------------------------------------------------------------------------------
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TT SUSTAIN: System for Urban Stormwater Treatment and Analysis INtegration
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TT BMP Site Assessment Results
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LID7    PLS_TCU 6.24434 0.00000
LID7    PLS_TPB 1.60358 0.00000
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LID7    Qpk     20.00444        0.00000
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Kimley»Horn

ATTACHMENT C2

Storage Alternatives Memorandum

Project	City of Los Angeles Broadway and Manchester Water Demand and Supply Task Order
Watearth #	21-260.0
Subject	Technical Memorandum - Evaluating Stormwater Storage Alternatives
Date	August 25, 2022
Prepared by	Jennifer J. Walker PE, DWRE, ENV SP, CFM, QSD Sinem Gokgoz Kilic, PhD

Draft

DRAFT MEMORANDUM RELEASED UNDER THE AUTHORITY OF **JENNIFER J. WALKER PE (C77079), DWRE, CFM** ON 2022-08-25 AND SHOULD NOT BE USED FOR DESIGN OR CONSTRUCTION.

Stormwater Storage

Underground storage galleries provide stormwater detention for areas with limited space due to existing site conditions. This memo evaluates runoff and stormwater storage alternative solutions concerning system types, depths, and locations. Each system's life-cycle cost and cost benefits, including maintenance requirements, are examined. Differences in infiltration capacity across multiple project zones are evaluated, and supervisory control and data acquisition (SCADA) requirements are discussed.

The storage alternatives presented in this memo are being considered for a 2.8-mile linear project area along Broadway and Manchester Avenues in Los Angeles, California. The stormwater will be captured from high traffic, mostly paved surfaces in the urban zone with limited space and nonpoint source. The captured stormwater will be treated and reused to meet the landscape irrigation demands. Any captured water not used for irrigation is to be infiltrated or discharged as needed. A schematic diagram of a typical stormwater collection and reuse system is shown in **Figure 1**.

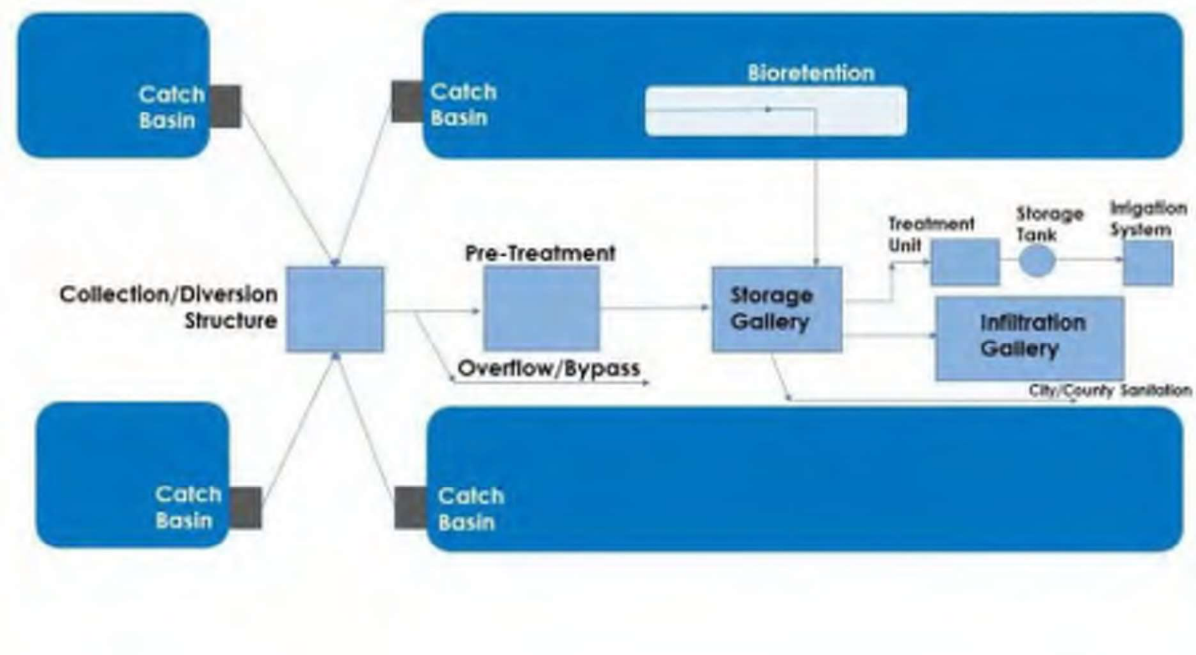

Figure 1: *Typical stormwater capture and reuse system schematic*

Centralized vs. Decentralized

The stormwater storage required for the project can be achieved via centralized or decentralized systems. A centralized system utilizes large storage structures that minimize the number of storage and associated appurtenances but require additional piping and conveyance of the captured runoff. In contrast, a decentralized system uses a network of storage devices to capture and store stormwater. Decentralized systems generally require lower initial capital investment but may have higher costs associated with operation and maintenance (O&M).

Given the linearity of the project site, a centralized system will require the construction of significant piping to accommodate irrigation needs throughout the site. In addition, the relatively flat topography of the project site poses additional challenges for achieving the minimum required slopes for stormwater conveyance to the storage device. As such, a centralized system for stormwater storage is not practical for the specific needs and conditions of the project. Alternative storage solutions discussed in this memo are assumed to be decentralized.

Storage Alternatives Evaluation

Storage alternatives selected for evaluation are based on preliminary runoff estimations, site constraints, and previous Watearth projects. The alternatives discussed in the following sections are considered with respect to local regulations, overall project objectives and site-specific constraints.

Storage Requirements

Local water quality requirements and standards related to outdoor non-potable stormwater reuse for irrigation are described in this section. For the City of Los Angeles, the use of collected stormwater is limited to irrigation of landscaped surfaces[1]. Irrigation systems utilizing untreated rainfall/non-potable cistern water are only allowable for subsurface and drip irrigation. Misting or spraying is prohibited.

Surface infiltration of untreated rainfall/runoff is allowed if it occurs at least 10 feet from an unprotected foundation structure, with at least 10 feet of clearance to the seasonal high ground water table, and at least 100 feet from a water supply well.

Stored water quality declines over time and may become a nuisance and a health hazard for the local community. A recirculation pump is recommended to maintain acceptable water quality. Vectors such as small mammals and insects may also degrade water quality. Storage galleries must be emptied periodically to prevent vector breeding unless exclusion devices are implemented to prevent vector access. A sealed storage system is recommended for inclusion in the project design.

All storage alternatives must be equipped with a built-in SCADA system to remotely control and monitor the field-based assets and their processes, such as wells, pump stations, valves, treatment plants, storage galleries, and reservoirs from a central location. Sensors should be considered at the pump(s) and any valve(s) that tie into the Los Angeles County Sanitation District and Bureau of Sanitation for the City to allow remote monitoring and management of discharges. Currently, limited information is available for specific discharge requirements for City and County sanitation systems. Additional information regarding allowed discharge during wet

[1] www.lacitysan.org/cs/groups/sg_sw/documents/document/y250/mde3/~edisp/cnt017152.pdf

and dry weather conditions, required level of treatment, and equipment specifications are expected from City and County Sanitation. SCADA automation system implementation is anticipated in the final design.

The selected alternative must be designed and implemented with consideration for O&M by the City. The location of storage devices must be easily accessible by city staff with sufficient room to perform the necessary maintenance and repairs. All alternatives considered herein require periodic sediment removal and inspection of critical system components. The following subsections provide evaluation of underground storage and infiltration galleries, dry wells, and bioretention systems with respect to the overall project objectives.

Underground Storage Galleries

Underground storage galleries are available in various materials and dimensions, from concrete vaults to underground chambers and large diameter pipes. The storage galleries are best suited to capture runoff from large impervious surfaces such as a parking lot. For sites with vehicular traffic, precast modular systems are commonly utilized. Most modular systems are configured to specific dimensions that conform to the spatial constraints of the project site. These systems are gravity-fed with pumps to convey harvested rainwater from the storage gallery to the outfall. A typical precast modular storage gallery is shown in **Figure 2**.

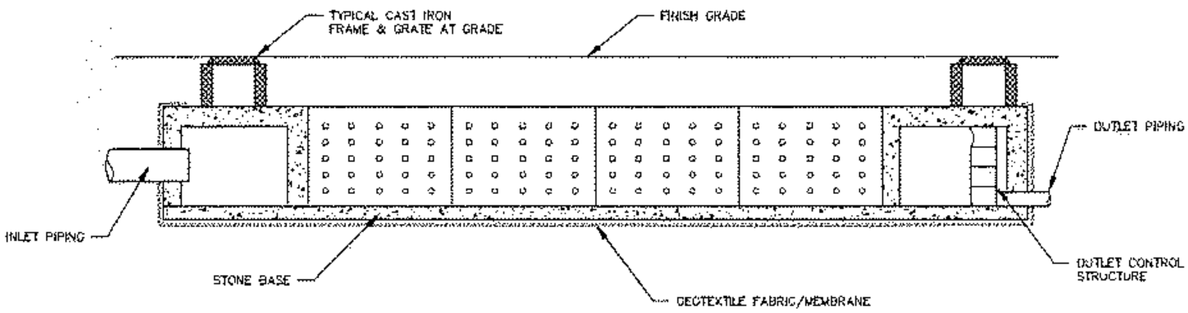

Figure 2: *Schematic Drawing of Typical Precast Storage Gallery (not to scale)*

Routine inspections and maintenance are essential for the proper function of underground storage galleries. Maintenance requirements include regular inspection of the unit and its constituent parts and accessories. Refer to the *City of Los Angeles Low Impact Development (LID) Best Management Practice (BMP) Handbook* for additional information regarding O&M requirements for stormwater capture and storage devices.

Infiltration Galleries & Drywells

Infiltration galleries are engineered, subsurface void spaces consisting of one or more containers, such as pipes, plastic tanks, or concrete vaults. Stormwater runoff enters the gallery through a surface inlet and is temporarily stored, allowing fine sediment and particles remaining after pretreatment to settle. If the water level reaches a certain height, it is discharged as overflow.

Infiltration galleries require a high ratio of sub-surface void space in permeable soils. Such systems are below grade infiltration structures that provide stormwater treatment in areas where space is limited and may receive street runoff from sheet flow, concentrated flow from a swale or other surface feature, or piped flow from a catch basin. Because infiltration galleries are not flow-through BMPs, it typically does not have outlets but may have overflow outlets for large storm events. An overflow device is required if the system is online and does not have an upstream bypass structure. Additionally, potential impacts of structural subgrade materials and the possibility of surface instability caused by soil piping and/or slope destabilization must be considered as part of infiltration gallery design[2].

Currently, the project area is divided into four potential irrigation zones. Refer to **Appendix A** for irrigation zone boundary. Approximately 25% of zone one on Broadway Avenue and 75% of irrigation zone two on Manchester Avenue are known liquefaction zones. Areas prone to liquefaction are unsuitable for below-surface stormwater storage features such as dry wells and infiltration galleries.

Like infiltration galleries, dry wells are designed to store and infiltrate stormwater runoff. Dry wells reduce the volume of stormwater runoff and enhance water quality. Dry wells typically receive concentrated flow from surface features or pipes and do not have outlets. In large storm events, partial infiltration of runoff is achieved by providing an overflow outlet. In dry well systems, significant or complete volume reduction is possible in smaller storm events. During large storm events, these systems may function as detention facilities and provide a limited amount of retention and infiltration[3]. Thus, any volume not captured by the storage gallery and drywells are discharged to overflow. The overflow inlet from the infiltration gallery should be designed for anticipated flows.

Refer to **Figure 3** below for a schematic drawing of a typical dry well system.

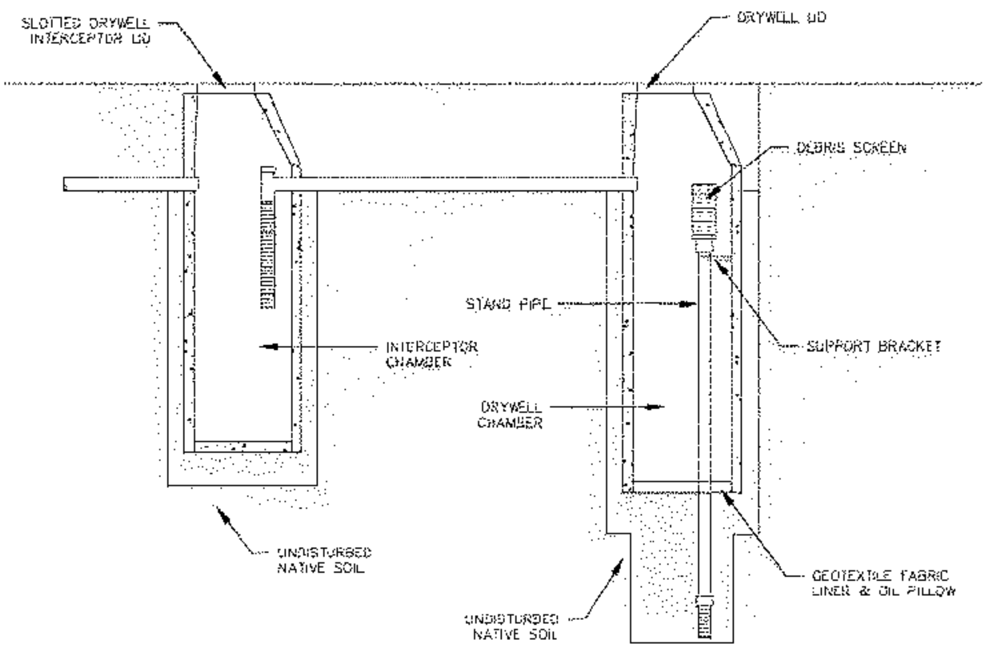

Figure 3: *Schematic Drawing of a Typical Dry Well System (not to scale)*

Infiltration galleries require routine maintenance to ensure the system does not significantly reduce performance. Maintenance includes inspecting pretreatment devices and ensuring water completely infiltrates within the maximum retention time of 96 hours. If water is still present after 96 hours, the dry well may be clogged with sediment, vegetation, or other debris. Inlets should be inspected regularly for debris that may clog the system. If infiltration rates have visibly

[2] dot.ca.gov/-/media/dot-media/programs/design/documents/9_dg-infiltration-gallery_ada.pdf

[3] http://modelstreetdesignmanual.com/model_street_design_manual.pdf

diminished, the system must be excavated for rehabilitation. Routine maintenance may include infiltration testing, service pump maintenance, water quality inspection, system flush, and air blasting. Monitoring wells are recommended for both galleries and wells.

Infiltration galleries and dry wells are the most flexible option for stormwater storage. However, these features may interfere with surrounding structures because its construction involves sub-surface excavation. Additionally, infiltration galleries are not appropriate for installation within the liquefaction zones. Therefore, it is essential to ensure infiltration features do not damage surrounding building foundations, pavement bases, and utilities. Once structural soundness is ensured, infiltration features may be located under sidewalks and in sidewalk planting strips, curb extensions, roundabouts, and medians.

Infiltration features are most effective when the street is graded appropriately. Dry wells require less surface area than galleries and may be more feasible in densely developed areas. Due to their size, dry wells are typically designed to manage stormwater runoff from smaller drainage areas. Dimensioning is adaptable to specific site needs. Several shallow dry wells are more effective than a single large, deep well.

Infiltration features should be sited on uncompacted soils with adequate infiltration capacity. Infiltration features are best used where soil and topography allow for moderate to good infiltration rates (0.5 inches per hour), and the depth to groundwater is at least 10 feet. Refer to the *City of Los Angeles LID BMP Handbook* for additional guidance on siting requirements.

Drainage areas that result in high sediment loading rates to the infiltration facility may require pretreatment to reduce sediment loads and avoid system clogging. Appropriate pretreatment includes sedimentation/settling basins, baffle boxes, hydrodynamic separators, media filters, vegetated swales, or filter strips because they increase the surface area for infiltration.

Bioretention

Bioretention stormwater treatment facilities are landscaped shallow depressions that capture and filter stormwater runoff. Bioretention facilities function as soil and plant-based filtration devices that remove pollutants through various physical, biological, and chemical treatment processes. The facilities typically consist of a ponding area, mulch layer, planting soils, plantings, and an optional subsurface gravel reservoir layer[4].

Bioretention is often implemented within road medians and planted with drought-tolerant native species. Bioretention receives, retains, and infiltrates stormwater runoff from inlets or sheet flow from adjoining paved areas. During storm events, a shallow ponding zone gradually infiltrates and filters through the bioretention soil media before infiltrating into the underlying soil. Installation of an underdrain for stormwater harvesting is required to convey water to downstream BMP features from the retention basin.

Annual plant, soil, and mulch layer maintenance are necessary to ensure optimum infiltration, storage, and pollutant removal capabilities. In general, biofiltration maintenance requirements are typical landscape care procedures. *Planning and Land Development Handbook for LID for the City of Los Angeles*[5] should be considered when determining system types and dimensions.

A summary of all storage alternatives discussed in the memorandum is in **Table 1**.

[4] www.lacitysan.org/cs/groups/sg_sw/documents/document/y250/mde3/~edisp/cnt017152.pdf

Table 1: Summary and comparison of most frequently used stormwater storage design components.

	O&M	Cost	Advantages	Disadvantages
Underground Storage Galleries	Requires periodic maintenance Must be checked for cracks and gaps frequently for vector control	Highest (Highest capital cost, Moderate O&M cost)	Highest potential volume Modular systems are configured to meet site constraints	Provides no opportunity for infiltration Requires maintenance on a regular basis
Infiltration Galleries and Drywells	Require routine maintenance for infiltration testing, service pump maintenance, water quality inspections, system flush, and air blasting	Medium (High capital cost, Moderate O&M cost)	High potential volume Discharge via infiltration providing aquifer recharge	Requires infiltration rates greater than 0.5 in/hr Requires maintenance to ensure infiltration occurs as designed
Bioretention and other LIDs	Must be kept free of debris, periodic removal and replacement of mulch to remove sediment and vegetative maintenance Routinely checked for proper function	Lowest (Low capital cost, Moderate O&M cost)	Small surface area Removes some pollutants Often combined with other storage options	Limited storage potential Requires more frequent maintenance High risk for vandalism or theft

Recommendations

Each of the examined storage alternatives are viable solutions for implementation within the project boundary. Based on the overall objectives of the project, the recommendation for storage are as follows:

1. **Distributed galleries** are the recommended storage solution. Distributed systems provide additional flexibility for siting and reduce the need for conveyance piping to be constructed.
2. **Infiltration galleries** should be placed within each of the irrigation zones identified. Localizing the storage to each of the irrigation zones allows for greater optimization. Infiltration galleries are not recommended in areas prone to liquefaction.
3. **Recirculation pumps** are recommended to maintain appropriate water quality in storage galleries. Long term storage may cause nuisance or become a health hazard to the surrounding community.
4. **Sealed storage devices** are recommended to prevent vectors from entering the system.
5. **LIDs and trees** are recommended throughout the project area. Bioretention reduces the peak flow entering the storage system during a storm event and provides additional benefits that are consistent with the overall objectives of the project. Trees intercept rainfall, reducing the runoff as well as providing shade and helping with urban heat island effect, especially in urbanized areas.

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Appendices

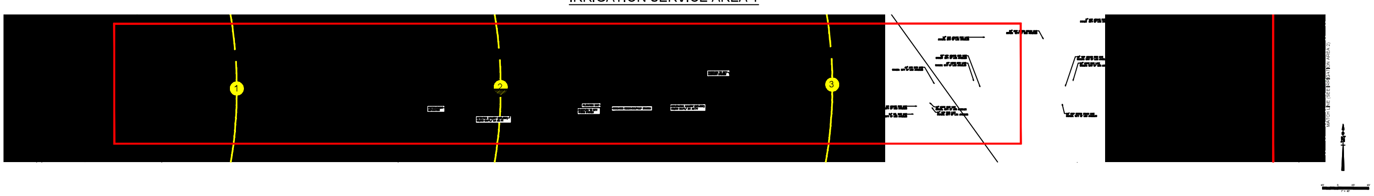
Appendix A – Irrigation Zone

Appendix B – City of Los Angeles BMP LID Handbook

Appendix A

Irrigation Zones

IRRIGATION SERVICE AREA 1



LEGEND:

- BORING LOCATIONS
- POTENTIAL CONTROLLER LOCATIONS (PER MIG MEASURE W AMENDMENT - EXHIBIT A)
- POTENTIAL STREET LIGHT SERVICE LOCATIONS (PER ALLIANCE 35% PLANS)
- LIQUEFACTION AREA
- IMPACTED CATCH BASINS PER 65% CIVIL DESIGN
- GENERAL FLOW PATTERN
- EXISTING DRAINAGE AREAS
- EXISTING CITY OF LA SANITARY SEWER LINE
- EXISTING LACSD SANITARY SEWER LINE
- EXISTING CITY OF LA STORM DRAIN LINE
- EXISTING LACFCD STORM DRAIN LINE
- X.XX DESIGN INFILTRATION RATE* (IN/HR)

*Both shallow and deep infiltration were tested. Infiltration rate shown is the highest of the two. See Infiltration Rates Table on the Key Map for more information.

Irrigation Demand - Service Area 1*	
Landscape Type	Water Demand (gal/month)
Parkway	53,335
Curb Extensions	0
Median	27,998
TOTAL	81,333

*Irrigation Demand based on 35% Plans.

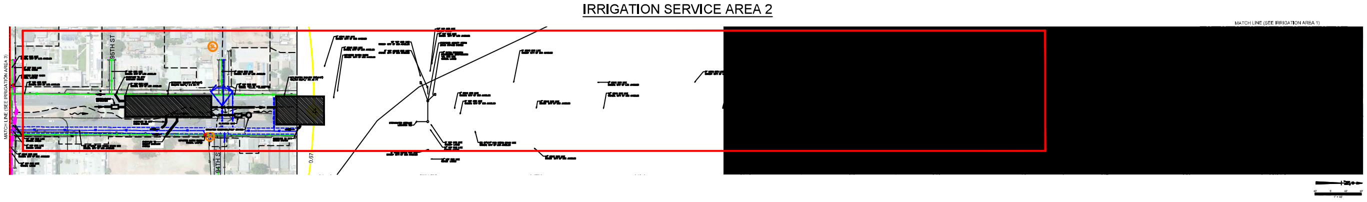
COUNCIL DISTRICT 8

BROADWAY-MANCHESTER ATP EQUITY PROJECT

MEASURE W EXHIBIT

6/14/2022

IRRIGATION SERVICE AREA 2



LEGEND:

- BORING LOCATIONS
- POTENTIAL CONTROLLER LOCATIONS (PER MIG MEASURE W AMENDMENT - EXHIBIT A)
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- EXISTING LACFCD STORM DRAIN LINE
- X.XX DESIGN INFILTRATION RATE (IN/HR)

*Both shallow and deep infiltration were tested, Infiltration rate shown is the highest of the two. See Infiltration Rates Table on the Key Map for more information.

Irrigation Demand - Service Area 2	
Landscape Type	**Water Demand (gal/month)**
Parkway	74,864
Curb Extensions	78,713
Median	100,093
TOTAL	253,670

*Irrigation Demand based on 35% Plans.

COUNCIL DISTRICT 8 SERVING THE SOUTH LA COMMUNITY

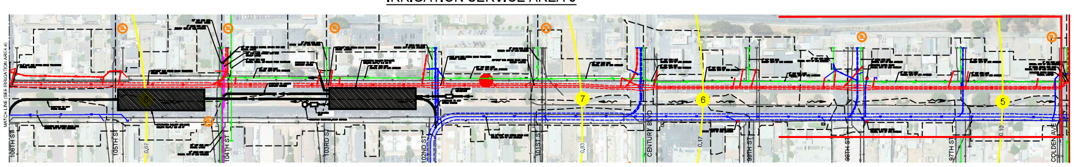
STREETS LA

BROADWAY-MANCHESTER ATP EQUITY PROJECT

MEASURE W EXHIBIT

6/14/2022

IRRIGATION SERVICE AREA 3



LEGEND:

- BORING LOCATIONS
- POTENTIAL CONTROLLER LOCATIONS (PER MIG MEASURE W AMENDMENT - EXHIBIT A)
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- X.XX DESIGN INFILTRATION RATE* (IN/HR)

*Both shallow and deep infiltration were tested, Infiltration rate shown is the highest of the two. See Infiltration Rates Table on the Key Map for more information.

Irrigation Demand - Service Area 3	
Landscape Type	**Water Demand (gal/month)**
Parkway	58,485
Curb Extensions	67,300
Median	273,844
TOTAL	399,629

*Irrigation Demand based on 35% Plans.

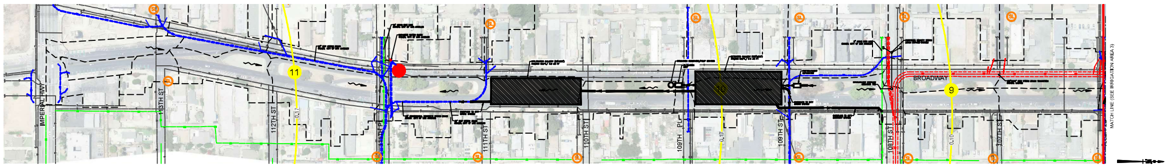
COUNCIL DISTRICT 8

BROADWAY-MANCHESTER ATP EQUITY PROJECT

MEASURE W EXHIBIT

6/14/2022

IRRIGATION SERVICE AREA 4



LEGEND:

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- EXISTING LACFCD STORM DRAIN LINE
- X.XX DESIGN INFILTRATION RATE* (IN/HR)

*Both shallow and deep infiltration were tested, Infiltration rate shown is the highest of the two. See Infiltration Rates Table on the Key Map for more information.

Irrigation Demand - Service Area 4	
Landscape Type	Water Demand (gal/month)
Parkway	72,014
Curb Extensions	61,867
Median	250,381
TOTAL	384,262

*Irrigation Demand based on 35% Plans.

COUNCIL DISTRICT 8

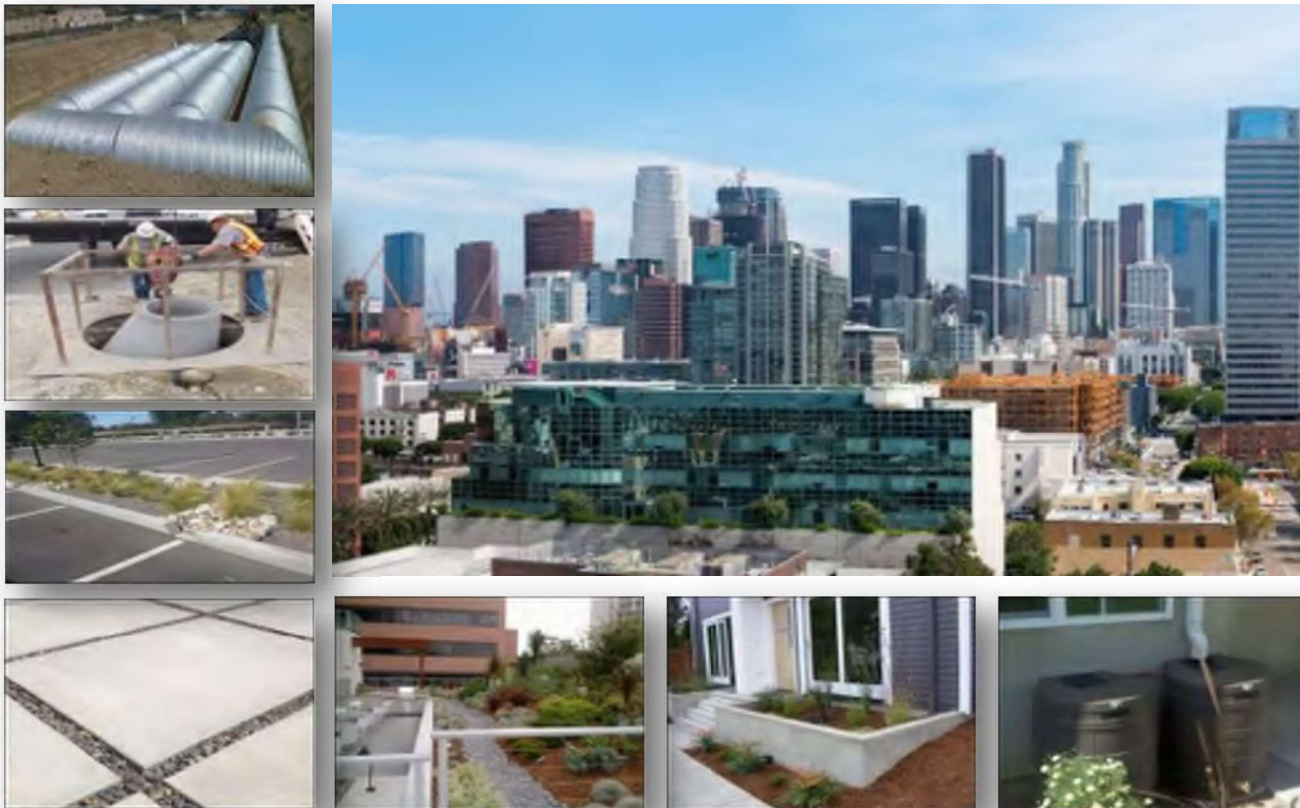
BROADWAY-MANCHESTER ATP EQUITY PROJECT

MEASURE W EXHIBIT

6/14/2022

Appendix B

City of Los Angeles LID BMP Handbook



PLANNING AND LAND DEVELOPMENT HANDBOOK FOR LOW IMPACT DEVELOPMENT (LID)

PART B
PLANNING ACTIVITES
5TH EDITION

May 9, 2016

CITY OF LOS ANGELES · FOUNDED 1781

environment LA SANITATION
CITY OF LOS ANGELES

WATERSHED PROTECTION DIVISION

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This 5th edition is a revision to the 4th edition to reflect the latest LID requirements as defined by the National Pollution Discharge Elimination System Permit (NPDES No. CASOO4001) and the City of Los Angeles Municipal Code. The handbook was originally created under the direction of the City of Los Angeles, who is fully responsible for the content within and a technical committee comprised of the Departments of Planning, Building and Safety, and Water and Power, the Bureaus of Street Services and Engineering, and individuals from the development, environmental, and consultant community.

This Development Best Management Practices Handbook, Part B Planning Activities, 5th edition was adopted by the City of Los Angeles, Board of Public Works on May 9, 2016, as authorized by Section 64.72 of the Los Angeles Municipal Code approved by Ordinance No. 183833.

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ACRONYMS AND ABBREVIATION

BMP	Best Management Practices
BOE	Bureau of Engineering
BOS	Bureau of Sanitation
CGPL	California General Plan Law
CEQA	California Environmental Quality Act
CZARA	Coastal Zone Act Reauthorization Amendments of 1990
C&A	Covenant and Agreement
DCP	Los Angeles Department of City Planning
EAF	Environmental Assessment Form
EIR	Environmental Impact Report
USEPA	United States Environmental Protection Agency
ESA	Environmentally Sensitive Area
ETWU	Estimated Total Water Use
CGPL	California General Plan Law
LADBS	Los Angeles Department of Building and Safety
LID	Low Impact Development
MAWA	Maximum Applied Water Allowance
MND	Mitigated Negative Declaration
MS4	Municipal Separate Storm Sewer Systems
NPDES	National Pollutant Discharge Elimination System
O&M	Operation and Maintenance
PCIS	Plan Check and Inspection System
RWQCB	Los Angeles Regional Water Quality Control Board
SOR	Stormwater Observation Report
SWRCB	State Water Resources Control Board (California)
SUSMP	Standard Urban Stormwater Mitigation Plan
ULARA	Upper Los Angeles River Area
ULARWM	Upper Los Angeles River Area Watermaster
WPD	Watershed Protection Division

SECTION 1: INTRODUCTION

1.1 BACKGROUND

Urban runoff discharged from municipal storm drain systems has been identified by local, regional, and national research programs as one of the principal causes of water quality impacts in most urban areas. Urban runoff potentially contains a host of pollutants such as trash and debris, bacteria and viruses, oil and grease, sediments, nutrients, metals, and toxic chemicals.

These contaminants can adversely affect receiving and coastal waters, associated biota, and public health. An epidemiological study by the Santa Monica Bay Restoration Project was conducted to investigate possible health effects of swimming in Santa Monica Bay. Study results indicated that individuals swimming near flowing storm drain outlets have a greater risk of developing various symptoms of illnesses compared to those swimming 400 yards away from the same drains. In addition, oil and grease from parking lots, leaking petroleum or other hydrocarbon products, leachate from storage tanks, pesticides, cleaning solvents, and other toxic chemicals can contaminate stormwater and be transported downstream into water bodies and receiving waters. Fertilizer constituents from lawns and golf courses or leaking septic tanks can cause algal blooms. Disturbances of the soil from construction can allow silt to wash into storm channels and receiving waters, making them muddy, cloudy, and inhospitable to natural aquatic organisms. Heavy metals are toxic to aquatic organisms and many artificial surfaces of the urban environment such as galvanized metal, paint, or preserved wood containing metals contribute to stormwater pollution as the surfaces corrode, flake, dissolve, or decay.

Land development and construction activities significantly alter drainage patterns and contribute pollutants to urban runoff primarily through erosion and removal or change of existing natural vegetation. When homes, shops, work places, recreational areas, roads, parking lots, and structures are built, increased flows are discharged into local waterways. As the amount of impervious surface increases, water that once percolated into the soil now flows over the land surface. Accordingly, increases in impervious surfaces can increase the frequency and intensity of stormwater flows through a watershed. Flow from rainstorms and other water uses wash rapidly across the impervious landscape, scouring the surface of various kinds of urban pollutants such as automotive fluids, cleaning solvents, toxic or hazardous chemicals, detergents, sediment, metals, bacteria, pesticides, oil and grease, and food wastes. These pollutants, unfiltered and unfettered, flow through stormwater infrastructure and ultimately contaminate receiving waters.

1.2 HANDBOOK PURPOSE AND SCOPE

The purpose of this handbook is to assist developers in complying with the requirements of the Development Planning Program regulations of the City's Stormwater Program. This handbook summarizes the City's project review and permitting process, identifies stormwater mitigation measures, and references source and treatment control BMP information. It provides guidance for individuals involved in new development and redevelopment projects. The target audience for this handbook includes developers, designers, contractors, homeowners, and City staffs that are engaged in plan-checking, permitting, and inspections related to land development activities. This handbook also contains the necessary forms and worksheets required to be completed by the developer for approval.

1.3 LEGAL FRAMEWORK

With public concern growing over urban runoff and stormwater pollution, local, state, and federal agencies have devised plans to control and/or treat stormwater-related pollution before it reaches receiving waters.

The Federal Clean Water Act is the principal vehicle for control of stormwater pollution. Under the Federal Clean Water Act, each municipality throughout the nation is issued a stormwater permit through the National Pollutant Discharge Elimination System (NPDES) program. The primary goal of each permit is to stop polluted discharges from entering the storm drain system and local receiving and coastal waters. In California, the NPDES stormwater permitting program is administered by the State Water Resources Control Board (SWRCB) through its nine Regional Boards.

On Nov 8, 2012, the Los Angeles Regional Water Quality Control Board (Regional Board or RWQCB) adopted Order No. RA-2012-0175 the NPDES Stormwater Permit (Permit) for the County of Los Angeles and cities within (NPDES No. CAS004001). The Permit was issued to Los Angeles County Flood Control District, the county of Los Angeles, and 84 incorporated cities within the coastal watersheds of Los Angeles County to reduce pollutants discharged from their Municipal Separate Storm Sewer Systems (MS4) to the Maximum Extent Practicable (MEP) statutory standard. On December 28, 2012 the Order became effective.
The requirement to implement the Permit is based on federal and state statutes, including Section 402(p) of the Federal Clean Water Act, Section 6217 of the Coastal Zone Act Reauthorization Amendments (CZARA) of 1990, and the California Water Code. The Federal Clean Water Act amendments of 1987 established a framework for regulating stormwater discharges from municipal, industrial, and construction activities under the NPDES program. The primary objectives of the stormwater program requirements are to:

- Effectively prohibit non-stormwater discharges, and
- Reduce the discharge of pollutants from stormwater conveyance systems to the MEP statutory standard.

Based on the Permit issued by the Regional Board, each permittee is required to develop and implement a number of stormwater management programs designed to reduce pollutants in stormwater and urban runoff. These programs are the Public Information and Participation Program, Industrial/Commercial Facilities Program, Illicit Connections and Illicit Discharges Elimination Program, Planning and Land Development Program, Development Construction Program, Public Agency Activities Program, and the Monitoring and Reporting Program.

One of these programs, the Planning and Land Development Program, focuses on preventing pollutants that could be generated from new development and redevelopment projects from reaching stormwater conveyance systems and receiving waters. Under this program, the RWQCB developed requirements for the Standard Urban Stormwater Mitigation Plan (SUSMP) which requires specific development and redevelopment categories to manage stormwater runoff. In 2002, the City of Los Angeles implemented the SUSMP program requiring all the affected land development projects to capture or treat stormwater runoff.

A relatively recent stormwater management approach aimed at achieving this goal is the use of Low Impact Development (LID). Over the past 10 years, LID practices have received increased attention and implementation, becoming a leading practice for stormwater management. In recognition of this, recent actions by the RWQCB, SWRCB, and US EPA have prioritized the use of LID as the preferred approach to stormwater management, including for the purpose of water quality compliance.

LID is a stormwater management strategy that seeks to mitigate the impacts of increases in runoff and stormwater pollution as close to its source as possible. LID comprises a set of site design approaches and Best Management Practices (BMPs) that promote the use of natural systems for infiltration, evapotranspiration, and use of stormwater. These LID practices can effectively remove nutrients, bacteria, and metals from stormwater while reducing the volume and intensity of stormwater flows. With respect to urban development and redevelopment projects, it can be applied onsite to mimic the site's predevelopment drainage characteristics. Through the use of various infiltration techniques, LID is geared towards minimizing surface area that produces large amounts of runoff and does not allow water to infiltrate into the ground. Where infiltration is infeasible, the use of bioretention, rain gardens, vegetated rooftops, and rain barrels that will store, evaporate, detain, and/or treat runoff can be used.

In November 2011, the City adopted the Stormwater LID Ordinance (Ordinance #181899) with the stated purpose of:

- Requiring the use of LID standards and practices in future developments and redevelopments to encourage the beneficial use of rainwater and urban runoff;
- Reducing stormwater/urban runoff while improving water quality;
- Promoting rainwater harvesting;
- Reducing offsite runoff and providing increased groundwater recharge;
- Reducing erosion and hydrologic impacts downstream; and
- Enhancing the recreational and aesthetic values in our communities.

The recently adopted NPDES Permit also adopts Low Impact Development principals and requires development and redevelopment projects to incorporate similar requirements as those outlined in the City's LID Ordinance. Under the City's LID Ordinance, stormwater mitigation is required for a much larger number of development and redevelopment projects.

In addition to the LID provisions, other programs dealing with stormwater pollution include the State of California General Plan Law (CGPL) for Municipalities and the California Environmental Quality Act (CEQA). The California CGPL and CEQA provide a basis for municipalities to review and comment on all projects within their jurisdiction. Under the CGPL, municipalities are required to develop policies and regulations that guide development within the municipality. Each development project is reviewed for conformance with these policies. Under CEQA, projects are also subject to review and comment for potential adverse environmental impacts, including impacts from stormwater discharges.

1.4 PLANNING AND LAND DEVELOPMENT PROGRAM

The Planning and Land Development Program is, in order of priority, comprised of a LID Plan and/or Source Control Measures. This handbook provides guidance for compliance with the LID and requirements. Project applicants will be required to incorporate stormwater mitigation measures into their design plans and submit the plans to the City for review and approval as described in Section 2.

1.4.1 Low Impact Development Plan

Adopted by the City of Los Angeles (November 14, 2011; updated September 2015) the Stormwater LID Ordinance requires stormwater mitigation for all development and redevelopment projects that create, add, or replace 500 square feet or more of impervious area.

The Stormwater LID Ordinance applies to all development and redevelopment in the City of Los Angeles that requires building permits within the City after the ordinance effective date except for the following:

- A development or redevelopment that only creates, adds, or replaces less than 500 square feet of impervious area;
- A development or redevelopment involving only emergency construction activity required to immediately protect public health and safety;
- Infrastructure projects within the public right-of-way;
- A development or redevelopment involving only activity related to gas, water, cable, or electricity services on private property;
- A development or redevelopment involving only re-striping of permitted parking lots;
- A project involving only exterior movie and television production sets, or facades on existing developed site.

SECTION 2: PROJECT REVIEW AND PERMITTING PROCESS

2.1 PLAN APPROVAL PROCESS

The requirement to incorporate stormwater pollution control measures into the design plans of new development and redevelopment projects in order to mitigate stormwater quality impacts is implemented through the City's plan review and approval process. During the review process, the plans will be reviewed for compliance with the City's General Plans, zoning ordinances, and other applicable local ordinances and codes, including stormwater requirements. Plans and specifications will be reviewed to ensure that the appropriate BMPs are incorporated to address stormwater pollution prevention goals. The reviewer will also determine if project designs need to be modified to address stormwater pollution prevention objectives.

New development and redevelopment projects are mainly processed through Department of City Planning (DCP) and LADBS. Entitlement approvals are processed by DCP and these projects require discretionary action. Building/Grading Permit approvals are processed by LADBS.

2.1.1 Department of City Planning Process

The Permit requirements are taken into account during the CEQA process for discretionary projects. The CGPL and CEQA provide a basis for municipalities to review and comment on all projects within their jurisdiction. Under CEQA, projects are also subject to review for any adverse impacts the projects may have on the environment, including those impacts from stormwater discharges. These project types (e.g., zone variances, conditional use permits, plan amendments, site plan reviews, etc.) are considered discretionary review projects requiring review by an elected or appointed decision-making body. All applications for DCP's discretionary decisions are required to be accompanied by an environmental clearance (e.g., Categorical Exemption, Negative Declaration, Mitigated Negative Declaration, or Environmental Impact Report). When an applicant files an application for a discretionary project, DCP staff at the public counter will determine whether the project qualifies for an exemption from CEQA. If the project is not exempt and could possibly have a significant impact, the applicant files an Environmental Assessment Form (EAF).

The DCP Plan Implementation Division prepares the Initial Study and Checklist. DCP takes mandatory compliance with the LID Ordinance into account when analyzing projects' potential impacts in regards to water absorption rates, drainage patterns, urban runoff or other water quality issues. In most cases, compliance with the LID Ordinance ensures that the project will have a less than significant effect upon the environment Stormwater mitigation measures. If no significant effect upon the environment is found in this and other CEQA categories, a Negative

Declaration will be issued for the project. If mitigation measures are needed, a Mitigated Negative Declaration (MND) is issued for the project, or an Environmental Impact Report (EIR) is required. Following approval by DCP, building/grading permits are obtained from LADBS.

2.1.2 Department of Building and Safety Process

Applicants must submit design plans to LADBS personnel for review and approval prior to issuance of building/grading permits. LADBS personnel determine if the project requires stormwater mitigation measures and refer applicable projects to WPD for review and approval. LADBS issues the applicant a "Clearance Worksheet" that identifies all of the outstanding approvals from City agencies. A building/grading permit will be issued once all corrections have been completed and clearances are obtained, including for stormwater requirements.

Outlined below are some guidelines for project applicants to follow in submitting design plans for review and approval.

Step One - Submit design plans

The project applicant submits the design plans to LADBS. During the plan review process, LADBS will refer projects needing discretionary action to DCP for additional processing.

Step Two - Define the project category

The plan check engineer will review the design plans and determine if the project is subject to the LID provisions. If the project is subject to LID provisions the plan check engineer will refer the applicant to WPD.

Step Three – Issue Building and/or Grading Permit

Once all items on the "Clearances Worksheet" have been completed, including stormwater requirements imposed by WPD, the plan check engineer issues the Building and/or Grading Permit.

2.1.3 Department of Public Works / Bureau of Sanitation Process

To ensure compliance with all City Codes, it is recommended that the architect, civil engineer, plumbing engineer, and/or landscape architect coordinate at the early stage of the project design. Also WPD plan-checking staff is available for consultation regarding the applicable requirements based on the project concept.

Step One - Identify appropriate BMPs

Identify, evaluate, and incorporate into the plan documents the appropriate BMPs for the project categories listed in Section 3 of this handbook.

To assist the residents in small scale residential development/redevelopment projects (4 units or less) Appendix E contains prescriptive methods detailing BMPs to be incorporated into the design plans. The advantage of the prescriptive methods is they were developed as pre-approved designs. Use of prescriptive methods for these types of project categories will dramatically reduce plan preparation and review time.

Approval for development projects and building/grading permits will not be granted/issued until appropriate and applicable stormwater BMPs are incorporated into the project design plans. Also, a plumbing permit from LADBS will be required for certain treatment control BMPs such as grease traps, sump pumps, and clarifiers. For all projects other than small scale residential developments (4 units or less), if an infiltration BMP is chosen for treatment control, a soils report to address the feasibility of infiltration will be required to be submitted with the plan for review and approval.

Step Two– Submit LID plans to WPD for review

For first review, the following is a list of the minimum submittal requirements for Small Scale Residential Developments (4 units or less):

- One (1) set of full plans (plot/site, elevation, utility, mechanical, plumbing, architectural, and landscape plans Projects greater than 2,500 SF will need to be wet stamped by a Civil Engineer/ Architect (of Record).
- Plans must include, but not limited to, at least the following:
    - Site / Plot Plan: Location and size of BMP(s) and identify landscaping area
    - BMP sizing by tributary area.
    - Detail of BMP(s) (including invert outlet elevations).
    - Architectural Building Elevations: Identify all downspouts and location of BMP(s).
- Stormwater Summary Form (Appendix C)
- Stormwater Observation Report Form (Appendix C)
- Draft Covenant & Agreement (C&A) Form (Appendix C) with an Operation & Maintenance Plan as discussed in Section 2.3 and 8.5”x11” Plot Plan clearly showing BMP size and location(s).

For first review, the following is a list of the minimum submittal requirement for All Other Development projects:

- One (1) set of plans (plot/site, architectural building elevations, utility, mechanical, plumbing, grading and landscape plans).
- LID Report which at a minimum include, but not limited to, at least the following:
    - Existing site conditions
    - Scope of work (Proposed site conditions)
    - Discussion on feasibility screening (infiltration, capture & use, and high efficiency biofiltration)
    - Volume calculation (by tributary area)
        - If certain areas will not be treated, quantify and explain how it will be compensated in a different tributary area.
- Plans must include, but not limited to, at least the following:
    - Location of all BMPs on plans, including elevations and drainage patterns.
    - Detailed drawings of all BMPs, including model, size, and capacity
    - Stenciling note and/or detail
    - Trash enclosure location and details
    - Landscaping areas
    - Stormwater Summary Form (Appendix D)
    - Stormwater Observation Report Form (Appendix D)
  - Manufacturer's product specifications to verify that the selected BMP model can adequately handle the design volume.
    - Stormwater Summary Form (Appendix C)
    - Stormwater Observation Report Form (Appendix D)
- Draft Covenant & Agreement (C&A) Form (Appendix D) with an Operation & Maintenance Plan as discussed in Section 2.3 and 8.5"x11" Plot Plan clearly showing BMP size and location(s).
- Final plans must be wet-stamped and signed by an engineer and/or architect.

Step Three – WPD Approval

WPD plan-checking staff will review the submitted documents and identify corrections. Once all LID requirements have been met, WPD staff will stamp **three (3) sets** of the approved plans, sign the applicant's clearance worksheet, and clear the project in the LADBS plan check tracking system, known as the Plan Check and Inspection System (PCIS).

2.2 INSPECTION PROCESS

To ensure that all stormwater related BMPs are constructed and/or installed in accordance with the approved LID Plan the City requires a Stormwater Observation Report (SOR) to be submitted to the City prior to the issuance of the Certificate of Occupancy (C of O).

All projects reviewed and approved will require a SOR which shall be prepared, signed, and stamped by the engineer of record (for example, a California-licensed civil engineer, architect, or qualified professional) responsible for the approved LID Plan, certifying that:

1. They are the engineer or architect responsible for the approved LID Plan and;
2. They, or the designated staff under their responsible charge, have performed the required site visits at each significant construction stage and at completion to verify that the BMPs shown on the approved plan have been constructed and installed in accordance with the approved LID Plan.

Project applicant (or engineer/architect/contractor) is required to bring the SOR form, approved plans and photos of the BMPs taken during various construction phases to the Bureau of Sanitation's public counter. An original SOR needs to be submitted (not a photocopy). The Certificate of Occupancy will be issued by LADBS after all required clearances are obtained, including the one by WPD plan-checking staff. At that stage the project has been determined, through the normal inspection process, to be built in accordance with the approved plan, including the construction and/or installation of appropriate stormwater-related BMPs and the project has been determined to comply with all applicable codes, ordinances, and other laws.

2.3 BMP MAINTENANCE

A Covenant and Agreement (C&A) document shall be submitted, along with the design plans showing the project's stormwater measures, during the plan review and approval process, and must be signed by the legal owner or authorized agent of the property. The C&A shall also be recorded with the County Recorder. The City will withhold the grading and/or building permit for the development application until this requirement is satisfied. A sample form of the C&A is provided in Appendix D.

Maintenance is crucial for proper and continuous operation, effectiveness, and efficiency of a structural or treatment control BMP. The cost of long-term maintenance should be evaluated during the BMP selection process. By signing a maintenance form, the legal property owner affirms he/she will perform regular and long-term maintenance of all BMPs installed onsite. For residential properties where the structural or treatment control BMPs are located within a common area and will be maintained by a homeowner's association, language regarding the responsibility for maintenance must be included in the project's conditions, covenants and restrictions (CC&Rs). The C&A is bound to the property and transfers to the new owner with any subsequent sale of the property. It should be noted that an original copy of the letter of authority should be submitted for individuals signing the C&A form that are not the property owners. Attached to the C&A will be an Operation and Maintenance (O&M) Plan (see Appendix D for a sample) describing the BMP operation and maintenance procedures, employee training program and duties, operating schedule, maintenance frequency, routine service schedule, and other activities. A maintenance log shall be maintained at the facility to document all of the activities mentioned above. These documents may be inspected by the City of Los Angeles at any time and shall be made available to the City upon request.

2.4 MUNICIPAL PROJECTS

Stormwater mitigation measures are required for all projects subject to the LID Plan. City projects that will be processed through DCP and/or LADBS will be subject to the review and approval process described in Section 2.1. For other City projects that do not undergo the plan review and approval process with DCP and/or LADBS, the public agency must use this handbook to incorporate the required stormwater mitigation measures into their projects.

Public agency projects other than from the City of Los Angeles, such as State of California, County of Los Angeles, the Metropolitan Transit Authority that require a permit from LADBS are required to prepare a LID Plan and implement stormwater mitigation measures. In addition, non-roadway transportation projects that meet the thresholds for LID categories are also required to implement stormwater mitigation measures. Examples of such projects include the rail lines and stations, airport runways, and busways. Such projects must incorporate stormwater BMPs into their design plans and specifications, which must be submitted to WPD for review and approval.

SECTION 3: STORMWATER MANAGEMENT MEASURES

3.1 GENERAL REQUIREMNTS

Project applicants for all developments and redevelopments will be required to incorporate stormwater mitigation measures into their design plans and submit the plans to the City for review and approval as indicated in Section 2. Projects must incorporate the following performance measures and practices into their design plans.

(1) Lessen the water quality impacts of development by using smart growth practices such as compact development, directing development towards existing communities via infill or redevelopment, and safeguarding of environmentally sensitive areas.

(2) Minimize the adverse impacts from storm water runoff on the biological integrity of Natural Drainage Systems and the beneficial uses of water bodies in accordance with requirements under CEQA (Cal. Pub. Resources Code § 21000 et seq.).

(3) Minimize the percentage of impervious surfaces on land developments by minimizing soil compaction during construction, designing projects to minimize the impervious area footprint, and employing Low Impact Development (LID) design principles to mimic predevelopment hydrology through infiltration, evapotranspiration and rainfall harvest and use.

(4) Maintain existing riparian buffers and enhance riparian buffers when possible.

(5) Minimize pollutant loadings from impervious surfaces such as roof tops, parking lots, and roadways through the use of properly designed, technically appropriate BMPs (including Source Control BMPs such as good housekeeping practices), LID Strategies, and Treatment Control BMPs.

(6) Properly select, design and maintain LID and Hydromodification Control BMPs to address pollutants that are likely to be generated, reduce changes to pre-development hydrology, assure long-term function, and avoid the breeding of vectors.

(7) Prioritize the selection of BMPs to remove storm water pollutants, reduce storm water runoff volume, and beneficially use storm water to support an integrated approach to protecting water quality and managing water resources in the following order of preference:

(a) On-site infiltration, bioretention and/or rainfall harvest and use.

(b) On-site biofiltration, off-site ground water replenishment, and/or off-site retrofit.

3.2 LOW IMPACT DEVELOPMENT (LID) PLAN

3.2.1 SMALL SCALE RESIDENTIAL DEVELOPMENT PROJECTS (4 UNITS AND LESS)

Small scale residential projects include all projects (4 units or less) that have a land disturbance activity and add, create or replace more than 500 square feet of impervious area. The majority of these projects are not required to complete a formal hydrologic analysis or obtain approval from the Upper Los Angeles River Area (ULARA) Watermaster. The basic objectives for these projects include reducing a site's impervious surfaces, improving a site's ability to infiltrate stormwater, conserving stormwater runoff for other on-site water demand uses, and reducing negative impacts downstream.

REQUIREMENTS:

i. Development or redevelopment less than one acre and adding less than 10,000 square feet of impervious surface area shall implement adequately sized LID BMP alternatives as defined and listed in Appendix E; or

ii. Development or redevelopment that are one acre or greater of disturbed area and adding more than 10,000 square feet of impervious surface area, the development shall comply with the standards and requirements of Section 3.2.3 - All Other Developments.

iii. Development and redevelopment projects that are greater than or equal to 2,500 square feet and within an ESA, shall comply with the standards and requirements of Section 3.2.3 - All Other Developments.

BEST MANAGEMENT PRACTICES (BMPS):

The following LID BMPs have been established as prescriptive LID BMPs to be employed on a qualifying small scale project. These BMPs are presented in the form of Fact Sheets in Appendix E with the intent of providing background context and sizing requirements to facilitate a permit applicant to follow and comply with the City of Los Angeles' Stormwater LID Ordinance. Applicants may choose from one or more of the prescriptive BMPs to comply with the ordinance.

The prescriptive specific small scales BMPs include the following:

1. Rain Tanks (with optional tree planting)
2. Permeable Pavements (or Porous Pavement Systems)
3. Planter Boxes
4. Rain Gardens
5. Dry Wells

Figure 3.1 demonstrates the use of all five of these small scale residential BMPs at a residence.

Figure 3.1- Small Scale Residential BMP Schematic

3.2.2 ALL OTHER DEVELOPMENTS

Any new development or redevelopment project that does not meet the requirements of Section 3.1.2 – Small Scale Residential Development Projects, shall comply with this section.

A LID Plan shall be prepared to comply with the following:

1. Stormwater runoff will be infiltrated, evapotranspired, captured and used, and/or treated through high removal efficiency Best Management Practices onsite, through stormwater management techniques as identified in Section 4.1. The onsite stormwater management techniques must be properly sized, at a minimum, to infiltrate, evapotranspire, store for use, and/or treat through a high removal efficiency biofiltration/biotreatment system, without any stormwater runoff leaving the site to the maximum extent feasible, for at least the volume of water produced by the stormwater quality design storm event that results from:

   i. The 0.75-inch, 24-hour rain event, or

   ii. The 85th percentile 24-hour runoff event determined from the Los Angeles County 85th percentile precipitation isohyetal map, ***whichever is greater****.*

   Refer to Los Angeles County website to determine the depth of the 85^{th} percentile, 24-hour runoff event. http://dpw.lacounty.gov/wrd/hydrologygis/. See also Appendix F.

REQUIREMENTS:

All other developments (residential developments of 5 units or more and nonresidential developments) shall adhere to the following requirements:

1. For new development or where redevelopment results in an alteration of at least fifty percent or more of the impervious surfaces of an existing developed site, the entire site shall comply with the standards and requirements of Section 3.2.2; or

2. Where the redevelopment results in an alteration of less than fifty percent of the impervious surfaces of an existing developed site, only such incremental development shall comply with the standards and requirements of Section 3.2.2.

If partial or complete onsite compliance of any type is technically infeasible, the project Site and LID Plan shall at a minimum treat runoff using a structural BMP as well as mitigated the equivalent volume under the Offsite Mitigation Option. Figure 3.3 depicts the design requirements for all other developments.

3.3 HYDROMODIFICATION

New development and/or redevelopment projects that drain to natural drainage systems in a small part of the Upper Los Angeles River watershed shall control post-development peak storm water runoff discharge rates, velocities, and duration (peak flow control) to mimic pre-development hydrology and to prevent accelerated stream erosion and to protect stream habitat. These controls should be consistent with the Hydromodification Control Plan developed by the County of Los Angeles, Department of Public Works.

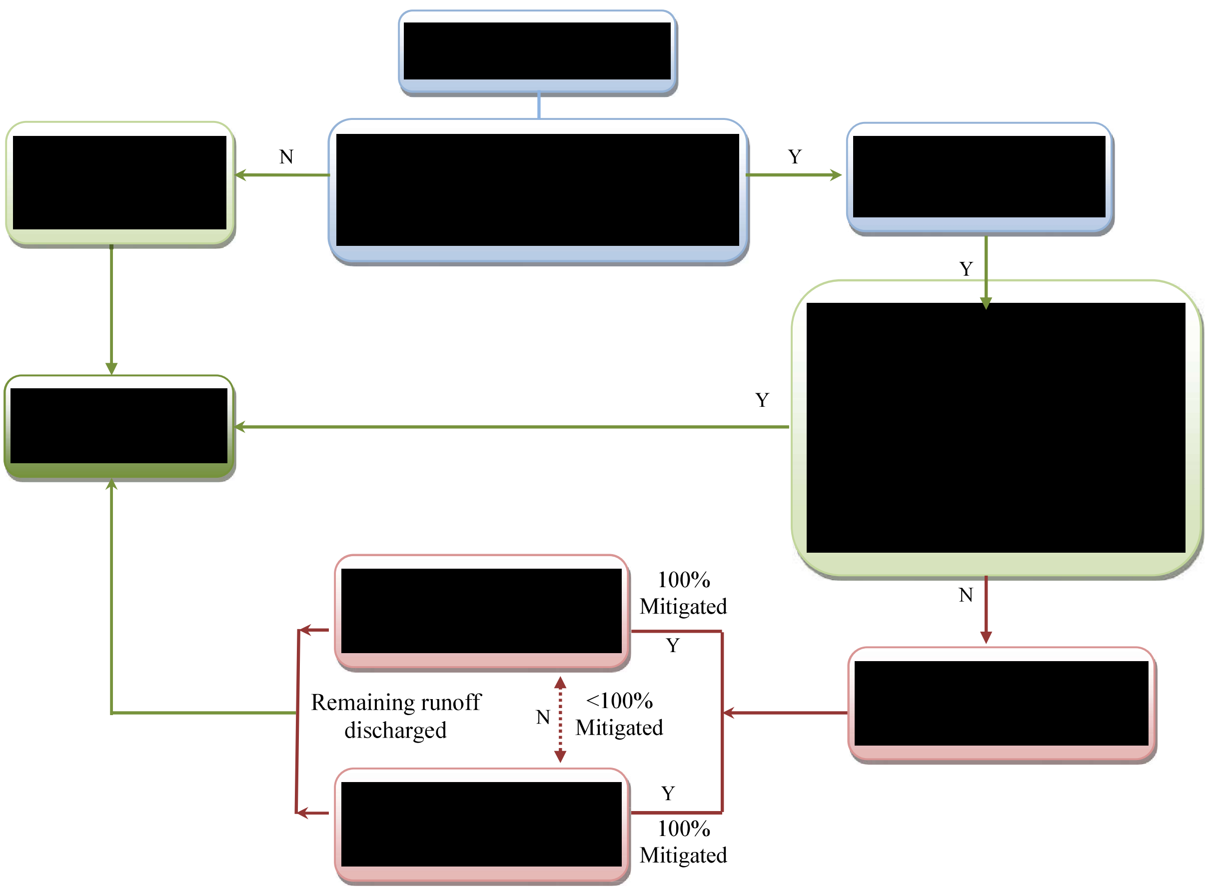
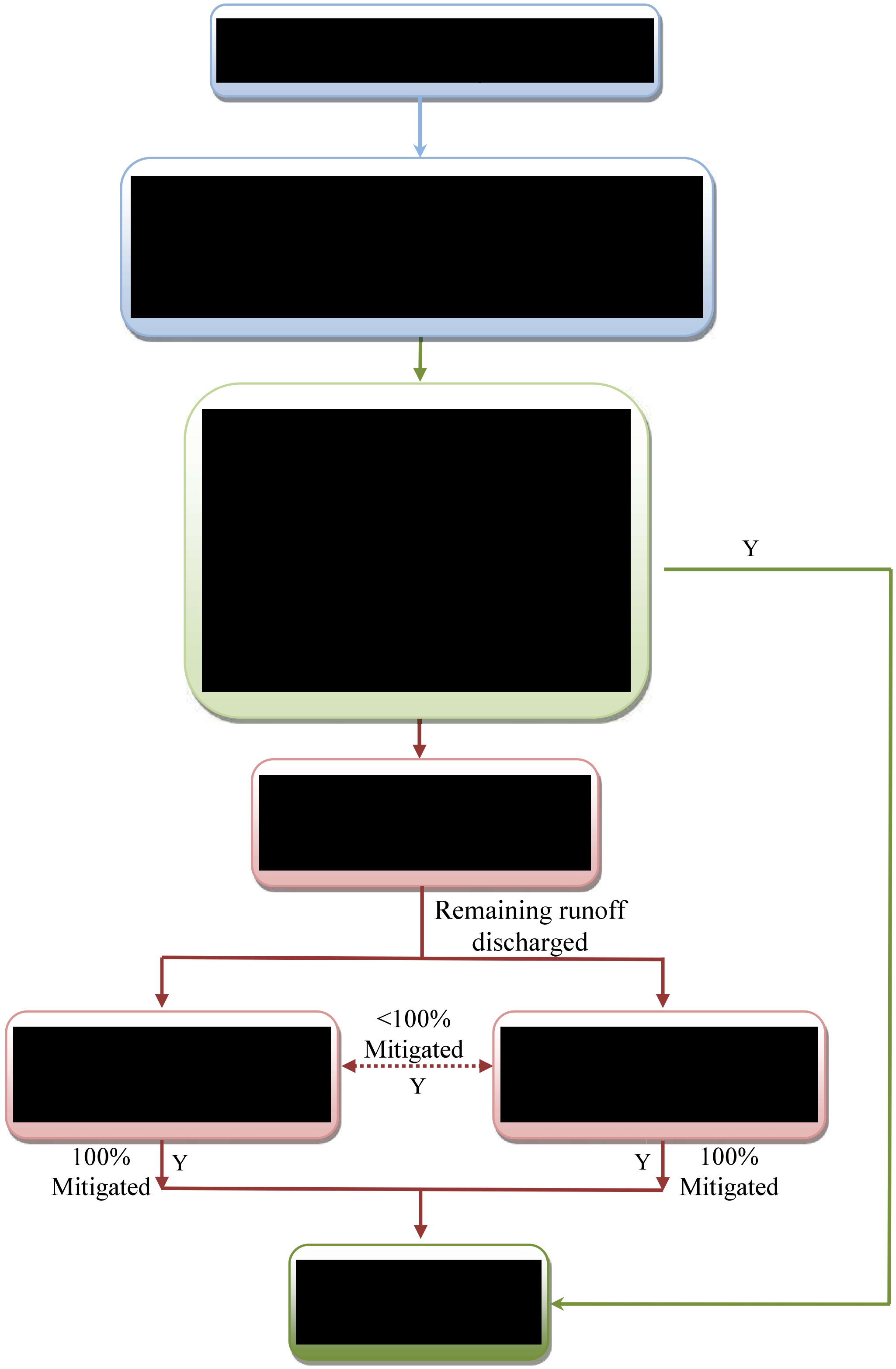


Figure3.2- Requirements for Residential Development of 4 Units or Less

Figure 3.3 – Requirements for All Other Development



3.4 SOURCE CONTROL MEASURES

Source control measures are low-technology practices designed to prevent pollutants from contacting stormwater runoff or to prevent discharge of contaminated runoff to the storm drainage system. This section addresses source control measures consisting of specific design features or elements. These control measures have been developed for specific types of sites or activities that have been identified as potential significant sources of pollutants in stormwater. When appropriate, the source control measure requirements discussed in this section shall be incorporated in the design plans in conjunction with any other operational source control measure such as good housekeeping, and employee training to optimize pollution prevention.

Some of the measures presented in this section require connection to the sanitary sewer system. Connection and discharge to the sanitary sewer system without prior approval or obtaining the required permits is prohibited. Contact the WPD staff to obtain information regarding obtaining sanitary sewer permits from the appropriate City office. Discharges of certain types of flows to the sanitary sewer system may be cost prohibitive and may not be allowed. The designer is urged to contact the appropriate City offices prior to completing site and equipment design of the facility.

Source control measures and associated design features specified for various sites and activities are summarized in Table 3.1. Fact Sheets are presented in Appendix G for each source control measure. These sheets include design criteria established by the City to ensure effective implementation of the required measures.

Table 3.1: Summary of Source Control Measure Design Features

Source Control Measure [a]	**DESIGN FEATURE OR ELEMENT**						
	Signs, placards, stencils	Surfacing (compatible, impervious)	Covers, screens	Grading/berming to prevent run-on	Grading/berming to provide secondary containment	Sanitary sewer connection	Emergency Storm Drain Seal
Storm Drain Message and Signage (S-1)	X						
Outdoor Material Storage Area Design (S-2)		X	X	X	X		X
Outdoor Trash Storage and Waste Handling Area Design (S-3)		X	X	X		X	
Outdoor Loading/Unloading Dock Area Design (S-4)		X	X	X	X		
Outdoor Repair/Maintenance Bay Design (S-5)		X	X	X	X		X
Outdoor Vehicle/Equipment/ Accessory Washing Area Design (S-6)		X	X	X	X	X	X
Fueling Area Design (S-7)		X	X	X	X		X

(a) Refer to Fact Sheets in Appendix G for detailed information and design criteria.

SECTION 4: BMP PRIORITIZATION AND SELECTION

4.1 PRIORITIZATION OF BMP SELECTION

BMPs shall be designed to manage and capture stormwater runoff. Infiltration systems are the first priority type of BMP improvements as they provide for percolation and infiltration of the stormwater into the ground, which not only reduces the volume of stormwater runoff entering the MS4, but in some cases, can contribute to groundwater recharge. If stormwater infiltration is not possible based on one or more of the project site conditions listed below, the developer shall utilize the next priority BMP.

The order of priority specified below shall apply to all projects categorized as "all other developments" in accordance with Section 3.2.2. Each type of BMP shall be implemented to the maximum extent feasible when determining the appropriate BMPs for a project.

1. Infiltration Systems
2. Stormwater Capture and Use
3. High Efficiency Biofiltration/Bioretention Systems
4. Combination of Any of the Above

For purposes of compliance with the LID requirements, and without changing the priority order of design preferences as mentioned in this section, all runoff from the water quality design storm event, as determined in Section 3.2.2 above, that has been treated through an onsite high removal efficiency biofiltration system shall be credited as equivalent to 100% infiltration regardless of the runoff leaving the site from the onsite high removal efficiency biofiltration system and that runoff volume shall not be subject to the offsite mitigation requirements.

If partial or complete onsite compliance of any type is technically infeasible, the project Site and LID Plan shall be required to maximize onsite compliance. Under this option a mechanical / hydrodynamic unit may be used. Any remaining runoff that cannot feasibly be managed onsite must be mitigated under the offsite mitigation option.

4.2 INFILTRATION FEASIBILITY SCREENING

The implementation of infiltration BMPs may be deemed infeasible at a project site due to existing site conditions. To assist in the determination of compliance feasibility, a categorical screening of specific site information shall be carried out to assess site conditions.

The first category of screening shall consist of specific site conditions which, if present at the site, would deem the specified BMP-type "feasible". The second category of screening shall consist of specific site conditions which, if present at the site, would deem the BMP-type "potentially feasible". Project locations passing this screening category may still be able to utilize the screened compliance measure, though the implementation of such a measure may require supplementary actions. The third category of screening shall consist of site conditions which, if present at the site, would deem a specified BMP-type "infeasible". This type of screening can generally be carried out in the pre-planning stage of a project. These categorical screenings must be verified by a site-specific geotechnical investigation report and/or hydrologic analysis conducted and certified by a State of California registered professional geotechnical engineer or geologist and approved by LADBS. Refer to the County of Los Angeles Department of Public Works Geotechnical and Materials Engineering Division for testing methods that can be used to determine the insitu infiltration rates[1].

To assist in the determination of site feasibility for infiltration BMPs, Table 4.1 has been created.

1 http://ladpw.org/gmed/permits/docs/policies/GS200.1.pdf

	Category 1 Screening (Feasible)	**Category 2 Screening (Potentially Feasible)**	**Category 3 Screening (Infeasible)**
Description	1. Underlying Groundwater ☐ Depth of bottom of infiltration facility to observed groundwater is > 10 ft 2. Site Soils ☐ Infiltration rate (K_{sat}) is > 0.5 in/hr ☐ Geotechnical hazards are not a potential near the site 3. Site Surroundings ☐ Buildings or structures are at least 25 ft away from the potential infiltration BMP ☐ Site is not located within the designated hillside grading area. ☐ No continuous presence of dry weather flows	1. Underlying Groundwater ☐ Depth from bottom of infiltration facility to observed groundwater is ≤ 10 ft ☐ Unconfined aquifer is present with beneficial uses that may be impaired by infiltration. Full treatment required if this is the case ☐ Groundwater is known to be polluted. Infiltration must be determined to be beneficial 2. Site Soils ☐ Infiltration rate is ≤ 0.5 in/hr but potential connectivity to higher K_{sat} soils is feasible ☐ Geotechnical hazards such as liquefaction are a potential near the site 3. Site Surroundings ☐ Buildings or structures are within 10 to 25 ft of the potential infiltration BMP ☐ High-risk areas such as service/gas stations, truck stops, and heavy industrial sites. Full treatment is required if this is the case, or high-risk areas must be separate from stormwater runoff mingling	1. Underlying Groundwater ☐ Depth from bottom of infiltration facility to observed groundwater is ≤ 5 ft ☐ Sites with soil and/or groundwater contamination** 2. Site Soils ☐ Infiltration rate is ≤ 0.3 in/hr and connectivity to higher K_{sat} soils is infeasible ☐ Building sites designated "Landslide" or "Hillside Grading" areas as specified by the Department of City Planning's Zone Information and Map Access System (ZIMAS) ☐ Geotechnical hazards such as liquefaction, collapsible soils, or expansive soils exist 3. Site Surroundings ☐ Site is located on a fill site ☐ Site is located on or within 50 feet upgradient of a steep slope (20% or greater) and has not been approved by a professional geotechnical engineer or geologist
Instructions	If all of the above boxes are checked, they shall be confirmed by a site-specific geotechnical investigation report and/or hydrologic analysis conducted and certified by a State of California registered professional geotechnical engineer or geologist, verifying that infiltration BMPs are feasible at the site*. Otherwise, proceed to Category 2 screening.	If all of the above boxes are checked, or if corresponding boxes in Category 1 are checked in combination with the above boxes, a site-specific geotechnical investigation report and/or hydrologic analysis conducted and certified by a State of California registered professional geotechnical engineer or geologist shall be carried out to approve infiltration measures*. Otherwise, proceed to Category 3 screening.	If any of the above boxes are checked, a site-specific geotechnical investigation report and/or hydrologic analysis conducted and certified by a State of California registered professional geotechnical engineer or geologist shall be submitted to prove infiltration practices are not feasible. *

Table 4.1: Infiltration Feasibility Screening

* Geotechnical Reports shall be approved by LADBS Grading Division. See Geotechnical Report Requirements herein.

** The presence of soil and/or groundwater contamination and/or the presence of existing or removed underground storage tanks shall be documented by CEQA or NEPA environmental reports, approved geotechnical reports, permits on file with the City, or a review of the State of California's Geotracker website.

Assessing Site Infiltration Feasibility

Assessing a site's potential for implementation of Low Impact Development Best Management Practices (LID BMPs) and infiltration BMPs requires both the review of existing information and the collection of site-specific measurements. Available information regarding site layout and slope, soil type, geotechnical conditions, and local groundwater conditions should be reviewed as discussed below. In addition, soil and infiltration testing is required to be conducted to determine if stormwater infiltration is feasible and to determine the appropriate design parameters for the infiltration BMP.

<u>Geotechnical Considerations and Report Requirements:</u>

As determined by the City of Los Angeles, Department of Building and Safety, Grading Division, a geotechnical report will be required for projects that will incorporate infiltration as part of the drainage system. Geotechnical reports shall be signed by a professional Geotechnical or Civil Engineer licensed in the State of California and/or a Certified Engineering Geologist.

Refer to the current Building & Safety information bulletin, "Guidelines for Stormwater Infiltration" for additional information, Appendix H.

<u>Site Conditions</u>

Slope:

The site's topography should be assessed to evaluate surface drainage, topographic high and low points, and to identify the presence of steep slopes that qualify as "Hillside Grading Areas" or "Landslide" locations, all of which have an impact on what type of infiltration BMPs will be most beneficial for a given project site. Stormwater infiltration is more effective on level or gently sloping sites. On hillsides, infiltrated runoff may seep a short distance down slope, which could cause slope instability depending on the soil or geologic conditions, or result in nuisance seepage. Figure E-1 in Appendix E provides general guidance of the City with slopes greater than 15%. Refer to LADBS Parcel Profile Report to see if project is located within one of these areas.

Soil Type and Geology:

The site's soil types and geologic conditions should be determined to evaluate the site's ability to infiltrate stormwater and to identify suitable, as well as unsuitable locations for locating infiltration-based BMPs. Areas designated as "liquefaction" should not be considered for infiltration. Refer to LADBS Parcel Profile Report to see if project is located within one of these areas.

In addition, available geologic or geotechnical reports on local geology should be reviewed to identify relevant features such as depth to bedrock, rock type, lithology, faults, and hydrostratigraphic or confining units. These geologic investigations may also identify shallow water tables and past groundwater issues that are important for BMP design (see below). Figure E-5 in Appendix E provides general guidance identifying parts of the City that have well-draining soil conditions.

Groundwater Considerations:

The depth to groundwater beneath the project during the wet season may preclude infiltration. A minimum of five feet of separation to the seasonal (December through April) high ground water level and mounded groundwater level is required. For projects located in the Upper Los Angeles River Area, ten feet of separation is required.

Infiltration on sites with contaminated soils or groundwater that could be mobilized or exacerbated by infiltration is not allowed, unless a site-specific analysis determines the infiltration would be beneficial. A site-specific analysis may be conducted where groundwater pollutant mobilization is a concern to allow for infiltration-based BMPs. Areas with known groundwater impacts include sites listed by the RWQCB's Leaking Underground Storage Tanks (LUST) program and Site Cleanup Program (SCP). The California State Water Resources Control Board maintains a database of registered contaminated sites through their 'Geotracker' Program. Registered contaminated sites can be identified in the project vicinity when the site address is typed into the "map cleanup sites" field. Mobilization of groundwater contaminants may also be of concern where contamination from natural sources is prevalent (e.g., marine sediments, selenium rich groundwater, to the extent that data is available). Figure E-3 in Appendix E provides general guidance identifying parts of the City that may be in areas of concern.

Upper Los Angeles River Watermaster Requirements:

Infiltration projects located in the Upper Los Angeles River Area (ULARA) must comply with the requirements of the ULARA Watermaster[2]. Boundaries, requirements and approval process of the ULARWM are shown in Appendix I.

Managing Offsite Drainage:

Locations and sources of offsite run-on to the site must be identified early in the design process. Offsite drainage must be considered when determining appropriate BMPs for the site so that the drainage can be managed. By identifying the locations and sources of offsite drainage, the volume of water running onto the site may be estimated and factored into the siting and sizing of onsite BMPs. Vegetated swales or storm drains may be used to intercept,

2 http://www.ularawatermaster.com/

divert, and convey offsite drainage through or around a site to prevent flooding or erosion that might otherwise occur.

4.3 CAPTURE AND USE FEASIBILITY SCREENING

Capture and use, commonly referred to as rainwater harvesting, collects and stores stormwater for later use, thereby offsetting potable water demand and reducing pollutant loading to the storm drain system, therefore sufficient landscaped area with appropriate water demand is needed for the captured runoff to be directed to. Partial capture and use can also be achieved as part of a treatment train by directing the overflow to a bioretention system to provide additional volume reduction and water quality treatment in instances where the quantity of runoff from a storm event exceeds the volume of the collection tank.

In the City of Los Angeles, the use of collected stormwater will primarily be limited to irrigation of landscaped surfaces. However, as new guidelines and guidance becomes available the potential for other uses of collected stormwater will be considered. Capture and use BMPs that are designed with the intent to use captured stormwater for indoor or consumptive purposes will be reviewed on a case-by-case basis to ensure that all treatment, plumbing, and Building and Safety codes are met.

Assessing Site Capture and Use Feasibility

As with infiltration BMPs, assessing a site's potential for implementation of capture and use BMPs requires both the review of existing information and the collection of site-specific measurements. Available information regarding the site's landscaped area should be reviewed as discussed below. In addition, human health concerns should be prioritized, particularly with regards to vector control issues arising from the addition of standing water on site.

Landscaped Area Assessment

To determine a site's feasibility for capture and use BMPs, the Estimated Total Water Usage (ETWU) for irrigation from October 1 – April 30 must be greater than or equal to the volume of water produced by the stormwater quality design storm event (i.e. $ETWU_{7\text{ - month}} \geq Vm$).

Los Angeles County Department of Public Health Requirements

Projects that are implementing rainfall or urban runoff capture and distribution systems must obtain approval from the County of Los Angeles, Department of Public Health. See Appendix J for the Policy and Operation Manual.

Vector Control Considerations

A vector is any insect, arthropod, rodent, or other animal that is capable of harboring or transmitting a causative agent of human disease. In the City of Los Angeles, the most significant vector population related to stormwater is mosquitoes.

Vector sources occur where conditions provide habitat suitable for breeding, particularly any source of standing water. This means that stormwater BMPs, especially those of the capture and use type, can be breeding grounds for mosquitoes and other vectors resulting in adverse public health effects related to vectors and disease transmission. Because of this, efforts shall be made to design capture and use BMPs that do not facilitate the breeding of vectors. Vectors should be considered during the preparation of stormwater management and maintenance plans and during preconstruction planning to avoid creating possible public health hazards.

Oversized capture and use BMPs designed to hold captured stormwater for longer than 72 hour periods will require additional treatment such as filtration or disinfection to protect the collection tanks from fouling, to prevent the breeding of vectors, and/or to improve the quality of water for reuse applications. These BMPs must have appropriate vector control measures incorporated into the design of the system to exclude vector access and breeding (i.e., observation access for vector inspection and treatment). They should be approved by the County of Los Angeles Department of Public Health. These scenarios will be reviewed on a case-by-case basis.

If vector breeding is taking place at a site as a result of contained stormwater or inadequately maintained BMPs, the Greater Los Angeles County Vector Control District has the ability to fine site owners for violating the California Health and Safety Code (Section 2060 – 2067).

4.4 INFILTRATION BMPS

Infiltration refers to the physcial process of percolation, or downward seepage, of water through a soil's pore space. As water infiltrates, the natural filtration, adsorption, and biological decomposition properties of soils, plant roots, and micro-organisms work to remove pollutants prior to the water recharging the underlying groundwater. Infiltration BMPs include infiltration basins, infiltration trenches, infiltration galleries, bioretention without an underdrain, dry wells, and permeable pavement. Infiltration can provide multiple benefits, including pollutant removal, peak flow control, groundwater recharge, and flood control. However, conditions that can limit the use of infiltration include soil properties, proximity to building foundations and other infrastructure, geotechnical hazards (e.g., liquefaction, landslides), and potential adverse impacts on groundwater quality (e.g industrial pollutant source areas, contaminated soils, groundwater plumes)[3]. To ensure that infiltration would be physcially feasible and desireable (i.e., not have adverse impacts), a categorical screening of site feasibility criteria must be completed prior to the use of infiltration BMPs following the guidelines presented in Section 4.2.

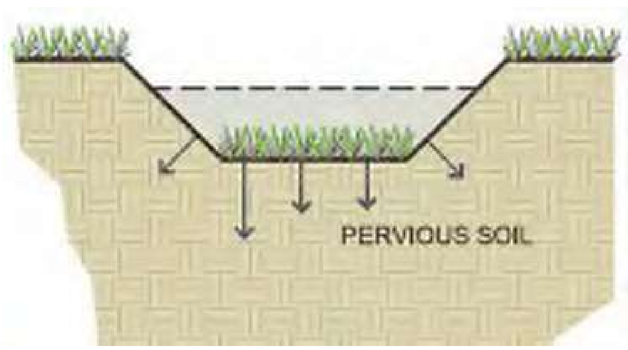
4.4.1 Infiltration BMP Types

Surface Infiltration BMPs

These BMPs rely on infiltration in a predominantly vertical (downward) direction and depend primarily on soil characteristics in the upper soil layers. These infiltration BMPs include:

Infiltration Basins

An infiltration basin consists of an earthen basin constructed in naturally pervious soils with a flat bottom typically vegetated with dry-land grasses or irrigated turf grass. An infiltration basin functions by retaining the design runoff volume in the basin and allowing the retained runoff to percolate into the underlying native soils over a specified period of time.



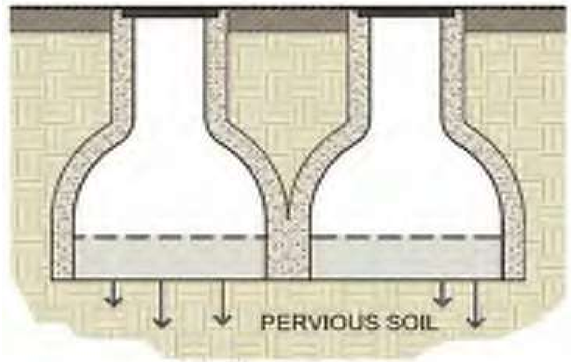
Infiltration Trenches

Infiltration trenches, which are similar to basins, are long, narrow, gravel-filled trenches, often vegetated, that infiltrate stormwater runoff from small drainage areas. Infiltration trenches may include a shallow depression at the surface, but the majority of runoff is stored in the void space within the gravel and infiltrates through the sides and bottom of the trench.

3 Depending on the design of the infiltration practice, Federal Underground Injection Control (UIC) Rules (40 CFR 144) may apply, which may further restrict the use of infiltration facilities in some locations.

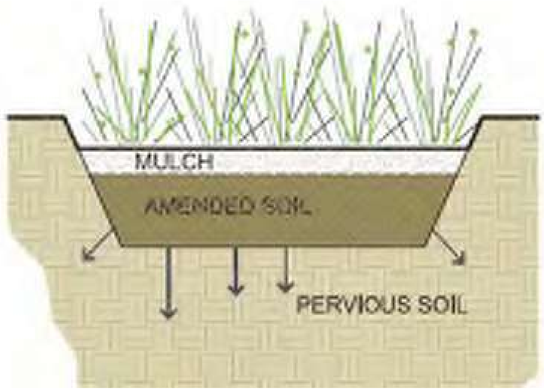
Infiltration Galleries

Infiltration galleries are open-bottom, subsurface vaults that store and infiltrate stormwater. A number of vendors offer prefabricated, modular infiltration galleries that provide subsurface storage and allow for infiltration. Infiltration galleries come in a variety of material types, shapes and sizes.



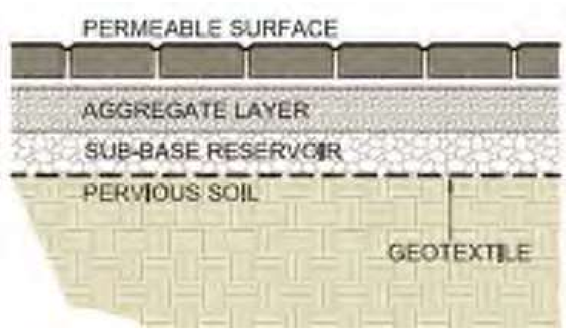
Bioretention

Bioretention stormwater treatment facilities are landscaped shallow depressions that capture and filter stormwater runoff. These facilities function as a soil and plant-based filtration device that removes pollutants through a variety of physical, biological, and chemical treatment processes. The facilities normally consist of a ponding area, mulch layer, planting soils, plantings, and, optionally, a subsurface gravel reservoir layer.



Permeable Pavements

Permeable (or pervious) pavements contain small voids that allow water to pass through to a stone base. They come in a variety of forms; they may be a modular paving system (concrete pavers, modular grass or gravel grids) or poured-in-place pavement (porous concrete, permeable asphalt). All permeable pavements with a stone reservoir base treat stormwater and remove sediments and metals to some degree by allowing stormwater to percolate through the pavement and enter the soil below.

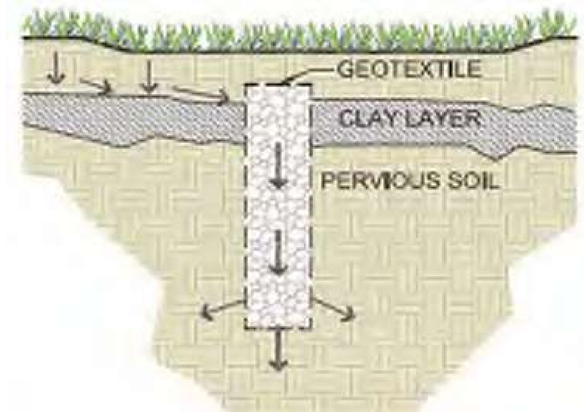


Multi-Directional Infiltration BMPs

These BMPs take advantage of the hydraulic conductivities (K_{sat}) of multiple soil strata and infiltration in multiple directions. They may be especially useful at locations where low K_{sat} values are present near the surface and soils with higher permeabilities exist beneath. A Multi-Directional Infiltration BMP may be implemented to infiltrate water at these lower soil layers, thus allowing infiltration to occur at sites that otherwise would be infeasible. These infiltration BMPs typically have smaller footprints and include, but are not limited to:

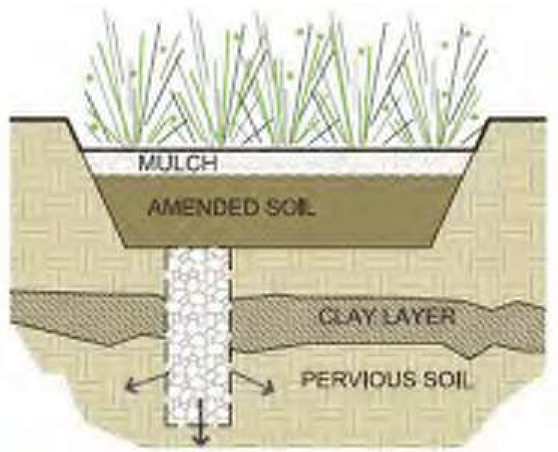
Dry Wells

A dry well is defined as an excavated, bored, drilled, or driven shaft or hole whose depth is greater than its width. Drywells are similar to infiltration trenches in their design and function, as they are designed to temporarily store and infiltrate runoff, primarily from rooftops or other impervious areas with low pollutant loading. A dry well may be either a drilled borehole filled with aggregate or a prefabricated storage chamber or pipe segment.



Hybrid Bioretention/Dry Wells

A bioretention facility with dry wells is useful in areas with low surface-level hydraulic conductivities that would normally deem a bioretention BMP infeasible but have higher levels of permeability in deeper strata. By incorporating drywells underneath the bioretention facility, water is able to be infiltrated at deeper soil layers that are suitable for infiltration, if present. This hybrid BMP combines the aesthetic and filtration qualities of a bioretention facility with the enhanced infiltration capabilities of a dry well.



4.4.2 Siting Requirements and Opportunity Criteria

Drainage areas implementing infiltration BMPs must pass the Category 1 or Category 2 Screening in accordance with the siting requirements set forth in Table 4.1. This screening process must be approved by a site-specific geotechnical investigation report and/or hydrologic analysis conducted and certified by a State of California registered professional geotechnical engineer or geologist.

Additionally, drainage areas that will result in high sediment loading rates to the infiltration facility shall require pretreatment to reduce sediment loads and avoid system clogging. Examples of appropriate pretreatment may include: sedimentation/settling basins, baffle boxes, hydrodynamic separators, media filters, vegetated swales, or filter strips.

4.4.3 Calculating Size Requirements for Infiltration BMPs

The main challenge associated with infiltration BMPs is preventing system clogging and subsequent infiltration inhibition. In addition, infiltration BMPs must be designed to drain in a reasonable period of time so that storage capacity is available for subsequent storms and so that standing water does not result in vector risks or plant mortality. Infiltration BMPs should be designed according to the requirements listed in Table 4.2 and outlined in the text following.

Infiltration facilities must be sized to completely infiltrate the design capture volume within 48 hours. Steps for the simple sizing method are provided below.

Step 1: Calculate the Design Volume

Infiltration facilities shall be sized to capture and infiltrate the design capture volume (V_{design}) of water produced by the stormwater quality design storm event as determined in section 3.2.2

$$V_{design}\text{ (cu ft)} = 0.0625\text{ (ft)} \times \text{Catchment Area (sq ft)}$$

or

$$V_{design}\text{ (cu ft)} = \text{depth of from }85^{th}\text{ percentile (ft)}^{4} \times \text{Catchment Area (sq ft)}$$

Where:

Catchment Area = (Impervious Area x 0.9) + [(Pervious Area + Undeveloped Area) x 0.1]

For catchment areas given in acres, multiply the above equation by 43,560 sq. ft./acre.

4 Refer to Los Angeles County website to determine the depth of the 85^{th} percentile, 24-hour runoff event. http://dpw.lacounty.gov/wrd/hydrologygis/. See also Appendix F.

Table 4.2: Infiltration BMP Design Criteria

Design Parameter	Unit	Basins and Trenches	Galleries	Bioinfiltration	Permeable Pavement	Dry Well[d]	Hybrid Bioretention/ Dry Well
Design Capture Volume, $V_{capture}$	cubic feet	Volume of water produced by the stormwater quality design storm event as determined in section 3.2.2 0.0625 (ft) x Catchment Area (sq. ft.)[a] *or* *= depth of from 85th percentile (ft) x Catchment Area (sq ft)*					
Design Drawdown Time	hrs	At surface = 48 Below grade = up to 96					
Setbacks and Elevations	-	In accordance with the Infiltration Feasibility Criteria, Section 4.2 and current Stormwater Informational Bulletien.					
Pretreatment	-	Appropriate Treatment Control Measure shall be provided as pretreatment for all tributary surfaces.					
Hydraulic Conductivity, $K_{sat,measured}$	in/hr	Measured hydraulic conductivity at the location of the proposed BMP at the depth of the proposed infiltrating surface (or effective infiltration rate where multi directional infiltration is occurring).					
Factor of Safety, FS[b]	-	3					
Facility geometry	-	Basin: Bottom slope ≤ 3%; side slope ≤ 3:1 (H:V)	Flat bottom slope	Bottom slope ≤ 3%; side slope ≤ 3:1 (H:V)	Pavement slope ≤ 5%; If ≥ 2%, area shall be terraced	Typical 18 – 36 inch diameter; flat bottom slope	Bioretention: Bottom slope ≤ 3%; side slope ≤ 3:1 (H:V) Drywell: flat bottom
Ponding Depth	inch	18 (max)[c]	-	18 (max)[c]	-	-	18 (max)[c]
Media Depth	feet	2 (min) 8 (max)	-	2 (min) 8 (max)	2 (min) 8 (max)	-	2 (min) 8 (max)
Washed gravel media diameter	inch	1 – 3	-	-	1 - 2	3/8 – 1	3/8 - 1
Inlet erosion control	-	Energy dissipater to reduce velocity					
Overflow device	-	Required if system is on-line and does not have an upstream bypass structure. Shall be designed to handle the peak storm flow in accordance with the Building and Safety code and requirements					

a: Catchment area = (impervious area x 0.9) + [(pervious area + undeveloped area) x 0.1]

b: Listed FS values to be used only if soil infiltration / percolation test was performed and a detailed geotechnical report from a professional geotechnical engineer or engineering geologist is provided. A FS of 6 will be assigned if only a boring was done.

c: Ponding depth may vary for galleries (which have a storage depth) and may be different from one vendor to another.

d. City of Los Angeles does not require the reduction factor to be applied to measured percolation rate.

Step 2: Determine the Design Infiltration Rate

The infiltration rate will decline between maintenance cycles as the surface becomes clogged with particulates and debris. Monitoring of actual facility performance has shown that the full-scale infiltration rate is far lower than the rate measured by small-scale testing. It is important that adequate conservatism is incorporated in the sizing of facilities depending on a site's infiltration rate and expected surface loading. Where applicable, the measured infiltration rate discussed here is the infiltration rate of the underlying soils and not the infiltration rate of the filter media bed or engineered surface soils.Facility maintenance is required to maintain the infiltration rate for the life of the project. Infiltration rates used for design must be divided by the appropriate factors of safety.

$$K_{sat,design} = K_{sat,measured}/FS$$

Where:

FS = Infiltration factor of safety, in accordance with Table 4.2

Measured infiltration rates shall be determined by in-ground, site specific infiltration tests or can be based on laboratory tests conducted on soil samples collected during the exploratory work for a site-specific geotechnical report.

Step 3: Calculate the BMP Surface Area

Determine the size of the required infiltrating surface by assuming the design capture volume will fill the available ponding depth plus the void spaces of the gravel fill (normally about 30 - 40% [5]) or amended soil (normally about 20 – 30%).

Determine the minimum infiltrating surface area necessary to infiltrate the design volume:

$$A_{min} = (V_{design} \times 12 \text{ in/ft}) / (T \times K_{sat,\ design})$$

Where:

A_{min} = Minimum infiltrating surface area (ft^2)

T = Drawdown time (hours), 48 hours

The calculated minimum BMP surface area only considers the surface area of the BMP where infiltration can occur. For dry wells, the calculated surface area is the total surface area of the well lying in soils with $K_{sat,measured}$ values > 0.3 in/hr. In other words, the portion of the dry well that extends through impermeable layers should not be considered part of the infiltrating area. For the hybrid bioretention/dry well BMP design, the calculated BMP surface area applies to the combined surface area of the bioretention facility and the infiltrating portion of the underlying dry well(s).

5 Terzaghi and Peck stated that in the densest possible arrangement of cohesionless spheres, the porosity is equivalent to 26%; in the loosest possible arrangement, the porosity is equal to 47% (Terzaghi K. and Peck R. Soil Mechanics in Engineering Practice. 2nd ed. New York: John Wiley and Sons; 1967).

For infiltration basins, the surface area should be calculated as the surface area at mid-ponding depth. For infiltration trenches, the surface area should be calculated at the bottom of the trench.

Note that A_{min} represents the minimum calculated surface area. It is up to the discretion of the developer if A_{min} will be exceeded to allow for less media storage.

*Step 4: Calculate the Total Storage Volume**

Determine the storage volume of the infiltration unit to be filled with media for capturing the design capture volume.

$$V_{storage} = V_{design} / n$$

Where:

$V_{storage}$ = Minimum media storage of the infiltration facility (ft^3)

n = void ratio (use 0.40 for gap graded gravel)

* Note: Dry wells with gravel fill may not store the entire design volume; additional storage unit(s) to capture the remaining design volume may be required upstream of the dry well.

Step 5: Calculate the Media Storage Depth

Determine the depth of the infiltration unit to be filled with media for capturing the design capture volume. The depth shall not exceed 8 feet – except for dry well(s).

$$D_{media} = V_{storage} / A_{min}$$

Where:

D_{media} = Minimum media storage depth of the infiltration facility (ft)

If D_{media} is calculated as greater than 8 feet, the design infiltration area (A_{design}) shall be increased and the depth of media shall be recalculated until it is less than 8 feet.

Many project developers may elect to increase the design infiltration area such that $A_{design} > A_{min}$. This is especially feasible where infiltration rates are relatively high (leading to a low A_{min} value). The depth of media (D_{media}) should be calculated using the actual design area in Step 5 above. For projects with designed infiltration areas significantly higher than A_{min}, it may be feasible to have no media storage (i.e. D_{media} = 0 ft). For this to apply, the following condition must be met:

$$A_{design} \geq (V_{design} \times 12\text{in/ft}) / (K_{sat,design} \times T)$$

Infiltration Sizing Example

Given: 30,000 ft^2 apartment complex (including parking) with 10,000 ft^2 of landscaped area. An infiltration test has resulted in a $K_{sat,measured}$ value of 1.0 in/hr; Factor of Safety = 3. Design an infiltration trench meeting the sizing requirements. Assume the trench is full of gap-graded gravel with a void ratio of 0.4.

1) Determine V_{design}

   85th Percentile storm event = 1.1-inch (0.0916 ft) > 0.75-inch (0.0625 ft)

   Therefore, use 1.1-inch (0.0916 ft)

   Catchment Area = (30,000ft^2 x 0.9) + [(10,000 ft^2) x 0.1] = 28,000 ft^2
   $\boldsymbol{V_{design}}$ = 0.0916 ft * 28,000 ft^2 = **2,565 ft^3**

2) Determine $K_{sat,design}$

   $\boldsymbol{K_{sat,design}}$ = $k_{sat,\ measured}$ / FS = (1 in/hr) / 3 = **0.333 in/hr**

3) Determine A_{min}

   $\boldsymbol{A_{min}} = (V_{design} \times 12 / (T \times k_{sat,\ design})$
   = (2,565ft^3 x 12 in/ft)/(48hrs x 0.333 in/hr) = ***1,925 ft^2***

4) Determine $V_{storage}$

   $\boldsymbol{V_{storage}} = V_{design}$ / n = 1,750 / 0.4 = **6,412ft^3**

5) Determine D_{media}

   $\boldsymbol{D_{media}} = V_{storage} / A_{min}$ = 6,412 ft^3 / 1,925 ft^2 = ***3.33 ft***

The trench should therefore be designed with a minimum of 1,925ft^2 of infiltrating surface area. At this minimum surface area, the gravel media depth should be at least 3.33 ft.

4.4.4 Design Criteria and Requirements

Unless specifically stated, the following criteria and requirements listed below are required for the implementation of all infiltration BMPs. Provisions not met must be approved by the City of Los Angeles.

Permeable Pavement Application
Los Angeles World Airports Parking

- Infiltration BMPs have been designed and constructed to promote uniform ponding and infiltration.
- Where necessary, a sediment forebay or separate pretreatment unit (e.g. vegetated swale, filter strip, hydrodynamic device, etc.) is located between the inlet and infiltration BMP. The sediment forebay has a volume greater than or equal to 25% of the total design volume.
- Sediment forebay has a minimum length to width ratio of 2:1 and is designed to conduct flow to the infiltration BMP.
- Any embankment slopes (interior and exterior) are not steeper than 3:1 (H:V) unless approved by the City of Los Angeles.
- The bottom of the infiltration bed is native soil and has been over-excavated to at least one foot in depth. It is recommended that the excavated soil be amended with 2 – 4 inches of coarse sand before being replaced uniformly without compaction.
- The hydraulic conductivity (Ksat) of the subsurface layers is sufficient to ensure the maximum drawdown time of 48 hours.
- Where Ksat values are greater than 2.4 in/hr, pretreatment is provided to address pollutants of concern prior to infiltration to protect groundwater quality; pretreatment may be considered to be addressed in the amended media or sand layers within the BMP if provided.
- Provided overflow safely conveys flows to the downstream stormwater conveyance system, an additional BMP, or an alternatively acceptable discharge point.
- Where the infiltration system is placed underground, an observation well is provided for inspection/mainteance purposes.
- Porous pavement facilities consist of various layers of material. The top layer consists of either asphalt or concrete with a percentage of voids of at least 15%. This layer is followed by a washed stone reservoir layer or a thick layer of washed aggregate with 25-

35% voids. Two transition layers are also present. The depth of each layer and the specific materials used shall be determined by a licensed civil engineer.

- Dry wells shall be filled with 3/4 – 1 inch washed crushed rock, recycled concrete aggregate, or open-graded gravel (i.e. gravel with a small percentage of small particles). If a perforated pipe has been installed in the well, perforations are 3/8" and are smaller than the fill gravel. A woven geotextile shall be placed over the top of the drywell to prevent sediment clogging.

4.4.5 Soil and Vegetation Requirements

Soil and vegetation to be incorporated in infiltration facilities shall be selected by a licensed landscape architect. In general, drought and flood resistant plant species native to California should be selected when possible. Soil media should be selected to not restrict performance requirements. Selected soils shall therefore have a higher hydraulic conductivity than the underlying soil, shall be able to support the selected plant palette, and shall be graded to provide adequate filtration as to not clog underlying soils.

4.4.6 Construction Requirements

To preserve and avoid the loss of infiltration capacity, the following construction guidelines shall be adhered to:

- The entire area draining to the infiltration facility is stabilized before construction of the infiltration facility begins, or a diversion berm is placed around the perimeter of the infiltration site to prevent sediment entrance during construction.

Underground Infiltration Units
Lowe's, Pacoima

- Infiltration BMPs shall not be used as sediment control facilities during construction.
- Compaction of the subgrade with vehicles and/or equipment is minimized. If the use of heavy equipment on the base of the facility cannot be avoided, the infiltrative capacity shall be restored by tilling or aerating prior to placing the infiltrative bed.
- Where pervious pavement is to be installed, installation of the pavement shall be scheduled as the the last installation at a development site. Vehicular traffic is prohibited for at least 2 days following installation. Site materials shall not stored on pervious pavement.

4.4.7 Operations and Maintenance

- Frequent inspections of the infiltration facilities shall occur to ensure that surface ponding infiltrates into the subsurface completely within the design drawdown time following storms. If vector breeding is taking place at a site as a result of contained stormwater or inadequately maintained BMPs, the Greater Los Angeles County Vector Control District has the ability to fine site owners for violating the California Health and Safety Code (Section 2060 – 2067).
- Regular inspections shall take place to ensure that the pretreatment sediment removal BMP/forebay is working efficiently. Sediment buildup exceeding 50% of the forebay sediment storage capacity shall be removed.
- The infiltration facility shall be maintained to prevent clogging. Maintenance activities include checking for debris/sediment accumulation and removal of such debris.
- Facility soil (if applicable) shall be maintained. Flow entrances, ponding areas, and surface overflow areas will be inspected for erosion periodically. Soil and/or mulch will be replaced as necessary to maintain the long-term design infiltration rate for the life of the project.
- Site vegetation shall be maintained as frequently as necessary to maintain the aesthetic apperance of the site as well as the filtration capabilities (where applicable). This includes the removal of fallen, dead, and/or invasive plants, watering as necessary, and the replanting and/or reseeding of vegetation for reestablishment as necessary.
- Pervious pavement areas that are damaged or clogged shall be replaced/repaired per manufacture's recommendation as needed.
- Follow all propritery operation and maintenance requirements

4.5 CAPTURE AND USE BMPS

Capture and Use refers to a specific type of BMP that operates by capturing stormwater runoff and holding it for efficient use at a later time. On a commercial or industrial scale, capture and use BMPs are typically synonomous with cisterns, which can be implemented both above and below ground. Cisterns are sized to store a specified volume of water with no surface discharge until this volume is exceeded. The primary use of captured runoff is for subsurface drip irrigation purposes. The temporary storage of roof runoff reduces the runoff volume from a property and may reduce the peak runoff velocity for small, frequently occurring storms. In addition, by reducing the amount of stormwater runoff that flows overland into a stormwater conveyance system, less pollutants are transported through the conveyance system into local streams and the ocean. The onsite use of the harvested water for non-potable domestic purposes conserves City-supplied potable water and, where directed to unpaved surfaces, can recharge groundwater in local aquifers.

Underground Cistern
Taylor Yard

4.5.1 Siting Requirements and Opportunity Criteria

Drainage areas implementing capture and use BMPs must pass the feasibility screening in accordance with the siting requirements set forth in Section 4.3. This screening process must be approved by a site-specific geotechnical investigation report and/or hydrologic analysis conducted and certified by a State of California registered professional civil engineer, geotechnical engineer, geologist, or other qualified professional.

Capture and use BMPs designed for these extended holding times will require additional treatment such as filtration or disinfection to protect the collection tanks from fouling, to prevent the breeding of vectors, and/or to improve the quality of water for reuse applications. These scenarios will be reviewed on a case-by-case basis.

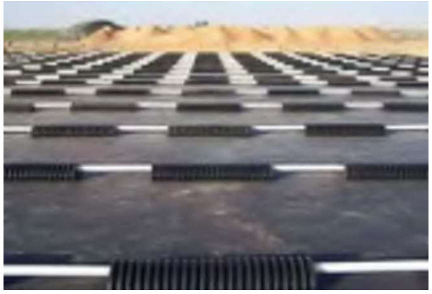
4.5.2 Irrigation / Dispersial of Captured Stormwater

A developer is required to hold harvested stormwater for the purpose of irrigation during dry periods. Calculations in line with the California Department of Water Resources Model Water Efficent Landscape Ordiance AB 1881 (also refer to City of Los Angles Irrigation Guidelines[6]) shall be provided. Captured stormwater should be used to offset the potable irrigation demand that would occur during the rain season (Oct 1 – Apr 31, 7 months). If the volume of captured

6 City of Los Angles Irrigation Guidelines: http://cityplanning.lacity.org/Forms_Procedures/2405.pdf

stormwater exceeds the Estimated Total Water Use for the rain season ($ETWU_7$),excess stormwater shall, at a minimum establish a schedule to release captured stormwater over landscaping.

4.5.3 Design Criteria and Requirements



Capture & Use

- Unless specifically stated, the following criteria and requirements listed below are required for the implementation of all capture and use BMPs. Provisions not met must be approved by the City of Los Angeles.
- Fertilizers, pesticides, or herbicides on landscaped areas shall be minmized.
- Above-ground cisterns are secured in place and designed to meet seismic requiremnts for tanks.
- Overflow outlet is provided upstream of the tank inlet and is designed to disperse overflow onsite. Dispersial and overflow must be through an approved landscape areas where erosion or suspension of sediment is minimized, or through a high flow biotreatment BMP. Overflow from the tank into the storm drain system is not allowed.
- For landscape applications, a subsurface drip irrigation system, a pop up, or other approved irrigation system, has been aproved and installed to adequately discharge the captured water[7].
- If a pumping system is used, a reliable pump capable of delivering 100% of the design capacity is provided. Pump is accessible for maintenance. Pump has been selected to operate within 20% of its best operating efficiency. A high/low-pressure pump shut off system is installed in the pump discharge piping in case of line clogging or breaking.
- If an automated harvesting control system is used, it is complete with a rainfall or soil moisture sensor. The automated system has been programmed to not allow for continuous application on any area for more than 2-hours.
- Dispersion is directed so as not to knowingly cause geotechnical hazards related to slope stability or triggering expansive (clayey) soil movement.
- Cisterns do not allow UV light penetration to prevent algae growth.
- Cistern placement allows easy access for regular maintenance. If cistern is undergrond, manhole shall be accessible, operational, and secure.

7 If alternative distribution systems (such as spray irrigation) are approved, the City will establish guidelines to implement these new systems.

- Refer to County of Los Angeles , Department of Health Services for additional guidelines and requiremnets (Appendix J).
- Provide observation access for vector inspection and treatment.

4.5.4 Operations and Maintenance

- Cistern components, including spigots, downspouts, and inlets will be inspected 4 times annually to ensure proper functionality. Parts will be repaired or replaced as needed.
- Cisterns and their components will be cleaned as necessary to prevent algae growth and the breeding of vectors.
- Dispersion areas will be maintained to remove trash and debris, loose vegetation, and rehabilitate any areas of bare soil.
- Effective energy dissipation and uniform flow spreading methods will be employed to prevent erosion and facilitate dispersion.
- Cisterns will be emptied as necessary to prevent vector breeding, unless exclusion devices are implemented to prevent vector access. If vector breeding is taking place at a site as a result of contained stormwater or inadequately maintained BMPs, the Greater Los Angeles County Vector Control District has the ability to fine site owners for violating the California Health and Safety Code (Section 2060 – 2067).

4.6 HIGH EFFICENCY BIOFILTRATION BMPS

Projects that have demonstrated they cannot manage 100% of the water quality design volume onsite through infiltration and/or capture and use BMPs may manage the remaining volume through the use of a high removal efficiency biofiltration/biotreatment BMP. A high removal efficiency biofiltration/biotreatment BMP shall be sized to adequately capture 1.5 times the volume not managed through infiltration and/or capture and use.

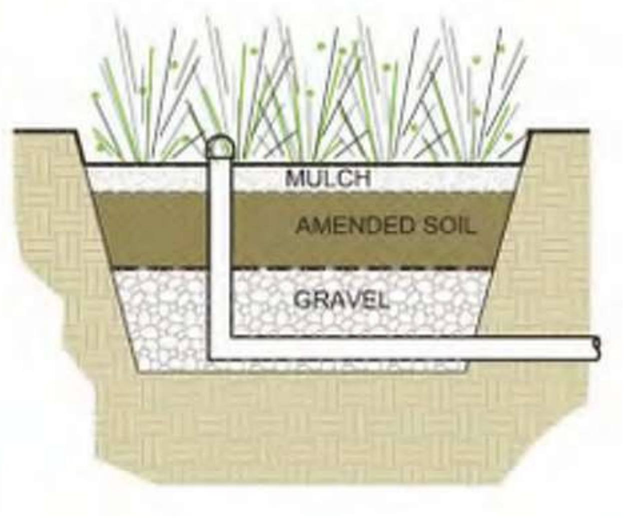
Bioretention (Planter Boxes)
Watermarke Tower

Biofiltration BMPs are landscaped facilities that capture and treat stormwater runoff through a variety of physical and biological treatment processes. Facilities normally consist of a ponding area, mulch layer, planting soils, plants, and in some cases, an underdrain. Runoff that passes through a biofiltration system is treated by the natural adsorption and filtration characteristics of the plants, soils, and microbes with which the water contacts. Biofiltration BMPs include vegetated swales, filter strips, planter boxes, high flow biotreatment units, bioinfiltration facilities, and bioretention facilities with underdrains. Biofiltration can provide multiple benefits, including pollutant removal, peak flow control, and low amounts of volume reduction through infiltration and evapotranspiration.

4.6.1 Biofiltration BMP Types

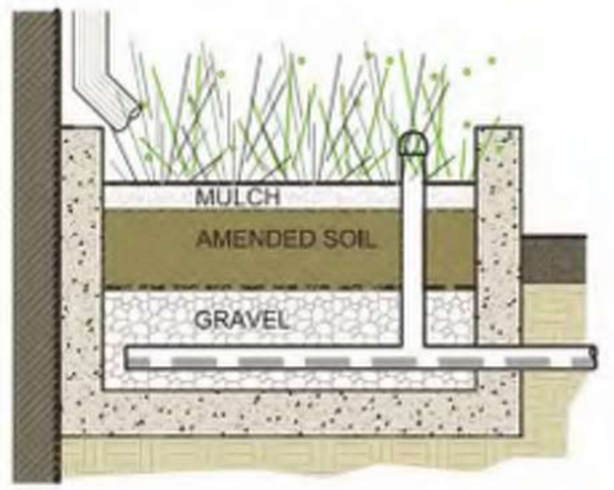
Biofiltration BMPs rely on various hydraulic residence times and flow-through rates for effective treatment. As a result, a variety of BMPs are available.

Bioretention with Underdrain



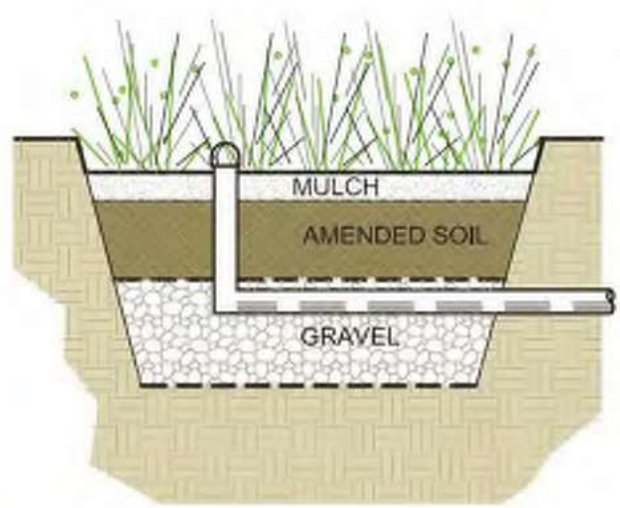
Bioretention facilities are landscaped shallow depressions that capture and filter stormwater runoff. As stormwater passes down through the planting soil, pollutants are filtered, adsorbed, and biodegraded by the soil and plants. Because they are not contained within an impermeable structure, they may allow for infiltration. For sites not passing the infiltration feasibility screening for reasons other than low infiltration rates (such as soil contamination, expansive soils, etc.), an impermeable liner may be needed to prevent incidental infiltration.

Planter Boxes



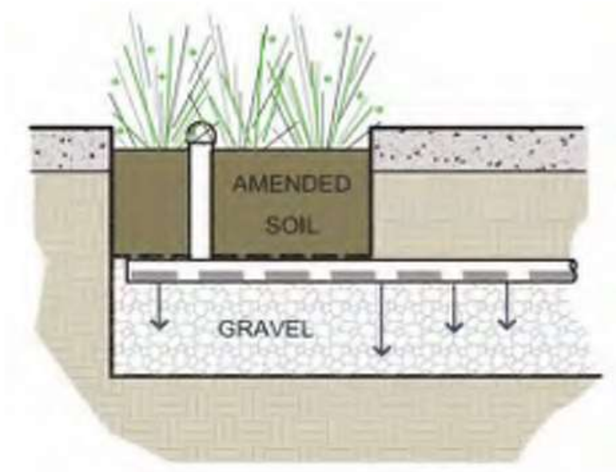
Planter boxes are bioretention treatment control measures that are completely contained within an impermeable structure with an underdrain (they do not infiltrate). They are similar to bioretention facilities with underdrains except they are situated at or above ground and are bound by impermeable walls. Planter boxes may be placed adjacent to or near buildings, other structures, or sidewalks.

Bioinfiltration



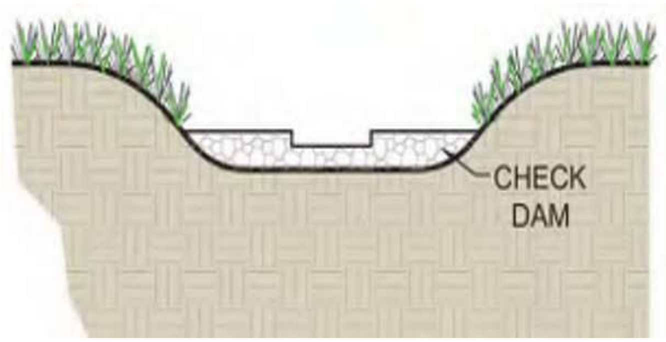
Bioinfiltration facilities are designed for partial infiltration of runoff and partial biotreatment. These facilities are similar to bioretention devices with underdrains but they include a raised underdrain above a gravel sump designed to facilitate infiltration and nitrification/denitrification. These facilities can be used in areas where there are little to no hazards associated with infiltration, but infiltration screening does not allow for infiltration BMPs due to low infiltration rates or high depths of fill.

High-Flow Biotreatment with Raised Underdrain



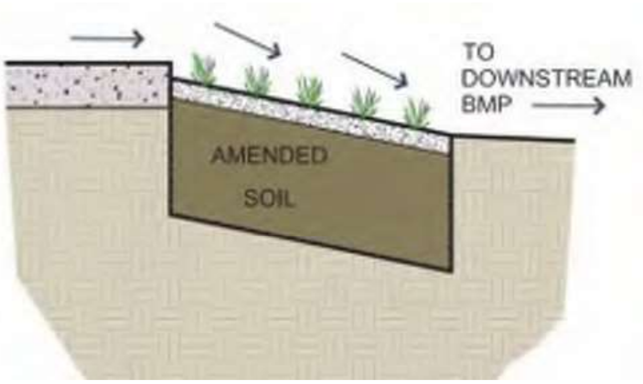
High-flow biotreatment devices are proprietary treatment BMPs that incorporate plants, soil, and microbes engineered to provide treatment at higher flow rates and with smaller footprints than their non-proprietary counterparts. Like bioinfiltration devices, they should incorporate a raised underdrain above a gravel sump to facilitate incidental infiltration where feasible. They must be shown to have pollutant removal efficiencies equal to or greater than the removal efficiencies of their non-proprietary counterparts. Proof of this performance must be provided by adequate third party field testing.

Vegetated Swales



Vegetated swales are open, shallow channels with dense, low-lying vegetation covering the side slopes and bottom that collect and slowly convey runoff to downstream discharge points. An effective vegetated swale achieves uniform sheet flow through the densely vegetated area for a period of several minutes. The vegetation in the swale can vary depending on its location and is the choice of the designer. Most swales are grass-lined.

Filter Strips (to be used as part of a treatment train)



Filter strips are vegetated areas designed to treat sheet flow runoff from adjacent impervious surfaces such as parking lots and roadways, or intensive landscaped areas such as golf courses. While some assimilation of dissolved constituents may occur, filter strips are generally more effective in trapping sediment and particulate-bound metals, nutrients, and pesticides. Filter strips are more effective when the runoff passes through the vegetation and thatch layer in the form of shallow, uniform flow. Filter strips are primarily used to pretreat runoff before it flows to an infiltration BMP or another biofiltration BMP.

4.6.2 Siting Requirements and Opportunity Criteria

Sites with plans to implement high removal efficiency biofiltration/biotreatment systems for the management of stormwater must first be screened for infiltration and capture and use BMP feasibility. Biofiltration should be implemented to treat all runoff onsite to the maximum extent feasible at sites incapable of implementing infiltration and/or capture and use BMPs as a result of the feasibility screening process set forth in this handbook.

Sites implementing biofiltration BMPs must have sufficient area available to ensure that BMPs produce adequate contact time for filtration to occur. For biofiltration BMPs with underdrains, sufficient vertical relief must exist to permit vertical percolation through the soil media to the underdrain below. For biofiltration BMPs with incidental infiltration, it must be demonstrated that there are no hazards associated with infiltration (i.e. infiltration screening does not allow for infiltration BMPs due to low infiltration rates or high depths of fill).

4.6.3 Calculating Size Requirements for Biofiltration BMPs

Biofiltration BMPs should be designed according to the requirements listed in Table 4.3 and outlined in the section below.

Table 4.3: Biofiltration BMP Design Criteria

Design Parameter	Unit	Bioretention with Underdrain	Planter Box	Bioinfiltration	High Flow Biotreatment[a]	Vegetated Swale	Filter Strip
Design Capture Volume, $V_{capture}$	cubic feet	Volume of water produced by the stormwater quality design storm event as determined in section 3.1.2 = 1.5 x 0.0625 (ft) x Catchment Area (sq. ft.)[b] *or* *= 1.5 x depth of from 85th percentile (ft) x Catchment Area (sq ft)* [b]					-
Drawdown Time	hr	Begins at surface = 48				-	-
Factor of Safety[c]	-	2				-	
Soil Media Infiltration Rate	in/hr	5 (max)			Per manufacturer's standards	-	
Max time to fill ponding depth (T_{Fill})	hrs	Min = 2; Max = 3[d]					
Contact Time	min	-				≥ 7	
Slope in Flow Direction	%	-				1% (min) 6% (max)	2% (min) 6% (max)
Flow Velocity	ft/sec	-				≤ 1	
Ponding Depth	inch	Min = 3 Max = 18	Min = 3 Max = 12	18	-	5	1
Minimim Inside Base Width	ft	2			-	Table 4.4	15
Soil Depth	ft	Min =1.5; Max = 2[d] ; Topped with 3" of mulch			-	2	-
Facility geometry	-	Bottom> 2% (max); Side slope ≤ 3:1(H:V)	-	Bottom> 2% (max) Side slope ≤3:1 (H:V)	-	See Table 4.5 Side slope ≤ 3:1 (H:V)	
Washed gravel diameter	inch	1-2			-	-	-
Underdrain	-	Slotted PVC pipe embeded in 12" gravel section(max), 6"(min); located 1" from bottom of facility		Slotted PVC pipe at least 2' above bottom of facility	Per manufacturer's standards	N/A	Not required
Erosion control	-	Energy dissipater to reduce velocity at inlet					
Overflow device	-	Shall be designed to handle peak storm flow in accordance with the Building and Safety code and requirements					Not Required

a: High flow biotreatment BMP design criteria displayed in Table 4.3 are general guidelines. Specific designs will vary depending on the vendor, design type, size, etc. High flow biotreatment BMPs must be sized to treat the design capture volume specified. They must be shown (by third party field testing) to have a pollutant removal efficiency equal to or greater than their non-proprietary counterparts.

b: Catchment area = (impervious area x 0.9) + [(pervious area + undeveloped area) x 0.1]

c: Listed FS values to be used only if soil infiltration / percolation test was performed and a detailed geotechnical report from a professional geotechnical engineer or engineering geologist is provided A FS of 6 will be assigned if only a boring was done.

d. For alternative designs see Appendix F

Biofiltration (Planter Boxes) treatment Sizing

With the exception of swales and filter strips, biofiltration facilities can be sized using one of two methods: a simple sizing method or a hydrologic routing modeling method. With either method the design capture volume must be completely infiltrated within the drawdown time shown in Table 4.3. Steps for the simple sizing method are provided below.

Step 1: Calculate the Design Volume

Biofiltration facilities shall be sized to capture and treat 150% of the design capture volume (V_{design}) of water produced by the stormwater quality design storm event as determined in section 3.1.2

= 1.5 x 0.0625 (ft) x Catchment Area (sq. ft.)

or

= 1.5 x depth of from 85th percentile (ft) x Catchment Area (sq ft)

Where

Catchment area = (Impervious Area x 0.9) + [(Pervious Area + Undeveloped Area) x 0.1]

Step 2: Determine the Design Infiltration Rate

The infiltration rate will decline between maintenance cycles as the surface and underlying soil matrix becomes clogged with particulates and debris. Monitoring of actual facility performance has shown that the full-scale infiltration rate is far lower than the rate measured by small-scale testing. It is important that adequate conservatism is incorporated in the sizing of facilities depending on a site's infiltration rate and expected surface loading. Unlike infiltration BMPs, the measured infiltration rate discussed here is the infiltration rate of the filter media bed or engineered surface soils in the biofilter. A target long-term $K_{sat,media}$ of 5 in/hr is recommended for non-proprietary amended soil media. Facility maintenance is required to maintain the infiltration rate for the life of the project. Infiltration rates used for design must be divided by the appropriate factors of safety.

$$K_{sat,design} = K_{sat,media}/FS$$

Step 3: Calculate the BMP Ponding Depth

Select a ponding depth (d_p) that satisfies geometric criteria and is congruent with the constraints of the site. The ponding depth must satisfy the maximum ponding depth constraint shown in Table 4.3 as well as the following:

$$d_p \text{ (ft)} = (K_{sat,design} \times T) / 12$$

Where:

d_p = Ponding depth (ft)

$K_{sat,design}$= Design infiltration rate of filter media (in/hr)

T = Required surface drain time (hrs), from Table 4.3

Step 4: Calculate the BMP Surface Area

Calculate infiltrating surface area (filter bottom area) required:

$$A_{min} = \frac{V_{design}}{[(T_{fill} K_{sat,design}/12) + d_p]}$$

Where:

A_{min} = Design infiltrating area (ft^2)

T_{fill}= Time to fill to max ponding depth with water (hrs), assume a maximum of 3 hours. If the minimum area requirement cannot be achieved using the design criteria in Table 4.3, T_{fill} can be modified to a minimum of 1 hour.

The calculated BMP surface area only considers the surface area of the BMP where infiltration through amended media can occur. The total footprint of the BMP should include a buffer for side slopes and freeboard.

Bioinfiltration BMPs and high-flow biotreatment devices should incorporate a raised underdrain above the gravel sump to facilitate incidental infiltration where feasible. For these instances, infiltration screening in accordance with Section 4.2 must be carried out to show that infiltration BMPs are not allowed due to low infiltration rates or high depths of fill (i.e. there are not hazards associated with infiltration). These BMPs are not suitable for project sites that do not pass infiltration feasibility screening due to associated hazards of infiltration (e.g. high groundwater table, contaminated soil or groundwater, landslide zones, liquefaction, etc.)

Swale Sizing

Swales shall be designed with a trapezoidal channel shape with side slopes of 3:1 (H:V). They shall incorporate at least two feet of soil beneath the vegetated surface. The following steps shall be followed for swale sizing. As is the case with other biofiltration BMPs, the sizing criteria presented in Table 4.5 must be met.

Step 1: Determine the Swale Base Width and Corresponding Unit Length

The base width of a swale must be between 2 and 10 feet. The designer may select the base width that is most appropriate for the site, but the swale length (per unit catchment area) must meet the minimum requirements as shown in Table 4.6 below.

Table 4.4: Swale Base Length (Per Unit Catchment Area)

Base of Swale	ft	2	3	4	5	6	7	8	9	10
Minimum Swale Length per Acre of Catchment Area	ft/acre	770	635	535	470	415	370	335	305	285

Step 2: Determine the Distance Between Check Dams

For volume storage, swales must incorporate check dams at specified intervals depending on the longitudinal slope of the swale, which must be between one and six percent. The check dams must be 12 inches in height and include a 6 inch deep notch in the middle of the check dam that is between one and two feet wide. All check dam structures shall extend across the entire base of the swale. They may be designed using a number of different materials including concrete blocks, gabions, gravel bags, rip rap, or earthen berms. The distance between successive check dams shall be determined from the longitudinal slope of the swale in the flow direction. Table 4.5 summarizes the design distances between check dams based on slope.

*Table 4.5: Check Dam Spacing Requirements for Swales**

Slope	%	1	2	3	4	5	6
Distance Between Checkdams	ft	N/A	N/A	33	25	20	17

* Depending on location of swale, approval from LADBS Grading Division may be required.

For intermediary slopes not shown in Table 4.5, linear interpolation may be used to calculate the distance between check dam structures.

Step 3: Determine the Total Swale Length

The total length of the swale (L_{swale}) is a function of the catchment area and unit swale length from Table 4.6. Total swale length is calculated as follows:

$$L_{swale}\text{ (ft)} = 1.5 \times \textit{Catchment Area}\text{ (ft}^2\text{)} \times \text{(1 acre/43,560 ft}^2\text{)} \times \textit{Swale Length per Acre of Catchment Area}\text{ (ft/acre)}$$

Where

Catchment area = (Impervious Area x 0.9) + [(Pervious Area + Undeveloped Area) x 0.1]

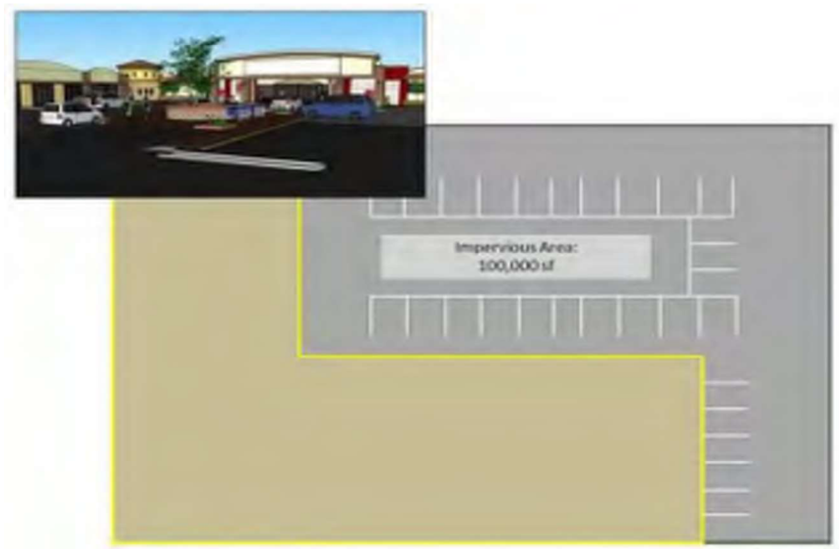
If there is adequate space on the site to accommodate a larger swale, consider using a greater length to increase the hydraulic residence time and improve the swale's pollutant removal capability. If the calculated length is too long for the site, the layout may be modified by meandering the swale or increasing the base width of the swale up to 10 feet. The total swale length shall never be less than 100 feet.

Filter Strip Sizing

Because filter strips are most often used for pretreatment purposes, their design will depend on the desired flow-rate to be treated and the type of BMP downstream, among other factors. As a result, filter strip sizing is not covered in this handbook, but will be determined on a case-by-case basis by the City of Los Angeles.

Bioinfiltration Sizing Example

Given: 20,000 ft^2 commercial development, 100% impervious (negligible landscaping). Design a bioinfiltration BMP to treat runoff from the entire development ($K_{sat,media}$= 5 in/hr; Factor of Safety = 2, T_{Fill} = 3 hrs).



1) Determine V_{design}

   85th Percentile storm event = 1.1-inch (0.0916 ft) > 0.75-inch (0.0625 ft)

   Therefore, use 1.1-inch (0.0916 ft)

   Catchment Area = (20,000ft^2 x 0.9) = 18,000ft^2
   V_{design} = 1.5 x 0.0916ft x 18,000ft^2 = **2,473ft^3**

2) Determine $K_{sat,design}$
   $K_{sat,design}$ = (5 in/hr) /2 = **2.5 in/hr**

3) Determine d_p
   d_p = (2.5 in/hr * 48 hrs)/12 = 10.0 ft
   Adhering to the max ponding depth requirements of Table 4.5, d_p **= 1.50 ft**

4) Calculate the infiltrating surface area, A_{min}

$$A_{min} = \frac{2{,}473\,cuft}{[(3hr * 2.5\,in/hr/12) + 1.5\,ft]} = \mathbf{1{,}136\ ft^2}$$

For a full capture system, each bioinfiltration unit must be sized by tributary area, for a total of 1,136 ft^2.

4.6.4 Design Criteria and Requirements

Unless specifically stated, all criteria and requirements listed below are required for the implementation of all biofiltration BMPs. Provisions not met must be approved by the City of Los Angeles.

Bioretention in a Parking Lot
Photo Credit: Geosyntec Consultants

- ◻ Where applicable, biofiltration BMPs shall be constructed with a minimum planting soil depth of 2 feet (3 feet preferred) and topped with 3 inches of mulch.
- ◻ Where applicable, biofiltration BMPs shall be designed to drain below the planting soil in less than 48 hours and completely drain from the underdrains in 96 hours.
- ◻ Underdrains shall be constructed of slotted PVC pipe, sloped at a minimum 0.5% and placed per Table 4.3 requirements. Underdrains drain freely to a downstream stormwater conveyance system, an additional BMP, or an alternatively acceptable discharge point.
- ◻ If system is online, an overflow is present. The overflow safely conveys flows to the downstream stormwater conveyance system, an additional BMP, or an alternatively acceptable discharge point.
- ◻ Inflow to swales shall be directed towards the upstream end of the swale.
- ◻ Bioinfiltration BMPs and high-flow biotreatment BMPs designed for secondary infiltration shall pass the infiltration feasibility screening for all hazardous criteria. If necessary, weep holes shall be used to increase infiltration.
- ◻ Swales shall be constructed with a bottom width between 2 and 10 feet. Check dams shall be incorporated at the appropriate distances as specified in Table 4.5. Check dams are 12 inches in height and include a 6 inch deep notch in the middle of the check dam that is 1-2 feet wide. Each check dam extends across the entire width of the swale’s base.
- ◻ Filter strips shall be constructed to extend across the full width of the tributary area. They shall be designed with sufficient slope in the flow direction to prevent ponding. They shall have a minimum length of 4 ft in the flow direction when sized for pretreatment purposes.

4.6.5 Soil and Vegetation Requirements

Soil and vegetation to be incorporated in biofiltration facilities shall be selected by a licensed landscape architect. In general, drought and flood resistant plant species native to Southern California should be selected when possible. Soil media should be selected to facilitate vigorous plant growth and not restrict performance requirements. Where the project receiving waters are impaired for nutrients, media should be selected to minimize the potential for leaching of nutrients from biofiltration systems.

4.6.6 Operations and Maintenance

Biofiltration areas require annual plant, soil, and mulch layer maintenance to ensure optimum infiltration, storage, and pollutant removal capabilities. In general, biofiltration maintenance requirements are typical landscape care procedures. The following operations and maintenance practices will be adhered to:

- Facility soil will be maintained. Flow entrances, ponding areas, and surface overflow areas will be inspected for erosion periodically. Soil and/or mulch will be replaced as necessary to maintain an infiltration rate at or near the initial $K_{sat,design}$value for the duration of the project.
- Site vegetation will be maintained as frequently as necessary to maintain fire protection, public safety, and the aesthetic appearance of the site as well as the filtration capabilities. This includes the removal of fallen, dead, and/or invasive plants, watering as necessary, and the replanting and/or reseeding of vegetation for reestablishment as necessary. Swales and filters will be mowed as necessary.
- BMP inlets will be inspected and maintained to ensure even flow enters the facility. Sediment collecting at the inlet will be removed as necessary.
- Proprietary devices will be inspected and maintained in accordance with the requirements of the manufacturer.

SECTION 5: OFFSITE MITIGATION MEASURES

5.1 OFFSITE MITGATION MEASURES

The option for offsite mitigation shall only be exercised after the following conditions have been met:

1. All the stormwater management techniques allowed (i.e., in priority order of infiltration, capture and use, treated through high removal efficiency biofiltration system) have been exhausted (i.e. are deemed technically infeasible), and;

2. A flow based proprietary mechanical device is installed to meet the flow generated from the stormwater quality design storm in order to maximize onsite compliance.

Offsite project BMPs should be located as close as possible to the project site, on private and/or public land, and should address a mix of land uses similar to those included in the proposed project. The offsite project shall not be located within waters of the U.S. and it shall be demonstrated that equivalent pollutant removal is accomplished prior to discharge to waters of the U.S.

For the remaining runoff that cannot feasibly be managed onsite, the project shall implement offsite mitigation in either:

1. The public right of way immediately adjacent to the subject development and/or;

2. Within the same sub-watershed (as defined as draining to the same HUC-12 hydrologic area as defined by the MS4 Permit) as the proposed project

Construction of an offsite mitigation project(s) shall achieve at least the same level of water quality protection as if all of the runoff were retained onsite and also be sized to mitigate the volume from the onsite and the tributary area from the adjacent street (from the crown of the street to the curb face for the entire length of the development site). All City Departments will assist the developer, when and where feasible, permitting and implementation of LID BMP projects within the public right of way.

Construction work in the public right-of-way will be the responsibility of the developer, and requires a “Revocable Permit” from the Department of Public Works, Bureau of Engineering (BOE). The developer will also be required to file a covenant and agreement with the county recorder’s office to insure the owner assumes full responsibility for perpetual maintenance of the onsite and offsite BMP(s) executed by a covenant and agreement. The type of BOE permit required depends on the scope of construction work. Additional permit information and detailed flowcharts can be found at: http://eng.lacity.org/techdocs/permits/index.htm

Green Infrastructure Projects

In an effort to assist developers the City has recently approved and adopted a series of green street standard plans. These plans provide a series of standards that developers can implement utilizing the public right of way immediately adjacent to the development. These standard plans provide general requirements for green streets, parkway swales in major/secondary highways, parkway swales in local/collector streets, parkway swales with no street parking, vegetated stormwater curb extensions, and interlocking pavers for vehicular and pedestrian alleys. The green street standard plans can be obtained from the Bureau of Engineering's Website at:

- http://eng.lacity.org/techdocs/stdplans/s-400.htm
- http://eng.lacity.org/techdocs/stdplans/Pdfs/Green%20Street%20Standard%20Plans%20FAQ%20Sheet_091010.pdf

Additional information on the City's Green Streets and Green Alleys design Guidelines can be found at: www.lastormwater.org

Appendix A	Development Planning Ordinances
Appendix B	Contact List
Appendix C	Small Scale Residential Plan Check Forms
Appendix D	All Other Development Plan Check Review Forms
Appendix E	Small Scale Residential Prescriptive Measures
Appendix F	All Other Development Sample Design Calculations
Appendix G	Source Control Measures
Appendix H	LA Department of Building and Safety Stormwater Infiltration Guidelines
Appendix I	Upper Los Angeles River Watermaster Requirements
Appendix J	County of LA Department of Public Health Policy and Operations Manual

ATTACHMENT C3

Treatment Alternatives Memorandum

Project	City of Los Angeles Broadway and Manchester Water Demand and Supply Task Order
Watearth #	21-260.0
Subject	Technical Memorandum - Evaluating Stormwater Treatment Alternatives
Date	August 25, 2022
Prepared by	Jennifer J. Walker PE, DWRE, ENV SP, CFM, QSD Sinem Gokgoz Kilic, PhD

Draft

DRAFT MEMORANDUM RELEASED UNDER THE AUTHORITY OF **JENNIFER J. WALKER PE (C77079), DWRE, CFM** ON 2022-08-25 AND SHOULD NOT BE USED FOR DESIGN OR CONSTRUCTION.

Stormwater Treatment

This memo presents and evaluates stormwater runoff treatment solutions. The stormwater collection and reuse system captures and retains stormwater for beneficial use. The system is typically comprised of the following components: collection system (curb, gutters, and storm sewers); storage unit (underground storage tank and bioretention); pre- and post-treatment systems (removal of solids, pollutants, and microorganisms, including any necessary control systems); and the distribution system (pumps, pipes, and control systems). A typical stormwater collection and reuse system is shown in **Figure 1**.

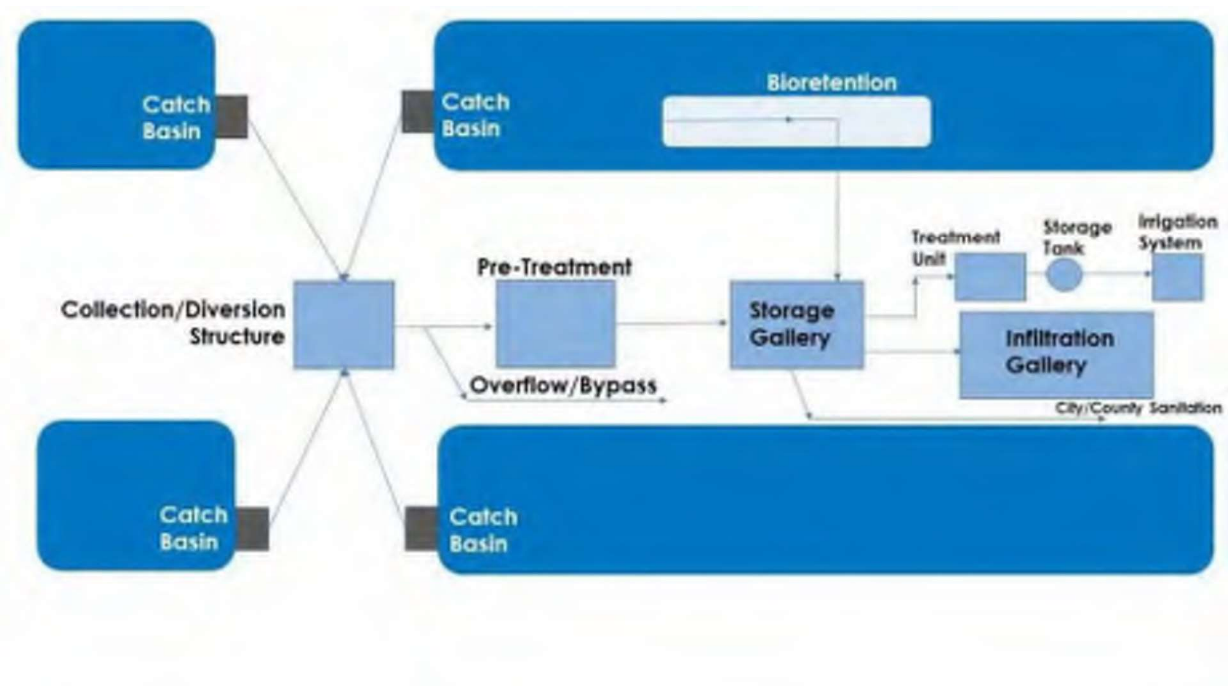


Figure 1: *Typical stormwater capture and reuse system schematic*

The specific components of a stormwater harvesting system and the required treatment depend on the catchment area surface, water source, and intended beneficial use. Treatment of water from rainwater harvesting systems requires disinfection and filtration for many applications of the captured water.

The treatment alternatives discussed in this memo are being considered for a 2.8-mile linear project area along Broadway and Manchester Avenues in Los Angeles, California. The catchment area for the Broadway and Manchester project is best described as urban. Harvesting surfaces are mostly paved surfaces with many sources of nonpoint pollution resulting in contaminated harvested stormwater. Pollutants typically associated with paved surface runoff are suspended solids, chlorides, grease and oil, particulates, dissolved nutrients, heavy metals, and other chemicals. In addition, any green spaces within the catchment area have the potential to generate high concentrations of pathogens that could cause illness or harm.

Irrigation reuse is the primary intended beneficial use considered for wet weather flows captured within the Broadway and Manchester project area. The secondary beneficial use is the discharge of wet weather flows into the sanitary sewer for water recycling. Water quality criteria for irrigation varies depending on the risk of exposure at the point of use and the type of landscape.

The Broadway and Manchester project has unrestricted use within the public right of way, and the landscape plants are non-food crops. Other project considerations include equipment maintenance (potential clogging of spray nozzles) and risk of exposure to wildlife. Drip irrigation water quality demands specific to Los Angeles are examined further in the next section.

Centralized vs. Decentralized Systems

Centralized or decentralized systems both achieve the stormwater capture and treatment required for the project. A centralized system utilizes a large storage structure that minimizes the number of storage and treatment devices. However, a centralized system is less practical for a project site that is linear in its geometry with spatial limitations. Decentralized systems are generally less capital intensive than centralized systems. However, decentralized systems are limited by their treatment capacity and capability for dealing with multiple contaminants. Maintenance is spread out when decentralized systems are used.

Treatment alternatives discussed in this memo apply to decentralized systems and can operate independently. However, a decentralized system becomes hybrid once connected and operated in conjunction with a centralized system. Factors to consider when introducing decentralized systems are scale, water demand, water availability, water quality, energy use, and environmental, legal, social, and economic factors[1].

Treatment Alternatives Evaluation

The treatment alternatives selected for evaluation are based on local regulations, feasibility, and site-specific conditions. The following subsections highlight requirements for treatment, advantages and disadvantages for each alternative, and recommendations for selection.

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[1] *Interactions Between Centralized and Decentralized Water Systems in Urban Context: A review*, Arora, Malano, (2015).

Treatment Requirements

Local water quality requirements and standards related to outdoor non-potable stormwater reuse for irrigation are described in this section. For the City of Los Angeles, the use of collected stormwater is limited to irrigation of landscaped surfaces[2].

The *Guidelines for Alternate Water Sources: Indoor and Outdoor Non-Potable Uses* provides treatment requirements applicable to the project. Collected stormwater is best categorized as "tier 3" and includes stormwater and dry weather runoff collected from nonpoint sources. The collected water can only be used at commercial, institutional, municipal, and industrial facilities. Further, tier 3 stormwater may contain excess fertilizers, herbicides, and insecticides; oil, grease, and toxic chemicals; sediment; salt; and bacteria and nutrients. Refer to the guideline for additional information regarding the tier system and specific requirements for each of the identified tiers.

Any water allowed for reuse for spray irrigation, non-interactive outdoor water features, vehicle washing, street sweeping, or dust control must meet the standards prescribed by the *National Sanitation Foundation) Standard 350*. Additional requirements in the *California Code of Regulation Title 22 Recycled Water Quality Equivalence* for point-of-use (POU) devices also apply. Captured water for reuse must meet all bacterial limits at the POU. The water must also conform to California Maximum Contamination Levels and the California Toxics Rule Standards. Stormwater influents should be tested to characterize chemical components after the first rain event of the rainfall year and at least two additional times during each rainfall year. A summary of stormwater analyses shall be maintained on premises, and final water quality results should be reported annually.

Irrigation systems utilizing untreated rainfall/non-potable cistern water shall only be used for subsurface irrigation. Misting or spraying is prohibited. Irrigation shall be controlled to prevent surface runoff from lands owned or controlled by the user. Surface infiltration of untreated rainfall/runoff is allowed if it occurs at least 10 feet from an unprotected foundation structure, with at least 10 feet of clearance to the seasonal high ground water table, and at least 100 feet from a water supply well.

Non-potable water quality declines over time, leading to microbial re-growth. If treated with chlorine, chlorine concentration will decay over time, requiring the installation of a disinfection system such as continuous chlorination. Additionally, a recirculation pump is recommended to mix the stored water to maintain acceptable water quality. Vectors such as small mammals and insects may also degrade water quality. Therefore, storage systems should be sealed for vector control and regularly inspected for cracks and openings.

All treatment alternatives must be equipped with Supervisory Control and Data Acquisition (SCADA) systems. In addition, sensors should be considered at pump areas and any valves that tie into the city and county-maintained facilities to allow remote monitoring of discharges. SCADA automation system integration is anticipated for the project during the design phase.

Treatment Alternatives

Treatment units that treat the water entering the storage system are called Point-of-Entry (POE) units. The units that treat the water at the point of consumption are called POU units. Although the POE and POU approaches can provide adequate protection if installed correctly, installing a POE treatment system as a pre-treatment method before stormwater collection into the storage facility is recommended. Using a POE system helps ensure that all the water entering the

[2] www.lacitysan.org/cs/groups/sg_sw/documents/document/y250/mde3/~edisp/cnt017152.pdf

system is safe to use, simplifies operational and maintenance requirements, and reduces installation costs. In addition, POU systems are recommended for use before irrigation to save cost and space.

Pre-treatment

Pre-treatment is integral to the Best Management Practices (BMPs) for stormwater collection and reuse. Pre-treatment ensures sediments and other pollutants in high concentrations do not degrade the system performance. Three common pre-treatment practices are settling devices, screens, vegetated filter strips, and bioretention. Sources and types of pollutants in the highest concentrations should be determined before deciding on the best treatment option.

Bioretention captures stormwater runoff within landscaped shallow depressions. Captured stormwater is filtered through soil that removes pollutants through various physical, biological, and chemical treatment processes. Bioretention typically consists of a ponding area, mulch layer, planting soils, plantings, and underdrain with an optional subsurface gravel reservoir layer.

Additionally, pollution prevention and public education is recommended to be integrated into the Low Impact Development (LID) feature design. The Broadway and Manchester project area is an ultra-urban setting with limited space making underground settling devices and pre-treatment screens the most suitable treatment options. However, underground settling devices and pre-treatment screens have a limited range of design flow that require additional investigation. A first flush diverter may also be beneficial to bypass very high concentrations of pollutants and filtration units capable of removing fine solids and hydrocarbons.

There are several systems that are well suited for pre-treatment filtration. Many vendors offer products which help remove trash, debris, and oil. Engineered and gravity media filters are among the most used filters. There are also water polishers, jellyfish units, and baffle boxes that would be suitable for pre-treatment. Baffle boxes which were used in previous projects also help with reducing bacterial regrowth. Each manufacturer would provide their specifications, cost, and treatment types. Below is a list of examples:

1. **Engineered filter media (Xylem)** Low tech/low cost. Anthracite-engineered media with the lowest uniformity coefficient provides superior filtration qualities, increased filter run volumes, and less water is required to thoroughly backwash.
2. **CDSTM Continuous Deflective Separation Treatment Method** Relatively easy to maintain with medium cost. A combination of swirl concentration and indirect screening to filter, separate, and trap debris, sediment, and hydrocarbons from stormwater runoff).
3. **Gravity Media Filtration (Xylem)** Highest Cost. Gravity filters are ideal for treating larger volumes than pressure filters can economically handle.

Disinfection

If the concentration of pathogens is high in the captured stormwater, or any potential for human exposure arises, captured stormwater needs to be properly disinfected. The following section presents three alternative options for disinfection.

In case harvested rainwater has the potential for any human exposure, disinfection is required. Regulations state the disinfection need to be chlorination or equivalent. Chlorination, UV, and ozone treatment alternatives are evaluated in the following sections and a summary is provided in **Table 1** on the following page.

Table 1: Summary and comparison of most frequently used stormwater disinfection treatments.

	Effectiveness	O&M	Cost	Advantages	Disadvantages
UV Light	Viruses - Good Bacteria - Good Parasites – Fair (varies)	Inspection and cleaning frequency is site-specific and very important Cleaning and equipment replacement and repairs	Medium (High capital cost, Moderate O&M costs)	Nontoxic, Physical process Short contact time. Non pH dependent Noncorrosive Requires least space Effective overall	Requires adequate dosage It may require many lamps Affected by turbidity and total suspended solids
Ozone	Viruses - Good Bacteria - Good Parasites - Good	Includes power consumption, supplies, miscellaneous equipment repairs, and staffing requirements	Highest (Highest capital cost, Moderate O&M costs)	Short contact time Decomposes rapidly Generated onsite Elevates dissolved oxygen	Requires adequate dosage Very reactive and corrosive Requires electrical power
Chlorination	Viruses - Poor Bacteria - Good Parasites - Poor	Storage, shipping, and handling pose a risk and require increased safety Inspect and clean annually	Lowest (Low capital cost, Moderate O&M costs)	Flexible and easily controlled dosage Lowest initial cost	Toxic Chemical process Long contact time pH-Dependent Corrosive

Ultraviolet Light

Ultraviolet light (UV) is a viable choice for simple disinfection applications where protection of the storage tank from the formation of biofilms is not an issue. A UV treatment system is typically positioned from the storage tank to the application where the rainwater will be used (e.g., landscape irrigation). UV light inactivates most microorganisms present in the water. However, UV light does not remove any microorganisms in the tank, biofilms on the tank surfaces, or any dissolved organic compounds in the water. Organic compounds in the water or microorganisms living in the tank can cause color or odor problems with the water[3]. The advantages, disadvantages, operation and maintenance requirements, and cost of this disinfection alternative are summarized in **Table 2**.

Table 2. Summary for Ultraviolet Disinfection

Advantages	Effective inactivation of most viruses, bacteria, and spores UV does not require chemical additives No residual byproducts that could harm humans or aquatic life Equipment requires minimal space
Disadvantages	Low dosages may not inactivate some viruses, spores, and cysts Turbidity and Total Suspended Solids (TSS) can reduce UV disinfection effectiveness It may require multiple units and lamps to achieve the desired effect
Operation and Maintenance	Optimize dosage and power consumption Regularly clean ballast, lamps, and the reactor Replace UV lamp periodically as suggested by manufacturer specifications
Cost	Units range from $3,000 to $5,500, depending on the flow to be treated Operations and Maintenance (O&M) cost is estimated at around $0.40/1000 gallons of treated water

Inadequate maintenance is one of the most common causes of ineffective UV systems. The quartz sleeves and Teflon tubes must be cleaned regularly. The required cleaning frequency and method are site and equipment specific. The frequency and method of cleaning provided by the manufacturer must be followed as part of operation and maintenance.

Ozone

Ozone systems treat the rainwater in the tank by recycling the water through an ozone injection system or by continuously bubbling the ozone into the storage tank. Ozone is a broad-spectrum biocide that treats all the water in the tank and prevents biofilms from forming on the tank surfaces. In addition, ozone can remove color and odors from the water that allow the water to be used in a wider array of applications[4].

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[3] https://www.epa.gov/sites/default/files/2015-06/documents/disinfection_small.pdf

[4] www.sustainabletechnologies.ca/app/uploads/2015/06/Ozone_TechBrief__March2015.pdf

Ozone disinfection is generally used in medium to large-sized plants after secondary treatment. In addition to disinfection, odor control is another common use for ozone in wastewater treatment. Ozone treatment achieves higher disinfection levels than chlorine or UV; however, the capital costs and maintenance expenditures are not competitive with available alternatives. Therefore, ozone is used only sparingly, primarily in cases where alternatives are ineffective[5]. The advantages, disadvantages, O&M requirements, and costs for ozone are summarized in **Table 3**.

Ozone and UV treatment systems may also be used in combination. Ozone treats the bulk of the water in the tanks, and UV can treat the water sent to the application. The combination approach provides redundancy should either system fail, ensuring that pathogens never reach the end use of the water. For applications where residual ozone might not be desirable in the water, UV will remove most of the ozone residual before the application.

Table 3. Ozone Disinfection Summary

Advantages	More effective than chlorine in destroying viruses and bacteria Short contact time No harmful residuals due to rapid decomposition Generated onsite Increases dissolved oxygen in the treated water
Disadvantages	Highly dosage-dependent Requires additional training for operational staff Highly reactive and corrosive Not economical for waters with high TSS or high organic content Prolonged exposure can cause irritation Relatively high capital costs and energy use
Operation and Maintenance	Optimize dosage and power consumption Ensure no leakage or overheating of the light unit occurs Calibrate per manufacturer recommendations
Cost	Units range from $2,500 to $4,000, depending on the flow to be treated Relatively high cost compared to other methods of disinfection High expenditure associated with O&M Ozone O&M cost is estimated at $0.68/1000 gallons

Chlorine

Chlorine is one of the most practical and widely used disinfectants for water. Chlorination is commonly used because it can kill disease-causing bacteria and control nuisance organisms

[5] https://www3.epa.gov/npdes/pubs/ozon.pdf

such as iron-reducing bacteria, slime, and sulfate-reducing bacteria. Chlorine destroys target organisms by oxidizing the cellular material of bacteria. Chlorine is supplied as a liquid, solid, or gas.

Chlorine as a disinfectant is more effective against viruses and less so against parasites in contrast to UV or ozone. UV disinfection can inactivate pathogens in a few tenths of a second, while chlorine requires a longer contact time. Conversely, UV disinfection best works on clear water, while chlorine is still effective for disinfection of relatively cloudy water. The effectiveness of UV disinfection is unaffected by the pH and temperature of the water. In contrast, the effectiveness of chlorine is affected by pH, temperature, and chlorine concentration in the water [6]. The advantages, disadvantages, operation and maintenance requirements, and cost of this disinfection alternative are summarized in **Table 4**.

Table 4. Summary for Chlorination Disinfection

Advantages	Chlorine residuals remain in the water following treatment and may aid in maintaining water quality Relatively low construction and O&M costs Requires less system optimization in startup
Disadvantages	Chlorine is corrosive and toxic Chlorine must be regularly resupplied
Operation and Maintenance	Monitor and optimize dosage per manufacturer recommendation Disassemble and clean system components as scheduled Inspect and clean valves and dosage pumps Periodically remove iron and manganese deposits Develop an emergency response plan for accidental release or spill Ensure safe storage and handling of chlorine
Cost	Units range from $325 to $700, depending on the flow to be chlorinated Chlorine as a solid is sold in tablets or drums based on weight 100 kg (45 lbs.) bucket of tablets ranges from $69 to $280 O&M cost is approximately $0.07/1000 gallons

[6] https://www.epa.gov/sites/default/files/2015-06/documents/disinfection_small.pdf

Recommendations

Watearth recommends the following to ensure a well maintained and operated stormwater capture and reuse project is achieved:

1. **Treatment Train:** Typically, each treatment utilizes one or more components that work together to remove pollutants, this combination, also known as a treatment train, can be composed of hydraulic, physical, biological, and chemical methods. A well-developed stormwater capture and reuse treatment train will combine these processes to ensure that public health is not placed in jeopardy. The recommended treatment train for the project include pre-treatment, post-treatment and disinfection as needed.
2. **Pre-treatment:** Removal of trash, debris, and oil from the captured stormwater before entering the storage or filtration units is very important in the efficiency and longevity of the stormwater capture systems.
3. **Post-treatment:** A filtration unit after the storage unit and before irrigation is highly recommended to keep the irrigation system running effectively without clogging. A filtration unit before irrigation would also reduce all dissolved matter, including salt, that might be harmful to the plants. Filtration is required for drip irrigation.
4. **Disinfection:** If disinfection is to be included, chlorination is the most economical method. However, chlorine is a hazardous substance and needs to be regularly transported to the site, Watearth recommends the use of a UV treatment system for disinfection. Ozone is the least favored since it is very reactive and corrosive and potentially not suitable for the facility in the public right of way. Disinfection is not required if all irrigation is to be subsurface and/or drip systems.

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Kimley»Horn

ATTACHMENT C4

Stormwater Capture Memo

STORMWATER CAPTURE MEMO
BROADWAY-MANCHESTER ATP EQUITY PROJECT

January 13, 2023

PRESENTED BY

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Appendix A – HydroCalc Results

1.0 INTRODUCTION

The Broadway-Manchester Active Transportation (ATP) Equity Project is along a 2.8-mile corridor of Manchester Avenue (from S. Vermont Ave to S. Broadway) and S. Broadway (from Manchester Ave to Imperial Highway) in South Los Angeles. The proposed project provides innovative active transportation treatments which include new bicycle lanes, improved sidewalks and ramps, signal modifications, urban greening through trees and landscaping, community paths and play spaces, and stormwater improvements. The objective of the stormwater improvements is to construct stormwater capture, storage, treatment, reuse, and discharge systems to progress the City towards stormwater quality compliance with the municipal separate storm sewer permit (MS4). The proposed stormwater components of this project are included in the Regional Infrastructure Program and the 5-year Stormwater Investment Plan (SIP) of the Upper Los Angeles River (ULAR) Watershed Area. The project has received Safe Clean Water Program funding and is currently scheduled to be completed in fiscal year 2024-2025.

This memo discusses how the Broadway-Manchester project can maximize stormwater capture benefits in a cost-effective manner while maintaining the function and transportation needs of the corridor. Four unique locations along Manchester Ave and S. Broadway were chosen where stormwater within city-owned storm drains will be diverted, treated and stored. This memorandum describes the steps taken to delinate the drainage areas, calculate the 85th percentile, 24-hour storm peak flows and volumes, and model the long-term stormwater capture and pollutant load reduction performance of the overall system. The information presented is intended to help provide a basis of design for the siting and sizing of each project element.

2.0 OBJECTIVES AND METHODS

2.1 Analysis Objectives

The objectives of the analysis are 1) to delineate the drainage areas of each of the four diversion points, 2) to calculate the peak flow rate and the runoff volume of these four drainage areas resulted from an 85th percentile, 24-hour rainfall event, and 3) to calculate the long-term runoff capture and pollutant removal using WMMS 2.0 modeling.

2.2 Drainage Area Delineation Methods

Drainage areas of the four diversion points were delineated using the storm drain information and curb line flow direction on NavigateLA (https://navigatela.lacity.org/navigatela/) and the LA County Digital Elevation Model (DEM). Areas draining to the catch basins that drain to the diversion point are considered within the drainage area, as illustrated in **Figure 1**. The directions of surface runoff were determined by delineated flowlines on NavigateLA and the ground elevations in the DEM. As-built drawings of the storm drains connected to the diversion points were referenced to identify upstream connections. The results were also checked against the Los Angeles County Watershed Management Modeling System 2.0 (WMMS 2.0) modeling subwatersheds. The percentages of impervious/pervious areas were generated from the WMMS 2.0 land use data.

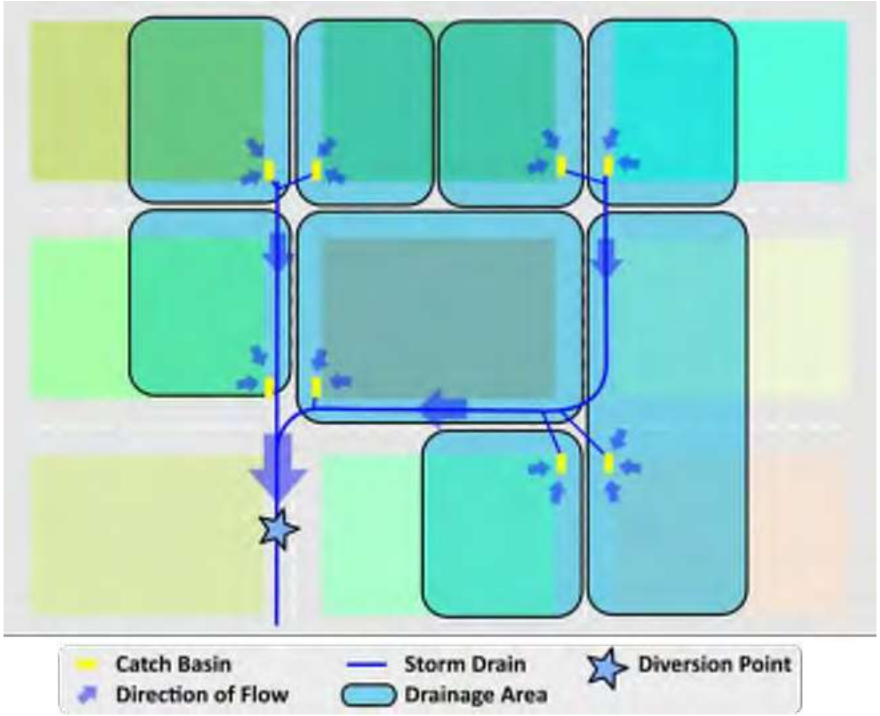


Figure 1. Example drainage area of an urban drainage system

2.3 85th Percentile Storm Analysis Methods

For each drainage area, HydroCalc 1.0.3 was used to calculate 1) the peak flow rate and 2) the runoff volume during an 85th percentile, 24-hour rainfall event. Inputs to HydroCalc were retrieved from the following sources:

- Drainage Area: delineated as described in Section 2.2;
- Flow Path Length: the longest flow path of each drainage area was measured in ArcGIS;
- Flow Path Slope: the elevation drop along the flow path were take from the LA County DEM. The elevation drop divided by flow path length gives the flow path slope;
- 85th percentile, 24-hour rainfall depth: the rainfall depth at the centroid of the drainage area was read and interpolated from the online LA County Hydrology Map (https://pw.lacounty.gov/wrd/hydrologygis/), as shown in **Figure 2** (left);
- Soil type: the most common soil type of each drainage area was read from the online LA County Hydrology Map (https://pw.lacounty.gov/wrd/hydrologygis/), as shown in **Figure 2** (right);
- Design Storm Frequency: 85th percentile, 24-hour storm was selected as the design storm.

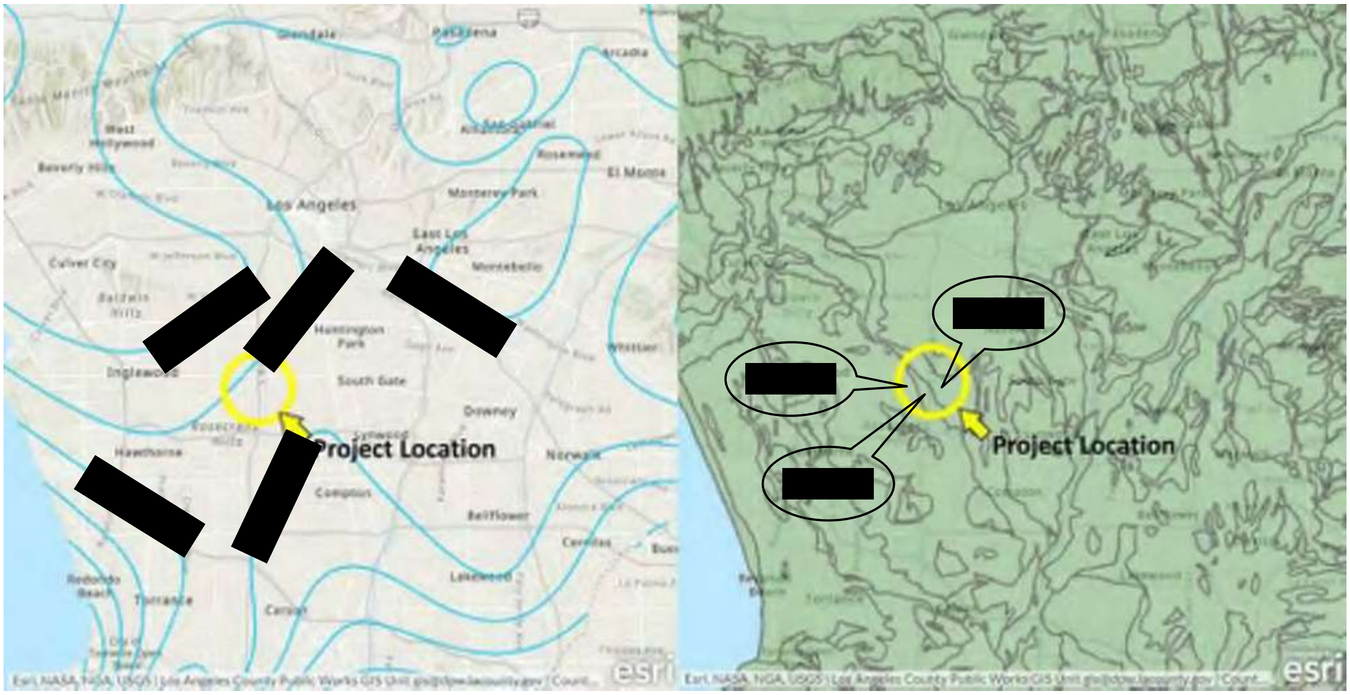


Figure 2. 85th percentile 24-hr rainfall (left) and soil type (right) data

2.4 Long-Term Performance Analysis Methods

To simulate the long-term performance of the stormwater capture project, the Loading Simulation Program C++ (LSPC) software and EPA SUSTAIN model will be used to simulate the contaminant loading, runoff volume, and flow rate associated with a long-term, 20-year continuous time series (Water Year 1999 to Water Year 2018). The LSPC and SUSTAIN model used is part of the Los Angeles County Watershed Management Modeling System (WMMS 2.0), which is accepted by the Los Angeles Water Quality Control Board for performance of compliance analyses in the context of EWMP/WMP development.

The previously delineated watersheds serve as the limits for the LSPC model. Runoff generation and pollutant build up is driven by the unique drainage area land uses to each diversion point. **Table 1** summarizes the land uses draining to each of the diversion points. **Figure 3** depicts the land uses within the drainage areas.

Long-term baseline flows and pollutant loads for the 20-year simulation period are summarized in **Table 2**. The total loadings presented in this table represent the maximum possible reductions that could be achieved by control measures at the project site. However, pragmatic diversion limitations, space constraints, and subsequent treatment mechanism as well as the ultimate inclusion of treatment features will ultimately limit how much runoff and pollutant mass can potentially be diverted into the BMPs. The minimum expected performance is the capture and treatment of the 85th percentile, 24-hour storm event which will have a significant reduction in the onsite pollutants.

Table 1. Drainage area land use breakdown

Land Use Category	Manchester-Vermont	Broadway-98th St	Broadway-102nd St	Broadway-106th St
Road	3.7 ac	9.8 ac	8.0 ac	14.7 ac
Residential	1.3 ac	6.8 ac	6.2 ac	10.7 ac
Commercial	1.6 ac	1.6 ac	0.7 ac	1.5 ac
Institutional	1.3 ac	1.3 ac	0.2 ac	1.1 ac
Roof	5.4 ac	12.0 ac	12.4 ac	23.3 ac
Irrigated	0.5 ac	2.2 ac	2.8 ac	5.4 ac
Pervious	1.3 ac	5.8 ac	7.7 ac	14.9 ac
Vegetation	3.0 ac	10.2 ac	10.5 ac	16.1 ac
SUM	**18.0 ac**	**49.8 ac**	**48.5 ac**	**87.7 ac**

Table 2. Summary of watershed and hydrologic conditions for the Broadway-Manchester drainage areas

Location	Drainage Area (acres)	% Impervious Area	Average Annual Runoff (ac-ft)	Average Annual Zn Loading (lbs)
Manchester-Vermont	18.0	72%	7.58	5.93
Broadway-98 St	49.8	62%	18.82	11.68
Broadway-102 St	48.5	56%	17.03	9.22
Broadway-106 St	87.7	58%	31.81	17.07
SUM			**75.24**	**43.90**

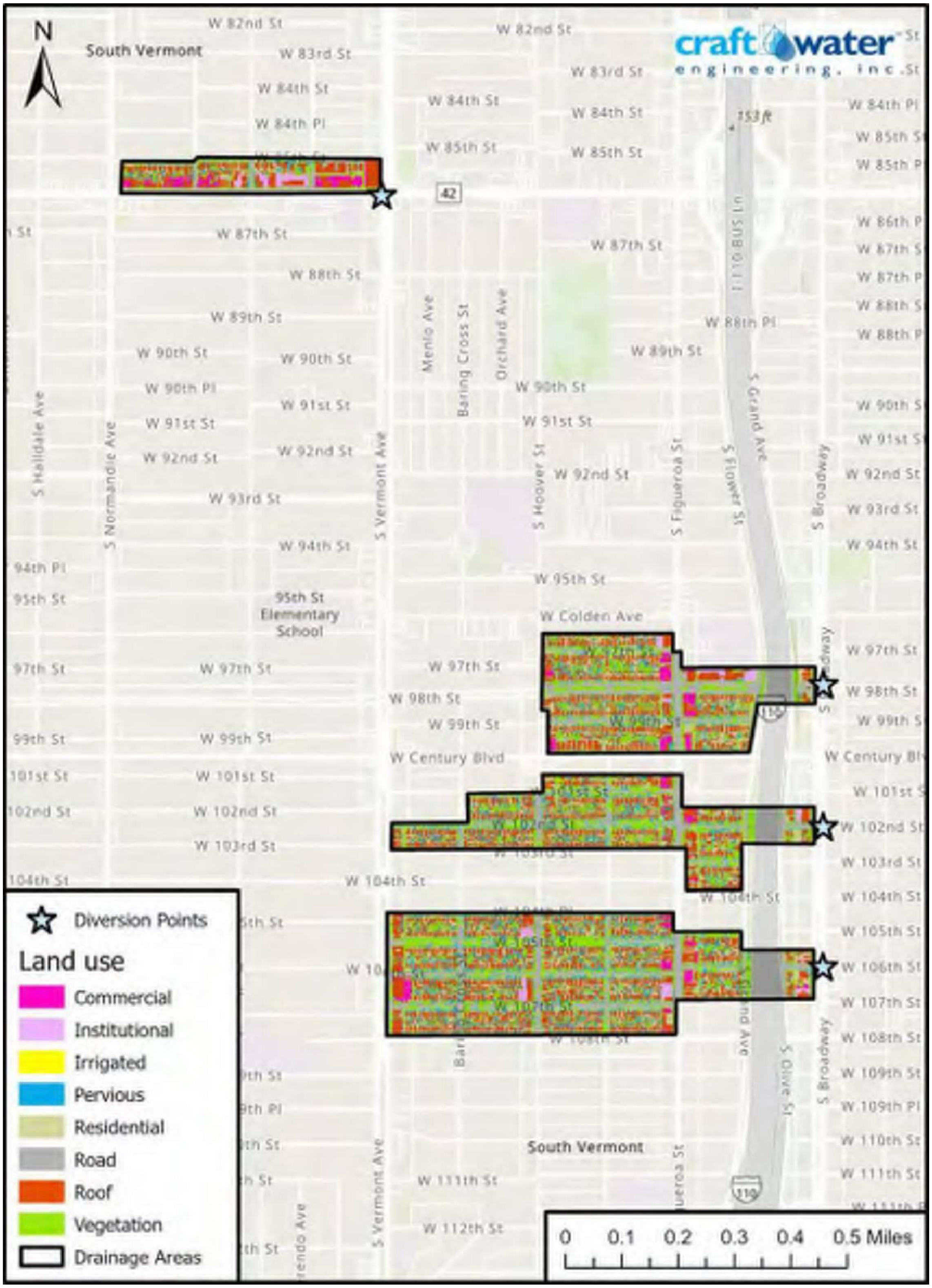


Figure 3. Land Use in Broadway-Manchester Drainage Areas

2.4.1 Key Assumptions

Based on the concept design, two storage systems are proposed for the project. One system accepts flow from the Manchester-Vermont diversion point and discharges to a sewer at a 0.5 cfs pumping rate. Another system accepts flows from the other three diversion points on S. Broadway and discharges to sewer using two 0.5 cfs pumps (a total of 1.0 cfs discharge rate).

Due to sewer capacity limitations, discharge of diverted stormwater to the sewer is limited to dry day hours during off-peak hours. The modeling used the following assumptions:

- No sewer discharge if the cumulative rainfall during the preceding 24 hours is larger than or equal to 0.1 in.
- When the dry-weather condition is met, discharge to sewer is allowed from 10 pm to 7 am (inclusive).

Figure 4 illustrates how allowable sewer discharge period is controlled by the rules described above. The sewer discharge rules will be updated should more information become available.

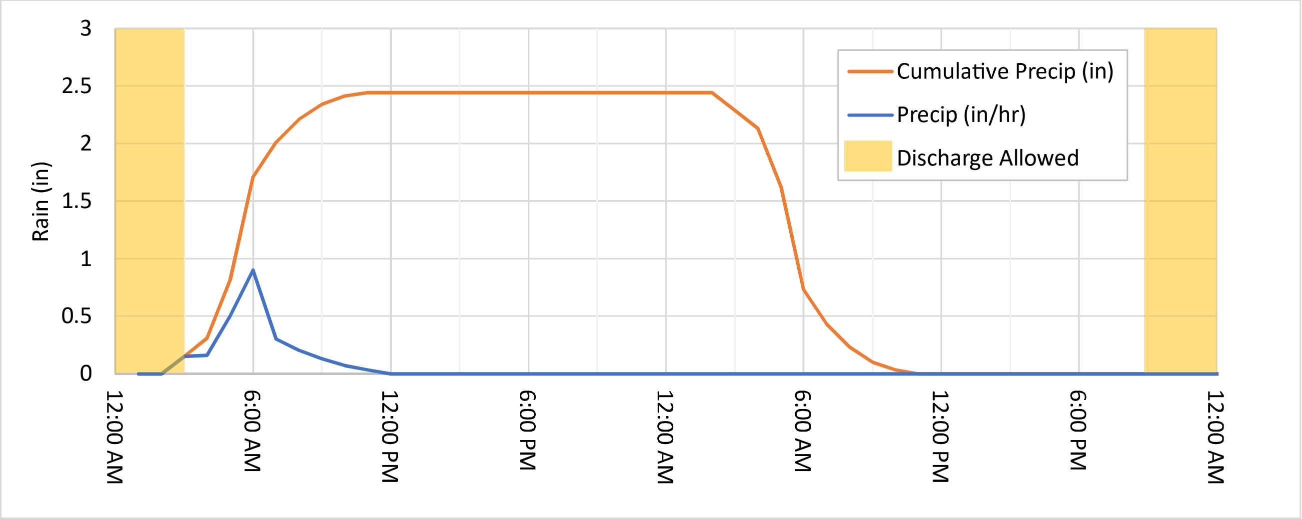


Figure 4. Allowable Sewer Discharge Periods

2.5 Safe, Clean Water Program Module

The project parameters of footprint, drawdown, and land use were input into the Safe, Clean Water Program module to measure the project performance relative to the scoring metrics.

3.0 RESULTS

3.1 Project Drainage Areas

The project has a total of **204.0 acres** of drainage area as subdivided into the four diversion locations as shown in **Figure 5**. The percentages of impervious and pervious areas according to the WMMS 2.0 land use data are summarized in **Table 3**.

Table 3. Drainage Area Sizes and Characteristics

Location	Drainage Area (acres)	Impervious area (acre)	Pervious Area (acre)	% Impervious Area	% Pervious Area
Manchester-Vermont	18.0	13.1	5.0	72%	28%
Broadway-98 St	49.8	31.1	18.7	62%	38%
Broadway-102 St	48.5	27.1	21.4	56%	44%
Broadway-106 St	87.7	50.7	37.0	58%	42%
SUM	**204.0**	**122.0**	**82.0**		

3.2 85th Percentile Storm Peak Flow and Runoff Volume

The inputs to HydroCalc are outlined in **Table 4** with the full model input and results shown in Appendix A.

Table 4. HydroCalc Inputs

Location	Drainage Area (acres)	% Impervious Area	Flow Path Length (ft)	Flow Path Slope	85th Percentile Rainfall (in)	Soil Type (2-180)
Manchester-Vermont	18.0	72%	2,446	0.0090	1.00	013
Broadway-98 St	49.8	62%	2,562	0.0047	0.97	006
Broadway-102 St	48.5	56%	3,964	0.0066	0.96	006
Broadway-106 St	87.7	58%	4,009	0.0085	0.96	013
SUM	**204.0**					

HydroCalc results are summarized in **Table 5**. The total runoff volume available for diversion at the four diversion points is **9.43 acre-feet**. The 85th percentile peak flow ranges from 1.97 cfs at the Manchester-Vermont point to 6.15 cfs at the Broadway-106 St point.

Table 5. HydroCalc Outputs for the 85th Percentile, 24-hour Storm

Location	85th Percentile Peak Flow (cfs)	85th Percentile Volume (acre-feet)
Manchester-Vermont	1.97	1.01
Broadway-98 St	4.14	2.38
Broadway-102 St	3.22	2.11
Broadway-106 St	6.15	3.93
SUM		**9.43**

The detailed HydroCalc inputs and outputs are shown in Appendix A – HydroCalc Results.

3.3 Recommended Design

To fully capture the 85th percentile peak flow and runoff volume, it is recommended that the diversion rate at each diversion point is equal to or larger than the peak flow in **Table 5**, and the storage volume at each diversion point is equal to or larger than the volume in **Table 5**.

As listed in **Table 6**, the maximum footprints of the six subsurface storage units have already been determined based on existing infrastructure and utilities. Two storage units hydraulically connected will be installed on Manchester Ave to receive stormwater diverted from the Manchester-Vermont diversion point. Four hydraulically connected storage units along S. Broadway will receive stormwater diverted from each of the other three diversion points, namely Broadway-98 St, Broadway-102 St, and Broadway-106 St. The locations of the storage units are shown in **Figure 6**. The recommended storage unit dimensions are summarized in **Table 6**.

Table 6. Recommended Storage Unit Dimensions

Unit No. (see Figure 6)	Diversion Points (see Figure 5)	Maximum Footprint (SF)	Maximum Footprint (AC)	Depth (ft)	Volume (AF)	Combined Volume (AF)	Target Volume (Table 5) (AF)
1	Manchester-Vermont	1,140	0.0262	15.5	0.41	1.03	1.01
2		1,764	0.0405	15.5	0.63		
3	Broadway-98 St, Broadway-102 St, Broadway-106 St Combined	6,127	0.1407	15	2.11	8.57	8.42
4		6,455	0.1482	15	2.22		
5		6,399	0.1469	15	2.20		
6		5,896	0.1354	15	2.03		
SUM			**0.6378**		**9.60**	**9.60**	**9.43**

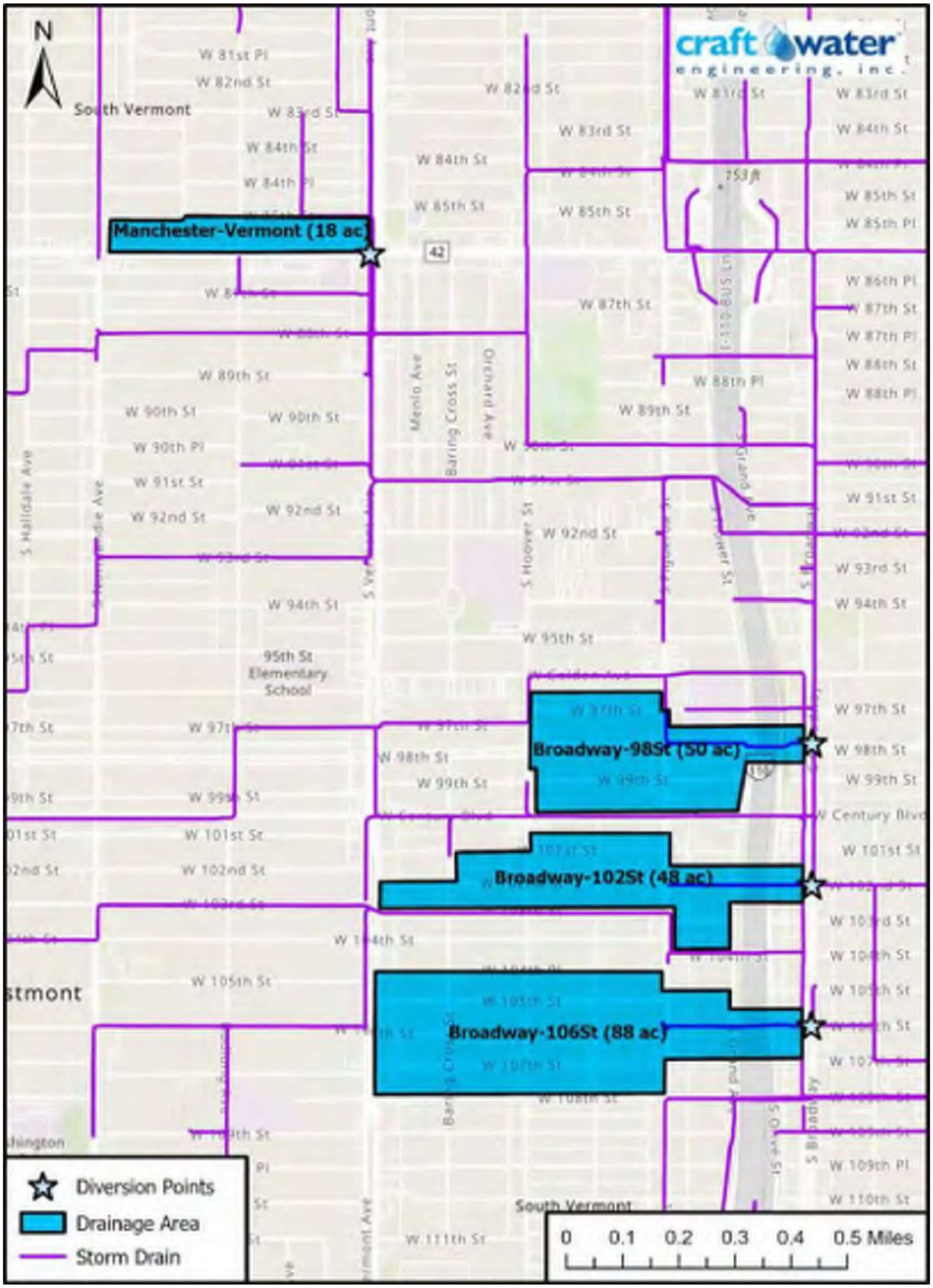


Figure 5. Drainage area to San Rafael Treatment Basin.

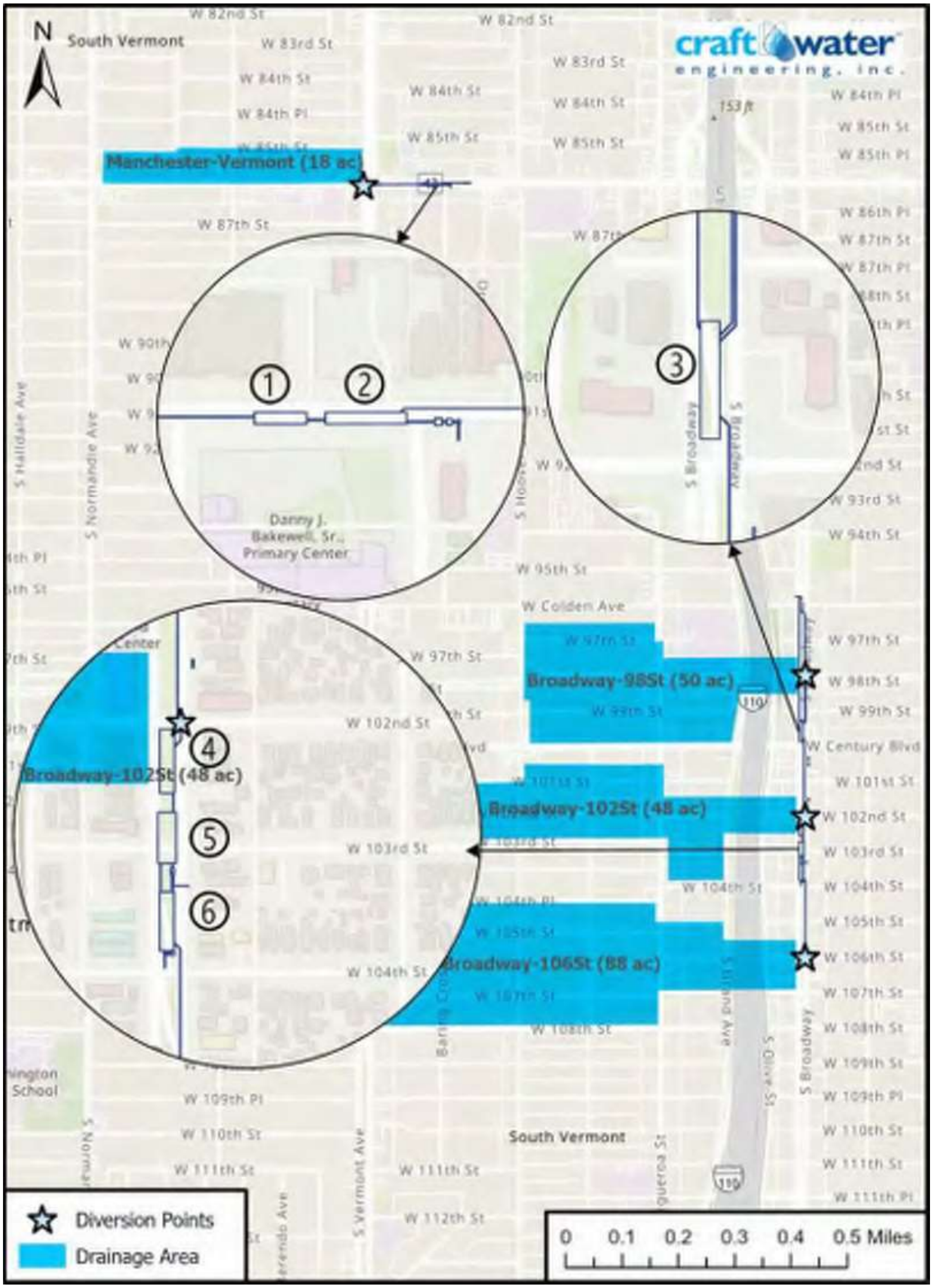


Figure 6. Locations of Subsurface Storage Units

3.4 Long-Term Performance Prediction

The performance of the system is driven by the inflow, storage, and outflow over the course of a variety of storm sizes and durations. For this project, the inflow and storage are driven by the 85th percentile, 24-hour storm event as described in Section 3.0. The storage sizing (area and depths) shown in **Table 6** are programmed into the WMMS 2.0 model with the above outlined drainage area land uses and the runoff from the 20-year continuous simulation period. The WMMS 2.0 model predicted the anticipated BMPs average annual performance over the course of the 20-year period as shown in **Table 7** and **Table 8**.

Table 7. Summary of watershed and hydrologic conditions for the Broadway-Manchester drainage areas

<table>
<tr><th>Location</th><th>Diversion Rate Modeled (cfs)</th><th>BMP Volume (ac-ft)</th><th>Average Annual Runoff Reduction (ac-ft)</th><th>Average Annual Zn Reduction (lbs)</th></tr>
<tr><td>Manchester-Vermont</td><td>2.0</td><td>1.01</td><td>5.6</td><td>5.4</td></tr>
<tr><td>Broadway-98 St</td><td>4.2</td><td>2.38</td><td rowspan="3">42.2</td><td rowspan="3">31.5</td></tr>
<tr><td>Broadway-102 St</td><td>3.3</td><td>2.11</td></tr>
<tr><td>Broadway-106 St</td><td>6.2</td><td>3.93</td></tr>
<tr><td>SUM</td><td></td><td></td><td>47.7
(72% of divertible)</td><td>36.9
(96% of divertible)</td></tr>
</table>

Table 8. Summary of water balance for the Broadway-Manchester drainage areas

Location	Average Annual Runoff Captured (ac-ft)	Average Annual Runoff to Sewer (ac-ft)	Average Annual Runoff to Irrigation Offset (ac-ft)*
Manchester-Vermont	5.6	5.6	0
Broadway-98 St	12.9	12.9	0
Broadway-102 St	10.2	10.2	0
Broadway-106 St	19.1	19.1	0
SUM	**47.7**	**47.7**	**0**

*Not recommended due to the minimal offset and substantial costs to implement. Supply benefit fully realized through the diversion to sanitary sewer.

3.5 Safe, Clean Water Program Module Performance and Scoring

The project parameters of footprint, drawdown, and land use were input into the Safe, Clean Water Program module to measure the project performance relative to the scoring metrics. **Figure 7** shows the anticipated performance and scoring for the project.

Los Angeles County Safe, Clean Water Program
INFRASTRUCTURE PROGRAM PROJECT SAFE, CLEAN WATER SCORING MATRIX REVIEW
BROADWAY-MANCHESTER MULTI-MODAL GREEN STREETS PROJECT

Section	Score Range	Scoring Standards	MAX SCORE	Broadway-Manchester: FY 2021-22 SCW Scoring Rubric Score	Broadway-Manchester: SCW Project Module Data	Broadway-Manchester: SCW Project Module 06/12/2023	COMMENT
A.1 Wet Weather Water Quality Benefits -OR-	50 points max	The project provides water quality benefits					
	20 points max	A.1.1: For Wet Weather BMPs Only: Water Quality Cost Effectiveness Cost Effectiveness) = (24-hour BMP Capacity) / (Life-Cycle Cost in $Millions) - <0.4 (AF / $-Million) = 0 points - 0.4 – 0.6 (AF / $-Million) = 7 points - 0.6 – 0.8 (AF / $-Million) = 11 points - 0.8 – 1.0 (AF / $-Million) = 16 points - >1.0 (AF / $-Million) = 20 points 1. Management of the 24-hour event is considered the maximum capacity of a Project for a 24-hour period. For water quality focused Projects, this would typically be the 85th percentile design storm capacity. Units are in acre-feet (AF)	20	15	0.55	15	Assumes similar construction costs of $14.8 Million for this analysis. BMP Size as capture and diversion to sanitary sewer.
	30 points max	A.1.2: For Wet Weather BMPs Only: Water Quality Benefit - Quantify the pollutant reduction (i.e. concentration, load, exceedance day, etc.) for a class of pollutants using a similar analysis as the E/WMP which uses the District's Watershed Management Modeling System (WMMS). The analysis should be an average percent reduction comparing influent and effluent for the class of pollutant over a ten year period showing the impact of the Project. Modeling should include the latest performance data to reflect the efficiency of the BMP type.	20	20	100%	20	Project treats the 85th Percentile and treats over 80% of the pollutant load
		Primary Class of Pollutants - <50% = 15 points - >80% = 20 points (20 points max) **Second or More Classes of Pollutants** - <50% = 5 points - >80% = 10 points (10 points max)	10	10	100%	10	Secondary Pollutant modeled for bacteria load reduction, provides over 80% pollutant load reduction
B. Significant Water Supply Benefits	25 points max	The project provides water supply benefits					
	13 points max	B1. Water Supply Cost Effectiveness. The total life-cycle cost per unit of acre-foot of stormwater and/or urban runoff volume captured for water supply is: - > $2,500 / ac-ft = 0 points - $2,000 - $2,500 / ac-ft = 3 points - $1,500 - $2,000 / ac-ft = 6 points - $1,000 - $1,500 / ac-ft = 10 points - < $1,000 / ac-ft = 13 points 1. Total Life-Cycle Cost: The annualized value of all Capital, planning, design, land acquisition, construction, and total life O&M costs for the Project for the entire life span of the Project (e.g. 50-year design life span should account for 50-years of O&M). The annualized cost is used over the present value to provide a preference to Projects with longer life spans.	13	0	$ 4,510	0	Similar results
	12 points max	B2. Water Supply Benefit Magnitude. The yearly additional water supply volume resulting from the project is: - < 25 ac-ft / year = 0 points - 25 – 100 ac-ft / year = 2 points - 100 - 200 ac-ft / year = 5 points - 200 - 300 ac-ft / year = 9 points - > 300 ac-ft / year = 12 points	12	5	47.7	2	Water supply benefit calculated dry-weather flow and discharged to the sanitary sewer (City and County sewers). WMMS 2.0 Modeling over 20 years of data.
C. Community Investment Benefits	10 points max	The project provides Community Investment Benefits					
	10 points	C1. Project includes: - ONE of the Community Investment Benefits identified below = 2 points - THREE distinct Community Investment Benefits identified below = 5 points - SIX distinct Community Investment Benefits identified below = 10 points	10	10	5	5	SCW Application stated benefit to median adjacent to school with letter from School Principal. Since this is not a school, it would not get credit for the project.
		Improved flood management, flood conveyance, or flood risk mitigation			1		
		Creation, enhancement, or restoration of parks, habitat, or wetlands			1		
		Improved public access to waterways			0		
		Enhanced or new recreational opportunities			1		
		Greening of schools			0		
		Reducing local heat island effect and increasing shade			1		
		Increasing the number of trees in mass and/or other vegetation at the site location that will increase carbon reduction/sequestration and improve air quality			1		
D. Nature-Based Solutions	15 points max	The project implements Nature-Based Solutions					
	15 points	D1. Project: Implements natural processes or mimics natural processes to slow, detain, capture, and absorb/infiltrate water in a manner that protects, enhances and/or restores habitat, green space and/or usable open space = 5 points	15	10	5	10	Surface bioswales and native vegetation along the medians provides nature based processes using natural materials
		Utilizes natural materials such as soils and vegetation with a preference for native vegetation = 5 points			5		
		Removes impermeable area from Project (1 point per 20% paved area removed) = 5 points			0		
E. Leveraging Funds and Community Support	10 points max	The project achieves one or more of the following					
	6 points max	E1. Cost-Share. Additional Funding has been awarded for the project. - > 25% Funding Matched = 3 points - > 50% Funding Matched = 6 points	6	3	25.0%	3	City Matching Funds of $1.8M Bias assumed
	4 points	E2. The project demonstrates strong local, community-based support and/or has been developed as part of a partnership with local NGOs/CBOs.	4	4	Yes	4	Active Community Outreach and Support Letters
Total	Total Points All Sections: 110		110	79		69	

Figure 7. Updated Safe, Clean Water Program Performance and Anticipated Scoring

4.0 SUMMARY

To maximise the stormwater capture benefits of the Broadway-Manchester project in a cost-effective manner, drainage area delination and runoff calculations were performed. Four locations along Manchester Ave and S. Broadway were chosen where stormwater in city-owned storm drains will be diverted. Per the analysis, the total drainage area of these four diversion locations is **204.0 acres**, and the total runoff volume available for diversion during an 85th percentile, 24-hour design storm is **9.43 acre-feet**. The recommended diversion rates and storage volumes of the four diversion points are based on the 85th percentile storm peak flows and runoff volumes of their own drainage area. Because the footprints of the subsurface storage units are limited, the storage depth of these units will need to be approximately **15 feet** to fully capture the 9.43 acre-feet volume. The long-term LSPC modeling demonstrates that approximately **46.8 ac-ft** of runoff and **37.1 lbs** of zinc are captured on an average annual basis.

APPENDIX A – HYDROCALC RESULTS

Peak Flow Hydrologic Analysis

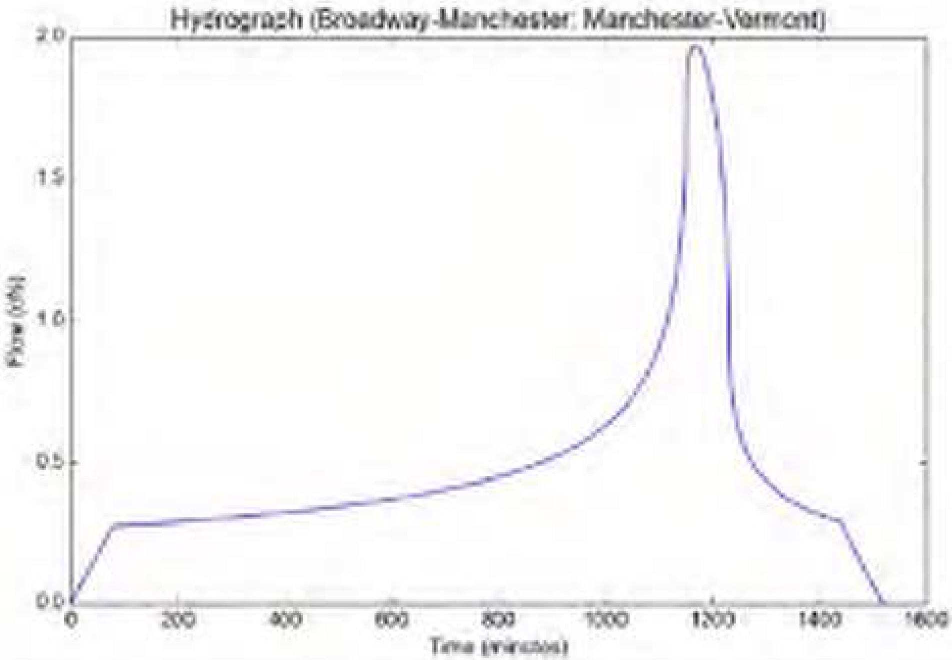
File location: C:/Users/YulunWu/OneDrive - [illegible]Water/Desktop/Broadway-Manchester - Manchester Vermont.pdf
Version: HydroCalc 1.0.3

Input Parameters

Project Name	Broadway-Manchester
Subarea ID	Manchester-Vermont
Area (ac)	18.0
Flow Path Length (ft)	2446.0
Flow Path Slope (vft/hft)	0.009
85th Percentile Rainfall Depth (in)	1.0
Percent Impervious	0.72
Soil Type	13
Design Storm Frequency	85th percentile storm
Fire Factor	0
LID	True

Output Results

Modeled (85th percentile storm) Rainfall Depth (in)	1.0
Peak Intensity (in/hr)	0.1621
Undeveloped Runoff Coefficient (Cu)	0.1
Developed Runoff Coefficient (Cd)	0.676
Time of Concentration (min)	80.0
Clear Peak Flow Rate (cfs)	1.9724
Burned Peak Flow Rate (cfs)	1.9724
24-Hr Clear Runoff Volume (ac-ft)	1.0057
24-Hr Clear Runoff Volume (cu-ft)	43808.4969



Peak Flow Hydrologic Analysis

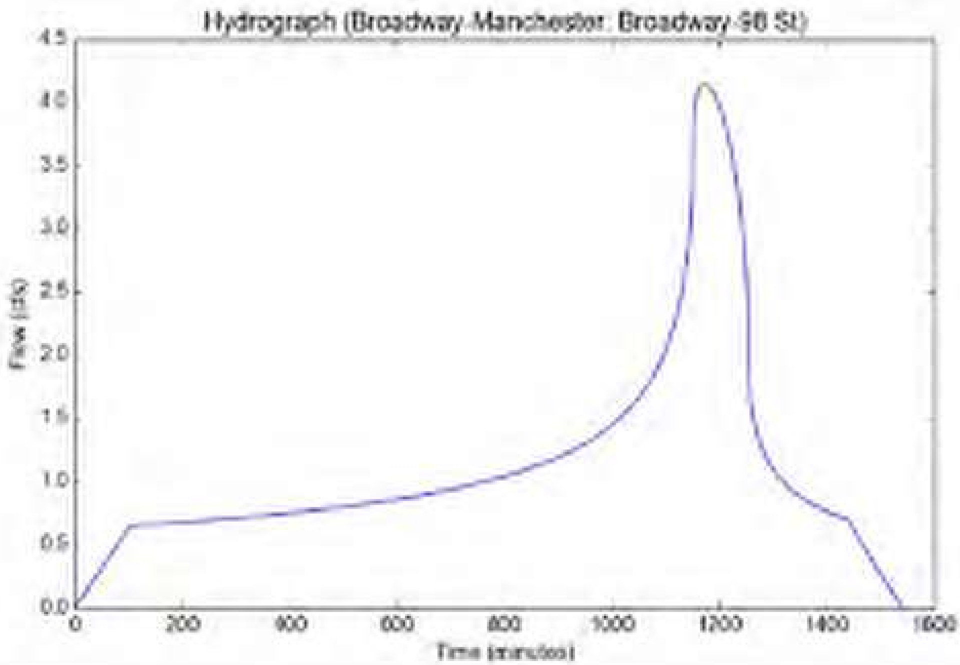
File location: C:/Users/YulunWu/OneDrive - nevWater/Desktop/Broadway-Manchester - Broadway-98 St.pdf
Version: HydroCalc 1.0.3

Input Parameters

Project Name	Broadway-Manchester
Subarea ID	Broadway-98 St
Area (ac)	49.8
Flow Path Length (ft)	2562.0
Flow Path Slope (vft/hft)	0.0047
85th Percentile Rainfall Depth (in)	0.97
Percent Impervious	0.62
Soil Type	6
Design Storm Frequency	85th percentile storm
Fire Factor	0
LID	True

Output Results

Modeled (85th percentile storm) Rainfall Depth (in)	0.97
Peak Intensity (in/hr)	0.1396
Undeveloped Runoff Coefficient (Cu)	0.1
Developed Runoff Coefficient (Cd)	0.596
Time of Concentration (min)	103.0
Clear Peak Flow Rate (cfs)	4.1441
Burned Peak Flow Rate (cfs)	4.1441
24-Hr Clear Runoff Volume (ac-ft)	2.3797
24-Hr Clear Runoff Volume (cu-ft)	103660.0816



Peak Flow Hydrologic Analysis

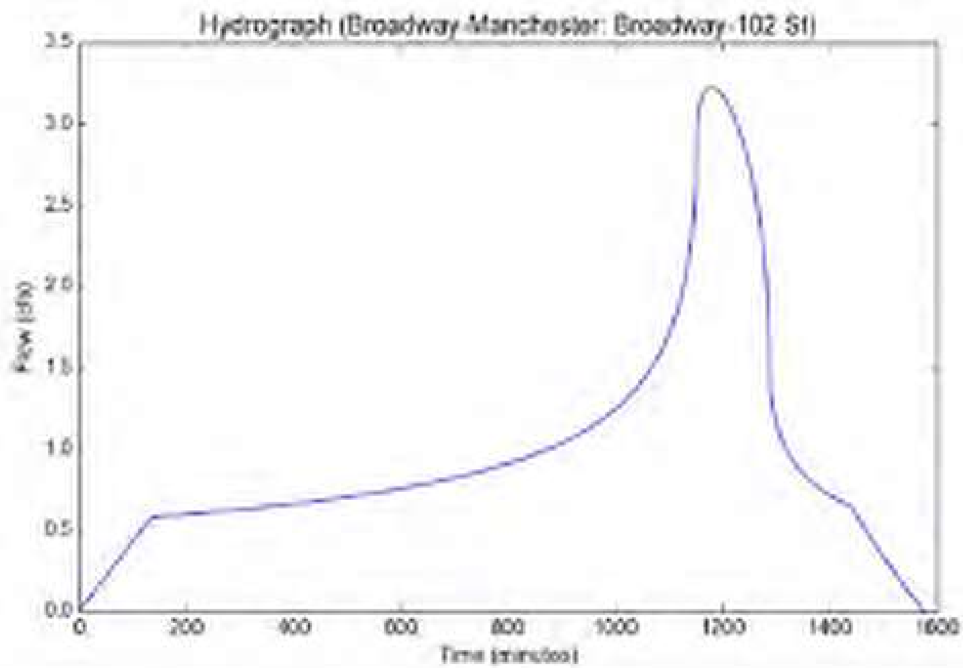
File location: C:/Users/YulunWu/OneDrive - ...Water/Desktop/Broadway-Manchester - Broadway-102 St.pdf
Version: HydroCalc 1.0.3

Input Parameters

Project Name	Broadway-Manchester
Subarea ID	Broadway-102 St
Area (ac)	48.5
Flow Path Length (ft)	3964.0
Flow Path Slope (vft/hft)	0.0066
85th Percentile Rainfall Depth (in)	0.96
Percent Impervious	0.56
Soil Type	6
Design Storm Frequency	85th percentile storm
Fire Factor	0
LID	True

Output Results

Modeled (85th percentile storm) Rainfall Depth (in)	0.96
Peak Intensity (in/hr)	0.1213
Undeveloped Runoff Coefficient (Cu)	0.1
Developed Runoff Coefficient (Cd)	0.548
Time of Concentration (min)	136.0
Clear Peak Flow Rate (cfs)	3.2229
Burned Peak Flow Rate (cfs)	3.2229
24-Hr Clear Runoff Volume (ac-ft)	2.1092
24-Hr Clear Runoff Volume (cu-ft)	91876.8497



Peak Flow Hydrologic Analysis

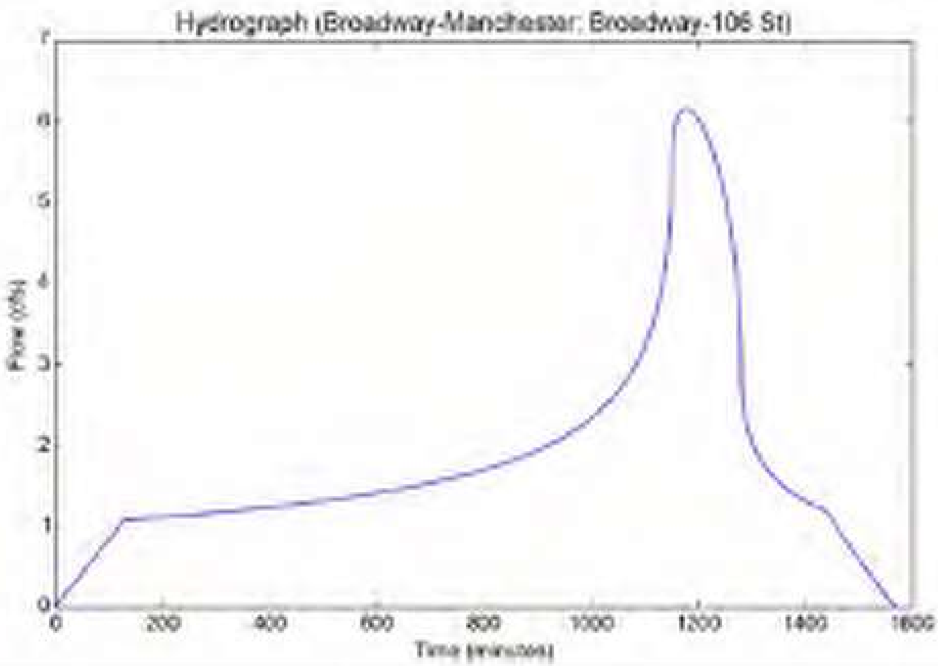
File location: C:/Users/[illegible]/OneDrive - [illegible]/Desktop/Broadway-Manchester - Broadway-106 St.pdf
Version: HydroCalc 1.0.3

Input Parameters

Project Name	Broadway-Manchester
Subarea ID	Broadway-106 St
Area (ac)	87.7
Flow Path Length (ft)	4009.0
Flow Path Slope (vft/hft)	0.0085
85th Percentile Rainfall Depth (in)	0.96
Percent Impervious	0.58
Soil Type	13
Design Storm Frequency	85th percentile storm
Fire Factor	0
LID	True

Output Results

Modeled (85th percentile storm) Rainfall Depth (in)	0.96
Peak Intensity (in/hr)	0.1243
Undeveloped Runoff Coefficient (Cu)	0.1
Developed Runoff Coefficient (Cd)	0.564
Time of Concentration (min)	129.0
Clear Peak Flow Rate (cfs)	6.1488
Burned Peak Flow Rate (cfs)	6.1488
24-Hr Clear Runoff Volume (ac-ft)	3.9252
24-Hr Clear Runoff Volume (cu-ft)	170982.2293



Kimley»Horn

ATTACHMENT D

Estimate of Probable Cost

Kimley»Horn

ATTACHMENT E

Irrigation Demand Calculations

121019: Broadway Manchester ATP

Preliminary Estimate of Irrigation Demand

3 May 2022

Local Reference Evapotranspiration (ETo): 6.48

Allowable Rainfall (R): 0

Street	Service Area	Streets	Landscape Typology	A Landscape Area (square footage)	Baseline Water Usage (gallons/month)	LWA Site Water Allotment (gallons/month)	DULQ Assumed Distribution Uniformity		KL Landscape Coefficient		LWRH Landscape Water Requirement (gallons/month) Subtotal	Subtotal x Service Area
Manchester Boulevard	Irrigation Service Area 1	Vermont to Broadway	Parkway	23,768	95,999	67,199	Drip - Pressure Compensating	90%	Trees / Shrubs / Groundcover (Medium)	0.5	53,335	81,334
Manchester Boulevard	Irrigation Service Area 1	Vermont to Broadway	Buffer	0	0	0	Drip - Pressure Compensating	90%	Trees / Shrubs / Groundcover (Medium)	0.5	0	
Manchester Boulevard	Irrigation Service Area 1	Vermont to Broadway	Standard Median	12,477	50,394	35,276	Drip - Pressure Compensating	90%	Trees / Shrubs / Groundcover (Medium)	0.5	27,998	
Manchester Boulevard	Irrigation Service Area 1	Vermont to Broadway	Median Park	0	0	0	Drip - Pressure Compensating	90%	Trees / Shrubs / Groundcover (Medium)	0.5	0	
Broadway	Irrigation Service Area 2	Manchester to Coldon	Parkway	33,362	134,749	94,324	Drip - Pressure Compensating	90%	Trees / Shrubs / Groundcover (Medium)	0.5	74,864	253,671
Broadway	Irrigation Service Area 2	Manchester to Coldon	Buffer	35,077	141,675	99,173	Drip - Pressure Compensating	90%	Trees / Shrubs / Groundcover (Medium)	0.5	78,713	
Broadway	Irrigation Service Area 2	Manchester to Coldon	Standard Median	4,858	19,621	13,735	Drip - Pressure Compensating	90%	Trees / Shrubs / Groundcover (Medium)	0.5	10,901	
Broadway	Irrigation Service Area 2	Manchester to Coldon	Median Park	39,747	160,537	112,376	Drip - Pressure Compensating	90%	Trees / Shrubs / Groundcover (Medium)	0.5	89,192	
Broadway	Irrigation Service Area 3	Coldon to 106th	Parkway	26,063	105,268	73,688	Drip - Pressure Compensating	90%	Trees / Shrubs / Groundcover (Medium)	0.5	58,485	399,629
Broadway	Irrigation Service Area 3	Coldon to 106th	Buffer	29,991	121,133	84,793	Drip - Pressure Compensating	90%	Trees / Shrubs / Groundcover (Medium)	0.5	67,300	
Broadway	Irrigation Service Area 3	Coldon to 106th	Standard Median	0	0	0	Drip - Pressure Compensating	90%	Trees / Shrubs / Groundcover (Medium)	0.5	0	
Broadway	Irrigation Service Area 3	Coldon to 106th	Median Park	122,034	492,893	345,025	Drip - Pressure Compensating	90%	Trees / Shrubs / Groundcover (Medium)	0.5	273,844	
Broadway	Irrigation Service Area 4	Imperial to 106th	Parkway	32,092	129,619	90,733	Drip - Pressure Compensating	90%	Trees / Shrubs / Groundcover (Medium)	0.5	72,014	384,263
Broadway	Irrigation Service Area 4	Imperial to 106th	Buffer	27,570	111,355	77,948	Drip - Pressure Compensating	90%	Trees / Shrubs / Groundcover (Medium)	0.5	61,867	
Broadway	Irrigation Service Area 4	Imperial to 106th	Standard Median	0	0	0	Drip - Pressure Compensating	90%	Trees / Shrubs / Groundcover (Medium)	0.5	0	
Broadway	Irrigation Service Area 4	Imperial to 106th	Median Park	111,578	450,662	315,463	Drip - Pressure Compensating	90%	Trees / Shrubs / Groundcover (Medium)	0.5	250,381	
											Total	**1,118,897**

Parkway = Back of Curb

Buffer = Between Bike Lane and Travel Lane

Standard Median

Median Park = south of 93nd of Broadway

MIG

ATTACHMENT F

Geotechnical Infiltration Report

Earth Mechanics, Inc.
Geotechnical & Earthquake Engineering

GEOTECHNICAL DATA REPORT FOR BEST MANAGEMENT PRACTICE DEVICES BROADWAY-MANCHESTER ATP EQUITY PROJECT CITY OF LOS ANGELES, LOS ANGELES COUNTY, CALIFORNIA

Prepared for:
Kimley-Horn & Associates, Inc.
660 S. Figueroa Street, Suite 2050
Los Angeles, CA 90017

Prepared by:

Earth Mechanics, Inc.
17800 Newhope Street, Suite B
Fountain Valley, California 92708

EMI Project Number: 21-169

May 27, 2022

May 27, 2022

EMI Project No. 21-169

Kimley-Horn & Associates, Inc.
660 S. Figueroa Street, Suite 2050
Los Angeles, CA 90017

Attention: Mr. Robert Blume, P.E.

Subject: ***Geotechnical Data Report for Best Management Practice (BMP) Devices***
Broadway-Manchester ATP Equity Project
City of Los Angeles, California

Dear Mr. Blume,

Attached is our Geotechnical Data Report for the subject project in the City of Los Angeles documenting our field testing and soil infiltration data evaluation and recommendations to assist in selection and design of the proposed BMP devices.

We appreciate the opportunity to provide geotechnical services for the project. If you have any questions, please call this office.

Sincerely,
EARTH MECHANICS, INC.

REGISTERED PROFESSIONAL ENGINEER DANE NICKLAUS NO. C84266 EXP. 9-30-2023 CIVIL STATE OF CALIFORNIA

Dane Nicklaus, PE
Project Engineer

REGISTERED PROFESSIONAL ENGINEER MIKE KAPUSKAR No. GE2564 Expires 12-31-22 GEOTECHNICAL STATE OF CALIFORNIA

Mike Kapuskar, PE, GE
Project Manager

DN:mk

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TABLES

FIGURES

APPENDICES

1.0 INTRODUCTION

1.1 Purpose and Scope of Work

This Data Report documents the findings of our geotechnical field investigation and site assessment performed for the Broadway-Manchester ATP Equity Project. The project includes numerous improvements along S. Broadway and Manchester Avenue, which include 11 proposed drywell locations. The project alignment is in the City of Los Angeles, California (see Figure 1). The purpose of the field investigation was to classify the subsurface soils, determine the soil infiltration rates, and identify the depth to groundwater for design of the proposed infiltration devices.

EMI's scope of work consisted of the following tasks:

- Performing a geotechnical field exploration consisting of excavating 11 exploratory borings and installing 11 temporary wells to conduct field infiltration tests (Small Diameter Boring for Deep Infiltration Test),
- Observing groundwater depths to determine groundwater levels and assess BMP device-to-groundwater separation (performed during the geotechnical field investigation),
- Evaluating soil conditions and conducting engineering analysis to estimate soil infiltration rates, and
- Preparing this report, which presents our findings, conclusions, and recommendations.

This work was conducted in general conformance with the practices for BMP evaluation outlined in the Los Angeles County Guidelines for Geotechnical Investigation and Reporting - Low Impact Development Stormwater Infiltration (2021).

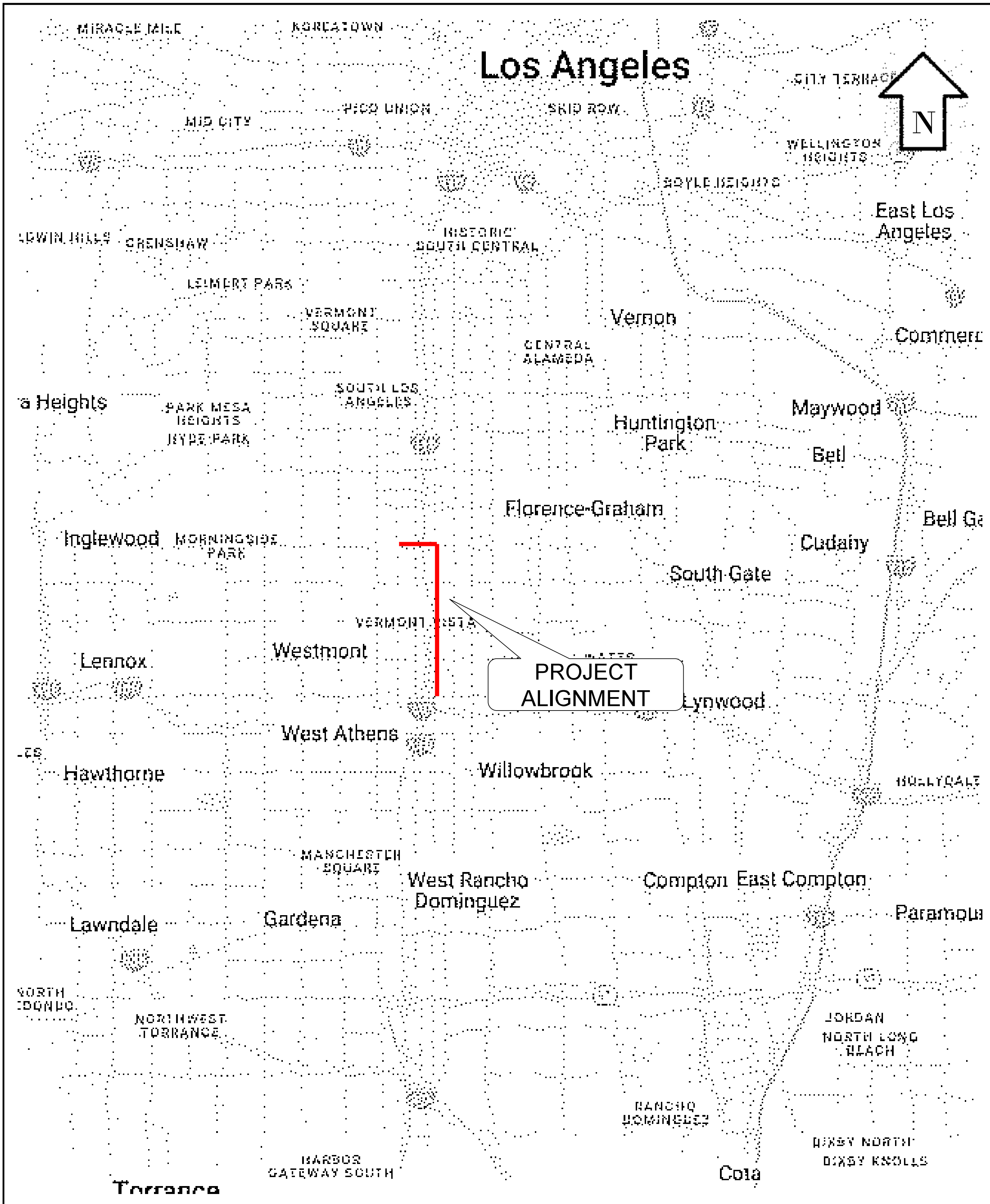
1.2 Site Description and Proposed Development

Based on the project information provided by Kimley-Horn & Associates, Inc. (KHA), improvements are proposed along S. Broadway between Imperial Highway and Manchester Avenue and along Manchester Avenue from Vermont Avenue to Figueroa Street. The proposed improvements consist of numerous general improvements and installing several drywells along S. Broadway and Manchester Avenue to improving drainage along the corridor. KHA has selected 11 BMP sites where infiltration devices are proposed. The BMP site information is provided in Table 1.

Table 1. BMP Site Description

BMP Site #	*Latitude (deg)*	*Longitude (deg)*	*Elevation (ft)*	*Site Location*	*Area Description*	*Ground Cover*	*Device Type*
1	33.96003	-118.29063	136	Manchester Ave. – Near S. Menlo Ave.	Near median area of existing roadway	Paved Road Surface	Drywell
2	33.96004	-118.28752	132	Manchester Ave. – Between Orchard Ave. and Hoover St.		Paved Road Surface	
3	33.96005	-118.28468	131	Manchester Ave. – About 150 ft west of Denver Ave.		Paved Road Surface	
4	33.95170	-118.27828	125	S. Broadway – Between W. 93rd St. and W. 94th St.	Partially Landscaped area within existing median turnout	Unpaved	
5	33.94861	-118.27831	130	S. Broadway – Between W. Colden Ave. and W. 97th St.		Unpaved	
6	33.94615	-118.27826	130	S. Broadway – Between W. 99th St. and W. Century Blvd.		Unpaved	
7	33.94473	-118.27828	131	S. Broadway – Between W. Century Blvd. and W. 101st St.		Unpaved	
8	33.94129	-118.27828	128	S. Broadway – Between W. 104th St. and W. 105th St.		Unpaved	
9	33.93881	-118.27824	131	S. Broadway – Between W. 107th St. and W. 108th St.		Unpaved	
10	33.93577	-118.27826	133	S. Broadway – Between W. 109th St. and W. 109th Pl.		Unpaved	
11	33.93334	-118.27838	135	S. Broadway – Between W. 111th Pl. and W. 112th St.		Unpaved	

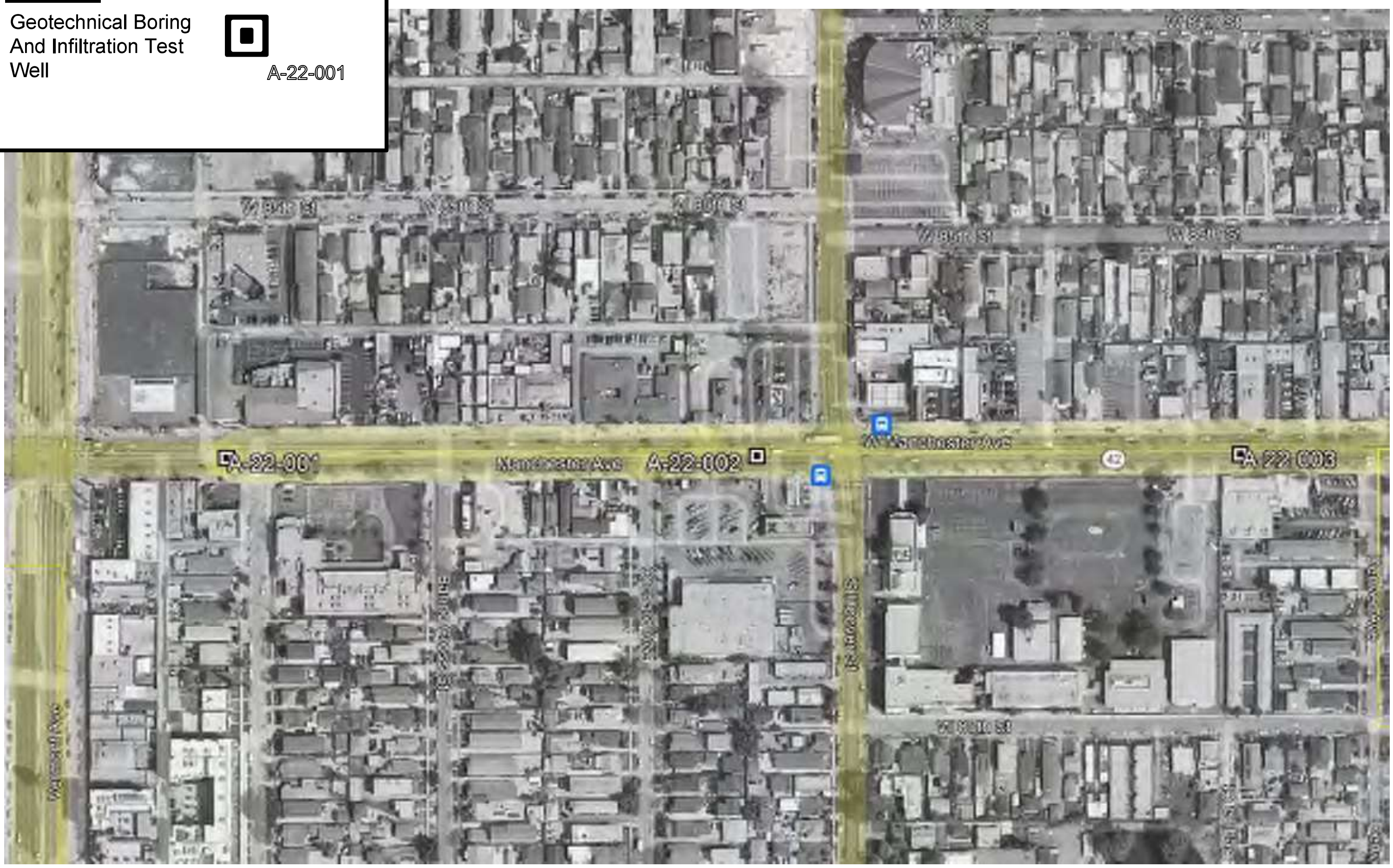
Note: Latitude, longitude, and elevations are approximate.



Broadway-Manchester ATP Equity Project	SITE LOCATION MAP
Earth Mechanics, Inc. Geotechnical and Earthquake Engineering	Figure 1
	Project No. 21-169 — Date: May 2022

Legend

Geotechnical Boring And Infiltration Test Well — A-22-001



Broadway – Manchester ATP Equity Project	BORING AND INFILTRATION TEST LOCATIONS	
Earth Mechanics, Inc. Geotechnical and Earthquake Engineering	Figure 2	
	Project No. 21-169	Date: May 2022

Legend

Geotechnical Boring And Infiltration Test Well — A-22-001

Broadway – Manchester ATP Equity Project	BORING AND INFILTRATION TEST LOCATIONS	
Earth Mechanics, Inc. Geotechnical and Earthquake Engineering		Figure 3
	Project No. 21-169	Date: May 2022

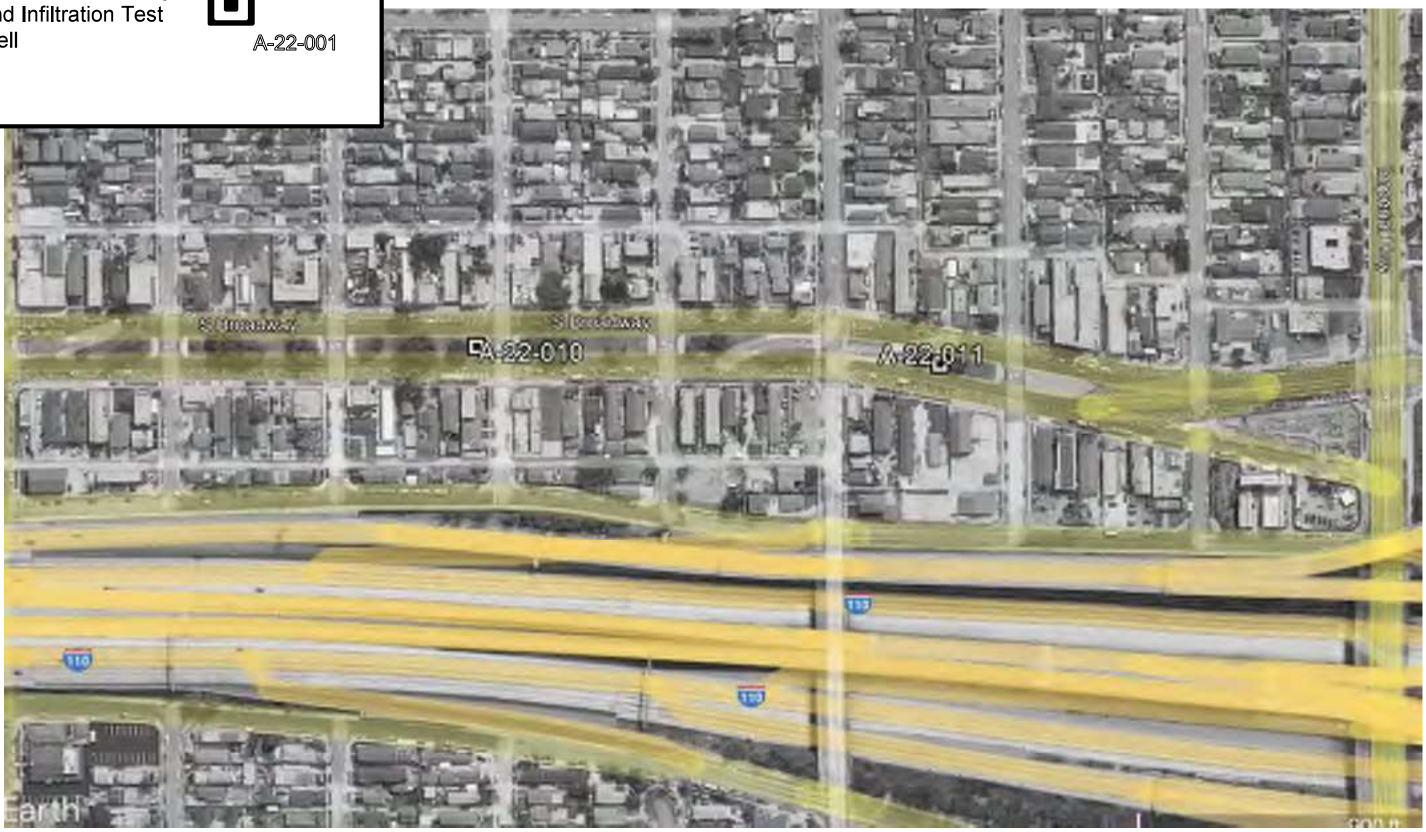
Legend

Geotechnical Boring And Infiltration Test Well — A-22-001

Broadway – Manchester ATP Equity Project	BORING AND INFILTRATION TEST LOCATIONS	
Earth Mechanics, Inc. Geotechnical and Earthquake Engineering	Figure 4	
	Project No. 21-169	Date: May 2022

Legend

Geotechnical Boring And Infiltration Test Well — A-22-001



Broadway – Manchester ATP Equity Project	BORING AND INFILTRATION TEST LOCATIONS	
Earth Mechanics, Inc. Geotechnical and Earthquake Engineering	Figure 5	
	Project No. 21-169	Date: May 2022

2.0 FIELD EXPLORATION AND INFILTRATION TESTING

For the proposed drywells, a geotechnical investigation was performed under the supervision of EMI between April 4 and 22, 2022. The field investigation included excavating and logging eleven geotechnical borings (A-22-001 to 011) and installing eleven temporary wells for conducting in-hole infiltration tests. The approximate locations of the borings and test wells are shown on Figure 2 through Figure 5.

The geotechnical borings were drilled to obtain information on subsurface earth materials and conditions for the proposed improvements. The borings were excavated to a depth of 50 feet below ground surface and the top of boring elevations ranged from 125 feet and 136 feet. Groundwater was encountered in one of the geotechnical borings, A-22-007, at a depth of about 36 feet below ground surface. Groundwater was not encountered within the other ten geotechnical borings excavated for the project. Appendix B can be referred to for the geotechnical boring logs.

Hollow-stem auger borings were drilled using truck-mounted drill rigs (CME 75) equipped with 8” diameter hollow-stem augers. The hand auger borings were drilled using a 3” diameter stainless steel hand auger. Subsurface soils and conditions were logged, and samples of soils were collected for laboratory testing. Soil samples were collected from borings generally at 5-ft intervals alternatively using the Standard Penetration Test (SPT) sampler and the Modified California Drive (MCD) sampler. The SPT sampler is unlined and has an inside diameter of 1.4” and the MCD sampler is lined with a series of 1” tall brass rings with an inside diameter of 2.4”. Blowcounts from the SPT and MCD samplers were recorded during the exploration. The samplers were driven into the soil using a 140-lb hammer falling 30” down a total depth of 18” or until refusal. The drill rigs were equipped with an automatic trip safety hammer. The blowcounts for the last 12” or less of penetration and hammer efficiencies are shown on the boring logs in Appendix B. After completion, the borings were backfilled with neat cement slurry and the ground surface was restored.

To estimate the soil infiltration rate for the proposed drywells, test wells were installed near the proposed locations provided by KHA. The test wells were installed within the boreholes that were excavated to collect subsurface soil samples. Test wells were installed to a depth of about 50 feet below existing grade. The test wells were constructed using 40-feet long 2-inch diameter Schedule 40 PVC screen (0.020’ slot size) with blank PVC casing extending to the ground surface. The bottom 40 feet of the test wells were backfilled with 3/8-inch pea gravel as the filter medium.

Constant- and falling-head in-hole permeability tests were conducted in general accordance with the Los Angeles County Guidelines for Geotechnical Investigation and Reporting - Low Impact Development Stormwater Infiltration (2021). Water for the infiltration tests was supplied from a 2,000-gallon water truck. The water supply line was connected from the truck to an electronic flow totalizer and then to a ball valve and ¾-inch PVC downtube assembly at the top of the test well. The ball valve was used to adjust flow and maintain the water level at 10 ft below the ground surface. An electronic water-level meter was used to measure the water level within the test well during the test. The flow quantities and water level within the test well were monitored and recorded for a minimum of 3 hours. After completion of the tests, the PVC pipe was removed, the test wells were backfilled with neat cement slurry, and the ground surface was restored.

Soil infiltration rates from the test wells were evaluated using methods described in the Los Angeles County Guidelines for Geotechnical Investigation and Reporting - Low Impact Development Stormwater Infiltration (2021).

A summary of the key test data is shown in Table 2 and Table 3. The infiltration test data is attached in Appendix A. The infiltration test locations are shown on Figure 2 through Figure 5. The locations shown are approximated based on physical measurements from identifiable features. Approximate existing ground surface elevations were obtained from Google Earth Pro (2022).

Table 2. Field Exploration Information

BMP Site #	*Test Location ID*	*Approx. Ground Surface Elevation (ft)*	*Borehole*	*Borehole Depth (ft)*	*Test Well Depth Interval (ft)*	*Groundwater Depth (ft)*	*Depth to Impermeable Layer / Slow Infiltration (ft)*
1	I-1	136	A-22-001	50	10 to 50	>50	>50
2	I-2	134	A-22-002	50	10 to 50	>50	40
3	I-3	130	A-22-003	50	10 to 50	>50	>50
4	I-4	125	A-22-004	50	10 to 50	>50	40
5	I-5	128	A-22-005	50	10 to 50	>50	45
6	I-6	130	A-22-006	50	10 to 50	>50	45
7	I-7	130	A-22-007	50	10 to 50	36.2	30
8	I-8	128	A-22-008	50	10 to 50	>50	28
9	I-9	132	A-22-009	50	10 to 50	>50	40
10	I-10	136	A-22-010	50	10 to 50	>50	35
11	I-11	136	A-22-011	50	10 to 50	>50	40

3.0 SUBSURFACE CONDITIONS

3.1 Soil Types

Earth materials encountered during the field investigation consisted of alluvial soils. Soil types were determined by visual inspection of samples during drilling and are summarized in Table 3 using the Uniform Soil Classification System (USCS) and Hydrologic Soil Group (HSG) Type. Additional information on soil types can be found in Section 4.1.

3.2 Present and Historical Groundwater

During the geotechnical field investigation by EMI for the project, groundwater was encountered at Borehole A-22-007 at an elevation of about 94 feet, or at a depth of about 36 feet below ground surface. The maximum depth of exploration reached to about elevation 50 feet. Groundwater was not encountered within any other the other boreholes excavated during the field investigation.

Regional well records from the Department of Water Resources Water Data Library (2022) were reviewed for groundwater measurements. Based on a single well found within a 2-mile radius from the project alignment, data shows one groundwater level measurement made in 1995. The well data shows that the historical groundwater level was more than 100 ft below ground surface.

Several boring logs and monitoring well logs are available on the Geotracker website (2022) from nearby environmental sites. Monitoring well logs from a site near the intersection of S. Broadway and Manchester Ave., near the northern project limit, show groundwater being deeper than 90 ft below ground surface. Borings excavated near W. Century Blvd. and S. Broadway show that groundwater is about 75 ft below ground surface. Near Imperial Hwy and S. Broadway, near the southern project limit, data shows that groundwater is deeper than 80 ft below ground surface.

Per California Geological Survey (CGS, 2006) map for the Inglewood Quadrangle, the depth to historical groundwater at the project site is from 10 ft to 50 ft below ground surface.

Based on available information and information collected during the recent field investigation, groundwater is generally deeper than 50 feet below ground surface at the site. However, groundwater was encountered at a depth of 36 feet below ground surface at Borehole A-22-007, indicating that groundwater can vary within the project alignment.

It should be noted, though, that soil moisture content and groundwater elevation can fluctuate due to variations in seasonal rainfall, nearby irrigation, changes to or addition of flood control improvements, groundwater injection or extraction activities, construction activities, or numerous other man-made or natural conditions.

3.3 Potential for Hydroconsolidation

Hydroconsolidation occurs when soil layers collapse (settle) when water is added under loads. Natural deposits susceptible to hydroconsolidation are typically aeolian, alluvial, or colluvial materials with high apparent dry strength.

Standard Penetration Test (SPT) blowcounts recorded in the existing alluvium during the geotechnical field investigation show generally medium dense to dense granular soils and medium stiff to stiff silts and clays. Hydroconsolidation is not anticipated to impact the proposed infiltration devices or nearby existing structures.

4.0 BMP SITE EVALUATION

4.1 Soil Infiltration Rates

Soil infiltration rates from the well infiltration tests were evaluated using the method described in the Guidelines for Geotechnical Investigation and Reporting - Low Impact Development Stormwater Infiltration (LA County, 2021). The measured infiltration rates are provided in Table 3. It should be noted that the presented design infiltration rates are unfactored.

Table 3. BMP Site Evaluation Summary

BMP Site #	*Location*	*Approx. GSE (ft)*	*Approx. GWD below FG (ft)*	*Controlling Soil Types*			*Design Infiltration Rates*	
				USCS	*HSG*	*Unit*	*Test Depth below FG (ft)*	*Averaged Rate (in/hr)*
1	Manchester Ave. – Near S. Menlo Ave.	136	>50	SM	A	Alluvium	10 - 25	2.5
				CL	B	Alluvium	25 - 50	0.3
2	Manchester Ave. – Between Orchard Ave. and Hoover St.	134	>50	SM	A	Alluvium	10 - 30	2.5
				ML	B	Alluvium	30 - 40	0.3
3	Manchester Ave. – About 150 ft west of Denver Ave.	130	>50	SM/ SP-SM	A	Alluvium	10 - 40	2.5
				SM/ ML	A	Alluvium	40 - 50	1.0
4	S. Broadway – Between W. 93rd St. and W. 94th St.	125	>50	SC/SM	A	Alluvium	10 - 25	2.0
				CL/ML	B	Alluvium	25 - 40	0.3
5	S. Broadway – Between W. Colden Ave. and W. 97th St.	128	>50	SM/ML	B	Alluvium	10 - 45	0.3
6	S. Broadway – Between W. 99th St. and W. Century Blvd.	130	>50	SP-SM/ SM	A	Alluvium	10 - 40	0.5
				CL	C	Alluvium	40 - 45	0.1
7	S. Broadway – Between W. Century Blvd. and W. 101st St.	130	36.2	SP-SM	A	Alluvium	10 - 25	2.5
				CL/ML	A	Alluvium	25 - 30	0.5
8	S. Broadway – Between W. 104th St. and W. 105th St.	128	>50	SP-SM	A	Alluvium	10 - 28	2.0
9	S. Broadway – Between W. 107th St. and W. 108th St.	132	>50	CL/ML	B	Alluvium	10 - 40	0.3
10	S. Broadway – Between W. 109th St. and W. 109th Pl.	136	>50	SP-SM/ SM	A	Alluvium	10 - 30	0.5
				CL	C	Alluvium	30 - 35	0.1
11	S. Broadway – Between W. 111th Pl. and W. 112th St.	136	>50	CL/ML/ SM	A	Alluvium	10 - 40	0.5

Notes:

GSE is an approximate existing ground surface elevation at BMP site and boreholes based on available data.

GWD is the highest groundwater depth below GSE of BMP site based on available groundwater data.

Soil types are predominant soil classifications within the depth explored.

HSG = Hydrologic Soil Group; USCS = Unified Soil Classification System.

Based on observations from the field investigation, the subsurface profile along Manchester Avenue is predominantly coarse-grained material, e.g., silty sand, clayey sand, and poorly graded sand, that has thinly interbedded layers of clay and silt within the upper 30 to 35 feet below ground surface. Below about 35 feet, fine-grained materials became more predominant within the soil borings.

The soils encountered along South Broadway during the geotechnical field investigation were observed to be predominantly coarse-grained material with clay and silt interbeds of varying thickness within the upper 35 to 40 feet below ground surface. Below a depth of about 40 feet, the soils become predominantly fine-grained.

4.2 Groundwater Separation and BMP Feasibility

Groundwater was encountered at a depth of about 36 feet below ground surface at one borehole, A-22-007, during EMI's field investigation. Groundwater was not encountered within any of the other ten boreholes drilled. Historic groundwater levels range from about 10 to 50 feet below ground surface.

Per the Los Angeles County Guidelines for Geotechnical Investigation and Reporting - Low Impact Development Stormwater Infiltration (2021), there is a 10-ft minimum vertical separation requirement between the base of the BMP device and highest seasonal groundwater level.

4.3 Reduction Factors

A reduction factor (RF) should be applied to the unfactored infiltration rates provided in Table 3. The reduction factor is intended to reduce the design values to represent long-term performance of the proposed infiltration devices. The total reduction factor is given based on the values provided in Table 4 and the LA County guidelines (2021). An RF = 3 is recommended based on information collected during the site-specific geotechnical investigation and assuming satisfactory long-term device maintenance. The RF assumes $RF_t = 1$, $RF_v = 1$, and $RF_s = 1$.

Table 4. Reduction Factors

Type of Factor	*Range of Values*
Small Diameter Boring	$RF_t = 1$ to 3
Site Variability, number of tests, and thoroughness of subsurface investigation	$RF_v = 1$ to 3
Long-term siltation, plugging, and maintenance	$RF_s = 1$ to 3

Total Reduction Factor, $RF = RF_t + RF_v + RF_s$
Design Infiltration Rate = Unfactored Infiltration Rate / RF

5.0 CONCLUSIONS AND RECOMMENDATIONS

This report presents the results of an evaluation of the soil and groundwater conditions at the Broadway-Manchester ATP Equity Project in the City of Los Angeles based on a geotechnical field investigation with in-hole permeability testing. The purpose of the evaluation was to assist KHA in assessing the feasibility of the site for BMP devices that are proposed as part of the project improvements.

The soil types encountered and observed infiltration rates are presented in Table 3. Appendix A presents the infiltration test data and analysis results for the project site. Based on observations from the field investigation, the subsurface profile along Manchester Avenue is predominantly coarse-grained material, e.g. silty sand, clayey sand, and poorly graded sand, that has thinly interbedded layers of clay and silt within the upper 30 to 35 feet below ground surface. Below about 35 feet, fine-grained materials became more predominant within the soil borings. The soils encountered along South Broadway during the geotechnical field investigation were observed to be predominantly coarse-grained material with clay and silt interbeds of varying thickness within the upper 35 to 40 feet below ground surface. Below a depth of about 40 feet, the soils become predominantly fine-grained.

Groundwater was encountered at borehole A-22-007 at a depth of about 36 feet below ground surface, however, groundwater was not encountered at any of the other exploratory locations during the geotechnical field investigation for the BMP devices. For details of stratigraphy at each borehole, refer to the boring logs provided in Appendix B.

Based on the test results, the range of calculated infiltration rates was <0.1 in/hr to 2.5 in/hr. At all locations, the average infiltration rate was greater than 0.3 in/hr in the soil layers where infiltration occurred.

A minimum Reduction Factor (RF) equal to 3 should be applied to the unfactored design infiltration rates. The RF assumes $RF_t = 1$, $RF_v = 1$, and $RF_s = 1$.

Per the Los Angeles County Guidelines for Geotechnical Investigation and Reporting - Low Impact Development Stormwater Infiltration (2021), the average design infiltration rates for the alluvium soils meet or exceed the minimum design infiltration rate criteria of 0.3 in/hr at all eleven sites. Refer to Table 2 and Table 3 for infiltration test information, unfactored soil infiltration rates, and depth to groundwater or impervious soil layers.

6.0 LIMITATIONS

This report is intended for use by KHA and the City of Los Angeles for the proposed drainage site evaluations for the Broadway-Manchester ATP Equity Project in the City of Los Angeles, California. This report is based on the project as described herein and the information obtained from the exploratory borings at the approximate locations as described on the boring logs. The findings and recommendations contained in this report are based on the results of the field investigation, literature review, and engineering analyses. Also, soils and subsurface conditions encountered in the exploratory borings are presumed to be representative of the project site; however, subsurface conditions and characteristics of soils between exploratory borings can vary. The findings reflect an interpretation of the direct evidence obtained. Recommendations presented herein assume that an appropriate level of quality control and quality assurance (inspections and tests) will be provided during construction. EMI should be notified of any pertinent changes in the project plans or if subsurface conditions are found to vary from those described herein. Modifications to the project plans or variations in subsurface conditions may require re-evaluation of the recommendations contained in this report.

The data, opinions, and recommendations contained herein are applicable to the specific design elements and locations which are the subject of this report. Data, opinions, and recommendations herein have no applicability to any other design elements or to any other locations, and any and all subsequent users accept any and all liability resulting from any use or reuse of the data, opinions, and recommendations without the prior written consent of EMI.

EMI is not responsible for construction means, methods, techniques, sequences, or procedures, or for safety precautions or programs in connection with the construction, for the acts or omissions of the Contractor, or any other person performing any of the construction, or for the failure of any worker to carry out the construction in accordance with the final construction drawings and specifications.

Services performed by EMI were conducted in a manner consistent with that level of care and skill ordinarily exercised by members of the profession currently practicing in the same locality under similar conditions. No other representation, expressed or implied, and no warranty or guarantee is included or intended.

7.0 REFERENCES

California Geological Survey, 2006, Seismic Hazard Zone Report for the Inglewood 7.5-Minute Quadrangle, Los Angeles County, California: Division of Mines and Geology, Seismic Hazard Zone Report 027.

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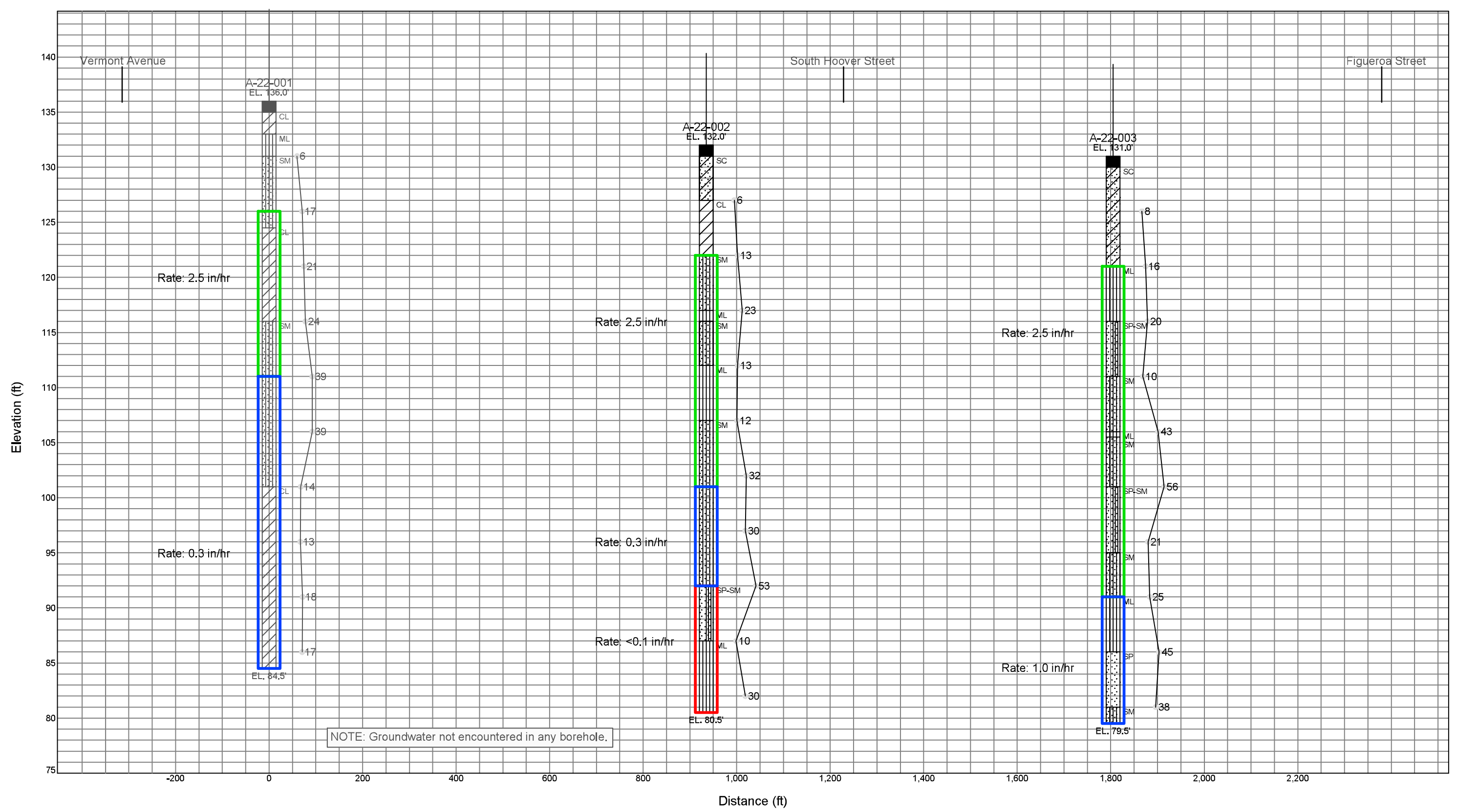
APPENDIX A

INFILTRATION TEST DATA AND CALCULATIONS



Earth Mechanics, Inc. Geotechnical and Earthquake Engineering	KHA, Broadway- Manchester ATP Dry Wells	Manchester Avenue Unfactored Infiltration Rate Profile
	Project No.: 21-169 / DATE: May 2022	

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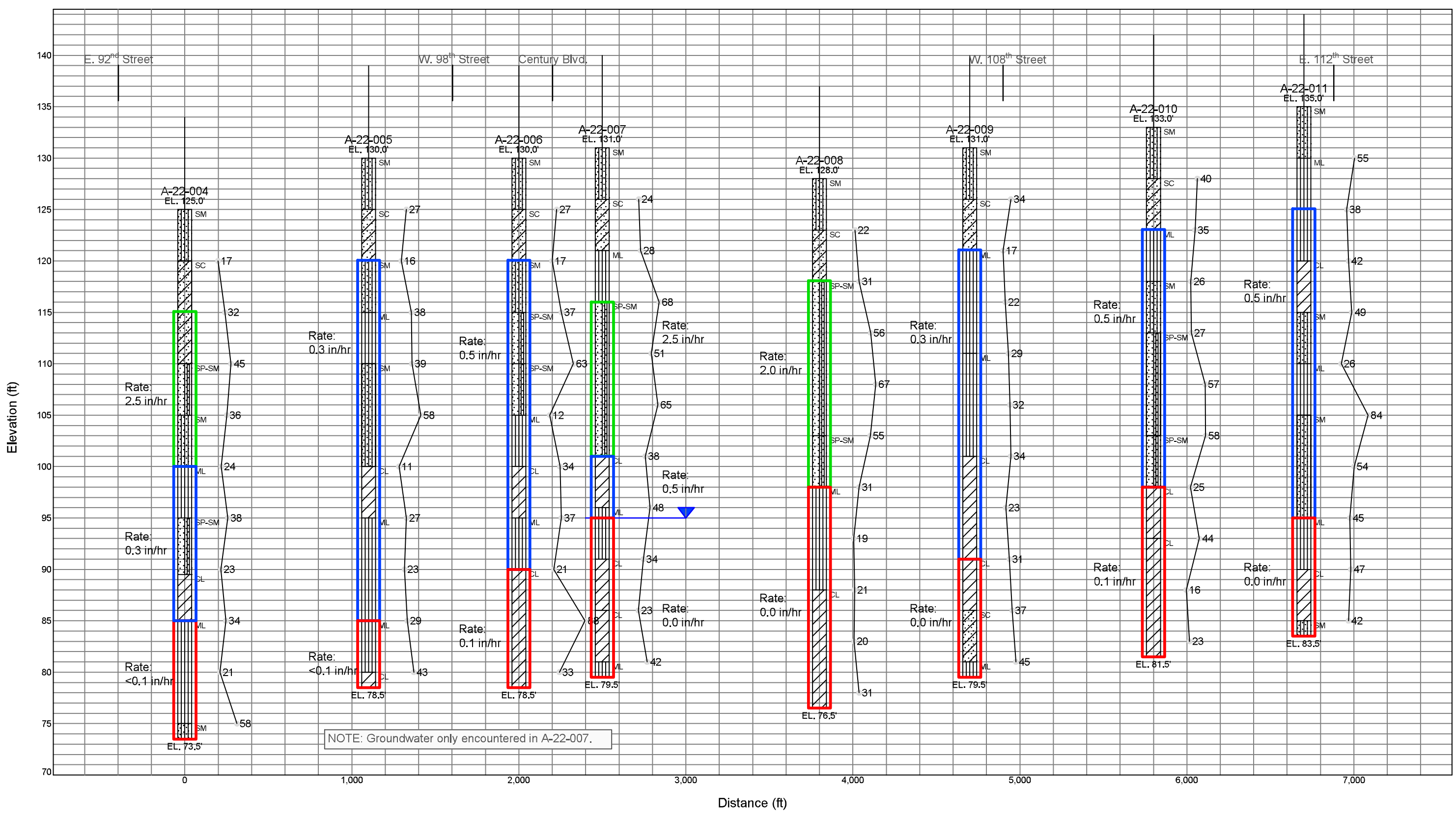


Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

KHA, Broadway- Manchester ATP Dry Wells

Project No.: 21-169

DATE: May 2022

South Broadway
Unfactored Infiltration Rate Profile

Location	Well Depth ft	Groundwater ft	Depth to GW or Impervious Layer ft	Layer Depth ft	Unfactored Infiltration Rate in/hr
I-1	50	NE	50	10 - 25 25 - 50	2.5 0.3
I-2	50	NE	40	10 - 30 30 - 40	2.5 0.3
I-3	50	NE	50	10 - 40 40 - 50	2.5 1.0
I-4	50	NE	40	10 - 25 25 - 40	2.0 0.3
I-5	50	NE	45	10 - 45	0.3
I-6	50	NE	45	10 - 40 40 - 45	0.5 0.1
I-7	50	36.2	30	10 - 25 25 - 30	2.5 0.5
I-8	50	NE	28	10 - 28	2.0
I-9	50	NE	40	10 - 40	0.3
I-10	50	NE	35	10 - 30 30 - 35	0.5 0.1
I-11	50	NE	40	10 - 40	0.5

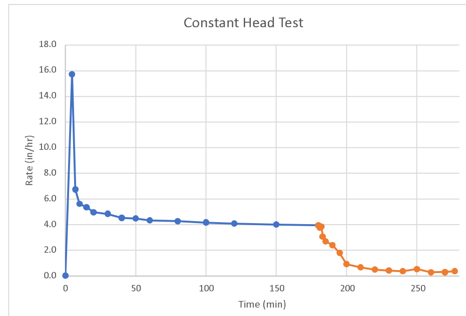
I-1 **Field Infiltration Test Data** Project: **Broaday/Manchester ATP Equity Project**

Depth to GW or Impermeable Layer 50

Diameter 8.0 in

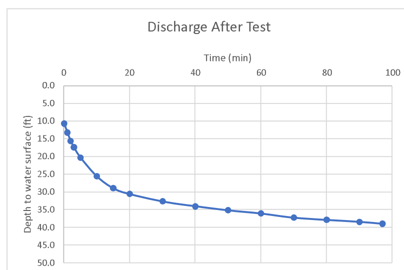
Perimeter 2.09 ft

Diameter		Area	Time	Depth	Volume	Volume	Delta	Time	Cumulative Time		Delta	Flow	Boring	Calc	Infiltration
in	ft	ft2		ft	L	gal	min	hr	mim	hr	Vol	gpm	Area	Flow	Rate
8	0.67	0.35	9:28	-	0	0	0	0	0	0.00	0	-	-	-	0.0
8	0.67	0.35	9:32	11.0	240	63.4	5	0.08	5	0.08	63.4	13.3	81.7	107.1	15.7
8	0.67	0.35	9:35	10.8	289	76.3	2	0.04	7	0.12	12.9	5.8	82.1	46.1	6.7
8	0.67	0.35	9:38	11.0	343	90.6	3	0.05	10	0.17	14.3	4.8	81.7	38.1	5.6
8	0.67	0.35	9:43	10.9	429	113.3	5	0.08	15	0.25	22.7	4.5	81.9	36.4	5.3
8	0.67	0.35	9:48	10.9	509	134.5	5	0.08	20	0.33	21.1	4.2	81.9	33.9	5.0
8	0.67	0.35	9:58	10.8	665	175.7	10	0.17	30	0.50	41.2	4.1	82.1	33.1	4.8
8	0.67	0.35	10:08	10.8	811	214.2	10	0.17	40	0.67	38.6	3.9	82.1	30.9	4.5
8	0.67	0.35	10:18	10.7	956	252.5	10	0.17	50	0.83	38.3	3.8	82.3	30.7	4.5
8	0.67	0.35	10:28	11.0	1095	289.3	10	0.17	60	1.00	36.7	3.7	81.7	29.5	4.3
8	0.67	0.35	10:48	10.7	1371	362.2	20	0.33	80	1.33	72.9	3.6	82.3	29.2	4.3
8	0.67	0.35	11:08	10.9	1639	433.0	20	0.33	100	1.67	70.8	3.5	81.9	28.4	4.2
8	0.67	0.35	11:28	10.7	1903	502.7	20	0.33	120	2.00	69.7	3.5	82.3	28.0	4.1
8	0.67	0.35	11:58	10.8	2291	605.2	30	0.50	150	2.50	102.5	3.4	82.1	27.4	4.0
8	0.67	0.35	12:28	10.7	2673	706.1	30	0.50	180	3.00	100.9	3.4	82.3	27.0	3.9



Drainage After Testing

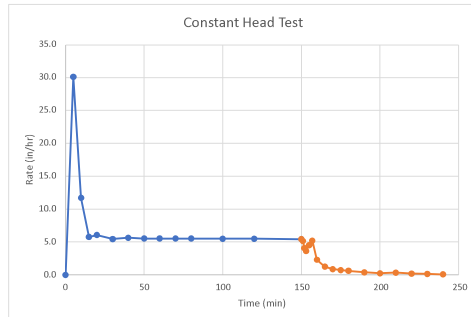
Time	Depth	Volume	Delta T	Delta V	Area	Flow GPM	Flow ft3/hı	Rate
12:30	10.7	47.2	0	0	0.0	0.0	0.0	3.9
12:31	13.2	44.2	1	3.0	77.1	3.0	24.1	3.7
12:32	15.6	41.3	1	2.9	72.0	2.9	23.1	3.8
12:33	17.4	39.1	1	2.2	68.3	2.2	17.3	3.0
12:35	20.3	35.6	2	3.5	62.2	1.7	14.0	2.7
12:40	25.6	29.3	5	6.4	51.1	1.3	10.2	2.4
12:45	29.0	25.2	5	4.1	44.0	0.8	6.5	1.8
12:50	30.6	23.3	5	1.9	40.6	0.4	3.1	0.9
13:00	32.7	20.8	10	2.5	36.2	0.3	2.0	0.7
13:10	34.1	19.1	10	1.7	33.3	0.2	1.3	0.5
13:20	35.2	17.8	10	1.3	31.0	0.1	1.1	0.4
13:30	36.1	16.7	10	1.1	29.1	0.1	0.9	0.4
13:40	37.3	15.2	10	1.4	26.6	0.1	1.2	0.5
13:50	37.9	14.5	10	0.7	25.3	0.1	0.6	0.3
14:00	38.5	13.8	10	0.7	24.1	0.1	0.6	0.3
14:07	39.0	13.2	7	0.6	23.0	0.1	0.7	0.4
Gal/ft	1.2							



I-2 **Field Infiltration Test Data** Project: **Broaday/Manchester ATP Equity Project**

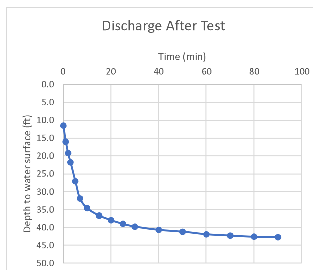
Depth to GW or Impermeable Layer	50	
Diameter	8.0	in
Perimeter	2.09	ft

Diameter		Area	Time	Depth	Volume	Volume	Delta	Time	Cumulative Time		Delta	Flow	Boring	Calc	Infiltration
in	ft	ft2		ft	L	gal	min	hr	mim	hr	Vol	gpm	Area	Flow	Rate
8	0.67	0.35	9:55	-	0	0	0	0	0	0.00	0	-	-	-	0.0
8	0.67	0.35	10:00	28.0	273	72.1	5	0.08	5	0.08	72.1	14.4	46.1	115.7	30.1
8	0.67	0.35	10:05	11.6	458	121.0	5	0.08	10	0.17	48.9	9.8	80.4	78.4	11.7
8	0.67	0.35	10:10	11.5	549	145.0	5	0.08	15	0.25	24.0	4.8	80.6	38.6	5.7
8	0.67	0.35	10:15	11.5	645	170.4	5	0.08	20	0.33	25.4	5.1	80.6	40.7	6.1
8	0.67	0.35	10:25	11.4	819	216.4	10	0.17	30	0.50	46.0	4.6	80.8	36.9	5.5
8	0.67	0.35	10:35	11.5	998	263.6	10	0.17	40	0.67	47.3	4.7	80.6	37.9	5.6
8	0.67	0.35	10:45	11.5	1174	310.1	10	0.17	50	0.83	46.5	4.6	80.6	37.3	5.5
8	0.67	0.35	10:55	11.5	1350	356.6	10	0.17	60	1.00	46.5	4.6	80.6	37.3	5.5
8	0.67	0.35	11:05	11.5	1525	402.9	10	0.17	70	1.17	46.2	4.6	80.6	37.1	5.5
8	0.67	0.35	11:15	11.5	1700	449.1	10	0.17	80	1.33	46.2	4.6	80.6	37.1	5.5
8	0.67	0.35	11:35	11.5	2049	541.3	20	0.33	100	1.67	92.2	4.6	80.6	37.0	5.5
8	0.67	0.35	11:55	11.5	2397	633.2	20	0.33	120	2.00	91.9	4.6	80.6	36.9	5.5
8	0.67	0.35	12:25	11.5	2913	769.5	30	0.50	150	2.50	136.3	4.5	80.6	36.4	5.4



Drainage After Testing

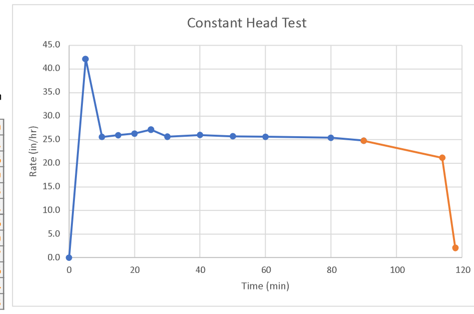
Time	Depth	Volume	Delta T	Delta V	Area	Flow GPM	Flow ft3/hı	Rate
12:27	11.5	32.7	0	0	0.0	0.0	0.0	5.4
12:28	16.0	28.9	1	3.8	71.2	3.8	30.7	5.2
12:29	19.2	26.2	1	2.7	64.5	2.7	21.8	4.1
12:30	21.8	24.0	1	2.2	59.1	2.2	17.7	3.6
12:32	27.1	19.5	2	4.5	48.0	2.3	18.1	4.5
12:34	31.9	15.4	2	4.1	37.9	2.0	16.4	5.2
12:37	34.6	13.1	3	2.3	32.3	0.8	6.1	2.3
12:42	36.7	11.3	5	1.8	27.9	0.4	2.9	1.2
12:47	38.0	10.2	5	1.1	25.1	0.2	1.8	0.8
12:52	39.0	9.4	5	0.9	23.0	0.2	1.4	0.7
12:57	39.8	8.7	5	0.7	21.4	0.1	1.1	0.6
13:07	40.7	7.9	10	0.8	19.5	0.1	0.6	0.4
13:17	41.2	7.5	10	0.4	18.4	0.0	0.3	0.2
13:27	41.9	6.9	10	0.6	17.0	0.1	0.5	0.3
13:37	42.3	6.5	10	0.3	16.1	0.0	0.3	0.2
13:47	42.6	6.3	10	0.3	15.5	0.0	0.2	0.2
13:57	42.8	6.2	10	0.1	15.2	0.0	0.1	0.1
Gal/ft	0.9							



I-3 **Field Infiltration Test Data** Project: **Broaday/Manchester ATP Equity Project**

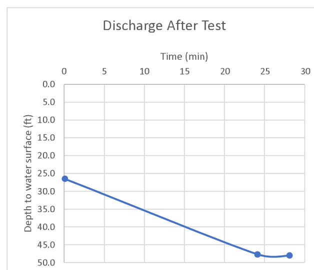
Depth to GW or Impermeable Layer	50	
Diameter	8.0	in
Perimeter	2.09	ft

Diameter in	ft	Area ft2	Time	Depth ft	Volume L	Volume gal	Delta min	Time hr	Cumulative Time mim	hr	Delta Vol	Flow gpm	Boring Area	Calc Flow	Infiltration Rate
8	0.67	0.35	9:22	-	0	0	0	0	0	0.00	0	-	-	-	0.0
8	0.67	0.35	9:27	36.0	243	64.2	5	0.08	5	0.08	64.2	12.8	29.3	103.0	42.1
8	0.67	0.35	9:32	28.0	475	125.5	5	0.08	10	0.17	61.3	12.3	46.1	98.3	25.6
8	0.67	0.35	9:37	27.0	721	190.5	5	0.08	15	0.25	65.0	13.0	48.2	104.2	26.0
8	0.67	0.35	9:42	27.0	970	256.2	5	0.08	20	0.33	65.8	13.2	48.2	105.5	26.3
8	0.67	0.35	9:47	27.0	1227	324.1	5	0.08	25	0.42	67.9	13.6	48.2	108.9	27.1
8	0.67	0.35	9:52	26.8	1472	388.9	5	0.08	30	0.50	64.7	12.9	48.6	103.8	25.6
8	0.67	0.35	10:02	26.7	1971	520.7	10	0.17	40	0.67	131.8	13.2	48.8	105.7	26.0
8	0.67	0.35	10:12	26.6	2467	651.7	10	0.17	50	0.83	131.0	13.1	49.0	105.1	25.7
8	0.67	0.35	10:22	26.6	2961	782.2	10	0.17	60	1.00	130.5	13.1	49.0	104.7	25.6
8	0.67	0.35	10:42	26.5	3946	1042.4	20	0.33	80	1.33	260.2	13.0	49.2	104.4	25.4
8	0.67	0.35	10:52	26.5	4426	1169.2	10	0.17	90	1.50	126.8	12.7	49.2	101.7	24.8



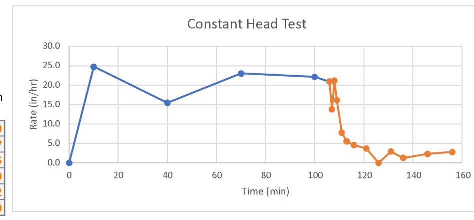
Drainage After Testing

Time	Depth	Volume	Delta T	Delta V		Area	Flow GPM	Flow ft3/hr	Rate		
10:52	26.5	28.2	0	0		0.0	0.0	0.0	24.8	0.1	90
11:16	47.7	2.8	24	25.4		4.8	1.1	8.5	21.2	24	114
11:20	48.0	2.4	4	0.4		4.2	0.1	0.7	2.1	28	118
Gal/ft	1.2										



I-3 **Field Infiltration Test Data** Project: **Broaday/Manchester ATP Equity Project**

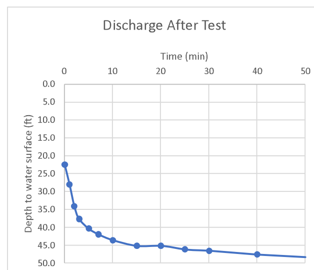
Depth to GW or Impermeable Layer	50	
Diameter	8.0	in
Perimeter	2.09	ft



Diameter in	ft	Area ft2	Time	Depth ft	Volume L	Volume gal	Delta min	Time hr	Cumulative Time mim	hr	Delta Vol	Flow gpm	Boring Area	Calc Flow	Infiltration Rate
8	0.67	0.35	11:20	-	0	0	0	0	0	0.00	0	-	-	-	0.0
8	0.67	0.35	11:30	24.0	530	140.0	10	0.17	10	0.17	140.0	14.0	54.5	112.3	24.7
8	0.67	0.35	12:00	23.2	1554	410.5	30	0.50	40	0.67	270.5	9.0	56.1	72.3	15.5
8	0.67	0.35	12:30	23.2	3080	813.6	30	0.50	70	1.17	403.1	13.4	56.1	107.8	23.0
8	0.67	0.35	13:00	22.8	4569	1207.0	30	0.50	100	1.67	393.4	13.1	57.0	105.2	22.2
8	0.67	0.35	13:06	22.5	4854	1282.3	6	0.10	106	1.77	75.3	12.5	57.6	100.6	21.0

Drainage After Testing

Time	Depth	Volume	Delta T	Delta V	Area	Flow GPM	Flow ft3/hr	Rate		
13:06	22.5	33.0	0	0	0.0	0.0	0.0	21.0	0.1	106
13:07	28.0	26.4	1	6.6	46.1	6.6	52.9	13.8	1	107
13:08	34.1	19.1	1	7.3	33.3	7.3	58.7	21.2	2	108
13:09	37.7	14.8	1	4.3	25.8	4.3	34.6	16.1	3	109
13:11	40.4	11.5	2	3.2	20.1	1.6	13.0	7.8	5	111
13:13	42.0	9.6	2	1.9	16.8	1.0	7.7	5.5	7	113
13:16	43.6	7.7	3	1.9	13.4	0.6	5.1	4.6	10	116
13:21	45.2	5.8	5	1.9	10.1	0.4	3.1	3.7	15	121
13:26	45.2	5.8	5	0.0	10.1	0.0	0.0	0.0	20	126
13:31	46.2	4.6	5	1.2	8.0	0.2	1.9	2.9	25	131
13:36	46.6	4.1	5	0.5	7.1	0.1	0.8	1.3	30	136
13:46	47.6	2.9	10	1.2	5.0	0.1	1.0	2.3	40	146
13:56	48.4	1.9	10	1.0	3.4	0.1	0.8	2.8	50	156
Gal/ft	1.2									



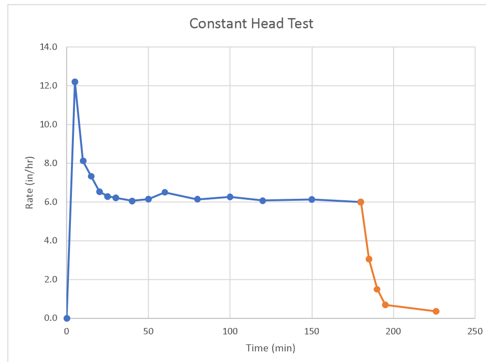
I-4 **Field Infiltration Test Data** Project: **Broaday/Manchester ATP Equity Project**

Depth to GW or Impermeable Layer 50

Diameter 8.0 in

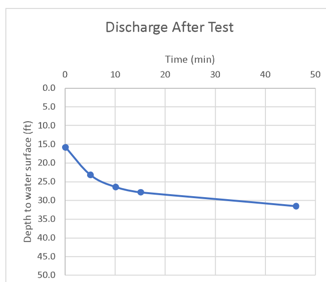
Perimeter 2.09 ft

Diameter		Area	Time	Depth	Volume	Delta	Time	Cumulative Time		Delta	Flow	Boring	Calc	Infiltration
in	ft	ft2		ft	gal	min	hr	mim	hr	Vol	gpm	Area	Flow	Rate
8	0.67	0.35	11:45	-	0	0	0	0	0.00	0	-	-	-	0.0
8	0.67	0.35	11:50	35.0	19.9	5	0.08	5	0.08	19.9	4.0	31.4	32.0	12.2
8	0.67	0.35	11:55	25.0	42.0	5	0.08	10	0.17	22.1	4.4	52.4	35.4	8.1
8	0.67	0.35	12:00	21.5	64.7	5	0.08	15	0.25	22.7	4.5	59.7	36.4	7.3
8	0.67	0.35	12:05	17.3	88.0	5	0.08	20	0.33	23.2	4.6	68.5	37.3	6.5
8	0.67	0.35	12:10	16.4	111.0	5	0.08	25	0.42	23.0	4.6	70.4	36.9	6.3
8	0.67	0.35	12:15	16.4	133.7	5	0.08	30	0.50	22.7	4.5	70.4	36.4	6.2
8	0.67	0.35	12:25	16.1	178.3	10	0.17	40	0.67	44.6	4.5	71.0	35.8	6.1
8	0.67	0.35	12:35	16.0	223.8	10	0.17	50	0.83	45.4	4.5	71.2	36.4	6.1
8	0.67	0.35	12:45	16.0	271.8	10	0.17	60	1.00	48.1	4.8	71.2	38.6	6.5
8	0.67	0.35	13:05	15.8	363.2	20	0.33	80	1.33	91.4	4.6	71.6	36.7	6.1
8	0.67	0.35	13:25	15.8	456.5	20	0.33	100	1.67	93.3	4.7	71.6	37.4	6.3
8	0.67	0.35	13:45	15.8	546.8	20	0.33	120	2.00	90.3	4.5	71.6	36.2	6.1
8	0.67	0.35	14:15	15.8	683.7	30	0.50	150	2.50	136.8	4.6	71.6	36.6	6.1
8	0.67	0.35	14:45	15.8	817.6	30	0.50	180	3.00	133.9	4.5	71.6	35.8	6.0



Drainage After Testing

Time	Depth	Volume	Delta T	Delta V	Area	Flow GPM	Flow ft3/hr	Rate
14:45	15.8	41.0	0	0	0	0	0	6.0
14:50	23.2	32.2	5	8.9	56.1	1.776	14.24	3.0
14:55	26.4	28.3	5	3.8	49.4	0.768	6.16	1.5
15:00	27.8	26.6	5	1.7	46.5	0.336	2.69	0.7
15:31	31.5	22.2	31	4.4	38.7	0.143226	1.15	0.4
Gal/ft	1.2							



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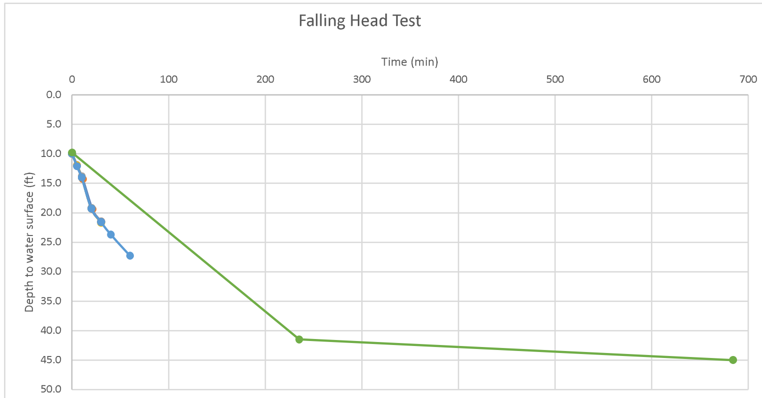
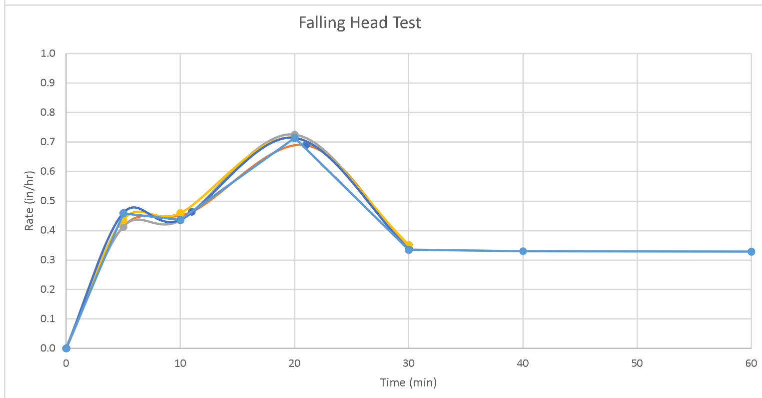
I-5 **Field Infiltration Test Data** Project: **Broaday/Manchester ATP Equity Project**

Depth to GW or Impermeable Layer	50	
Diameter	8.0	in
Perimeter	2.09	ft

Time	Depth	Volume	Delta T	Delta V	Area	Flow GPM	Flow ft3/hr	Rate
Falling Head Test #1								
8:32	10.0	36.0	0	0	0.0	0.0	0.0	-
8:37	11.9	34.3	5	1.7	79.8	0.3	2.7	0.4
8:43	14.3	32.1	6	2.2	74.8	0.4	2.9	0.5
8:53	19.4	27.5	10	4.6	64.1	0.5	3.7	0.7
9:02	21.5	25.7	9	1.9	59.7	0.2	1.7	0.3
Falling Head Test #2								
9:03	10.0	36.0	0	0.0	0.0	0.0	0.0	-
9:08	11.9	34.3	5	1.7	79.8	0.3	2.7	0.4
9:13	13.8	32.6	5	1.7	75.8	0.3	2.7	0.4
9:23	19.2	27.7	10	4.9	64.5	0.5	3.9	0.7
9:33	21.5	25.7	10	2.1	59.7	0.2	1.7	0.3
Falling Head Test #3								
9:33	10.0	36.0	0	0	0.0	0.0	0.0	-
9:38	12.0	34.2	5	1.8	79.6	0.4	2.9	0.4
9:43	14.0	32.4	5	1.8	75.4	0.4	2.9	0.5
9:53	19.3	27.6	10	4.8	64.3	0.5	3.8	0.7
10:03	21.7	25.5	10	2.2	59.3	0.2	1.7	0.4
Falling Head Test #4								
10:05	10.0	36.0	0	0	0.0	0.0	0.0	-
10:10	12.1	34.1	5	1.9	79.4	0.4	3.0	0.5
10:15	14.0	32.4	5	1.7	75.4	0.3	2.7	0.4
10:25	19.3	27.6	10	4.8	64.3	0.5	3.8	0.7
10:35	21.6	25.6	10	2.1	59.5	0.2	1.7	0.3
Falling Head Test #5								
10:37	10.0	36.0	0	0	0.0	0.0	0.0	-
10:42	12.1	34.1	5	1.9	79.4	0.4	3.0	0.5
10:47	14.0	32.4	5	1.7	75.4	0.3	2.7	0.4
10:57	19.3	27.6	10	4.8	64.3	0.5	3.8	0.7
11:07	21.6	25.6	10	2.1	59.5	0.2	1.7	0.3
11:17	23.7	23.7	10	1.9	55.1	0.2	1.5	0.3
11:37	27.3	20.4	20	3.2	47.5	0.2	1.3	0.3
Falling Head Test #6								
8:18	9.8	36.2	0	0	0.0	0.0	0.0	-
12:13	41.5	7.7	235	28.5	17.8	0.1	1.0	0.7
15:47	45.0	4.5	449	31.7	10.5	0.1	0.6	0.6





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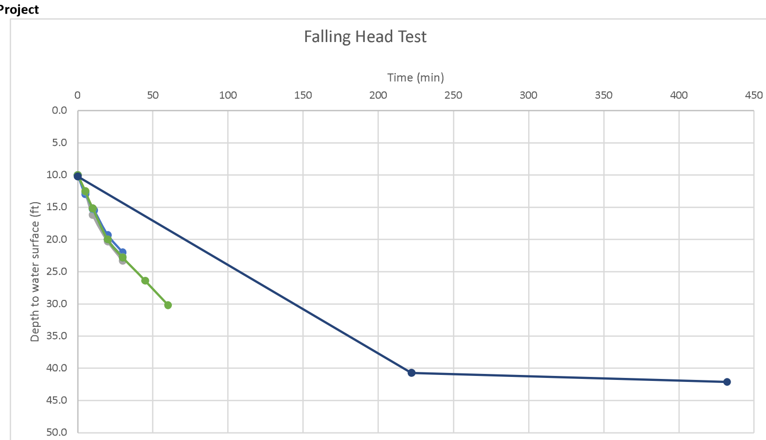
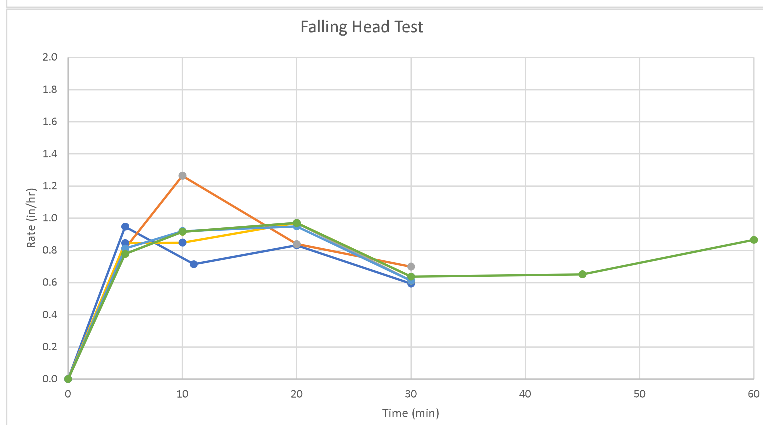
I-6 **Field Infiltration Test Data** Project: **Broaday/Manchester ATP Equity Project**

Depth to GW or Impermeable Layer 45
Diameter 8.0 in
Perimeter 2.09 ft

Time	Depth	Volume	Delta T	Delta V	Area	Flow GPM	Flow ft3/hr	Rate	
Falling Head Test #1									
12:27	10.0	38.5	0	0	0.0	0.0	0.0	-	
12:32	13.0	35.2	5	3.3	67.0	0.7	5.3	0.9	
12:38	15.5	32.5	6	2.8	61.8	0.5	3.7	0.7	
12:47	19.3	28.3	9	4.2	53.8	0.5	3.7	0.8	
12:57	22.0	25.3	10	3.0	48.2	0.3	2.4	0.6	
Falling Head Test #2									
13:00	10.0	38.5	0	0.0	0.0	0.0	0.0	-	
13:05	12.6	35.6	5	2.9	67.9	0.6	4.6	0.8	
13:10	16.2	31.7	5	4.0	60.3	0.8	6.4	1.3	
13:20	20.3	27.2	10	4.5	51.7	0.5	3.6	0.8	
13:30	23.3	23.9	10	3.3	45.4	0.3	2.6	0.7	
Falling Head Test #3									
13:31	10.0	38.5	0	0	0.0	0.0	0.0	-	
13:36	12.5	35.8	5	2.8	68.1	0.6	4.4	0.8	
13:41	15.2	32.8	5	3.0	62.4	0.6	4.8	0.9	
13:51	20.0	27.5	10	5.3	52.4	0.5	4.2	1.0	
14:01	22.7	24.5	10	3.0	46.7	0.3	2.4	0.6	
Falling Head Test #4									
14:02	10.0	38.5	0	0	0.0	0.0	0.0	-	
14:07	12.7	35.5	5	3.0	67.6	0.6	4.8	0.8	
14:12	15.2	32.8	5	2.8	62.4	0.6	4.4	0.8	
14:22	20.0	27.5	10	5.3	52.4	0.5	4.2	1.0	
14:32	22.8	24.4	10	3.1	46.5	0.3	2.5	0.6	
Falling Head Test #5									
14:33	10.0	38.5	0	0	0.0	0.0	0.0	-	
14:38	12.6	35.6	5	2.9	67.9	0.6	4.6	0.8	
14:43	15.3	32.7	5	3.0	62.2	0.6	4.8	0.9	
14:53	20.0	27.5	10	5.2	52.4	0.5	4.1	1.0	
15:03	22.7	24.5	10	3.0	46.7	0.3	2.4	0.6	
Falling Head Test #6									
15:04	10.0	38.5	0	0	0.0	0.0	0.0	-	
15:09	12.5	35.8	5	2.8	68.1	0.6	4.4	0.8	
15:14	15.2	32.8	5	3.0	62.4	0.6	4.8	0.9	
15:24	20.0	27.5	10	5.3	52.4	0.5	4.2	1.0	
15:34	22.8	24.4	10	3.1	46.5	0.3	2.5	0.6	
15:49	26.4	20.5	15	4.0	39.0	0.3	2.1	0.7	
16:04	30.2	16.3	15	4.2	31.0	0.3	2.2	0.9	
Falling Head Test #7									
8:33	10.2	38.3	0	0	0.0	0.0	0.0	-	
12:15	40.7	4.7	222	33.6	9.0	0.2	1.2	1.6	
15:45	42.1	3.2	210	1.5	6.1	0.0	0.1	0.1	432

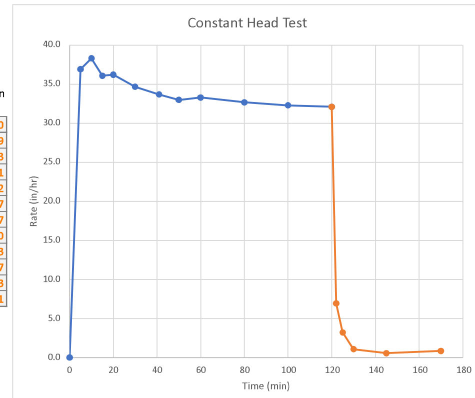




I-7 **Field Infiltration Test Data** Project: **Broaday/Manchester ATP Equity Project**

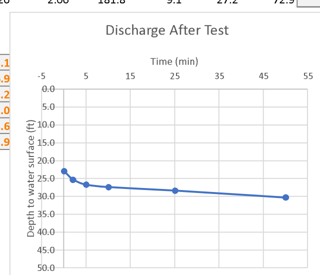
Depth to GW or Impermeable Layer 36
Diameter 8.0 in
Perimeter 2.09 ft

Diameter in	ft	Area ft2	Time	Depth ft	Volume L	Volume gal	Delta min	Time hr	Cumulative Time mim	hr	Delta Vol	Flow gpm	Boring Area	Calc Flow	Infiltration Rate
8	0.67	0.35	9:00	-	0	0	0	0	0	0.00	0	-	-	-	0.0
8	0.67	0.35	9:05	23.9	184	48.6	5	0.08	5	0.08	48.6	9.7	25.3	78.0	36.9
8	0.67	0.35	9:10	23.9	375	99.1	5	0.08	10	0.17	50.5	10.1	25.3	80.9	38.3
8	0.67	0.35	9:15	23.9	555	146.6	5	0.08	15	0.25	47.6	9.5	25.3	76.3	36.1
8	0.67	0.35	9:20	23.6	740	195.5	5	0.08	20	0.33	48.9	9.8	26.0	78.4	36.2
8	0.67	0.35	9:30	23.3	1103	291.4	10	0.17	30	0.50	95.9	9.6	26.6	76.9	34.7
8	0.67	0.35	9:41	23.0	1500	396.3	11	0.18	41	0.68	104.9	9.5	27.2	76.5	33.7
8	0.67	0.35	9:50	23.0	1818	480.3	9	0.15	50	0.83	84.0	9.3	27.2	74.9	33.0
8	0.67	0.35	10:00	23.0	2175	574.6	10	0.17	60	1.00	94.3	9.4	27.2	75.6	33.3
8	0.67	0.35	10:20	23.0	2875	759.5	20	0.33	80	1.33	184.9	9.2	27.2	74.2	32.7
8	0.67	0.35	10:40	23.0	3567	942.3	20	0.33	100	1.67	182.8	9.1	27.2	73.3	32.3
8	0.67	0.35	11:00	23.0	4255	1124.1	20	0.33	120	2.00	181.8	9.1	27.2	72.9	32.1



Drainage After Testing

Time	Depth	Volume	Delta T	Delta V	Area	Flow GPM	Flow ft3/hr	Rate
11:00	23.0	18.2	0	0	0.0	0.0	0.0	32.1
11:02	25.3	15.0	2	3.2	22.4	1.6	12.9	6.9
11:05	26.7	13.0	3	2.0	19.5	0.7	5.2	3.2
11:10	27.4	12.0	5	1.0	18.0	0.2	1.6	1.0
11:25	28.4	10.6	15	1.4	15.9	0.1	0.7	0.6
11:50	30.3	8.0	25	2.7	11.9	0.1	0.9	0.9



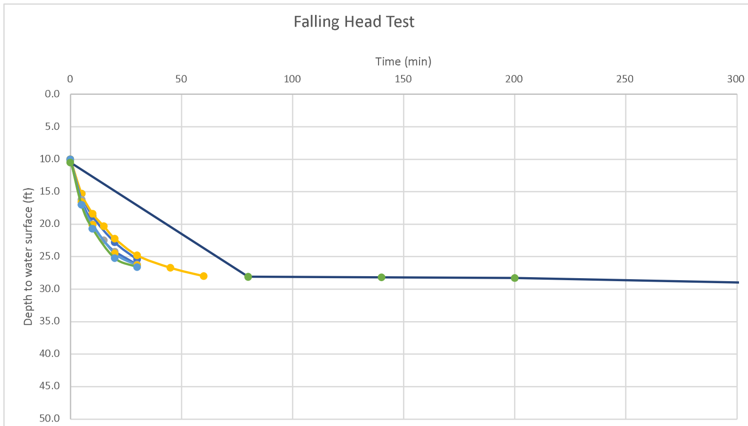
I-8 **Field Infiltration Test Data** Project: **Broaday/Manchester ATP Equity Project**

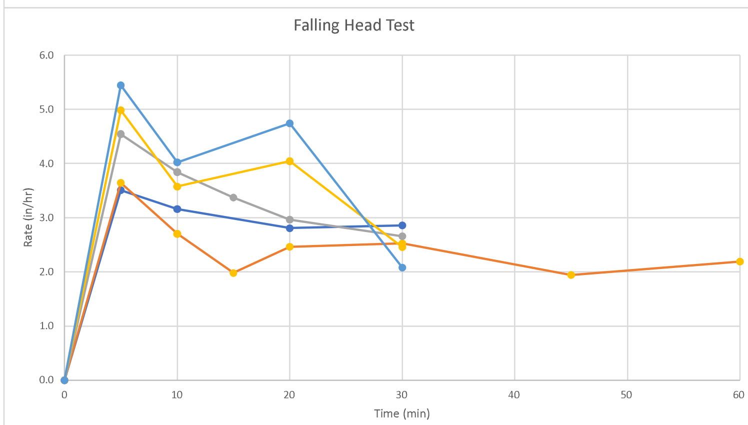
Depth to GW or Impermeable Layer 30

Diameter 8.0 in

Perimeter 2.09 ft

Time	Depth	Volume	Delta T	Delta V	Area	Flow GPM	Flow ft3/hr	Rate
Falling Head Test #1								
8:55	10.2	21.8	0	0	0.0	0.0	0.0	-
9:00	15.3	16.2	5	5.6	30.8	1.1	9.0	3.5
9:05	18.8	12.3	5	3.9	23.5	0.8	6.2	3.2
9:15	22.8	7.9	10	4.4	15.1	0.4	3.5	2.8
9:25	25.4	5.1	10	2.9	9.6	0.3	2.3	2.9
Falling Head Test #2								
9:30	10.0	22.0	0	0.0	0.0	0.0	0.0	-
9:35	15.3	16.2	5	5.8	30.8	1.2	9.4	3.6
9:40	18.4	12.8	5	3.4	24.3	0.7	5.5	2.7
9:45	20.3	10.7	5	2.1	20.3	0.4	3.4	2.0
9:50	22.2	8.6	5	2.1	16.3	0.4	3.4	2.5
10:00	24.8	5.7	10	2.9	10.9	0.3	2.3	2.5
10:15	26.7	3.6	15	2.1	6.9	0.1	1.1	1.9
10:30	28.0	2.2	15	1.4	4.2	0.1	0.8	2.2
Falling Head Test #3								
10:33	10.0	22.0	0	0	0.0	0.0	0.0	-
10:38	16.2	15.2	5	6.8	28.9	1.4	10.9	4.5
10:43	20.0	11.0	5	4.2	20.9	0.8	6.7	3.8
10:48	22.5	8.3	5	2.8	15.7	0.6	4.4	3.4
10:53	24.2	6.4	5	1.9	12.1	0.4	3.0	3.0
11:03	26.2	4.2	10	2.2	8.0	0.2	1.8	2.7
Falling Head Test #4								
11:06	10.0	22.0	0	0	0.0	0.0	0.0	-
11:11	16.6	14.7	5	7.3	28.1	1.5	11.6	5.0
11:16	20.1	10.9	5	3.9	20.7	0.8	6.2	3.6
11:26	24.5	6.1	10	4.8	11.5	0.5	3.9	4.0
11:36	26.3	4.1	10	2.0	7.7	0.2	1.6	2.5
Falling Head Test #5								
11:38	10.0	22.0	0	0	0.0	0.0	0.0	-
11:43	17.0	14.3	5	7.7	27.2	1.5	12.4	5.4
11:48	20.7	10.2	5	4.1	19.5	0.8	6.5	4.0
11:58	25.2	5.3	10	5.0	10.1	0.5	4.0	4.7
12:08	26.6	3.7	10	1.5	7.1	0.2	1.2	2.1
Falling Head Test #6								
12:10	10.5	21.5	0	0	0.0	0.0	0.0	-
13:30	28.1	2.1	80	19.4	4.0	0.2	1.9	5.9
14:30	28.2	2.0	60	0.1	3.8	0.0	0.0	0.0
15:30	28.3	1.9	60	0.1	3.6	0.0	0.0	0.0
4/7/2022								
8:53	34.1	-4.5	1043	6.4	-8.6	0.0	0.0	-0.1
15:39	36.1	-6.7	1449	2.2	-12.8	0.0	0.0	0.0

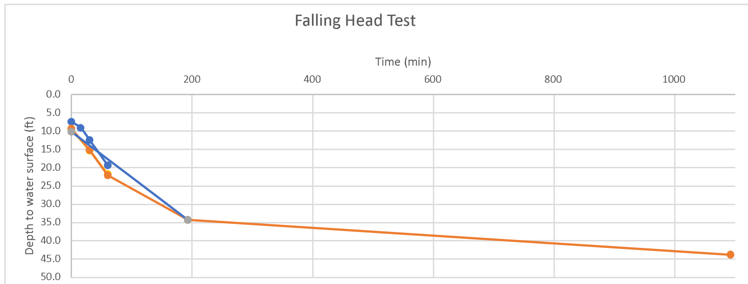


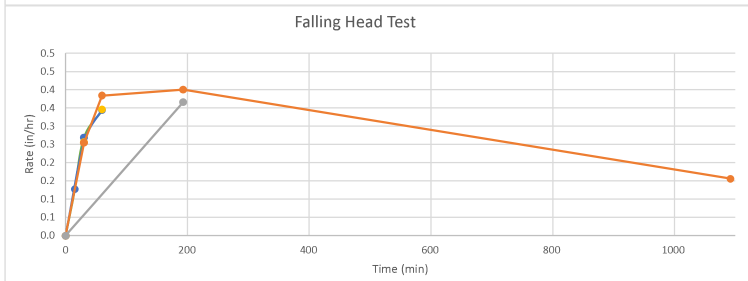


I-9 **Field Infiltration Test Data** Project: **Broaday/Manchester ATP Equity Project**

Depth to GW or Impermeable Layer		50	
Diameter	8.0	in	
Perimeter	2.09	ft	

Time	Depth	Volume	Delta T	Delta V	Area	Flow GPM	Flow ft3/hr	Rate
Falling Head Test #1								
12:45	7.4	42.6	0	0	0.0	0.0	0.0	-
13:00	9.1	40.9	15	1.7	85.7	0.1	0.9	0.1
13:15	12.4	37.6	15	3.3	78.7	0.2	1.8	0.3
13:45	19.3	30.7	30	6.9	64.3	0.2	1.8	0.3
Falling Head Test #2								
13:46	9.5	40.5	0	0.0	0.0	0.0	0.0	-
14:16	15.3	34.7	30	5.8	72.7	0.2	1.6	0.3
14:46	21.7	28.3	30	6.4	59.3	0.2	1.7	0.3
Falling Head Test #3								
14:48	9.3	40.7	0	0	0.0	0.0	0.0	-
15:18	15.1	34.9	30	5.8	73.1	0.2	1.6	0.3
15:48	22.1	27.9	30	7.0	58.4	0.2	1.9	0.4
	34.3	15.7						0.4
9:00	43.8	6.2	1032	21.7	13.0	0.0	0.2	0.2
Falling Head Test #4								
9:09	10.2	39.8	0	0	0.0	0.0	0.0	-
12:22	34.3	15.7	193	24.1	32.9	0.1	1.0	0.4





I-10 **Field Infiltration Test Data** Project: **Broaday/Manchester ATP Equity Project**

Depth to GW or Impermeable Layer	30	
Diameter	8.0	in
Perimeter	2.09	ft

Falling Head Test #1

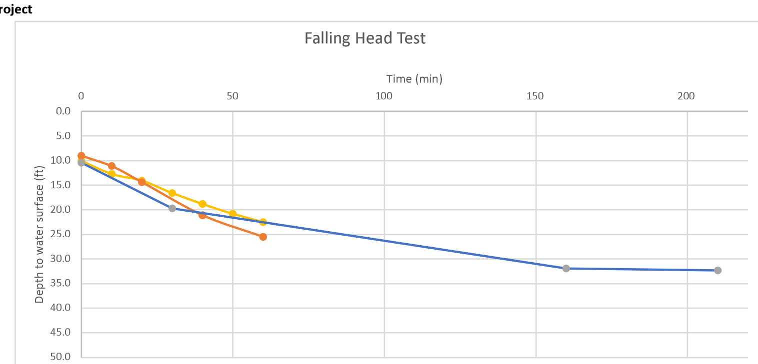
Time	Depth	Volume	Delta T	Delta V	Area	Flow GPM	Flow ft3/hr	Rate
9:50	10.0	24.0	0	0.0	0.0	0.0	0.0	-
10:00	12.7	20.8	10	3.2	36.2	0.3	2.6	0.9
10:10	14.1	19.1	10	1.7	33.3	0.2	1.3	0.5
10:20	16.6	16.1	10	3.0	28.1	0.3	2.4	1.0
10:30	18.8	13.4	10	2.6	23.5	0.3	2.1	1.1
10:40	20.8	11.0	10	2.4	19.3	0.2	1.9	1.2
10:50	22.5	9.0	10	2.0	15.7	0.2	1.6	1.3

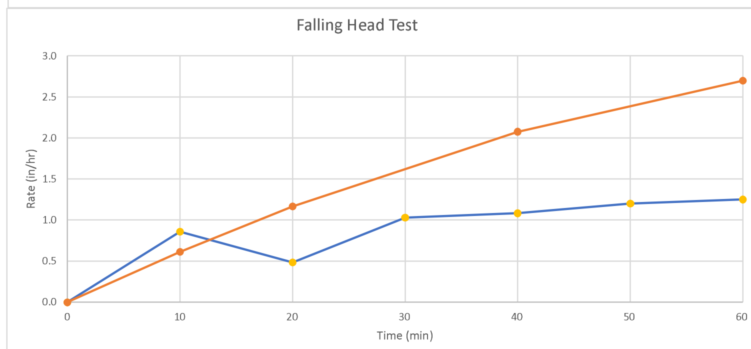
Falling Head Test #2

10:57	9.0	25.2	0	0	0.0	0.0	0.0	-
11:07	11.1	22.7	10	2.5	39.6	0.3	2.0	0.6
11:17	14.4	18.7	10	4.0	32.7	0.4	3.2	1.2
11:37	21.1	10.7	20	8.0	18.6	0.4	3.2	2.1
11:57	25.5	5.4	20	5.3	9.4	0.3	2.1	2.7

Falling Head Test #3

12:00	10.4	23.5	0	0	0.0	0.0	0.0	-
12:30	19.7	12.4	30	11.2	21.6	0.4	3.0	1.7
14:40	31.9	-2.3	130	14.6	-4.0	0.1	0.9	-2.7
15:30	32.3	-2.8	50	0.5	-4.8	0.0	0.1	-0.2





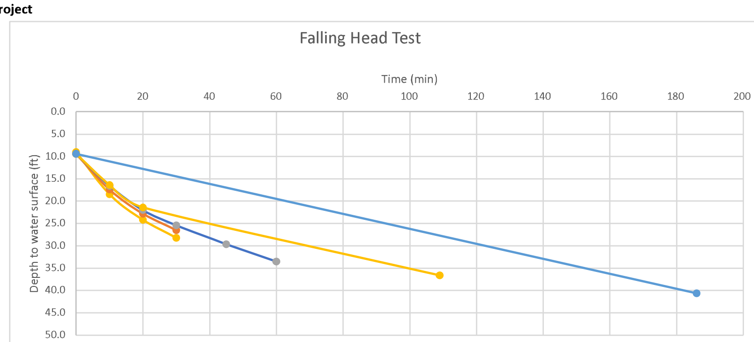
I-11 **Field Infiltration Test Data** Project: **Broaday/Manchester ATP Equity Project**

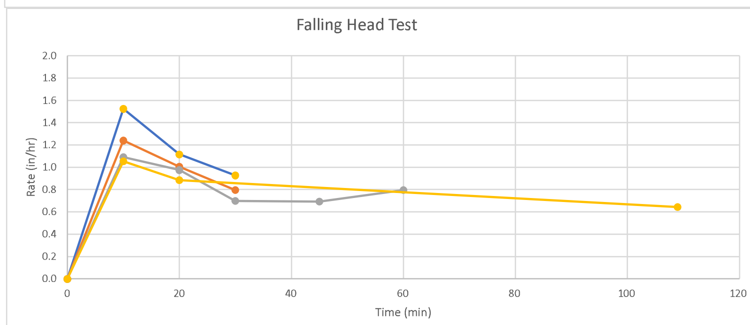
Depth to GW or Impermeable Layer 50

Diameter 8.0 in

Perimeter 2.09 ft

Time	Depth	Volume	Delta T	Delta V	Area	Flow GPM	Flow ft3/hr	Rate
Falling Head Test #1								
13:00	9.0	45.1	0	0	0.0	0.0	0.0	-
13:10	18.5	34.7	10	10.5	66.0	1.0	8.4	1.5
13:20	24.2	28.4	10	6.3	54.0	0.6	5.0	1.1
13:30	28.2	24.0	10	4.4	45.7	0.4	3.5	0.9
Falling Head Test #2								
13:30	9.4	44.7	0	0.0	0.0	0.0	0.0	-
13:40	17.4	35.9	10	8.8	68.3	0.9	7.1	1.2
13:50	22.8	29.9	10	5.9	57.0	0.6	4.8	1.0
14:00	26.5	25.9	10	4.1	49.2	0.4	3.3	0.8
Falling Head Test #3								
14:05	9.4	44.7	0	0	0.0	0.0	0.0	-
14:15	16.6	36.7	10	7.9	70.0	0.8	6.4	1.1
14:25	22.0	30.8	10	5.9	58.6	0.6	4.8	1.0
14:35	25.4	27.1	10	3.7	51.5	0.4	3.0	0.7
14:50	29.6	22.4	15	4.6	42.7	0.3	2.5	0.7
15:05	33.5	18.2	15	4.3	34.6	0.3	2.3	0.8
Falling Head Test #4								
15:06	9.4	44.7	0	0	0.0	0.0	0.0	-
15:16	16.4	37.0	10	7.7	70.4	0.8	6.2	1.1
15:26	21.4	31.5	10	5.5	59.9	0.6	4.4	0.9
16:55	36.6	14.7	89	16.7	28.1	0.2	1.5	0.6
Falling Head Test #5								
8:08	9.4	44.7	0	0	0.0	0.0	0.0	-
11:14	40.6	10.3	186	34.3	19.7	0.2	1.5	0.9





APPENDIX B

GEOTECHNICAL BORING LOGS

LOG OF BORING NO. A-22-001

Grade Elevation:	**136.0 ft**				
Boring Depth:	**51.5 ft**	Driller:	**ABC Liovin Drilling**	SHEET **1 of 2**	
Borehole Diameter:	**8"**	Type of Rig:		Comments:	
Date Drilled:	**4-18-22**	Hammer Data:	**Automatic Hammer, 140 lbs/ 30 in drop**		
Logged By:	**DN**	Groundwater Reading:			

Depth (ft)	Sample Type	Sample	Blows/foot	Graphic Log	GEOTECHNICAL DESCRIPTION	Moisture (%)	Dry Density (pcf)	Test/ Results
0					ASPHALT Asphalt~ 8 inches/ Concrete~ 4 inches.			
					Lean CLAY (CL); reddish brown; moist; few fine SAND; mostly medium plasticity fines.			
					SILT with SAND (ML); reddish brown; moist; little fine SAND; mostly nonplastic fines.			
5	X	S-1	6		SILTY SAND (SM); loose; dark brown; moist; mostly fine SAND; some nonplastic to low plasticity fines; some CLAY; to CLAYEY SAND.			
10	X	S-2	17		Medium dense; brown; medium to fine SAND; little nonplastic fines.			
					Lean CLAY (CL); very stiff; dark brown; moist; few fine SAND; mostly medium plasticity fines.			
15	X	S-3	21		Olive brown.			
20	X	S-4	24		SILTY SAND (SM); medium dense; brown; moist; trace fine GRAVEL; mostly medium to fine SAND; some nonplastic to low plasticity fines.			
25								

(continued)

(CONTINUED) LOG OF BORING NO. A-22-001

Date Drilled: **4-18-22**

Logged By: **DN**

Comments:

Depth (ft)	Sample Type	Sample	Blows/foot	Graphic Log	GEOTECHNICAL DESCRIPTION	Moisture (%)	Dry Density (pcf)	Test/ Results
25	X	S-5	39		Dense; light brown; fine SAND; little nonplastic fines. SILTY SAND (SM) *(continued)*.			
30	X	S-6	39		Medium to fine SAND.			
35	X	S-7	14		Lean CLAY (CL); stiff; olive brown; moist; few coarse to fine SAND; mostly medium plasticity fines; lensed SILTY SAND.			
40	X	S-8	13		Fine SAND.			
45	X	S-9	18		Very stiff; brown to olive brown; lensed SILTY SAND.			
50	X	S-10	17		Trace coarse to fine GRAVEL; few SAND.			
					Bottom of borehole at 51.5 ft bgs			

Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

KHA, Broadway- Manchester STP Dry Wells

Project Number: 21-169

Date: 4-29-22

LOG OF BORING NO. A-22-002

Grade Elevation:	**132.0 ft**				
Boring Depth:	**51.5 ft**	Driller:	**ABC Liovin Drilling**	SHEET **1 of 2**	
Borehole Diameter:	**8"**	Type of Rig:		Comments:	
Date Drilled:	**4-19-22**	Hammer Data:	**Automatic Hammer, 140 lbs/ 30 in drop**		
Logged By:	**DV**	Groundwater Reading:			

Depth (ft)	Sample Type	Sample	Blows/foot	Graphic Log	GEOTECHNICAL DESCRIPTION	Moisture (%)	Dry Density (pcf)	Test/ Results
0					ASPHALT Asphalt~8 inches/ Concrete~4 inches.			
					CLAYEY SAND (SC); brown; moist; few fine GRAVEL; mostly coarse to fine SAND; some low to medium plasticity fines; GRAVEL is angular to subangular; rock fragments and debris (asphalt and concrete).			
5		S-1	6		SANDY lean CLAY (CL); stiff; olive brown; moist; few fine GRAVEL; little coarse to fine SAND; mostly medium plasticity fines; GRAVEL is angular to subangular; lensed SILT.			
10		S-2	13		SILTY SAND (SM); medium dense; olive brown; moist; trace fine GRAVEL; mostly medium to fine SAND; some nonplastic to low plasticity fines; GRAVEL is angular to subangular; lensed fine SAND and lensed Lean CLAY.			
15		S-3	23		SANDY SILT (ML); medium dense; olive brown; moist; some medium to fine SAND; mostly nonplastic fines; borderline SILTY SAND.			
					SILTY SAND (SM); medium dense; olive brown; moist; mostly medium to fine SAND; little nonplastic fines; borderline Poorly Graded SAND with SILT; lensed SANDY SILT.			
20		S-4	13		SANDY SILT (ML); stiff; olive gray; moist; trace fine GRAVEL; some medium to fine SAND; mostly nonplastic fines; GRAVEL is angular to subangular; lensed CLAY.			
25								

(continued)

(CONTINUED) LOG OF BORING NO. A-22-002

Date Drilled:	4-19-22	Comments:	SHEET 2 of 2
Logged By:	DV		

Depth (ft)	Sample Type	Sample	Blows/foot	Graphic Log	GEOTECHNICAL DESCRIPTION	Moisture (%)	Dry Density (pcf)	Test/ Results
25		S-5	12		SILTY SAND (SM); medium dense; olive gray; moist; mostly medium to fine SAND; some nonplastic fines; lensed SANDY SILT- borderline.			
30		S-6	32		Olive brown to olive gray; little fines; lensed fine to medium SAND; lensed SANDY SILT.			
35		S-7	30					
40		S-8	53		Poorly graded SAND with SILT (SP-SM); very dense; olive gray; moist; mostly medium to fine SAND; few nonplastic fines.			
45		S-9	10		SANDY SILT (ML); stiff; olive gray; moist; little fine SAND; mostly nonplastic to low plasticity fines; lensed SILT- borderline SILT with SAND.			
50		S-10	30		Very stiff; trace fine GRAVEL; some medium to fine SAND; nonplastic fines; lensed SILT with SAND; GRAVEL is angular to subangular; some SILTY SAND.			
					Bottom of borehole at 51.5 ft bgs			

Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

KHA, Broadway- Manchester STP Dry Wells

Project Number: 21-169 | Date: 4-28-22

LOG OF BORING NO. A-22-003

Grade Elevation:	131.0 ft				
Boring Depth:	51.5 ft	Driller:	ABC Liovin Drilling	SHEET 1 of 2	
Borehole Diameter:	8"	Type of Rig:		Comments:	
Date Drilled:	4-20-22	Hammer Data:	Automatic Hammer, 140 lbs/ 30 in drop		
Logged By:	DV	Groundwater Reading:			

Depth (ft)	Sample Type	Sample	Blows/foot	Graphic Log	GEOTECHNICAL DESCRIPTION	Moisture (%)	Dry Density (pcf)	Test/ Results
0					ASPHALT Asphalt~ 8 inches/ Concrete~ 4 inches.			
					CLAYEY SAND with GRAVEL (SC); brown to olive brown; moist; little coarse to fine GRAVEL; mostly coarse to fine SAND; some low plasticity fines; GRAVEL is angular to subangular; rock fragments and debris (asphalt and cement); lensed SILTY SAND.			
5		S-1	8		Loose; low to medium plasticity fines; lensed CLAY and SILTY SAND.			
10		S-2	16		SANDY SILT (ML); very stiff; olive brown; moist; few fine GRAVEL; some medium to fine SAND; mostly nonplastic fines; GRAVEL is angular to subangular; lensed SILTY SAND.			
15		S-3	20		Poorly graded SAND with SILT (SP-SM); medium dense; olive to olive brown; dry to moist; few fine GRAVEL; mostly medium to fine SAND; few nonplastic fines; GRAVEL is angular to subangular, borderline SILTY SAND.			
20		S-4	10		SILTY SAND (SM); loose; olive brown; dry to moist; few fine GRAVEL; mostly coarse to fine SAND; little nonplastic fines; GRAVEL is angular to subangular.			
25								

(continued)

(CONTINUED) LOG OF BORING NO. A-22-003

Date Drilled:	4-20-22	Comments:	SHEET 2 of 2
Logged By:	DV		

Depth (ft)	Sample Type	Sample	Blows/foot	Graphic Log	GEOTECHNICAL DESCRIPTION	Moisture (%)	Dry Density (pcf)	Test/ Results
25					SANDY SILT (ML); hard; olive brown; moist; some fine SAND; mostly nonplastic fines; borderline SILTY SAND.			
	X	S-5	43		SILTY SAND (SM); dense; olive brown; moist; few fine GRAVEL; mostly coarse to fine SAND; little nonplastic fines; GRAVEL is angular to subangular; borderline Poorly Graded SAND with SILT.			
30	X	S-6	56		Poorly graded SAND with SILT (SP-SM); very dense; light brown; moist; few fine GRAVEL; mostly medium to fine SAND; few nonplastic fines; GRAVEL is angular to subangular.			
35	X	S-7	21		Medium dense; olive brown; coarse to medium SAND.			
					SILTY SAND (SM); medium dense; olive brown; moist; some fine SAND; mostly nonplastic fines; borderline SANDY SILT; lensed SILT/ CLAY.			
40	X	S-8	25		SANDY SILT (ML); very stiff; olive brown to brown; moist; some medium to fine SAND; mostly low plasticity fines; borderline SANDY Lean CLAY; lensed Poorly Graded SAND; some CLAY/ SILT-mixed sample.			
45	X	S-9	45		Poorly graded SAND (SP); dense; light brown; moist; trace fine GRAVEL; mostly medium to fine SAND; trace nonplastic fines; GRAVEL is angular; lensed CLAY.			
50	X	S-10	38		SILTY SAND (SM); dense; olive brown; moist; mostly fine SAND; little nonplastic fines; borderline Poorly Graded Sand with SILT.			
					Bottom of borehole at 51.5 ft bgs			

Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

KHA, Broadway- Manchester STP Dry Wells

Project Number: 21-169 | Date: 4-28-22

LOG OF BORING NO. A-22-004

Grade Elevation:	**125.0 ft**				
Boring Depth:	**51.5 ft**	Driller:	**ABC Liovin Drilling**	SHEET **1 of 2**	
Borehole Diameter:	**8"**	Type of Rig:		Comments:	
Date Drilled:	**4-4-22**	Hammer Data:	**Automatic Hammer, 140 lbs/ 30 in drop**		
Logged By:	**DV**	Groundwater Reading:		Boring Backfill: grout	

Depth (ft)	Sample Type	Sample	Blows/foot	Graphic Log	GEOTECHNICAL DESCRIPTION	Moisture (%)	Dry Density (pcf)	Test/ Results
0					SILTY SAND (SM); brown; moist; few fine GRAVEL; mostly coarse to fine SAND; some nonplastic to low plasticity fines; GRAVEL is angular to subangular; some CLAY; lensed roots and grass.			
5	X	S-1	17		CLAYEY SAND (SC); medium dense; brown; moist; few fine GRAVEL; mostly coarse to fine SAND; some low plasticity fines; GRAVEL is angular to subangular; some SILT.			
10	X	S-2	32		Dense; brown to olive brown; lensed SANDY SILT.			
15	X	S-3	45		Poorly graded SAND with SILT (SP-SM); dense; olive brown; dry to moist; few fine GRAVEL; mostly medium to fine SAND; few nonplastic fines; GRAVEL is angular to subangular; borderline SILTY SAND.			
20	X	S-4	36		SILTY SAND (SM); dense; olive brown; moist; trace fine GRAVEL; mostly coarse to fine SAND; little nonplastic fines; GRAVEL is angular to subangular; borderline Poorly Graded SAND with SILT.			
25								

(continued)

(CONTINUED) LOG OF BORING NO. A-22-004

Date Drilled: 4-4-22	Comments:	SHEET 2 of 2
Logged By: DV	Boring Backfill: grout	

Depth (ft)	Sample Type	Sample	Blows/foot	Graphic Log	GEOTECHNICAL DESCRIPTION	Moisture (%)	Dry Density (pcf)	Test/ Results
25	X	S-5	24		SANDY SILT (ML); very stiff; olive brown; moist; little fine SAND; mostly nonplastic to low plasticity fines; lensed SILT to SILT with SAND; lensed CLAY.			
30	X	S-6	38		Poorly graded SAND with SILT (SP-SM); dense; olive brown; moist; few fine GRAVEL; mostly medium to fine SAND; few nonplastic fines; GRAVEL is angular to subangular; lensed SILT/ CLAY.			
35	X	S-7	23		Lean CLAY with GRAVEL (CL); very stiff; olive gray; moist; little fine GRAVEL; few fine SAND; mostly low to medium plasticity fines; GRAVEL is angular to subangular- cementation; lensed SILT- borderline CL/ML.			
40	X	S-8	34		SANDY SILT (ML); hard; olive gray; moist; few fine GRAVEL; some fine SAND; mostly nonplastic to low plasticity fines; GRAVEL is angular to subangular- cementation; lensed SILT/ CLAY.			
45	X	S-9	21		Very stiff; medium to fine SAND; nonplastic fines; lensed SILT; borderline SILTY SAND.			
50	X	S-10	58		SILTY SAND (SM); very dense; olive gray; moist; mostly medium to fine SAND; some nonplastic fines; borderline SANDY SILT; increase in SAND.			
					Bottom of borehole at 51.5 ft bgs			

Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

KHA, Broadway- Manchester STP Dry Wells

Project Number: 21-169 | Date: 4-28-22

LOG OF BORING NO. A-22-005

Grade Elevation:	**130.0 ft**		
Boring Depth:	**51.5 ft**	Driller:	**ABC Liovin Drilling**
Borehole Diameter:	**8"**	Type of Rig:	
Date Drilled:	**4-4-22**	Hammer Data:	**Automatic Hammer, 140 lbs/ 30 in drop**
Logged By:	**DV**	Groundwater Reading:	

Comments:

Depth (ft)	Sample Type	Sample	Blows/foot	Graphic Log	GEOTECHNICAL DESCRIPTION	Moisture (%)	Dry Density (pcf)	Test/ Results
0					SILTY SAND (SM); brown; moist; few fine GRAVEL; mostly coarse to fine SAND; some nonplastic fines; GRAVEL is angular to subangular.			
5	X	S-1	27		CLAYEY SAND (SC); medium dense; olive brown; moist; few fine GRAVEL; mostly coarse to fine SAND; some low plasticity fines; GRAVEL is angular to subangular; some SILT/ CLAY.			
10	X	S-2	16		SILTY SAND (SM); medium dense; olive brown; moist; few fine GRAVEL; mostly medium to fine SAND; some nonplastic fines; GRAVEL is angular to subangular; lensed SANDY SILT.			
15	X	S-3	38		SANDY SILT (ML); hard; olive brown; moist; trace fine GRAVEL; some medium to fine SAND; mostly nonplastic fines; GRAVEL is angular to subangular; borderline SILTY SAND.			
20	X	S-4	39		SILTY SAND (SM); dense; olive brown; moist; few fine GRAVEL; mostly medium to fine SAND; some nonplastic fines; GRAVEL is angular to subangular.			
25								

(continued)

(CONTINUED) LOG OF BORING NO. A-22-005

Date Drilled: **4-4-22**
Logged By: **DV**
Comments:
SHEET **2 of 2**

Depth (ft)	Sample Type	Sample	Blows/foot	Graphic Log	GEOTECHNICAL DESCRIPTION	Moisture (%)	Dry Density (pcf)	Test/ Results
25	X	S-5	58		Very dense; trace GRAVEL; fine SAND; lensed SANDY SILT- borderline. SILTY SAND (SM) *(continued)*.			
30	X	S-6	11		SANDY lean CLAY with GRAVEL (CL); stiff; olive gray; moist; little fine GRAVEL; some fine SAND; mostly low to medium plasticity fines; GRAVEL is angular to subangular- cementation; lensed SILT.			
35	X	S-7	27		SANDY SILT with GRAVEL (ML); very stiff; olive gray; moist; little fine GRAVEL; some fine SAND; mostly low plasticity fines; GRAVEL is angular to subangular- cementation; lensed SILT/ CLAY; borderline SILTY SAND.			
40	X	S-8	23					
45	X	S-9	29		SANDY SILT (ML); very stiff; olive gray; moist; trace fine GRAVEL; some fine SAND; mostly nonplastic to low plasticity fines; GRAVEL is angular to subangular; lensed SILT.			
50	X	S-10	43		Lean CLAY with SAND (CL); hard; olive gray; moist; few fine SAND; mostly medium plasticity fines; lensed Lean CLAY; lensed CLAYEY SAND.			
					Bottom of borehole at 51.5 ft bgs			

Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

KHA, Broadway- Manchester STP Dry Wells

Project Number: 21-169 | Date: 4-28-22

LOG OF BORING NO. A-22-006

Grade Elevation:	**130.0 ft**				
Boring Depth:	**51.5 ft**	Driller:	**ABC Liovin Drilling**	SHEET **1 of 2**	
Borehole Diameter:	**8"**	Type of Rig:		Comments:	
Date Drilled:	**4-5-22**	Hammer Data:	**Automatic Hammer, 140 lbs/ 30 in drop**		
Logged By:	**DV**	Groundwater Reading:			

Depth (ft)	Sample Type	Sample	Blows/foot	Graphic Log	GEOTECHNICAL DESCRIPTION	Moisture (%)	Dry Density (pcf)	Test/ Results
0					SILTY SAND with GRAVEL (SM); brown; moist; little fine GRAVEL; mostly coarse to fine SAND; little nonplastic to low plasticity fines; GRAVEL is angular to subangular; lensed CLAY; some rock fragments.			
5		S-1	27		CLAYEY SAND (SC); medium dense; brown; moist; few fine GRAVEL; mostly coarse to fine SAND; some low plasticity fines; GRAVEL is angular to subangular.			
10		S-2	17		SILTY SAND (SM); medium dense; brown to olive brown; moist; trace fine GRAVEL; mostly medium to fine SAND; little nonplastic fines; GRAVEL is angular to subangular; increase in SAND; borderline Poorly Graded SAND with SILT.			
15		S-3	37		Poorly graded SAND with SILT (SP-SM); dense; olive brown; moist; trace fine GRAVEL; mostly medium to fine SAND; few nonplastic fines; GRAVEL is angular to subangular; borderline SILTY SAND.			
20		S-4	63		Poorly graded SAND with SILT and GRAVEL (SP-SM); very dense; olive brown; moist; little fine GRAVEL; mostly coarse to medium SAND; few nonplastic fines; GRAVEL is angular to subangular.			
25								

(continued)

(CONTINUED) LOG OF BORING NO. A-22-006

Date Drilled: **4-5-22**

Logged By: **DV**

Comments:

Depth (ft)	Sample Type	Sample	Blows/foot	Graphic Log	GEOTECHNICAL DESCRIPTION	Moisture (%)	Dry Density (pcf)	Test/ Results
25	X	S-5	12		SANDY SILT with GRAVEL (ML); stiff; olive gray; moist; little fine GRAVEL; some medium to fine SAND; mostly low to medium plasticity fines; GRAVEL is angular to subangular- cementation; lensed CLAY and SILT.			
30	X	S-6	34		SANDY lean CLAY with GRAVEL (CL); hard; olive gray; moist; little fine GRAVEL; some medium to fine SAND; mostly low to medium plasticity fines; GRAVEL is angular to subangular; lensed SILT/ CLAY.			
35	X	S-7	37		SANDY SILT with GRAVEL (ML); hard; olive gray; moist; little fine GRAVEL; some medium to fine SAND; mostly nonplastic to low plasticity fines; GRAVEL is angular to subangular- cementation; lensed CLAY; borderline SILTY SAND.			
40	X	S-8	21		Lean CLAY with SAND (CL); very stiff; olive gray; moist; few fine GRAVEL; few fine SAND; mostly medium plasticity fines; GRAVEL is angular to subangular- cementation; lensed CLAY/ SILT.			
45	X	S-9	88		Hard.			
50	X	S-10	33					
					Bottom of borehole at 51.5 ft bgs			

LOG OF BORING NO. A-22-007

Grade Elevation:	**131.0 ft**				
Boring Depth:	**51.5 ft**	Driller:	**ABC Liovin Drilling**	SHEET **1 of 2**	
Borehole Diameter:	**8"**	Type of Rig:		Comments:	
Date Drilled:	**4-7-22**	Hammer Data:	**Automatic Hammer, 140 lbs/ 30 in drop**		
Logged By:	**DV**	Groundwater Reading:			

Depth (ft)	Sample Type	Sample	Blows/foot	Graphic Log	GEOTECHNICAL DESCRIPTION	Moisture (%)	Dry Density (pcf)	Test/ Results
0					SILTY SAND with GRAVEL (SM); brown; moist; little fine GRAVEL; mostly coarse to fine SAND; some low plasticity fines; GRAVEL is angular to subangular; lensed CLAY.			
5	X	S-1	24		CLAYEY SAND with GRAVEL (SC); medium dense; brown; moist; little fine GRAVEL; mostly coarse to fine SAND; some low to medium plasticity fines; GRAVEL is angular to subangular; lensed SILT to SANDY SILT.			
10	X	S-2	28		SANDY SILT with GRAVEL (ML); very stiff; brown to olive brown; moist; little fine GRAVEL; some coarse to fine SAND; mostly low plasticity fines; GRAVEL is angular to subangular; lensed CLAY to CLAYEY SAND.			
15	X	S-3	68		Poorly graded SAND with SILT and GRAVEL (SP-SM); very dense; olive brown; moist; little fine GRAVEL; mostly medium to fine SAND; few nonplastic fines; GRAVEL is angular to subangular; lensed SILTY SAND- borderline.			
20	X	S-5	51		Coarse to medium SAND.			
25								

(continued)

(CONTINUED) LOG OF BORING NO. A-22-007

Date Drilled:	**4-7-22**	Comments:	SHEET **2 of 2**
Logged By:	**DV**		

Depth (ft)	Sample Type	Sample	Blows/foot	Graphic Log	GEOTECHNICAL DESCRIPTION	Moisture (%)	Dry Density (pcf)	Test/ Results
25	X	S-5	65		Poorly graded SAND with SILT and GRAVEL (SP-SM) *(continued)*.			
30	X	S-6	38		SANDY lean CLAY (CL); hard; olive gray; moist; few fine GRAVEL; some medium to fine SAND; mostly low to medium plasticity fines; GRAVEL is angular to subangular; lensed SAND; some CLAY/ SILT.			
35	X	S-7	48		SANDY SILT (ML); hard; grayish brown; moist; some fine SAND; mostly nonplastic fines; lensed CLAY.			
40	X	S-8	34		SANDY lean CLAY (CL); hard; olive gray; moist; trace fine GRAVEL; little fine SAND; mostly low to medium plasticity fines; Lensed CLAY; GRAVEL is angular to subangular.			
45	X	S-9	23		Lean CLAY with GRAVEL (CL); very stiff; olive gray; moist; little fine GRAVEL; few fine SAND; mostly medium plasticity fines; GRAVEL is angular to subangular- cementation; lensed SILT.			
50	X	S-10	42		SANDY SILT (ML); hard; olive gray; moist; few fine GRAVEL; some fine SAND; mostly low plasticity fines; GRAVEL is angular to subangular- cementation; lensed CLAY.			
					Bottom of borehole at 51.5 ft bgs			

Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

KHA, Broadway- Manchester STP Dry Wells

Project Number: 21-169 | Date: 4-28-22

LOG OF BORING NO. A-22-008

Grade Elevation:	**128.0 ft**			
Boring Depth:	**51.5 ft**	Driller:	**ABC Liovin Drilling**	SHEET **1 of 2**
Borehole Diameter:	**8"**	Type of Rig:		Comments:
Date Drilled:	**4-5-22**	Hammer Data:	**Automatic Hammer, 140 lbs/ 30 in drop**	
Logged By:	**DV**	Groundwater Reading:		

Depth (ft)	Sample Type	Sample	Blows/foot	Graphic Log	GEOTECHNICAL DESCRIPTION	Moisture (%)	Dry Density (pcf)	Test/ Results
0					SILTY SAND with GRAVEL (SM); brown; moist; little coarse to fine GRAVEL; mostly coarse to fine SAND; little nonplastic to low plasticity fines; GRAVEL is angular to subangualr; rock fragments; lensed CLAY.			
5		S-1	22		CLAYEY SAND with GRAVEL (SC); medium dense; brown; moist; little fine GRAVEL; mostly coarse to fine SAND; some low to medium plasticity fines; GRAVEL is angular to subangular; lensed SILT; borderline SANDY Lean CLAY.			
10		S-2	31		Poorly graded SAND with SILT (SP-SM); dense; olive brown; moist; few fine GRAVEL; mostly medium to fine SAND; few nonplastic fines; GRAVEL is angular to subangular.			
15		S-3	56		Very dense.			
20		S-4	67					
25								

(continued)

(CONTINUED) LOG OF BORING NO. A-22-008

Date Drilled: 4-5-22

Logged By: DV

Comments:

Depth (ft)	Sample Type	Sample	Blows/foot	Graphic Log	GEOTECHNICAL DESCRIPTION	Moisture (%)	Dry Density (pcf)	Test/ Results
25	X	S-5	55		Poorly graded SAND with SILT and GRAVEL (SP-SM); very dense; olive gray; dry to moist; little fine GRAVEL; mostly coarse to medium SAND; few nonplastic fines; GRAVEL is angular to subangular; borderline SILTY SAND.			
30	X	S-6	31		SANDY SILT (ML); hard; olive gray; moist; few fine GRAVEL; some medium to fine SAND; mostly low to medium plasticity fines; GRAVEL is angular to subangular- cementation; lensed SILT/ CLAY.			
35	X	S-7	19		Very stiff; fine SAND; nonplastic to low plasticity fines; lensed CLAY.			
40	X	S-8	21		SANDY lean CLAY with GRAVEL (CL); very stiff; olive gray; moist; little fine GRAVEL; little fine SAND; mostly low to medium plasticity fines; GRAVEL is angular to subangular- cementation; lensed CLAY/ SILT.			
45	X	S-8	20					
50	X	S-10	31		Hard.			
					Bottom of borehole at 51.5 ft bgs			

Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

KHA, Broadway- Manchester STP Dry Wells

Project Number: 21-169

Date: 4-28-22

LOG OF BORING NO. A-22-009

Grade Elevation:	**131.0 ft**				
Boring Depth:	**51.5 ft**	Driller:	**ABC Liovin Drilling**	SHEET **1 of 2**	
Borehole Diameter:	**8"**	Type of Rig:		Comments:	
Date Drilled:	**4-6-22**	Hammer Data:	**Automatic Hammer, 140 lbs/ 30 in drop**		
Logged By:	**DV**	Groundwater Reading:			

Depth (ft)	Sample Type	Sample	Blows/foot	Graphic Log	GEOTECHNICAL DESCRIPTION	Moisture (%)	Dry Density (pcf)	Test/ Results
0					SILTY SAND (SM); brown; moist; few coarse to fine GRAVEL; mostly coarse to fine SAND; some low plasticity fines; GRAVEL is angular to subangular; some CLAY; lensed roots and grass.			
5	X	S-1	34		CLAYEY SAND (SC); dense; brown; moist; few fine GRAVEL; mostly coarse to fine SAND; some low to medium plasticity fines; GRAVEL is angular to subangular.			
10	X	S-2	17		SANDY SILT (ML); very stiff; olive brown; moist; few fine GRAVEL; some medium to fine SAND; mostly low plasticity fines; GRAVEL is angular to subangular; lensed CLAYEY SAND and CLAY.			
15	X	S-3	22		Olive brown to olive gray; little fine GRAVEL; fine SAND; lensed CLAY.			
20	X	S-4	29		SILT with SAND (ML); very stiff; olive gray; few fine GRAVEL; few fine SAND; mostly low to medium plasticity fines; GRAVEL is angular to subangular- cementation; lensed SILT/ CLAY.			
25								

(continued)

(CONTINUED) LOG OF BORING NO. A-22-009

Date Drilled:	4-6-22	Comments:	SHEET 2 of 2
Logged By:	DV		

Depth (ft)	Sample Type	Sample	Blows/foot	Graphic Log	GEOTECHNICAL DESCRIPTION	Moisture (%)	Dry Density (pcf)	Test/ Results
25	X	S-5	32		Hard; trace GRAVEL; low plasticity fines; lensed roots; some CLAY to CLAYEY SILT. SILT with SAND (ML) *(continued)*.			
30	X	S-6	34		Lean CLAY with SAND (CL); hard; olive gray; moist; few fine GRAVEL; few fine SAND; mostly low to medium plasticity fines; GRAVEL is angular to subangular- cementation; lensed SILT and CLAY.			
35	X	S-7	23		Very stiff; trace GRAVEL; medium plasticity fines.			
40	X	S-8	31		SANDY lean CLAY with GRAVEL (CL); hard; brown; moist; little fine GRAVEL; some coarse to fine SAND; mostly low to medium plasticity fines; GRAVEL is angular to subangular; lensed SANDY Lean CLAY.			
45	X	S-9	37		CLAYEY SAND (SC); dense; brown; moist; few fine GRAVEL; mostly coarse to medium SAND; little low plasticity fines; GRAVEL is angular to subangular; lensed SANDY Lean CLAY.			
50	X	S-10	45		SANDY SILT (ML); hard; brown to olive brown; moist; few fine GRAVEL; little medium to fine SAND; mostly low plasticity fines; lensed SILT with SAND and SILTY SAND; GRAVEL is angular to subangular- cementation; some CLAY.			
					Bottom of borehole at 51.5 ft bgs			

Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

KHA, Broadway- Manchester STP Dry Wells

Project Number: 21-169 | Date: 4-28-22

LOG OF BORING NO. A-22-010

Grade Elevation:	**133.0 ft**				
Boring Depth:	**51.5 ft**	Driller:	**ABC Liovin Drilling**	SHEET **1 of 2**	
Borehole Diameter:	**8"**	Type of Rig:		Comments:	
Date Drilled:	**4-6-22**	Hammer Data:	**Automatic Hammer, 140 lbs/ 30 in drop**		
Logged By:	**DV**	Groundwater Reading:			

Depth (ft)	Sample Type	Sample	Blows/foot	Graphic Log	GEOTECHNICAL DESCRIPTION	Moisture (%)	Dry Density (pcf)	Test/ Results
0					SILTY SAND (SM); brown; moist; few fine GRAVEL; mostly coarse to fine SAND; some low plasticity fines; GRAVEL is angular to subangular; some CLAY.			
5	X	S-1	40		CLAYEY SAND (SC); dense; brown; moist; few fine GRAVEL; mostly coarse to fine SAND; some low to medium plasticity fines; GRAVEL is angular to subangular; lensed SILT.			
10	X	S-2	35		SANDY SILT (ML); hard; olive brown; moist; few fine GRAVEL; some medium to fine SAND; mostly nonplastic to low plasticity fines; GRAVEL is angular to subangular; lensed CLAY.			
15	X	S-3	26		SILTY SAND (SM); medium dense; olive brown; moist; mostly medium to fine SAND; some nonplastic to low plasticity fines; lensed SAND and SILT; borderline SANDY SILT.			
20	X	S-4	27		Poorly graded SAND with SILT (SP-SM); medium dense; olive brown; moist; few fine GRAVEL; mostly medium to fine SAND; few nonplastic fines; GRAVEL is angular to subangular; lensed SILT/ CLAY.			
25								

(continued)

(CONTINUED) LOG OF BORING NO. A-22-010

Date Drilled: **4-6-22**
Logged By: **DV**
Comments:

Depth (ft)	Sample Type	Sample	Blows/foot	Graphic Log	GEOTECHNICAL DESCRIPTION	Moisture (%)	Dry Density (pcf)	Test/ Results
25	X	S-5	57		Very dense; lensed SILTY SAND. Poorly graded SAND with SILT (SP-SM) *(continued)*.			
30	X	S-6	58		Poorly graded SAND with SILT and GRAVEL (SP-SM); very dense; light brown; moist; little fine GRAVEL; mostly coarse to medium SAND; few nonplastic fines; GRAVEL is angular to subangular; lensed SILT/ CLAY.			
35	X	S-7	25		SANDY lean CLAY (CL); very stiff; olive gray; moist; few fine GRAVEL; little fine SAND; mostly medium plasticity fines; GRAVEL is angular to subangular; lensed SILT/ CLAY.			
40	X	S-8	44		Lean CLAY with SAND (CL); hard; olive gray; moist; trace fine GRAVEL; few fine SAND; mostly medium plasticity fines; GRAVEL is angular to subangular; lensed SILT/ CLAY.			
45	X	S-9	16		Very stiff; cementation; lensed SILT.			
50	X	S-10	23		Lensed SILT/ CLAY- some SANDY SILT.			
					Bottom of borehole at 51.5 ft bgs			

Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

KHA, Broadway- Manchester STP Dry Wells

Project Number: 21-169 | Date: 4-28-22

LOG OF BORING NO. A-22-011

Grade Elevation:	**135.0 ft**			
Boring Depth:	**51.5 ft**	Driller:	**ABC Liovin Drilling**	SHEET **1 of 2**
Borehole Diameter:	**8"**	Type of Rig:		Comments:
Date Drilled:	**4-7-22**	Hammer Data:	**Automatic Hammer, 140 lbs/ 30 in drop**	
Logged By:	**DV**	Groundwater Reading:		

Depth (ft)	Sample Type	Sample	Blows/foot	Graphic Log	GEOTECHNICAL DESCRIPTION	Moisture (%)	Dry Density (pcf)	Test/ Results
0					SILTY SAND with GRAVEL (SM); brown; moist; little fine GRAVEL; mostly coarse to fine SAND; little low plasticity fines; GRAVEL is angular to subangular; some CLAY.			
5	X	S-1	55		SANDY SILT with GRAVEL (ML); hard; olive brown; dry to moist; little fine GRAVEL; some medium to fine SAND; mostly low plasticity fines; GRAVEL is angular to subangular; lensed CLAY; some cementation.			
10	X	S-2	38		Low to medium plasticity fines.			
15	X	S-3	42		SANDY lean CLAY with GRAVEL (CL); hard; brown; moist; little fine GRAVEL; some coarse to fine SAND; mostly medium plasticity fines; GRAVEL is angular to subangular- cementation; lensed SILT.			
20	X	S-4	49		SILTY SAND (SM); dense; brown; moist; few fine GRAVEL; mostly medium to fine SAND; some nonplastic to low plasticity fines; GRAVEL is angular to subangular; lensed SILT/ CLAY.			
25								

(continued)

(CONTINUED) LOG OF BORING NO. A-22-011

Date Drilled:	4-7-22	Comments:	SHEET 2 of 2
Logged By:	DV		

Depth (ft)	Sample Type	Sample	Blows/foot	Graphic Log	GEOTECHNICAL DESCRIPTION	Moisture (%)	Dry Density (pcf)	Test/ Results
25	X	S-5	26		SANDY SILT (ML); very stiff; olive brown; moist; trace fine GRAVEL; some fine SAND; mostly nonplastic to low plasticity fines; GRAVEL is angular to subangular; lensed SILT/ CLAY- borderline SILTY SAND.			
30	X	S-6	84		SILTY SAND (SM); very dense; olive brown; moist; trace fine GRAVEL; mostly medium to fine SAND; some nonplastic fines; GRAVEL is angular to subangular; lensed SANDY SILT.			
35	X	S-7	54					
40	X	S-8	45		SANDY SILT (ML); hard; brown; moist; few fine GRAVEL; some medium to fine SAND; mostly low plasticity fines; GRAVEL is angular to subangular- cementation; lensed CLAY.			
45	X	S-9	47		Lean CLAY with SAND (CL); hard; olive brown; moist; few fine SAND; mostly medium plasticity fines; lensed SILT and SAND.			
50	X	S-10	42		SILTY SAND (SM); hard; brown; moist; mostly fine SAND; some nonplastic fines; lensed SANDY SIT; some CLAY.			
					Bottom of borehole at 51.5 ft bgs			

Kimley»Horn

ATTACHMENT G

Draft O&M Matrix

	SURFACE MAINTENANCE	Responsible Agency	TREE, VEGETATION & IRRIGATION MAINTENANCE	Responsible Agency	SUBSURFACE MAINTENANCE	Responsible Agency
PRE-DESIGN / DESIGN	Pre-design Report (review by all groups)	StreetsLA	Inventory of existing landscape and irrigation system	Urban Forestry Division	Invetory of existing underground system	LASAN
	Inventory of existing surface system	StreetsLA	Current O&M guidelines	Urban Forestry Division	Current O&M guidelines	LASAN
	Current O&M guidelines	StreetsLA	Design plant pallette	Urban Forestry Division	Conditions and repair analysis	LASAN
	Conditions and repair analysis	StreetsLA	Design guidelines for maintenance	Urban Forestry Division	Improvements assessment	LASAN
	Improvements assessment	StreetsLA	Memorandum of Agreement (MOA)	Urban Forestry Division	Design guidelines for maintenance & access	LASAN
	Design guidelines for maintenance & access	StreetsLA			Memorandum of Agreement (MOA)	LASAN
	Geotechnical Report	StreetsLA				
	Design Plans and Specs (review by all groups)	StreetsLA				
	Memorandum of Agreement (MOA)	StreetsLA				
PLAN REVIEW / PERMITTING	Surface BMP Plan Review	StreetsLA	Tree Plan Review	Urban Forestry Division	Subsurface Storm Drain System Plan Review	LASAN
	O&M Plan Review	StreetsLA	Landscape Plan Review	Urban Forestry Division	O&M Plan Review	LASAN
	Surface drainage system review	StreetsLA	Irrigation Plan Review	Urban Forestry Division	LACSD JWPCP Discharge Permit	StreetsLA
			O&M Plan Review	Urban Forestry Division	LASAN Industrial Wastewater Permit	StreetsLA
			Permits will be obtained by SLA	StreetsLA		
POST-CONSTRUCTION MONITORING & OPTIMIZATION (ESTABLISHMENT PERIOD)	Removal of trash, sediment, and debris	StreetsLA	Watering or irrigation	Urban Forestry Division	Storage Galleries	LASAN
	Erosion repair and control	StreetsLA	Weed removal	Urban Forestry Division	Hydrodynamic Separator	LASAN
	Pavement inspection	StreetsLA	Inspect mulch and soil for loss, compaction, or other issues affecting health of vegetation	Urban Forestry Division	Pumps	LASAN
	Street sweeping	StreetsLA	Pruning or trimming as neccessary	Urban Forestry Division	Subsurface irrigation filter/reservoir system	LASAN
	Vacuuming of permeable pavers	StreetsLA	Bioswales/rain gardens	Urban Forestry Division	Performance Measure during Storm Event	LASAN
	Catch basin inserts	StreetsLA	Parkway planters	Urban Forestry Division		
	Infiltration strips	StreetsLA	Vegetated Medians	Urban Forestry Division		
	Permeable: concrete, cement and asphalt	StreetsLA	Trees	Urban Forestry Division		
	SCADA Control System	LASAN	Subsurface irrigation system	Urban Forestry Division		
			Performance Measure during Storm Event	Urban Forestry Division		
LONG-TERM OPERATIONS & MAINTENANCE	Removal of trash, sediment, and debris	StreetsLA	Replacement of soil, mulch , or vegetation	Urban Forestry Division	Removal of trash, sediment and debris	LASAN
	Erosion repair and control	StreetsLA	Bio-retention/swale system	Urban Forestry Division	Subsurface storm drain system	LASAN
	Pavement inspection	StreetsLA			Underground BMP treatment system	LASAN
	Street sweeping	StreetsLA				
	Vacuuming of permeable pavers	StreetsLA				
	SCADA Control System	LASAN				
MONITORING / TESTING	Water sampling monitoring	LASAN	Landscape & tree health	Urban Forestry Division	Inflow/Outflow Monitoring	LASAN
	Monitor rate of sediment accumulation	LASAN	Drip irrigation system	Urban Forestry Division	Performance Measure during Storm Event	LASAN
			Irrigation control and filtration system	Urban Forestry Division	Water Quality Testing	LASAN
			Bio-retention/swale system	StreetsLA	Underground BMP treatment system	LASAN
			Inflow/Outflow Monitoring	Urban Forestry Division		

Kimley»Horn

ATTACHMENT H

Alternatives Analysis

DocuSign Envelope ID: 72555627-0C15-4573-B11A-A451D042EA9C

Measure W SCW Scoring Criteria

Section	Criteria	Criteria Thresholds	Scoring						Scoring Justification				
			Max Score	Feasibility Study	A	B	C	Preferred Alternative (Alternative 3)	Feasibility Study	A	B	C	Preferred Alternative (Alternative 3)
A.1 Wet + Dry Weather Water Quality Benefits	A.1.1 Water Quality Effectiveness	Cost Effectiveness = (24-hour BMP Capacity) / (Construction Cost in $Millions) · <0.4 = 0 points · 0.4-0.6 = 7 points · 0.6-0.8) = 11 points · 0.8-1.0 = 14 points · >1.0 = 20 points	**20**	11	7	7	11	7	0.6 acre-feet capacity/$-Million	0.4-0.5 acre-feet capacity/$-Million (9.4 AF/$18.4-22.6M)	0.5-0.6 acre-feet capacity/$-Million (15 AF/$25M min-30.2M)	0.6-0.7 acre-feet capacity/$-Million (25.3 AF/$35.6-43.7M)	0.4 acre-feet capacity/$-Million (9.4 AF/$23.2M)
	A.1.2 Water Quality Benefits	Primary Pollutant Reduction: · >50% = 15 points · >80% = 20 points Secondary Pollutant Reduction: · >50% = 5 points · >80% = 10 points	**30**	30	25	30	30	30	81% removal of primary and secondary pollutants	78% removal of primary pollutant (Nutrient, Nitrogen) 100% removal of seconday pollutant (Trash)	~81.6% removal of primary pollutant (Nutrient, Nitrogen) 100% removal of seconday pollutant (Trash)	88% removal of primary pollutant (Nutrient, Nitrogen) 100% removal of seconday pollutant (Trash)	96% removal of primary pollutant (Zinc) 100% removal of seconday pollutant (Trash)
A.2 Dry Weather Only Water Quality Benefits	A.2.1: For dry weather BMPs only.	Projects must be designed to capture, infiltrate, treat and release, or divert 100% (unless infeasible or prohibited for habitat, etc) of all tributary dry weather flows	**20**										
	A.2.2: For Dry Weather BMPs Only.	Tributary Size of the Dry Weather BMP: · <200 Acres = 10 points · >200 Acres = 20 points	**20**										
B. Significant Water Supply Benefits	B1. Water Supply Cost Effectiveness	· >$2500/ac-ft = 0 points · $2,000–2,500/ac-ft = 3 points · $1500-2,000/ac-ft = 6 points · $1000–1500/ac-ft = 10 points · <$1000/ac-ft = 13 points	**13**	0	0	0	0	0	$11,959/AF				
	B2. Water Supply Benefit Magnitude	· <25 ac-ft/year = 0 points · 25 - 100 ac-ft/year = 2 points · 100 - 200 ac-ft/year = 5 points · 200 - 300 ac-ft/year = 9 points · >300 ac-ft/year = 12 points	**12**	5	2	2	2	2	**100 AFY:** -28.8 AFY Irrigation (76.9 AFY Demand) -71.3 AFY Sewer Drawdown	**57.75 AFY:** -5.05 AFY Irrigation (40 AFY Demand) -52.60 AFY Sewer Drawdown (maximized per LASAN/LACSD sewer capacity results) -0.1 AFY Parkway BMPs	**69.15 AFY:** -9.44 AFY Irrigation (40 AFY Demand) -59.61 AFY Sewer Drawdown (maximized per LASAN/LACSD sewer capacity results) -0.1 AFY Parkway BMPs	**72.56 AFY:** -9.45 AFY Irrigation (40 AFY Demand) -63.01 AFY Sewer Drawdown (maximized per LASAN/LACSD sewer capacity results) -0.1 AFY Parkway BMPs	**~59.7 AFY:** 0 AFY Irrigation (40 AFY Demand) 59.6 AFY Sewer Drawdown 0.1 AFY Parkway BMPs
C. Community Investments Benefits	The Project provides Community Investment Benefits	· One Benefit = 2 points · Three Benefits = 5 points · Six Benefits = 10 points	**10**	10	10	10	10	10	1. Flood risk mitigation 2. Creation, enhancement, and restoration of parks and habitat 3. New recreational opportunities 4. Greening of schools 5. Reduces local heat island effect and increases shade 6. Increases the number of trees and other vegetation that will increase carbon reduction and improve air quality				
D. Nature-Based Solutions	The Project implements Nature-Based Solutions	· Implements natural processes or mimics natural processes to slow, detain, capture, and absorb/infiltrate water in a manner that protects, enhances and/or restores habitat, green space and/or usable open space = 5 points · Utilizes natural materials such as soils and vegetation with a preference for native vegetation = 5 points · Removes Impermeable Area from Project (1 point per 20% paved area removed) = 5 points	**15**	10	10	10	10	10	• Adds new bioswales in parkways to treat first flush • Plants new native vegetation in street median and parkways • Removes 6% impermeable area				
E. Leveraging Funds and Community Support	E1. Cost-Share	· >25% Funding Matched = 3 points · >50% Funding Matched = 6 points	**6**	3	6	6	6	6	25% Funding Matched	A funding match of >25% or >50% will be required in order to meet construction costs (Currently funded $10.5M for construction).	A funding match of >50% will be required in order to meet construction costs (Currently funded $10.5M for construction).	A funding match of >50% will be required in order to meet construction costs (Currently funded $10.5M for construction).	A funding match of >50% will be required in order to meet construction costs (Currently funded $10.5M for construction).
	E2. Local Support	The Project demonstrates strong local, community-based support and/or has been developed as part of a partnership with local NGOs/CBOs.	**4**	4	4	4	4	4	Strong community support as a result of engagement and community-driven design process				
			Total Cost	**$14.76M ($10.5M Funded)**	$18.4-**22.6M**	$24.6-**30.2M**	$35.6-**43.7M**	$19.0-**23.3M**					
			Total Score	**73**	**64**	**69**	**73**	**69**					

Response to Comments Matrix

LASAN 5/25/2023 Comments

BROADWAY MANCHESTER COMMENT MATRIX - MEASURE W 5/25/2023 LASAN COMMENTS

Agency/Department: LASAN

Submittal: Conceptual (Provided 08/26/2022)

Action Code: A - Accept/will comply, B - Agency Action, C - Clarify/Discuss, D - Delete Comment, E - Different Submittal

FILLED OUT BY REVIEWER				FILLED OUT BY RESPONDER	
Comment No.	**Page No.**	**Reviewer**	**Comment**	**Action**	**Response**
1		Lorena Matos	Craft water's SW hydrology studies were performed using Hydrocalc software. The drainage area was found to be about 205 acres. According to our BOE expert hydrocalc does not provide valid/accurate results for areas exceeding 200 acres. The suggestion is to reach out to BOE to clarify it and how it applies to this project. The HydroCalc results may need to be validated against another model's results, since it could change the scope of the project.	A	Per the LA County Hydrology Manual, the Modified Rational Method (MODRAT) is acceptable for watersheds of any size. The HydroCalc tool replaced the MODRAT tool and is now used by LA County. We have 4 distinct drainage areas for this project that are 18.0 acres, 48.5 acres, 49.8 acres, and 87.8 acres and we analyzed each separate from each other. The tool is not being used to analyze one large 200-acre drainage area. We did also utilize the WMMS 2.0 model which incorporates routing and found flow rates and volumes that are lower than those predicted by HydroCalc. We felt that the more conservative approach was presented by HydroCalc.
2		Lorena Matos	Structures such as galleries found on Broadway are going to be located within medians and Maintenance vehicle pullouts (MVPs) to reduce impact to traffic. However, structures located in Manchester will require traffic control for maintenance as there are no medians on that location.	A	Maintenance access can be provided on the existing median on Manchester Ave. The existing median can be reconstructed with a mountable truck apron for the LASAN Vactor truck. Traffic control will still be needed in the #1 Eastbound lane and the Westbound left turn pocket onto Menlo Ave. LASAN did not have any objections to the maintenance layout presented in the 5/31/2023 O&M Meeting. See the following pages for the 5/31/2023 O&M meeting notes and exhibit.
3		Lorena Matos	Maintenance: Are there alternatives to putting the structures in the roadway?	A	The stormwater gallery structures in the roadway are the only option because there are adjacent water lines at this location. Placing the storage galleries closer to the curb is not possible due to a conflicting LADWP water line running parallel.

MEASURE W - LASAN O&M COORDINATION MEETING NOTES

Broadway-Manchester Multi-Modal Green Streets Project
City of Los Angeles, StreetsLA
DATE: 05/31/2023 **TIME:** 1:00pm – 2:00pm
PLACE: Teams Virtual Meeting

1. **Attendees**
   Gina Liang, StreetsLA
   Albert Kam, StreetsLA
   Clint Menk, LASAN
   Azya Jackson, LASAN
   Valeria Arteaga, LASAN
   Nicole Dias, Kimley-Horn
   Clarissa Stevenson, Kimley-Horn
   Janessa Mendoza, Kimley-Horn

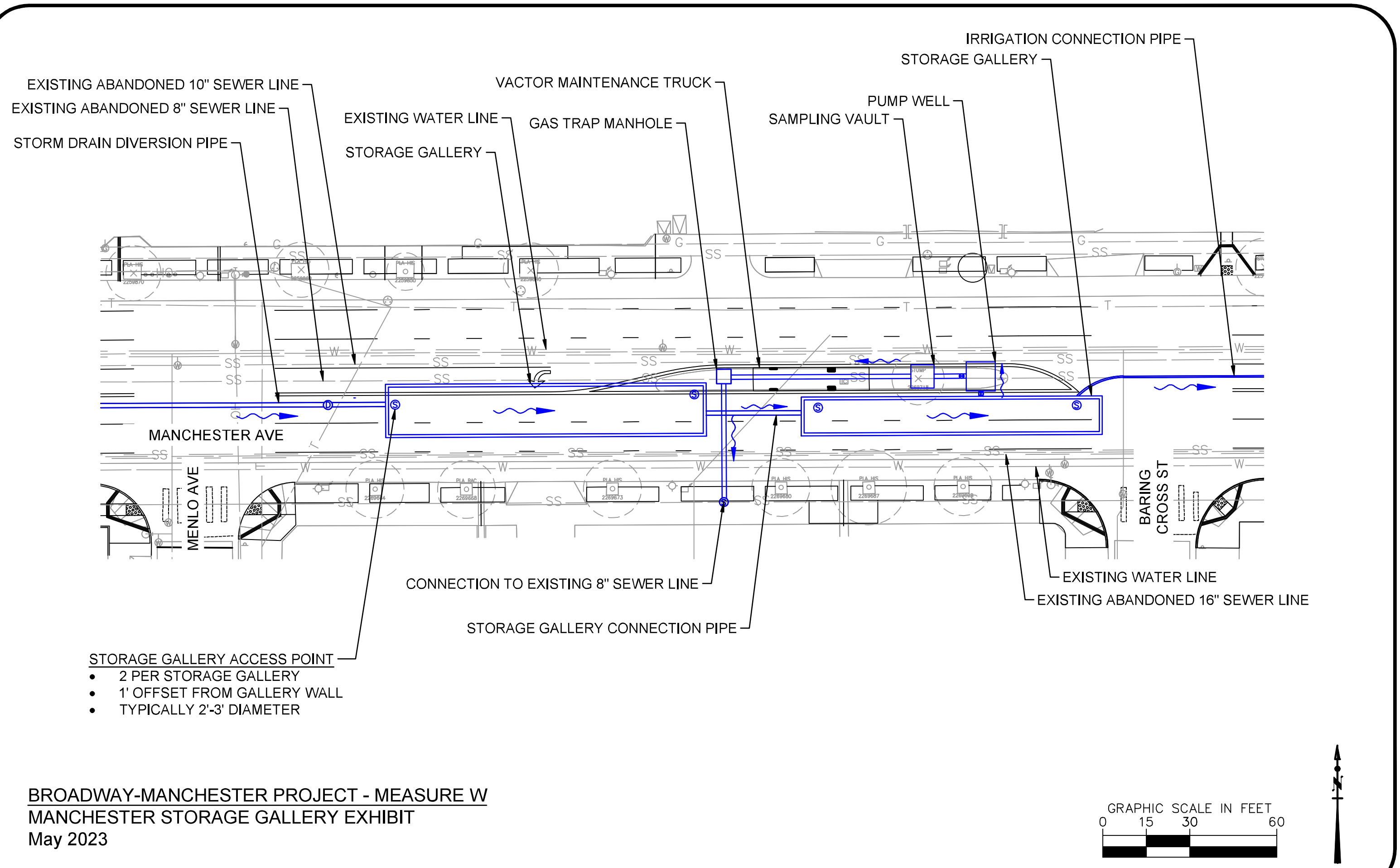
2. **Manchester Maintenance Access**
   - Kimley-Horn investigated alternative placement of the stormwater storage galleries on Manchester. Due to conflicts with the existing water lines, placement near the curb line is not possible. It was determined that the best placement is in the roadway closer to the median on Manchester Avenue.
   - The existing median can be reconstructed with a mountable truck apron for the LASAN Vactor truck (40' x 8.5') to park. Traffic control will still be needed for the #1 Eastbound lane and the Westbound left turn pocket onto Menlo Ave.
   - The Vactor truck boom only moves from the driver's door, around the front of the truck to the passenger side door. The Vactor truck is 8.5' wide with doors closed and 12.5' wide with doors open.
   - LASAN had no objections to the maintenance layout as shown on the Manchester Focus Exhibit, attached for reference.

3. **Operations and Maintenance Components**
   - LASAN requested that the bottom of storage galleries have a minimum 1% slope with 2% preferred. This allows for the sediment to drain more easily to one side and maintenance will be easier.
   - LASAN typically uses 30" diameter maintenance holes. If no physical entry is required into the storage gallery, then a maintenance hole will be sufficient. Access hatches are required if physical entry will be needed.
   - An 8" diameter observation port is requested at the downstream end of the storage gallery. This will allow LASAN to lower a camera into the gallery and observe sediment levels without sending people into the gallery.
     - The standard plan for a light pole can be used for reference.
   - Three phase pumps in conjunction with the SCADA system are preferred by LASAN. The pump also needs to be able to be activated remotely.
   - Valves do not have to be electric or remote controlled.

- Isolation valves are required between the storm drain connection and hydrodynamic separator (HDS) as well as between the storage galley and sewer pump well. This will allow LASAN to close off incoming flows while maintenance activities are being performed.
- The irrigation controller will be hard wired, not solar.

4. Action Items

- Kimley-Horn will provide maintenance frequency for all items as well as inspection and maintenance requirements in the Operations and Maintenance Manual being prepared along with the Measure W PS&E package.



BROADWAY-MANCHESTER PROJECT - MEASURE W

MANCHESTER STORAGE GALLERY EXHIBIT

May 2023

Response to Comments Matrix

LASAN 2/13/2023 Comments

BROADWAY MANCHESTER COMMENT MATRIX - 2/13/2023 LASAN COMMENTS

Agency/Department: LASAN

Submittal: Conceptual (Provided 08/26/2022)

Action Code: A - Accept/will comply, B - Agency Action, C - Clarify/Discuss, D - Delete Comment, E - Different Submittal

LASAN Comments on Draft Technical Memo (Submitted 8/26/2022)*				LASAN Draft Technical Memo Comments Backcheck (Received 2/13/2023)**			Kimley-Horn Response	
Comment No.	Page No.	Reviewer	Comment	Reviewer	Action	Comment	Action	Response
1	2	Clint Menk/CWCD	Maximum depth of stormwater structures should be 25 ft. Not 30 ft. This is the maximum working depth for our vacuum combination cleaners.	Wilmer Cuc/CWCD	Addressed	Recommendation added to 35% package, per pages 2,8	A	Addressed.
2	6, various	Clint Menk/CWCD	Infiltration galleries need to be serviceable without a crane. We need a minimum of 2 access hatches - 1 on the entry side and 1 on the exit side There should be entry and exit ramps for equipment to enter the galleries If entry is required, the galleries must be of sufficient height for the equipment/personnel to work.	Wilmer Cuc/CWCD	Addressed	Recommendation added to 35% package, per pages 11, 283	A	Addressed.
3	17	Clint Menk/CWCD	Show what utilities will be relocated and how the existing sewer lines and/or storm drains will be protected from the proposed work What are the distances (vertical and horizontal) between the proposed stormwater structures and the existing sewer?	Wilmer Cuc/CWCD	To clarify/discuss	Not found/provided	A	Utilities were shown on the 35% plans. Pipe protection for existing pipes will be detailed out in the 65% submittal package. Dimensions for horizontal clearances and cover were provided in the 35% plans.
4	6	Clint Menk/CWCD	Treatment alternatives: Alternative 1 (Engineered filter media) and Alternative 3 (Gravity media filtration) are not acceptable options due to increased mechnical maintenance and changing of consumables.	Wilmer Cuc/CWCD	Addressed	Recommendation added to 35% package, per page 7	A	Addressed.
5	6	Clint Menk/CWCD	Pump station: What O&M will be required?	Wilmer Cuc/CWCD	To clarify/discuss	Pages 8 and 358 provide some details for maintenance. However, more specs are needed	A	More detailed specifications will be provided in the Performance Specifications with the 65% submittal package.
6	6	Clint Menk/CWCD	Stormwater galleries: What O&M will be required?	Wilmer Cuc/CWCD	Addressed	Recommendation added to 35% package, per pages 280, 282	A	Addressed.
7	11	Clint Menk/CWCD	The SCADA system must be compatible with existing LASAN SCADA systems and communicate with Venice Pump Plant.	Wilmer Cuc/CWCD	Addressed	Recommendation added to 35% package, per page 30	A	Addressed.
8	11	Clint Menk/CWCD	SCADA: Incorporate SCADA costs as a line item in this project. SCADA in the project will not be covered by LAWINS or any other project.	Wilmer Cuc/CWCD	Addressed	Recommendation added to 35% package, per page 30	A	Addressed.
9	17	Clint Menk/CWCD	Irrigation: Who will maintain the irrigation system? Rec and Park?	Wilmer Cuc/CWCD	Addressed	Recommendation added to 35% package, per page 449	A	Addressed.
10		Clint Menk/CWCD	Memorandum of Agreement (MOA) would need to dictate/delineate what departments will maintain what assets.	Wilmer Cuc/CWCD	Addressed	Recommendation added to 35% package, per page 449	A	Addressed.
11		Clint Menk/CWCD	Provide a plot plan/concept showing the various alternatives relative to the utilities. Make the plot plan to scale.	Wilmer Cuc/CWCD	To clarify/discuss	Provide further clarification on specifics	A	Profile view of the proposed pipes in relation to existing utilities will be included in the 65% submittal.
12		Clint Menk/CWCD	On plan documents, show the distance from the median to utilities	Wilmer Cuc/CWCD	To clarify/discuss	Not found/provided	A	Dimensions from proposed work to utilities are included in the 35% plans. Additional dimensions from the median to utilities will be included in the 65% plans.
13	19	Clint Menk/CWCD	Use a conical bottom modified CDS unit and include an outlet screen or other method to prevent any trash bypass.	Wilmer Cuc/CWCD	Addressed	Recommendation added to 35% package, per page 14	A	Addressed.
14	42	Clint Menk/CWCD	Modified CDS units with conical bottoms and no trash bypass are preferred. If a baffle box is needed due to depth constraints, use a Nutrient Separating Baffle Box (NSBB) or equivalent. DSBB is not accepted due to mechanical components that are difficult to maintain.	Wilmer Cuc/CWCD	Addressed	Recommendation added to 35% package, per page 14	A	Addressed.
15		Clint Menk/CWCD	Water is being diverted to the sewers of a non-City agency. We will need Executive level approval.	Wilmer Cuc/CWCD	To clarify/discuss	Provide further clarification on specifics	A	Executive approval will need to be coordinated between the agencies.
16		Clint Menk/CWCD	Where will we access the site for maintenance? Do lanes need to be shut down?	Wilmer Cuc/CWCD	Addressed	Recommendation added to 35% package, per pages 24, 25	A	Addressed.
17		Clint Menk/CWCD	Provide elevations/profile views for the drawings of the different alternatives; What is the sequence of the flows.	Wilmer Cuc/CWCD	To clarify/discuss	Drawing for the three alternatives does not include elevations/profile views.	A	Profile views will be included for the preferred alternative in the 65% submittal package.
18	19	Clint Menk/CWCD	Provide shut off valve/gate upstream of the stormwater storage gallery/downstream of the hydrodynamic separator (HDS) to isolate the HDS. (Depends on elevation of stormwater gallery inlet).	Wilmer Cuc/CWCD	To clarify/discuss	No valve/gate visible between HDS unit and storage gallery. Only one slide gate/vault upstream of HDS unit is shown on conceptual drawings.	A	The gate valves are shown in the 35% plans. The conceptual site details will be updated to include the valves for the 65% submittal.
19	19	Clint Menk/CWCD	Provide shut off valve/gate upstream of the pump well to isolate it from the stormwater storage gallery.	Wilmer Cuc/CWCD	To clarify/discuss	Sewer drawdown pump well does not appear to have a shut off valve/gate upstream to isolate it from the storage galleries (per conceptual drawings). The irrigation system wet well w/ pump does have a gate vault enabling it to isolate from storage galleries.	A	The gate valves are shown in the 35% plans. The conceptual site details will be updated to include the valves for the 65% submittal.
20	42	Clint Menk/CWCD	Provide shut off valve/gate downstream of the hydrodynamic separator (currently shown as an DSBB).	Wilmer Cuc/CWCD	Addressed	Recommendation added to 35% package, per pages 24	A	Addressed.

BROADWAY MANCHESTER COMMENT MATRIX - 2/13/2023 LASAN COMMENTS

Agency/Department: LASAN

Submittal: Conceptual (Provided 08/26/2022)

Action Code: A - Accept/will comply, B - Agency Action, C - Clarify/Discuss, D - Delete Comment, E - Different Submittal

LASAN Comments on Draft Technical Memo (Submitted 8/26/2022)*				LASAN Draft Technical Memo Comments Backcheck (Received 2/13/2023)**			Kimley-Horn Response	
Comment No.	Page No.	Reviewer	Comment	Reviewer	Action	Comment	Action	Response
21	42	Clint Menk/CWCD	In the baffle box, provide full access straight down into the structure. Do not use concrete partitions. Open hatches from above should provide clear overhead access to the unit for cleaning.	Wilmer Cuc/CWCD	Addressed	Recommendation added to 35% package, per pages 24	A	Addressed.

*A Response to Comments Matrix for these comments was submitted with the Measure W Updated Technical Memo on 1/14/2023.

**LASAN provided a backcheck of their Draft Technical Memo comments and confirmed if they were addressed or needed additional clarification on 2/13/2023.

BROADWAY-MANCHESTER MULTI-MODAL GREEN STREETS PROJECT

To:	Gina Liang, RLA City of Los Angeles – StreetsLA
From:	Bob Blume, P.E. Nicole Dias, P.E. Kimley-Horn and Associates, Inc
Date:	November 21, 2023
Subject:	Broadway-Manchester Multi-Modal Green Streets Project – Preferred Alternative Selection Addendum Memorandum

INTRODUCTION

This memorandum documents the additional design factors contributing to the modification of the preferred alternative selected in the Broadway-Manchester Multi-Modal Green Streets Project technical memorandum (Tech Memo).

BACKGROUND

Alternative 3 was selected as the preferred alternative as described in the Alternatives Analysis section of the Tech Memo. As the Alternative 3 concept advanced in design, additional design, construction, and maintenance constraints were identified. These constraints, and the modifications they required to the system design, are documented below.

PROJECT CONSTRAINTS

1. **Existing Trees –** There are many existing trees within the medians and sidewalk parkways which are prioritized to be maintained. Modifications to the project layout and design had to be made to avoid the removal of existing trees.
2. **Utility Impacts –** On S Broadway, utilities are primarily located within the sidewalks and in the roadway pavement along the sidewalk curb line, with laterals primarily crossing the roadway at intersections, leaving the wide medians relatively free of utilities, making them an ideal location for large storm water storage galleries. However, along Manchester, utilities are not confined to one location, and are found under the existing median, roadway, sidewalks, and laterally crossing the roadway mid-block between intersections. This created challenges in identifying a location for the storm water galleries along Manchester that did not require utility relocations.
3. **Traffic Impacts –** Due to the lack of median space along Manchester, the only feasible location for the system components would be under the roadway pavement of the 6-lane, high volume W Manchester Avenue. Construction would require the closure of half the roadway width, one direction of travel, for an extended time period for the excavation and construction of the galleries. Closing one direction of travel would greatly impact traffic operations on W Manchester Ave and the community as this is a heavily trafficked arterial.
4. **Maintenance Requirements –** The location of equipment within the roadway, and the maintenance activities required for the equipment, raised concern for the City regarding multiple maintenance locations in the middle of a 6-lane, high volume roadway, especially if personnel entry into the system under the roadway was ever required. Along with the safety concerns, the maintenance access points placed in the roadway would require closures similar to construction closures whenever routine maintenance is required.

Kimley»Horn

PROJECT MODIFICATIONS

Based on the constraints identified above, it was determined that the proposed system under W Manchester Avenue is not feasible.

The following modified tables and information replace the tables and preferred alternative information in the Tech Memo.

Modified Table 4: Preferred Alternative Drainage Areas and Hydrology Information

Location	Pipe	Area (ac)	85th Percentile Peak Flow (cfs)	85th Percentile Runoff Volume (ac-ft) and Storage Gallery Sizing
Broadway at 98th St	36" RCP	49.8	4.14	2.38
Broadway at 102nd St	36" RCP	48.5	3.22	2.11
Broadway at 106th St	30" RCP	87.7	6.15	3.93
Total		186.00	13.51	8.42

Modified Table 5: Alternative Comparison

System Components	Feasibility Study	Preferred Alternative
Total Storage Gallery Volume (ac-ft)	9.4	8.4
Total Infiltration Gallery Volume (ac-ft)	-	-
Total Project Capture Volume (ac-ft/yr)	100	43.3
Bioretention Volume (ac-ft/yr)	-	-
Irrigation Reuse Volume (ac-ft/yr)	28.8	22.12
Infiltration Volume (ac-ft/yr)	-	-
Sewer Drawdown Volume (ac-ft/yr)	71.3	21.07
Order of Magnitude Cost Range ($M)	$14.76	$25.6

Measure W SCW Scoring Criteria

Section	Criteria	Criteria Thresholds	Scoring			Scoring Justification	
			Max Score	Feasibility Study	Preferred Alternative	Feasibility Study	Preferred
A.1 Wet + Dry Weather Water Quality Benefits	A.1.1 Water Quality Effectiveness	Cost Effectiveness = (24-hour BMP Capacity) / (Construction Cost in $Millions) · <0.4 = 0 points · 0.4-0.6 = 7 points · 0.6-0.8) = 11 points · 0.8-1.0 = 14 points · >1.0 = 20 points	**20**	11	7	0.6 acre-feet capacity/$-Million	0.4 acre-feet capacity/$-Million (8.4 AF/$21M)
	A.1.2 Water Quality Benefits	Primary Pollutant Reduction: · >50% = 15 points · >80% = 20 points Secondary Pollutant Reduction: · >50% = 5 points · >80% = 10 points	**30**	30	30	81% removal of primary and secondary pollutants	96% removal of primary pollutant (Zinc) 100% removal of seconday pollutant (Trash)
B. Significant Water Supply Benefits	B1. Water Supply Cost Effectiveness	· >$2500/ac-ft = 0 points · $2,000–2,500/ac-ft = 3 points · $1500-2,000/ac-ft = 6 points · $1000–1500/ac-ft = 10 points · <$1000/ac-ft = 13 points	**13**	0	0	$11,959/AF	
	B2. Water Supply Benefit Magnitude	· <25 ac-ft/year = 0 points · 25 - 100 ac-ft/year = 2 points · 100 - 200 ac-ft/year = 5 points · 200 - 300 ac-ft/year = 9 points · >300 ac-ft/year = 12 points	**12**	5	2	**100 AFY:** -28.8 AFY Irrigation (76.9 AFY Demand) -71.3 AFY Sewer Drawdown	**~43.3 AFY:** 22.12 AFY Irrigation 21.07 AFY Sewer Drawdown 0.1 AFY Parkway BMPs
C. Community Investments Benefits	The Project provides Community Investment Benefits	· One Benefit = 2 points · Three Benefits = 5 points · Six Benefits = 10 points	**10**	10	10	1. Flood risk mitigation 2. Creation, enhancement, and restoration of parks and habitat 3. New recreational opportunities 4. Greening of schools 5. Reduces local heat island effect and increases shade 6. Increases the number of trees and other vegetation that will increase carbon reduction and improve air quality	
D. Nature-Based Solutions	The Project implements Nature-Based Solutions	· Implements natural processes or mimics natural processes to slow, detain, capture, and absorb/infiltrate water in a manner that protects, enhances and/or restores habitat, green space and/or usable open space = 5 points · Utilizes natural materials such as soils and vegetation with a preference for native vegetation = 5 points · Removes Impermeable Area from Project (1 point per 20% paved area removed) = 5 points	**15**	10	10	● Adds new bioswales in parkways to treat first flush ● Plants new native vegetation in street median and parkways ● Removes 6% impermeable area	
E. Leveraging Funds and Community Support	E1. Cost-Share	· >25% Funding Matched = 3 points · >50% Funding Matched = 6 points	**6**	3	6	25% Funding Matched	Caltrans Cost Share = 50% Caltrans Funding Contribution = $11,886,981
	E2. Local Support	The Project demonstrates strong local, community-based support and/or has been developed as part of a partnership with local NGOs/CBOs.	**4**	4	4	Strong community support as a result of engagement and community-driven design process	
			Total Cost	**$14.76M ($10.5M Funded)**	**$21M**		
			Total Score	**73**	**69**		

CITY OF LOS ANGELES
CALIFORNIA

ERIC GARCETTI
MAYOR

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November 8, 2022

ELECTRONIC SUBMITTAL (safecleanwaterla@dpw.lacounty.gov)

DPW-Safe, Clean Water LA
Attn: Safe Clean Water Program Team

REQUEST FOR MODIFICATIONS TO SCOPE OF WORK - EXHIBIT A, SECTION A-1, A-3 AND A-10 OF AGREEMENT NO. 2021RPULAR05 FOR THE BROADWAY-MANCHESTER MULTI-MODAL GREEN STREETS PROJECT

The City of Los Angeles (City) Bureau of Sanitation and Environment (LASAN), as the Project Developer, is requesting to make modifications to the Scope of Work – Exhibit A, Section A-1, A-3 and A-10 of Agreement No. 2021RPULAR05 for the Broadway-Manchester Multi-Modal Green Streets Project (Project) for Quarter 1 (Q1) Fiscal Year (FY) 22-23 Quarterly Report.

As described in the original application and Transfer Agreement, the Broadway-Manchester Multi-Modal Green Streets Project is a stormwater quality improvement project located within the City along a 2.8-mile corridor of Manchester Avenue (from Vermont Avenue to Broadway) and Broadway (from Manchester Avenue to Imperial Hwy.), which is within the historically underserved community of South Los Angeles. It will implement parkway bioswales to capture runoff from small storms, surface diversion, pretreatment, and retention in storage to capture runoff up to the 85th percentile 24-hour storm, and treatment of the stored water for street median and parkway landscape use.

The Project is part of a larger multi-benefit project that was envisioned by the community and integrates with the Active Transportation Program (ATP) funded bicycle infrastructure, pedestrian safety improvements, improved transit connections, and public spaces to create a safe, green, and vibrant neighborhood in line with the goals of the Safe Clean Water (SCW) Regional Program. The Project was planned as a design-build project so that the subsurface stormwater BMP improvements covered under the SCW Regional Program funds could be constructed prior to the above-ground active transportation improvements covered under the ATP Program. The estimated Project cost at the time the Project was submitted for SCW Regional Program funding was $11,719,000, which was awarded in Round 2, SCW Regional Program Funds.

The Transfer Agreement for this Project was executed by the Los Angeles Flood Control District on May 25, 2022 and the first year funds were deposited at the end of June 2022, a year after the original start date shown in the application and Transfer Agreement. To avoid delay and advance design, the City of Los Angeles Bureau of Street Services (StreetsLA), the Project lead, conducted a competitive bidding process for the design of this project and selected a consultant based on the best value. As the consultant for the ATP project, they have begun the preliminary engineering efforts that will also inform design decisions for the project scope. By doing so they can effectively integrate the stormwater quality improvements into the overall project design. The team will accelerate the project design so that it aligns with the ATP schedule to produce one cohesive construction document reflecting the multi-benefit scope of the project. One contract delivered by one design team will be more efficient to manage thereby reducing construction impacts to the community, and avoiding confusion and engagement fatigue.

To efficiently and effectively deliver the big vision of the multi-grant funded Project and not delay the ATP project, StreetsLA is requesting that the Project schedule and budget plan be updated so that both projects are designed and constructed together. A summary of the requested modifications is provided below.

Table 1. Section A-1 Budget Plan Modification: Leveraged Funds

Type		Source	Amount	Status	Activity Description
Approved SCWP Leveraged Funds	Grant Award	Caltrans ATP	$3,927,000	Awarded	Construction work including Site preparation, catch basins, and some landscaping
Modified SCWP Leveraged Funds	**Grant Award**	**Caltrans ATP**	**$3,927,000**	**Awarded**	**Planning, Design and Construction work including Site preparation, catch basins, and some landscaping**

Table 2. Section A-1 Budget Plan Modifications: SCW Program Contribution

Fiscal Year	FY 21-22	FY 22-23	FY 23-24	FY 24-25	FY 25-26
Current Funding Projections	$886,000	$4,000,000	$4,000,000	$2,833,000	$0
Revised Funding Distribution	**$886,000**	**$4,000,000**	**$0**	**$4,000,000**	**$2,833,000**

Table 3. Section A-1 Budget Plan Modifications: SCW Program Budget Plan

Development Phase		SCW Funding per Fiscal Year					
		FY 21-22	FY 22-23	FY 23-24	FY 24-25	FY 25-26	TOTAL
Approved Budget Plan	Design	$886,000	$0	$0	$0	$0	$886,000
	Construction	$0	$4,000,000	$4,000,000	$2,833,000	$0	$10,833,000
	TOTAL	$886,000	$4,000,000	$4,000,000	$2,833,000	$0	$11,719,000
Revised Budget Plan	**Design**	**$886,000**	**$370,260**	**$0**	**$0**	**$0**	**$1,256,260**
	Construction	**$0**	**$3,629,740**	**$0**	**$4,000,000**	**$2,833,000**	**$10,462,740**
	TOTAL	**$886,000**	**$4,000,000**	**$0**	**$4,000,000**	**$2,833,000**	**$11,719,000**

Table 4. Sections A-3 Estimated Reasonable Total Activity Cost

Tasks	Current Cost Estimate			**Revised Cost Estimate**		
	Total Cost	Cost Share	SCW Cost	**Total Cost**	**Cost Share**	**SCW Cost**
Design	$886,000	$0	$886,000	**$2,256,260**	**$1,000,000**	**$1,256,260**
Construction	$14,760,000	$3,927,000	$10,833,000	**$13,389,740**	**$2,927,000**	**$10,462,740**
Total	$15,646,000	$3,927,000	$11,719,000	**$15,646,000**	**$3,927,000**	**$11,719,000**

Table 5. Section A-10 Work Schedule and Completion Date Modifications

Activity Name	Phase Type	Activity Type	Original Schedule		**Revised Schedule**	
			Activity Start	Activity End	**Activity Start**	**Activity End**
Planning	Planning	Pre-Design	7/1/21	12/31/21	**1/1/22**	**12/31/22**
Design	Environmental Documentation	CEQA/NEPA	1/1/22	6/30/22	**1/1/22**	**4/31/23**
	Design	Design	1/1/22	6/30/22	**1/1/23**	**9/30/23**
Bid and Award	Construction	Bid and Award	NA	NA	**10/1/23**	**3/30/24**
Construction	Construction	Construction	7/1/22	10/31/24	**4/1/24**	**6/30/26**
Post Construction	Post Construction Monitoring	Post Construction	11/1/24	4/30/25	**7/1/26**	**12/31/26**
Optimization	Other	Optimization	11/1/24	4/30/25	**7/1/26**	**12/31/26**
O&M	O&M	O&M	5/1/25	5/1/75	**1/1/27**	**1/1/77**

With this letter, LASAN is notifying the Safe, Clean Water Program of the Project's modifications, which would be part of the Project's Quarterly Report for Q1 FY 22-23 in the Safe Clean Water Module. If you have any questions, please contact StreetsLA, Ana Tabuena-Ruddy at Ana.Tabuena-Ruddy@lacity.org or Mara Luevano at mara.luevano@lacity.org. Inquiries can also be directed to the City's Measure W Program general email address at san.safecleanwater@lacity.org.

Sincerely,

Michael Scaduto, P.E., ENV SP
Principal Engineer
Safe Clean Water Implementation Division
LA Sanitation and Environment

cc: Julie Allen, LASAN
Teresa Villegas, ULAR WASC Chair
Ana Tabuena-Ruddy, StreetsLA

CITY OF LOS ANGELES
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August 14, 2023

ELECTRONIC SUBMITTAL (safecleanwaterla@dpw.lacounty.gov)

DPW-Safe, Clean Water LA
Attn: Safe Clean Water Program Team

REQUEST FOR MODIFICATIONS TO SCOPE OF WORK - EXHIBIT A, SECTIONS A-3 AND A-10 OF AGREEMENT NO. 2021RPULAR05 FOR THE BROADWAY-MANCHESTER MULTI-MODAL GREEN STREETS PROJECT

The City of Los Angeles Bureau of Sanitation and Environment (LASAN), on behalf of the Bureau of Street Services (StreetsLA) and as the Project Developer, is requesting to make modifications to the Scope of Work – Exhibit A, Sections A-3 and A-10 of Agreement No. 2021RPULAR05 for the Broadway-Manchester Multi-Modal Green Street Project (Project) for Quarter 4 (Q4) Fiscal Year (FY) 22-23 Quarterly Report.

As described in the original application and transfer agreement, the Broadway-Manchester Multi-Modal Green Streets Project is a stormwater quality improvement project located within the City of Los Angeles along a 2.8-mile corridor of Manchester Avenue (from Vermont Avenue to Broadway) and Broadway (from Manchester Avenue to Imperial Hwy.), which is within the historically underserved community of South Los Angeles. It will implement parkway bioswales to capture runoff from small storms, surface diversion, pretreatment, and retention in storage to capture runoff up to the 85th percentile 24-hour storm, and treatment of the stored water for street median and parkway landscape use.

The Project is part of a larger multi-benefit project that was envisioned by the community and integrates with the Active Transportation Program (ATP) funded bicycle infrastructure, pedestrian safety improvements, improved transit connections, and public spaces to create a safe, green, and vibrant neighborhood in line with the goals of the Safe Clean Water (SCW) Regional Program. The Project was planned as a design-build project so that the subsurface stormwater BMP improvements covered under the SCW Regional Program funds could be constructed prior to the above-ground active transportation improvements covered under the ATP Program.

The estimated project cost at the time the Project was submitted for Measure W Regional Program funding was $11,719,000 which was awarded in Round 2, Measure W Regional Program Funds.

The Transfer Agreement for this Project was executed by the District on May 25, 2022. Since the grant application, the estimated total project cost has increased due to construction cost inflation. In addition, the StreetsLA and the Project team is in the process of revisiting Design plans based on information gained from the extensive alternatives analysis for the Measure W preferred alternative. Site investigations were performed to help inform the subsurface excavation of an Aerially Deposited Lead (ADL) investigation of unpaved soils to be disturbed.

At this time, LASAN would like to report modifications on behalf of StreetsLA to the following sections of Exhibit A of the Transfer Agreement.

Scope of Work Section	**Section Breakdown**		
(A-3) Estimated Reasonable Total Activity Cost	**Phase**	**Approved**	**Modification**
	Design	$2,256,260	$2,532,260
	Construction	$13,389,740	$25,626,837
	Total Project Cost	**$15,646,000**	**$28,159,097**

Scope of Work Section	**Section Breakdown**				
(A-10) Reporting Module Schedule	**Phase**	**Approved Start Date**	**Approved End Date**	**Start Date Modifications**	**End Date Modifications**
	Planning:	01/01/22	12/31/22	**01/01/22**	**12/31/22**
	CEQA/NEPA:	01/01/22	04/31/23	**01/01/22**	**9/30/23**
	Design:	01/01/23	09/30/23	**01/01/23**	**11/30/23**
	Bid and Award	10/01/23	03/30/24	**12/01/23**	**3/30/24**
	Construction:	04/01/24	06/30/26	**04/25/24**	**12/14/26**
	Post Construction:	07/01/26	12/31/26	**07/01/26**	**12/31/26**
	Optimization:	07/01/26	12/31/26	**07/01/26**	**12/31/26**
	O&M:	01/01/27	01/01/77	**01/01/27**	**01/01/77**

In addition, in the FY22/23 Q4 reports, LASAN and StreetsLA are outlining a technical Scope Modification under the "Cost Share Modifications" category. As reported in previous quarterly reports to date, the City has been leveraging funding from Municipal Funds for staff charges in support of project delivery. City of Los Angeles Public Works staff charges relate to planning, design, and construction (i.e. project administration, design review, outreach, environmental review, and construction management). In addition, LASAN has assisted StreetsLA to obtain funding from Caltrans in the amount of $11.4 million dollars to go towards delivery expenditures for the Project. These investments reflect the City's commitment to leveraging and maximizing benefits delivered in the Regional Program. A summary of the leverage fund amounts for this Project is provided below.

	Timeframe	Approved	Modification
Leveraging Funds for the Project	From Project Approval Through FY22/23 Q3	$0	$489,063.69
	FY22/23 Q4	$0	$1,828.49
	Estimate for the Future Through Project Completion	$0	$15,813,981.00
	Total Estimated Through Project Completion	**$0**	**$16,304,873.18**

With this letter, LASAN and StreetsLA are notifying the Safe, Clean Water Program of the Project's modifications, which would be part of the Project's Quarterly Report for FY22/23 Q4 in the Safe Clean Water Module. If you have any questions, please contact the City's Measure W Program general email address at san.safecleanwater@lacity.org.

Sincerely,

Michael Scaduto, P.E., ENV SP
Principal Engineer
Safe Clean Water Implementation Division
LA Sanitation and Environment

cc:
Julie Allen, LASAN
Susie Santilena, LASAN
Sean Phan, LASAN
Ida Meisami-Fard, LASAN
Shirley Lau, StreetsLA
Al Bazzi, StreetsLA
Gina Liang, StreetsLA
Albert Kam, StreetsLA

ATTACHMENT A: Project Modification Request (PMR) FORM

The purpose of this PMR form is to initiate the Project modification process and provide the District with information necessary to evaluate the Project modification request.

Regional Program	☑Infrastructure Program Project ☐Scientific Studies Program ☐Technical Resources Program
Project/Study Name	Lankershim Blvd Local Area Urban Flow Management Project
Project/Study Lead	City of Los Angeles, Sanitation and Environment (LASAN)
Watershed Area(s)	Upper Los Angeles River
Current Project Phase	Design
Approved Stormwater Investment Plan Fiscal Year	FY20-21
Transfer Agreement ID (e.g., 2020RPULAR52)	2020RPULAR06

Has Transfer Agreement or most recent Addendum been executed (i.e., signed by the project lead and the District)? ☐ Yes ☑ No

What type(s) of modification request?

☑ like-for-like modifications
☐ functionally equivalent BMP modifications
☐ modifications to Project or Study components that were not material to the WASC, ROC, or Board's decision to include the Project or Study in the SIP
☐ minor modifications to the budget or schedule of intermediate tasks where the total Funded Activity amount and Funded Activity completion date is unchanged
☐ change in primary or secondary objective
☐ change in Project benefits
☐ change in methodology (e.g., infiltration instead of diversion to sanitary sewer)
☐ decrease in BMP capacity
☐ change in Project or Study location
☐ change in capture area where benefits claimed are diminished or where there is a change in the municipalities that are receiving benefits
☐ updated engineering analysis resulting in a reduction of benefits claimed
☑ increase in Construction Cost or Life Cycle Cost greater than 10%
☑ increase or reallocation of annual funding distribution
☑ change in Funded Activity completion date
☑ other, please describe:

Increased project cost sharing.

Impact on scope or benefits?

- ☐ Improved
- ☐ Diminished
- ☑ Neither
- ☐ Not Sure

Description of the proposed modification(s) and the reason(s) why the modification(s) is/are being proposed.

LASAN, working in conjunction with City of Los Angeles Bureau of Engineering (BOE) and its consultant, have concluded the Pre-Design for the Lankershim Boulevard Local Area Urban Flow Management Project (Project). The conceptual design in the Feasibility Study of the Project served as the basis for the three (3) alternatives that were evaluated in the Pre-Design Report (PDR). All three (3) alternatives included approximately 8,000 linear feet of storm drain main line installed in the center of Lankershim Boulevard to mitigate flooding. Each alternative would also have green street elements consisting of approximately 315 street trees, 232 parkway infiltration planters, and 15 vegetated median islands. A preferred alternative was identified and is further developed as part of detailed design.
Since the execution of the Transfer Agreement (TA), the total project and construction costs have increased due to high cost escalation and economic inflation over the past few years. The Covid-19 Pandemic has been a major factor contributing to both material and labor shortages, which resulted in high escalation and inflation. The City of Los Angeles Bureau of Engineering (BOE) released a report in July 2022 with suggested inflation rates for project estimates. In August of 2023, BOE released an updated report with a revised inflation rate. Both of the rates are included as appendices for reference.

The modifications reported in this PMR are described in detail in Appendix A. Please also refer to the letters attached with modifications that were approved by the ULAR WASC on June 7, 2023 and November 1, 2023, before the PMR process was established. The modifications previously accepted included changes to A-1 Budget Plan Modifications, A-10 Work Schedule and Completion Date Modifications, and Cost Share Modification of Exhibit A - Scope of Work of the Transfer Agreement.

If applicable, list previously approved funding allocations/disbursements and revised funding request:

Note, if some or all of a previously Funded Activity cannot be completed as a result of the proposed modification, please include a description and indicate the amount of unused funds. Any unused funds should be reallocated and accounted for in your revised funding request.

Fiscal Year	Approved Funding Allocations	Revised Funding Request	Description/Phase *If applicable, include description of unused funds*
FY 20-21	$5,139,380	$5,139,380	Approved funding received
FY 21-22	$5,139,380	$5,139,380	Approved funding received
FY 22-23	$5,139,380	$5,139,380	Approved but not yet received. Addendum #2 pending CEQA
FY 23-24	$0	$0	Funding was deferred on 11/2022 to FY24/25
FY 24-25	$5,139,380	$5,139,380	Funding was deferred on 11/2022 to FY25/26
Future Funding	$5,139,380	$16,139,380	Requesting additional funding for FY25/26 ($6M); FY26/27 ($5M)
TOTAL	$25,696,900	$36,696,900	Refer to table 1 in Appendix A for details

A: SCWP Approved Total Funding Allocations	$25,696,900
B: Revised SCWP Anticipated Total Funding Request	$36,696,900
C: Difference between B and A	$11,000,000

If applicable, description of difference in SCWP Anticipated Total Funding Request. As a reminder, annual funding is at the discretion of the WASC, ROC, and ultimately the Board of Supervisors.

Besides requesting additional funding from SCWP, LASAN has been actively pursuing various options to fill the funding gap. These include leveraging the City's Measure W Municipal Funds, requesting funding from Senate Bill 1 (SB1) - Road Maintenance and Rehabilitation Funds, submitting a Letter of Intent (LOI) to the Caltrans State Highway Operation and Protection Program (SHOPP) FY24/25, and applying for both State and Federal Grants. An LOI was submitted to a NOAA grant, but the Project was not selected. Overall, the City will be contributing 57% of the total project cost to implement the Project while 43% is from the Regional funding.

The Project has savings from the pre-design and design phases which will be used for the construction of the Project. Appendix A is included as attachment for reference.

Brief description of Supporting Documentation provided.

Appendix A - Lankershim Project Modification Request (PMR) Details
Appendix B - Existing Flooding Conditions
Appendix C - Project Benefit Comparison
Appendices D and E - Quarter 1 and 4 (Q1 and Q4) Fiscal Year (FY) 22-23 Quarterly Report Modification Letters
Appendices F and G - BOE Inflation Rate Letters

I certify the information and supporting documentation provided is accurate and true.	☑ YES
I understand this is a request and it is under the WASC's discretion to consider requested modifications.	☑ YES

Name Michael Scaduto, P.E., ENV SP

Organization City of Los Angeles, LASAN

Signature *Michael Scaduto* Digitally signed by Michael Scaduto Date: 2023.11.30 07:17:55-08'00'

Date 11/30/2023

FOR DISTRICT USE ONLY

Proposed Modifications to Projects or Studies:

	Status	Date
Modified Project or Study is **consistent** with the Project or Study included in the current fiscal year's SIP and proposed modifications were **approved** by the District.	☐ YES	
Modified Project or Study is **NOT consistent** with the Project or Study included in the current fiscal year's SIP. **If yes, select all that apply**:	☑ YES	12/13/23
PMR was received **after** October 31 of a fiscal year and the PMR will be considered for approval during the preparation of **subsequent** SIP for the fiscal year after the next	☐ YES	-
For Infrastructure Program Projects, modified Project was sent to **Scoring Committee**. If yes, revised score:	☐ YES	
Project or Study **abandoned** the proposed modifications	☐ YES	
Projector or Study was **withdrawn** from consideration by the WASC and shall issue repayment of unspent funds	☐ YES	
Proposed modifications were **recommended for approval** in the SIP	☐ YES ☐ NO	

Proposed Modifications to Project Concepts:

	Status	Date
Proposed modifications were deemed **consistent** with the Project concept that was approved by the WASC, ROC and Board for inclusion in the SIP and can be addressed within the existing budget. District will proceed to incorporate the proposed modification into the Feasibility Study immediately.	☐ YES	
Proposed modifications were deemed significant enough to result in a **significantly different** Project concept from the one approved by the WASC, ROC and Board for inclusion in the SIP. **If yes, select one:**	☐ YES	
District to **discontinue** work on the Feasibility Study, return unused funds to be programmed in the SIP for the next fiscal year, and advise the proponent to submit the modified Project concept during the Call for Projects for a future fiscal year.	☐ YES	-
District to **abandon** the proposed modifications and proceed with the Project concept included in the SIP.	☐ YES	-

Appendix A: Lankershim Project Modification Request (PMR) Details

What type(s) of modification request?

Like for like modifications:

The Pre-Design Report determined the number of drywells needed to target 80 percent load reduction for the primary pollutant (zinc). The number of drywells needed to meet this target was determined based on the field percolation testing and the hydrologic/hydraulic analysis. The original application assumed 0.5 cfs capacity per drywell with limited geotechnical analysis. A full geotechnical investigation was performed and the actual infiltration rate was determined to be 6.0 in/hr (0.10 cfs). Due to the infiltration rate, the Project shifted from capturing the 85th percentile storm to ensuring that the 80% reduction of zinc and the 100% reduction in trash was maintained for the whole watershed. The Project will not only maintain these percentages but will slightly increase in the total overall zinc removed from the Project site (102 lbs per year versus the original 99 lbs. per year). Long-term zinc load reduction is still above 80% and trash reduction remains unchanged. All dry weather flows from the now increased drainage area will be captured.

SCW Metrics	Orig. Scope	Updated Scope	
Number of Drywells	52	110	+
20-year Avg Water Supply	111 ac-ft/yr (138 tot.)	125 ac-ft/yr (173 tot.)	+
20-year Avg Zn Reduction	99 lbs./yr (102 tot.)	102 lbs./yr (127 tot.)	+
Trash Reduction	100%	100%	=
Drainage Area	213.5 ac	401.8 ac	+

The project location has a history of flooding from previous storm seasons, and the proposed infrastructure improvements from this project will contribute to alleviating future flooding along Lankershim Blvd. and adjacent properties. This project will eliminate the need for flood control project which is in the top 10 prioritization ranking under the Flood Protection Prioritization Program. Images captured during a storm event are included in Appendix B.

Increase in Construction Cost or Life Cycle Cost greater than 10%

Since the original cost estimate, the design has been modified to include additional dry-wells, catch basins, and pipes to ensure coverage for the additional drainage area identified while maintaining the 80% target. Additionally, construction costs have increased due to escalation and inflation, which was attributed to supply chain shortages in both labor and materials.

Phase	Approved	Modified
Pre-Design	$1,530,000	$641,837
Design	$5,660,000	$903,940
EIR Consultant	$0	$745,200
Bid and Award	$1,030,000	$205,778
Construction	$14,396,900	$78,500,000
Construction Management	$0	$3,303,245
Post Construction	$2,580,000	$0
Optimization	$500,000	$500,000
Audit Fee	$0	$200,000
Total Project Cost	**$25,696,900**	**$85,000,000**

Increase or reallocation of annual funding distribution:

Change of total Regional funding request (from $25,696,900 to $36,696,900).

Table 1. Approved SCW Program contribution and additional request

Cash Flow	FY 20/21	FY 21/22	FY 22/23	FY 23/24	FY 24/25	FY 25/26	FY26/27	TOTAL
Approved	$5,139,380	$5,139,380	$5,139,380	$0	$5,139,380	$5,139,380	$0	$25,696,900
Additional Request	$0	$0	$0	$0	$0	$6,000,000	$5,000,000	$11,000,000
Total Regional Funding	$5,139,380	$5,139,380	$5,139,380	$0	$5,139,380	$11,139,380	$5,000,000	$36,696,900

Change in Funded Activity completion date:

<u>Pre-design phase</u>:
Original end date: 04/30/23 Actual end date: 11/03/23

<u>Design Phase:</u>
Original start date: 05/01/23 Actual start date: 11/06/23

Reason: The results of the geotechnical evaluation required further alternative iterations to ensure a design that meets the water quality, water supply, and community benefits identified in the application.

Other – Increased project cost sharing.

As reported in previous quarterly reports to date, the City has been leveraging funding from Municipal Funds in support of the project delivery. LASAN has incurred cost share expenditures for the City of Los Angeles, Department of Public Works charges for project administration and implementation, design review, community engagement and outreach, environmental review, and construction management. The estimated cost staff support is $6.36M. In addition, the City is also contributing leverage funding to offset the cost increase. The City has budgeted $3 million dollars in capital Senate Bill 1 (SB1) – Road Maintenance and Rehabilitation funds in FY23/24 to go towards delivery expenditures for the Project. These investments reflect the City's commitment to leveraging and maximizing benefits delivered in the Regional Program. A summary of the leverage fund to offset the Project's cost increase is provided below

Funding Info	FY 23/24 (Secured)	FY 24/25 (Proposed)	FY 25/26 (Proposed)	FY 26/27 (Proposed)	TOTAL
SB 1	$3,000,000	$6,500,000	$6,500,000	$6,000,000	$22,000,000
Municipal Funding	$0	$10,000,000	$8,000,000	$8,303,100	$26,303,100

Appendix B: Lankershim Project Existing Flooding Conditions

A site visit was conducted immediately following a storm event on February 24th, 2023 and August 20, 2023 for assessment of existing drainage patterns and runoff flow conditions in the project area. The National Oceanic and Atmospheric Administration (NOAA) National Weather Service (NWS) recorded a rainfall total of 0.53 inches and 3.08 inches for those days, respectively at the rain gauge locate at the Bob Hope Airport in Burbank, approximately two miles southeast of the Project site. The observed surface runoff demonstrated drainage patterns and flow rates for approximately a 2-year storm event according to recorded precipitation data for the time interval of the site visit.

Figure 1 – Flooding at local depressed area north of the I-5 Freeway

Figure 2 – Existing culvert outlet flow to Tuxford Street

Figure 3 – Runoff flow along north side of Tuxford St east of Lankershim Blvd

Figure 4 – Caltrans pump discharge flow at Kewen Avenue

Appendix C: Lankershim Project Benefit Comparison

SCWP Metric	Description of Changes
A. Water Quality Benefits	The overall pollutant removal for the project remains unchanged. The Project encountered two new pieces of information during the pre-design that necessitated an alternative that could meet the original goals of the initial feasibility study; 1) an additional 188 acres of drainage area that were not originally accounted for, and 2) the geotechnical investigation yielding a decrease in drywell capacity from 0.5 cfs to 0.1 cfs per drywell. This information significantly increased the required sizing to fully capture and infiltrate the 85^{th} percentile, 24-hour event. The Project instead shifted to ensuring that the 80% reduction of zinc and the 100% reduction in trash was maintained for the whole watershed. The Project will not only maintain these percentages but will slightly increase in the total overall zinc removed from the Project site (102 lbs per year versus the original 99 lbs per year).
B. Water Supply Benefits	The modeled annual water supply through drywell infiltration into the San Fernando Basin is increased from 111 to 125 ac-ft/yr due to the increased number of dry wells from the larger drainage area.
C. Community Investment Benefits	The modified project has the same community investment benefits with a focus on flood relief with the proposed adjacent flood control system.
D. Nature-Based Solutions	The same nature-based solutions including infiltration drywells, new trees, parkway planters, and vegetated medians will be provided.
E. Leveraging Funds	The City of Los Angeles leveraged Municipal Funds for staff charges in support of project delivery. The estimated City staff cost to support the project is $6.36M. In addition, the City is also contributing leverage funding, of $48.3M to offset the project cost increase. These investments reflect the City's commitment to leveraging and maximizing benefits delivered in the Regional Program.
E. Community Support	The community support for the project remains the same.

CITY OF LOS ANGELES
CALIFORNIA

ERIC GARCETTI
MAYOR

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LOS ANGELES, CA 90015
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November 8, 2022

ELECTRONIC SUBMITTAL (safecleanwaterla@dpw.lacounty.gov)

DPW-Safe, Clean Water LA
Attn: Safe Clean Water Program Team

REQUEST FOR MODIFICATIONS TO SCOPE OF WORK - EXHIBIT A, SECTION A-1 AND A-10 OF AGREEMENT NO. 2020RPULAR06 FOR THE LANKERSHIM BOULEVARD LOCAL AREA URBAN FLOW MANAGEMENT PROJECT

The City of Los Angeles (City) Bureau of Sanitation and Environment (LASAN), as the Project Developer, is requesting to make modifications to the Scope of Work – Exhibit A, Section A-1 and A-10 of Agreement No. 2020RPULAR06 for the Lankershim Boulevard Local Area Urban Flow Management Project (Project) for Quarter 1 (Q1) Fiscal Year (FY) 22-23 Quarterly Report.

As described in the original application and Transfer Agreement, the Lankershim Boulevard Local Area Urban Flow Management Project is a stormwater quality improvement project located between Tuxford and Sherman Way in the City's San Fernando Valley, North Hollywood. The Project will implement a mix of catch basins and drywells that overflow into a central stormwater discharge pipe and connect to the LA County Flood Control District's (District) storm drain system. This new design is expected to capture and infiltrate up to 111 acre-foot of stormwater per year.

The Project aims to improve the City's water quality by capturing and infiltrating stormwater while also providing flood mitigation and community enhancement through greening of the Project area. In addition, the Project will add landscaping to the community to offer greening benefits. The estimated Project cost at the time the Project was submitted for Measure W Regional Program funding was $25,696,000, which was awarded in Round 1, Measure W Regional Program Funds.

The Transfer Agreement for this Project was executed by the District on August 6, 2021. LASAN has selected a design consultant and begun the pre-design phase of the Project. The consultants have provided LASAN with an updated Project schedule based on the Project's scope and schedule of deliverables.

LASAN would like to report modifications to the following sections of Exhibit A of the Transfer Agreement.

Table 1. Section A-1 Budget Plan Modifications

Fiscal Year	FY 20-21	FY 21-22	FY 22-23	FY 23-24	FY 24-25	FY 25-26
Current Funding Projections	$5,139,380	$5,139,380	$5,139,380	$5,139,380	$5,139,380	$0
Revised Funding Distribution	**$5,139,380**	**$5,139,380**	**$5,139,380**	**$0**	**$5,139,380**	**$5,139,380**

Table 2. Section A-10 Work Schedule and Completion Date Modifications

Activity Name	Phase Type	Activity Type	Original Schedule		**Revised Schedule**	
			Activity Start	Activity End	**Activity Start**	**Activity End**
Planning	Planning	Pre-Design	01/01/21	06/30/21	**02/21/22**	**04/30/23**
Design	Environmental Documentation	CEQA & Permitting	12/01/21	08/31/22	**05/01/23**	**12/31/24**
Design	Design	Design	07/01/21	08/31/22	**05/01/23**	**12/31/24**
Bid and Award	Construction	Bid and Award	09/01/22	10/31/22	**01/01/25**	**06/30/25**
Construction	Construction	Construction	11/01/22	03/31/25	**07/01/25**	**10/31/27**
Optimization	Other	Optimization	07/01/24	06/30/25	**11/01/27**	**10/31/28**
Post Construction	Post Construction Monitoring	Post Construction	12/01/23	06/30/25	**11/01/27**	**10/31/30**
Operation and Maintenance	O&M	O&M	07/01/25	12/31/50	**11/01/28**	**11/01/58**

With this letter, LASAN is notifying the Safe, Clean Water Program of the Project's modifications, which would be part of the Project's Quarterly Report for Q1 FY 22-23 in the Safe Clean Water Module. If you have any questions, please contact my staff, Carmen Andrade at carmen.andrade@lacity.org. Inquiries can also be directed to the City's Measure W Program general email address at san.safecleanwater@lacity.org.

Sincerely,

Michael Scaduto Digitally signed by Michael Scaduto
Date: 2022.11.09 22:42:45-08'00'

Michael Scaduto, P.E., ENV SP
Principal Engineer
Safe Clean Water Implementation Division
LA Sanitation and Environment

cc: Julie Allen, LASAN
Teresa Villegas, ULAR WASC Chair
Carmen Andrade, LASAN

CITY OF LOS ANGELES

CALIFORNIA

KAREN BASS
MAYOR

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WWW.LACITYSAN.ORG

August 14, 2023

ELECTRONIC SUBMITTAL (safecleanwaterla@dpw.lacounty.gov)

DPW-Safe, Clean Water LA
Attn: Safe Clean Water Program Team

REQUEST FOR MODIFICATIONS TO SCOPE OF WORK - AGREEMENT NO. 2020RPULAR06 FOR THE LANKERSHIM BOULEVARD LOCAL AREA URBAN FLOW MANAGEMENT NETWORK PROJECT

The City of Los Angeles Bureau of Sanitation and Environment (LASAN), as the Project Developer, is requesting to make modifications to the Scope of Work – Agreement No. 2020RPULAR06 for the Lankershim Boulevard Local Area Urban Flow Management Project (Project) for Quarter 4 (Q4) Fiscal Year (FY) 22-23 Quarterly Report.

As described in the original application and transfer agreement, the Lankershim Boulevard Local Area Urban Flow Management Project is a stormwater quality improvement project located between Tuxford and Sherman Way in the City's San Fernando Valley, North Hollywood. The Project will implement a mix of catch basins and dry wells that overflow into a central stormwater discharge pipe and connect to the LA County Flood Control District's storm drain system. This new design is expected to capture and infiltrate up to 111 acre-feet of stormwater per year. The Project aims to improve the City of Los Angeles' (City's) water quality by capturing and infiltrating stormwater while also providing flood mitigation and community enhancement through greening of the Project area. In addition, the Project will add landscaping to the community to offer greening benefits. The estimated Project cost at the time the Project was submitted for Measure W Regional Program funding was $25,696,000, which was awarded in Round 1, Measure W Regional Program Funds.

The Transfer Agreement for this Project was executed by the District on August 6, 2021. Since that execution, LASAN has selected a Design consultant and begun the Pre-Design phase of the Project which includes the preliminary engineering efforts to evaluate alternatives, select a Design concept, prepare a Pre-Design Report, and conduct outreach. The total project and construction costs are expected to have increased over the past years of extraordinary economic conditions and LASAN will promptly report these modifications once the Pre Design Report for the Project is completed in the next two months.

In addition, in the FY22/23 Q4 reports, LASAN is outlining a technical Scope Modification under the "Cost Share Modifications" category. As reported in previous quarterly reports to date, the City has been leveraging funding from Municipal Funds for staff charges in support of project delivery. City of Los Angeles Public Works staff charges relate to planning, design, and construction (i.e. project administration, design review, outreach, environmental review, and construction management). In addition, the City has budgeted $3 million dollars in capital Senate Bill 1 (SB1) - Road Maintenance and Rehabilitation funds to go towards delivery expenditures for the Project. These investments reflect the City's commitment to leveraging and maximizing benefits delivered in the Regional Program. A summary of the leverage fund amounts for this Project is provided below.

	Timeframe	Approved	Modification
Leveraging Funds for the Project	From Project Approval Through FY 22/23 Q3	$0	$223,966.13
	FY 22/23 Q4	$0	$86,422.21
	Estimate for the Future Through Project Completion	$0	$6,048,738.30
	Total Estimated Through Project Completion	**$0**	**$6,359,126.64**

With this letter, LASAN is notifying the Safe, Clean Water Program of the Project's modifications, which would be part of the Project's Quarterly Report for FY22/23 Q4 in the Safe Clean Water Module. If you have any questions, please contact the City's Measure W Program general email address at san.safecleanwater@lacity.org.

Sincerely,

Michael Scaduto Digitally signed by Michael Scaduto
Date: 2023.08.11 07:53:00-07'00'

Michael Scaduto, P.E., ENV SP
Principal Engineer
Safe Clean Water Implementation Division
LA Sanitation and Environment

cc:
Julie Allen, LASAN
Susie Santilena, LASAN
Sean Phan, LASAN
Ida Meisami-Fard, LASAN

GEN. FORM 160 (Rev. 6-80)

CITY OF LOS ANGELES
INTER-DEPARTMENTAL CORRESPONDENCE

Agenda Item No. 9

Date: 7/28/22

To: Municipal Facilities Committee

From: Deborah Weintraub, AIA, LEEDAP
Chief Deputy City Engineer

Electronically Signed by Deborah Weintraub on 07/12/2022 12:53:31 PM

Subject: **FUNDING FOR CONSTRUCTION COST INFLATION**

Recommendations:

1. That the Bureau of Engineering (BOE) work with the office of the City Administrative Officer to develop a funding strategy for projects that are either in construction and/or starting construction in Fiscal Year 2022-23 due to construction cost inflation, and;
2. Reassess market conditions in January 2023 to adjust this strategy accordingly.

Introduction:

The BOE is submitting this report in order to alert our City Hall colleagues of significant price increases we are experiencing in construction cost bids. The construction cost increases have a variety of causes and are extraordinary. In order to deliver committed capital projects to the City residents, the funding allocations for construction projects may need to be augmented.

Background:

Non-residential building inflation between 2011 and 2020 on a national basis was on average 3.7% annually (Zarenski, 2021[1]), and 2.4% in California (California Department of General Services). While the pandemic initially decreased construction activity in 2020, in 2021 there was a large increase in demand for construction materials. Unfortunately, this demand was met with serious supply chain challenges, and this resulted in a reduction in the availability of construction materials and higher construction costs.

Between January 2020 to July 2021, prices of all materials and services for new construction performed by contractors has gone up 26.3% on a national average (AGC, August 2021[2]), and 13% in California (California Department of General Services, 2022). The California Department of General Services also reported that new construction costs in California went up 15.22% from June 2021 to June 2022.

Through 2022, prices for construction materials have continued their ascent and in addition, skilled labor has become even more scarce than previous years. Construction project starts are also being delayed to account for supply chain challenges and labor shortages, and the

[1] Zarenski is a nationally recognized construction economics analyst, author, educator and presenter. Website: https://edzarenski.com/ . Article: https://edzarenski.com/2022/02/11/construction-inflation-2022/
[2] AGC is an organization of qualified construction contractors and industry related companies dedicated to skill, integrity and responsibility. Website: https://www.agc.org/

time delays and the uncertainty in product pricing are also resulting in higher bids (Engineering News Record, 2021). Contractors are transferring these risks to the Owner at the time of bidding.

Forecast:

Market analysis is showing the construction cost escalation rate in Los Angeles is currently 7.99% per year (Rider Levett Bucknall (RLB), 2022[3]), however, RLB is using 8.04% per year in their cost estimate calculations, and HNTB[4] is using 15%.

Below is a summary of some of the other market forces impacting construction costs. As of February 2022, diesel fuel, steel mill products, lumber, plywood, copper, brass, aluminum, plastic, gypsum, concrete, pavement, and roofing have all gone up drastically and forecasts are predicting that prices through 2022 will exceed peak prices of 2021 (Engineering News Record, 2022[5]). Interest rates are set to continue to rise, and the Russia-Ukraine war creates a lot of uncertainty and has market impacts. Supply chain and labor issues continue to cause a backlog of orders and an inventory shortage, indicating a supply-demand imbalance that will result in higher-priced goods and services. The anticipated pace of inflation is not likely to decelerate until 2023, with manufacturers potentially beginning to catch up to demand in late 2022, potentially with supply chains largely unclogged by late-2023 (CBRE, 2022[6]).

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[3] RLB is a global cost consultant partner and a nationally recognized project management and advisory firm. Website: https://www.rlb.com/americas/. Article: https://s31756.pcdn.co/americas/wp-content/uploads/sites/4/2022/03/City-Market-Insight-LOS-ANGELES-Q1-2022.pdf

[4] HNTB is a national engineering consulting company, with a strong presence in Southern California. Website: https://www.hntb.com/

[5] Engineering News Record is a national magazine that covers the engineering and construction industry. Website: https://www.enr.com/

[6] CBRE is the world's largest commercial real estate services & investment company. Website: https://www.cbre.com/about-us . Article: https://www.cbre.com/en/insights/reports/2022-fm-cost-trends-report .

Data Analysis:

***New Construction Inflation has gone up 54% in the past 10 years**

Source: Department of General Services California Construction Cost Index (CCCI), 2022
Information graphed by the Bureau of Engineering, June 2022
"The California Construction Cost index is developed based upon Building Cost Index (BCI) cost indices average for San Francisco and Los Angeles ONLY as produced by Engineering News Record (ENR) and reported in the second issue each month" (DGS).

BOE Bid Results:

In the past couple of years, there has been a wide range of cost changes with a general trend of higher than average cost increases. For example, BOE looked at price escalation data from City bids from 2021 to 2022 for two key construction scopes used on our projects that are typically bid on a unit price basis; concrete sidewalk/driveway and concrete pavement. In the past year the average unit cost of concrete sidewalk/driveway and concrete pavement increased by 79% and 21% respectively. We also found that there was a high variation on the cost changes in AC pavement.

In addition, we looked at 20 Municipal Facility project bids between 2017 to the present. These projects are typically bid on a lump sum basis. Our analysis was to look at the variance between the low bid and City Engineer's Estimate on a project-by-project basis. The average in the variance between the low bid price as compared to the City Engineer Estimate from 2017 through 2021 was that the low bid averaged 5.9% higher than the City Engineer's estimate. In 2022 this number increased dramatically to the low bids averaging 40.68% higher than the City Engineer's Estimate.

BOE Actions:

BOE is in the process of developing a draft cost inflation clause for City construction contracts, which would establish the mechanism for cost adjustments during construction for demonstrated inflationary cost increases and decreases. BOE intends to vet the proposed language with the local construction industry and with our City partners. This will help offset the perceived need by contractors to price risk into their bids.

Additionally, BOE is in the process of revising the suggested inflation rates for project budgeting. Since 2014, BOE suggested using 5% as the inflation rate for all new construction. The below chart is BOE's suggested inflation rates to use for future estimates:

Date	Annual Rate
July 1, 2022 - June 30, 2023	15%
July 1, 2023 - June 30, 2024	12%
July 1, 2024 - June 30, 2025	9%
July 1, 2025 - June 30, 2026	8%
July 1, 2026 - June 30, 2027	8%

The potential recession may cause changes in these inflation rates. Therefore, it is recommended to re-assess these rates in six months.

RL/MA:tt

Box\CMD\Administration\Municipal Facilities Meeting Minutes\MFC Report Construction Inflation

cc: Mary Hodge, Deputy Mayor
Aura Garcia, Board of Public Works
Teresa Villegas, Board of Public Works
Mike Davis, Board of Public Works
Vahid Khorsand, Board of Public Works
Susana Reyes, Board of Public Works.
Gary Lee Moore, Bureau of Engineering
Ted Allen, Bureau of Engineering
Alfred Mata, Bureau of Engineering
Julie Sauter, Bureau of Engineering
Jose Fuentes, Bureau of Engineering
Richard Louie, Bureau of Engineering

FORM GEN. 160 (Rev. 11-02)

CITY OF LOS ANGELES
INTERDEPARTMENTAL CORRESPONDENCE

Agenda Item No. 3

Date: August 21, 2023

To: Municipal Facilities Committee

From: Ted Allen, City Engineer
Bureau of Engineering

Subject: **FUNDING FOR CONSTRUCTION COST INFLATION UPDATE**

The Bureau of Engineering (BOE) is submitting this report to follow up on the Report presented at the July 2022 meeting which alerted our City Hall colleagues to significant price increases being experienced in construction cost bids. The construction cost increases have a variety of causes and remain higher than historic norms for the last decade, but have started to decline from recent highs. In order to deliver committed capital projects to the City residents, the funding allocations for construction projects may need to be augmented.

In the July 2022 report, BOE released the following chart for suggested inflation rates to use for future estimates:

Inflation rates per July 2022 Report	
Period	Construction Cost Inflation Annual Rate (%)
July 1, 2022 - June 30, 2023	15
July 1, 2023 - June 30, 2024	12
July 1, 2024 - June 30, 2025	9
July 1, 2025 - June 30, 2026	8
July 1, 2026 - June 30, 2027	8

Based on current market conditions, we recommend the chart be updated to the following:

Inflation Rates per July 2023 Report	
Period	Construction Cost Inflation Annual Rate (%)
July 1, 2022 - June 30, 2023	15
July 1, 2023 - June 30, 2024	8
July 1, 2024 - June 30, 2025	7
July 1, 2025 - June 30, 2026	6
July 1, 2026 - June 30, 2027	5

It should be noted that inflation for different construction types may vary. The proposed inflation rates assume that cost estimates being completed now are starting with unit costs that have accounted for the large inflationary pressures seen previously. Otherwise, additional adjustments should be made as needed to account for prior inflation to the point in time that the unit costs were established.

TA/DW/RL/MA/:tt:eg

BOX\EXE_Ready for Signature\TSA\Outbox\Archived\2023\Revised_Construction Inflation MFC Report 080323 _eg

cc: Randall Winston, Office of the Mayor
Aura Garcia, Board of Public Works
Teresa Villegas, Board of Public Works
Mike Davis, Board of Public Works
Vahid Khorsand, Board of Public Works
Susana Reyes, Board of Public Works

ATTACHMENT A: Project Modification Request (PMR) FORM

The purpose of this PMR form is to initiate the Project modification process and provide the District with information necessary to evaluate the Project modification request.

Regional Program	☑Infrastructure Program Project ☐Scientific Studies Program ☐Technical Resources Program
Project/Study Name	Lincoln Park Neighborhood Green Street Network Project
Project/Study Lead	City of Los Angeles, Sanitation and Environment (LASAN)
Watershed Area(s)	Upper Los Angeles River
Current Project Phase	Pre-Design
Approved Stormwater Investment Plan Fiscal Year	FY21-22
Transfer Agreement ID (e.g., 2020RPULAR52)	2021RPULAR04

Has Transfer Agreement or most recent Addendum been executed (i.e., signed by the project lead and the District)? ☐ Yes ☑ No

What type(s) of modification request?

☐ like-for-like modifications
☐ functionally equivalent BMP modifications
☐ modifications to Project or Study components that were not material to the WASC, ROC, or Board's decision to include the Project or Study in the SIP
☐ minor modifications to the budget or schedule of intermediate tasks where the total Funded Activity amount and Funded Activity completion date is unchanged
☐ change in primary or secondary objective
☐ change in Project benefits
☐ change in methodology (e.g., infiltration instead of diversion to sanitary sewer)
☐ decrease in BMP capacity
☐ change in Project or Study location
☐ change in capture area where benefits claimed are diminished or where there is a change in the municipalities that are receiving benefits
☐ updated engineering analysis resulting in a reduction of benefits claimed
☑ increase in Construction Cost or Life Cycle Cost greater than 10%
☑ increase or reallocation of annual funding distribution
☑ change in Funded Activity completion date
☑ other, please describe:

Increased project cost sharing.

Impact on scope or benefits?

☐ Improved
☐ Diminished
☑ Neither
☐ Not Sure

Description of the proposed modification(s) and the reason(s) why the modification(s) is/are being proposed.

LASAN, in conjunction with the City of Los Angeles Bureau of Engineering (BOE), has selected a design consultant and begun the Pre-Design phase of the Project which includes the preliminary engineering efforts to evaluate Project's alternatives, conduct community outreach, and prepare a Pre-Design Report (PDR) which includes a recommended alternative.

Since the execution of the Transfer Agreement (TA), the total project and construction costs have increased due to high cost escalation and economic inflation over the past few years. The Covid-19 Pandemic has been a major factor contributing to both material and labor shortages, which resulted in high escalation and inflation. BOE released a report in July 2022 with suggested inflation rate for project estimates. In August of 2023, BOE released an updated report with a revised inflation rate. Both of the rates are included as appendices for reference.

The modifications reported in this PMR are described in detail in Appendix A. Please also refer to the letters attached with modifications that were presented and approved by the ULAR WASC on June 7, 2023 and November 1, 2023, before the PMR process was established. The modifications previously accepted by the WASC included changes to Section A-1 Budget Plan Modifications, Section A-10 Work Schedule and Completion Date Modifications, and Cost Share Modification of Exhibit A - Scope of Work of the TA.

If applicable, list previously approved funding allocations/disbursements and revised funding request:

Note, if some or all of a previously Funded Activity cannot be completed as a result of the proposed modification, please include a description and indicate the amount of unused funds. Any unused funds should be reallocated and accounted for in your revised funding request.

Fiscal Year	Approved Funding Allocations	Revised Funding Request	Description/Phase *If applicable, include description of unused funds*
FY 21-22	$3,726,916	$3,726,916	Approved funding received
FY 22-23	$3,726,916	$3,726,916	Approved funding received
FY 23-24	$0	$0	Funding was deferred on 11/2022 to FY24/25
FY 24-25	$3,726,916	$3,726,916	Funding was deferred on 11/2022 to FY25/26
FY 25-26	$3,726,916	$6,976,916	Funding deferred to FY26/27. Requesting an additional $3.25M.
Future Funding	$3,726,916	$12,476,916	Request additional funding for FY26/27 ($4.75M); FY27/28 ($4M)
TOTAL	$18,634,580	$30,634,580	Refer to table 1 in Appendix A for details

A: SCWP Approved Total Funding Allocations	$18,634,580
B: Revised SCWP Anticipated Total Funding Request	$30,634,580
C: Difference between B and A	$12,000,000

If applicable, description of difference in SCWP Anticipated Total Funding Request. As a reminder, annual funding is at the discretion of the WASC, ROC, and ultimately the Board of Supervisors.

Besides requesting additional funding from SCWP, LASAN has been actively pursuing various options to fill the funding gap. These include leveraging the City's Measure W Municipal Funds, securing an additional $1.6M from Prop O for FY24/25 to be used during construction, and actively seeking grants from State and Federal.

The Project has savings from the pre-design phase which will be used for the construction of the Project. Appendix A is included as attachment for reference.

Brief description of Supporting Documentation provided.

Appendix A - Lincoln Project Modification Request (PMR) Details
Appendices B and C - Quarter 1 and 4 (Q1 and Q4) Fiscal Year (FY) 22-23 Quarterly Report Modification Letters
Appendices D and E - BOE Inflation Rate Letters

I certify the information and supporting documentation provided is accurate and true.	☑ YES
I understand this is a request and it is under the WASC's discretion to consider requested modifications.	☑ YES

Name Michael Scaduto, P.E., ENV SP

Organization City of Los Angeles, LASAN

Signature *Michael Scaduto* Digitally signed by Michael Scaduto Date: 2023.11.30 07:18:20-08'00'

Date 11/30/2023

FOR DISTRICT USE ONLY

Proposed Modifications to Projects or Studies:

	Status	Date
Modified Project or Study is **consistent** with the Project or Study included in the current fiscal year's SIP and proposed modifications were **approved** by the District.	☐ YES	
Modified Project or Study is **NOT consistent** with the Project or Study included in the current fiscal year's SIP. **If yes, select all that apply**:	☑ YES	12/11/23
PMR was received **after** October 31 of a fiscal year and the PMR will be considered for approval during the preparation of **subsequent** SIP for the fiscal year <u>after</u> the next	☐ YES	-
For Infrastructure Program Projects, modified Project was sent to **Scoring Committee**. If yes, revised score:	☐ YES	
Project or Study **abandoned** the proposed modifications	☐ YES	
Projector or Study was **withdrawn** from consideration by the WASC and shall issue repayment of unspent funds	☐ YES	
Proposed modifications were **recommended for approval** in the SIP	☐ YES ☐ NO	

Proposed Modifications to Project Concepts:

	Status	Date
Proposed modifications were deemed **consistent** with the Project concept that was approved by the WASC, ROC and Board for inclusion in the SIP and can be addressed within the existing budget. District will proceed to incorporate the proposed modification into the Feasibility Study immediately.	☐ YES	
Proposed modifications were deemed significant enough to result in a **significantly different** Project concept from the one approved by the WASC, ROC and Board for inclusion in the SIP. **If yes, select one:**	☐ YES	
District to **discontinue** work on the Feasibility Study, return unused funds to be programmed in the SIP for the next fiscal year, and advise the proponent to submit the modified Project concept during the Call for Projects for a future fiscal year.	☐ YES	-
District to **abandon** the proposed modifications and proceed with the Project concept included in the SIP.	☐ YES	-

Appendix A: Lincoln Project Modification Request (PMR) Details

What type(s) of modification request?

Increase in Construction Cost or Life Cycle Cost greater than 10%

Since the original cost estimate as submitted in the application, construction costs have increased due to escalation and inflation which was attributed by supply chain shortages in both labor and materials.

Phase	Approved	Modified
Pre-Design	$655,762	$452,942
Design	$1,530,113	$792,601
EIR Consultant	$0	$750,000
Bid and Award	$0	$233,172
Construction	$16,448,705	$31,759,729
Construction Management	$0	$915,835
Post Construction	$0	$1,002,958
Optimization	$0	$1,092,763
Total Project Cost	**$18,634,580**	**$37,000,000**

Increase or reallocation of annual funding distribution:

Change of total Regional funding request (from $18,634,580 to $30,634,580).

Table 1. Approved SCW Program contribution and additional request.

Cash Flow	FY 21/22	FY 22/23	FY 23/24	FY 24/25	FY 25/26	FY 26/27	FY 27/28	TOTAL
Approved	$3,726,916	$3,726,916	$0	$3,726,916	$3,726,916	$3,726,916	$0	$18,634,580
Additional Request	$0	$0	$0	$0	$3,250,000	$4,750,000	$4,000,000	$12,000,000
Total Regional Funding	$3,726,916	$3,726,916	$0	$3,726,916	$6,976,916	$8,476,916	$4,000,000	$30,634,580

Change in Funded Activity completion date:

Three (3) geotechnical borings with percolation tests revealed that the proposed project area for the green streets were not suitable for infiltration or claiming the credits claimed in the original SCWP Infrastructure Program application. Therefore, the project team is evaluating alternative locations to install drywells or infiltration gallery type structures to maintain the water supply and water quality credits submitted in the original application. While the locations providing water quality and supply benefits will change, the locations as proposed in the project application for the green streets will still have parkway planters and trees as a landscaping element to increase urban green space. Due to these changes, the project is continuing in the planning phases to determine the best locations to provide the maximum amount of benefit while preserving the drainage area.

Phase	Approved Start Date	Approved End Date	Start Date Modification	End Date Modification
Pre-Design	10/01/22	03/31/23	03/01/22	11/30/2023
Design	04/01/23	09/30/24	12/01/2023	05/31/2025
Bid and Award	10/01/24	03/31/25	06/01/2025	11/30/2025
Construction	04/01/25	03/31/27	12/01/2025	03/31/2028
Post Construction	04/01/27	03/31/28	04/01/2028	03/31/2029

Other – Increased project cost sharing.

As reported in previous quarterly reports to date, the City has been leveraging funding from Municipal Funds in support of the project delivery. LASAN has incurred cost share expenditures for the City of Los Angeles, Department of Public Works charges for project administration and implementation, design review, community engagement and outreach, environmental review, and construction management. The estimated City staff cost to support the Project is $4 million. In addition, the City has budgeted $1.6 million dollars in capital Proposition O (Prop O) – for FY24/25 to go towards delivery expenditures for the Project. These investments reflect the City's commitment to leveraging and maximizing benefits delivered in the Regional Program. A summary of the leverage fund to offset the Project's cost increase is provided below

Funding Info	FY 24/25 (Secured)	FY 25/26 (Proposed)	FY 26/27 (Proposed)	FY 27/28 (Proposed)	TOTAL
Prop O	$1,600,000	$0	$0	$0	$1,600,000
Municipal Funding	$0	$750,000	$3,575,892	$439,528	$4,765,420

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PRESIDENT

M. TERESA VILLEGAS
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DR. MICHAEL R. DAVIS
PRESIDENT PRO TEMPORE

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DR. FERNANDO CAMPOS
EXECUTIVE DIRECTOR

CITY OF LOS ANGELES

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ERIC GARCETTI
MAYOR

BUREAU OF SANITATION

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November 8, 2022

ELECTRONIC SUBMITTAL (safecleanwaterla@dpw.lacounty.gov)

DPW-Safe, Clean Water LA
Attn: Safe Clean Water Program Team

REQUEST FOR MODIFICATIONS TO SCOPE OF WORK - EXHIBIT A, SECTION A-1 AND A-10 OF AGREEMENT NO. 2021RPULAR04 FOR THE LINCOLN PARK NEIGHBORHOOD GREEN STREET NETWORK PROJECT

The City of Los Angeles (City) Bureau of Sanitation and Environment (LASAN), as the Project Developer, is requesting to make modifications to the Scope of Work – Exhibit A, for sections A-1 and A-10 of Agreement No. 2021RPULAR04 for the Lincoln Park Neighborhood Green Street Network Project (Project) for Quarter 1 (Q1) Fiscal Year (FY) 22-23 Quarterly Report

As described in the original application and Transfer Agreement, the Lincoln Park Neighborhood Green Street Network Project is a proposed regional project led by LASAN in partnership with the City of Los Angeles Recreation and Parks Department (RAP) to implement a regional multi-benefit stormwater project in Lincoln Park and the adjacent neighborhood. The Project begins at Lincoln Park which is located near the intersection of Valley Boulevard and Mission Road (3501 Valley Blvd, Los Angeles, CA 90031) in the Lincoln Heights Neighborhood of Los Angeles, Council District 14 and extends into the neighboring streets to the west of the park. Lincoln Park is home to the Plaza de la Raza Theatre, The Wall Las Memorias AIDS Memorial, and a statue of Florence Nightingale, along with walking paths and recreational facilities.

The Project aims to improve water quality to the Lincoln Heights neighborhood (Upper Los Angeles River Watershed) and Lincoln Park Lake. Other improvements include flood mitigation and habitat restoration. Modifications to the park will also increase the safety of the park and as well as improve community access through enhancements to the lake. The estimated Project cost at the time the Project was submitted for Measure W Regional Program funding was $18, 634,580, which was awarded in Round 2, Measure W Regional Program Funds.

The Transfer Agreement for this Project was executed by the Los Angeles Flood Control District on May 25, 2022. LASAN has developed the contractual documents to obtain technical design services. A Task Order Solicitation (TOS) was issued, and after reviewing proposals and conducting interviews, a consultant was selected and the Notice To Proceed (NTP) will be issued Q2 FY 22-23.

LASAN would like to report modifications to the following sections of Exhibit A of the Transfer Agreement.

Table 1. Section A-1 Budget Plan Modifications

Fiscal Year	FY 21-22	FY 22-23	FY 23-24	FY 24-25	FY 25-26	FY 26-27
Current Funding Projections	$3,726,916	$3,726,916	$3,726,916	$3,726,916	$3,726,916	$0
Revised Funding Distribution	**$3,726,916**	**$3,726,916**	**$0**	**$3,726,916**	**$3,726,916**	**$3,726,916**

Table 2. Section A-10 Work Schedule and Completion Date Modifications

Activity Name	Phase Type	Activity Type	Original Schedule		**Revised Schedule**	
			Activity Start	Activity End	**Activity Start**	**Activity End**
Planning	Planning	Pre-Design	07/01/21	06/30/22	**10/01/22**	**03/31/23**
Design	Environmental Documentation	CEQA & Permitting	NA	NA	**04/01/23**	**09/30/24**
Design	Design	Design	10/01/21	12/31/22	**04/01/23**	**09/30/24**
Bid and Award	Construction	Bid and Award	NA	NA	**10/01/24**	**03/31/25**
Construction	Construction	Construction	11/01/22	03/31/25	**04/01/25**	**03/31/27**
Post Construction	Post Construction	Post Construction and Optimization	NA	NA	**04/01/27**	**03/31/28**

With this letter, LASAN is notifying the Safe, Clean Water Program of the Project's modifications, which would be part of the Project's Quarterly Report for Q1 FY 22-23 in the Safe Clean Water Module. If you have any questions, please contact my staff, Carmen Andrade at carmen.andrade@lacity.org . Inquiries can also be directed to the City's Measure W Program general email address at san.safecleanwater@lacity.org.

Sincerely,

Michael Scaduto Digitally signed by Michael Scaduto Date: 2022.11.09 22:44:26-08'00'

Michael Scaduto, P.E., ENV SP
Principal Engineer
Safe Clean Water Implementation Division
LA Sanitation and Environment

cc: Julie Allen, LASAN
Teresa Villegas, ULAR WASC Chair
Carmen Andrade, LASAN

CITY OF LOS ANGELES
CALIFORNIA

KAREN BASS
MAYOR

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August 14, 2023

ELECTRONIC SUBMITTAL (safecleanwaterla@dpw.lacounty.gov)

DPW-Safe, Clean Water LA
Attn: Safe Clean Water Program Team

REQUEST FOR MODIFICATIONS TO SCOPE OF WORK - AGREEMENT NO. 2021RPULAR04 FOR THE LINCOLN PARK NEIGHBORHOOD GREEN STREET NETWORK PROJECT

The City of Los Angeles Bureau of Sanitation and Environment (LASAN), as the Project Developer, is requesting to make modifications to the Scope of Work – Agreement No. 2021RPULAR04 for the Lincoln Park Neighborhood Green Street Network Project (Project) for Quarter 4 (Q4) Fiscal Year (FY) 22-23 Quarterly Report.

As described in the original application and Transfer Agreement, the Lincoln Park Neighborhood Green Street Network Project is a proposed regional project led by LASAN in partnership with the City of Los Angeles Recreation and Parks Department (RAP) to implement a regional multi-benefit stormwater project in Lincoln Park and the adjacent neighborhood. The Project begins at Lincoln Park which is located near the intersection of Valley Boulevard and Mission Road (3501 Valley Blvd, Los Angeles, CA 90031) in the Lincoln Heights Neighborhood of Los Angeles, Council District 14 and extends into the neighboring streets to the west of the park. The Project aims to improve water quality to the Lincoln Heights neighborhood (Upper Los Angeles River Watershed) and Lincoln Park Lake. Other improvements include flood mitigation and habitat restoration. Modifications to the park will also increase the safety of the park and as well as improve community access through enhancements to the lake.

The Transfer Agreement for this Project was executed by the District on May 31, 2022. Since that execution, LASAN has selected a Design consultant and begun the Pre-Design phase of the Project which includes the preliminary engineering efforts to evaluate alternatives, select a Design concept, prepare a Pre-Design Report, and conduct outreach. The total project and construction costs are expected to have increased over the past years of extraordinary economic conditions and LASAN will promptly report these modifications once the Pre-Design Report for the Project is completed in the next two months.

In the FY22/23 Q4 reports, LASAN is outlining a technical Scope Modification under the "Cost Share Modifications" category. As reported in previous quarterly reports to date, the City has been leveraging funding from Municipal Funds for staff charges in support of project delivery. City of Los Angeles Public Works staff charges relate to planning, design, and construction (i.e. project administration, design review, outreach, environmental review, and construction management). In addition, LASAN has also obtained funding from Prop O in the amount of $1.6 million dollars to go towards delivery expenditures for the Project. These investments reflect the City's commitment to leveraging and maximizing benefits delivered in the Regional Program.

A summary of the leverage fund amounts for this Project is provided below.

	Timeframe	Approved	Modification
Leveraging Funds for the Project	From Project Approval Through FY22/23 Q3	$0	$197,555.69
	FY22/23 Q4	$0	$52,184.39
	Estimate for the Future Through Project Completion	$0	$3,755,532.70
	Total Estimated Through Project Completion	**$0**	**$4,005,272.78**

With this letter, LASAN is notifying the Safe, Clean Water Program of the Project's modifications, which would be part of the Project's Quarterly Report for FY22/23 Q4 in the Safe Clean Water Module. If you have any questions, please contact the City's Measure W Program general email address at san.safecleanwater@lacity.org.

Sincerely,

Michael Scaduto
Digitally signed by Michael Scaduto
Date: 2023.08.11 07:51:11-07'00'

Michael Scaduto, P.E., ENV SP
Principal Engineer
Safe Clean Water Implementation Division
LA Sanitation and Environment

cc:
Julie Allen, LASAN
Susie Santilena, LASAN
Sean Phan, LASAN
Ida Meisami-Fard, LASAN

GEN. FORM 160 (Rev. 6-80)

CITY OF LOS ANGELES
INTER-DEPARTMENTAL CORRESPONDENCE

Agenda Item No. 9

Date: 7/28/22

To: Municipal Facilities Committee

From: Deborah Weintraub, AIA, LEEDAP
Chief Deputy City Engineer

Electronically Signed by Deborah Weintraub on 07/12/2022 12:53:31 PM

Subject: **FUNDING FOR CONSTRUCTION COST INFLATION**

Recommendations:

1. That the Bureau of Engineering (BOE) work with the office of the City Administrative Officer to develop a funding strategy for projects that are either in construction and/or starting construction in Fiscal Year 2022-23 due to construction cost inflation, and;
2. Reassess market conditions in January 2023 to adjust this strategy accordingly.

Introduction:

The BOE is submitting this report in order to alert our City Hall colleagues of significant price increases we are experiencing in construction cost bids. The construction cost increases have a variety of causes and are extraordinary. In order to deliver committed capital projects to the City residents, the funding allocations for construction projects may need to be augmented.

Background:

Non-residential building inflation between 2011 and 2020 on a national basis was on average 3.7% annually (Zarenski, 2021[1]), and 2.4% in California (California Department of General Services). While the pandemic initially decreased construction activity in 2020, in 2021 there was a large increase in demand for construction materials. Unfortunately, this demand was met with serious supply chain challenges, and this resulted in a reduction in the availability of construction materials and higher construction costs.

Between January 2020 to July 2021, prices of all materials and services for new construction performed by contractors has gone up 26.3% on a national average (AGC, August 2021[2]), and 13% in California (California Department of General Services, 2022). The California Department of General Services also reported that new construction costs in California went up 15.22% from June 2021 to June 2022.

Through 2022, prices for construction materials have continued their ascent and in addition, skilled labor has become even more scarce than previous years. Construction project starts are also being delayed to account for supply chain challenges and labor shortages, and the

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time delays and the uncertainty in product pricing are also resulting in higher bids (Engineering News Record, 2021). Contractors are transferring these risks to the Owner at the time of bidding.

Forecast:

Market analysis is showing the construction cost escalation rate in Los Angeles is currently 7.99% per year (Rider Levett Bucknall (RLB), 2022[3]), however, RLB is using 8.04% per year in their cost estimate calculations, and HNTB[4] is using 15%.

Below is a summary of some of the other market forces impacting construction costs. As of February 2022, diesel fuel, steel mill products, lumber, plywood, copper, brass, aluminum, plastic, gypsum, concrete, pavement, and roofing have all gone up drastically and forecasts are predicting that prices through 2022 will exceed peak prices of 2021 (Engineering News Record, 2022[5]). Interest rates are set to continue to rise, and the Russia-Ukraine war creates a lot of uncertainty and has market impacts. Supply chain and labor issues continue to cause a backlog of orders and an inventory shortage, indicating a supply-demand imbalance that will result in higher-priced goods and services. The anticipated pace of inflation is not likely to decelerate until 2023, with manufacturers potentially beginning to catch up to demand in late 2022, potentially with supply chains largely unclogged by late-2023 (CBRE, 2022[6]).

[3] RLB is a global cost consultant partner and a nationally recognized project management and advisory firm. Website: https://www.rlb.com/americas/. Article: https://s31756.pcdn.co/americas/wp-content/uploads/sites/4/2022/03/City-Market-Insight-LOS-ANGELES-Q1-2022.pdf

[4] HNTB is a national engineering consulting company, with a strong presence in Southern California. Website: https://www.hntb.com/

[5] Engineering News Record is a national magazine that covers the engineering and construction industry. Website: https://www.enr.com/

[6] CBRE is the world's largest commercial real estate services & investment company. Website: https://www.cbre.com/about-us . Article: https://www.cbre.com/en/insights/reports/2022-fm-cost-trends-report .

Data Analysis:

***New Construction Inflation has gone up 54% in the past 10 years**

Source: Department of General Services California Construction Cost Index (CCCI), 2022
Information graphed by the Bureau of Engineering, June 2022
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In addition, we looked at 20 Municipal Facility project bids between 2017 to the present. These projects are typically bid on a lump sum basis. Our analysis was to look at the variance between the low bid and City Engineer's Estimate on a project-by-project basis. The average in the variance between the low bid price as compared to the City Engineer Estimate from 2017 through 2021 was that the low bid averaged 5.9% higher than the City Engineer's estimate. In 2022 this number increased dramatically to the low bids averaging 40.68% higher than the City Engineer's Estimate.

BOE Actions:

BOE is in the process of developing a draft cost inflation clause for City construction contracts, which would establish the mechanism for cost adjustments during construction for demonstrated inflationary cost increases and decreases. BOE intends to vet the proposed language with the local construction industry and with our City partners. This will help offset the perceived need by contractors to price risk into their bids.

Additionally, BOE is in the process of revising the suggested inflation rates for project budgeting. Since 2014, BOE suggested using 5% as the inflation rate for all new construction. The below chart is BOE's suggested inflation rates to use for future estimates:

Date	Annual Rate
July 1, 2022 - June 30, 2023	15%
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The potential recession may cause changes in these inflation rates. Therefore, it is recommended to re-assess these rates in six months.

RL/MA:tt

Box\CMD\Administration\Municipal Facilities Meeting Minutes\MFC Report Construction Inflation

cc: Mary Hodge, Deputy Mayor
Aura Garcia, Board of Public Works
Teresa Villegas, Board of Public Works
Mike Davis, Board of Public Works
Vahid Khorsand, Board of Public Works
Susana Reyes, Board of Public Works.
Gary Lee Moore, Bureau of Engineering
Ted Allen, Bureau of Engineering
Alfred Mata, Bureau of Engineering
Julie Sauter, Bureau of Engineering
Jose Fuentes, Bureau of Engineering
Richard Louie, Bureau of Engineering

FORM GEN. 160 (Rev. 11-02)

Agenda Item No. 3

CITY OF LOS ANGELES
INTERDEPARTMENTAL CORRESPONDENCE

Date: August 21, 2023

To: Municipal Facilities Committee

From: Ted Allen, City Engineer
Bureau of Engineering

Subject: **FUNDING FOR CONSTRUCTION COST INFLATION UPDATE**

The Bureau of Engineering (BOE) is submitting this report to follow up on the Report presented at the July 2022 meeting which alerted our City Hall colleagues to significant price increases being experienced in construction cost bids. The construction cost increases have a variety of causes and remain higher than historic norms for the last decade, but have started to decline from recent highs. In order to deliver committed capital projects to the City residents, the funding allocations for construction projects may need to be augmented.

In the July 2022 report, BOE released the following chart for suggested inflation rates to use for future estimates:

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Based on current market conditions, we recommend the chart be updated to the following:

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TA/DW/RL/MA/:tt:eg

BOX\EXE_Ready for Signature\TSA\Outbox\Archived\2023\Revised_Construction Inflation MFC Report 080323 _eg

cc: Randall Winston, Office of the Mayor
Aura Garcia, Board of Public Works
Teresa Villegas, Board of Public Works
Mike Davis, Board of Public Works
Vahid Khorsand, Board of Public Works
Susana Reyes, Board of Public Works

GEN. FORM 160 (Rev. 6-80)

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Date: 7/28/22

To: Municipal Facilities Committee

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Chief Deputy City Engineer

Electronically Signed by Deborah Weintraub on 07/12/2022 12:53:31 PM

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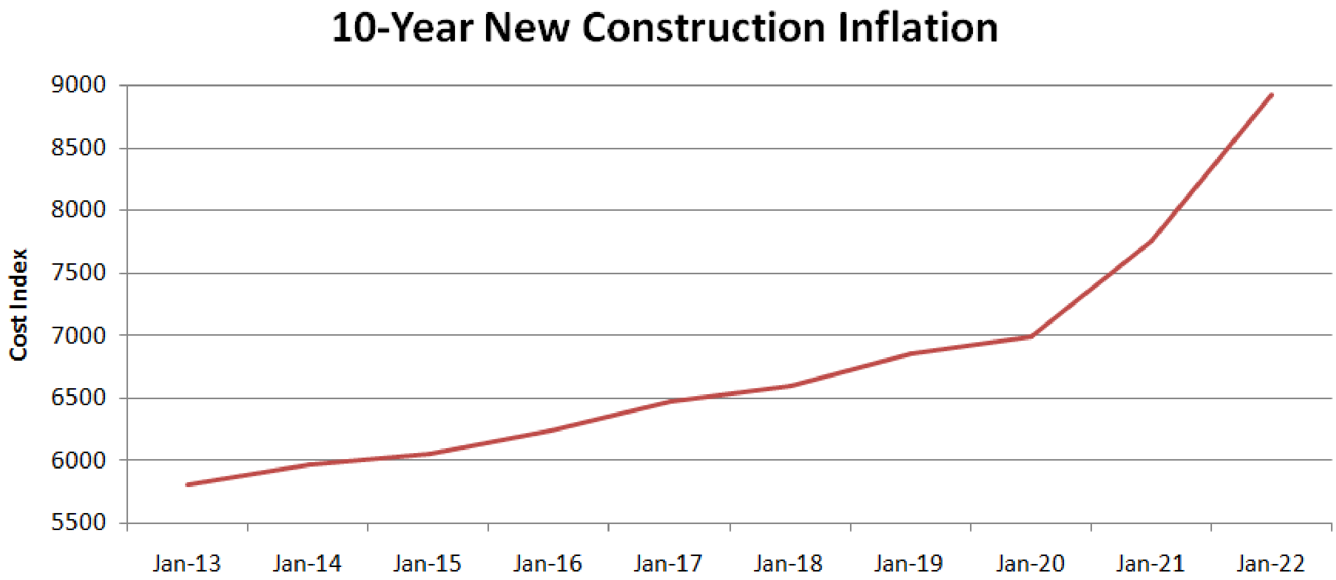

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FORM GEN. 160 (Rev. 11-02)

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KAREN BASS
MAYOR

December 1, 2023

The Honorable Teresa Villegas
Chair, Upper Los Angeles River Watershed Area Steering Committee
Los Angeles County Flood Control District
900 S Fremont Avenue
Alhambra, CA 91803

RE: City of Los Angeles Stormwater Project Priorities for the Upper LA River Watershed Area

Dear Chair Villegas,

I write to support your development of the forthcoming Upper LA River Watershed Area Steering Committee (ULAR WASC) Stormwater Investment Plan (SIP), affecting the City's Bureau of Sanitation (LASAN), Bureau of Street Services (BSS), and Department of Water & Power (LADWP). The City of Los Angeles appreciates your consideration of our Project Modification Request forms and our Round 5 Regional Program applications. Acknowledging that our collective requests far outweigh the available funding for Fiscal Year 2024-25 (FY25), this letter establishes the City's project priorities based on overall community benefits and optimal return on investment in an effort to support your difficult decision-making.

The City of Los Angeles has benefited greatly from the County's development of the Safe Clean Water Program (SCWP). As any other municipality in the County, the City seeks to maximize our ability to capture and treat stormwater, enhance local water supply, and provide multi-purpose community benefits through the Municipal and Regional Programs administered by the County. The County's newly developed Project Modification Request (PMR) process provides additional benefits to the City by establishing a process to seek gap funding for previously awarded projects where current projected costs are higher than initial project estimates. The City has prepared PMRs for ten projects in the ULAR watershed that detail the total project shortfalls for City projects. I understand that the ULAR WASC will be asked to put forward a FY25 SIP using a very limited budget that considers the Regional Program's new project applications against gap funding requests submitted in PMR forms. We recognize that this may raise tough questions about worthwhile and competing watershed-wide priorities.

To this end, the City of Los Angeles has thoughtfully and intentionally analyzed its portfolio of projects and competing needs and would like to share a list of project priorities to demonstrate how the ULAR WASC could maximize environmental and community benefits despite limited funding. Please consider our priorities listed below for the ULAR WASC FY25 SIP, in order of importance, and details on specific projects in the accompanying table (Attachment 1):

- To reduce environmental injustices, the City prefers funding for projects located in Disadvantaged Communities, as defined by the County Regional Program's Disadvantaged Community Policies.
- To fulfill our prior commitments to the ULAR WASC and our neighbors, the City prefers gap funding for previously awarded Regional Program projects over new awards requested in Round 5 applications, which will ensure awarded projects have sufficient funds in order to come to fruition.
- To deliver near-term environmental and community benefits, the City prefers funding for fully-designed projects without scope changes that are expected to break ground during Fiscal Years 2024-25 and 2025-26; such projects are near certain and will deliver immediate results upon completion.
- To be accountable to our partners and grantors, the City prefers funding for projects that leverage match funding from external partners beyond the City and County.
- To attenuate the ULAR WASC's SIP decision-making process for FY25, the City prefers to be considered for funding for new projects beginning in FY26 over competing for the extremely limited budget available for FY25, except in cases where projects leverage deadline-dependent match funding from external partners beyond the City and County.

These priorities are shared across LASAN, BSS, and LADWP, as presented to the Mayor's Office, the City Administrative Officer, and the Chief Legislative Analyst, who comprise the City's Measure W Administrative Oversight Committee. I hope that offering consistent principles and priorities for the City of Los Angeles simplifies decision-making for the ULAR WASC more broadly.

Sincerely,

Karen Bass

KAREN BASS
Mayor
City of Los Angeles

CC: Members of the Upper Los Angeles River Watershed Area Steering Committee

Attachment 1 - City of LA Regional Project Priorities (in order of priority). Please note highlighted cells where FY 2024-25 requests are delayed, except in cases where projects leverage deadline-dependent match funding from external partners.

Upper Los Angeles River WASC

Project	Start of Construction	DAC Benefit	Leverage Funding	Regional Program Funding	FY 20/21	FY 21/22	FY 22/23	FY 23/24	FY 24/25	FY 25/26	FY 26/27	FY 27/28	FY 28/29	Total
Broadway-Manchester Multi-Modal Green Street Project (Rd 2)	12/2024	Yes	$15.8M State	Approved FY 23/24 SIP	$ -	$ 886,000	$ 4,000,000	$ -	$ 4,000,000	$ 2,833,000	$ -	$ -	$ -	$ 11,719,000
				Additional Request	$ -	$ -	$ -	$ -	$ 626,116	$ 2,833,000	$ -	$ -	$ -	$ 3,459,116
				PMR SIP Recomendation	$ -	$ 886,000	$ 4,000,000	$ -	$ 4,626,116	$ 5,666,000	$ -	$ -	$ -	$ 15,178,116
David M. Gonzales Recreation Center Stormwater Capture Project (Rd 2)	9/2024	Yes	$19.8M Local $2.3M State	Approved FY 23/24 SIP	$ -	$ 388,000	$ 581,000	$ 1,550,000	$ 2,130,000	$ 3,099,000	$ 4,067,000	$ 3,873,000	$ 3,675,000	$ 19,363,000
				Additional Request	$ -	$ -	$ -	$ -	$ 4,669,238	$ 4,669,238	$ 4,669,238	$ 4,669,238	$ 4,669,238	$ 23,346,190
				PMR SIP Recomendation	$ -	$ 388,000	$ 581,000	$ 1,550,000	$ 6,799,238	$ 7,768,238	$ 8,736,238	$ 8,542,238	$ 8,344,238	$ 42,709,190
Lankershim Blvd LAUFM (Rd 1)	7/2025	Yes	$48.3M Local	Approved FY 23/24 SIP	$ 5,139,380	$ 5,139,380	$ 5,139,380	$ -	$ 5,139,380	$ 5,139,380	$ -	$ -	$ -	$ 25,696,900
				Additional Request	$ -	$ -	$ -	$ -	$ -	$ 6,000,000	$ 5,000,000	$ -	$ -	$ 11,000,000
				PMR SIP Recomendation	$ 5,139,380	$ 5,139,380	$ 5,139,380	$ -	$ 5,139,380	$ 11,139,380	$ 5,000,000	$ -	$ -	$ 36,696,900
Lincoln Park Neighborhood Green Street (Rd 2)	12/2025	Yes	$6.3M Local	Approved FY 23/24 SIP	$ -	$ 3,726,916	$ 3,726,916	$ -	$ 3,726,916	$ 3,726,916	$ 3,726,916	$ -	$ -	$ 18,634,580
				Additional Request	$ -	$ -	$ -	$ -	$ -	$3,250,000	$4,750,000	$4,000,000	$0	$ 12,000,000
				PMR SIP Recomendation	$ -	$ 3,726,916	$ 3,726,916	$ -	$ 3,726,916	$ 6,976,916	$ 8,476,916	$ 4,000,000	$ -	$ 30,634,580
Valley Village Park Stormwater Capture Project (Rd 1)	7/2024	Yes	$3.1M Local	Approved FY 23/24 SIP	$ 1,112,070	$ 1,270,938	$ 476,602	$ 317,734	$ -	$ -	$ -	$ -	$ -	$ 3,177,344
				Additional Request	$ -	$ -	$ -	$ -	$ -	$6,470,533	$6,470,533	$0	$0	$ 12,941,066
				PMR SIP Recomendation	$ 1,112,070	$ 1,270,938	$ 476,602	$ 317,734	$ -	$ 6,470,533	$ 6,470,533	$ -	$ -	$ 16,118,410
Strathern Park North Stormwater Capture Project (Rd 1)	1/2025	Yes	$9.2M Local	Approved FY 23/24 SIP	$ 3,247,512	$ 3,711,442	$ 1,391,791	$ 927,861	$ -	$ -	$ -	$ -	$ -	$ 9,278,606
				Additional Request	$ -	$ -	$ -	$ -	$ -	$11,921,049	$11,921,049	$0	$0	$ 23,842,098
				PMR SIP Recomendation	$ 3,247,512	$ 3,711,442	$ 1,391,791	$ 927,861	$ -	$ 11,921,049	$ 11,921,049	$ -	$ -	$ 33,120,704
Fernangeles Park Stormwater Capture Project (Rd 1)	11/2024	Yes	$8.1M Local	Approved FY 23/24 SIP	$ 2,926,262	$ 3,344,299	$ 1,254,112	$ 836,075	$ -	$ -	$ -	$ -	$ -	$ 8,360,748
				Additional Request	$ -	$ -	$ -	$ -	$ -	$14,233,533	$14,233,533	$0	$0	$ 28,467,066
				PMR SIP Recomendation	$ 2,926,262	$ 3,344,299	$ 1,254,112	$ 836,075	$ -	$ 14,233,533	$ 14,233,533	$ -	$ -	$ 36,827,814
Whitsett Fields Park North Stormwater Capture Project (Rd 3)	3/2026	Yes	$8.6M Local	Approved FY 23/24 SIP	$ -	$ -	$ 840,000	$ 1,679,000	$ 1,679,000	$ 1,679,000	$ 2,516,000	$ -	$ -	$ 8,393,000
				Additional Request	$ -	$ -	$ -	$ -	$ -	$4,502,466	$4,502,466	$4,502,466	$4,502,466	$ 18,009,864
				PMR SIP Recomendation	$ -	$ -	$ 840,000	$ 1,679,000	$ 1,679,000	$ 6,181,466	$ 7,018,466	$ 4,502,466	$ 4,502,466	$ 26,402,864
Valley Plaza Park Stormwater Capture Project (Rd 2)	1/2026	Yes	$27.0M Local	Approved FY 23/24 SIP	$ -	$ 529,000	$ 794,000	$ -	$ 2,910,000	$ 4,232,000	$ 7,670,000	$ 5,290,000	$ 5,022,000	$ 26,447,000
				Additional Request	$ -	$ -	$ -	$ -	$ -	$8,622,253	$8,622,253	$8,622,253	$8,622,254	$ 34,489,013
				PMR SIP Recomendation	$ -	$ 529,000	$ 794,000	$ -	$ 2,910,000	$ 12,854,253	$ 16,292,253	$ 13,912,253	$ 13,644,254	$ 60,936,013

Round 5 Projects submitted for consideration														
Project	Start of Construction	DAC Benefit	Leverage Funding	Regional Program Funding	FY 20/21	FY 21/22	FY 22/23	FY 23/24	FY 24/25	FY 25/26	FY 26/27	FY 27/28	FY 28/29	Total
Osborne Street: Path to Park Access	7/2026	Yes	$4.9M State $2.8M Local	Requesting	$ -	$ -	$ -	$ -	$150,000	$1,194,780	$3,262,088	$4,893,132	$ -	$ 9,500,000
LA River Green Infrastructure	7/2026	Yes	$3.1M Local	Requesting	$ -	$ -	$ -	$ -	$938,214	$1,340,306	$4,467,683	$4,802,759	$5,504,850	$ 17,053,812
Sun Valley Green Neighborhood Infrastructure	1/2027	Yes	$2.6M Local	Requesting	$ -	$ -	$ -	$ -	$763,363	$708,836	$381,681	$5,725,221	$5,865,220	$ 13,444,321
Pollutant Source Characterization Study	N/A	Citywide	$ -	Requesting	$ -	$ -	$ -	$ -	$98,840	$766,010	$617,750	$617,750	$370,650	$ 2,471,000
Street Sweeping Study	N/A	CityWide	$105k Local	Requesting	$ -	$ -	$ -	$ -	$282,400	$321,230	$84,720	$ -	$ -	$ 688,350

ATTACHMENT A: Project Modification Request (PMR) FORM

The purpose of this PMR form is to initiate the Project modification process and provide the District with information necessary to evaluate the Project modification request.

Regional Program	☐Infrastructure Program Project ☑Scientific Studies Program ☐Technical Resources Program
Project/Study Name	Fire Effects Study in the ULAR Watershed Management Area
Project/Study Lead	San Gabriel Valley Council of Governments
Watershed Area(s)	Rio Hondo, Upper Los Angeles River
Current Project Phase	Completed Year 1 of Monitoring; Planning Year 2 of Monitoring; Develope
Approved Stormwater Investment Plan Fiscal Year	FY21-22
Transfer Agreement ID (e.g., 2020RPULAR52)	2021RPRH50 & 2021RPULAR52

Has Transfer Agreement or most recent Addendum been executed (i.e., signed by the project lead and the District)? ☑ Yes ☐ No

What type(s) of modification request?

☐ like-for-like modifications

☐ functionally equivalent BMP modifications

☐ modifications to Project or Study components that were not material to the WASC, ROC, or Board's decision to include the Project or Study in the SIP

☐ minor modifications to the budget or schedule of intermediate tasks where the total Funded Activity amount and Funded Activity completion date is unchanged

☐ change in primary or secondary objective

☐ change in Project benefits

☐ change in methodology (e.g., infiltration instead of diversion to sanitary sewer)

☐ decrease in BMP capacity

☐ change in Project or Study location

☐ change in capture area where benefits claimed are diminished or where there is a change in the municipalities that are receiving benefits

☐ updated engineering analysis resulting in a reduction of benefits claimed

☐ increase in Construction Cost or Life Cycle Cost greater than 10%

☑ increase or reallocation of annual funding distribution

☐ change in Funded Activity completion date

☐ other, please describe:

Impact on scope or benefits?

☑ Improved
☐ Diminished
☐ Neither
☐ Not Sure

Description of the proposed modification(s) and the reason(s) why the modification(s) is/are being proposed.

Based on work conducted in the first year of the study, opportunities to expand the scope with an additional year and additional funds were identified to increase the study benefits. Detail on the proposed expansions and their associated benefits are described in the attached scope of work.

If applicable, list previously approved funding allocations/disbursements and revised funding request:

Note, if some or all of a previously Funded Activity cannot be completed as a result of the proposed modification, please include a description and indicate the amount of unused funds. Any unused funds should be reallocated and accounted for in your revised funding request.

Fiscal Year	Approved Funding Allocations	Revised Funding Request	Description/Phase *If applicable, include description of unused funds*
FY21-22	$264,436	$264,436	No Change
FY22-23	$257,161	$257,161	No Change
FY23-24	$283,403	$283,403	No Change
FY24-25	$0	$417,224	Refer to attached proposed expanded scope of work
Future Funding			
TOTAL	$805,000	$1,222,224	Refer to attached proposed expanded scope of work

A: SCWP Approved Total Funding Allocations	$805,000
B: Revised SCWP Anticipated Total Funding Request	$1,222,224
C: Difference between B and A	$417,224

If applicable, description of difference in SCWP Anticipated Total Funding Request. As a reminder, annual funding is at the discretion of the WASC, ROC, and ultimately the Board of Supervisors.

Refer to the attached scope of work for the proposed expansion of the study for an additional year and additional funds to increase the study benefits.

Brief description of Supporting Documentation provided.

Proposed expansion of the Fire Effects Study scope of work for an additional year and details on the expected increase in the achievement of SCWP goals from expanding the Study.

I certify the information and supporting documentation provided is accurate and true.	☑ YES
I understand this is a request and it is under the WASC's discretion to consider requested modifications.	☑ YES

Name Marisa Creter

Organization San Gabriel Valley Council of Gov

Signature Marisa Creter

Date 11/30/2023

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Proposed Modifications to Projects or Studies:

	Status	Date
Modified Project or Study is **consistent** with the Project or Study included in the current fiscal year's SIP and proposed modifications were **approved** by the District.	☐ YES	
Modified Project or Study is **NOT consistent** with the Project or Study included in the current fiscal year's SIP. **If yes, select all that apply**:	☑ YES	12/13/2023
PMR was received **after** October 31 of a fiscal year and the PMR will be considered for approval during the preparation of **subsequent** SIP for the fiscal year after the next	☐ YES	
For Infrastructure Program Projects, modified Project was sent to **Scoring Committee**. If yes, revised score:	☐ YES	
Project or Study **abandoned** the proposed modifications	☐ YES	
Projector or Study was **withdrawn** from consideration by the WASC and shall issue repayment of unspent funds	☐ YES	
Proposed modifications were **recommended for approval** in the SIP	☐ YES ☐ NO	

Proposed Modifications to Project Concepts:

	Status	Date
Proposed modifications were deemed **consistent** with the Project concept that was approved by the WASC, ROC and Board for inclusion in the SIP and can be addressed within the existing budget. District will proceed to incorporate the proposed modification into the Feasibility Study immediately.	☐ YES	
Proposed modifications were deemed significant enough to result in a **significantly different** Project concept from the one approved by the WASC, ROC and Board for inclusion in the SIP. **If yes, select one:**	☐ YES	
District to **discontinue** work on the Feasibility Study, return unused funds to be programmed in the SIP for the next fiscal year, and advise the proponent to submit the modified Project concept during the Call for Projects for a future fiscal year.	☐ YES	-
District to **abandon** the proposed modifications and proceed with the Project concept included in the SIP.	☐ YES	-

FIRE EFFECTS STUDY IN THE ULAR WATERSHED MANAGEMENT AREA

SCOPE OF WORK MODIFICATION

The current Fire Effects Study includes eight tasks. Detail on how the proposed project modification will expand on the existing scope of work is described below.

- Task 1: Project Management and Client Meetings
- Task 2: Develop Work Plan
- Task 3: Regulatory Support
- Task 4: Wet Weather Monitoring
- Task 5: Dry Weather Monitoring
- Task 6: Interim Report
- Task 7: Data Analysis and Modeling
- Task 8: Final Report

Task 1: Project Management and Client Meetings

Expand overall project management and monthly TAC meetings for the additional year of the study. In addition, complete quarterly reports and annual reporting for the SCWP for the additional year of the study.

Deliverables

- Monthly TAC Meeting Minutes
- Quarterly and Annual SCWP Reports

Task 2: Develop Work Plan

The existing Work Plan will be updated to integrate the additional monitoring and modeling efforts described under the subsequent Tasks.

Deliverables

- Revised Final Work Plan

Task 3: Regulatory Support

Expand quarterly meetings with Regional Water Quality Control Board personnel for the additional year of the study. In addition, an additional technical stakeholder group meeting for regional coordination will be held for the additional year of the study. This will include further engagement for Board personnel after the conclusion of the modeling efforts to discuss potential uses and proactively engage on implications of the findings. Given the stringent water quality objectives for stormwater, the potential increase in pollutant loading from fires could cause exceedances. This is a factor not currently considered in the regulatory framework. The results of this study are expected to inform the isolated impacts of potential fires. Therefore, a proactive approach will be taken to engage Board personnel on the findings of this study and potential next steps for use.

Deliverables

- Quarterly Regional Board Meeting Minutes
- Technical Stakeholder Group Meeting Minutes

Task 4: Wet Weather Monitoring

Maintain funds for rapid-response post-fire monitoring in wet weather. Following a significant wildfire, WSP will monitor up to three sites for up to three wet weather events with a forecasted rainfall total of > 0.25 inches during the 2024 monitoring year. Because fires occur unexpectedly, monitoring locations are not pre-determined. To the extent possible, sites with previous, available monitoring data, accessibility, and an ability to coordinate with other monitoring programs, will be selected. The most appropriate sites downstream of the burn area to be monitored will be determined in coordination with the Project Manager and in accordance with the Upper Los Angeles River Watershed Management Area Fire Effects Study Work Plan and Quality Assurance Project Plan (Work Plan). If no new fires occur, no additional monitoring will be performed outside of the original scope.

Task 5: Dry Weather Monitoring

Maintain funds for post-fire rapid response monitoring, in which immediate post-fire monitoring will be conducted during dry weather. After the occurrence of a wildfire, mobilization of field crews will depend on the criteria developed in the Work Plan (safety, accessibility, representativeness, etc.). If mobilized, WSP will monitor up to three sites for two dry weather events during the 2024 monitoring year. Because fires occur unexpectedly, monitoring locations are not pre-determined. To the extent possible, sites with previous, available monitoring data, accessibility, and an ability to coordinate with other monitoring programs will be selected. Following a significant wildfire, the most appropriate sites to be monitored will be determined in coordination with the Project Manager. Sampling will be performed in accordance with the Work Plan and reference the Upper Los Angeles River Area Post-Fire Rapid Response Work Plan (November 2020).

Task 6: Interim Report

No Change.

Task 7: Data Analysis and Modeling

The primary enhanced efforts of the proposed modifications are under the data analysis of historic fires in Southern California and the model scenarios representative of potential post-fire impacts.

For the additional data analysis, under the existing study a database has been compiled of historic monitoring data related to fires in Southern California from other sources, as shown in Table 1. Preliminary analyses were conducted to help inform the changes to hydrology and pollutant concentrations following fire events. The original scope was limited in this effort and therefore focused on broader statistical analyses and comparisons of pre- and post-fire data. The original effort primarily characterized historic fires based on two variables; burned area and burn severity. The compiled database presents an opportunity to expand on this historic data analysis to focus on additional characteristics of fires that may impact hydrology and water quality changes. This will include further investigation of temporal impacts, such as how long a fires lasts, how long impacts to hydrology and water quality are observed after a fire, along with the influence of storm dynamics following fires. Additional spatial factors will be investigated as well, including distinguishing between the impacts of fires on different land uses and land cover (e.g., soils and slopes) in terms of the response to hydrology and water quality changes. This will be used to better inform the physical parameters adjusted in the modeling to represent the realities of fire impacts more directly. In addition, there are other confounding factors in the data compiled that could be further sorted through with additional analyses. Confounding factors can be better isolated by breaking the data down into additional categories, which therefore will allow observations on conditions more directly caused by fires. There are still many unknowns regarding why elevated pollutant levels are often observed after fires, and expanding this historic data analysis can help to inform more details on the physical and chemical responses.

Table 1. Compiled Historic Fire-Related Data.

Stakeholder	**Available Data**	**Data Timeline**
ULAR WMG	CIMP station data	Historical data through 2021
	LARWMP water quality and bioassessment data	2008–present
Ventura County	Water quality and bioassessment data, including burned areas	2015–2021
Orange County	Santiago Fire burn areas	2007–2008 wet season
SCCWRP	SCCWRP Natural resources data Arroyo Seco (Station Fire) Contaminant Loading following wildfires Aerial deposition (Santa Monica Bay)	2001–2010
San Gabriel River Regional Monitoring Program	Monitoring at burn sites (Babcock Fire)	2020–2021
Riverside County	Holy Fire post-fire monitoring report	2018
Various Under the SMC Program	SMC Data	2011–2021

LARWMP = Los Angeles River Watershed Monitoring Program; SCCWRP = Southern California Coastal Water Research Project; CIMP = Coordinated Integrated Monitoring Program, SMC = Stormwater Monitoring Coalition; TBD = to be determined;
ULAR = Upper Los Angeles River, WMG = Watershed Management Group

For the additional model scenarios, under the existing study a finite number of post-fire landscape changes are being represented. This primarily consists of representing a minimal and worst-case scenario for three key variables on potential fires in the Upper Los Angeles River; burn area, burn severity, and proximity of burn to assessment points. This is intended to roughly bracket the potential impacts to the watershed. The additional funds will be used to expand the post-fire impact scenarios to look at multiple variations of the variables, such as including more moderate burn severity cases and various representations of where the potential fires take place in the upper watershed of the Upper Los Angeles River. Consistent with the expansion of the data analysis, additional temporal and spatial factors will be represented in the model scenarios under the additional scope. This will include varying the period of a fire and how soon after subsequent storm events are experienced. This will also include representation of different impacts when a fire burns on different land uses and land cover. While the current modeling focuses mostly on the landscape changes and hydrologic and water quality conditions response, the additional funds will also be used to expand the characterization of atmospheric deposition from nearby fires, potentially not directly in the watershed. Additional fire model scenarios will provide more context to determine relative risk of potential fires to this area and stormwater quality, which therefore can best inform decisions for more resilient stormwater management.

Deliverables

- Integrate in the Post-Fire and Climate Change Watershed Model Report and Model Files
- Integrate in the Post-Fire BMP Performance Report

Task 8: Final Report

Results of the additional monitoring, data analysis, and modeling described in the above tasks will the integrated in the Final Report planned for the Fire Effects Study.

Deliverables

- Integrate in the Final Report

SAFE, CLEAN WATER PROGRAM GOALS

The expansion of the Fire Effects Study will significantly enhance the achievement of the Safe, Clean Water Program goals, including the following:

- **Improve water quality and contribute to attainment of water-quality requirements** – the expansion of the Fire Effects Study will help characterize how fires may result in elevated pollutant levels in our watersheds. By better understanding these potential impacts, the study will recommend more resilient management strategies to improve water quality under these conditions. This will include recommendations for strategies that can more directly address the core causes of degraded water quality.
- **Encourage innovation and adoption of new technology and practices** – the expansion of the Fire Effects Study will identify how potential fires and projected climate change may influence the performance of stormwater BMPs. More innovative BMP designs that can maximize performance under these changing conditions will be recommended. In addition, recommendations may include the adoption of new practices to address the core causes of elevated pollution under fire conditions.
- **Invest in independent scientific research** – the Fire Effects Study collaborated with multiple agencies to compile the historic database of fire-related data. Expanding the data analysis with this database will contribute to the overall scientific research on the impacts of fires to stormwater quality. There are still many unknowns regarding why elevated pollutant levels are often observed after fires, and expanding this historic data analysis can help to inform more details on the physical and chemical responses. In addition, the models being developed under this study are a first of its kind representation of post-fire impacts to a watershed.
- **Implement an iterative planning and evaluation process to ensure adaptive management** – the Fire Effects Study itself implements adaptive management by evaluating current stormwater management strategies performance under potential fire and climate change projections to inform recommended design adjustments under these changing conditions.

SCHEDULE MODIFICATION

The following table provides an overview of the modified schedule for the Fire Effects Study.

Task	Task Description	Original Completion Date	Modified Completion Date
1	Project Management and Client Meetings	Ongoing	Extend through December 2025
2	Develop Work Plan (final work plan)	April 2022	Revised Work Plan August 2024
3	Regulatory Support	November 2024	Extend through December 2025
4	Wet Weather Monitoring	October 2022-October 2023 October 2023-October 2024	Extend through April 2024 [a]
5	Dry Weather Monitoring	May 2022-May 2023 May 2023-May 2024	Extend through September 2024[a]
6	Interim Report	November 2023	No change
7	Data Analysis and Modeling	May 2022- September 2024	Extend through September 2025
8	Final Report	November 2024	Extend through November 2025

Notes:

a. The Wet Season in the region is defined as October 1 through April 30, annually. Dry Season is defined as May 1 through September 30, annually. To adhere to the proposed project end data, Wet Weather and Dry Weather monitoring activities would target events during the regional wet and dry seasons to receive analytical results in time to be integrated into the Study models.

BUDGET MODIFICATION

Table 2. ULAR and Rio Hondo WMG Fire Study Cost Estimate

Task No.	Task Description	WASC	Original Budget	Additional Budget	Total
1	Project Management and Client Meetings	Rio Hondo	$9,044	$4,155	$13,199
		Upper Los Angeles River	$30,276	$13,911	$44,187
2	Develop Work Plan	Rio Hondo	$22,547	$2,295	$24,842
		Upper Los Angeles River	$75,483	$7,685	$83,168
3	Regulatory Support	Rio Hondo	$11,859	$6,211	$18,070
		Upper Los Angeles River	$39,701	$20,793	$60,494
4	Wet Weather Monitoring	Rio Hondo	$38,629	$20,553	$59,182
		Upper Los Angeles River	$129,322	$68,810	$198,132
5	Dry Weather Monitoring	Rio Hondo	$22,100	$3,250	$25,350
		Upper Los Angeles River	$73,986	$10,881	$84,867
6	Interim Report	Rio Hondo	$12,464	$0	$12,464
		Upper Los Angeles River	$41,726	$0	$41,726
7	Data Analysis and Modeling	Rio Hondo	$40,186	$51,520	$91,706
		Upper Los Angeles River	$134,534	$172,480	$307,014
8	Final Report	Rio Hondo	$28,323	$7,976	$36,299
		Upper Los Angeles River	$94,820	$26,704	$121,524
Total		**Rio Hondo**	**$185,150**	**$95,962**	**$281,112**
		Upper Los Angeles River	**$619,850**	**$321,262**	**$941,112**

ATTACHMENT A: Project Modification Request (PMR) FORM

The purpose of this PMR form is to initiate the Project modification process and provide the District with information necessary to evaluate the Project modification request.

Regional Program	☐Infrastructure Program Project ☑Scientific Studies Program ☐Technical Resources Program
Project/Study Name	preSIP: A Platform for Watershed Science and Collaboration
Project/Study Lead	San Gabriel Valley Council of Governments
Watershed Area(s)	Upper Los Angeles River, Rio Hondo
Current Project Phase	Finalization
Approved Stormwater Investment Plan Fiscal Year	FY22/23
Transfer Agreement ID (e.g., 2020RPULAR52)	2020RPRH51 & 2020RPULAR51

Has Transfer Agreement or most recent Addendum been executed (i.e., signed by the project lead and the District)? ☑ Yes ☐ No

What type(s) of modification request?

☐ like-for-like modifications

☐ functionally equivalent BMP modifications

☐ modifications to Project or Study components that were not material to the WASC, ROC, or Board's decision to include the Project or Study in the SIP

☐ minor modifications to the budget or schedule of intermediate tasks where the total Funded Activity amount and Funded Activity completion date is unchanged

☐ change in primary or secondary objective

☑ change in Project benefits

☐ change in methodology (e.g., infiltration instead of diversion to sanitary sewer)

☐ decrease in BMP capacity

☐ change in Project or Study location

☐ change in capture area where benefits claimed are diminished or where there is a change in the municipalities that are receiving benefits

☐ updated engineering analysis resulting in a reduction of benefits claimed

☐ increase in Construction Cost or Life Cycle Cost greater than 10%

☑ increase or reallocation of annual funding distribution

☐ change in Funded Activity completion date

☐ other, please describe:

Impact on scope or benefits?

☑ Improved
☐ Neither
☐ Diminished
☐ Not Sure

Description of the proposed modification(s) and the reason(s) why the modification(s) is/are being proposed.

The preSIP scientific study accomplished its goals of (1) engaging watershed partners, (2) identifying hundreds of high-impact project opportunities, (3) articulating alternative multi-benefit pathways to clean water, and (4) building out a digital platform to coordinate, track, and adapt in real-time. The study benefits have been lauded by Watershed Coordinators and received notoriety at national conferences. If programatically implemented, the preSIP outcomes could reimagine watershed programs and drastically reduce costs to achieve compliance with the MS4 Permit (which would, in turn, free up resources for other multi-benefit, nature-based, and community-benefiting projects).

When presenting preSIP study progress to the Upper LA River WASC, the WASC acknowledged the implications of the study on regional compliance planning and recommended that the study re-engage with Regional Board staff to validate study methodology and outcomes. Members of the preSIP Technical Advisory Committee (TAC) agree with this recommendation and additionally advised the study team to further validate the preSIP modeling approach through external independent review. Additionally, members of the TAC see the value in funding ongoing support and maintenance of the digital platform that was developed by the study to track and adapt stormwater project implementation planning across the ULAR and RH watersheds. There is a need to invest in the institutionalization of the preSIP's valuable products to maximize the use and impact of the study.

This Project Modification requests additional funding to extend the project by three years to support implementation and pursue the recommendations of the WASC and TAC. Extending the study enables the Watershed Group to integrate the use of the preSIP tools into their daily processes and also socialize the outcomes with their respective external stakeholders, including the Regional Board. The requested additional funding would specifically support ongoing engagement with Regional Board staff, engagement of an independent peer reviewer to examine model methods and results, update of models and tools based on comments from reviewers, and ongoing support and maintenance of the preSIP digital platform.

If applicable, list previously approved funding allocations/disbursements and revised funding request:

Note, if some or all of a previously Funded Activity cannot be completed as a result of the proposed modification, please include a description and indicate the amount of unused funds. Any unused funds should be reallocated and accounted for in your revised funding request.

Fiscal Year	Approved Funding Allocations	Revised Funding Request	Description/Phase *If applicable, include description of unused funds*
21-23	$2,340,000	$0	
24-25	$0	$73,500	
25-26	$0	$73,500	
26-27	$0	$73,500	
Future Funding			
TOTAL	$2,340,000	$220,500	

A: SCWP Approved Total Funding Allocations	$2,340,000
B: Revised SCWP Anticipated Total Funding Request	$2,560,500
C: Difference between B and A	$220,500

If applicable, description of difference in SCWP Anticipated Total Funding Request. As a reminder, annual funding is at the discretion of the WASC, ROC, and ultimately the Board of Supervisors.

As noted above, the additional requested funding would support implementation and pursue the recommendations of the WASC and TAC. Extending the study enables the Watershed Group to integrate the use of the preSIP tools into their daily processes and also socialize the outcomes with their respective external stakeholders, including the Regional Board. The requested additional funding would specifically support ongoing engagement with Regional Board staff, engagement of an independent peer reviewer to examine model methods and results, update of models and tools based on comments from reviewers, and ongoing support and maintenance of the preSIP digital platform.

Brief description of Supporting Documentation provided.

Revised Scope of Work.

I certify the information and supporting documentation provided is accurate and true.	☑ YES
I understand this is a request and it is under the WASC's discretion to consider requested modifications.	☑ YES

Name Marisa Creter

Organization San Gabriel Valley Council of Governments

Signature Marisa Creter

Date 11/30/2023

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Proposed Modifications to Projects or Studies:

	Status	Date
Modified Project or Study is **consistent** with the Project or Study included in the current fiscal year's SIP and proposed modifications were **approved** by the District.	☐ YES	
Modified Project or Study is **NOT consistent** with the Project or Study included in the current fiscal year's SIP. **If yes, select all that apply**:	☐ YES	
PMR was received **after** October 31 of a fiscal year and the PMR will be considered for approval during the preparation of **subsequent** SIP for the fiscal year after the next	☐ YES	-
For Infrastructure Program Projects, modified Project was sent to **Scoring Committee**. If yes, revised score:	☐ YES	
Project or Study **abandoned** the proposed modifications	☐ YES	
Projector or Study was **withdrawn** from consideration by the WASC and shall issue repayment of unspent funds	☐ YES	
Proposed modifications were **recommended for approval** in the SIP	☐ YES ☐ NO	

Proposed Modifications to Project Concepts:

	Status	Date
Proposed modifications were deemed **consistent** with the Project concept that was approved by the WASC, ROC and Board for inclusion in the SIP and can be addressed within the existing budget. District will proceed to incorporate the proposed modification into the Feasibility Study immediately.	☐ YES	
Proposed modifications were deemed significant enough to result in a **significantly different** Project concept from the one approved by the WASC, ROC and Board for inclusion in the SIP. **If yes, select one:**	☐ YES	
District to **discontinue** work on the Feasibility Study, return unused funds to be programmed in the SIP for the next fiscal year, and advise the proponent to submit the modified Project concept during the Call for Projects for a future fiscal year.	☐ YES	-
District to **abandon** the proposed modifications and proceed with the Project concept included in the SIP.	☐ YES	-

SCOPE OF WORK

The massive extent of area and stakeholders in the ULAR watershed means that there are numerous intertwined goals, ideas, and programs that must be reconciled by the WASCs as they develop SIPs. With so many diverse Regional Program stakeholders and project proposals to consider, the ULAR/RH WASCs will be challenged to reconcile these diverse needs into cohesive SIPs that reliably support EWMP implementation and measurable clean water objectives. Furthermore, the current WASC guidelines for SIP development are open to significant interpretation and do not provide a detailed structured technical approach to coordinate regional SIPs with other efforts.

The goal of the preSIP study is therefore to provide the ULAR Group and ULAR/RH WASCs with a technical platform to:

- build a balanced SIP that maximizes SCWP objectives at the watershed-scale (particularly meaningful water quality improvement at a watershed scale),
- build a cost-effective SIP that is defensible to taxpayers who voted for clean water, and
- build a collaborative SIP that complements concurrent ULAR Group spending and activities.

This will be accomplished through the following tasks.

TASK 1: PROJECT MANAGEMENT

Project management and financial controls will be maintained with the Flood Control District. This task includes providing quarterly reports, which will also be summarized in an annual report. Reports will provide an update on progress and outcomes on the following tasks. This task also includes monthly coordination meetings with a Stakeholder Group of ULAR EWMP members, NGOs, and water agencies to be established in Task 2 below.

Deliverables:

- Quarterly Reports
- Annual Reports
- Monthly Progress Meetings with Stakeholder Subcommittee

TASK 2: DEFINE GOALS, OBJECTIVES, AND METRICS

To set appropriate objectives and build a robust compliance road map founded in science, engineering, and stakeholder preferences, it will be necessary to apply recent lessons learned from adaptive management of the ULAR (and other) EWMPs; these include (but are not limited to): updating water quality analysis assumptions and interpretations to better align with observed watershed data and the latest regulatory trends, facilitating true regional collaboration between municipalities by dissolving jurisdictional boundaries, and reimagining how watershed project portfolios can by augmented by—and dovetail with—water supply programs to reduce overall program efficiency. Orienting the SIP around a collaborative, science-based compliance pathway will directly support local agencies, but will also reassure wary stakeholders who have previously expressed concerns about the certainty and specificity of the EWMPs.

Using the most up-to-date watershed data, models, and scientific understanding, the ULAR EWMP Group will work with the Stakeholder Group to develop specific goals for success. These goals will supplement existing Infrastructure Program scoring criteria with *higher-resolution, site-specific metrics* to ensure that the SIP is meaningfully judged against the goals relevant to local communities, ecosystems, and MS4 permit compliance. For example, the specific pollutant load reduction targets and water supply augmentation goals will be characterized to set measurable benchmarks by which SIP performance can be gauged over time at the watershed scale. This will provide a compass to steer the ULAR Group towards projects *where* they are needed and will provide a gauge for the ULAR/RH WASCs to self-evaluate the overall success of the SIP once those projects are plugged into the watershed.

To set quantitative goals for water quality and water supply, the ULAR Group will leverage and update the ULAR EWMP watershed model (which is being updated for 2021 EWMP revisions). Because the current modeling system is configured to evaluate water quality at the jurisdictional- and *subwatershed*-scale, the model will be recalibrated using the most recently available local data to provide a reliable foundation for project performance assessment at a truly *watershed* scale. Then, meaningful watershed-wide goals will be computed to supplement the subwatershed-scale recommendations provided in the EWMP.

This task also includes establishment of, and coordination with, a group of municipal, NGO, and water agency stakeholders. Two workshops will be conducted to first kick-off the study and clarify local needs, and then work with the Stakeholder Group to review watershed priorities.

Deliverables:

- Stakeholder Group Workshop – Study Kickoff
- Watershed Model Recalibration Memo
- Draft Watershed Area Priorities Report
- Stakeholder Group Workshop – Watershed Priorities
- Final Watershed Area Priorities Report

TASK 3: IDENTIFY AND RECONCILE WATERSHED-WIDE OPPORTUNITIES

A key objective of the preSIP study is to compile an inventory of project opportunities (both planned and currently unknown) throughout the entirety of the ULAR/RH Watershed Areas. This will provide the necessary baseline of candidates to enable the WASCs to confidently select the “best projects” when building their SIPs, and to ensure that local municipalities have a high-certainty hopper of projects to implement their EWMPs.

This step will adapt specialized tools and models—previously forged and validated by the ULAR Watershed Group using watershed science and engineering—for Watershed-Area-wide application. The investigators will pair these tools with high-resolution datasets and an existing literature review of over 100 plans and 300 stakeholders to identify the full suite of known project opportunities watershed wide. This will ensure that SIP development is driven by a real understanding of the range of project opportunities in the context of already-planned EWMP projects (to provide valuable context for those submitted by project advocates). It will also help the ULAR Group understand how similar or proximal projects might be potentially bundled for collective efficiency and to reduce redundancy before submittal to the WASC for funding.

Stakeholder engagement with the Stakeholder Group will continue to be a critical element throughout the project to ensure that the ultimate results meet EWMP and SCWP goals. Once the initial list of project opportunities is built, it will be loaded into a web-based mapping tool for review by the ULAR Group and Stakeholder Group. A workshop will then be conducted to review the list of opportunities and discuss the menu of potential project types that should be considered at the sites.

Deliverables:

- Inventory of Existing/Planning Projects (Memo and Web Map Link)
- Stakeholder Group Workshop – Existing/Planned Project Inventory Review and Project Screening Menu Development
- Project Screening Methods Memo

- Link to Web Map of Consolidated Opportunities
- Final Link to Web Map of Consolidated Opportunities

TASK 4: DESIGN A TECHNICAL PLATFORM TO ASSESS ALTERNATIVE SIP SCENARIOS AND BENEFITS

Once meaningful, measurable goals are defined and a full roster of achievable projects is established, then these components can be combined into a system that will enable the ULAR Group and ULAR/RH WASC to scenario-play various alternative combinations of projects in a watershed context to build their best SIP. The platform will also provide the ULAR watershed group with a tool to adaptively manage their EWMP on-the-fly.

A key advantage of this platform is that it is a decision support tool and will allow flexibility to adapt the SIP over time as new information is discovered and as EWMP implementation evolves; to be clear, the preSIP outcomes will certainly not generate and prescribe a SIP, but rather will give the WASC necessary, data-driven tools to confidently build and test different alternatives that align with ULAR EWMP goals. By conducting the analysis at the watershed scale, it will enable projects that are networked in series (i.e., upstream/downstream from each other) to be analyzed synergistically.

A final workshop will be conducted with the Stakeholder Group to review the draft preSIP platform and discuss what analytics are useful for analyzing alternative watershed programs.

Deliverables:

- Stakeholder Group Workshop – preSIP platform
- Draft Link to preSIP Platform
- Final Link to preSIP Platform

TASK 5: ONGOING ENGAGEMENT AND IMPLEMENTATION

If programatically implemented, the preSIP outcomes could reimagine watershed programs and drastically reduce costs to achieve compliance with the MS4 Permit (which would, in turn, free up resources for other multi-benefit, nature-based, and community-benefiting projects).

When presenting preSIP study progress to the Upper LA River WASC, the WASC acknowledged the implications of the study on regional compliance planning and recommended that the study re-engage with Regional Board staff to validate study methodology and outcomes. Members of the preSIP Technical Advisory Committee (TAC) agree with this recommendation and additionally advised the study team to further validate the preSIP modeling approach through external independent review. Additionally, members of the TAC see the value in funding ongoing support and maintenance of the digital platform that was developed by the study to track and adapt stormwater project implementation planning across the ULAR and RH watersheds.

This task supports ongoing engagement and implementation for three years to address the recommendations of the WASC and TAC. The specific scope includes up to six engagement meetings with Regional Board staff to pursue validation of preSIP modeling methods and results, engagement of an independent peer reviewer to examine model methods and results, update of models and tools based on comments from reviewers, and ongoing support and maintenance of the preSIP digital platform.

Deliverables:

- Regional Board Engagement Meetings (6)
- Independent Peer Review of preSIP Model Setup and Outputs

- Updated Model Calibration Memo (Draft and Final)
- Annual Digital Platform Maintenance (3 years)

STUDY BENEFITS AND SCW PROGRAM GOALS

Simply put, the ULAR Group and ULAR/RH WASCs can expect the following tangible and valuable outcomes from this scientific study:

- **a comprehensive list of candidate SIP projects (including coordination of Regional Program project submittals with the EWMP and other concurrent local programs), and**
- **a platform to validate that the SIP maximizes SCWP objectives at the watershed scale, including flexibility to adapt the SIP over time.**

While these outcomes will be useful for the ULAR/RH WASC as they develop SIPs into perpetuity by providing certainty that projects being put in the ground will deliver the desired outcomes, the framework will also serve as a valuable template for other WASCs and EWMP Groups to emulate as they build concurrent programs.

This scientific study uniquely addresses and advances all of the goals of the SCWP by enabling the ULAR Group to conduct a "programmatic feasibility study" and test their proposed SIPs to ensure—using watershed science—that they appropriately balance water quality improvement, water supply augmentation, community investments, and nature-based solutions, while effectively leveraging local support and funds. The primary metrics for success of the study are the successful completion of the specified deliverables with the support of the WASC stakeholders.

The following summarizes how the study will address a number of the SCW Program goals (Chapter 18.04 of the Code):

A. **Improve water quality and contribute to attainment of water-quality requirements:** The study will progress the ULAR Group towards attainment of water quality objectives by identifying cost-effective strategies and understanding in what order they should be implemented to efficiently improve water quality.
B. **Increase drought preparedness by capturing more Stormwater and/or Urban Runoff to store, clean, reuse, and/or recharge groundwater basins:** The study will evaluate how investments in water supply augmentation can be coordinated with water quality improvement and community benefits at the watershed scale
C. **Improve public health by preventing and cleaning up contaminated water, increasing access to open space, providing additional recreational opportunities, and helping communities mitigate and adapt to the effects of climate change through activities such as increasing shade and green space:** By engaging with the WASC stakeholder groups, the study will produce project recommendations that are actually wanted and needed by local communities
D. **Leverage other funding sources to maximize SCW Program Goals:** The ULAR Group has already invested $105,000 to validate these methods in a pilot area; the preSIP will also identify how additional partners can be engaged at the watershed-scale to potentially co-funding multi-benefit projects.
E. **Invest in infrastructure that provides multiple benefits:** a primary goal of the preSIP is to develop a value system to prioritize projects in a way that meets the multiple goals of the WASC stakeholder groups, while also integrating with the ULAR EWMP goals.
F. **Prioritize Nature-Based Solutions**: by building the list of candidate projects from the ground up in collaboration with stakeholders, the preSIP study will ensure that locally desired project types and benefits are considered

G. **Provide a spectrum of project sizes from neighborhood to regional scales:** by building the list of candidate projects from the ground up in collaboration with stakeholders, the preSIP study will ensure that locally desired project sizes are considered
H. **Encourage innovation and adoption of new technologies and practices:** This study is applying significant advances in the scientific understanding of watershed science, and uniquely linking those to a stakeholder feedback loop so that multi-benefit planning can be accelerated
I. **Invest in independent scientific research:** although the preSIP concept has been proven in pilot areas of the ULAR watershed, this study will provide regional value by demonstrating how watershed science can be used to enhance SCWP goals
J. **Provide DAC Benefits:** prioritization of projects will be configured such that DAC benefits can be more easily evaluated
K. **Provide Regional Program infrastructure funds benefiting each Municipality in proportion to the funds generated in their jurisdiction:** by enabling scenario-play, the preSIP will enable municipalities to evaluate investments individually or collectively at the watershed scale
L. **Implement an iterative planning and evaluation process to ensure adaptive management:** The Plan itself is adaptive management of the ULAR Groups current strategy.
M. **Promote green jobs and career pathways:** the preSIP will give the WASCs and ULAR group a structured technical platform to evaluate different scales and types of projects in different locations throughout the watershed; this can enable assessment of future green job potential watershed wide
N. **Ensure ongoing operations and maintenance for projects:** by gaining a better understanding of the longer-term roadmap of potential projects, municipalities and project proponents can begin to budget and plan for ongoing O&M resources

BUDGET

Table 1 summarizes the budget by task, fiscal year, and watershed area. The fee proposal is made on a firm-fixed price basis, to be invoiced monthly based on percentage complete of each task.

Table 1. Scientific Study Budget

Task		20-21		21-22		22-23		24-25		25-26		26-27		Subtotals		Grand Total by Task
		ULAR	RH	ULAR	RH	ULAR	RH	ULAR	RH	ULAR	RH	ULAR	RH	ULAR	RH	
1	Project Management	$70,000	$21,000	$70,000	$21,000	$40,000	$12,000	--	--	--	--	--	--	$180,000	$54,000	**$234,000**
2	Define Goals, Objectives, Metrics	$105,000	$31,500	$70,000	$21,000	--	$0	--	--	--	--	--	--	$175,000	$52,500	**$227,500**
3	Identify and Reconcile Watershed-Wide Opportunities	$525,000	$157,500	$455,000	$136,500	--	$0	--	--	--	--	--	--	$980,000	$294,000	**$1,274,000**
4	Design Technical Platform	--	--	$105,000	$31,500	$360,000	$108,000	--	--	--	--	--	--	$465,000	$139,500	**$604,500**
5	Ongoing Engagement and Implementation	--	--	--	--	--	--	$56,540	$17,010	$56,540	$17,010	$56,540	$17,010	$169,470	$51,030	**$220,500**
	Subtotals	**$700,000**	**$210,000**	**$700,000**	**$210,000**	**$400,000**	**$120,000**	**$56,540**	**$17,010**	**$56,540**	**$17,010**	**$56,540**	**$17,010**	**$1,969,470**	**$591,030**	**$2,560,500**
	Grand Total by Year	**$910,000**		**$910,000**		**$520,000**		**$73,500**		**$73,500**		**$73,500**				

SCHEDULE

The following schedule assumes a Notice to Proceed (NTP) of December 1, 2020. Given the delay in the anticipated funding for the first fiscal year, the required reporting begins with the Second Quarter and only includes three of the quarterly reports given the condensed timeline. The schedule is summarized in Table 2.

Table 2. Scientific Study Schedule

Task	Task Name	Completion Date
n/a	Assumed NTP	December 1, 2020
1	Stakeholder Group Coordination Meetings	Monthly
2	Stakeholder Group Workshop – Study Kickoff	January 31, 2021
1	Quarterly Report	February 15, 2021
2	Watershed Model Recalibration Memo	May 31, 2021
1	Quarterly Report	May 15, 2021
2	Draft Watershed Area Priorities Report	June30, 2021
2	WASC Stakeholder Workshop – Goal Setting	July31, 2021
1	Quarterly Report	August 15, 2021
2	Final Watershed Area Priorities Report	September 30, 2021
3	Stakeholder Group Workshop – Existing/Planned Project Inventory Review and Project Screening Menu Development	October 31, 2021
3	Inventory of Existing/Planning Projects (Memo and Web Map Link)	October 31, 2021
1	Quarterly Report	November 15, 2021
3	Project Screening Methods Memo	December 31, 2021
1	Annual Report	December 31, 2021
1	Quarterly Report	February 15, 2022
3	Link to Web Map of Consolidated Opportunities	February 28, 2022
1	Quarterly Report	May 15, 2022
3	Final Link to Web Map of Consolidated Opportunities	June 30, 2022
4	Stakeholder Group Workshop – preSIP platform	June 30, 2022
1	Quarterly Report	August 15, 2022
1	Quarterly Report	November 15, 2022
1	Annual Report	December 31, 2022
4	Draft Link to preSIP Platform	May 25, 2023
1	Quarterly Report	February 15, 2023
1	Quarterly Report	May 15, 2023
4	Final Link to preSIP Platform	October 31, 2023

Task	Task Name	Completion Date
5	Maintenance, updates, and web hosting of preSIP digital platform software (Year 1)	April 30, 2025
5	Regional Board Meeting 1	April 30, 2025
5	External Peer Review Summary	September 31, 2025
5	Regional Board Meeting 2	October 31, 2025
5	Draft Model Calibration Memo	January 31, 2026
5	Maintenance, updates, and web hosting of preSIP digital platform software (Year 2)	April 30, 2026
5	Regional Board Meeting 3	April 30, 2026
5	Regional Board Meeting 4	October 31, 2026
5	Maintenance, updates, and web hosting of preSIP digital platform software (Year 3)	April 30, 2027
5	Regional Board Meeting 5	April 30, 2027
5	Final Model Calibration Memo	June 31, 2027
5	Regional Board Meeting 6	October 31, 2027

ATTACHMENT A: Project Modification Request (PMR) FORM

The purpose of this PMR form is to initiate the Project modification process and provide the District with information necessary to evaluate the Project modification request.

Regional Program	☐Infrastructure Program Project ☑Scientific Studies Program ☐Technical Resources Program
Project/Study Name	preSIP: A Platform for Watershed Science and Collaboration
Project/Study Lead	San Gabriel Valley Council of Governments
Watershed Area(s)	Upper Los Angeles River, Rio Hondo
Current Project Phase	Finalization
Approved Stormwater Investment Plan Fiscal Year	FY22/23
Transfer Agreement ID (e.g., 2020RPULAR52)	2020RPRH51 & 2020RPULAR51

Has Transfer Agreement or most recent Addendum been executed (i.e., signed by the project lead and the District)? ☑ Yes ☐ No

What type(s) of modification request?

☐ like-for-like modifications

☐ functionally equivalent BMP modifications

☐ modifications to Project or Study components that were not material to the WASC, ROC, or Board's decision to include the Project or Study in the SIP

☐ minor modifications to the budget or schedule of intermediate tasks where the total Funded Activity amount and Funded Activity completion date is unchanged

☐ change in primary or secondary objective

☐ change in Project benefits

☐ change in methodology (e.g., infiltration instead of diversion to sanitary sewer)

☐ decrease in BMP capacity

☐ change in Project or Study location

☐ change in capture area where benefits claimed are diminished or where there is a change in the municipalities that are receiving benefits

☐ updated engineering analysis resulting in a reduction of benefits claimed

☐ increase in Construction Cost or Life Cycle Cost greater than 10%

☐ increase or reallocation of annual funding distribution

☑ change in Funded Activity completion date

☐ other, please describe:

Impact on scope or benefits?

☐ Improved
☐ Diminished
☑ Neither
☐ Not Sure

Description of the proposed modification(s) and the reason(s) why the modification(s) is/are being proposed.

The preSIP Study completion date was previously modified to September 30, 2023, in the Quarterly Report for FY22/23 Q3. The previous modification was made due to delay in receipt of funding for both the first and the final fiscal year of study. This Project Modification Request is to extend the study completion date for the currently funded activities by one additional month to October 31, 2023, to provide additional time for study finalization due to the previous funding delays.

If applicable, list previously approved funding allocations/disbursements and revised funding request:

Note, if some or all of a previously Funded Activity cannot be completed as a result of the proposed modification, please include a description and indicate the amount of unused funds. Any unused funds should be reallocated and accounted for in your revised funding request.

Fiscal Year	Approved Funding Allocations	Revised Funding Request	Description/Phase *If applicable, include description of unused funds*
Future Funding			
TOTAL			

NOT APPLICABLE

A: SCWP Approved Total Funding Allocations	NOT APPLICABLE
B: Revised SCWP Anticipated Total Funding Request	
C: Difference between B and A	

If applicable, description of difference in SCWP Anticipated Total Funding Request. As a reminder, annual funding is at the discretion of the WASC, ROC, and ultimately the Board of Supervisors.

Not applicable.

Brief description of Supporting Documentation provided.

Revised Schedule A10 included.

I certify the information and supporting documentation provided is accurate and true.	☑ YES
I understand this is a request and it is under the WASC's discretion to consider requested modifications.	☑ YES

Name Marisa Creter

Organization San Gabriel Valley Council of Governments

Signature Marisa Creter

Date 11/30/2023

FOR DISTRICT USE ONLY

Proposed Modifications to Projects or Studies:

	Status	Date
Modified Project or Study is **consistent** with the Project or Study included in the current fiscal year's SIP and proposed modifications were **approved** by the District.	☐ YES	
Modified Project or Study is **NOT consistent** with the Project or Study included in the current fiscal year's SIP. **If yes, select all that apply**:	☐ YES	
PMR was received **after** October 31 of a fiscal year and the PMR will be considered for approval during the preparation of **subsequent** SIP for the fiscal year <u>after</u> the next	☐ YES	-
For Infrastructure Program Projects, modified Project was sent to **Scoring Committee**. If yes, revised score:	☐ YES	
Project or Study **abandoned** the proposed modifications	☐ YES	
Projector or Study was **withdrawn** from consideration by the WASC and shall issue repayment of unspent funds	☐ YES	
Proposed modifications were **recommended for approval** in the SIP	☐ YES ☐ NO	

Proposed Modifications to Project Concepts:

	Status	Date
Proposed modifications were deemed **consistent** with the Project concept that was approved by the WASC, ROC and Board for inclusion in the SIP and can be addressed within the existing budget. District will proceed to incorporate the proposed modification into the Feasibility Study immediately.	☐ YES	
Proposed modifications were deemed significant enough to result in a **significantly different** Project concept from the one approved by the WASC, ROC and Board for inclusion in the SIP. **If yes, select one:**	☐ YES	
District to **discontinue** work on the Feasibility Study, return unused funds to be programmed in the SIP for the next fiscal year, and advise the proponent to submit the modified Project concept during the Call for Projects for a future fiscal year.	☐ YES	-
District to **abandon** the proposed modifications and proceed with the Project concept included in the SIP.	☐ YES	-

Table 2. Scientific Study Schedule

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